FINAL

Focused Feasibility Study Report

Upper Basin of the Coeur d'Alene River, Bunker Hill Mining and Metallurgical Complex Superfund Site

Volume 1

Addendum to the Draft Final Report, Executive Summary, and Main Text

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Addendum to the Draft Final Focused Feasibility Study Report, Upper Basin of the Coeur d'Alene River

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1.0 Overview

This Addendum to the *Draft Final Focused Feasibility Study* [FFS] *Report, Upper Basin of the Coeur d'Alene River, Bunker Hill Mining and Metallurgical Complex Superfund Site*, supplements the Draft Final FFS Report. Collectively, this Addendum and the Draft Final FFS Report provide the feasibility study analysis that supports the draft Selected Remedy for an Interim Record of Decision (ROD) Amendment for the Upper Basin of the Coeur d'Alene River (hereafter referred to as "the draft Selected Remedy"). The combination of this Addendum and the Draft Final FFS Report constitutes the Final FFS Report for the Upper Basin. This Addendum also documents and provides the rationale for differences between the draft Selected Remedy and the Preferred Alternative that was identified in the *Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Mining and Metallurgical Complex Superfund Site* (EPA, 2010).

This Addendum is intended to serve as a bridge between Remedial Alternative 3+(d) in the Draft Final FFS Report and the draft Selected Remedy by describing the differences between the two, presenting the reasons for those differences and, where appropriate, providing supporting technical documentation. The Draft Final FFS Report has not been revised to reflect the draft Selected Remedy and the differences between the draft Selected Remedy and Remedial Alternative 3+(d).

Remedial Alternative 3+(d) (hereafter referred to as "Alternative 3+(d)" in this Addendum) was EPA's Preferred Remedial Alternative in the Proposed Plan (EPA, 2010). In consideration of public and stakeholder comments on the Upper Basin Proposed Plan, and using additional information developed by EPA, EPA has reduced the scope of the draft Selected Remedy and is not including all of the remedial actions that were presented in Alternative 3+(d) in the Draft Final FFS Report (and in the Preferred Remedial Alternative in the Proposed Plan). The remedial actions included in the draft Selected Remedy are expected to result in the achievement of cleanup levels for soil and sediments where actions are taken, and to result in significant improvements to surface water and groundwater quality, but the draft Selected Remedy is not expected to fully address surface water or groundwater contamination at all locations in the Upper Basin. Thus, the draft Selected Remedy is an interim remedy for the Upper Basin. Consistent with 40 *Code of Federal Regulations* (CFR) 300.430(a)(ii)(B) and 40 CFR 300.430(f)(1)(ii)(C)(1), the draft Selected Remedy is neither inconsistent with nor precludes implementation of a final remedy that will attain applicable and relevant or appropriate requirements (ARARs). The final remedy will be identified in subsequent decision documents.

Both the Draft Final FFS Report and the draft Selected Remedy include remedial actions and remedy protection actions to be taken in the Upper Basin. The remedy protection actions are the same in the draft Selected Remedy as they are in Alternative RP-2, as presented in the Draft Final FFS Report and the Proposed Plan. The most significant differences between Alternative 3+(d) and the draft Selected Remedy include:

- Reduction in the scope of Alternative 3+,the Operable Unit 3 (OU 3) component of Alternative 3+(d), including reduction of the number of mine and mill sites from 345 to 145;
- Changes to remedial actions including (1) changes to groundwater collection and treatment actions between Wallace and Elizabeth Park, and (2) updates to typical conceptual designs (TCDs) and waste removal quantities for sites in Ninemile Creek based on additional site characterization work; and
- Changes to stream and riparian cleanup actions included in Alternative 3+(d).

Sections 2.0 through 4.0 summarize these changes to Alternative 3+(d) as presented in the Draft Final FFS Report. Section 5.0 lists additional updated information that has become available since the publication of the Draft Final FFS Report.

2.0 Reduction in Scope from Alternative 3+(d) to the Draft Selected Remedy

Alternative 3+(d) previously included remedial actions at 345 mine and mill sites[1] located in the Upper Basin that would be required to meet cleanup goals based on available data and predictions of the effectiveness of the cleanup. It is important to note that these 345 mine and mill sites did not include the groundwater-based remedial actions in OU 2 that are not associated with specific mine and mill sites. No changes were made to the OU 2 groundwater collection and treatment actions included in Alternative 3+(d). Upon consideration of comments received on the Proposed Plan expressing concern about the cost and duration of the Upper Basin cleanup, EPA decided to reduce the number of mine and mill sites addressed by the draft Selected Remedy. Table 1 provides a list of every OU 3 mine and mill site included in Alternative 3+(d) in the Draft Final FFS Report, and identifies the sites retained for remedial action in the draft Selected Remedy and a rationale for each site that is no longer included in the draft Remedy.[2]

First, in developing the draft Selected Remedy for the Upper Basin, EPA made the following changes from Alternative 3+(d) as presented in the Draft Final FFS Report:

- **Removal of the Lucky Friday Complex.** The draft Selected Remedy does not include remedial actions for the Lucky Friday Complex (an active facility owned by Hecla Mining Company) that were previously included in Alternative 3+(d). Lucky Friday sites included in Alternative 3+(d) but not in the draft Selected Remedy are MUL037, MUL038, MUL058, and MUL131.
- **Changes Based on Additional Mine and Mill Site Characterization**. Following consideration of public and stakeholder comments received on the Proposed Plan, during the summer of 2011 EPA conducted additional characterization of some lower-priority sites. These sites were deemed to be of low priority on the basis of site-specific data, downstream water quality at or near ambient water quality criteria (AWQC), or both. As a result of this focused characterization sampling, 42 sites where contaminant concentrations in soil samples were found to be below screening levels are not included

[1] The Draft Final FFS Report states that Alternative 3+ includes 348 mine and mill sites. This total erroneously includes three sites in Canyon Creek (WAL007, WAL008, and WAL012) that are in Alternative 4+ but not in Alternative 3+. Therefore, the correct number of sites in Alternative 3+ is 345.

[2] The tables referenced in the main text of this Addendum are provided following Section 6.0, References, and precede the attachments.

in the draft Selected Remedy. The sites that were included in Alternative 3+(d) but are not included in the draft Selected Remedy are listed in Table 2. The Technical Memorandum (TM) provided as Attachment 1 to this Addendum[3] provides additional details of these changes and the focused characterization sampling that led to them.

In addition, following conclusion of the Proposed Plan comment period, EPA worked with the Basin Environmental Improvement Project Commission's Upper Basin Project Focus Team (PFT) to categorize sites included in Alternative 3+(d) based on available analytical data, field observations, historical information, current status, and other site knowledge. Some sites were categorized as active facilities and previously remediated sites. EPA decided to remove these sites from the draft Selected Remedy based on the following rationale:

- **Active Facility Sites**. These are sites where industrial and/or commercial activities are currently occurring. At some of these sites, access controls and/or protective barriers installed consistent with the Institutional Control Program (ICP) administered by the Panhandle Health District are in place that prevent or minimize direct contact with source materials. In addition to the presence of in-place measures to reduce direct-contact risk, the active sites are typically overseen by regulatory agencies outside the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Therefore, regulatory methods outside CERCLA are available to address the potential release of contaminants that may pose risks to human health and the environment. If these other regulatory programs fail to adequately address these sites or if sites are closed or are no longer active, EPA will need to evaluate whether cleanup actions are necessary to address contamination in the future. Nineteen (19) sites were identified as active facilities and are not included in the draft Selected Remedy.
- **Remediated Sites**. Over time, cleanup actions have been conducted by EPA, other agencies, and property owners within the Upper Basin. The majority of actions taken at these sites focused on human health risks, but in some cases additional actions were taken to reduce contaminant loading to surface water and groundwater. Currently, sites where cleanup actions have been conducted are being monitored to determine their effectiveness in meeting remedial action objectives (RAOs). Review of the monitoring results and the protectiveness of these cleanup actions is documented in Five-Year Review Reports consistent with CERCLA and the 2002 ROD for OU 3 (EPA, 2002). Potential shortcomings of these cleanup actions in achieving RAOs and protection of human health and the environment will be addressed as part of the Five-Year Review process. Twenty-five (25) sites where cleanup has already occurred were identified as remediated sites and are not included in the draft Selected Remedy.

With input from the Upper Basin PFT, the remaining sites were categorized as either "strong consensus" or "contingent." Strong consensus sites were defined as sites having available information confirming substantial risks to human health and the environment from mining-related contamination. The contingent sites had limited information available regarding potential risks to human health and the environment. EPA conducted a desktop data review evaluation to determine which contingent sites would not be included in the draft Selected Remedy. This review resulted in the list of sites included in the draft Selected Remedy and the elimination of the former site categories of strong consensus and

[3] CH2M HILL, May 25, 2012. *Technical Memorandum: Upper Coeur d'Alene Basin 2011 Focused Characterization Sampling: Results from Selected Mine and Mill Sites.* Prepared for U.S. Environmental Protection Agency Region 10.

contingent. The TM provided as Attachment 2 to this Addendum[4] describes this evaluation in detail.

The results of the contingent site evaluation resulted in the identification of 114 sites for removal from the draft Selected Remedy based on available data showing that these sites posed a relatively lower risk to human health and the environment.[5] The rationale for removing sites included potential human health risks; downstream water quality; site-specific data such as location within a watershed and contaminant concentrations[6]; riparian acreage and erosion potential; and the volume of waste materials.

Following the reduction in scope of Alternative 3+(d) described above, a total of 200 mine and mill sites originally included in Alternative 3+(d) in the Draft Final FFS Report (CH2M HILL, 2010) and the Proposed Plan (EPA, 2010) are not included in the draft Selected Remedy. The draft Selected Remedy now includes remedial actions at 145 sites in the Upper Basin instead of the previous 345 sites. These 145 sites constitute the locations of the highest-priority actions for the Upper Basin based on the available data.

3.0 Changes to Water Collection Actions and Ninemile Creek Waste Volumes and TCDs from Alternative 3+(d) to the Draft Selected Remedy

EPA has also changed some of the remedial actions at the 145 sites carried forward from Alternative 3+(d) to the draft Selected Remedy. The changes include:

- Changes to the water collection actions between Wallace and Elizabeth Park, and
- Changes to estimated waste volumes and TCDs for source sites in the Ninemile Creek Watershed.

These are described in Sections 3.1 and 3.2.

3.1 Changes to the Water Collection Actions between Wallace and Elizabeth Park

Hydraulic isolation and groundwater collection actions along the South Fork of the Coeur d'Alene River (SFCDR) between Wallace and Elizabeth Park, a reach of more than 10 miles in length, were previously included in Alternative 3+(d) in the Draft Final FFS Report. These actions included a stream liner on the SFCDR and a French drain alongside the SFCDR throughout the entire reach for collection of groundwater. EPA received comments from the community and project stakeholders regarding these proposed actions after they were carried forward to the Preferred Alternative in the Proposed Plan. These comments expressed concern that the actions were too costly, were not implementable, would have negative impacts on aquatic life during and potentially after construction, and would be too disruptive to the community. After receiving these comments and conducting further

[4] CH2M HILL, August 2, 2012*Technical Memorandum: Evaluation of Mine and Mill Source Sites for Removal from the Forthcoming Upper Basin Selected Remedy.* Prepared for U.S. Environmental Protection Agency Region 10.

[5] These sites are referred to as sites identified for "Contingent Removal" in Table 1.

[6] The review of site-specific contaminant concentrations included data collected during the focused characterization sampling conducted in the summer of 2011, which is described in the TM provided as Attachment 1 to this Addendum.

evaluation, EPA significantly reduced the scope of these actions to focus only on the Osburn area, where metals loading to the SFCDR is known to be significant and has been well characterized (CH2M HILL, 2009b through 2009f).

Changes to the remedial actions include constructing a groundwater interception drain only in the Osburn area (a reach of less than 1 mile in length) and elimination of the stream liner along the SFCDR between Wallace and Elizabeth Park. The SFCDR Watershed Groundwater Flow Model (CH2M HILL, 2009a) was used to develop a conceptual design for these revised actions and to estimate the remedial effectiveness, in terms of net reduction in dissolved zinc load in the SFCDR. The evaluation is documented in the TM that is provided as Attachment 3 to this Addendum.[7] A summary of the changes to the remedial actions from Alternative 3+(d) to the draft Selected Remedy is presented in Table 3.

3.2 Changes to Estimated Waste Volumes and TCDs for Source Sites in the Ninemile Creek Watershed

In keeping with EPA's adaptive management approach, pre-design investigation work was conducted in the Ninemile Creek Watershed in the summer of 2011. Data collected during the investigation provided updated, more accurate estimates of contaminated waste volumes at specific source sites. Site data and associated costs have been updated based on this new information, and revisions have been made to the TCDs for selected source areas in the Ninemile Creek Watershed. The TM provided as Attachment 4 to this Addendum[8] documents and explains these changes. A summary of the changes is provided in Table 4.

4.0 Changes to Stream and Riparian Actions from Alternative 3+(d) to the Draft Selected Remedy

During the public review period for the Upper Basin Proposed Plan (EPA, 2010), EPA received comments from stakeholders and the public concerning the location, extent, and in some cases the technical approach proposed for some of the stream and riparian cleanup actions included in the Preferred Alternative presented in the Proposed Plan. In response to those comments and as part of EPA's evaluation to reduce the scope of the Preferred Alternative (as described previously), those stream and riparian actions that were co-located with floodplain and sediment removal actions were determined to be priority actions for inclusion in the draft Selected Remedy. These sediment removal actions are primarily designated for riparian areas (along rivers and creeks). Stream and riparian stabilization actions will be conducted following remedial actions to stabilize rivers and creeks at the remediated locations. Therefore, the draft Selected Remedy refers to these actions as stream and riparian "stabilization" actions. Table 5 lists the stream and riparian reaches included in Alternative 3+(d) in the Draft Final FFS Report and the Proposed Plan and identifies the reaches included in the draft Selected Remedy. Changes to the stream and riparian cleanup actions as previously included in Alternative 3+(d) are summarized below.

- **No stream and riparian actions in the Upper SFCDR Watershed (the SFCDR upstream of Wallace).** EPA has determined that stream and riparian stabilization actions are not

[7] CH2M HILL, July 20, 2012.*Technical Memorandum: Application of the SFCDR Watershed Groundwater Flow Model to the Revised Groundwater Components of the Upper Basin Selected Remedy for Mainstem SFCDR Watershed Segment 01*. Prepared for U.S. Environmental Protection Agency Region 10.

[8] CH2M HILL, August 1, 2012.*Technical Memorandum: Summary of Changes to Source Volumes and Typical Conceptual Designs for Alternative 3+(d) Source Sites in the Ninemile Creek Watershed*. Prepared for U.S. Environmental Protection Agency Region 10.

needed in the Upper SFCDR at this time because the draft Selected Remedy includes only one sediment removal site (WAL038, located between Wallace and Mullan) and relatively few sediment removal actions in this watershed. In addition, most of the Upper SFCDR currently has abundant rock, riprap, and riparian vegetation, indicating that minimal erosion is likely occurring in this stretch of the river compared with other reaches of the SFCDR. Therefore, no stream and riparian stabilization actions are included for this watershed in the draft Selected Remedy.

- **Removal of selected stream and riparian actions in the Ninemile Creek Watershed.** The draft Selected Remedy does not include any remedial actions in the West Fork of Ninemile Creek; therefore, no stream and riparian stabilization actions will be needed for this reach. Stream and riparian stabilization actions will be conducted at the remaining reaches in the Ninemile Creek Watershed, particularly the East Fork of Ninemile Creek.
- **No stream and riparian actions in SFCDR reaches through Wallace.** The draft Selected Remedy does not include stream and riparian stabilization actions in SFCDR reaches through Wallace. It is not expected that any sediment removal actions will be conducted through this area due to existing infrastructure (a county bridge, culverts, Interstate 90 support columns, and a concrete channel). Therefore, stream and riparian stabilization actions will not be conducted in these reaches.
- **Stream reaches removed from the Big Creek and Moon Creek Watersheds.** Based on the reduction of the scope of the remedial actions included in the draft Selected Remedy, one reach in each of these watersheds that was previously identified for stream and riparian actions is no longer included in the draft Selected Remedy because no remedial actions are identified for these reaches.
- **No stream and riparian actions in the Pine Creek Watershed.** The draft Selected Remedy does not include any stream and riparian stabilization actions for Pine Creek. With EPA's reduction of the scope of the remedial actions included in the draft Selected Remedy, relatively few sediment removal actions are identified in the Pine Creek Watershed.
- **No stream and riparian actions west of Pinehurst in the Mainstem SFCDR Watershed.** Alternative 3+(d) proposed stream and riparian cleanup actions in three reaches of the SFCDR to the west of Pinehurst. The draft Selected Remedy does not include any remedial actions in this area; therefore, stream and riparian stabilization actions west of Pinehurst are not included in the draft Selected Remedy. Stream and riparian stabilization actions will be conducted in the Mainstem SFCDR Watershed east of Kellogg.

The TM provided as Attachment 5 to this Addendum[9] documents in detail the changes and associated rationale for reducing the scope of stream and riparian actions included in the draft Selected Remedy.

[9] CH2M HILL, July 20, 2012. *Technical Memorandum: Updates to Stream and Riparian Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site*. Prepared for U.S. Environmental Protection Agency Region 10.

5.0 Information Updates Since Publication of the Draft Final FFS Report

The following updates of information presented in Volume 1 of the Draft Final FFS Report were identified by the U.S. Fish and Wildlife Service (USFWS) when reviewing the Draft Final FFS Report and the Upper Basin Proposed Plan (EPA, 2010):

- **Section 4.2.2, page 4-8**: The third sentence of the bulleted text at the bottom of the page states: "The entire Coeur d'Alene River Basin is designated as Critical Habitat Unit (CHU) Number 29, changed from the 2002 designation of CHU 14, Coeur d'Alene Lake Basin." This is no longer correct. In September 2010 the critical habitat rule for the bull trout was finalized. The finalized rule defines CHU Number 29 (Coeur d'Alene River Basin Unit) to include the entire mainstem of the Coeur d'Alene River, the entire North Fork Coeur d'Alene River to its headwaters, and numerous tributary streams.
- **Section 4.2.2, page 4-9**: The second last paragraph states: "On January 22, 2010, the USFWS Idaho Field Office updated the list, indicating to USEPA that the gray wolf was delisted from the ESA." In May 2011 the U.S. Congress delisted the gray wolf in Montana, Idaho, portions of Eastern Washington, and Eastern Oregon (50 CFR Part 17).
- **Section 4.2.2, page 4-10**: The first full paragraph regarding critical habitat for the bull trout is no longer correct as discussed above. The finalized rule defines CHU Number 29 (Coeur d'Alene River Basin Unit) to include the entire mainstem of the Coeur d'Alene River, the entire North Fork Coeur d'Alene River to its headwaters, and numerous tributary streams.

6.0 References

CH2M HILL. April 2009 (2009a). *South Fork of the Coeur d'Alene River Watershed: Basinwide Groundwater Flow Model Documentation*. Prepared for U.S. Environmental Protection Agency Region 10.

CH2M HILL. May 20, 2009 (2009b). *Technical Memorandum: Osburn Flats Subsurface Exploration and Well Installation Summary, Upper Coeur d'Alene Basin Field Investigation, Osburn, Idaho, October 2008*. Prepared for U.S. Environmental Protection Agency Region 10.

CH2M HILL. June 2009 (2009c). *2008 High-Flow and Low-Flow Surface Water Study Report, Upper Basin of the South Fork Coeur d'Alene River, Bunker Hill Superfund Site, Shoshone County, Idaho*. Prepared for U.S. Environmental Protection Agency Region 10.

CH2M HILL. July 2009 (2009d). *Technical Report, Osburn Flats Groundwater-Surface Water Interaction Study, Upper Coeur d'Alene Basin, Osburn, Idaho*. Prepared for U.S. Environmental Protection Agency Region 10.

CH2M HILL. August 28, 2009 (2009e). *Technical Memorandum: Osburn Flats Aquifer Testing Summary, Upper Coeur d'Alene Basin Field Studies, Phase 2 Investigation, Bunker Hill Mining and Metallurgical Complex Superfund Site*. Prepared for U.S. Environmental Protection Agency Region 10.

CH2M HILL. September 18, 2009 (2009f). *Technical Memorandum: Conceptual Site Model, Osburn Flats in Operable Unit 3, Bunker Hill Mining and Metallurgical Complex Superfund Site*. Prepared for U.S. Environmental Protection Agency Region 10.

U.S. Environmental Protection Agency. July 12, 2010. *Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Mining and Metallurgical Complex Superfund Site.*

Tables

TABLE 1

Mine and Mill Sites Included in Alternative 3+(d), and Rationale for Removal of Sites from Draft Selected Remedy

Addendum to the Draft Final Focused Feasibility Study Report, Upper Basin of the Coeur d'Alene River

Watershed	Site ID	Site Name	Alternative 3+(d) Site Included in or Removed from Draft Selected Remedy	Rationale for Removal from Draft Selected Remedy
Big Creek	KLE025	SUNSHINE TAILINGS POND: NO. 2	Removed	Active Facility
Big Creek	KLE026	SILVER SYNDICATE	Removed	Active Facility
Big Creek	KLE027	NORTH AMERICAN MINE	Removed	Active Facility
Big Creek	KLE053	NORTH AMERICAN/SILVER SYNDICATE MINE	Removed	Active Facility
Big Creek	KLE054	CRESCENT/HOOPER TUNNEL	Removed	Active Facility
Big Creek	POL001	SUNSHINE CONSOLIDATED ROCKFORD GROUP	Removed	Contingent Removal
Big Creek	POL002	SILVER DALE AND BIG HILL MINE	Removed	Contingent Removal
Big Creek	POL008	GLOBE MINE	Removed	Contingent Removal
Big Creek	POL010	WESTERN STAR MINE	Removed	Contingent Removal
Big Creek	POL011	WOLFSON MINE	Removed	Contingent Removal
Big Creek	POL022	FIRST NATIONAL MINE	Removed	Contingent Removal
Big Creek	POL044	UNNAMED PROSPECT	Removed	Contingent Removal
Big Creek	POL052	LUCKY BOY MINE	Removed	Contingent Removal
Big Creek	POL067	UNNAMED ADIT	Removed	Contingent Removal
Big Creek	POL068	UNNAMED ADIT	Removed	Contingent Removal
Big Creek	KLE047	BIG CK IMPACTED RIPARIAN: NO. 1	Included	Not applicable
Big Creek	KLE071	BIG CK IMPACTED RIPARIAN: NO. 3	Included	Not applicable
Big Creek	KLE073	BIG CK IMPACTED RIPARIAN: NO. 2	Included	Not applicable
Big Creek	POL066	UNNAMED ADIT	Removed	2011 Focused Characterization
Canyon Creek	BUR066	MOONLIGHT MINE	Removed	Contingent Removal
Canyon Creek	BUR068	HEADLIGHT MINE	Removed	Contingent Removal
Canyon Creek	BUR088	AJAX NO.2	Removed	Contingent Removal
Canyon Creek	BUR099	BENTON MINE	Removed	Contingent Removal
Canyon Creek	BUR105	OOM PAUL NO. 2	Removed	Contingent Removal
Canyon Creek	BUR125	MIDWAY SUMMIT MINE	Removed	Contingent Removal
Canyon Creek	BUR134	ALCIDES PROSPECT & IMPERIAL MINE	Removed	Contingent Removal
Canyon Creek	BUR135	SONORA MINE	Removed	Contingent Removal
Canyon Creek	BUR176	UNNAMED ADIT	Removed	Contingent Removal
Canyon Creek	BUR185	WEST MAMMOTH MINE	Removed	Contingent Removal
Canyon Creek	BUR189	DULUTH MINE CANYON CK	Removed	Contingent Removal
Canyon Creek	BUR204	UNNAMED ROCK DUMP	Removed	Contingent Removal
Canyon Creek	BUR067	TAMARACK NO.7 (1200 LEVEL)	Included	Not applicable
Canyon Creek	BUR072	STANDARD-MAMMOTH NO. 4	Included	Not applicable
Canyon Creek	BUR073	STANDARD-MAMMOTH CAMPBELL ADIT	Included	Not applicable
Canyon Creek	BUR075	SHERMAN 1000 LEVEL (OREANO ADIT)	Included	Not applicable
Canyon Creek	BUR087	HERCULES NO. 3	Included	Not applicable
Canyon Creek	BUR090	HERCULES NO. 4	Included	Not applicable
Canyon Creek	BUR094	SHERMAN 600 LEVEL	Included	Not applicable
Canyon Creek	BUR096	ANCHOR MINE	Included	Not applicable
Canyon Creek	BUR097	HIDDEN TREASURE MINE	Included	Not applicable
Canyon Creek	BUR098	HERCULES NO. 5	Included	Not applicable
Canyon Creek	BUR107	AJAX NO. 3	Included	Not applicable
Canyon Creek	BUR109	OOM PAUL NO. 1	Included	Not applicable
Canyon Creek	BUR112	GEM NO. 2	Included	Not applicable
Canyon Creek	BUR117	FRISCO MILLSITE	Included	Not applicable
Canyon Creek	BUR118	FRISCO NO. 2 & NO. 1	Included	Not applicable
Canyon Creek	BUR119	BLACK BEAR NO. 4	Included	Not applicable
Canyon Creek	BUR120	SILVER MOON MINE	Included	Not applicable
Canyon Creek	BUR121	BLACK BEAR FRACTION	Included	Not applicable
Canyon Creek	BUR122	FLYNN MINE	Included	Not applicable

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Canyon Creek	BUR124	OMAHA MINE	Included	Not applicable
Canyon Creek	BUR128	HECLA-STAR MINE & MILLSITE COMPLEX	Included	Not applicable
Canyon Creek	BUR129	TIGER-POORMAN MINE	Included	Not applicable
Canyon Creek	BUR130	MARSH MINE	Included	Not applicable
Canyon Creek	BUR141	CANYON CK IMPACTED FLOODPLAIN	Included	Not applicable
Canyon Creek	BUR142	GEM MILLSITE	Included	Not applicable
Canyon Creek	BUR143	CANYON CK IMPACTED RIPARIAN	Included	Not applicable
Canyon Creek	BUR144	STANDARD-MAMMOTH LOADING AREA	Included	Not applicable
Canyon Creek	BUR145	ONEILL GULCH UNNAMED ROCK DUMP	Included	Not applicable
Canyon Creek	BUR146	GORGE GULCH IMPACTED RIPARIAN	Included	Not applicable
Canyon Creek	BUR149	AJAX NO.2 ADJACENT ROCK DUMP	Included	Not applicable
Canyon Creek	BUR150	CANYON CK GARBAGE DUMP	Included	Not applicable
Canyon Creek	BUR153	CANYON CK IMPACTED FLOODPLAIN (CCSeg02 & CCSeg04)	Included	Not applicable
Canyon Creek	BUR177	JOE MATT MINE	Included	Not applicable
Canyon Creek	BUR178	WEST HECLA MINE	Included	Not applicable
Canyon Creek	BUR180	STANLEY MINE	Included	Not applicable
Canyon Creek	BUR190	GEM NO. 3	Included	Not applicable
Canyon Creek	BUR191	FRISCO NO. 3	Included	Not applicable
Canyon Creek	BUR192	BLACK BEAR MILLSITE	Included	Not applicable
Canyon Creek	OSB047	CANYON CK FORMOSA REACH SVNRT REHAB	Included	Not applicable
Canyon Creek	WAL009	HECLA-STAR TAILINGS PONDS	Included	Not applicable
Canyon Creek	WAL010	CANYON CK POND REACH SVNRT REHAB	Included	Not applicable
Canyon Creek	WAL011	CANYON SILVER (FORMOSA) MINE	Included	Not applicable
Canyon Creek	WAL039	STANDARD-MAMMOTH MILLSITE	Included	Not applicable
Canyon Creek	WAL040	CANYON CK IMPACTED FLOODPLAIN	Included	Not applicable
Canyon Creek	WAL041	CANYON CK REPOSITORY REACH SVNRT REHAB	Included	Not applicable
Canyon Creek	WAL042	CANYON CK TAILINGS REPOSITORY SVNRT	Included	Not applicable
Canyon Creek	WAL081	WALLACE OLD PRIVATE LANDFILL	Included	Not applicable
Canyon Creek	BUR089	IDAHO AND EASTERN MINE	Removed	2011 Focused Characterization
Canyon Creek	BUR132	GERTIE MINE	Removed	2011 Focused Characterization
Canyon Creek	BUR133	RUSSEL MINE	Removed	2011 Focused Characterization
Canyon Creek	BUR166	UNNAMED ADIT	Removed	2011 Focused Characterization
Canyon Creek	BUR187	UNNAMED ADIT	Removed	2011 Focused Characterization
Canyon Creek	THO023	UNNAMED ADIT	Removed	2011 Focused Characterization
Mainstem SFCDR	KLE075	SILVER SUMMIT MILLSITE (Polaris)	Removed	Active Facility
Mainstem SFCDR	OSB119	OSBURN ZANETTI GRAVEL OPERATION	Removed	Active Facility
Mainstem SFCDR	WAL001	OSBURN TAILINGS PONDS	Removed	Active Facility
Mainstem SFCDR	WAL020	CALADAY MINE	Removed	Active Facility
Mainstem SFCDR	KLE016	SYNDICATE MINING & EXPLORATION CO.	Removed	Contingent Removal
Mainstem SFCDR	KLE020	NEW HILARITY MINE	Removed	Contingent Removal
Mainstem SFCDR	KLE021	ALHAMBRA MINE	Removed	Contingent Removal
Mainstem SFCDR	KLE033	POLARIS MINE	Removed	Contingent Removal
Mainstem SFCDR	KLE051	FLORENCE MINE	Removed	Contingent Removal
Mainstem SFCDR	KLE066	RHODE ISLAND NO. 1 & NO. 2 & ASSOC. ADITS	Removed	Contingent Removal
Mainstem SFCDR	KLE068	UNNAMED ADIT (St. Joe No. 2)	Removed	Contingent Removal
Mainstem SFCDR	MUL085	VIENNA INTERNATIONAL MINE	Removed	Contingent Removal
Mainstem SFCDR	MUL086	WIBBERDING-GOLDEN SLIPPER MINES	Removed	Contingent Removal
Mainstem SFCDR	OSB025	CAPITOL SILVER-LEAD: NO. 3	Removed	Contingent Removal
Mainstem SFCDR	OSB070	SILVERORE-INSPIRATION MINE	Removed	Contingent Removal

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Mine and Mill Sites Included in Alternative 3+(d), and Rationale for Removal of Sites from Draft Selected Remedy

Addendum to the Draft Final Focused Feasibility Study Report, Upper Basin of the Coeur d'Alene River

Watershed	Site ID	Site Name	Alternative 3+(d) Site Included in or Removed from Draft Selected Remedy	Rationale for Removal from Draft Selected Remedy
Mainstem SFCDR	OSB072	WESTERN UNION UPPER ADIT	Removed	Contingent Removal
Mainstem SFCDR	OSB074	ST. JOE NO. 1	Removed	Contingent Removal
Mainstem SFCDR	OSB076	UNNAMED ADIT (May Claim)	Removed	Contingent Removal
Mainstem SFCDR	OSB078	UNNAMED ADIT (Hardscrabble Claim)	Removed	Contingent Removal
Mainstem SFCDR	POL021	ECLIPSE MINE	Removed	Contingent Removal
Mainstem SFCDR	POL064	UNNAMED ADIT	Removed	Contingent Removal
Mainstem SFCDR	WAL016	ARGENTINE MINE	Removed	Contingent Removal
Mainstem SFCDR	WAL034	SHIELDS GULCH IMPACTED RIPARIAN	Removed	Contingent Removal
Mainstem SFCDR	WAL035	OSBURN ROCKPIT ALONG I-90: NO. 2	Removed	Contingent Removal
Mainstem SFCDR	KLE011[a]	SILVER CRESCENT TAILINGS	Included	Not applicable
Mainstem SFCDR	KLE034	SILVER DOLLAR MINE	Included	Not applicable
Mainstem SFCDR	KLE035	SILVER SUMMIT MINE	Included	Not applicable
Mainstem SFCDR	KLE040	SF CDA RIVER IMPACTED FLOODPLAIN: NO. 5	Included	Not applicable
Mainstem SFCDR	KLE048	SF CDA RIVER SVNRT REHAB	Included	Not applicable
Mainstem SFCDR	KLE049	SF CDA RIVER IMPACTED RIPARIAN (MidGradSeg01 & MidGradSeg02)	Included	Not applicable
Mainstem SFCDR	KLE067	ST. JOE NO. 4	Included	Not applicable
Mainstem SFCDR	KLE069	ST. JOE NO. 3	Included	Not applicable
Mainstem SFCDR	OSB065	SF CDA RIVER IMPACTED FLOODPLAIN: NO. 3	Included	Not applicable
Mainstem SFCDR	OSB117	OSBURN ZANETTI STOCKPILED TAILINGS	Included	Not applicable
Mainstem SFCDR	OSB118	OSBURN NORTH TAILINGS AREA	Included	Not applicable
Mainstem SFCDR	OSB120	SF CDA RIVER IMPACTED FLOODPLAIN: NO. 4	Included	Not applicable
Mainstem SFCDR	WAL002	WESTERN UNION LOWER ADIT	Included	Not applicable
Mainstem SFCDR	WAL004	SF CDA RIVER RAILROAD YARDS & IMP FLDP	Included	Not applicable
Mainstem SFCDR	WAL014	ST. ELMO MINE	Included	Not applicable
Mainstem SFCDR	KLW061	BH NO. 2	Removed	Contingent Removal
Mainstem SFCDR	KLW062	BLUEBIRD MINE & GUY CAVE AREA	Removed	Contingent Removal
Mainstem SFCDR	KLW070	MILO CK IMPACTED RIPARIAN: NO. 1	Removed	Contingent Removal
Mainstem SFCDR	KLW095	PHIL SHERIDAN MINE	Removed	Contingent Removal
Mainstem SFCDR	KLE042	MOON CK POND AT MOUTH	Removed	Remediated Site
Mainstem SFCDR	KLE062	OSBURN FLATS BUREAU OF MINES TESTPLOTS	Removed	Remediated Site
Mainstem SFCDR	KLE074	COEUR D ALENE MILLSITE	Removed	Remediated Site
Mainstem SFCDR	POL018	MERGER MINE	Removed	Remediated Site
Mainstem SFCDR	POL019	COEUR D ALENE MINE	Removed	Remediated Site
Mainstem SFCDR	WAL036	LAKE CK IMPACTED RIPARIAN	Removed	Remediated Site
Mainstem SFCDR	WAL037	HERCULES MILLSITE	Removed	Remediated Site
Mainstem SFCDR	KLE023	PIONEER MINES INC. PROPERTY	Removed	2011 Focused Characterization
Mainstem SFCDR	KLE070	UNNAMED ADIT	Removed	2011 Focused Characterization
Mainstem SFCDR	OSB030	SILVERTON PROSPECT UPPER ADIT	Removed	2011 Focused Characterization
Mainstem SFCDR	OSB073	SILVERTON PROSPECT LOWER ADIT	Removed	2011 Focused Characterization
Mainstem SFCDR	OSB075	UNNAMED ADIT	Removed	2011 Focused Characterization
Mainstem SFCDR	WAL024	WAR EAGLE MINE	Removed	2011 Focused Characterization
Mainstem SFCDR	WAL046	DAY MINES CLAIMS	Removed	2011 Focused Characterization
Mainstem SFCDR	WAL055	UNNAMED ADIT	Removed	2011 Focused Characterization
Mainstem SFCDR	WAL056	PEERLESS GROUP (OSCEOLA)	Removed	2011 Focused Characterization
Mainstem SFCDR	WAL057	PEERLESS GROUP	Removed	2011 Focused Characterization
Mainstem SFCDR	WAL058	UNNAMED ADIT	Removed	2011 Focused Characterization
Mainstem SFCDR	WAL062	UNNAMED ADIT	Removed	2011 Focused Characterization
Mainstem SFCDR	WAL064	UNNAMED ADIT	Removed	2011 Focused Characterization
Mainstem SFCDR	WAL072	UNNAMED ADIT	Removed	2011 Focused Characterization

TABLE 1

Mine and Mill Sites Included in Alternative 3+(d), and Rationale for Removal of Sites from Draft Selected Remedy

Addendum to the Draft Final Focused Feasibility Study Report, Upper Basin of the Coeur d'Alene Rivel

Watershed	Site ID	Site Name	Alternative 3+(d) Site Included in or Removed from Draft Selected Remedy	Rationale for Removal from Draft Selected Remedy
Mainstem SFCDR	WAL073	UNNAMED ADIT	Removed	2011 Focused Characterization
Moon Creek	KLE061	UNNAMED TUNNEL	Removed	Contingent Removal
Moon Creek	KLE064	UNNAMED ADIT	Removed	Contingent Removal
Moon Creek	KLE014	ROYAL ANNE MINE	Included	Not applicable
Moon Creek	KLE041	MOON CK IMPACTED RIPARIAN	Included	Not applicable
Moon Creek	KLE008	MAINE-STANDARD MINE	Removed	2011 Focused Characterization
Moon Creek	KLE063	UNNAMED ADIT	Removed	2011 Focused Characterization
Moon Creek	KLE065	UNNAMED ADITS	Removed	2011 Focused Characterization
Ninemile Creek	BUR051	SUNSET MINE	Included	Not applicable
Ninemile Creek	BUR053	INTERSTATE-CALLAHAN MINE/ROCK DUMPS	Included	Not applicable
Ninemile Creek	BUR055	INTERSTATE MILLSITE	Included	Not applicable
Ninemile Creek	BUR056	TAMARACK ROCK DUMPS	Included	Not applicable
Ninemile Creek	BUR058	TAMARACK NO. 3	Included	Not applicable
Ninemile Creek	BUR139	REX NO. 1	Included	Not applicable
Ninemile Creek	BUR140	NINEMILE CREEK IMPACTED FLOODPLAIN	Included	Not applicable
Ninemile Creek	BUR160	INTERSTATE-CALLAHAN LOWER ROCK DUMPS	Included	Not applicable
Ninemile Creek	BUR170	TAMARACK 400 LEVEL	Included	Not applicable
Ninemile Creek	BUR171	TAMARACK NO. 5	Included	Not applicable
Ninemile Creek	BUR172	TAMARACK UNNAMED ADIT	Included	Not applicable
Ninemile Creek	BUR173	TAMARACK MILLSITE	Included	Not applicable
Ninemile Creek	OSB038	CALIFORNIA NO. 4	Included	Not applicable
Ninemile Creek	OSB039	DAYROCK MINE	Included	Not applicable
Ninemile Creek	OSB040	EF NINEMILE CK HECLA REHAB	Included	Not applicable
Ninemile Creek	OSB044	SUCCESS MINE ROCK DUMP	Included	Not applicable
Ninemile Creek	OSB048	AMERICAN MINE	Included	Not applicable
Ninemile Creek	OSB052	DAYROCK MINE TLGS PILE/SVNRT REPOSITORY	Included	Not applicable
Ninemile Creek	OSB056	EF NINEMILE CK IMPACTED RIPARIAN	Included	Not applicable
Ninemile Creek	OSB057	EF NINEMILE CK IMPACTED RIPARIAN	Included	Not applicable
Ninemile Creek	OSB058	EF NINEMILE CK SVNRT REHAB	Included	Not applicable
Ninemile Creek	OSB059	NINEMILE CK BELOW DAYROCK MINE	Included	Not applicable
Ninemile Creek	OSB060	NINEMILE CK SVNRT REHAB NEAR BLACKCLD	Included	Not applicable
Ninemile Creek	OSB082	MONARCH MINE BLACKCLOUD CK	Included	Not applicable
Ninemile Creek	OSB088	ALAMEDA MINE	Included	Not applicable
Ninemile Creek	OSB089	SUCCESS NO. 3	Included	Not applicable
Ninemile Creek	OSB115	OPTION MINE	Included	Not applicable
Ninemile Creek	WAL033	NINEMILE CK POTENTIAL TAILINGS DEPOSIT	Included	Not applicable
Ninemile Creek	BUR054	REX NO. 2 / SIXTEEN-TO-ONE MINE	Removed	Remediated Site
Ninemile Creek	OSB061	BLACKCLOUD CK MILLSITE	Removed	Remediated Site
Ninemile Creek	BUR052	LITTLE SUNSET MINE	Removed	2011 Focused Characterization
Ninemile Creek	OSB032	DULUTH MINE BLACKCLOUD CK	Removed	2011 Focused Characterization
Ninemile Creek	OSB033	RUTH MINE	Removed	2011 Focused Characterization
Ninemile Creek	OSB084	BLACKCLOUD CK IMPACTED RIPARIAN	Removed	2011 Focused Characterization
Ninemile Creek	OSB085	BLACKCLOUD CK IMPACTED RIPARIAN	Removed	2011 Focused Characterization
Ninemile Creek	WAL006	NORTHSIDE MINE	Removed	2011 Focused Characterization
Pine Creek	KLW083	LIBERAL KING PART OF TUNNEL: NO. 2	Removed	Contingent Removal
Pine Creek	MAS009	SHETLAND MINING CO-NABOB SILVER-LEAD	Removed	Contingent Removal
Pine Creek	MAS023	BLUE EAGLE MINE	Removed	Contingent Removal
Pine Creek	MAS028	LON CHANEY GROUP	Removed	Contingent Removal
Pine Creek	MAS030	TRAPPER CREEK SILVER	Removed	Contingent Removal
Pine Creek	MAS031	TRAPPER MINING & SMELTING COMPANY LTD.	Removed	Contingent Removal

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Watershed	Site ID	Site Name	Alternative 3+(d) Site Included in or Removed from Draft Selected Remedy	Rationale for Removal from Draft Selected Remedy
Pine Creek	MAS032	L AND J PROSPECT	Removed	Contingent Removal
Pine Creek	MAS033	COEUR D ALENE PREMIER	Removed	Contingent Removal
Pine Creek	MAS052	OWL/FRED MINE	Removed	Contingent Removal
Pine Creek	MAS055	UNNAMED ADIT	Removed	Contingent Removal
Pine Creek	MAS057	UNNAMED ADIT	Removed	Contingent Removal
Pine Creek	MAS065	UNNAMED PROSPECT	Removed	Contingent Removal
Pine Creek	MAS068	UNNAMED ADIT	Removed	Contingent Removal
Pine Creek	TWI006	MANHATTAN MINE	Removed	Contingent Removal
Pine Creek	TWI012	KC PROSPECT	Removed	Contingent Removal
Pine Creek	TWI014	GREAT DUNKARD MINE	Removed	Contingent Removal
Pine Creek	TWI027	UNNAMED PROSPECT	Removed	Contingent Removal
Pine Creek	TWI030	UNNAMED ADIT	Removed	Contingent Removal
Pine Creek	KLW075	MATCHLESS MINE	Included	Not applicable
Pine Creek	KLW079	GOLD EAGLE MINING CO.	Included	Not applicable
Pine Creek	KLW082	CARBONATE MINE: NO. 2	Included	Not applicable
Pine Creek	KLW085	CARBONATE MINE: NO. 1	Included	Not applicable
Pine Creek	MAS003	LIBERAL KING MINE & MILLSITE	Included	Not applicable
Pine Creek	MAS007	NABOB 1300 LEVEL	Included	Not applicable
Pine Creek	MAS011	IDAHO PROSPECT: NO. 2	Included	Not applicable
Pine Creek	MAS012	LYNCH-PINE CREEK MINE	Included	Not applicable
Pine Creek	MAS013	NABOB 600 LEVEL (300 Level)	Included	Not applicable
Pine Creek	MAS014	HILARITY MINE	Included	Not applicable
Pine Creek	MAS015	LITTLE PITTSBURG MINE: NO. 2	Included	Not applicable
Pine Creek	MAS016	LITTLE PITTSBURG MINE: NO. 1	Included	Not applicable
Pine Creek	MAS020	SIDNEY (RED CLOUD) MINE/MILLSITE	Included	Not applicable
Pine Creek	MAS021	NEVADA-STEWART MINE	Included	Not applicable
Pine Creek	MAS022	SURPRISE MINE & UPPER ROCK DUMP	Included	Not applicable
Pine Creek	MAS025	DOUGLAS MINE & MILLSITE	Included	Not applicable
Pine Creek	MAS029	BIG IT MINE	Included	Not applicable
Pine Creek	MAS035	NABOB 600 LEVEL SHAFT	Included	Not applicable
Pine Creek	MAS036	DENVER CK TAILINGS PILE	Included	Not applicable
Pine Creek	MAS040	DENVER CK IMPACTED RIPARIAN: NO. 2	Included	Not applicable
Pine Creek	MAS041	DENVER CK IMPACTED RIPARIAN: NO. 3	Included	Not applicable
Pine Creek	MAS042	DENVER CK IMPACTED RIPARIAN: NO. 4	Included	Not applicable
Pine Creek	MAS043	DENVER CK IMPACTED RIPARIAN: NO. 1	Included	Not applicable
Pine Creek	MAS045	HIGHLAND CK IMPACTED RIPARIAN	Included	Not applicable
Pine Creek	MAS046	HIGHLAND & RED CLOUD CK IMPACTED RIPAR	Included	Not applicable
Pine Creek	MAS054	MARMION OR SF FRACTION	Included	Not applicable
Pine Creek	MAS078	HIGHLAND-SURPRISE MINE & MILLSITE	Included	Not applicable
Pine Creek	MAS083	NABOB MILLSITE	Included	Not applicable
Pine Creek	MAS084	DOUGLAS MINESITE TAILINGS REPOSITORY	Included	Not applicable
Pine Creek	KLW077	GENERAL MINE	Removed	Remediated Site
Pine Creek	MAS006	NABOB TAILINGS POND	Removed	Remediated Site
Pine Creek	MAS008	NABOB 600 LEVEL (Crystalite)	Removed	Remediated Site
Pine Creek	MAS017	SIDNEY (DENVER) 500 LEVEL	Removed	Remediated Site
Pine Creek	MAS018	DENVER MINE (NABOB ADIT)	Removed	Remediated Site
Pine Creek	MAS019	STAR ANTIMONY LOWER ADIT	Removed	Remediated Site
Pine Creek	MAS072	UNNAMED ADIT	Removed	Remediated Site
Pine Creek	MAS079	HIGHLAND-SURPRISE LOWER ROCK DUMP	Removed	Remediated Site
Pine Creek	KLW080	BOBBY ANDERSON MINE	Removed	Remediated Site

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Pine Creek	MAS027	CONSTITUTION LOWER MINE & ROCK DUMP	Removed	Remediated Site
Pine Creek	MAS048	CONSTITUTION LOWER MILLSITE & TAILINGS	Removed	Remediated Site
Pine Creek	MAS049	CONSTITUTION UPPER TAILINGS (non-BLM land)	Removed	Remediated Site
Pine Creek	MAS050	CONSTITUTION UPPER TUNNEL & ROCK DUMP	Removed	Remediated Site
Pine Creek	MAS081	SIDNEY (RED CLOUD) ROCK DUMP	Removed	Remediated Site
Pine Creek	MAS053	UNNAMED ADITS	Removed	2011 Focused Characterization
Pine Creek	TWI002	PALISADE MINE LOWER WORKINGS	Removed	2011 Focused Characterization
Pine Creek	TWI008	WEST PINE CREEK DEPOSIT	Removed	2011 Focused Characterization
Pine Creek	TWI009	EQUITABLE PROSPECT	Removed	2011 Focused Characterization
Pine Creek	TWI011	UNNAMED ADIT	Removed	2011 Focused Characterization
Pine Creek	TWI013	BLUEBIRD PROSPECT (HANNIBAL)	Removed	2011 Focused Characterization
Pine Creek	TWI018	UNNAMED PROSPECT	Removed	2011 Focused Characterization
Pine Creek	TWI020	UNNAMED ADIT	Removed	2011 Focused Characterization
Pine Creek	TWI029	UNNAMED ADIT	Removed	2011 Focused Characterization
Upper SFCDR	LOK008	IDAHO SILVER NO. 2	Removed	Active Facility
Upper SFCDR	LOK050	DAISY GULCH TAILINGS POND	Removed	Active Facility
Upper SFCDR	LOK051	DAISY GULCH OLD LANDFILL	Removed	Active Facility
Upper SFCDR	MUL019	MORNING NO. 6	Removed	Active Facility
Upper SFCDR	MUL020	LUCKY FRIDAY TAILINGS POND No. 3	Removed	Active Facility
Upper SFCDR	MUL042	GOLD HUNTER NO. 5	Removed	Active Facility
Upper SFCDR	LOK001	LUCKY CALUMET NO. 1	Removed	Contingent Removal
Upper SFCDR	LOK002	LUCKY CALUMET NO. 2	Removed	Contingent Removal
Upper SFCDR	LOK005	LUCKY BOY NO. 2	Removed	Contingent Removal
Upper SFCDR	LOK006	LUCKY BOY NO. 1	Removed	Contingent Removal
Upper SFCDR	LOK007	BUTTE & COEUR D ALENE (IDAHO SILVER)	Removed	Contingent Removal
Upper SFCDR	LOK010	HASH HOUSE MINE	Removed	Contingent Removal
Upper SFCDR	LOK017	BEACON LIGHT	Removed	Contingent Removal
Upper SFCDR	LOK048	SNOWSTORM APEX	Removed	Contingent Removal
Upper SFCDR	LOK053	UNNAMED ADIT	Removed	Contingent Removal
Upper SFCDR	MUL006	SQUARE DEAL MINE	Removed	Contingent Removal
Upper SFCDR	MUL008	ALICE MINE	Removed	Contingent Removal
Upper SFCDR	MUL009	SILVER SHAFT	Removed	Contingent Removal
Upper SFCDR	MUL013	WE LIKE MINE	Removed	Contingent Removal
Upper SFCDR	MUL014	GROUSE MINE	Removed	Contingent Removal
Upper SFCDR	MUL015	WEST STAR MINE	Removed	Contingent Removal
Upper SFCDR	MUL022	SUNSHINE PREMIER MINE	Removed	Contingent Removal
Upper SFCDR	MUL023	FANNY GREMM MINE	Removed	Contingent Removal
Upper SFCDR	MUL029	NORTH FRANKLIN MINE	Removed	Contingent Removal
Upper SFCDR	MUL030	WALL STREET MINE	Removed	Contingent Removal
Upper SFCDR	MUL031	CINCINNATI MINE	Removed	Contingent Removal
Upper SFCDR	MUL033	AMERICAN COMMANDER NO. 2	Removed	Contingent Removal
Upper SFCDR	MUL043	SILVER REEF MINE	Removed	Contingent Removal
Upper SFCDR	MUL047	LOTTIE L. MINE	Removed	Contingent Removal
Upper SFCDR	MUL048	ALMA MINE	Removed	Contingent Removal
Upper SFCDR	MUL049	COPPER PLATE MINE	Removed	Contingent Removal
Upper SFCDR	MUL051	PILOT MINE	Removed	Contingent Removal
Upper SFCDR	MUL056	COUGHLIN MINE	Removed	Contingent Removal
Upper SFCDR	MUL057	BUTTE AND COEUR D ALENE MINE	Removed	Contingent Removal
Upper SFCDR	MUL059	ROCK CREEK MINE ROCK DUMP	Removed	Contingent Removal
Upper SFCDR	MUL060	ROCK CREEK MINE	Removed	Contingent Removal

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Watershed	Site ID	Site Name	Alternative 3+(d) Site Included in or Removed from Draft Selected Remedy	Rationale for Removal from Draft Selected Remedy
Upper SFCDR	MUL063	GEM STATE MINE	Removed	Contingent Removal
Upper SFCDR	MUL065	MOE MINE	Removed	Contingent Removal
Upper SFCDR	MUL073	ATLAS MINE (CARBONATE HILL)	Removed	Contingent Removal
Upper SFCDR	MUL081	REINDEER QUEEN MINE	Removed	Contingent Removal
Upper SFCDR	MUL083	COPPER QUEEN MINE	Removed	Contingent Removal
Upper SFCDR	MUL103	MISSOULA MINE	Removed	Contingent Removal
Upper SFCDR	MUL119	UNNAMED ADIT	Removed	Contingent Removal
Upper SFCDR	MUL135	UNNAMED ADIT	Removed	Contingent Removal
Upper SFCDR	MUL136	UNNAMED ADIT	Removed	Contingent Removal
Upper SFCDR	MUL139	UNNAMED ADIT	Removed	Contingent Removal
Upper SFCDR	MUL141	MILL CK IMPACTED RIPARIAN No. 3	Removed	Contingent Removal
Upper SFCDR	MUL145	MILL CK IMPACTED RIPARIAN No. 2	Removed	Contingent Removal
Upper SFCDR	MUL146	MORNING NO. 3	Removed	Contingent Removal
Upper SFCDR	MUL149	MILL CK IMPACTED RIPARIAN No. 1	Removed	Contingent Removal
Upper SFCDR	MUL150	DEADMAN GULCH IMPACTED RIPARIAN	Removed	Contingent Removal
Upper SFCDR	MUL153	DEADMAN GULCH IMPACTED RIPARIAN	Removed	Contingent Removal
Upper SFCDR	THO020	BULL FROG MINE	Removed	Contingent Removal
Upper SFCDR	WAL013	GRANADA MINE	Removed	Contingent Removal
Upper SFCDR	LOK004	SNOWSHOE NO. 2	Included	Not applicable
Upper SFCDR	LOK009	SNOWSTORM NO. 4	Included	Not applicable
Upper SFCDR	LOK011	SNOWSTORM NO. 3	Included	Not applicable
Upper SFCDR	LOK024	SILVER CABLE MINE	Included	Not applicable
Upper SFCDR	MUL012	STAR 1200 LEVEL	Included	Not applicable
Upper SFCDR	MUL018	MULLAN METALS MINE	Included	Not applicable
Upper SFCDR	MUL021	INDEPENDENCE MINE	Included	Not applicable
Upper SFCDR	MUL027 [b]	MORNING NO. 4	Included	Not applicable
Upper SFCDR	MUL028	MORNING NO. 5	Included	Not applicable
Upper SFCDR	MUL045	HOMESTAKE MINE	Included	Not applicable
Upper SFCDR	MUL052	COPPER KING MINE	Included	Not applicable
Upper SFCDR	MUL053	NATIONAL MINE	Included	Not applicable
Upper SFCDR	MUL054	UNNAMED ADIT	Included	Not applicable
Upper SFCDR	MUL071	ATLAS MINE	Included	Not applicable
Upper SFCDR	MUL120	BANNER MINE NO. 2	Included	Not applicable
Upper SFCDR	MUL129	ATLAS MINE ROCK DUMP	Included	Not applicable
Upper SFCDR	MUL132	NATIONAL MILLSITE ADJACENT TAILINGS	Included	Not applicable
Upper SFCDR	MUL142	GROUSE GULCH IMPACTED RIPARIAN	Included	Not applicable
Upper SFCDR	WAL038	SF CDA RIVER IMPACTED FLOODPLAIN: NO. 1	Included	Not applicable
Upper SFCDR	WAL076	MARY D CLAIM WORKINGS	Included	Not applicable
Upper SFCDR	WAL077	GOLCONDA TAILINGS	Included	Not applicable
Upper SFCDR	MUL001	GOLCONDA MINESITE	Removed	Remediated Site
Upper SFCDR	MUL002	GOLCONDA MILLSITE	Removed	Remediated Site
Upper SFCDR	MUL037	LUCKY FRIDAY TAILINGS POND No. 2	Removed	Hecla Site
Upper SFCDR	MUL038	GOLD HUNTER NO. 6	Removed	Hecla Site
Upper SFCDR	MUL058	LUCKY FRIDAY TAILINGS POND No. 1	Removed	Hecla Site
Upper SFCDR	MUL131	NATIONAL MILLSITE	Removed	Hecla Site
Upper SFCDR	MUL004	UNITED LEAD ZINC MINE	Removed	2011 Focused Characterization
Upper SFCDR	MUL007	WONDER MINE	Removed	2011 Focused Characterization

Notes:

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Watershed	Site ID	Site Name	Alternative 3+(d) Site Included in or Removed from Draft Selected Remedy	Rationale for Removal from Draft Selected Remedy

[a] The KLE011 source area is actually the Silver Summit Tailings Pond. It is believed that the names were mistakenly switched within the Bureau of Land Management (BLM) GIS database. For consistency, the BLM naming convention has not been revised.

[b] According to Hecla records, this site (MUL027) is actually the Morning No. 3 portal and waste rock pile.

SFCDR = South Fork Coeur d'Alene River

TABLE 2

Sites not Included in Draft Selected Remedy based on 2011 Focused Characterization Sampling Results [a]

Addendum to the Draft Final Focused Feasibility Study Report, Upper Basin of the Coeur d'Alene River

Site ID	Site Name	<2.0 mm Soil Fraction		2.0-4.0 mm Soil Fraction	
		Arsenic (mg/kg)	Lead (mg/kg)	Arsenic (mg/kg)	Lead (mg/kg)
Upper SFCDR Watershed					
MUL004	United Lead Zinc Mine	5.9	22.7	U	4.4
MUL007	Wonder Mine	6.3	53.6	U	11
Moon Creek Watershed					
KLE008	Maine-Standard Mine	55.1	33.1	14	9.6
KLE063	Unnamed Adit	22.5	58.4	23.4	34
KLE065	Unnamed Adits	40.5	54.8	14	11
Big Creek Watershed					
POL066	Unnamed Adit	5.9	14.0	U	3.2
Ninemile Creek Watershed					
WAL006	Northside Mine	6.8	44.7	U	16.1
BUR052	Little Sunset Mine	26.2	98.2	U	7.7
OSB032	Duluth Mine Blackcloud Creek	U	26.5	U	6.0
OSB033	Ruth Mine	6.4	23.8	U	6.9
OSB084	Blackcloud Creek Impacted Riparian	U	17.1	U	13.2
OSB085	Blackcloud Creek Impacted Riparian	4.9	325	U	465
Canyon Creek Watershed					
BUR089	Idaho and Eastern Mine	9.9	34.9	U	12.4
BUR132	Gertie Mine	8.6	19.5	U	6.0
BUR133	Russel Mine	4.9	33.3	U	11
BUR166	Unnamed Adit	24.5	187	11	45.9
BUR187	Unnamed Adit	5.1	21.2	4.9	31.4
THO023[b]	Unnamed Adit	--	--	--	--
East Fork Pine Creek Watershed					
MAS053	Unnamed Adits	8.7	32.3	7.2	15.7
West Fork Pine Creek Watershed					
TWI002	Palisade Mine Lower Workings	U	11.0	7.2	7.3
TWI008	West Pine Creek Deposit	5	22.5	4.9	6.1
TWI009	Equitable Prospect	5.7	11.0	U	U
TWI011	Unnamed Adit	5	18.3	U	3.5
TWI013	Bluebird Prospect (Hannibal)	76.3	46.3	85.5	27.9
TWI018	Unnamed Prospect	26.9	33.7	8.5	4.4
TWI020	Unnamed Adit	30.3	117	28	78.5
TWI029	Unnamed Adit	24.9	70.8	24.3	52.3
Mainstem SFCDR Watershed					
KLE023	Pioneer Mines Inc. Property	9.5	45.5	9.4	27
KLE070	Unnamed Adit	19	44	16	20
WAL024	War Eagle Mine	16	12.9	13	7.7
WAL046	Day Mines Claims	32.4	234	19	79.9
WAL055	Unnamed Adit	26.9	55.4	21	18.8
WAL056	Peerless Group (Osceola)	15	28	13	11
		26.3	9.2	12	U

TABLE 2

Sites not Included in Draft Selected Remedy based on 2011 Focused Characterization Sampling Results [a]

Addendum to the Draft Final Focused Feasibility Study Report, Upper Basin of the Coeur d'Alene River

Site ID	Site Name	<2.0 mm Soil Fraction		2.0-4.0 mm Soil Fraction	
		Arsenic (mg/kg)	Lead (mg/kg)	Arsenic (mg/kg)	Lead (mg/kg)
WAL057	Peerless Group	16	26.5	7	12
WAL058	Unnamed Adit	9.9	15.9	5.8	U
WAL062[b]	Unnamed Adit	--	--	--	--
WAL064	Unnamed Adit	6.1	56.3	U	28.6
WAL072[b]	Unnamed Adit	--	--	--	--
WAL073	Unnamed Adit	5.9	29.9	U	4.3
OSB030	Silverton Prospect Upper Adit	5.2	51.3	U	8.4
OSB073	Silverton Prospect Lower Adit	11	115	9.5	45.3
		12	50.8	U	5.2
OSB075	Unnamed Adit	26.4	100	24.9	43.1

Notes:

[a] Decision criteria established in the Upper Coeur d'Alene Basin Focused Characterization Sampling Quality Assurance Project Plan (QAPP) consisted of the following: (1) if there is no evidence of ore production and soil concentrations are greater than 530 mg/kg lead and/or 100 mg/kg arsenic, the site will be retained in the Upper Basin Selected Remedy; (2) if there is no evidence of ore production and soil concentrations are less than 530 mg/kg lead and/or 100 mg/kg arsenic, the site will be removed from the Upper Basin Selected Remedy.

[b] No waste piles or other mining disturbances were observed in the vicinity of the documented site location; therefore, the site was removed from the draft Selected Remedy.

-- = Not sampled
mg/kg = milligram(s) per kilogram
mm = millimeter
SFCDR = South Fork Coeur d'Alene River
U = Nondetect

TABLE 3

Summary of Differences between Alternative 3+(d) and Draft Selected Remedy: Hydraulic Isolation Actions along SFCDR between Wallace and Elizabeth Park

Addendum to the Draft Final Focused Feasibility Study Report, Upper Basin of the Coeur d'Alene River

		Actions Included in Alternative 3+(d)				Actions Included in Draft Selected Remedy			
Site ID	**Trait Description**	**TCD**	**TCD Description**	**Quantity**	**Units**	**TCD**	**TCD Description**	**Quantity**	**Units**
KLE048	Floodplain Sediments	C14c	Stream Lining	3,000	linear feet	C14c	Stream Lining	0	linear feet
KLE048	Floodplain Sediments	C15b	French Drain	3,000	linear feet	C15b	French Drain	0	linear feet
KLE048	Groundwater	WT01	Centralized HDS Treatment at CTP	598	gpm	WT01	Centralized HDS Treatment at CTP	0	gpm
KLE049	Floodplain Sediments	C14c	Stream Lining	2,500	linear feet	C14c	Stream Lining	0	linear feet
KLE049	Floodplain Sediments	C15b	French Drain	2,500	linear feet	C15b	French Drain	0	linear feet
KLE049	Groundwater	WT01	Centralized HDS Treatment at CTP	598	gpm	WT01	Centralized HDS Treatment at CTP	0	gpm
OSB065	Floodplain Sediments	C14c	Stream Lining	22,000	linear feet	C14c	Stream Lining	0	linear feet
OSB065	Floodplain Sediments	C15b	French Drain	22,000	linear feet	C15c	French Drain	4,600	linear feet
OSB065	Groundwater	WT01	Centralized HDS Treatment at CTP	598	gpm	WT01	Centralized HDS Treatment at CTP	3,900	gpm
OSB120	Floodplain Sediments	C14c	Stream Lining	14,000	linear feet	C14c	Stream Lining	0	linear feet
OSB120	Floodplain Sediments	C15b	French Drain	14,000	linear feet	C15b	French Drain	0	linear feet
OSB120	Groundwater	WT01	Centralized HDS Treatment at CTP	598	gpm	WT01	Centralized HDS Treatment at CTP	0	gpm
WAL004	Floodplain Sediments	C14c	Stream Lining	8,500	linear feet	C14c	Stream Lining	0	linear feet
WAL004	Floodplain Sediments	C15b	French Drain	8,500	linear feet	C15b	French Drain	0	linear feet
WAL004	Groundwater	WT01	Centralized HDS Treatment at CTP	598	gpm	WT01	Centralized HDS Treatment at CTP	0	gpm

Notes:

CTP = Central Treatment Plant
gpm = gallons per minute
HDS = high-density sludge
SFCDR = South Fork of the Coeur d'Alene River
TCD = typical conceptual design

TABLE 4

Summary of Differences between Alternative 3+(d) and Draft Selected Remedy: Ninemile Creek Watershed Remedial Action TCDs and Quantities

Addendum to the Draft Final Focused Feasibility Study Report, Upper Basin of the Coeur d'Alene River

Site ID	Site Name	TCD in Alternative 3+(d)	Direct Capital Cost Quantity in Alternative 3+(d) (cy)	TCD in Draft Selected Remedy	Direct Capital Cost Quantity in Draft Selected Remedy (cy)
BUR053	INTERSTATE-CALLAHAN MINE/ROCK DUMPS	C01+C04	692,000	C01+C07+HAUL-2	111,500
BUR055	INTERSTATE MILLSITE	C01b+C08a	5,500	C01b+C07+HAUL-2	30,700
BUR055	INTERSTATE MILLSITE	C01+C07	14,000	C01+C07+HAUL-2	78,200
BUR056	TAMARACK ROCK DUMPS	C02b	293,000	C01+C07+HAUL-2	253,600
BUR058	TAMARACK NO. 3	NONE	23,000	C01+C07+HAUL-2	13,500
BUR139	REX NO. 1	C03	-	C01+C07+HAUL-2	5,500
BUR140	NINEMILE CREEK IMPACTED FLOODPLAIN	C01b+C08a	10,000	C01b+C07+HAUL-2	10,000
BUR160	INTERSTATE-CALLAHAN LOWER ROCK DUMPS	C04	-	C01+C07+HAUL-2	74,100
BUR170	TAMARACK 400 LEVEL	C03	11,000	C01+C07+HAUL-2	17,700
BUR171	TAMARACK NO. 5	C03	-	C01+C07+HAUL-2	6,500
BUR172	TAMARACK UNNAMED ADIT	C03	-	C01+C07+HAUL-2	4,300
BUR173	TAMARACK MILLSITE	C01+C07	-	C01+C07+HAUL-2	5,200
OSB038	CALIFORNIA NO. 4	C01+C03	31,000	C01+C07+HAUL-2	15,100
OSB039	DAYROCK MINE	C01b+C08a+NONE	22,000	C01b+C07+HAUL-2	22,000
OSB039	DAYROCK MINE	C01+C07	11,000	C01+C07+HAUL-2	11,000
OSB040	EF NINEMILE CK HECLA REHAB	C01b+C08a+NONE	19,000	C01b+C07+HAUL-2	19,000
OSB044	SUCCESS MINE ROCK DUMP	C01b+C08a	10,000	C01b+C07+HAUL-2	4,300
OSB044	SUCCESS MINE ROCK DUMP	C02a	17,000	C01+C07+HAUL-2	7,300
OSB044	SUCCESS MINE ROCK DUMP	C01+C08a	360,000	C01+C07+HAUL-2	155,100
OSB056	EF NINEMILE CK IMPACTED RIPARIAN	C01b+C08a	1,600	C01b+C07+HAUL-2	1,600
OSB057	EF NINEMILE CK IMPACTED RIPARIAN	C01b+C08a	13,000	C01b+C07+HAUL-2	13,000
OSB058	EF NINEMILE CK SVNRT REHAB	C01b+C08a	1,600	C01b+C07+HAUL-2	1,600
OSB059	NINEMILE CK BELOW DAYROCK MINE	C01b+C08a	33,000	C01b+C07+HAUL-2	33,000
OSB060	NINEMILE CK SVNRT REHAB NEAR BLACKCLD	C01b+C07	800	C01b+C07+HAUL-2	800
OSB082	MONARCH MINE BLACKCLOUD CK	C01+C03	13,000	C01+C07+HAUL-2	13,000
OSB115	OPTION MINE	C01+C03	200	C01+C07+HAUL-2	300
WAL033	NINEMILE CK POTENTIAL TAILINGS DEPOSIT	C01b+C07+NONE	34,000	C01b+C07+HAUL-2	34,000

Notes:

The source IDs, names, trait descriptions, and estimated quantities are based on the inventory of source sites conducted by the Bureau of Land Management (BLM) in 1999 in support of the Remedial Investigation/Feasibility Study (RI/FS) for the Coeur d'Alene Basin.

cy = cubic yards

Typical Conceptual Design (TCD) Codes

C01 = Excavation (dry)
C01b = Excavation (60% dry, 40% wet)
C02a = Regrade/Consolidate/Revegetate: Lower Part of Pile in 100-Year Floodplain
C03 = Low-Permeability Cap
C04 = Low-Permeability Cap with Seepage Collection
C07 = Waste Consolidation Area Above Flood Level
C08a = Repository, 1 million cy
NONE = No Action
HAUL-2 = Haul to Repository

TABLE 5

Summary of Differences between Alternative 3+(d) and Draft Selected Remedy: Stream and Riparian Actions

Addendum to the Draft Final Focused Feasibility Study Report, Upper Basin of the Coeur d'Alene River

Watershed	Segment ID	Stream and Riparian Reach Included in Alternative 3+(d)	Stream and Riparian Reach Included in or Removed from Draft Selected Remedy	Rationale for Removal from Draft Selected Remedy
Big Creek	BigCrkSeg04	BIG04-2	Removed	No remedial actions included in draft Selected Remedy.
Big Creek	BigCrkSeg04	BIG04-3	Included	Not applicable.
Moon Creek	MoonCrkSeg01	MC01-2	Removed	No remedial actions included in draft Selected Remedy.
Moon Creek	MoonCrkSeg02	MC02-2	Included	Not applicable.
Moon Creek	MoonCrkSeg02	MC02-3	Included	Not applicable.
Moon Creek	MoonCrkSeg02	MC02-4	Included	Not applicable.
Pine Creek	PineCrkSeg03	PC03-1	Removed	No sediment removal actions included in draft Selected Remedy.
Pine Creek	PineCrkSeg03	PC03-2	Removed	No sediment removal actions included in draft Selected Remedy.
Pine Creek	PineCrkSeg03	PC03-3	Removed	No sediment removal actions included in draft Selected Remedy.
Upper SFCDR	UpperSFCDRSeg01	UG01-4	Removed	No remedial actions included in draft Selected Remedy.
Upper SFCDR	UpperSFCDRSeg01	UG01-5	Removed	No remedial actions included in draft Selected Remedy.
Upper SFCDR	UpperSFCDRSeg01	UG01-6	Removed	No remedial actions included in draft Selected Remedy.
Upper SFCDR	UpperSFCDRSeg01	UG01-7	Removed	No remedial actions included in draft Selected Remedy.
Upper SFCDR	UpperSFCDRSeg01	UG01-8	Removed	No remedial actions included in draft Selected Remedy.
Upper SFCDR	UpperSFCDRSeg01	UG01-9	Removed	Limited remedial action and sediment removal actions included in draft Selected Remedy.
Upper SFCDR	UpperSFCDRSeg01	UG01-10	Removed	No remedial actions included in draft Selected Remedy.
Upper SFCDR	UpperSFCDRSeg01	UG01-11	Removed	No remedial actions included in draft Selected Remedy.
Upper SFCDR	UpperSFCDRSeg01	UG01-12	Removed	Limited remedial action and sediment removal actions included in draft Selected Remedy.
Upper SFCDR	UpperSFCDRSeg01	UG01-13	Removed	Limited remedial action and sediment removal actions included in draft Selected Remedy.
Upper SFCDR	UpperSFCDRSeg01	UG01-14	Removed	Limited remedial action and sediment removal actions included in draft Selected Remedy.
Upper SFCDR	UpperSFCDRSeg01	UG01-15	Removed	Limited remedial action and sediment removal actions included in draft Selected Remedy.
Upper SFCDR	UpperSFCDRSeg01	UG01-16	Removed	Limited remedial action and sediment removal actions included in draft Selected Remedy.
Upper SFCDR	UpperSFCDRSeg01	UG01-17	Removed	Limited remedial action and sediment removal actions included in draft Selected Remedy.
Upper SFCDR	UpperSFCDRSeg01	UG01-18	Removed	Limited remedial action and sediment removal actions included in draft Selected Remedy.
Upper SFCDR	UpperSFCDRSeg01	UG01-19	Removed	Limited remedial action and sediment removal actions included in draft Selected Remedy.
Canyon Creek	CCSeg02	CC02-1	Included	Not applicable.
Canyon Creek	CCSeg04	CC04-1	Included	Not applicable.
Canyon Creek	CCSeg05	CC05-1	Included	Not applicable.
Canyon Creek	CCSeg05	CC05-2	Included	Not applicable.
Mainstem SFCDR	MIDGradSeg01	MG01-1	Removed	Infrastructure through Wallace. No sediment removal actions will occur.
Mainstem SFCDR	MIDGradSeg01	MG01-2	Removed	Infrastructure through Wallace. No sediment removal actions will occur.
Mainstem SFCDR	MIDGradSeg01	MG01-3	Removed	Infrastructure through Wallace. No sediment removal actions will occur.
Mainstem SFCDR	MIDGradSeg01	MG01-4	Included	Not applicable.
Mainstem SFCDR	MIDGradSeg01	MG01-5	Included	Not applicable.
Mainstem SFCDR	MIDGradSeg01	MG01-6	Included	Not applicable.
Mainstem SFCDR	MIDGradSeg01	MG01-7	Included	Not applicable.
Mainstem SFCDR	MIDGradSeg01	MG01-8	Included	Not applicable.
Mainstem SFCDR	MIDGradSeg01	MG01-9	Included	Not applicable.
Mainstem SFCDR	MIDGradSeg01	MG01-10	Included	Not applicable.
Mainstem SFCDR	MIDGradSeg01	MG01-11	Included	Not applicable.

TABLE 5

Summary of Differences between Alternative 3+(d) and Draft Selected Remedy: Stream and Riparian Actions

Addendum to the Draft Final Focused Feasibility Study Report, Upper Basin of the Coeur d'Alene River

Watershed	Segment ID	Stream and Riparian Reach Included in Alternative 3+(d)	Stream and Riparian Reach Included in or Removed from Draft Selected Remedy	Rationale for Removal from Draft Selected Remedy
Mainstem SFCDR	MIDGradSeg01	MG01-12	Included	Not applicable.
Mainstem SFCDR	MIDGradSeg01	MG01-13	Included	Not applicable.
Mainstem SFCDR	MIDGradSeg01	MG01-14	Included	Not applicable.
Mainstem SFCDR	MIDGradSeg01	MG01-15	Included	Not applicable.
Mainstem SFCDR	MIDGradSeg01	MG01-16	Included	Not applicable.
Mainstem SFCDR	MIDGradSeg01	MG01-17	Included	Not applicable.
Mainstem SFCDR	MIDGradSeg01	MG01-18	Included	Not applicable.
Mainstem SFCDR	MIDGradSeg02	MG02-10	Removed	No remedial actions included in draft Selected Remedy.
Mainstem SFCDR	MIDGradSeg02	MG02-11	Removed	No remedial actions included in draft Selected Remedy.
Mainstem SFCDR	MIDGradSeg02	MG02-12	Removed	No remedial actions included in draft Selected Remedy.
Ninemile Creek	NMSeg01	NM01-1	Included	Not applicable.
Ninemile Creek	NMSeg02	NM02-1	Included	Not applicable.
Ninemile Creek	NMSeg03	NM03-1	Removed	No remedial actions included in draft Selected Remedy.
Ninemile Creek	NMSeg04	NM04-1	Included	Not applicable.
Ninemile Creek	NMSeg04	NM04-2	Included	Not applicable.
Ninemile Creek	NMSeg04	NM04-3	Included	Not applicable.

Note:

SFCDR = South Fork Coeur d'Alene River

Attachments

ATTACHMENT 1

Technical Memorandum: Upper Coeur d'Alene Basin 2011 Focused Characterization Sampling: Results from Selected Mine and Mill Sites

Upper Coeur d'Alene Basin 2011 Focused Characterization Sampling: Results from Selected Mine and Mill Sites

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DATE: May 25, 2012

1.0 Introduction

This Technical Memorandum (TM) presents the background, methodology, and results of the Focused Characterization Sampling Program conducted in the Upper Basin of the Coeur d'Alene River from June through August 2011. The Program was conducted at selected mine and mill sites included in the U.S. Environmental Protection Agency's (EPA's) Preferred Remedial Alternative that was presented in the Proposed Plan for the Upper Basin (EPA, 2010). The Program was a cooperative effort involving EPA, the Basin Environmental Improvement Project Commission's Upper Basin Project Focus Team (PFT), the Idaho Department of Environmental Quality (IDEQ), the U.S. Department of the Interior Bureau of Land Management (BLM), and the Asarco Trust group.

The objective of the 2011 Focused Characterization Sampling Program was to obtain information on selected "Contingent Sites" (defined below) by using screening criteria to evaluate whether the sites need to be addressed by remedial actions at this time.

2.0 Background

EPA's Preferred Remedial Alternative presented in the Proposed Plan included proposed remedial actions at 345 mine and mill source sites[1] in the Upper Basin. The Upper Basin boundary is shown in Figure 1.[2] During the public review process for the Proposed Plan, some comments were received suggesting that EPA should further prioritize the cleanup actions included in the Preferred Remedial Alternative, and that some of the listed mine and mill sites may not require remedial actions if additional site characterization and analytical

[1] The Proposed Plan (EPA, 2010) stated that the Preferred Remedial Alternative for OU 3 (Alternative 3+) included 348 sites. This total inadvertently included three sites in Canyon Creek (WAL007, WAL008, and WAL012) that were included in Alternative 4+ but not in Alternative 3+. Therefore, the correct number of mine and mill sites in the Preferred Remedial Alternative is 345.

[2] Referenced figures are provided following Section 7.0, References.

data are collected and compared with site cleanup goals. EPA considered these comments and further evaluated whether the scope of remedial actions should be reduced. The first two stages of this process included grouping sites into categories and subsequent focused characterization sampling, which are described below.

In coordination with the Upper Basin PFT and the overall Basin Commission, EPA grouped the source sites included in the Preferred Remedial Alternative into the following categories:

- **Strong Consensus Sites:** Mine and mill sites where (1) available data have confirmed the presence of contamination and that risks to human health and/or the environment are above acceptable exposure levels, and (2) there is strong agreement among project stakeholders and community representatives that remedial actions are required and appropriate.
- **Active Sites:** Mine and mill sites where active industrial and/or commercial activities are currently occurring, and the owners or activities on these sites currently manage the risk of a release, or potential release, of hazardous substances through regulatory mechanisms outside the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) that enforce compliance with requirements to protect human health and the environment.
- **Remediated Sites:** Mine and mill sites where previous removal or remedial actions have been conducted, remedial effectiveness monitoring is ongoing and subject to CERCLA Five-Year Review requirements, and the need for additional actions has yet to be determined.
- **Contingent Sites:** Mine and mill sites where (1) there may be localized adverse impacts, but the sites are typically located in drainage areas with water quality that is close to or meets cleanup criteria; and/or (2) additional information is needed to make informed remedial decisions.

To establish a process for obtaining needed additional information, EPA, the Upper Basin PFT, IDEQ, BLM, and the Asarco Trust implemented the 2011 Focused Characterization Sampling Program that is described in the remaining sections of this TM.

3.0 Selection of Sites for Focused Characterization Sampling

In conjunction with the Upper Basin PFT, EPA developed a list of 83 candidate mine and mill sites from the Contingent Sites list that needed further characterization to evaluate whether the sites required remedial action at this time. Table 1 lists these 83 candidate sites.[3]

Screening and decision criteria were developed by EPA and the PFT to guide site selection, data collection, and data use. The criteria are shown in Figure 2 and described below. A desktop review of the available information for each site was conducted to establish a subset of sites that were considered for inclusion in the 2011 Focused Characterization Sampling Program.

[3] Referenced tables are presented at the end of this TM, following the figures.

- Step 1: Historical information was reviewed to identify whether ore production had occurred at each candidate site. It was agreed by EPA and the PFT that if ore production had occurred and was documented, this information was sufficient to conclude that waste piles likely existed at the site that were probable sources of contamination; therefore, it would not be necessary to include that site in the Focused Characterization Sampling Program. Sources of information included BLM and Idaho Geological Survey reports, historical reports, and documents at the Wallace District Mining Museum located in Wallace, Idaho.
- Step 2: The information obtained about ore production was evaluated as follows:
  - If ore production had occurred at a site, the site was excluded from the 2011 Focused Characterization Sampling Program and retained for potential remedial action, with the acknowledgement that additional data review and/or characterization of this site may be performed in the future.
  - The information obtained indicated that ore production had occurred at nine of the 83 candidate Contingent Sites. These nine sites, which are shown in boldface in Table 1, were not included in the 2011 Focused Characterization Sampling Program.
  - If ore production did not occur at a site, the site was included in the 2011 Focused Characterization Sampling Program.

As described in Section 4.0, the field effort for the Program consisted of a physical site inspection and soil sampling of waste piles for arsenic and lead. The field sampling data were reviewed, and arsenic and lead concentrations were compared to decision criteria. The results are presented in full in Section 5.0 and summarized in Section 6.0.

4.0 Field Activities

As the result of the screening described above, 74 sites were selected for inclusion in the 2011 Focused Characterization Sampling Program. Of those 74 sites, 41 were located on public land (i.e., owned by BLM and the U.S. Forest Service) and 33 were located on privately owned property. EPA was able to obtain access agreements with landowners for 24 of the privately owned sites, but was not able to secure such agreements for nine of those sites. Therefore, the total number of sites available to conduct the Focused Characterization Sampling was reduced from 74 to 65.

Sampling was actually conducted at 53 of those 65 sites. Fourteen sites were not sampled because of either access difficulties or lack of time to conduct sampling before the end-of-August deadline, while two additional sites were sampled inadvertently.[4] Therefore, the total number of sampled sites for which data were evaluated as part of the Focused Characterization Sampling Program was 51. The sites are listed in Table 1. Also as indicated in Table 1, no evidence of mining activity was observed at three mine sites (THO023 in the

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[4] As documented in Table 2, sampling was mistakenly conducted at two sites (THO018 and WAL063) that were not included in EPA's Preferred Remedial Alternative presented in the Upper Basin Proposed Plan (EPA, 2010) or in the Quality Assurance Project Plan (QAPP) for the Upper Basin Focused Characterization Sampling (CH2M HILL, 2011). These two sites are not included in the decisionmaking process for identifying sites that will be addressed during implementation of the Upper Basin Selected Remedy.

Canyon Creek Watershed, and WAL062 and WAL072 in the Mainstem South Fork Coeur d'Alene River [SFCDR] Watershed).

The number of sites sampled in each of the primary Upper Basin watersheds is indicated below, and the sites are shown by watershed on Figures 3 through 9 respectively.

- Upper SFCDR Watershed – 3 sites
- Canyon Creek Watershed – 9 sites
- Ninemile Creek Watershed – 7 sites
- Big Creek Watershed – 1 site
- Moon Creek Watershed – 4 sites
- Pine Creek Watershed – 13 sites
- Mainstem SFCDR Watershed – 14 sites

Field activities conducted at the sites consisted of a physical site inspection and soil sampling of waste piles. The physical site inspection was conducted to document the general physical features and characteristics of each site to identify any evidence of ore. The inspection also recorded features pertinent to determination of risk and the release (or threatened release) of potential hazardous substances from historical mining activities, such as waste pile erosion, the proximity of waste piles to surface water, the condition and coverage of vegetation, and identification of potential receptors.

Soil sampling was conducted at each waste pile to characterize arsenic and lead concentrations using a multi-incremental sampling approach as described in the *Quality Assurance Project Plan, Upper Coeur d'Alene Basin Focused Characterization Sampling, Shoshone County, Idaho* (QAPP; CHM HILL, 2011). A total of 30 individual samples were collected and uniformly spaced across each waste pile from the ground surface to 1 foot below grade. The individual samples were then composited into a single sample. The composited soil samples were submitted to the EPA Region 10 Manchester Environmental Laboratory for size fractioning (<2.0 millimeters [mm] and 2.0 to 4.0 mm) analysis for Target Analyte List (TAL) metals.

5.0 Analytical Results

Table 2 lists the arsenic and lead concentrations detected in the two soil fractions of each composited soil sample collected. Table 2 also identifies (with boldfacing) whether or not the metals concentrations exceeded decision criteria, which would result in the following:

- If there was no evidence of ore production and metals concentrations in soil were greater than 530 mg/kg for lead and/or 100 mg/kg for arsenic, the site would be retained for potential remedial action.
- If there was no evidence of ore production and metals concentrations in soil were lower than the decision criteria indicated above, the site would be removed from further consideration for remedial action at this time.

The following sections summarize the analytical results by primary Upper Basin watershed. The sampling locations are shown on Figures 3 through 9, which also indicate whether arsenic and/or lead concentrations were above or below the decision criteria.

5.1 Upper SFCDR Watershed

Of the three sites in the Upper SFCDR Watershed where focused characterization soil samples were collected from waste piles, arsenic and lead concentrations were below the decision criteria at two sites. At site MUL006, arsenic and lead concentrations exceeded the decision criteria of 100 mg/kg and 530 mg/kg, respectively, in both soil fractions.

5.2 Canyon Creek Watershed

At the nine sites in the Canyon Creek Watershed where samples were collected, arsenic concentrations did not exceed the decision criterion of 100 mg/kg. Lead concentrations exceeded the decision criterion of 530 mg/kg at four sites (BUR105, BUR134, BUR149, and BUR150) in the <2.0 mm soil fraction. Lead concentrations also exceeded the criterion in the 2.0 to 2.4 mm soil fraction at sites BUR105 and BUR149.

5.3 Ninemile Creek Watershed

At the seven sites in the Ninemile Creek Watershed where samples were collected, arsenic concentrations did not exceed the decision criterion. Lead concentrations exceeded the decision criterion at one site (OSB048) in both soil fractions.

5.4 Big Creek Watershed

Neither arsenic nor lead exceeded their respective decision criteria in the one soil sample collected from the Big Creek Watershed, in either soil fraction.

5.5 Moon Creek Watershed

At the four sites in the Moon Creek Watershed where samples were collected, lead concentrations did not exceed the decision criterion of 530 mg/kg. Arsenic concentrations exceeded the decision criterion of 100 mg/kg at one site (KLE064) in both soil fractions.

5.6 Pine Creek Watershed

At the 13 sites in the Pine Creek Watershed where samples were collected, lead concentrations did not exceed the decision criterion. Arsenic concentrations exceeded the decision criterion at four sites (MAS031 in the East Fork, and TWI012, TWI014, and TWI030 in the West Fork) in the <2.0 mm soil fraction. Arsenic concentrations also exceeded the criterion in the 2.0 to 2.4 mm soil fraction at sites TWI012 and TWI014.

5.7 Mainstem SFCDR Watershed

At the 14 sites in the Mainstem SFCDR Watershed where soil samples were collected, lead concentrations did not exceed the decision criterion. Arsenic concentrations exceeded the decision criterion at one site (KLE016) in both soil fractions.

6.0 Summary of Results

The purpose of the 2011 Focused Characterization Sampling Program was to gather information and data with which to retain sites in or remove sites from the Upper Basin

Preferred Remedial Alternative presented in the Upper Basin Proposed Plan (EPA, 2010). As described in Section 3.0 and illustrated in Figure 2, screening and decision criteria were established to support these potential revisions. The results of the 2011 Focused Characterization Sampling Program indicated the following:

- Arsenic and/or lead concentrations at a total of 39 sites did not exceed the decision criteria. These 39 sites, listed in Table 3, are therefore removed from further consideration for remedial action at this time. The locations of these sites are shown on Figures 3 through 9.
- Also as indicated in Table 3, no evidence of mining activity was observed at three mine sites (THO023 in the Canyon Creek Watershed, and WAL062 and WAL072 in the Mainstem SFCDR Watershed). These sites are also removed from further consideration for remedial action at this time. The locations of these sites are shown on Figures 4 and 9.
- Arsenic and/or lead concentrations at a total of 12 sites exceeded the decision criteria. These 12 sites, listed in Table 4, are therefore retained for potential remedial action. The locations of these sites are shown on Figures 3 through 5 and 7 through 9. (Big Creek, shown in Figure 6, is the only major Upper Basin watershed with no sites in this category.)

Table 5 details these results and accounts for sites using elements of the screening and decision criteria process. In summary, the results of the 2011 Field Characterization Sampling Program for selected mine and mill sites in the Upper Basin indicate that 42 sites and their associated remedial actions should be removed from further consideration for remedial action at this time.

Additional subsequent steps were taken by EPA to further reduce the scope of the Selected Remedy that will be documented in the forthcoming Record of Decision (ROD) Amendment for the Upper Basin of the Coeur d'Alene River. Discussion of the Selected Remedy scope reduction is provided in the *Technical Memorandum: Evaluation of Mine and Mill Source Sites for Removal from the Forthcoming Upper Basin ROD Amendment* (CH2M HILL, 2012).

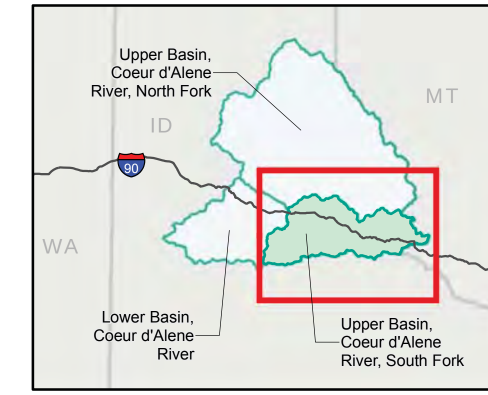
7.0 References

CH2M HILL. April 2011. *Quality Assurance Project Plan, Upper Coeur d'Alene Basin Focused Characterization Sampling, Shoshone County, Idaho.* Prepared for U.S. Environmental Protection Agency Region 10.

CH2M HILL. March 21, 2012. *Draft Technical Memorandum: Evaluation of Mine and Mill Source Sites for Removal from the Forthcoming Upper Basin ROD Amendment.* Prepared for U.S. Environmental Protection Agency Region 10.

U.S. Environmental Protection Agency (EPA). July 12, 2010. *Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Mining and Metallurgical Complex Superfund Site.*

Figures



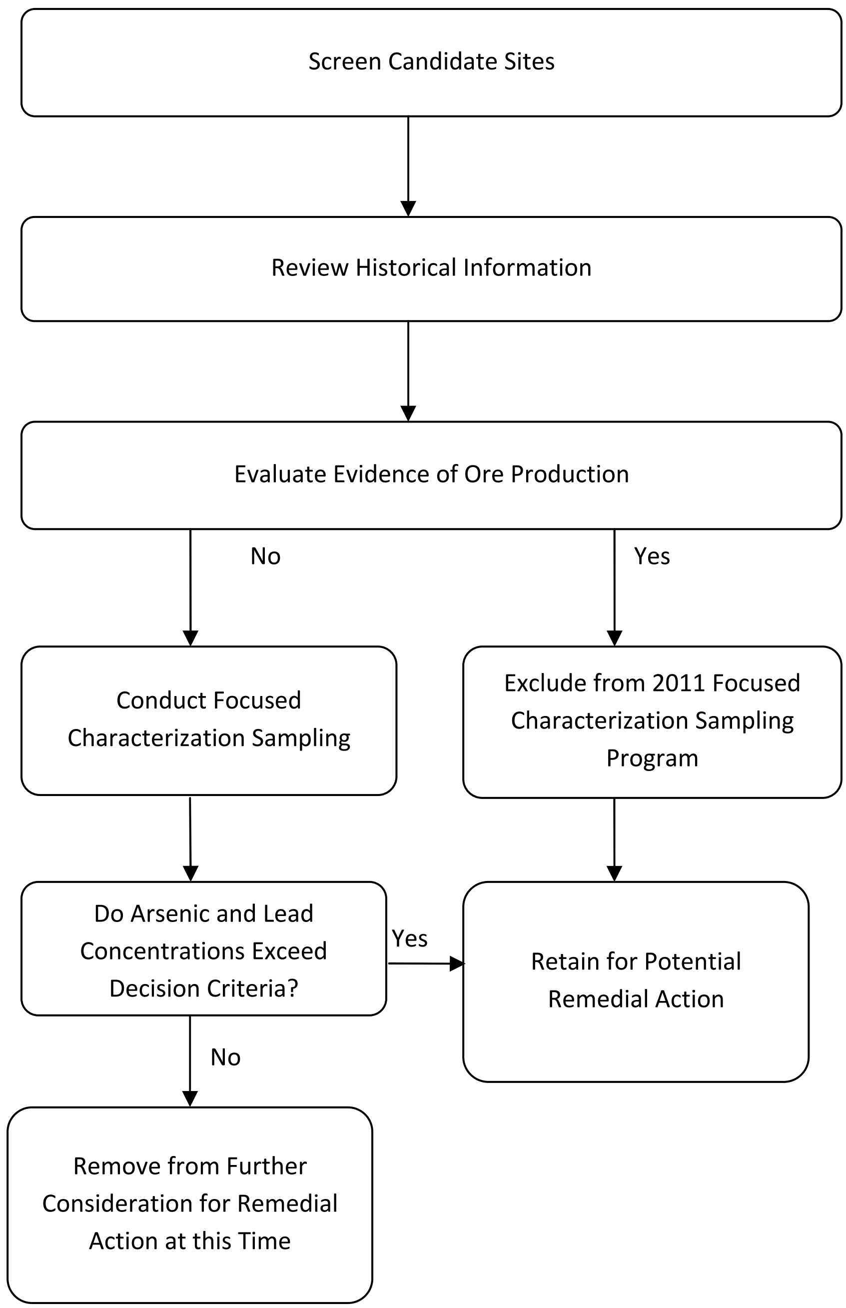
Candidate Site
City Limit
Coeur d'Alene River Subbasin Boundary
State Boundary

Source: ESRI World Imagery

N
0 1 2 4 Miles

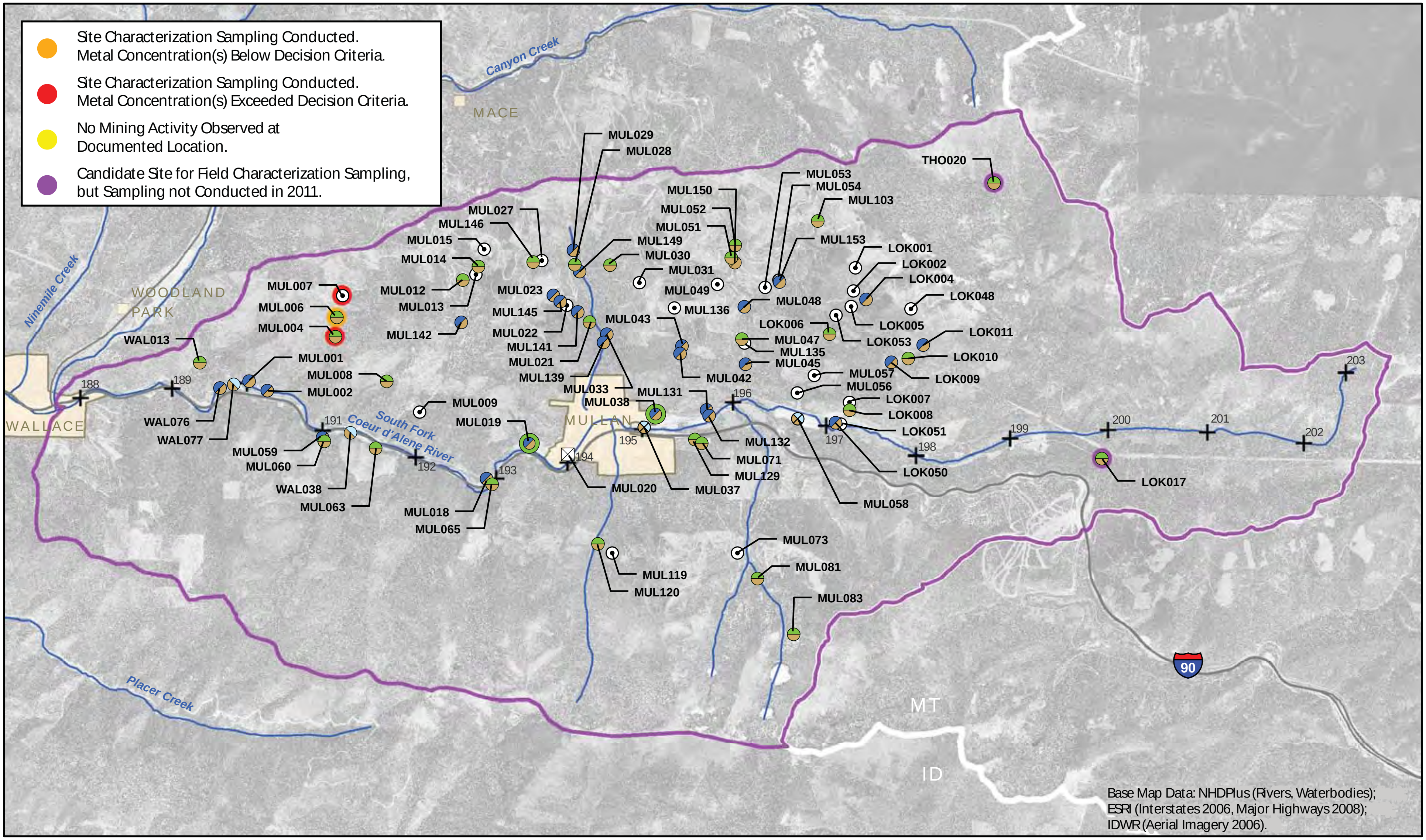
Figure 1
Location Map
Upper Coeur d'Alene Basin
2011 Focused Characterization Sampling
BUNKER HILL SUPERFUND SITE

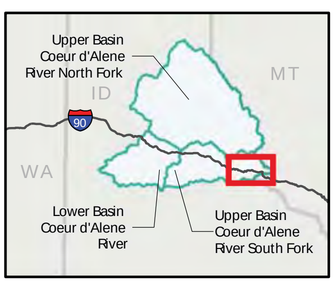
EPA



Note: Sites with no evidence of mining were also considered for removal from the Preferred Remedial Alternative for the Upper Basin.

Figure 2
Screening and Decision Criteria for Candidate Sites
Upper Coeur d'Alene Basin
2011 Focused Characterization Sampling
BUNKER HILL SUPERFUND SITE
EPA





Remedial Action Types Identified in Proposed Plan:

- Excavation/Cap
- Excavation/Cap/Local Waste Consolidation Area
- Excavation/Local Waste Consolidation Area
- Excavation/Repository
- Excavation/Repository; Impoundment Closure
- Impoundment Closure; Hydraulic Isolation
- Regrade/Consolidate/Revegetate
- **LOK011** (Site ID)

- River Mile (20)
- River/Creek
- Watershed Segment
- City Limit
- State Boundary

N

0 0.5 1 Miles

Figure 3
Sites Included in the Focused Characterization Sampling Program: Upper SFCDR Watershed
Upper Coeur d'Alene Basin
2011 Focused Characterization Sampling
BUNKER HILL SUPERFUND SITE

EPA

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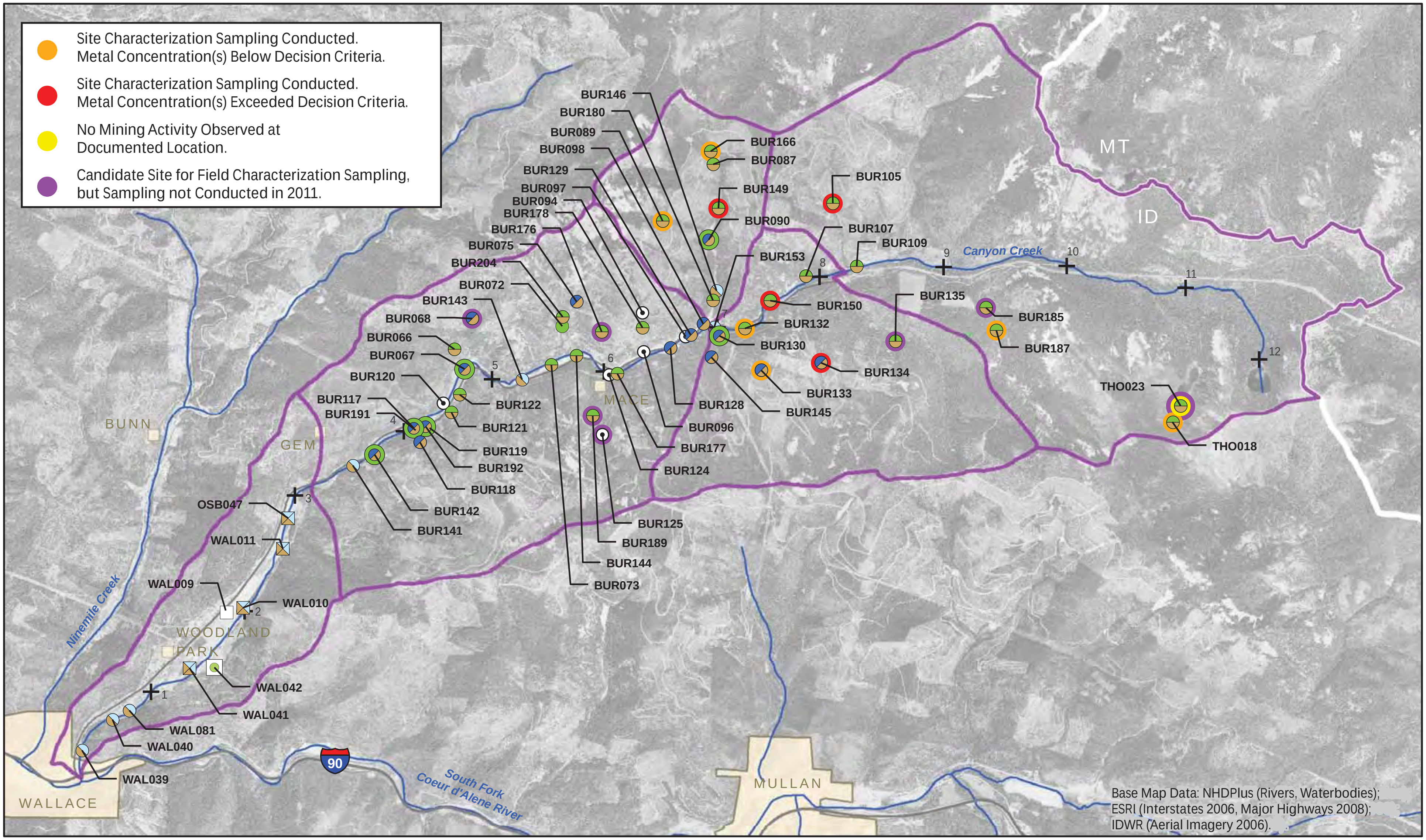

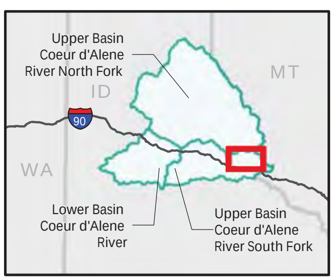

Remedial Action Types Identified in Proposed Plan:

- Cap/Hydraulic Isolation
- Cap
- Excavation/Cap
- Excavation/Cap/Local Waste Consolidation Area
- Excavation/Local Waste Consolidation Area
- Excavation Repository
- Excavation Repository; Hydraulic Isolation
- Hydraulic Isolation
- Regrade/Consolidate/Revegetate
- **BUR187** (Site ID)

- River Mile
- River/Creek
- Watershed Segment
- City Limit
- State Boundary

N

0 0.5 1 Miles

Figure 4
Sites Included in the Focused Characterization Sampling Program: Canyon Creek Watershed
Upper Coeur d'Alene Basin
2011 Focused Characterization Sampling
BUNKER HILL SUPERFUND SITE

EPA

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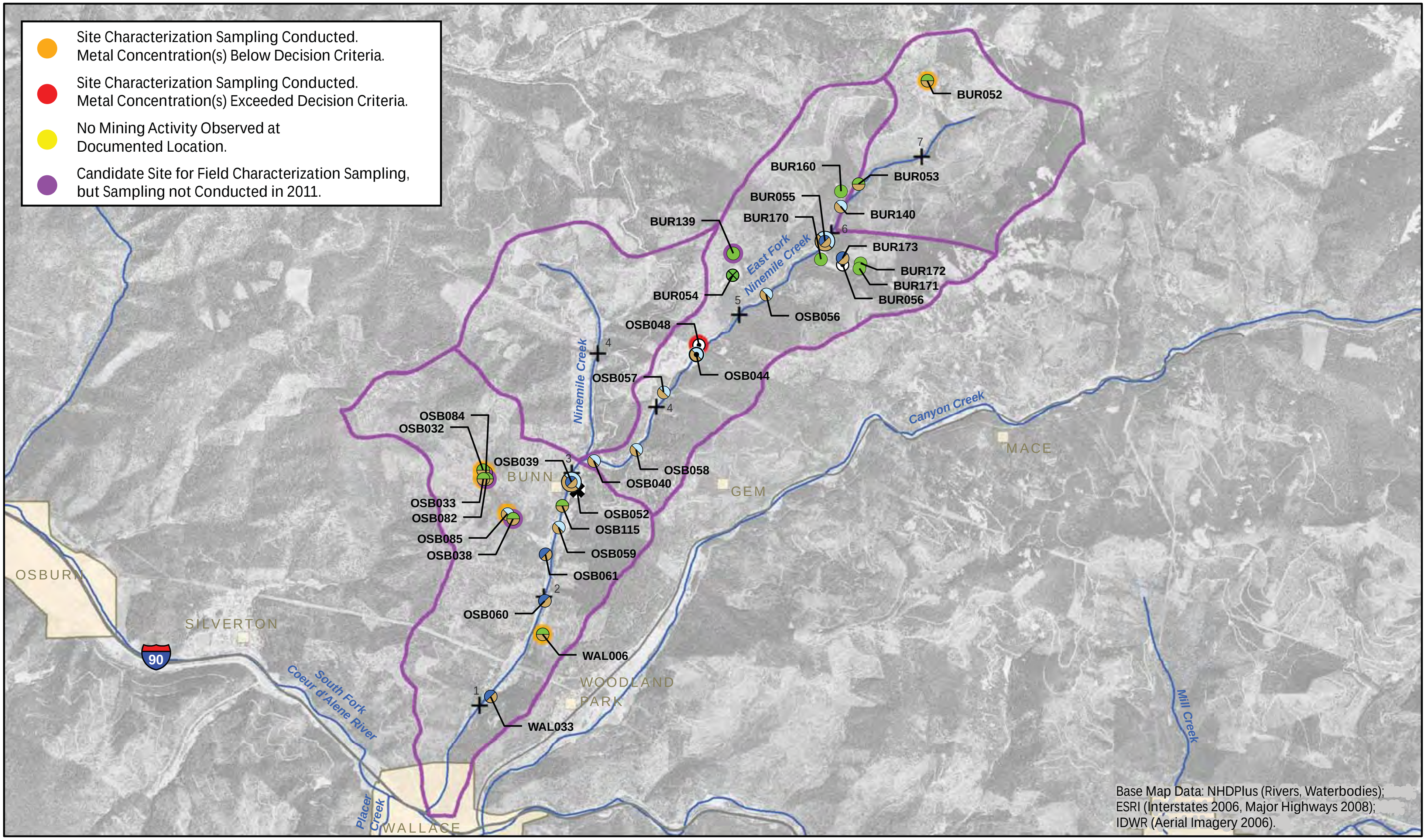

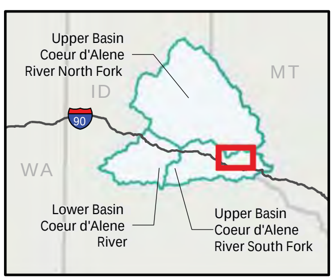

Remedial Action Types Identified in Proposed Plan:

- Cap
- Cap; Impoundment Closure
- Excavation/Cap
- Excavation/Local Waste Consolidation Area
- Excavation/Local Waste Consolidation Area; Excavation/Repository
- Excavation/Repository
- Excavation/Repository; Regrade/Consolidate/ Revegetate
- Impoundment Closure
- Regrade/Consolidate/ Revegetate
- **BUR139** (Site ID)

- River Mile
- River/Creek
- Watershed Segment
- City Limit

N

0 0.5 1 Miles

Figure 5
Sites Included in the Focused Characterization Sampling Program: Ninemile Creek Watershed
Upper Coeur d'Alene Basin
2011 Focused Characterization Sampling
BUNKER HILL SUPERFUND SITE

EPA

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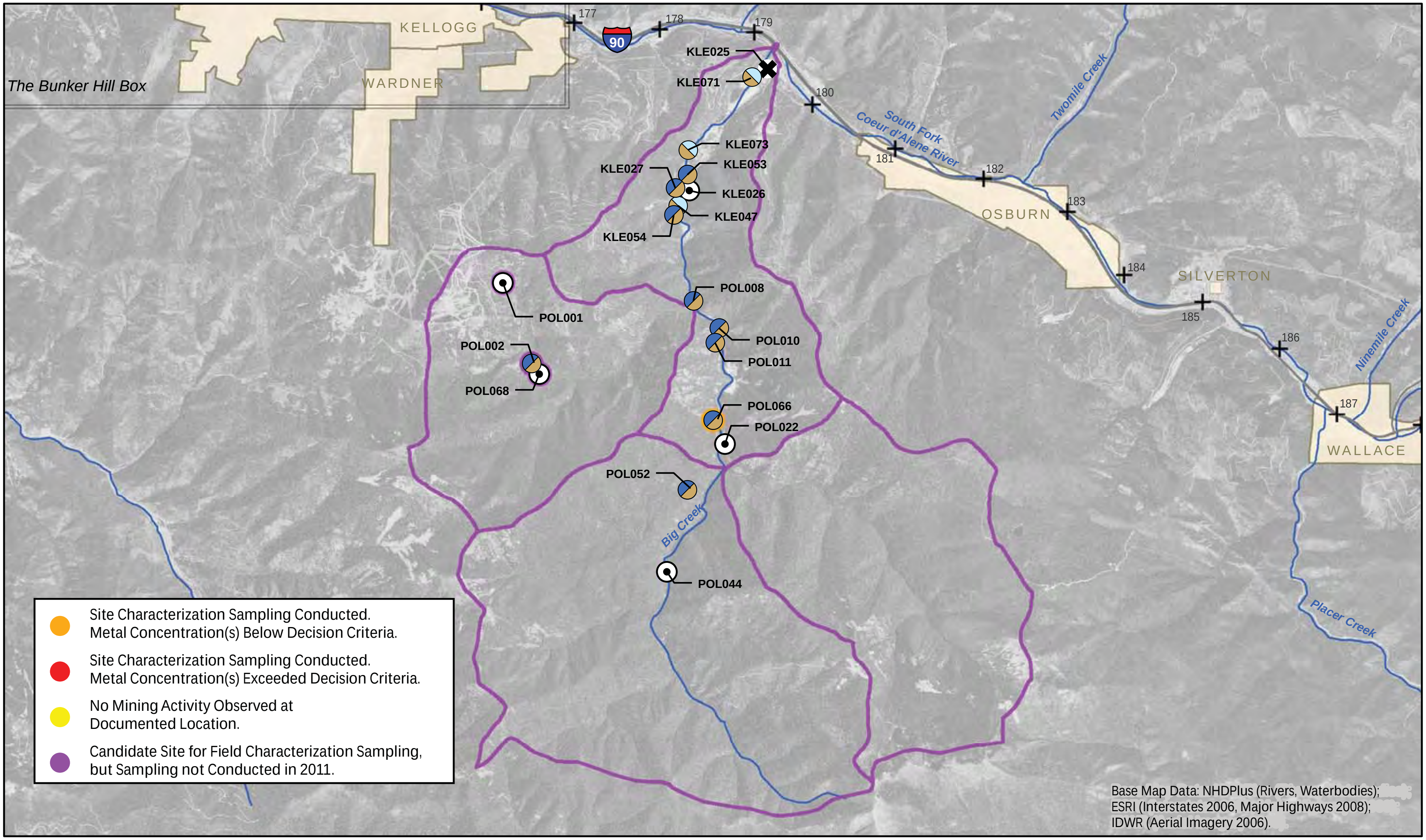

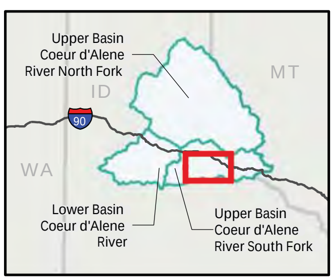

Remedial Action Types Identified in Proposed Plan:

- Excavation/Local Waste Consolidation Area
- Excavation/Regional Repository
- Impoundment Closure
- Regrade/Consolidate/Revegetate
- **POL010** (Site ID)

- 184 River Mile
- River/Creek
- Watershed Segment
- City Limit

N 0 0.5 1 Miles

Figure 6
Sites Included in the Focused Characterization Sampling Program: Big Creek Watershed
Upper Coeur d'Alene Basin
2011 Focused Characterization Sampling
BUNKER HILL SUPERFUND SITE

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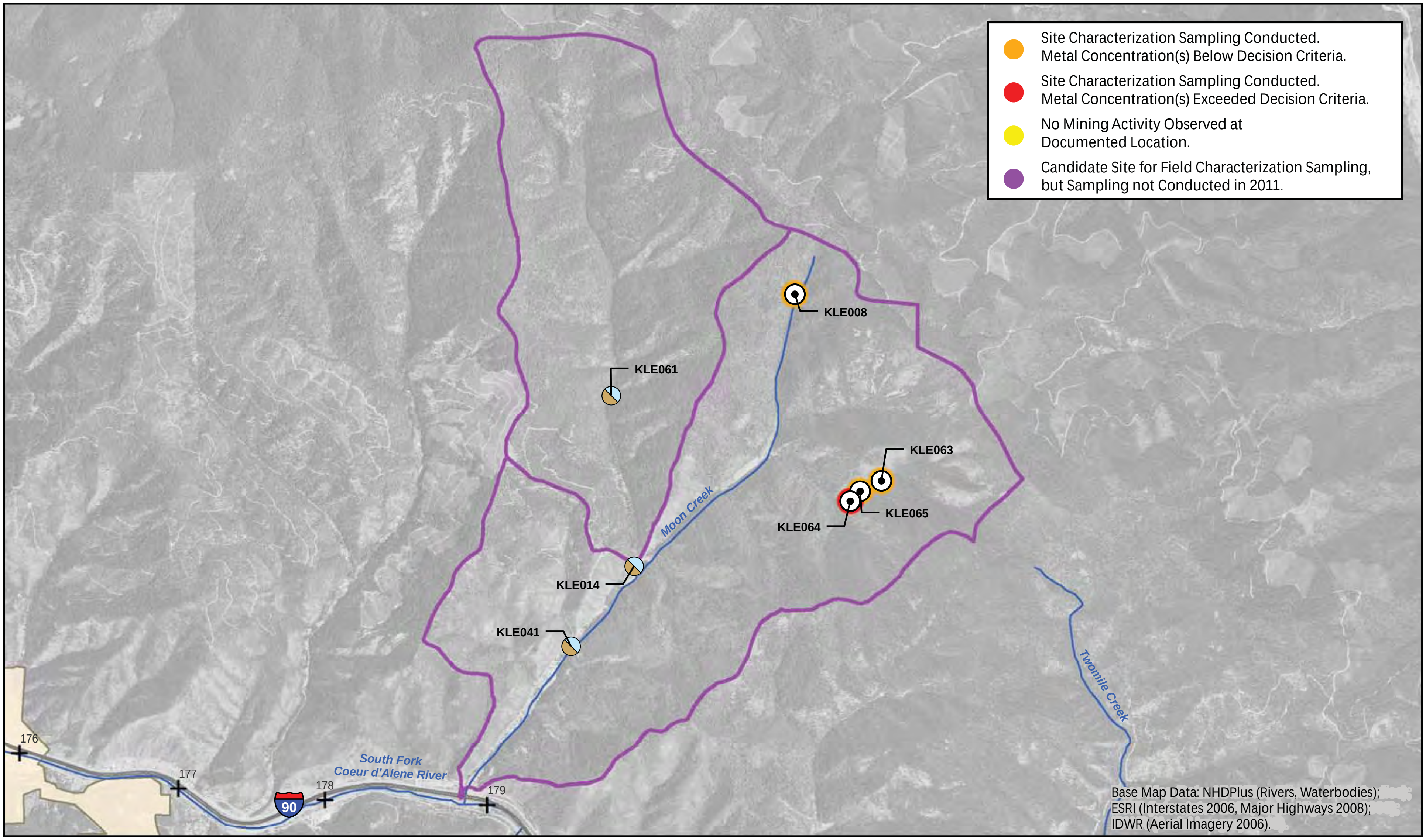

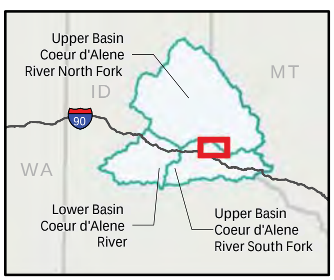

Remedial Action Types Identified in Proposed Plan:

- Excavation/Regional Repository
- Regrade/Consolidate/Revegetate
- **KLE063** (Site ID)

- 179 River Mile
- River/Creek
- Watershed Segment
- City Limit

N

0 0.5 1 Miles

Figure 7
Sites Included in the Focused Characterization Sampling Program: Moon Creek Watershed
Upper Coeur d'Alene Basin
2011 Focused Characterization Sampling
BUNKER HILL SUPERFUND SITE

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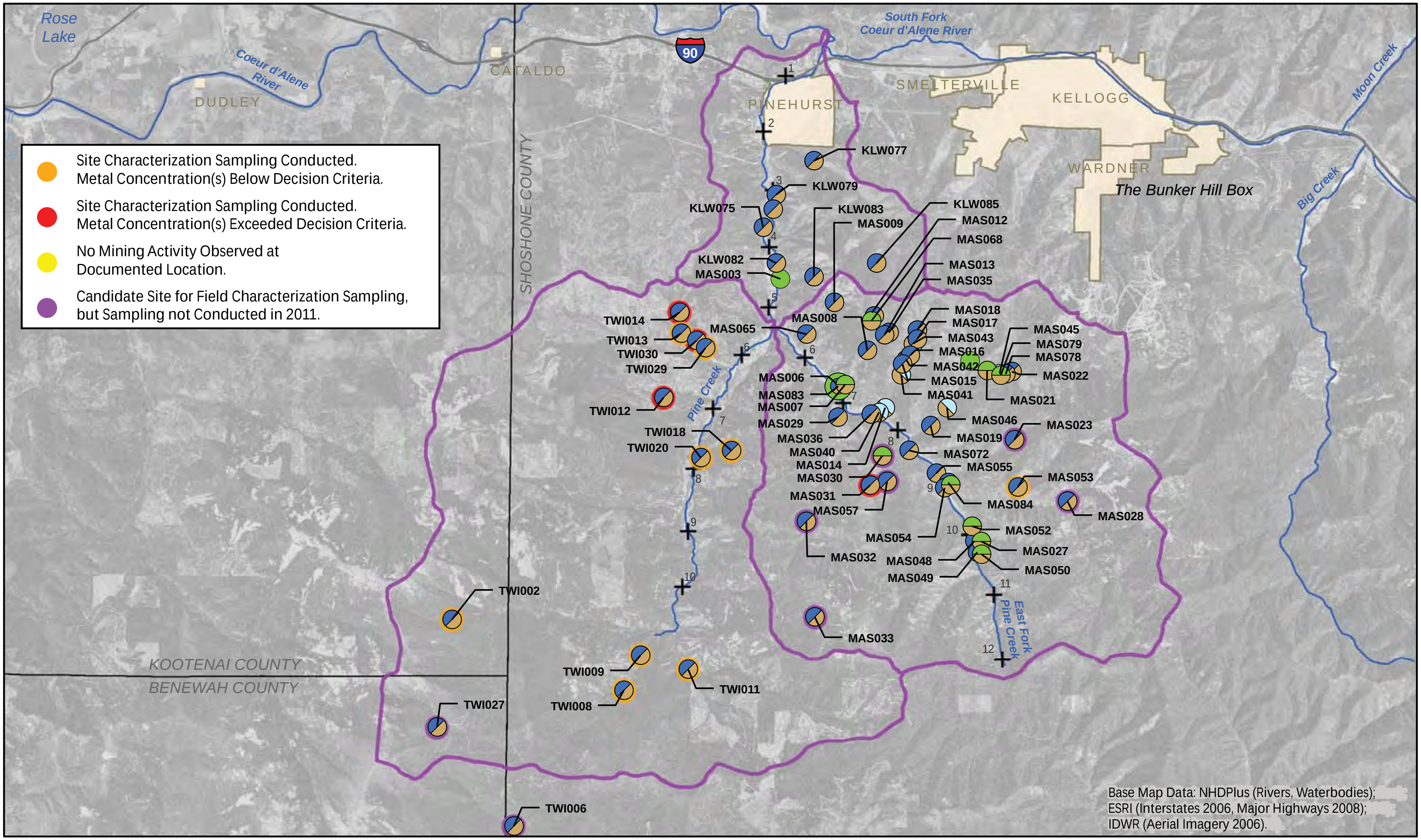

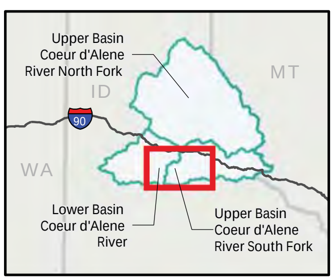

Remedial Action Types Identified in Proposed Plan:

- Cap
- Excavation/Cap
- Excavation/Cap/ Local Repository
- Excavation/Local Repository
- Excavation/Regional Repository
- Impoundment Closure
- **MAS023** (Site ID)
- River Mile
- River/Creek
- Watershed Segment
- City Limit
- County Boundary

N

0 1 2 Miles

Figure 8
Sites Included in the Focused Characterization Sampling Program: Pine Creek Watershed
Upper Coeur d'Alene Basin
2011 Focused Characterization Sampling
BUNKER HILL SUPERFUND SITE

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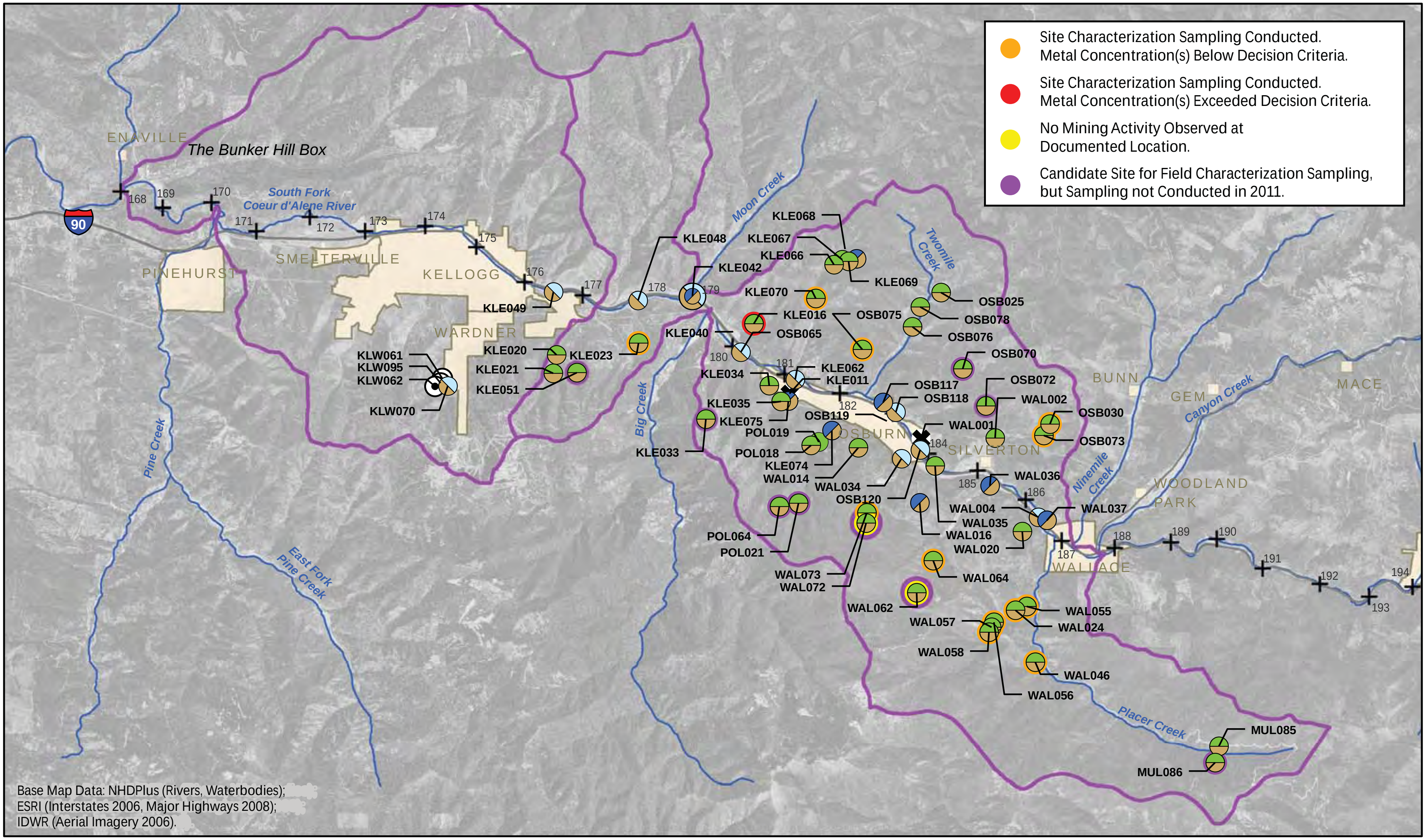

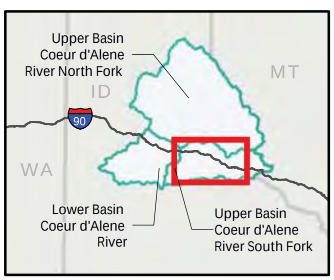

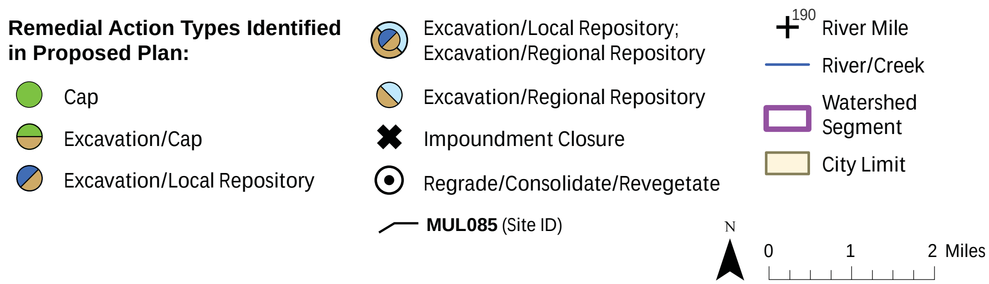

Figure 9
Sites Included in the Focused Characterization Sampling Program: Mainstem SFCDR Watershed
Upper Coeur d'Alene Basin
2011 Focused Characterization Sampling
BUNKER HILL SUPERFUND SITE

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Tables

TABLE 1

List of Candidate Contingent Sites

Upper Coeur d'Alene Basin 2011 Focused Characterization Sampling, Bunker Hill Superfund Site

BLM Site ID	Site Name	Characterization Sampling Conducted
Upper SFCDR Watershed		
LOK017	**Beacon Light**	
MUL004	United Lead Zinc Mine	X
MUL006	Square Deal Mine	X
MUL007	Wonder Mine	X
THO020	Bull Frog Mine	
Canyon Creek Watershed		
THO023	Unnamed Adit	
BUR068	Headlight Mine	
BUR089	Idaho and Eastern Mine	X
BUR105	Oom Paul No. 2	X
BUR125	Midway Summit	
BUR132	Gertie Mine	X
BUR133	Russel Mine	X
BUR134	Alcides Prospect and Imperial Mine	X
BUR135	**Sonora Mine**	
BUR149	Ajax No. 2 Adjacent Rock Dump	X
BUR150	Garbage Dump	X
BUR166	Unnamed Adit	X
BUR176	Unnamed Adit	
BUR185	**West Mammoth Mine**	
BUR187	Unnamed Adit	X
BUR189	Duluth Mine Canyon Creek	
Ninemile Creek Watershed		
WAL006	Northside Mine	X
BUR052	Little Sunset Mine	X
BUR139	**Rex No. 1**	
OSB032	Duluth Mine Blackcloud Creek	X
OSB033	Ruth Mine	X
OSB038	**California No. 4**	
OSB048	American Mine	X
OSB082	**Monarch Mine Blackcloud Creek**	
OSB084	Blackcloud Creek Impacted Riparian	X
OSB085	Blackcloud Creek Impacted Riparian	X
Big Creek Watershed		
POL001	Sunshine Consolidated Rockford Group	
POL002	Silver Dale and Big Hill Mine	
POL066	Unnamed Adit	X
POL068	Unnamed Adit	
Moon Creek Watershed		
KLE008	Maine-Standard Mine	X
KLE063	Unnamed Adit	X
KLE064	Unnamed Adit	X
KLE065	Unnamed Adits	X
Pine Creek Watershed (East Fork)		
MAS023	Blue Eagle Mine	
MAS028	Lon Chaney Group	
MAS030	Trapper Creek Silver	
MAS031	Trapper Mining & Smelting Company Ltd.	X
MAS032	L and J Prospect	
MAS033	Coeur d'Alene Premier	
MAS053	Unnamed Adits	X

TABLE 1

List of Candidate Contingent Sites

Upper Coeur d'Alene Basin 2011 Focused Characterization Sampling, Bunker Hill Superfund Site

BLM Site ID	Site Name	Characterization Sampling Conducted
MAS057	Unnamed Adit	
Pine Creek Watershed (West Fork)		
TWI002	Palisade Mine Lower Workings	X
TWI006	Manhattan Mine	
TWI008	West Pine Creek Deposit	X
TWI009	Equitable Prospect	X
TWI011	Unnamed Adit	X
TWI012	KC Prospect	X
TWI013	Bluebird Prospect (Hannibal)	X
TWI014	Great Dunkard Mine	X
TWI018	Unnamed Prospect	X
TWI020	Unnamed Adit	X
TWI027	Unnamed Prospect	
TWI029	Unnamed Adit	X
TWI030	Unnamed Adit	X
Mainstem SFCDR Watershed		
KLE016	Syndicate Mining & Exploration Co.	X
KLE023	Pioneer Mines Inc. Property	X
KLE033	**Polaris Mine**	
KLE051	**Florence Mine**	
KLE070	Unnamed Adit	X
MUL086	Wibberding-Golden Slipper Mines	
POL021	Eclipse Mine	
POL064	Unnamed Adit	
WAL024	War Eagle Mine	X
WAL046	Day Mines Claims	X
WAL055	Unnamed Adit	x
WAL056	Peerless Group (Osceola)	x
WAL057	Peerless Group	X
WAL058	Unnamed Adit	X
WAL062	Unnamed Adit	
WAL064	Unnamed Adit	X
WAL072	Unnamed Adit	
WAL073	Unnamed Adit	X
OSB030	Silverton Prospect Upper Adit	X
OSB070	Silverore-Inspiration Mine	
OSB072	**Western Union Upper Adit**	
OSB073	Silverton Prospect Lower Adit	X
OSB075	Unnamed Adit	X

Notes:

Sites were selected for data collection in response to comments received on the Upper Basin Proposed Plan regarding mine and mill sites identified for cleanup. The list of sites was developed by the U.S. Environmental Protection Agency (EPA) and the Upper Basin Project Focus Team (PFT) and based on the lack of ore production and the limited knowledge of these sites. BLM = Bureau of Land Management; SFCDR = South Fork of the Coeur d'Alene River.

Boldfaced sites were removed from the field characterization sampling effort based on the site selection criteria described in Section 3.0 of this Technical Memorandum.

The Characterization Sampling Conducted column shows the sites that were sampled in 2011. These sites are identified with an X. Sites that were not sampled are not given an identifier. These sites were either removed from the field characerization sampling effort based on the site selection criteria; or were not sampled due to lack of private property access, no direct physical access, no observed mining disturbance, or schedule limitations.Three sites were not sampled, but were verified in the field as having no observed mining disturbance (i.e., THO023, WAL062, and WAL072).

TABLE 2

Waste Pile Analytical Results

Upper Coeur d'Alene Basin 2011 Focused Characterization Sampling, Bunker Hill Superfund Site

BLM Site ID[a]	Site Name	<2.0 mm Soil Fraction			2.0-4.0 mm Soil Fraction		
		% Mass of Bulk Sample	Arsenic (mg/kg)	Lead (mg/kg)	% Mass of Bulk Sample	Arsenic (mg/kg)	Lead (mg/kg)
Decision Criteria [b]			*100 mg/kg*	*530 mg/kg*		*100 mg/kg*	*530 mg/kg*
Upper SFCDR Watershed							
MUL004	United Lead Zinc Mine	47.5%	5.9	22.7	13.2%	U	4.4
MUL006	Square Deal Mine	44.5%	178[c]	3,160	13.9%	144	1,620
MUL007	Wonder Mine	48.6%	6.3	53.6	9.5%	U	12.9
Canyon Creek Watershed							
THO018[d]	Unnamed Adit	40.3%	6	51.9	21.3%	U	92.1
BUR089	Idaho and Eastern Mine	62.8%	9.9	34.9	8.2%	U	12.4
BUR105	Oom Paul No. 2	33.7%	13	1,920	18.2%	4.9	1,710
BUR132	Gertie Mine	40.3%	8.6	19.5	19.9%	U	6.0
BUR133	Russel Mine	53.8%	4.9	33.3	12.0%	U	11
BUR134	Alcides Prospect and Imperial Mine	41.1%	8.9	762	19.6%	5.4	170
BUR149	Ajax No. 2 Adjacent Rock Dump	31.5%	16	1,690	19.9%	6.1	2,040
BUR150	Garbage Dump	36.6%	33.2	2,500	15.8%	12	431
BUR166	Unnamed Adit	35.5%	24.5	187	16.5%	11	45.9
BUR187	Unnamed Adit	34.5%	5.1	21.2	18.8%	4.9	31.4
Ninemile Creek Watershed							
WAL006	Northside Mine	62.2%	6.8	44.7	9.4%	U	16.1
BUR052	Little Sunset Mine	24.5%	26.2	98.2	15.9%	U	7.7
OSB032	Duluth Mine Blackcloud Creek	49.2%	U	26.5	14.1%	U	6.0
OSB033	Ruth Mine	36.7%	6.4	23.8	16.5%	U	6.9
OSB048	American Mine	41.3%	14	606	10.0%	22.7	1,490
OSB084	Blackcloud Creek Impacted Riparian	34.0%	U	17.1	15.8%	U	13.2
OSB085	Blackcloud Creek Impacted Riparian	42.4%	4.9	325	16.3%	U	465
Big Creek Watershed							
POL066	Unnamed Adit	38.4%	5.9	14.0	16.5%	U	3.2
Moon Creek Watershed							
KLE008	Maine-Standard Mine	47.0%	55.1	33.1	19.3%	14	9.6
KLE063	Unnamed Adit	53.9%	22.5	58.5	13.0%	23.4	34
KLE064	Unnamed Adit	38.0%	554	51	16.2%	168	16.3
KLE065	Unnamed Adits	39.2%	40.5	54.8	17.1%	14	11
Pine Creek Watershed (East Fork)							
MAS031	Trapper Mining & Smelting Company Ltd.	33.7%	164	78.4	17.9%	54.1	32.4
MAS053	Unnamed Adits	39.3%	8.7	32.3	11.4%	7.2	15.7
Pine Creek Watershed (West Fork)							
TWI002	Palisade Mine Lower Workings	49.4%	U	11.0	10.4%	7.2	7.3
TWI008	West Pine Creek Deposit	45.6%	5.0	22.5	11.2%	4.9	6.1
TWI009	Equitable Prospect	36.4%	5.7	11.0	14.8%	U	U
TWI011	Unnamed Adit	34.6%	5.0	18.3	13.4%	U	3.5
TWI012	KC Prospect	42.3%	2,010	315	15.9%	5,180	199
TWI013	Bluebird Prospect (Hannibal)	58.6%	76.3	46.3	14.1%	85.5	27.9
TWI014	Great Dunkard Mine	45.3%	1,060	31.9	14.3%	776	18.8

TABLE 2

Waste Pile Analytical Results

Upper Coeur d'Alene Basin 2011 Focused Characterization Sampling, Bunker Hill Superfund Site

BLM Site ID[a]	Site Name	<2.0 mm Soil Fraction			2.0-4.0 mm Soil Fraction		
		% Mass of Bulk Sample	Arsenic (mg/kg)	Lead (mg/kg)	% Mass of Bulk Sample	Arsenic (mg/kg)	Lead (mg/kg)
TWI018	Unnamed Prospect	25.6%	26.9	33.7	14.6%	8.5	4.4
TWI020	Unnamed Adit	50.3%	30.3	117	15.3%	28	78.5
TWI029	Unnamed Adit	45.7%	24.9	70.8	20.1%	24.3	52.3
TWI030	Unnamed Adit	30.3%	243	110	13.0%	35.9	23.4
Mainstem SFCDR Watershed							
KLE016	Syndicate Mining & Exploration Co.	66.7%	140	150	4.3%	114	35.4
KLE023	Pioneer Mines Inc. Property	32.7%	9.5	45.5	12.7%	9.4	27
KLE070	Unnamed Adit	43.0%	19	44	12.1%	16	20
WAL024	War Eagle Mine	71.3%	16	12.9	16.3%	13	7.7
WAL046	Day Mines Claims	41.8%	32.4	234	16.7%	19	79.9
WAL055	Unnamed Adit	29.0%	26.9	55.4	9.9%	21	18.8
WAL056[e]	Peerless Group (Osceola)	52.4%	15	28	12.0%	13	11
		55.8%	26.3	9.2	19.4%	12	U
WAL057	Peerless Group	47.2%	9.9	15.9	15.1%	5.8	U
WAL058	Unnamed Adit	35.1%	16	26.5	9.9%	7	12
WAL063[f]	Unnamed Adit	42.8%	U	19.3	13.2%	U	U
WAL064	Unnamed Adit	51.3%	6.1	56.3	13.3%	U	28.6
WAL073[g]	Unnamed Adit	50.5%	5.9	29.9	8.6%	U	4.3
OSB030	Silverton Prospect Upper Adit	39.5%	5.2	51.3	16.9%	U	8.4
OSB073[e]	Silverton Prospect Lower Adit	40.8%	11	115	12.1%	9.5	45.3
		34.3%	12	50.8	17.1%	U	5.2
OSB075	Unnamed Adit	40.8%	26.4	100	16.7%	24.9	43.1

Notes:

[a] Sites selected for data collection in response to comments received on the Upper Basin Proposed Plan regarding mine and mill sites identified for cleanup. The list of sites was generated by the U.S. Environmental Protection Agency (EPA) and the Upper Basin Project Focus Team (PFT) and based on the lack of ore production and limited knowledge of these sites.

[b] Decision criteria were established in the Quality Assurance Project Plan (QAPP) for the Upper Basin Focused Characterization Sampling (CH2M HILL, 2011) and consisted of the following: (1) If there is no evidence of ore production and concentrations in soil are greater than 530 mg/kg for lead and/or 100 mg/kg for arsenic, the site will be retained in the Upper Basin Preferred Alternative; and (2) if there is no evidence of ore production and concentrations in soil are less than 530 mg/kg for lead and/or 100 mg/kg for arsenic, the site will potentially be removed from the Upper Basin Preferred Alternative.

[c] Bold values indicate concentrations exceeding the decision criteria. A shaded row indicates the site will be retained in the Upper Basin Preferred Alternative.

[d] Field characterization sampling was conducted at THO018 instead of THO023. No mining activity was observed at the THO023 location. These two sites are located in close proximity to each other, and THO018 was mistaken for THO023. THO018 was not included in the QAPP for the Upper Basin Focused Characterization Sampling (CH2M HILL, 2011).

[e] Two soil samples were collected at each of the sites WAL056 and OSB073 because evidence of two discrete mining-impacted areas was observed at these sites.

[f] Field characterization sampling was conducted at WAL063 instead of WAL062. No mining activity was observed at the WAL062 location. These two sites are located in close proximity to each other, and the only mining activity in this area was observed at WAL063. WAL063 was not included in the QAPP for the Upper Basin Focused Characterization Sampling (CH2M HILL, 2011).

[g] No mining activity was observed at the WAL072 location.

BLM = Bureau of Land Management; mm = millimeter(s); mg/kg = milligram(s) per kilogram; SFCDR = South Fork of the Coeur d'Alene River; U = nondetect.

TABLE 3

Sites with Metals Concentrations Below Decision Criteria[a]

Upper Coeur d'Alene Basin 2011 Focused Characterization Sampling, Bunker Hill Superfund Site

BLM Site ID	Site Name	<2.0 mm Soil Fraction		2.0-4.0 mm Soil Fraction	
		Arsenic (mg/kg)	Lead (mg/kg)	Arsenic (mg/kg)	Lead (mg/kg)
Upper SFCDR Watershed					
MUL004	United Lead Zinc Mine	5.9	22.7	U	4.4
MUL007	Wonder Mine	6.3	53.6	U	12.9
Canyon Creek Watershed					
BUR089	Idaho and Eastern Mine	9.9	34.9	U	12.4
BUR132	Gertie Mine	8.6	19.5	U	6.0
BUR133	Russel Mine	4.9	33.3	U	11
BUR166	Unnamed Adit	24.5	187	11	45.9
BUR187	Unnamed Adit	5.1	21.2	4.9	31.4
THO023[b]	Unnamed Adit	--	--	--	--
Ninemile Creek Watershed					
WAL006	Northside Mine	6.8	44.7	U	16.1
BUR052	Little Sunset Mine	26.2	98.2	U	7.7
OSB032	Duluth Mine Blackcloud Creek	U	26.5	U	6.0
OSB033	Ruth Mine	6.4	23.8	U	6.9
OSB084	Blackcloud Creek Impacted Riparian	U	17.1	U	13.2
OSB085	Blackcloud Creek Impacted Riparian	4.9	325	U	465
Big Creek Watershed					
POL066	Unnamed Adit	5.9	14.0	U	3.2
Moon Creek Watershed					
KLE008	Maine-Standard Mine	55.1	33.1	14	9.6
KLE063	Unnamed Adit	22.5	58.5	23.4	34
KLE065	Maine-Standard Mine	40.5	54.8	14	11
Pine Creek Watershed (East Fork)					
MAS053	Unnamed Adits	8.7	32.3	7.2	15.7
Pine Creek Watershed (West Fork)					
TWI002	Palisade Mine Lower Workings	U	11.0	7.2	7.3
TWI008	West Pine Creek Deposit	5.0	22.5	4.9	6.1
TWI009	Equitable Prospect	5.7	11.0	U	U
TWI011	Unnamed Adit	5.0	18.3	U	3.5
TWI013	Bluebird Prospect (Hannibal)	76.3	46.3	85.5	27.9
TWI018	Unnamed Prospect	26.9	33.7	8.5	4.4
TWI020	Unnamed Adit	30.3	117	28	78.5
TWI029	Unnamed Adit	24.9	70.8	24.3	52.3
Mainstem SFCDR Watershed					
KLE023	Pioneer Mines Inc. Property	9.5	45.5	9.4	27
KLE070	Unnamed Adit	19	44	16	20
WAL024	War Eagle Mine	16	12.9	13	7.7
WAL046	Day Mines Claims	32.4	234	19	79.9
WAL055	Unnamed Adit	26.9	55.4	21	18.8
WAL056	Peerless Group (Osceola)	15	28	13	11
		26.3	9.2	12	U
WAL057	Peerless Group	9.9	15.9	5.8	U

TABLE 3

Sites with Metals Concentrations Below Decision Criteria[a]

Upper Coeur d'Alene Basin 2011 Focused Characterization Sampling, Bunker Hill Superfund Site

BLM Site ID	Site Name	<2.0 mm Soil Fraction		2.0-4.0 mm Soil Fraction	
		Arsenic (mg/kg)	Lead (mg/kg)	Arsenic (mg/kg)	Lead (mg/kg)
WAL058	Unnamed Adit	16	26.5	7	12
WAL062[b]	Unnamed Adit	--	--	--	--
WAL064	Unnamed Adit	6.1	56.3	U	28.6
WAL072[b]	Unnamed Adit	--	--	--	--
WAL073	Unnamed Adit	5.9	29.9	U	4.3
OSB030	Silverton Prospect Upper Adit	5.2	51.3	U	8.4
OSB073	Silverton Prospect Lower Adit	11	115	9.5	45.3
		12	50.8	U	5.2
OSB075	Unnamed Adit	26.4	100	24.9	43.1

Notes:

[a] Decision criteria were established in the Quality Assurance Project Plan (QAPP) for the Upper Basin Focused Characterization Sampling (CH2M HILL, 2011) and consisted of the following: (1) If there is no evidence of ore production and concentrations in soil are greater than 530 mg/kg for lead and/or 100 mg/kg for arsenic, the site will be retained in the Upper Basin Preferred Alternative; and (2) if there is no evidence of ore production and concentrations in soil are less than 530 mg/kg for lead and/or 100 mg/kg for arsenic, the site will potentially be removed from the Upper Basin Preferred Alternative.

[b] No waste piles or other mining disturbances were observed in the vicinity of the documented site location; therefore, the site is recommended for removal from the Upper Basin Preferred Alternative.

BLM = Bureau of Land Management
-- = Not sampled
mm = millimeter(s)
mg/kg = milligram(s) per kilogram
SFCDR = South Fork of the Coeur d'Alene River
U = Nondetect

TABLE 4

Sites with Metals Concentrations Exceeding Decision Criteria[a]

Upper Coeur d'Alene Basin 2011 Focused Characterization Sampling, Bunker Hill Superfund Site

BLM Site ID	Site Name	<2.0 mm Soil Fraction		2.0-4.0 mm Soil Fraction		Decision Criteria Exceedence Parameter
		Arsenic (mg/kg)	Lead (mg/kg)	Arsenic (mg/kg)	Lead (mg/kg)	
Upper SFCDR Watershed						
MUL006	Square Deal Mine	178[b]	3,160	144	1,620	Arsenic and Lead
Canyon Creek Watershed						
BUR105	Oom Paul No. 2	13	1,920	4.9	1,710	Lead
BUR134	Alcides Prospect and Imperial Mine	8.9	762	5.4	170	Lead
BUR149	Ajax No. 2 Adjacent Rock Dump	16	1,690	6.1	2,040	Lead
BUR150	Garbage Dump	33.2	2,500	12	431	Lead
Ninemile Creek Watershed						
OSB048	American Mine	14	606	22.7	1,490	Lead
Moon Creek Watershed						
KLE064	Unnamed Adit	554	51	168	16	Arsenic
Pine Creek Watershed (East Fork)						
MAS031	Trapper Mining & Smelting Company Ltd.	164	78.4	54.1	32.4	Arsenic
Pine Creek Watershed (West Fork)						
TWI012	KC Prospect	2,010	315	5,180	199	Arsenic
TWI014	Great Dunkard Mine	1,060	31.9	776	18.8	Arsenic
TWI030	Unnamed Adit	243	110	35.9	23.4	Arsenic
Mainstem SFCDR Watershed						
KLE016	Syndicate Mining & Exploration Co.	140	150	114	35.4	Arsenic

Notes:

[a] Decision criteria were established in the Quality Assurance Project Plan (QAPP) for the Upper Basin Focused Characterization Sampling (CH2M HILL, 2011) and consisted of the following: (1) If there is no evidence of ore production and concentrations in soil are greater than 530 mg/kg for lead and/or 100 mg/kg for arsenic, the site will be retained in the Upper Basin Preferred Alternative; and (2) if there is no evidence of ore production and concentrations in soil are less than 530 mg/kg for lead and/or 100 mg/kg for arsenic, the site will potentially be removed from the Upper Basin Preferred Alternative.

[b] Bold values indicate concentrations exceeding the decision criteria.

BLM = Bureau of Land Management

mm = millimeter(s); mg/kg = milligram(s) per kilogram

SFCDR = South Fork of the Coeur d'Alene River

TABLE 5

Summary of 2011 Focused Characterization Sampling and Decision Criteria Results

Upper Coeur d'Alene Basin 2011 Focused Characterization Sampling, Bunker Hill Superfund Site

	Number of Sites	Number of Sites Removed from Upper Basin Preferred Alternative	Number of Sites Retained in Upper Basin Preferred Alternative
Candidate Sites Considered for 2011 Focused Characterization Sampling	83	--	--
Sites Screened (Removed from Focused Characterization Sampling) Based on Historical Review	9	--	9
Sites Included in 2011 Focused Characterization Sampling Program	74	--	--
Sites Sampled[a]	51[a]	--	--
Sites Not Sampled[b]	20[b]	--	20
Sites with No Evidence of Mining	3	3	--
Sites with No Decision Criteria Exceedences	39	39	--
Sites with Decision Criteria Exceedences	12	--	12
Total	--	42	41

Notes:

[a] The total number of sites shown is only for sites included in the Upper Coeur d'Alene Basin Focused Characterization Sampling Quality Assurance Project Plan (QAPP) (CH2M HILL, 2011). Two sites were sampled that were not targeted in that QAPP.

[b] Sites were not sampled due to lack of private property access, no direct physical access, and schedule limitations.

-- = Not applicable

ATTACHMENT 2

Technical Memorandum: Evaluation of Mine and Mill Source Sites for Removal from the Forthcoming Upper Basin Selected Remedy

Evaluation of Mine and Mill Source Sites for Removal from the Forthcoming Upper Basin Selected Remedy

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DATE: August 2, 2012

1.0 Introduction

Alternative 3+(d) in the *Draft Focused Feasibility Study* [FFS] *Report, Upper Basin of the Coeur d'Alene River, Bunker Hill Mining and Metallurgical Complex Superfund Site* (CH2MHILL, 2010) presented a suite of remedial actions that would be included in a final remedy for surface water and for soil, sediments, and source materials where actions are taken to protect human health and the environment in the Upper Basin. Implementation of Alternative 3+(d) for the Operable Unit 3 (OU 3) portion of the Upper Basin will present unique challenges given the nature and extent of the metals contamination in the Upper Basin, the number of remedial actions needed, and the size and complexity of the area. To address uncertainty during the management and implementation of the Selected Remedy that will be presented in the forthcoming Record of Decision (ROD) Amendment for the Upper Basin, the U.S. Environmental Protection Agency (EPA) identified the use of an adaptive management framework where information and understanding gained in the Upper Basin over time will be used to revise and guide the implementation of remedial actions to achieve cleanup goals. Consistent with the adaptive management framework and in response to comments received from stakeholders and the public on the *Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Mining and Metallurgical Complex Superfund Site* (EPA, 2010a), EPA decided to select an interim remedy instead of a final remedy in the forthcoming Upper Basin ROD Amendment that focuses on addressing mining-related contamination in priority areas where data indicate the greatest risks to human health and the environment are present.

This Technical Memorandum (TM) presents the methodology used and results of an evaluation of Upper Basin mine and mill sites that were identified for remedial action in the Preferred Alternative as presented in the Proposed Plan (and were included in Alternative 3+(d) in the FFS Report), but which have been determined to be of lower priority and thus will not be included in the Selected Remedy to be documented in the forthcoming Upper Basin ROD Amendment. The purpose of the evaluation was to identify sites where, based on the operational and remedial history of the site as well as all available information regarding potential risks to human health and the environment resulting from mining-related contamination, EPA has decided not to take action at this time.

2.0 Background

The Proposed Plan (EPA, 2010a) presented the Preferred Alternative for a comprehensive remedy for the Upper Basin which addressed historical mining-related contamination. The Preferred Alternative included remedial actions at 345 mine and mill sites[1] located in the Upper Basin that would be required to meet cleanup goals based on available data and predictions of the effectiveness of the cleanup. The remedial actions at these mine and mill sites did not include the groundwater treatment actions identified for the Bunker Hill Box and referred to as Operable Unit 2 (OU 2) Alternative (d) in the Proposed Plan. EPA is retaining OU 2 Alternative (d) for inclusion in the Selected Remedy.

Following the conclusion of the Proposed Plan comment period, EPA worked with the Upper Basin Project Focus Team (PFT) to categorize mine and mill sites included in the Preferred Alternative based on available analytical data, field observations, historical information, current status, and other site knowledge. This categorization of sites was conducted as a first step towards implementation planning and in response to community and stakeholder comments requesting more description of how the Preferred Alternative would be implemented and where the focus areas would be in the near term. Mine and mill sites were subsequently categorized into the following categories:

Strong Consensus Sites – Mine and mill sites where available information confirmed substantial risks to human health and the environment from mining-related contamination requiring remedial action.

Active Sites – Mine and mill sites where active industrial and/or commercial activities are currently occurring. At some of these sites, access controls and/or Institutional Controls Program (ICP) protective barriers are in place that prevent or minimize direct contact with source materials. In addition to the presence of in-place measures to reduce direct contact risks, the active mine and mill sites are typically overseen by regulatory agencies outside the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Therefore, regulatory methods both within and outside CERCLA are available to address the potential release of contaminants that may pose a risk to human health and the environment.

Remediated Sites – Over time, cleanup actions have been conducted by EPA, other agencies, and property owners within the Upper Basin. The majority of actions that have been taken at these mine and mill sites focused on human health risks but, where appropriate, additional actions were taken to reduce contamination at the sites and the transport of contamination downstream from these sites. Currently, sites where cleanup actions have been taken are being monitored to determine their effectiveness towards meeting remedial action objectives. Review of the monitoring results and the protectiveness of these clean up actions is documented in Five-Year Reviews consistent with CERCLA and the 2002 ROD for OU 3 (EPA, 2002). Potential shortcomings of these clean up actions in achieving remedial action objectives and protection of human health and the environment

[1] The Proposed Plan (EPA, 2010a) stated that the Preferred Remedial Alternative for OU 3 (Alternative 3+(d)) included 348 mine and mill sites. This total erroneously included three sites in Canyon Creek (WAL007, WAL008, and WAL012) that were in Alternative 4+ but not in Alternative 3+. Therefore, the correct number of mine and mill sites in the Preferred Remedial Alternative should have been 345.

will be addressed as part of the Five-Year Review process or through the adaptive management process.

Contingent Sites – Mine and mill sites where limited information is available regarding the potential risks to human health and the environment. EPA has worked with stakeholders and the Upper Basin PFT to gather available information for these sites, including the results of a field effort conducted in 2011 to obtain additional information at some of the sites and potentially remove them from the Selected Remedy to be included in the forthcoming ROD Amendment. The 42 mine and mill sites shown in Table 1[2] were removed from the Selected Remedy based on the results of the 2011 focused characterization sampling (CH2M HILL, 2012).

In consideration of comments received on the Proposed Plan from the community and stakeholders, EPA has reduced the scope of the Selected Remedy and is not including all of the remedial actions that were presented in the Preferred Alternative in the Proposed Plan. Therefore, the Selected Remedy is not expected to fully address surface water contamination at all locations in the Upper Basin, and thus is an interim remedy for the Upper Basin. The Selected Remedy is also not intended to fully address groundwater contamination. However, the remedial actions included in the Selected Remedy are expected to result in the achievement of cleanup goals for soil and sediments where actions are taken. The Selected Remedy will address many significant sources of contamination in the Upper Basin and will significantly contribute to meeting remedial action objectives, thus supporting a final protective remedy for the Upper Basin.

The reduction in scope of the Selected Remedy from a final to an interim remedy resulted in a need to determine which mine and mill sites will be retained in the Selected Remedy and which sites will be removed. Both active facilities (Table 2) and mine and mill sites where clean up actions have been conducted (Table 3) will be removed from the Selected Remedy. As noted above, there are other regulatory approaches that can be used to address future issues at these sites, should they occur. In addition, EPA has reviewed mine and mill sites that were previously categorized as contingent sites to determine whether additional sites may be removed. Removal of mine and mill sites from the Selected Remedy is based on lines of evidence that suggest that the potential risk to human health and the environment is relatively low. This will allow the Selected Remedy that will be presented in the forthcoming ROD Amendment to focus on sites with the greatest risks to human health and the environment in the Upper Basin.

3.0 Contingent Mine and Mill Site Evaluation

Mine and mill sites included in the Preferred Alternative presented in the Proposed Plan that were later categorized as contingent sites were evaluated to assess the potential risks to human health and the environment posed by mining-related contamination.

The initial evaluation of mine and mill sites included review of available site-specific contaminant concentration data for each contingent site. If available data indicated that lead concentrations were less than 530 milligrams per kilogram (mg/kg) in soil, sediments, and

[2] The tables referenced in this TM are provided following Section 5.0, References.

source materials[3] and/or site-specific surface water concentrations were equal to or less than the ambient water quality criteria (AWQC), the sites were identified for removal from the Selected Remedy. Sites where soil, sediment, or source material lead concentrations exceeded 530 mg/kg or site-specific surface water contaminant concentrations were greater than the AWQC were retained for inclusion in the Selected Remedy.

Following the evaluation of site-specific data, available human health exposure information regarding the sites was evaluated. Aerial maps and information gathered during the focused characterization sampling of mine and mill sites (CH2MHILL, 2012) were evaluated to assess the potential risk of exposure to humans by contact with potentially contaminated materials at each site. Information used to evaluate the potential human health exposure risk at each site included the proximity of the site to residences or residential areas, access to the site, recreational use observed at the site during field visits, mine waste types present at the site, and contaminant concentrations measured. Mine and mill sites were then assigned a human health risk level of none, low, moderate, or high based on the human health risk observations identified above. All sites with a human health risk level of high were retained for inclusion in the Selected Remedy as additional data collection and verification will be needed to ensure that these sites do not pose a significant risk to human health.

Mine and mill sites with human health risk levels of none, low, and moderate or with no human health risk information were then evaluated using the following screening criteria:

Erosion Potential – During field investigations in the Upper Basin, evidence of erosion has been noted by field teams. In addition, information regarding erosion of mine wastes at some sites was provided by review of Idaho Geological Survey (IGS) reports as well as information provided by Upper Basin PFT members based on their personal knowledge. Mine and mill sites where erosion information was available were assigned an erosion potential description of no erosion potential, minimal erosion potential, moderate erosion potential, or high erosion potential. Sites with lower erosion potential were given priority for potential removal from the Selected Remedy.

Riparian Acreage – The U.S. Department of the Interior Bureau of Land Management (BLM) developed the original estimated areal extents for the mine and mill sites located within the Upper Basin using field reconnaissance notes and aerial maps from the 1990s. In addition, BLM estimated the areal extent of riparian areas, floodplains, and stream channels in the general vicinity of mine and mill sites in the Upper Basin. BLM overlaid the maps of areal extent of mine and mill sites and riparian areas to provide a rough estimate of the acreage of riparian, floodplain, and stream channel areas that were contained within mine and mill sites in the Upper Basin. The acreage of riparian, floodplain, and stream channel area located within a site was used as an indicator of the relative potential impact that the site may be having on these habitat areas. Sites with no or minimal riparian acreage were given priority for potential removal from the Selected Remedy.

Downstream Water Quality – With the exception of Canyon and Ninemile Creeks and OU 2, minimal site-specific water quality data are available for the majority of mine and mill sites located in the Upper Basin. For smaller side tributaries to the South Fork Coeur

[3] The evaluation of contingent mine and mill sites focused on lead in soil, sediments, and source materials because data for lead are the most widely available.

d'Alene River (SFCDR), water quality information is limited to a small number of samples (typically 1 to 5 samples collected between 1997 and 2008) obtained from the mouth of each tributary prior to entering the SFCDR. For the purposes of this evaluation, available site-specific and downstream water quality data were evaluated with respect to AWQC to assess the potential impacts that upstream sites may be having on downstream water quality. Sites with downstream AWQC ratios equal to or below 1.0 were given priority for potential removal from the Selected Remedy.

Location Within Watershed – A number of mine and mill sites identified for cleanup in the Preferred Alternative are located in the upper reaches of watersheds and are not in close proximity to riparian, floodplain, or stream channel areas. The location of each site within its respective watershed and available downstream water quality data were evaluated to assess the potential impact of a site on downstream water quality. Sites located in the upper reaches of the watershed with downstream AWQC ratios equal to or below 1.0 were given priority for potential removal from the Selected Remedy.

Volume of Waste Materials – Initial volumes and types of mine waste materials present at a site were estimated during development of the Preferred Alternative. Mine and mill sites estimated to have relatively small volumes of waste materials (typically 200 cubic yards or less) or relatively low-concentration mine wastes (e.g., upland waste rock) were identified. The locations of these sites within their respective watersheds and downstream water quality data were used to evaluate the potential for risk to human health and the environment from these sources.

The screening of mine and mill sites using the above criteria focused on identifying those sites with the lowest potential to present a significant risk to human health and the environment. In general, sites identified for removal from the Selected Remedy exhibited one or all of the following characteristics:

- Minimal or no documented erosion of source materials
- Minimal or no riparian, floodplain, or stream channel areas within the site footprint
- Downstream water quality measurements near or below the AWQC for dissolved zinc
- Location in an upstream area of the watershed
- Small volumes of relatively low-concentration mine wastes

Table 4 lists the 114 sites that met one or more of the above screening criteria and can therefore be considered for removal from the Selected Remedy. Table 4 also presents the associated lines of evidence that were available to support exclusion of these sites from the Selected Remedy.

4.0 Summary

A total of 200 mine and mill sites originally included in Alternative 3+(d) in the Draft Final FFS Report (CH2M HILL, 2010) and in the Preferred Alternative presented in the Proposed Plan (EPA, 2010a) will not be included in the Selected Remedy to be documented in the forthcoming Upper Basin ROD Amendment, based on the designation of the mine and mill sites as active facilities (19 sites, as indicated in Table 2), prior cleanup actions that have been conducted at sites (25 sites, as indicated in Table 3), and available lines of evidence suggesting minimal potential risks to human health and the environment (42 and 114 sites as indicated in Tables 1 and 4, respectively). The locations of active, remediated, and contingent sites removed from the Selected Remedy along with sites retained for inclusion in the Selected Remedy (Table 5) are shown in Figures 1 through 4.[4]

While the mine and mill sites listed in Tables 1 through 4 are not included in the Selected Remedy, it should not be inferred that they do not pose a risk to human health and the environment. EPA plans to continue to collect additional field data at these sites to determine whether the sites need to be addressed by remedial actions in the future. Any sites with potential impacts to human health (e.g., because of proximity to remediated yards) will be priorities for collecting additional field data. These activities will include evaluating field data using screening criteria consistent with field efforts conducted in 2011 and as documented in the TM *Upper Coeur d'Alene Basin 2011 Focused Characterization Sampling: Results from Selected Mine and Mill Sites* (CH2M HILL, 2012).

As cleanup actions proceed in the Upper Basin and more information becomes available either through work in specific areas or through ongoing site characterization efforts, it may be necessary to evaluate some of these sites for inclusion in another decision document. In addition, as cleanup proceeds and more information becomes available, sites that have not yet been identified may be discovered that pose a risk to human health and the environment and may need to be included in another decision document.

5.0 References

CH2M HILL. July 2010. *Draft Final Focused Feasibility Study Report, Upper Basin of the Coeur d'Alene River, Bunker Hill Mining and Metallurgical Complex Superfund Site.* Prepared for U.S. Environmental Protection Agency Region 10.

CH2M HILL. May 25, 2012. *Technical Memorandum: Upper Coeur d'Alene Basin 2011 Focused Characterization Sampling: Results from Selected Mine and Mill Sites*. Prepared for U.S. Environmental Protection Agency Region 10.

U. S. Environmental Protection Agency (EPA). September 12, 2002. *Record of Decision: The Bunker Hill Mining and Metallurgical Complex Operable Unit 3*.

U. S. Environmental Protection Agency (EPA). July 12, 2010 (2010a). *Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Mining and Metallurgical Complex Superfund Site.*

U. S. Environmental Protection Agency (EPA). November 2010 (2010b). *Five-Year Review Report: 2010 Five-Year Review for the Bunker Hill Mining and Metallurgical Complex Superfund Site Operable Units 1, 2, and 3, Idaho and Washington*.

[4] These figures are provided at the end of this TM, following the tables.

Tables

TABLE 1

Summary of Mine and Mill Sites Not Retained in the Selected Remedy After 2011 Focused Characterization Sampling

Evaluation of Mine and Mill Source Sites for Removal from the Forthcoming Upper Basin Selected Remedy

BLM Site Number	Source Name	Watershed
POL066	UNNAMED ADIT	Big Creek
BUR089	IDAHO AND EASTERN MINE	Canyon Creek
BUR132	GERTIE MINE	Canyon Creek
BUR133	RUSSEL MINE	Canyon Creek
BUR166	UNNAMED ADIT	Canyon Creek
BUR187	UNNAMED ADIT	Canyon Creek
THO023	UNNAMED ADIT	Canyon Creek
KLE008	MAINE-STANDARD MINE	Moon Creek
KLE063	UNNAMED ADIT	Moon Creek
KLE065	UNNAMED ADITS	Moon Creek
BUR052	LITTLE SUNSET MINE	Ninemile Creek
OSB032	DULUTH MINE BLACKCLOUD CK	Ninemile Creek
OSB033	RUTH MINE	Ninemile Creek
OSB084	BLACKCLOUD CK IMPACTED RIPARIAN	Ninemile Creek
OSB085	BLACKCLOUD CK IMPACTED RIPARIAN	Ninemile Creek
WAL006	NORTHSIDE MINE	Ninemile Creek
MAS053	UNNAMED ADITS	Pine Creek
TWI002	PALISADE MINE LOWER WORKINGS	Pine Creek
TWI008	WEST PINE CREEK DEPOSIT	Pine Creek
TWI009	EQUITABLE PROSPECT	Pine Creek
TWI011	UNNAMED ADIT	Pine Creek
TWI013	BLUEBIRD PROSPECT (HANNIBAL)	Pine Creek
TWI018	UNNAMED PROSPECT	Pine Creek
TWI020	UNNAMED ADIT	Pine Creek
TWI029	UNNAMED ADIT	Pine Creek
KLE023	PIONEER MINES INC. PROPERTY	SFCDR (West)
KLE070	UNNAMED ADIT	SFCDR (West)
MUL004	UNITED LEAD ZINC MINE	SFCDR (East)
MUL007	WONDER MINE	SFCDR (East)
OSB030	SILVERTON PROSPECT UPPER ADIT	SFCDR (West)
OSB073	SILVERTON PROSPECT LOWER ADIT	SFCDR (West)
OSB075	UNNAMED ADIT	SFCDR (West)
WAL024	WAR EAGLE MINE	SFCDR (West)
WAL046	DAY MINES CLAIMS	SFCDR (West)
WAL055	UNNAMED ADIT	SFCDR (West)
WAL056	PEERLESS GROUP (OSCEOLA)	SFCDR (West)
WAL057	PEERLESS GROUP	SFCDR (West)
WAL058	UNNAMED ADIT	SFCDR (West)
WAL062	UNNAMED ADIT	SFCDR (West)
WAL064	UNNAMED ADIT	SFCDR (West)
WAL072	UNNAMED ADIT	SFCDR (West)
WAL073	UNNAMED ADIT	SFCDR (West)

Notes:

See *Technical Memorandum: Upper Coeur d'Alene Basin 2011 Focused Characterization Sampling: Results from Selected Mine and Mill Sites* (CH2M HILL, 2012) for additional details.

BLM = U.S. Department of the Interior Bureau of Land Management
SFCDR = South Fork Coeur d'Alene River

TABLE 2

Active Mine and Mill Sites

Evaluation of Mine and Mill Source Sites for Removal from the Forthcoming Upper Basin Selected Remedy

BLM Site Number	Source Name	Watershed
KLE025	Sunshine Tailings Pond No. 2	Big Creek
KLE026	Silver Syndicate	Big Creek
KLE027	North American Mine	Big Creek
KLE053	North American/Silver Syndicate Mine	Big Creek
KLE054	Crescent/Hooper Tunnel	Big Creek
LOK008	Idaho Silver No. 2	SFCDR Tributary (Daisy Gulch, SF-206)
MUL042	Gold Hunter No. 5	SFCDR Tributary (Gold Hunter Gulch, SF-212)
KLE075	Silver Summit Millsite (Polaris)	SFCDR (West)
LOK050	Daisy Gulch Tailings Pond	SFCDR (East)
LOK051	Daisy Gulch Old Landfill	SFCDR (East)
MUL019	Morning No. 6	SFCDR (East)
MUL020	Lucky Friday No. 3	SFCDR (East)
MUL037	Lucky Friday Tailings Pond No. 2	SFCDR (East)
MUL038	Gold Hunter No. 6	SFCDR (East)
MUL058	Lucky Friday Tailings Pond No. 1	SFCDR (East)
MUL131	National Millsite	SFCDR (East)
OSB119	Osburn Zanetti Gravel Operation	SFCDR (West)
WAL001	Osburn Tailings Ponds	SFCDR (West)
WAL020	Caladay Mine	SFCDR (West)

Notes:

Active sites are defined as mine and mill sites where active industrial and/or commercial activities are currently occurring. At some of these sites, access controls and/or Institutional Controls Program (ICP) protective barriers are in place that prevent or minimize direct contact with source materials.

BLM = U.S. Department of the Interior Bureau of Land Management
SFCDR = South Fork Coeur d'Alene River

TABLE 3

Remediated Mine and Mill Sites

Evaluation of Mine and Mill Source Sites for Removal from the Forthcoming Upper Basin Selected Remedy

BLM Site Number	Source Name	Watershed	Comments and Documentation for Remedial Action
WAL036	Lake Cr Imp Riparian	SFCDR Tributary (Lake Creek, SF-238)	Identified for remediation by Yards Program 2012-2013
BUR054	Rex No. 2/Sixteen-to-One Mine	Ninemile Creek	Currently monitored under the remedial action effectiveness program. Remedial actions were conducted in 2006-2007 and included: removal of onsite debris, realignment of Rex Creek channel and lining with rip-rap, consolidation of source materials onsite and capping with clean materials, regrading of surface to promote surface water runoff and help new vegetation grow, and construction of a toe buttress to strengthen the tailings pile.
OSB061	Blackcloud Ck Millsite	Ninemile Creek	Site was largely capped by the yard cleanup program. Currently the capped site is occupied by a residence.
KLW077	General Mine	Pine Creek	Remediated as part of Clean Water Act grant work in Little Pine Creek.
KLW080	Bobby Anderson Mine	Pine Creek	Portion of rock dump addressed by road right-of-way remediation
MAS008	Nabob 600 Level (Crystalite)	Pine Creek	BLM conducted remediation consisting of reclaiming/ revegetating the rock dump
MAS017	Sidney (Denver) 500 Level	Pine Creek	Sidney Mining and the State of Idaho conducted remediation and stabilization on the lower portion of the working along the creek. BLM conducted limited removal of waste materials.
MAS018	Denver Mine (Nabob Adit)	Pine Creek	BLM conducted stream work at bottom of site, and installed a cutoff wall to prevent creek from entering Sidney shaft. The waste pile dumps were not included in these remedial actions.
MAS019	Star Antimony Lower Adit	Pine Creek	BLM conducted remedial actions consisting of regrading and revegetation.
MAS027, MAS048, MAS049, MAS050	Constitution Mine and Millsite	Pine Creek	Currently monitored under the remedial action effectiveness program. Remedial actions were conducted in 2006 and included: relocation and consolidation of source materials from the lower segment to the upper segment, stabilization with hydro-seeding, and revegetation. In addition, surface water controls were installed to control onsite runoff and minimize sediment transport from erosion to East Fork Pine Creek.
MAS072	Unnamed Adit	Pine Creek	BLM conducted rock dump revegetation and installed a mine discharge pilot water treatment system, which indicated that the adit had high iron and low zinc concentrations.
MAS079	Highland Surprise Lower Rock Dump	Pine Creek	Remedial actions consisting of regrading/ revegetation, and stream armoring were conducted by BLM.
MAS081	Sidney (Red Cloud) Rock Dump	Pine Creek	BLM conducted regrading and recontouring and creek realignment.
MAS006	Nabob Tailings Pile	Pine Creek	BLM actions at the millsite primarily consisted of improving mine safety operations, installing a groundwater drain, and capping of tailings.
KLE042	Moon Ck Pond at Mouth	SFCDR (West)	Remediated under the Institutional Controls Program.
KLE062	Osburn Flats USBM Test Plots	SFCDR (West)	Detailed design of the remedial action is complete, and the project either has been conducted recently or is scheduled for the near future.
KLE074	CDA Mill Site	SFCDR (West)	The CDA Mine and Mill Site were remediated in 2001, and the remedies are functioning as intended according to the 2010 Five-Year Review Report (U.S. Environmental Protection Agency [EPA], 2010b).
MUL001, MUL002	Golconda Mine and Millsite	SFCDR (East)	Currently monitored under the remedial action effectiveness program. Remedial actions were conducted in 2006-2007 and included: design and construction of a water diversion structure to route water through pipes from the site and mine adit (away from existing tailings) to the SFCDR, removal of source materials to an upland area (which was capped and stabilized), and armoring the base of the waste pile along the SFCDR.
POL018	Merger Mine	SFCDR (West)	Work completed by CDA Mines.
POL019	CDA Mine	SFCDR (West)	The CDA Mine and Mill Site were remediated in 2001, and the remedies are functioning as intended according to the 2010 Five-Year Review Report (EPA, 2010b).
WAL037	Hercules Millsite	SFCDR (West)	Remediated, part of Wallace Yard project.

Notes:

Remediated sites are defined as sites where cleanup actions have been taken or are being monitored to determine their effectiveness in meeting remedial action objectives

BLM = U.S. Department of the Interior Bureau of Land Management
SFCDR = South Fork Coeur d'Alene River
USBM = U.S. Bureau of Mines

TABLE 4

Contingent Mine and Mill Sites for Removal from Selected Remedy

Evaluation of Mine and Mill Source Sites for Removal from the Forthcoming Upper Basin Selected Remedy

BLM Site Number	Source Name	Watershed	Human Health Exposure Criteria [1]	Erosion Potential Criteria [2]	Riparian Acreage	Riparian Acreage Criteria [3]	AWQC at the Downstream Segment	Downstream Water Quality Criteria [4]	Location Within Watershed Criteria [5]	Volume of Waste Materials (cy)	Volume of Waste Materials Criteria [6]	Additional Site-Specific Information [7]	Notes
POL001	Sunshine Consolidated Rockford Group	Big Creek (BC-260)	--	--	0	X	0.060	X	X	8,160		X	Waste pile sample indicated low levels of cadmium (1.5 mg/kg). Water quality data from adit indicate that the discharge is below the AWQC. Site has no riparian acreage, AWQC exceedance ratio for dissolved zinc is less than 1.0 downstream, and site is located high up in the watershed.
POL002	Silver Dale & Big Hill Mine	Big Creek (BC-260)	--	--	0.68	X	0.060	X	X	1,700			Site is located in the communities of Big Creek and Sunshine drinking water source areas. Site contains 0.68 acre of riparian habitat, and AWQC exceedance ratio for dissolved zinc is less than 1.0 downstream.
POL008	Globe Mine	Big Creek (BC-260)	--	--	0.34	X	0.060	X		8,160			Site has limited riparian habitat (0.34 acre) and AWQC exceedance ratio for dissolved zinc is less than 1.0 downstream.
POL010	Western Star Mine	Big Creek (BC-260)	--	--	0.19	X	0.060	X		4,560			Site has limited riparian area (0.19 acre), and AWQC exceedance ratio for dissolved zinc is less than 1.0 downstream.
POL011	Wolfson Mine	Big Creek (BC-260)	--	--	0.13	X	0.060	X	X	3,120			Site has limited riparian area (0.13 acre), and AWQC exceedance ratio for dissolved zinc is less than 1.0 downstream. In addition, site is located far up in the watershed.
POL022	First National Mine	Big Creek (BC-260)	--	--	0.85	X	0.060	X	X	4,600		X	IGS collected waste dump and adit samples (arsenic 210 mg/kg, cadmium 2.2 mg/kg, and copper 26 mg/kg). Adit discharge was below AWQC. Site has limited riparian area (0.85 acre), and AWQC exceedance ratio for dissolved zinc is less than 1.0 downstream.
POL044	Unnamed Prospect	Big Creek (BC-260)	--	--	0.30	X	0.060	X	X	200	X		Site has limited riparian area (0.30 acre), low waste volume (200 cy), and AWQC exceedance ratio for dissolved zinc is less than 1.0 downstream. In addition, site is located far up in the watershed.
POL052	Lucky Boy Mine	Big Creek (BC-260)	--	--	0.14	X	0.060	X		4,600		X	IGS sampled the waste dump. Lead concentrations were low (120 mg/kg). Site has limited riparian area (0.14 acre), and AWQC exceedance ratio for dissolved zinc is less than 1.0 downstream.
POL067	Unnamed Adit	Big Creek (BC-260)	--	--	0	X	0.060	X		0	X	X	TCD has a passive treatment component. The adit discharge has low dissolved zinc concentrations (<0.01 mg/L). Site has no riparian area, low waste volume, and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
POL068	Unnamed Adit	Big Creek (BC-260)	--	--	0.20	X	0.060	X	X	200	X		Site has limited riparian area (0.20 acre), low waste volume (200 cy), and AWQC exceedance ratio for dissolved zinc is less than 1.0 downstream. In addition, site is located far up in the watershed.
BUR066	Moonlight Mine	Canyon Creek (CC-282)	X	X	0.30	X	10.2			7,000			Site has low risk of human exposure, no observed erosion potential, and limited riparian area (0.3 acre).
BUR068	Headlight Mine	Canyon Creek (CC-282)	X	X	0	X	10.2		X	12,000			Site has no risk of human exposure, moderate erosion potential, no riparian area, and is located high up in the watershed.
BUR105	Oom Paul No. 2	Canyon Creek (CC-290)	X	X	0.27	X	0.110	X	X	6,500			Site has a low risk of human exposure, no observed erosion potential, minimal riparian area (0.27 acre), is located high up in the watershed, and the downstream dissolved zinc AWQC exceedance ratio is less than 1.0.
BUR125	Midway Summit Mine	Canyon Creek (CC-503)	--	--	0		3.06		X	8,000			Site contains no riparian area and is located high up in the watershed.
BUR134	Alcides Prospect & Imperial Mine	Canyon Creek (CC-290)	--	--	0	X	0.110	X	X	14,400			Site contains no riparian area and is located high up in the watershed, and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
BUR135	Sonora Mine	Canyon Creek (CC-290)	--	--	0.58	X	0.110	X		200	X		Site has a small waste volume (200 cy), limited riparian area (0.58 acre), is located high up in the watershed, and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
BUR176	Unnamed Adit	Canyon Creek (CC-503)	--	--	0.56	X	3.06			200	X		Site has a small waste volume (200 cy) and limited riparian area (0.56 acre).
BUR185	West Mammoth Mine	Canyon Creek (CC-290)	--	--	0.31	X	0.110	X	X	200	X		Site has a small waste volume (200 cy), limited riparian area (0.31 acre), is located high up in the watershed, and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
BUR189	Duluth Mine Canyon Ck	Canyon Creek (CC-503)	--	--	0	X	3.06		X	200	X		Site has a small waste volume (200 cy) and no riparian area, and is located high up in the watershed.
BUR204	Unnamed Rock Dump	Canyon Creek (CC-503)	--	--	0.19	X	3.06		X	200	X		Site has a small waste volume (200 cy) and limited riparian area (0.19 acre), and is located high up in the watershed.
BUR088	Ajax No. 2	Canyon Creek (CC-392)	--	--	0	X	1.54	X		0			Proposed remedial action includes an active treatment component, although no water quality data from the adit discharge are available. The site has no riparian area, and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.6.
BUR099	Benton Mine	Canyon Creek (CC-392)	--	--	0	X	1.54	X		0			Proposed remedial action includes an active treatment component, although no water quality data from the adit discharge is available. The site has no riparian area, and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.6.
KLE061	Unnamed Tunnel	Moon Creek (MC-262)	--	--	0.10	X	1.35	X		200	X		Site has a small waste volume (200 cy) and limited riparian area (0.1 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.5.
KLE064	Unnamed Adit	Moon Creek (MC-262)	--	--	0.10	X	1.35	X	X	200	X		Site has a small waste volume (200 cy) and limited riparian area (0.1 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.5.
KLW083	Liberal King Part of Tunnel No. 2	Pine Creek (PC-313)	--	--	0.58		1.68		X	13,920			Site has limited riparian area (0.58 acre) and is located high up in the watershed.
MAS009	Shetland Mining Co/Nabob Silver-Lead	Pine Creek (PC-312)	--	--	0.31	X	5.75		X	7,440			Site has limited riparian area (0.31 acre) and is located high up in the watershed.
MAS023	Blue Eagle Mine	Pine Creek (PC-312)	--	--	0.35		5.75		X	1000			Site has limited riparian area (0.35 acre) and is located high up in the watershed.
MAS028	Lon Cheney Group	Pine Creek (PC-312)	--	--	0.45	X	5.75		X	10,800			Site has limited riparian area (0.45 acre) and is located high up in the watershed.
MAS030	Trapper Creek Silver	Pine Creek (PC-312)	--	--	0.28	X	5.75		X	6,720			Site has limited riparian area (0.28 acre) and is located high up in the watershed.
MAS031	Trapper Mining & Smelting	Pine Creek (PC-312)	--	--	0.18	X	5.75		X	4,320			Site has limited riparian area (0.18 acre) and is located high up in the watershed.
MAS032	L&J Prospect	Pine Creek (PC-312)	--	--	0.27	X	5.75		X	80	X		Site has limited riparian area (0.27 acre) and low waste volume (80 cy), and is located high up in the watershed.
MAS033	CDA Premiere	Pine Creek (PC-312)	--	--	0.20	X	5.75		X	4,800			Site has limited riparian area (0.20 acre) and is located high up in the watershed.
MAS052	Owl/Fred Mine	Pine Creek (PC-312)	--	--	0.22	X	5.75		X	5,280			Site has limited riparian area (0.22 acre) and is located high up in the watershed.
MAS055	Unnamed Adit	Pine Creek (PC-312)	--	--	0	X	5.75		X	200	X		Site has no riparian area and a small waste volume (200 cy), and is located high up in the watershed.
MAS057	Unnamed Adit	Pine Creek (PC-312)	--	--	0.17	X	5.75		X	200	X		Site has a small waste volume (200 cy) and limited riparian area (0.17 acre), and is located high up in the watershed.
MAS065	Unnamed Prospect	Pine Creek (PC-312)	--	--	0.20	X	5.75		X	200	X		Site has a small waste volume (200 cy) and limited riparian area (0.20 acre), and is located high up in the watershed.
MAS068	Unnamed Adit	Pine Creek (PC-312)	--	--	0.16	X	5.75			200	X		Site has a small waste volume (200 cy) and limited riparian area (0.16 acre).

TABLE 4

Contingent Mine and Mill Sites for Removal from Selected Remedy

Evaluation of Mine and Mill Source Sites for Removal from the Forthcoming Upper Basin Selected Remedy

BLM Site Number	Source Name	Watershed	Human Health Exposure Criteria [1]	Erosion Potential Criteria [2]	Riparian Acreage	Riparian Acreage Criteria [3]	AWQC at the Downstream Segment	Downstream Water Quality Criteria [4]	Location Within Watershed Criteria [5]	Volume of Waste Materials (cy)	Volume of Waste Materials Criteria [6]	Additional Site-Specific Information [7]	Notes
TWI006	Manhattan Mine	Pine Creek (PC-311)	--	--	0	X	0.0657	X		4,800			Site has no riparian area, and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
TWI012	KC Prospect	Pine Creek (PC-311)	--	--	0.16	X	0.0657	X		3,840			Site has limited riparian area (0.16 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
TWI014	Great Dunkard Mine	Pine Creek (PC-311)	--	--	0.25	X	0.0657	X	X	6,000			Site has limited riparian area (0.25 acre), is located high up in the watershed, and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
TWI027	Unnamed Prospect	Pine Creek (PC-311)	--	--	0	X	0.0657	X		200	X		Site has no riparian area and low waste volume (200 cy), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
TWI030	Unnamed Adit	Pine Creek (PC-311)	--	--	0	X	0.0657	X		200	X		Site has no riparian area and low waste volume (200 cy), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
KLE016	Syndicate Mining	SFCDR (West)	--	--	0.62	X	8.70			200	X		Site has a small waste volume (200 cy) and limited riparian area (0.62 acre).
KLE020	New Hilarity Mine	SFCDR (West)	--	--	0	X	8.70		X	36,000			Site has no riparian area and is located far up in the watershed.
KLE021	Alhambra Mine	SFCDR (West)	--	--	0	X	8.70		X	200	X		Site has no riparian area and is located far up in the watershed.
KLE051	Florence Mine	SFCDR (West)	--	--	0	X	8.70		X	200	X		Site has no riparian area and is located far up in the watershed.
MUL063	Gem State Mine	SFCDR (East) (SF-228)	X	X	0	X	1.41			5,040			Site has moderate risk for human exposure, no observed erosion potential, and no riparian area.
MUL065	Moe Mine	SFCDR (East) (SF-228)	X	X	0	X	1.41			7,440			Site has moderate risk for human exposure, no observed erosion potential, and no riparian area.
POL021	Eclipse Mine	SFCDR (West) (SF-268)	--	--	0.66	X	8.70		X	200	X		Site has a small waste volume (200 cy) and limited riparian area (0.66 acre), and is located far up in the watershed.
POL064	Unnamed Adit	SFCDR (West) (SF-268)	--	--	0	X	8.70		X	200	X		Site has small waste volume (200 cy) and no riparian area, and is located far up in the watershed.
WAL035	Osburn Rockpit Along I-90	SFCDR (West)	X	X	4.79		8.70			140,000			The rock pit was not a developed mineral site, there is no risk of human exposure, and there is low potential for erosion.
WAL016	Argentine Mine	SFCDR Tributary (Argentine Gulch, SF-242)	--	--	0.48	X	0.128	X		200	X		Site has a small waste volume (200 cy) and limited riparian area (0.48 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL119	Unnamed Adit	SFCDR Tributary (Boulder Creek, SF-214)	--	--	0.28	X	0.0767	X		200	X		Site has a small waste volume (200 cy) and limited riparian area (0.28 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
LOK007	Butte & CDA (Idaho Silver)	SFCDR Tributary (Daisy Gulch, SF-206)	--	--	0.27	X	0.0310	X		6,480			IGS data review indicates that the mineral production of the mine was uncertain. Site has limited riparian area (0.27 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
LOK010	Hash House Mine	SFCDR Tributary (Daisy Gulch, SF-206)	--	--	0.27	X	0.0310	X		3,360			Processing of the mine rock was not conducted at this site and was done primarily at the bottom of the gulch. Site has limited riparian area (0.27 acre).
LOK048	Snowstorm Apex	SFCDR Tributary (Daisy Gulch, SF-206)	X	X	0.27	X	0.0310	X		6,480			Mine was primarily a copper ore producer. Processing did not occur onsite and was done at LOK008. Site has low human health exposure, moderate erosion potential, limited riparian area (0.27 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL047	Lottie L. Mine	SFCDR Tributary (Deadman Gulch, SF-209)	X	X	0.23	X	0.0181	X		5,520			Site has low risk of human exposure, no observed erosion potential, limited riparian area (0.23 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL048	Alma Mine	SFCDR Tributary (Deadman Gulch, SF-209)	X	X	0.68	X	0.0181	X		21,360			Site has low risk of human exposure, moderate erosion potential, limited riparian area (0.68 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL049	Copper Plate Mine	SFCDR Tributary (Deadman Gulch, SF-209)	--	--	0.30	X	0.0181	X		7,200			Site has limited riparian area (0.30 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL051	Pilot Mine	SFCDR Tributary (Deadman Gulch, SF-209)	X	X	0.65	X	0.0181	X		28,800			Site has low risk of human exposure, moderate erosion potential, limited riparian area (0.65 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL103	Missoula Mine	SFCDR Tributary (Deadman Gulch, SF-209)	X		0	X	0.0181	X		6,300			Site has low risk of human exposure and no riparian area, and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL135	Unnamed Adit	SFCDR Tributary (Deadman Gulch, SF-209)	--	--	0.18	X	0.0181	X		200	X		Site has limited riparian area (0.18 acre) and low waste volume (20 cy),and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL150	Deadman Gulch Imp Riparian	SFCDR Tributary (Deadman Gulch, SF-209)	--	--	3.02	X	0.0181	X		15,100			Site has limited riparian area (3.02 acres), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL153	Deadman Gulch Imp Riparian	SFCDR Tributary (Deadman Gulch, SF-209)	--	--	1.52	X	0.0181	X		7,600			Site has limited riparian area (1.52 acres), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
WAL013	Granada Mine	SFCDR Tributary (Dexter Gulch, SF-229)	X	X	0.34	X	0.204	X		8,160			Site has low risk of human exposure, no observed erosion potential, limited riparian area (0.34 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
LOK001	Lucky Calumet No. 1	SFCDR Tributary (Gentle Annie Gulch, SF-207)	--	--	0	X	0.108	X		30,960			IGS data review indicates that mine was primarily used for copper ore production. In addition, site has no riparian area, and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
LOK002	Lucky Calumet No. 2	SFCDR Tributary (Gentle Annie Gulch, SF-207)	--	--	0.95	X	0.108	X		30,480			Site has limited riparian area (0.95 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
LOK005	Lucky Boy No. 2	SFCDR Tributary (Gentle Annie Gulch, SF-207)	--	--	0.18	X	0.108	X		4,320			Site has limited riparian area (0.18 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
LOK006	Lucky Boy No. 1	SFCDR Tributary (Gentle Annie Gulch, SF-207)	X	X	0.17	X	0.108	X		6,240			Site has low risk of human exposure, no observed erosion potential, limited riparian area (0.17 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
LOK053	Unnamed Adit	SFCDR Tributary (Gentle Annie Gulch, SF-207)	--	--	0.31	X	0.108	X		200	X		Site has a small waste volume (200 cy) and limited riparian area (0.31 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL056	Coughlin Mine	SFCDR Tributary (Gentle Annie Gulch, SF-207)	--	--	0	X	0.108	X		8,400			Site has no riparian area, and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL057	Butte & CDA Mine	SFCDR Tributary (Gentle Annie Gulch, SF-207)	--	--	0	X	0.108	X		18,960			Site has no riparian area, and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL043	Silver Reef Mine	SFCDR Tributary (Gold Hunter Gulch, SF-212)	--	--	0.63	X	0.0646	X		17,520			Site has limited riparian area (0.63 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.

TABLE 4

Contingent Mine and Mill Sites for Removal from Selected Remedy

Evaluation of Mine and Mill Source Sites for Removal from the Forthcoming Upper Basin Selected Remedy

BLM Site Number	Source Name	Watershed	Human Health Exposure Criteria [1]	Erosion Potential Criteria [2]	Riparian Acreage	Riparian Acreage Criteria [3]	AWQC at the Downstream Segment	Downstream Water Quality Criteria [4]	Location Within Watershed Criteria [5]	Volume of Waste Materials (cy)	Volume of Waste Materials Criteria [6]	Additional Site-Specific Information [7]	Notes
MUL136	Unnamed Adit	SFCDR Tributary (Gold Hunter Gulch, SF-212)	--	--	0	X	0.0646	X		200	X		Site has no riparian area and low waste volume (200 cy), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL009	Silver Shaft	SFCDR Tributary (Grouse Gulch, SF-223)	--	--	0	X	11.4			6,000			Site has no riparian area.
MUL013	We Like Mine	SFCDR Tributary (Grouse Gulch, SF-223)	--	--	0	X	11.4			12,720			Site has no riparian area. BLM performed stabilization of rock dump and water treatment pilot test.
MUL014	Grouse Mine	SFCDR Tributary (Grouse Gulch, SF-223)	--	--	0.33	X	11.4			7,920		X	Adit water quality data indicate that the dissolved zinc concentration is low (0.84 mg/L). The selected remedial action contains an active treatment component. Site has limited riparian area (0.33 acre).
MUL015	West Star Mine	SFCDR Tributary (Grouse Gulch, SF-223)	--	--	0	X	11.4			23,000			Site has no riparian area.
THO020	Bullfrog Mine	SFCDR Tributary (Little North Fork, SF-202)	--	--	0	X	0.102	X		6,960			Site has no riparian area, and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL022	Sunshine Premiere	SFCDR Tributary (Mill Creek, SF-216)	X	X	0.32	X	0.0231	X		8,400			Site has no human health exposure, moderate erosion potential, limited riparian area (0.32 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL023	Fanny Gremm Mine	SFCDR Tributary (Mill Creek, SF-216)			0	X	0.0231	X		31,200			Site has no riparian area, and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL029	North Franklin Mine	SFCDR Tributary (Mill Creek, SF-216)	X	X	0.63	X	0.0231	X		20,400			Site has moderate human health exposure potential, moderate erosion potential, limited riparian area (0.63 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL030	Wall Street Mine	SFCDR Tributary (Mill Creek, SF-216)	X		0	X	0.0231	X		8,640			Site has no human health exposure, no riparian area, and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL031	Cincinnati Mine	SFCDR Tributary (Mill Creek, SF-216)	X	X	0	X	0.0231	X		8,160			Site has no human health exposure, no observed erosion potential, no riparian area, and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL033	American Commander No. 2	SFCDR Tributary (Mill Creek, SF-216)	X	X	0.46		0.0231	X		15,840			Site has low human health exposure potential, moderate erosion potential, and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL139	Unnamed Adit	SFCDR Tributary (Mill Creek, SF-216)	--	--	0.24	X	0.0231	X		200	X		Site has small waste volume (200 cy) and limited riparian area (0.24 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL141	Mill Ck Imp Riparian No. 3	SFCDR Tributary (Mill Creek, SF-216)	--	--	1.93	X	0.0231	X		9,650			Site has limited riparian area (1.93 acres), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL145	Mill Ck Imp Riparian No. 2	SFCDR Tributary (Mill Creek, SF-216)	--	--	0	X	0.0231	X		4,200			Site has no riparian area, and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL146	Morning No. 3[a]	SFCDR Tributary (Mill Creek, SF-216)	--	--	0	X	0.0231	X		31,440			Site has no riparian area, and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL149	Mill Creek Impacted Riparian No. 1	SFCDR Tributary (Mill Creek, SF-216)	--	--	1.13	X	0.0231	X		5,650			Site has limited riparian area (1.13 acres), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
OSB070	Silverore-Inspiration Mine	SFCDR Tributary (Nichols Gulch, SF-245)	--	--	1.3	X	0.132	X		31,000			Site has limited riparian area (1.3 acres), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
OSB072	Western Union Upper Adit	SFCDR Tributary (Nichols Gulch, SF-245)	X		0.23	X	0.132	X		200	X		Site has low human health exposure potential and limited riparian area (0.23 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL085	Vienna Intl Mine	SFCDR Tributary (Placer Creek, SF-234)	X	X	0.37	X	0.0335	X		200	X		Site has low human health exposure potential, moderate erosion potential, limited riparian area (0.37 acre), low waste volume (200 cy), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL086	Wibberding-Golden Slipper	SFCDR Tributary (Placer Creek, SF-234)	X	X	0	X	0.0335	X		30,000			Site has no human health exposure potential, no observed erosion potential, no riparian area, and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL059	Rock Creek Mine Rock Dump	SFCDR Tributary (Rock Creek, SF-225)	X	X	0.94	X	1.41	X		22,560			Site has moderate human exposure potential, moderate erosion potential, limited riparian area (0.94 acre), and the downstream AWQC exceedance ratio is less than 1.5.
MUL060	Rock Creek Mine	SFCDR Tributary (Rock Creek, SF-225)	--	--	0.21	X	0.0359	X		5,040			Site has limited riparian area (0.21 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL008	Alice Mine	SFCDR Tributary (Ruddy Gulch, SF-224)		X	1.1	X	0.0445	X		33,000		X	IGS waste samples are available indicating that this site is not a risk. In addition, the site has low erosion potential, is located far up in the watershed, has limited riparian area (1.1 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
WAL034	Shields Gulch Imp Riparian	SFCDR Tributary (Shields Gulch, SF-244)	--	--	6.08	X	0.0201	X		78,000			Site has limited riparian area (6.08 acres), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
KLE066	Rhode Island No. 1 & No. 2 & assoc. adits	SFCDR Tributary (Terror Gulch, SF-252)	--	--	0.38	X	0.224	X		200	X		Site has small waste volume (200 cy), limited riparian area (0.38 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
KLE068	St Joe No. 2	SFCDR Tributary (Terror Gulch, SF-252)	--	--	0.21	X	0.224	X		14,000		X	IGS sampled the waste dump. Lead concentrations ranged from 84 to 390 mg/kg. In addition, the site has limited riparian area (0.21 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
OSB074	St. Joe No. 1	SFCDR Tributary (Terror Gulch, SF-252)	--	--	0	X	0.224	X		0	X		Remedial action includes passive treatment, and the site has low waste volume. Location of adit is potentially in the St. Joe river watershed.
MUL006	Square Deal Mine	SFCDR Tributary (Trowbridge Gulch, SF-226)	--	--	0.13	X	0.109	X		17,520			Site has limited riparian area (0.13 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
OSB076	Unnamed Adit (May Claim)	SFCDR Tributary (Twomile Creek, SF-248)	--	--	0.18	X	0.067	X		200	X		Site has limited riparian area (0.18 acre) and low waste volume (200 cy), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
OSB078	Unnamed Adit (Hardscrabble Claim)	SFCDR Tributary (Twomile Creek, SF-248)	X	X	0.08	X	0.067	X		200	X		Site has moderate potential for human exposure, moderate erosion potential, limited riparian area (0.08 acre), low waste volume (200 cy), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
LOK017	Beacon Light	SFCDR Tributary (Unknown, SF-201)		X	0	X	0.178	X		31,000			Site has high human access, no observed potential for erosion, no riparian area, and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0. In addition, the IGS exploration records at Wallace Museum indicate that this mine was an ore producer.
MUL073	Atlas Mine (Carbonate Hill)	SFCDR Tributary (Willow Creek, SF-210)	--	--	0	X	0.0490	X		560	X	X	IGS data indicate that the waste pile is primarily an asbestos pile. Site has no riparian area, and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
MUL081	Reindeer Queen Mine	SFCDR Tributary (Willow Creek, SF-210)	X	X	0.76	X	0.0490	X		8,000		X	Site has moderate human exposure potential, moderate erosion potential, limited riparian area (0.76 acre), and IGS waste dump samples indicate minimal risk.

TABLE 4

Contingent Mine and Mill Sites for Removal from Selected Remedy

Evaluation of Mine and Mill Source Sites for Removal from the Forthcoming Upper Basin Selected Remedy

BLM Site Number	Source Name	Watershed	Human Health Exposure Criteria [1]	Erosion Potential Criteria [2]	Riparian Acreage	Riparian Acreage Criteria [3]	AWQC at the Downstream Segment	Downstream Water Quality Criteria [4]	Location Within Watershed Criteria [5]	Volume of Waste Materials (cy)	Volume of Waste Materials Criteria [6]	Additional Site-Specific Information [7]	Notes
MUL083	Copper Queen Mine	SFCDR Tributary (Willow Creek, SF-210)	X	X	0.64	X	0.0490	X		15,360			IGS data indicate that this mine was an extensively developed copper mine. Site has low human health exposure potential, no observed erosion potential, limited riparian area (0.64 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
OSB025	Capitol Silver Lead No. 3	SFCDR Tributary (Twomile Creek)	X	X	0.5	X	0.067	X		12,000			Site has low human health exposure potential, no observed erosion potential, limited riparian area (0.5 acre), and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
KLE033	Polaris Mine	SFCDR Tributary (Unknown, SF-257)	--	--	1.6	X	0.05	X	X	25,000			Site has limited riparian acreage (1.6 acres) and is located far up in the watershed, and the downstream AWQC exceedance ratio for dissolved zinc is less than 1.0.
KLW061	BH No. 2	SFCDR (West)	--	--						333,120			Additional site characterization is needed to determine risks posed to human health and the environment. If, upon further analysis, actions are determined to be warranted, they could be implemented through the existing ROD for OU 2.
KLW062	Bluebird Mine and Guy Cave Area	SFCDR (West)	--	--						51,120			Additional site characterization is needed to determine risks posed to human health and the environment. If, upon further analysis, actions are determined to be warranted, they could be implemented through the existing ROD for OU 2.
KLW070	Milo Creek Impacted Riparian No. 1	SFCDR (West)	--	--						9,350			Additional site characterization is needed to determine risks posed to human health and the environment. If, upon further analysis, actions are determined to be warranted, they could be implemented through the existing ROD for OU 2.
KLW095	Phil Sheridan Mine	SFCDR (West)	--	--						19,680			Additional site characterization is needed to determine risks posed to human health and the environment. If, upon further analysis, actions are determined to be warranted, they could be implemented through the existing ROD for OU 2.

Notes:

[1] **Human Health Exposure Criteria –** An "X" indicates that the results of analyzing GIS coverages and information gathered during field investigations of mine and mill sites where human health risk observations were available were assigned a human health risk level of none, low, or moderate.

[2] **Erosion Potential Criteria** – An "X" indicates that the site, during field investigations in the Upper Basin, was observed to have no erosion potential, minimal erosion potential, or moderate erosion potential.

[3] **Riparian Acreage Criteria** – An "X" indicates that there is minimal riparian area associated with the site.

[4] **Downstream Water Quality Criteria** – An "X" indicates that site-specific water quality data (specifically the dissolved zinc AWQC exceedance ratio) indicate that the downstream water quality data do not appear to be impacted by upstream sites. The AWQC exceedance ratio was calculated using the 1997 low-flow dataset for the SFCDR, Big Creek, Moon Creek, and Pine Creek Watersheds. The 2008 low-flow dataset was used for the Canyon Creek and Ninemile Creek Watersheds.

[5] **Location Within Watershed Criteria** – An "X" indicates that the site is located in the upper reaches of the watershed outside riparian, floodplain, or stream channel areas.

[6] **Volume of Waste Materials Criteria –** An "X" indicates that the initial volumes and types of mine waste materials present at the site were estimated during development of the Preferred Alternative. Sites estimated to have relatively small volumes (typically 200 cubic yards or less) or relatively low-concentration mine wastes (upland waste rock) were identified.

[7] **Additional Site-Specific Information** – An "X" indicates that contaminant concentrations, site-specific water quality data, and information from field visits were available for the site and that the data were used to evaluate the potential risks to human health and the environment posed by the site.

-- = Site was not evaluated for human health exposure or erosion potential.

[a] According to Hecla records, this site (MUL146) actually the portal and waste rock pile for Morning No. 2.

AWQC = ambient water quality criterion/criteria
cy = cubic yards
IGS = Idaho Geological Survey
mg/kg = milligram(s) per kilogram
mg/L = milligram(s) per liter
OU = Operable Unit
ROD = Record of Decision
SFCDR = South Fork Coeur d'Alene River
TCD = typical conceptual design

TABLE 5

Mine and Mill Sites Retained in the Selected Remedy

Evaluation of Mine and Mill Source Sites for Removal from the Forthcoming Upper Basin Selected Remedy

BLM Site Number	Source Name	Watershed
KLE047	BIG CK IMPACTED RIPARIAN: NO. 1	Big Creek
KLE071	BIG CK IMPACTED RIPARIAN: NO. 3	Big Creek
KLE073	BIG CK IMPACTED RIPARIAN: NO. 2	Big Creek
BUR067	TAMARACK NO. 7 (1200 LEVEL)	Canyon Creek
BUR072	STANDARD-MAMMOTH NO. 4	Canyon Creek
BUR073	STANDARD-MAMMOTH CAMPBELL ADIT	Canyon Creek
BUR075	SHERMAN 1000 LEVEL (OREANO ADIT)	Canyon Creek
BUR087	HERCULES NO. 3	Canyon Creek
BUR090	HERCULES NO. 4	Canyon Creek
BUR094	SHERMAN 600 LEVEL	Canyon Creek
BUR096	ANCHOR MINE	Canyon Creek
BUR097	HIDDEN TREASURE MINE	Canyon Creek
BUR098	HERCULES NO. 5	Canyon Creek
BUR107	AJAX NO.3	Canyon Creek
BUR109	OOM PAUL NO. 1	Canyon Creek
BUR112	GEM NO. 2	Canyon Creek
BUR117	FRISCO MILLSITE	Canyon Creek
BUR118	FRISCO NO. 2 & NO. 1	Canyon Creek
BUR119	BLACK BEAR NO. 4	Canyon Creek
BUR120	SILVER MOON MINE	Canyon Creek
BUR121	BLACK BEAR FRACTION	Canyon Creek
BUR122	FLYNN MINE	Canyon Creek
BUR124	OMAHA MINE	Canyon Creek
BUR128	HECLA-STAR MINE & MILLSITE COMPLEX	Canyon Creek
BUR129	TIGER-POORMAN MINE	Canyon Creek
BUR130	MARSH MINE	Canyon Creek
BUR141	CANYON CK IMPACTED FLOODPLAIN	Canyon Creek
BUR142	GEM MILLSITE	Canyon Creek
BUR143	CANYON CK IMPACTED RIPARIAN	Canyon Creek
BUR144	STANDARD-MAMMOTH LOADING AREA	Canyon Creek
BUR145	ONEILL GULCH UNNAMED ROCK DUMP	Canyon Creek
BUR146	GORGE GULCH IMPACTED RIPARIAN	Canyon Creek
BUR149	AJAX NO.2 ADJACENT ROCK DUMP	Canyon Creek
BUR150	CANYON CK GARBAGE DUMP	Canyon Creek
BUR153	CANYON CK IMPACTED FLOODPLAIN (CCSeg02 & CCSeg04)	Canyon Creek
BUR177	JOE MATT MINE	Canyon Creek
BUR178	WEST HECLA MINE	Canyon Creek
BUR180	STANLEY MINE	Canyon Creek
BUR190	GEM NO. 3	Canyon Creek
BUR191	FRISCO NO. 3	Canyon Creek

TABLE 5

Mine and Mill Sites Retained in the Selected Remedy

Evaluation of Mine and Mill Source Sites for Removal from the Forthcoming Upper Basin Selected Remedy

BLM Site Number	Source Name	Watershed
BUR192	BLACK BEAR MILLSITE	Canyon Creek
OSB047	CANYON CK FORMOSA REACH SVNRT REHAB	Canyon Creek
WAL009	HECLA-STAR TAILINGS PONDS	Canyon Creek
WAL010	CANYON CK POND REACH SVNRT REHAB	Canyon Creek
WAL011	CANYON SILVER (FORMOSA) MINE	Canyon Creek
WAL039	STANDARD-MAMMOTH MILLSITE	Canyon Creek
WAL040	CANYON CK IMPACTED FLOODPLAIN	Canyon Creek
WAL041	CANYON CK REPOSITORY REACH SVNRT REHAB	Canyon Creek
WAL042	CANYON CK TAILINGS REPOSITORY SVNRT	Canyon Creek
WAL081	WALLACE OLD PRIVATE LANDFILL	Canyon Creek
KLE014	ROYAL ANNE MINE	Moon Creek
KLE041	MOON CK IMPACTED RIPARIAN	Moon Creek
BUR051	SUNSET MINE	Ninemile Creek
BUR053	INTERSTATE-CALLAHAN MINE/ROCK DUMPS	Ninemile Creek
BUR055	INTERSTATE MILLSITE	Ninemile Creek
BUR056	TAMARACK ROCK DUMPS	Ninemile Creek
BUR058	TAMARACK NO. 3	Ninemile Creek
BUR139	REX NO. 1	Ninemile Creek
BUR140	NINEMILE CREEK IMPACTED FLOODPLAIN	Ninemile Creek
BUR160	INTERSTATE-CALLAHAN LOWER ROCK DUMPS	Ninemile Creek
BUR170	TAMARACK 400 LEVEL	Ninemile Creek
BUR171	TAMARACK NO. 5	Ninemile Creek
BUR172	TAMARACK UNNAMED ADIT	Ninemile Creek
BUR173	TAMARACK MILLSITE	Ninemile Creek
OSB038	CALIFORNIA NO. 4	Ninemile Creek
OSB039	DAYROCK MINE	Ninemile Creek
OSB040	EF NINEMILE CK HECLA REHAB	Ninemile Creek
OSB044	SUCCESS MINE ROCK DUMP	Ninemile Creek
OSB048	AMERICAN MINE	Ninemile Creek
OSB052	DAYROCK MINE TLGS PILE/SVNRT REPOSITORY	Ninemile Creek
OSB056	EF NINEMILE CK IMPACTED RIPARIAN	Ninemile Creek
OSB057	EF NINEMILE CK IMPACTED RIPARIAN	Ninemile Creek
OSB058	EF NINEMILE CK SVNRT REHAB	Ninemile Creek
OSB059	NINEMILE CK BELOW DAYROCK MINE	Ninemile Creek
OSB060	NINEMILE CK SVNRT REHAB NEAR BLACKCLD	Ninemile Creek
OSB082	MONARCH MINE BLACKCLOUD CK	Ninemile Creek
OSB088	ALAMEDA MINE	Ninemile Creek
OSB089	SUCCESS NO.3	Ninemile Creek
OSB115	OPTION MINE	Ninemile Creek
WAL033	NINEMILE CK POTENTIAL TAILINGS DEPOSIT	Ninemile Creek

TABLE 5

Mine and Mill Sites Retained in the Selected Remedy

Evaluation of Mine and Mill Source Sites for Removal from the Forthcoming Upper Basin Selected Remedy

BLM Site Number	Source Name	Watershed
KLW075	MATCHLESS MINE	Pine Creek
KLW079	GOLD EAGLE MINING CO.	Pine Creek
KLW082	CARBONATE MINE: NO. 2	Pine Creek
KLW085	CARBONATE MINE: NO. 1	Pine Creek
MAS003	LIBERAL KING MINE & MILLSITE	Pine Creek
MAS007	NABOB 1300 LEVEL	Pine Creek
MAS011	IDAHO PROSPECT: NO. 2	Pine Creek
MAS012	LYNCH-PINE CREEK MINE	Pine Creek
MAS013	NABOB 600 LEVEL (300 Level)	Pine Creek
MAS014	HILARITY MINE	Pine Creek
MAS015	LITTLE PITTSBURG MINE: NO. 2	Pine Creek
MAS016	LITTLE PITTSBURG MINE: NO. 1	Pine Creek
MAS020	SIDNEY (RED CLOUD) MINE/MILLSITE	Pine Creek
MAS021	NEVADA-STEWART MINE	Pine Creek
MAS022	SURPRISE MINE & UPPER ROCK DUMP	Pine Creek
MAS025	DOUGLAS MINE & MILLSITE	Pine Creek
MAS029	BIG IT MINE	Pine Creek
MAS035	NABOB 600 LEVEL SHAFT	Pine Creek
MAS036	DENVER CK TAILINGS PILE	Pine Creek
MAS040	DENVER CK IMPACTED RIPARIAN: NO. 2	Pine Creek
MAS041	DENVER CK IMPACTED RIPARIAN: NO. 3	Pine Creek
MAS042	DENVER CK IMPACTED RIPARIAN: NO. 4	Pine Creek
MAS043	DENVER CK IMPACTED RIPARIAN: NO. 1	Pine Creek
MAS045	HIGHLAND CK IMPACTED RIPARIAN	Pine Creek
MAS046	HIGHLAND & RED CLOUD CK IMPACTED RIPAR	Pine Creek
MAS054	MARMION OR SF FRACTION	Pine Creek
MAS078	HIGHLAND-SURPRISE MINE & MILLSITE	Pine Creek
MAS083	NABOB MILLSITE	Pine Creek
MAS084	DOUGLAS MINESITE TAILINGS REPOSITORY	Pine Creek
KLE011[a]	SILVER CRESCENT TAILINGS	SFCDR (West)
KLE034	SILVER DOLLAR MINE	SFCDR (West)
KLE035	SILVER SUMMIT MINE	SFCDR (West)
KLE040	SF CDA RIVER IMPACTED FLOODPLAIN: NO. 5	SFCDR (West)
KLE048	SF CDA RIVER SVNRT REHAB	SFCDR (West)
KLE049	SF CDA RIVER IMPACTED RIPARIAN (MidGradSeg01 & MidGradSeg02)	SFCDR (West)
KLE067	ST. JOE NO. 4	SFCDR (West)
KLE069	ST. JOE NO. 3	SFCDR (West)
LOK004	SNOWSHOE NO. 2	SFCDR (East)
LOK009	SNOWSTORM NO. 4	SFCDR (East)

TABLE 5

Mine and Mill Sites Retained in the Selected Remedy

Evaluation of Mine and Mill Source Sites for Removal from the Forthcoming Upper Basin Selected Remedy

BLM Site Number	Source Name	Watershed
LOK011	SNOWSTORM NO. 3	SFCDR (East)
LOK024	SILVER CABLE MINE	SFCDR (East)
MUL012	STAR 1200 LEVEL	SFCDR (East)
MUL018	MULLAN METALS MINE	SFCDR (East)
MUL021	INDEPENDENCE MINE	SFCDR (East)
MUL027	MORNING NO. 4[b]	SFCDR (East)
MUL028	MORNING NO. 5	SFCDR (East)
MUL045	HOMESTAKE MINE	SFCDR (East)
MUL052	COPPER KING MINE	SFCDR (East)
MUL053	NATIONAL MINE	SFCDR (East)
MUL054	UNNAMED ADIT	SFCDR (East)
MUL071	ATLAS MINE	SFCDR (East)
MUL120	BANNER MINE NO. 2	SFCDR (East)
MUL129	ATLAS MINE ROCK DUMP	SFCDR (East)
MUL132	NATIONAL MILLSITE ADJACENT TAILINGS	SFCDR (East)
MUL142	GROUSE GULCH IMPACTED RIPARIAN	SFCDR (East)
OSB065	SF CDA RIVER IMPACTED FLOODPLAIN: NO. 3	SFCDR (West)
OSB117	OSBURN ZANETTI STOCKPILED TAILINGS	SFCDR (West)
OSB118	OSBURN NORTH TAILINGS AREA	SFCDR (West)
OSB120	SF CDA RIVER IMPACTED FLOODPLAIN: NO. 4	SFCDR (West)
WAL002	WESTERN UNION LOWER ADIT	SFCDR (West)
WAL004	SF CDA RIVER RAILROAD YARDS & IMP FLDP	SFCDR (West)
WAL014	ST. ELMO MINE	SFCDR (West)
WAL038	SF CDA RIVER IMPACTED FLOODPLAIN: NO. 1	SFCDR (East)
WAL076	MARY D CLAIM WORKINGS	SFCDR (East)
WAL077	GOLCONDA TAILINGS	SFCDR (East)

Notes:

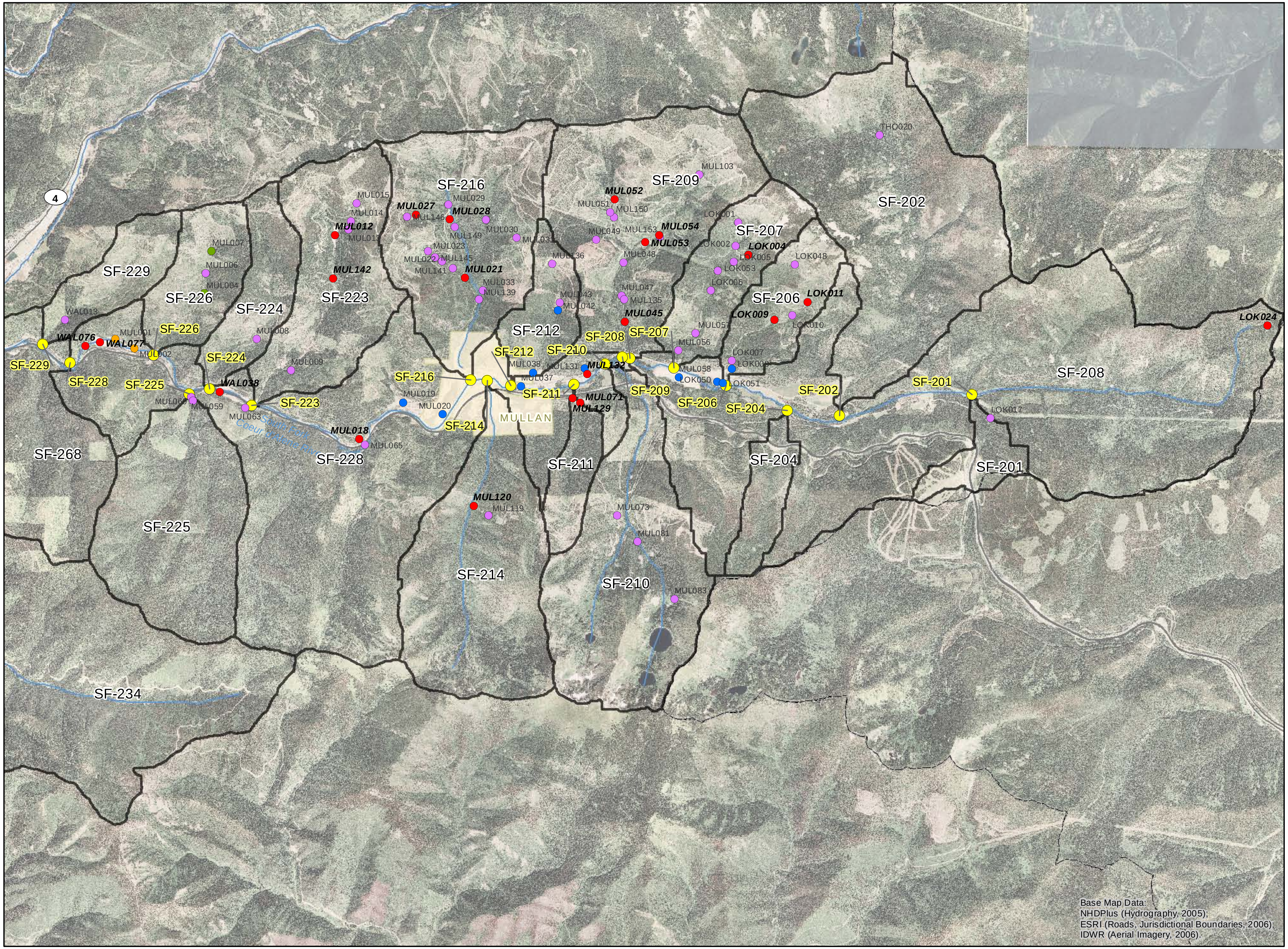
This table presents the mine and mill sites retained in the remedy. There are 5 specific actions that are included within the Remedy that are not specifically mine and mill sites, including: Woodland Park Option C, and remedial actions in Operable Unit 2 (OU 2) in the Bunker Hill Box.

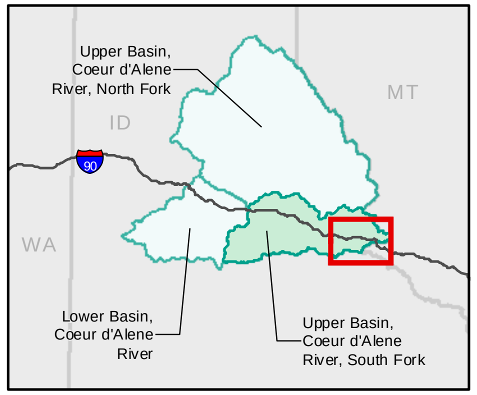
[a] The KLE011 source area is actually the Silver Summit Tailings Pond. It is believed that the names were mistakenly switched within the BLM GIS database. For consistency, the BLM naming convention has not been revised.

[b] According to Hecla records, this site (MUL027) is actually the Morning No. 3 portal and waste rock pile.

BLM = U.S. Department of the Interior Bureau of Land Management
SFCDR = South Fork Coeur d'Alene River

Figures





- Active (Removed)
- Likely Low-Risk Site (Removed)
- Remediated (Removed)
- Removed Based on 2011 Focused Characterization Sampling
- Retained in Selected Remedy
- River/Creek
- City Limit
- County Boundary
- Boundary of Watershed Portion Upstream from Surface Water Monitoring Station

MUL052 - Site Retained in the Selected Remedy

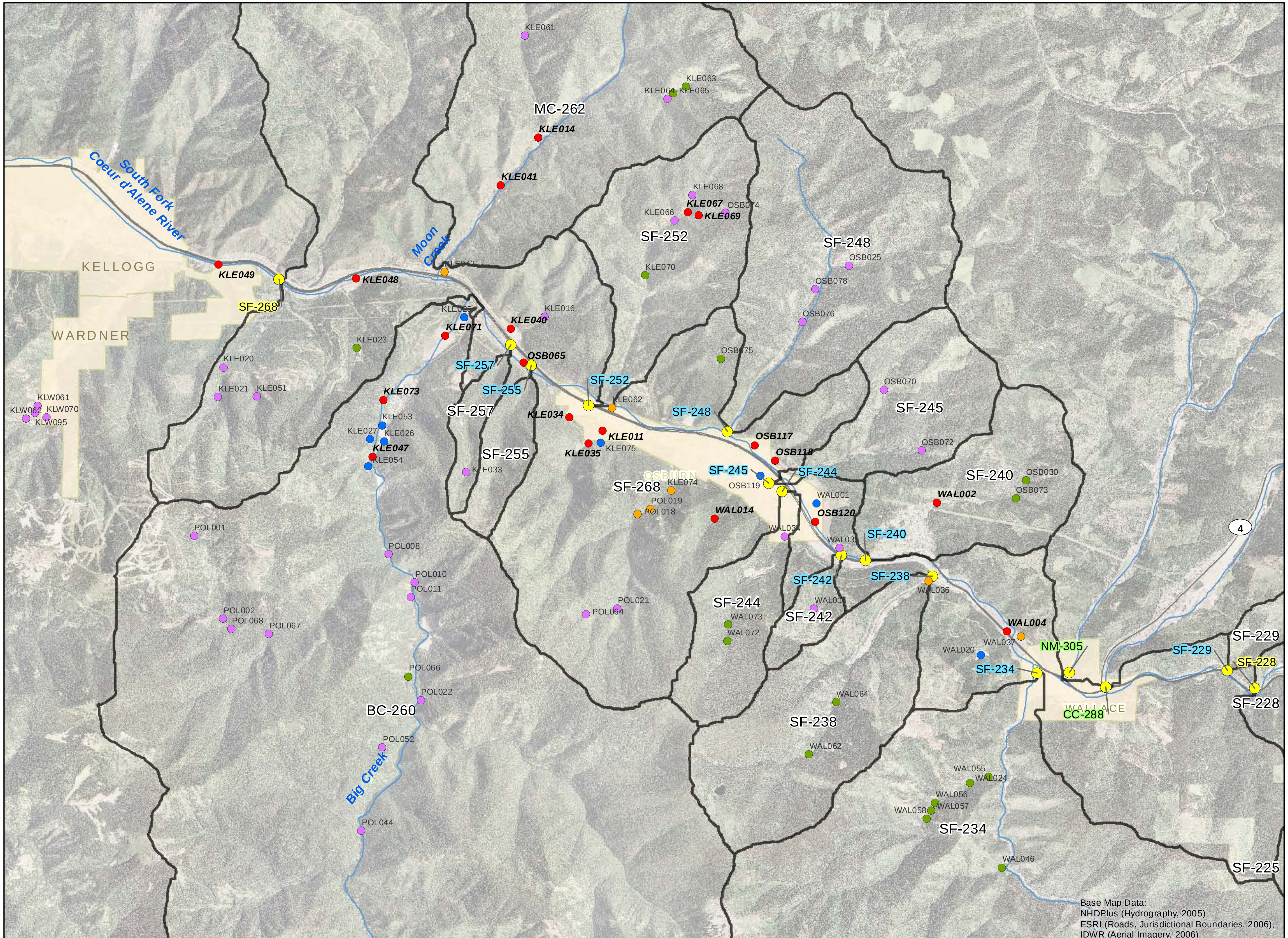
SF-201 1997 Mainstem SFCDR Surface Water Monitoring Station

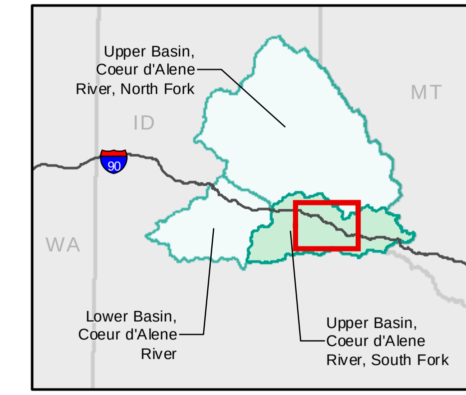
N

0 2,000 4,000 8,000 Feet

Figure 1
Summary of Sites Removed from the Selected Remedy in the SFCDR (East) Watershed
Evaluation of Sites to be Removed from the Forthcoming Upper Basin Selected Remedy

EPA





- Active (Removed)
- Likely Low-Risk Site (Removed)
- Remediated (Removed)
- Removed Based on 2011 Focused Characterization Sampling
- Retained in Selected Remedy
- River/Creek
- City Limit
- County Boundary
- Boundary of Watershed Portion Upstream from Surface Water Monitoring Station

WAL002 - Site Retained in the Selected Remedy

Mainstem SFCDR Surface Water Monitoring Stations:
SF-268 2008 Monitoring Station

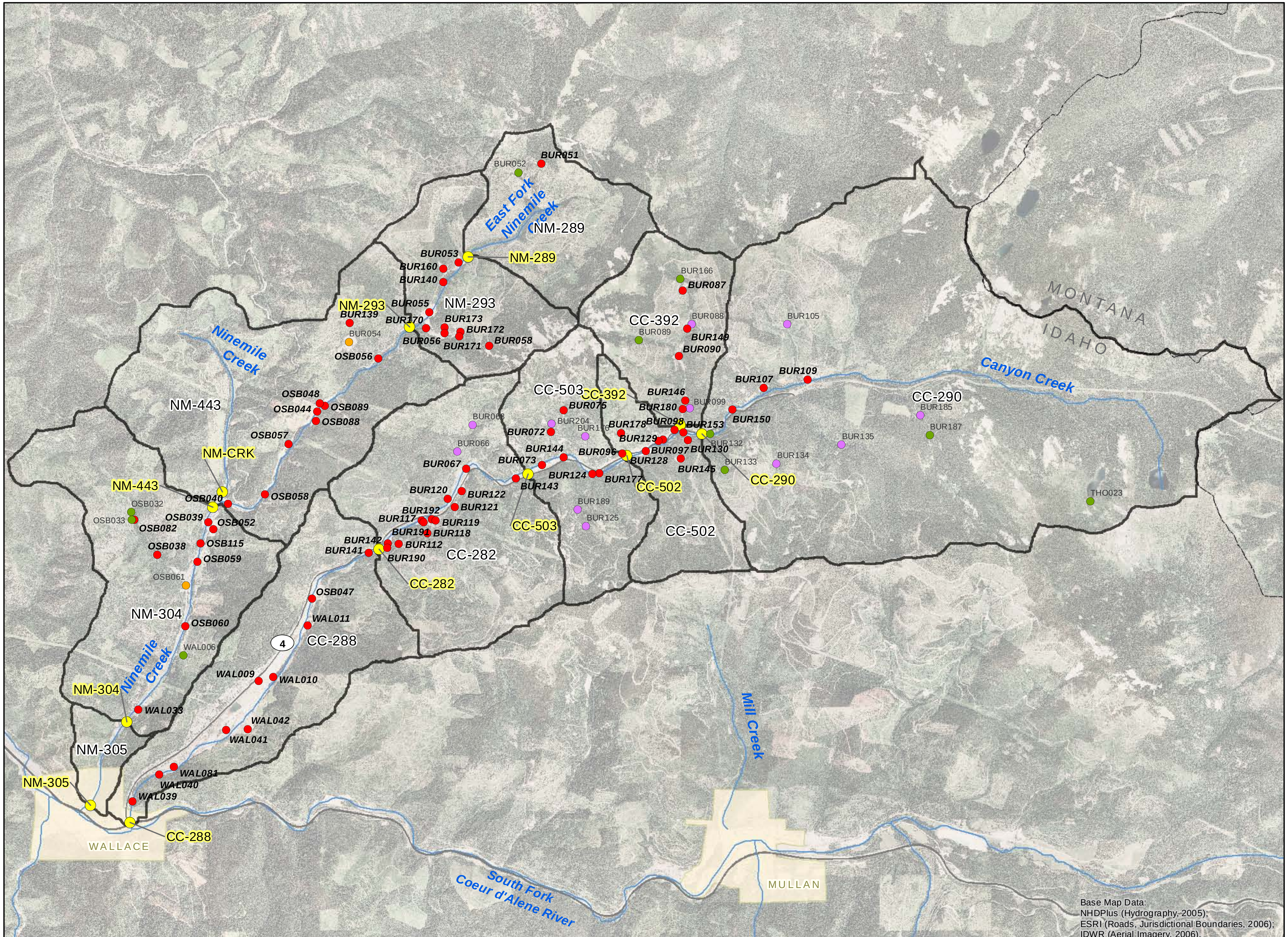
Tributary Surface Water Monitoring Stations:
SF-229 1997 Monitoring Station
NM-305 2007 Monitoring Station

N

0 2,000 4,000 8,000 Feet

Figure 2
Summary of Sites Removed from the Selected Remedy in the SFCDR (West), Big Creek, and Moon Creek Watersheds
Evaluation of Sites to be Removed from the Forthcoming Upper Basin Selected Remedy

EPA



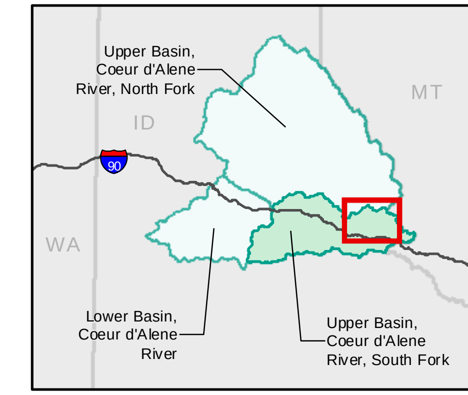


Figure 3
Summary of Sites Removed from the Selected Remedy in the Canyon Creek and Ninemile Creek Watersheds
Evaluation of Sites to be Removed from the Forthcoming Upper Basin Selected Remedy

EPA

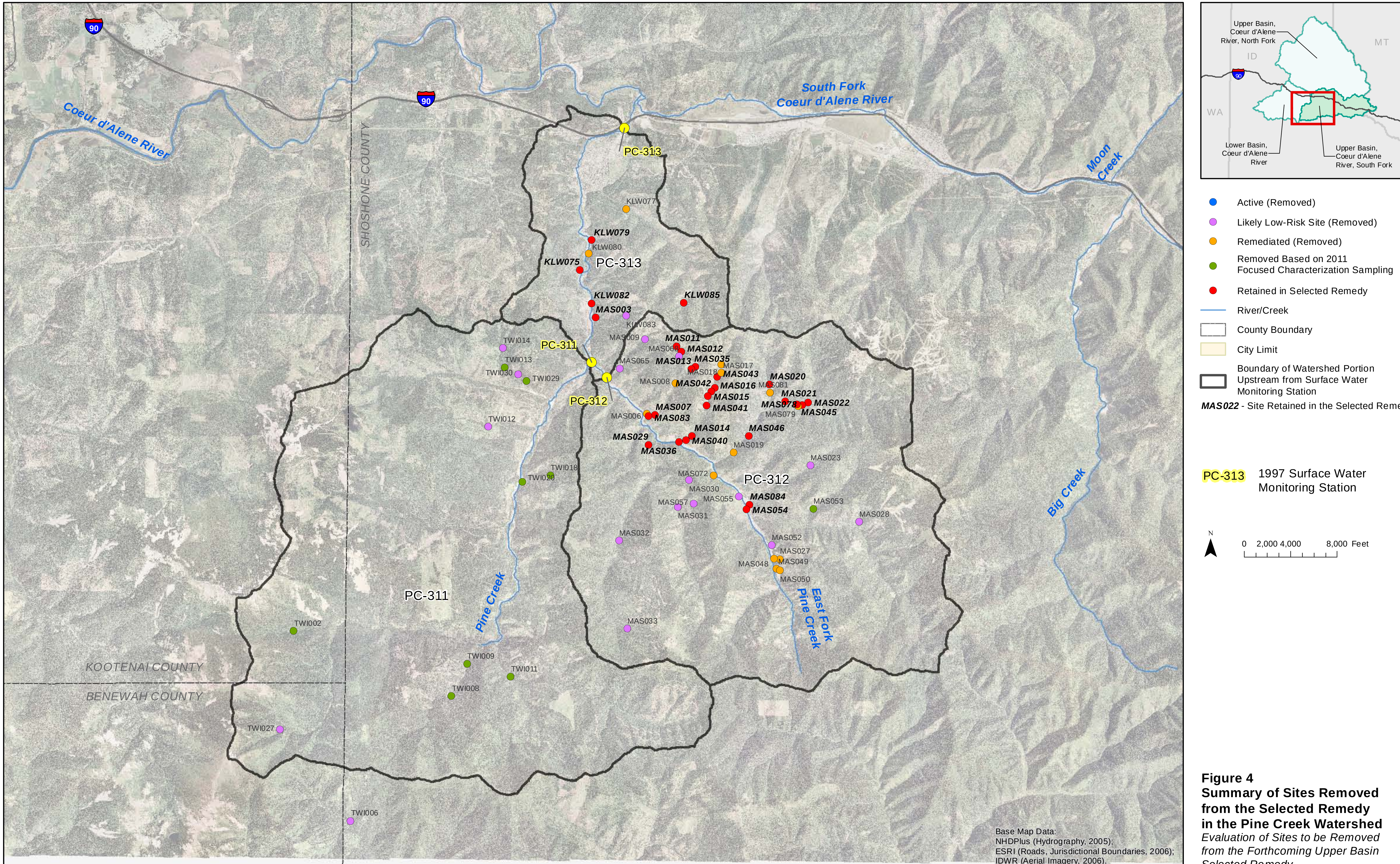


Figure 4
Summary of Sites Removed from the Selected Remedy in the Pine Creek Watershed
Evaluation of Sites to be Removed from the Forthcoming Upper Basin Selected Remedy

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ATTACHMENT 3

Technical Memorandum: Application of the SFCDR Watershed Groundwater Flow Model to the Revised Groundwater Components of the Upper Basin Selected Remedy for Mainstem SFCDR Watershed Segment 01

Application of the SFCDR Watershed Groundwater Flow Model to the Revised Groundwater Components of the Upper Basin Selected Remedy for Mainstem SFCDR Watershed Segment 01

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DATE: July 20, 2012

This Technical Memorandum (TM) provides the basis and technical support for changes made to the hydraulic isolation and groundwater collection actions for Segment 01 of the Mainstem South Fork Coeur d'Alene River (SFCDR) Watershed as presented in the Preferred Alternative in the Upper Basin Proposed Plan (U.S. Environmental Protection Agency [EPA], 2010). Segment 01 of the Mainstem SFCDR Watershed is located within Upper Basin portion of Operable Unit (OU) 3 of the Bunker Hill Mining and Metallurgical Complex Superfund Site.

Following the receipt of stakeholder comments on the Upper Basin Proposed Plan and further evaluation by EPA, changes were made to the hydraulic isolation and groundwater actions between Wallace and Elizabeth Park that are included in the Selected Remedy. In keeping with EPA's overall effort to reduce the scope of the Selected Remedy, these remedial actions have been significantly reduced. Previously, in the Draft Final Focused Feasibility Study (FFS) Report for the Upper Basin (CH2M HILL, 2010), hydraulic isolation and groundwater collection actions along the SFCDR between Wallace and Elizabeth Park (a reach over 10 miles in length) were included for Segment 01 in Alternative 3+(d), which was the Preferred Remedial Alternative presented in the Upper Basin Proposed Plan. Those remedial actions are no longer included in the Selected Remedy that is being documented in the Record of Decision (ROD) Amendment for the Upper Basin (EPA, in preparation). Instead, a French drain (a groundwater interception drain) only in the Osburn Flats area (a reach less than 1 mile in length) is included. The stream liner along the SFCDR between Wallace and Elizabeth Park that was previously included in the Preferred Remedial Alternative is also no longer part of the Selected Remedy. The revised remedial action for Segment 01 of the Mainstem SFCDR Watershed is presented in Figure 1.[1]

It should be noted that although a French drain is the assumed process option for groundwater collection in the Osburn area for the purposes of the Upper Basin ROD Amendment and associated cost estimation, extraction wells are another process option that could achieve the same objective of groundwater collection. Extraction wells will be evaluated during the design phase of the Selected Remedy when additional site-specific information is available.

[1] The figures referenced in the text of this TM are provided following the references on page 6.

This TM documents the application of the SFCDR Watershed groundwater flow model (hereafter referred to as the SFCDR Model) to perform remedial effectiveness assessments of the revised remedial action for Segment 01 of the Mainstem SFCDR Watershed. The SFCDR Model is a numerical tool that was developed to characterize the distribution of dissolved metals loading to the SFCDR from the groundwater system under current conditions, and to evaluate the relative effectiveness of various potential remedial actions. The SFCDR Model uses MicroFEM, an integrated groundwater modeling software program (Hemker and Nijsten, 2003). Construction and initial calibration of the SFCDR Model are documented in the *South Fork of the Coeur d'Alene River Watershed: Basinwide Groundwater Flow Model Documentation* (CH2M HILL, 2009a), while groundwater flow model refinements, additional calibration, and application of the tool to the Upper Basin remedial alternatives are documented in the Draft Final FFS Report (CH2M HILL, 2010).

Application of Groundwater Flow Model to Revised Remedial Alternative for OU 3

Figure 1 shows the location and nature of the revised remedial action for Segment 01 of the Mainstem SFCDR Watershed. As described in Section A.5.6 in Appendix A of the Draft Final FFS Report, the objective of the previously anticipated remedial actions along the SFCDR between Wallace and Elizabeth Park was to hydraulically isolate this entire reach via stream lining and collection and treatment of dissolved-metals-contaminated groundwater that would otherwise discharge to the SFCDR. The revised remedial action focuses on reducing metals loading to the SFCDR in Osburn Flats, for two reasons: (1) because of the uncertainty associated with the nature of groundwater-surface water interaction and the distribution of dissolved-phase metals loading to the Mainstem SFCDR in the majority of the watershed upstream from Elizabeth Park; and (2) because of the estimated costs associated with implementing the previously anticipated actions between Elizabeth Park and Wallace. The revised remedial action involves installing a French drain parallel to the SFCDR in the highest dissolved-metals-loading reach in Osburn Flats, between Twomile Creek and Terror Gulch. The drain will be installed on the south side of Interstate 90.

Simulation Results

The French drain in the revised remedial action was simulated using the SFCDR Model. French drain elevations were set at 10 feet below the baseflow groundwater table elevation. Because of the coarse-grained nature of the aquifer materials in Osburn Flats (horizontal hydraulic conductivities ranging from approximately 400 to 2,000 feet per day), no additional coarse backfill material was simulated.

The modeling simulation was performed to obtain an estimate of the effectiveness of the action in reducing dissolved metals loading to the SFCDR. The effectiveness of the action was estimated by running a model simulation with the remedy in place, and comparing the results with a baseline no-action simulation. The difference in metals loading between the two simulations represents the benefit of implementing the revised remedial action. Other information obtained from the modeling simulation included estimated flow rates of groundwater into the French drain and estimated metals loading associated with those flows. The estimated metals loading entering the drain represents the mass of metals that would be removed from the system through treatment at the Central Treatment Plant (CTP) in Kellogg, Idaho. The methodology used to estimate metals loading is described in Section A.4 in Appendix A of the Draft Final FFS Report (CH2M HILL, 2010).

The revised remedial action was simulated under four different hydraulic conditions:

1. Steady-state baseflow conditions observed during the fall of 2008 (representing an approximate 25th percentile flow as defined by the SFCDR flow at the U.S. Geological Survey stream gauge at Pinehurst [Station SF-271]). "Baseflow" generally represents the low-flow period that occurs in late summer and early fall each year.

2. A 7Q10 flow, representing extreme low-flow conditions. The 7Q10 flow is defined as the lowest 7-day average flow that occurs on average only once every 10 years.
3. A 90th percentile flow condition. This represents the high-flow conditions that typically occur each spring.
4. An average annual flow condition. This was evaluated by performing a transient model simulation based on daily data collected over the course of a 365-day period (July 1, 2008 through June 30, 2009) and then averaging the daily results.

Simulation of these four hydraulic conditions in the SFCDR Model provided information on the estimated range of performance of the revised remedial action throughout the year under varying hydrologic regimes. Discussions of these hydrologic conditions are presented in Section A.3 in Appendix A of the Draft Final FFS Report.

Figure 2 presents simulated upstream groundwater flowlines from "gaining" reaches of the SFCDR in Osburn Flats under no-action, baseflow conditions (patterns are similar for other hydrologic conditions). ("Gaining" reaches are defined as those where groundwater discharges to surface water; similarly, "losing" reaches are those where surface water discharges to groundwater.) Flowlines present a two-dimensional graphical depiction of the simulated three-dimensional groundwater flow field. Flowlines are started at a given node or nodes and can be tracked forward or backward along a groundwater flowpath through time/space. For this analysis, flowlines were started in model nodes representing the groundwater discharge point (where groundwater is exiting the model domain/simulation) represented by the western gaining reach of the SFCDR in Osburn Flats (see Figure 2), and were tracked backward to investigate the source of water to this reach. By following the path of a given flowline from the gaining reach to the terminus, Figure 2 shows that the sources of water to the SFCDR include upstream losing portions of the SFCDR (flowlines that terminate at the SFCDR in the eastern portion of Osburn Flats), tributaries (flowlines that track up Terror Gulch and/or other tributary canyons north and south of Osburn Flats), and groundwater underflow from the SFCDR alluvial system upstream (flowlines that track eastward within the alluvial aquifer system).

Figure 3 shows simulated upstream groundwater flowlines from the same gaining reaches of the SFCDR and depicts sources of water to the SFCDR with the revised remedial action (the French drain) in place. Comparison of Figures 2 and 3 shows that the area of the SFCDR that was gaining under the "no action" scenario presented in Figure 2 is still gaining under the "with action" scenario presented in Figure 3, although the source of the water entering the SFCDR changes. With no action in place (Figure 2), sources of water to the SFCDR include upstream losing portions of the SFCDR, tributaries, and the SFCDR alluvial aquifer system. As shown in Figure 3 (which presents simulated flowlines with the revised remedial action in place), there is a much lower density of flowlines that track to the eastern losing reach of the SFCDR in Osburn Flats and the upstream SFCDR alluvial aquifer system, and there is a higher density of flowlines that track upstream to the tributary alluvial aquifer systems in Terror Gulch and Twomile Creek. These densities suggest that operation of the French Drain will impact groundwater-surface water interactions. The alluvial aquifers in Terror Gulch and Twomile Creek are significantly less contaminated than the SFCDR alluvial aquifer system, which will contribute to the net reduction in dissolved metals loading to the SFCDR resulting from the revised remedial action. Figure 4 presents simulated upstream groundwater flowlines from the French drain with the revised remedial action in place, and therefore depicts sources of water to the drain (primarily the eastern losing reach of the SFCDR in Osburn Flats). A comparison of Figures 2, 3, and 4 suggests that the majority of groundwater underflow that discharged to the SFCDR under the no-action scenario would discharge to the French drain with the remedy in place.

Tables 1 through 4[2] present summaries of simulated flows for no action, the remedial actions previously anticipated in Alternative 3+(d) and the Preferred Remedial Alternative in the Upper Basin Proposed Plan, and the revised remedial action under the four hydraulic conditions discussed above: baseflow, 7Q10, 90th percentile, and average annual flow conditions, respectively. These tables show the following:

- Within Segment 01 of the Mainstem SFCDR Watershed, between Wallace and Elizabeth Park under no-action conditions, the SFCDR Model suggests that the SFCDR would gain between 9 cubic feet per second (cfs) and 10 cfs and lose between 10 and 12.3 cfs.
- With the previously anticipated components of Alternative 3+(d) in place, there would be no groundwater-surface water interaction along the SFCDR as a result of stream lining; i.e., the SFCDR would not gain any groundwater, nor would it lose any water to groundwater. The French drain inflow would range from 6.3 to 8 cfs.
- With the revised remedial action in place, the SFCDR Model suggests that the SFCDR would gain between 5.6 and 6.4 cfs and lose between 14.1 and 16.8 cfs.

The net reduction in streamflow (reduction in stream gain plus increase in stream loss) between the no-action and revised remedial action simulations under the various hydrologic conditions ranges from 6.9 to 8.0 cfs. This means that, in comparison to the no-action scenario, when the revised remedial action is implemented there is expected to be a net reduction of stream flow in the SFCDR. Estimated stream flow reductions associated with the Upper Basin Selected Remedy are discussed in detail in the TM *Estimated Stream Flow Reductions Resulting from Groundwater Remedial Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site* (CH2M HILL, 2012).

The SFCDR will not be lined as part of the revised remedial action; therefore, the increase in stream loss between the no-action and revised remedial action simulations is due to induced stream leakage in a portion of the SFCDR that was gaining in the absence of the French drain. Additionally, although the French drain length will be shorter under the revised remedial action than under Alternative 3+(d) and the Preferred Remedial Alternative, there is an increase in drain flow ranging from 0.9 to 2.1 cfs because of induced streamflow from the unlined SFCDR and the deeper drain elevation under the revised remedial action.

In summary, the groundwater flow modeling demonstrates that compared with both no action and the previously anticipated remedial actions, the revised remedial action is expected to result in a greater reduction in net stream flow. In addition, the average annual flow to the French drain under the revised remedial action is estimated to be 8.9 cfs. This value will be used for planning purposes for treatment at the CTP in Kellogg.

Tables 5 through 8 present summaries of the simulated dissolved zinc loading for no action, the remedial actions previously anticipated in Alternative 3+(d) and the Preferred Remedial Alternative in the Upper Basin Proposed Plan, and the revised remedial action under the baseflow, 7Q10, 90th percentile, and average annual hydrologic conditions, respectively. These data suggest that under no-action conditions, the net dissolved zinc loading to Mainstem SFCDR Watershed Segment 01 would be between 41 and 57 pounds per day (lb/day) under the various flow conditions. Tables 5 through 8 also show the following:

- The previously anticipated remedial actions would remove the no-action dissolved zinc load from the SFCDR system; however, the load to the remedial action drains (the treatment load) would range from 61 to 77 lb/day.

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[2] The tables referenced in the text of this TM are provided at the end of the document, following the figures.

- Under the revised remedial action there would be a reduction in load to the SFCDR ranging from 47 to 52 lb/day under the various hydrologic conditions. The treatment load to the French drain under the revised remedial action would range from 111 to 134 lb/day.

The increase in treatment load between the previously anticipated remedial actions and the revised remedial action (ranging from 41 to 57 lb/day) is the result of increased drain flow (discussed above) and a difference in assumed dissolved zinc concentrations. For the revised remedial action, it was assumed that the French drain system would be set far enough away from the SFCDR that any induced flow from the river would flow through contaminated sediments before discharging to the drain system and would, therefore, enter the drain with dissolved zinc concentrations similar to those measured in the groundwater system. Analytical data from wells and piezometers nearest the French drain were assumed to be representative of drain inflow concentrations. It was further assumed that the inflow to the eastern portion of the drain would have a dissolved zinc concentration of 3.2 milligrams per liter (mg/L) (the concentration at well SF-OB-MW-08 in 2008), and that inflow to the western portion of the drain would have a dissolved zinc concentration of 1.5 mg/L (the concentration at piezometer SF-OB-PZ-19 in 2008).

Along the SFCDR between Wallace and Elizabeth Park, there is a greater density of groundwater data for the Osburn area than there is for the rest of this approximately 10-mile reach. This density of data allowed for the treatment load estimation approach described above, where the concentration of dissolved zinc entering the French drain under the revised remedial action varies from one end of the drain to the other based on adjacent groundwater monitoring well data. For the previously anticipated remedial actions along the entire reach (from Wallace to Elizabeth Park), such groundwater data were not available and a different approach was used. For the previously anticipated actions, a uniform dissolved zinc concentration equal to the average concentration measured in Osburn Flats monitoring wells in the fall of 2008 (1.8 mg/L) (CH2M HILL, 2009b) was used. The approach used for estimating treatment load for the revised remedial action therefore represents a more refined estimate due to the greater density of groundwater data in the vicinity of the French drain.

To understand the potential impact of these two different approaches on the estimation of treatment load under the revised remedial action, calculations were made using both the “variable” zinc concentration approach (the approach described above in which the concentration varies along the drain length based on nearby groundwater well data) and the “uniform” zinc concentration approach, in which the dissolved zinc concentration entering the drain is assumed to be 1.8 mg/L. The results of this sensitivity analysis showed that the estimated treatment load was consistently higher using the variable concentration assumption (ranging from 30 to 37 lb/day higher, depending on the hydraulic condition). Groundwater concentrations in the vicinity of the French drain and the resulting dissolved zinc loading are subject to significant uncertainty at this time, and the difference in results using these two approaches provides some indication of the range of results that may be expected. Prior to implementation, additional pre-design studies will be needed to better define dissolved zinc concentrations in groundwater and assess how these may affect the estimated treatment load and net load reduction to the SFCDR with the operation of the French drain.

In summary, the estimated load reduction in Segment 01 of the Mainstem SFCDR Watershed achieved by the revised remedial action would be similar to the estimated load reduction achieved by the remedial actions previously anticipated under Alternative 3+(d) and the Preferred Remedial Alternative in the Upper Basin Proposed Plan. Additionally, this load reduction would be achieved at a much lower cost. Table 9 summarizes the estimated costs of the previously anticipated remedial actions, the revised remedial action, and the differences between them. The revised remedial action will result in a capital cost savings of more than $337 million and an annual operations and maintenance cost savings of more than $4 million.

References

CH2M HILL. April 2009 (2009a). *South Fork of the Coeur d'Alene River Watershed: Basinwide Groundwater Flow Model Documentation*. Prepared for U.S. Environmental Protection Agency, Region 10.

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CH2M HILL. July 2010. *Draft Final Focused Feasibility Study Report, Upper Basin of the Coeur d'Alene River, Bunker Hill Mining and Metallurgical Complex Superfund Site*. Prepared for U.S. Environmental Protection Agency, Region 10.

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Hemker, C.J., and G.J. Nijsten. 2003. *Groundwater Flow Modeling Using MicroFEM©.*

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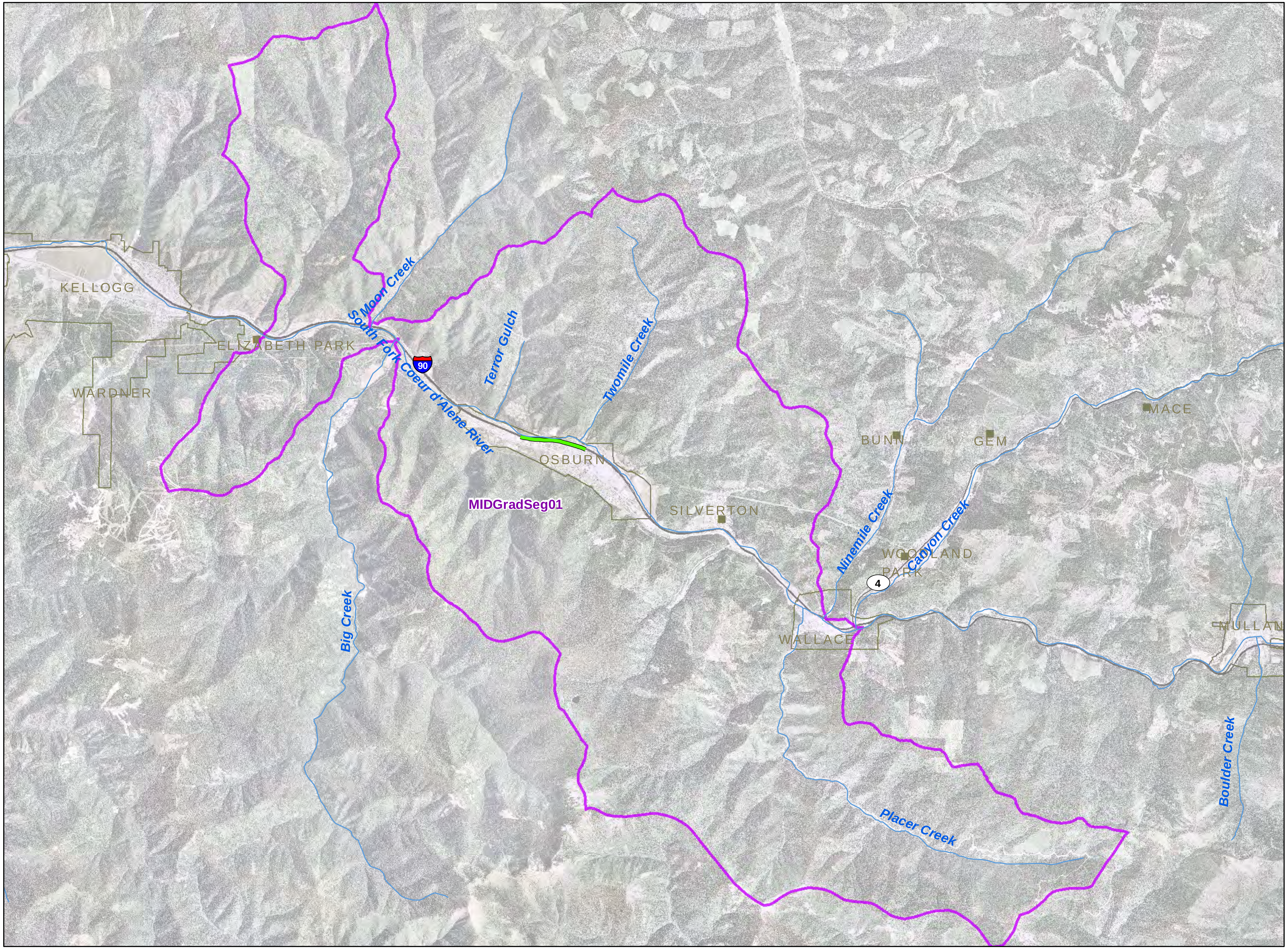
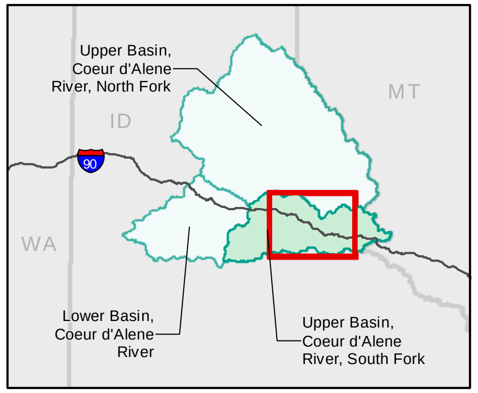
Figures





French Drain
River/Creek
City Limit

N
0 3,000 6,000 12,000 Feet

Source: NHDPlus (Rivers, Waterbodies); ESRI base data (Interstates 2006, Major Highways 2008); IDWR (Aerial Imagery 2006).

Figure 1
Revised Remedial Action for Mainstem SFCDR Watershed Segment 01
Application of SFCDR Model to Revised Remedial Action
BUNKER HILL SUPERFUND SITE

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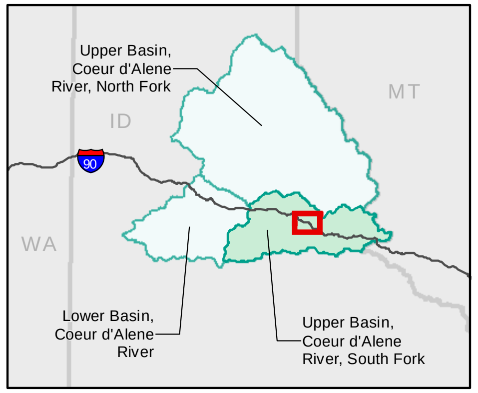


Simulated Groundwater Flowpath

Simulated Groundwater Flow Direction

Gaining Stream Reach

River/Creek

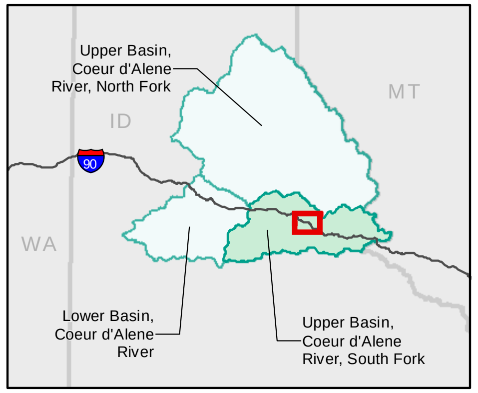
City Limit

N

0 750 1,500 3,000 Feet

Source: NHDPlus (Rivers, Waterbodies); ESRI base data (Interstates 2006, Major Highways 2008); IDWR (Aerial Imagery 2006).

Figure 2
Simulated Upstream Groundwater Flowlines from the SFCDR, Mainstem SFCDR Watershed Segment 01, No Action, Baseflow Conditions
Application of SFCDR Model to Revised Remedial Action
BUNKER HILL SUPERFUND SITE



French Drain
Simulated Groundwater Flowpath
Simulated Groundwater Flow Direction
Gaining Stream Reach
River Creek
City Limit

N
0 750 1,500 3,000 Feet

Source: NHDPlus (Rivers, Waterbodies); ESRI base data (Interstates 2006, Major Highways 2008); IDWR (Aerial Imagery 2006).

Figure 3
Simulated Upstream Groundwater Flowlines from the SFCDR, Mainstem SFCDR Watershed Segment 01, Revised Remedial Action, Baseflow Conditions
Application of SFCDR Model to Revised Remedial Action
BUNKER HILL SUPERFUND SITE

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Figure 4
Simulated Upstream Groundwater Flowlines from the French Drain, Mainstem SFCDR Watershed Segment 01, Revised Remedial Action, Baseflow Conditions
Application of SFCDR Model to Revised Remedial Action
BUNKER HILL SUPERFUND SITE

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Tables

TABLE 1
Model-Simulated Flows – Baseflow Conditions
Application of SFCDR Model to Revised Remedial Action, Mainstem SFCDR Watershed Segment 01
Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

Simulation	Total SFCDR Gain (cfs)	Total SFCDR Loss (cfs)	French Drain Inflow (cfs)
Mainstem SFCDR Watershed Segment 01 - No Action	9.7	11.0	NA
Mainstem SFCDR Watershed Segment 01 - Previously Anticipated Components of Alternative 3+(d)	0.0	0.0	7.6
Mainstem SFCDR Watershed Segment 01 - Revised Remedial Action	6.1	15.0	8.9
Increase in French Drain Inflow			1.3

	Reduction in SFCDR Gain (cfs)	Increase in SFCDR Loss (cfs)	Net Stream Flow Reduction (cfs)
Comparison of Revised Remedial Action and No Action Scenarios	3.6	4.0	7.6

Notes:
cfs = cubic feet per second
NA = not applicable
SFCDR = South Fork Coeur d'Alene River

TABLE 2
Model-Simulated Flows – 7Q10 Flow Conditions
Application of SFCDR Model to Revised Remedial Action, Mainstem SFCDR Watershed Segment 01
Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

Simulation	Total SFCDR Gain (cfs)	Total SFCDR Loss (cfs)	French Drain Inflow (cfs)
Mainstem SFCDR Watershed Segment 01 - No Action	9.0	11.5	NA
Mainstem SFCDR Watershed Segment 01 - Previously Anticipated Components of Alternative 3+(d)	0.0	0.0	6.3
Mainstem SFCDR Watershed Segment 01 - Revised Remedial Action	5.6	15.0	8.4
Increase in French Drain Inflow			2.1

	Reduction in SFCDR Gain (cfs)	Increase in SFCDR Loss (cfs)	Net Stream Flow Reduction (cfs)
Comparison of Revised Remedial Action and No Action Scenarios	3.4	3.5	6.9

Notes:
cfs = cubic feet per second
NA = not applicable
SFCDR = South Fork Coeur d'Alene River

TABLE 3

Model-Simulated Flows – 90th Percentile Flow Conditions

Application of SFCDR Model to Revised Remedial Action, Mainstem SFCDR Watershed Segment 01

Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

Simulation	Total SFCDR Gain (cfs)	Total SFCDR Loss (cfs)	French Drain Inflow (cfs)
Mainstem SFCDR Watershed Segment 01 - No Action	9.8	12.3	NA
Mainstem SFCDR Watershed Segment 01 - Previously Anticipated Components of Alternative 3+(d)	0.0	0.0	8.0
Mainstem SFCDR Watershed Segment 01 - Revised Remedial Action	6.3	16.8	10.0
Increase in French Drain Inflow			2.0

	Reduction in SFCDR Gain (cfs)	Increase in SFCDR Loss (cfs)	Net Stream Flow Reduction (cfs)
Comparison of Revised Remedial Action and No Action Scenarios	3.5	4.5	8.0

Notes:

cfs = cubic feet per second

NA = not applicable

SFCDR = South Fork Coeur d'Alene River

TABLE 4

Model-Simulated Flows – Average Annual Flow Conditions

Application of SFCDR Model to Revised Remedial Action, Mainstem SFCDR Watershed Segment 01

Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

Simulation	Total SFCDR Gain (cfs)	Total SFCDR Loss (cfs)	French Drain Inflow (cfs)
Mainstem SFCDR Watershed Segment 01 - No Action	10.0	10.0	NA
Mainstem SFCDR Watershed Segment 01 - Previously Anticipated Components of Alternative 3+(d)	0.0	0.0	8.0
Mainstem SFCDR Watershed Segment 01 - Revised Remedial Action	6.4	14.1	8.9
Increase in French Drain Inflow			0.9

	Reduction in SFCDR Gain (cfs)	Increase in SFCDR Loss (cfs)	Net Stream Flow Reduction (cfs)
Comparison of Revised Remedial Action and No Action Scenarios	3.6	4.1	7.7

Notes:

cfs = cubic feet per second

NA = not applicable

SFCDR = South Fork Coeur d'Alene River

TABLE 5

Simulated Dissolved Zinc Loading – Baseflow Conditions

Application of SFCDR Model to Revised Remedial Action, Mainstem SFCDR Watershed Segment 01

Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

Simulation	Net Load to SFCDR[a] (lb/day)	Reduction in Load from No Action (lb/day)	Treatment Load (lb/day)
Mainstem SFCDR Watershed Segment 01 - No Action[b]	50	0	NA
Mainstem SFCDR Watershed Segment 01 - Previously Anticipated Components of Alternative 3+(d)[b]	0	50	74
Mainstem SFCDR Watershed Segment 01 - Revised Remedial Action[c]	-1	51	118
Increase in Treatment Load, Revised Remedial Action Assuming Variable Zinc Concentrations			44

Notes:

lb/day = pound(s) per day
NA = not applicable
SFCDR = South Fork Coeur d'Alene River

[a]Net load to the SFCDR is calculated as estimated load from gaining reaches minus estimated load from losing reaches of the SFCDR.

[b]Limited dissolved zinc data in groundwater are available for the majority of this reach (Wallace to Elizabeth Park). Load estimates were calculated assuming that the average dissolved zinc concentration in Osburn (the only area where groundwater data are available), 1.8 milligrams per liter (mg/L), applies to the entire reach.

[c]For the French drain system under the revised remedial action, analytical data from wells and piezometers nearest the French drain were assumed to be representative of drain inflow concentrations. It was assumed that the inflow to the eastern portion of the drain would have a dissolved zinc concentration of 3.2 mg/L (the concentration at well SF-OB-MW08 in 2008) and inflow to the western portion of the drain would have a dissolved zinc concentration of 1.5 mg/L (the concentration at piezometer SF-OB-PZ-19 in 2008). The resulting estimated concentration to the drain is a flow-weighted average and represents a more refined concentration estimate than was possible for the no-action and previously anticipated action scenarios due to lack of data outside the Osburn area.

TABLE 6

Simulated Dissolved Zinc Loading – 7Q10 Flow Conditions

Application of SFCDR Model to Revised Remedial Action, Mainstem SFCDR Watershed Segment 01

Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

Simulation	Net Load to SFCDR[a] (lb/day)	Reduction in Load from No Action (lb/day)	Treatment Load (lb/day)
Mainstem SFCDR Watershed Segment 01 - No Action[b]	41	0	NA
Mainstem SFCDR Watershed Segment 01 - Previously Anticipated Components of Alternative 3+(d)[b]	0	41	61
Mainstem SFCDR Watershed Segment 01 - Revised Remedial Action[c]	-6	47	111
Increase in Treatment Load, Revised Remedial Action Assuming Variable Zinc Concentrations			50

Notes:

lb/day = pound(s) per day
NA = not applicable
SFCDR = South Fork Coeur d'Alene River

[a]Net load to the SFCDR is calculated as estimated load from gaining reaches minus estimated load from losing reaches of the SFCDR.

[b]Limited dissolved zinc data in groundwater are available for the majority of this reach (Wallace to Elizabeth Park). Load estimates were calculated assuming that the average dissolved zinc concentration in Osburn (the only area where groundwater data are available), 1.8 milligrams per liter (mg/L), applies to the entire reach.

[c]For the French drain system under the revised remedial action, analytical data from wells and piezometers nearest the French drain were assumed to be representative of drain inflow concentrations. It was assumed that the inflow to the eastern portion of the drain would have a dissolved zinc concentration of 3.2 mg/L (the concentration at well SF-OB-MW08 in 2008) and inflow to the western portion of the drain would have a dissolved zinc concentration of 1.5 mg/L (the concentration at piezometer SF-OB-PZ-19 in 2008). The resulting estimated concentration to the drain is a flow-weighted average and represents a more refined concentration estimate than was possible for the no-action and previously anticipated action scenarios due to lack of data outside the Osburn area.

TABLE 7

Simulated Dissolved Zinc Loading – 90th Percentile Flow Conditions

Application of SFCDR Model to Revised Remedial Action, Mainstem SFCDR Watershed Segment 01

Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

Simulation	Net Load to SFCDR[a] (lb/day)	Reduction in Load from No Action (lb/day)	Treatment Load (lb/day)
Mainstem SFCDR Watershed Segment 01 - No Action[b]	45	0	NA
Mainstem SFCDR Watershed Segment 01 - Previously Anticipated Components of Alternative 3+(d)[b]	0	45	77
Mainstem SFCDR Watershed Segment 01 - Revised Remedial Action[c]	-7	52	134
Increase in Treatment Load, Revised Remedial Action Assuming Variable Zinc Concentrations			57

Notes:

lb/day = pound(s) per day
NA = not applicable
SFCDR = South Fork Coeur d'Alene River

[a]Net load to the SFCDR is calculated as estimated load from gaining reaches minus estimated load from losing reaches of the SFCDR.

[b]Limited dissolved zinc data in groundwater are available for the majority of this reach (Wallace to Elizabeth Park). Load estimates were calculated assuming that the average dissolved zinc concentration in Osburn (the only area where groundwater data are available), 1.8 milligrams per liter (mg/L), applies to the entire reach.

[c]For the French drain system under the revised remedial action, analytical data from wells and piezometers nearest the French drain were assumed to be representative of drain inflow concentrations. It was assumed that the inflow to the eastern portion of the drain would have a dissolved zinc concentration of 3.2 mg/L (the concentration at well SF-OB-MW08 in 2008) and inflow to the western portion of the drain would have a dissolved zinc concentration of 1.5 mg/L (the concentration at piezometer SF-OB-PZ-19 in 2008). The resulting estimated concentration to the drain is a flow-weighted average and represents a more refined concentration estimate than was possible for the no-action and previously anticipated action scenarios due to lack of data outside the Osburn area.

TABLE 8

Simulated Dissolved Zinc Loading – Average Annual Flow Conditions

Application of SFCDR Model to Revised Remedial Action, Mainstem SFCDR Watershed Segment 01

Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

Simulation	Net Load to SFCDR[a] (lb/day)	Reduction in Load from No Action (lb/day)	Treatment Load (lb/day)
Mainstem SFCDR Watershed Segment 01 - No Action[b]	57	0	NA
Mainstem SFCDR Watershed Segment 01 - Previously Anticipated Components of Alternative 3+(d)[b]	0	57	77
Mainstem SFCDR Watershed Segment 01 - Revised Remedial Action[c]	5	52	118
Increase in Treatment Load, Revised Remedial Action Assuming Variable Zinc Concentrations			41

Notes:

lb/day = pound(s) per day
NA = not applicable
SFCDR = South Fork Coeur d'Alene River

[a]Net load to the SFCDR is calculated as estimated load from gaining reaches minus estimated load from losing reaches of the SFCDR.

[b]Limited dissolved zinc data in groundwater are available for the majority of this reach (Wallace to Elizabeth Park). Load estimates were calculated assuming that the average dissolved zinc concentration in Osburn (the only area where groundwater data are available), 1.8 milligrams per liter (mg/L), applies to the entire reach.

[c]For the French drain system under the revised remedial action, analytical data from wells and piezometers nearest the French drain were assumed to be representative of drain inflow concentrations. It was assumed that the inflow to the eastern portion of the drain would have a dissolved zinc concentration of 3.2 mg/L (the concentration at well SF-OB-MW08 in 2008) and inflow to the western portion of the drain would have a dissolved zinc concentration of 1.5 mg/L (the concentration at piezometer SF-OB-PZ-19 in 2008). The resulting estimated concentration to the drain is a flow-weighted average and represents a more refined concentration estimate than was possible for the no-action and previously anticipated action scenarios due to lack of data outside the Osburn area.

TABLE 9
Cost Comparison - Previously Anticipated Remedial Actions and Revised Remedial Action
Application of SFCDR Model to Revised Remedial Action, Mainstem SFCDR Watershed Segment 01
Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

Simulation	Total Capital Costs	Annual O&M Costs	Total 30-year NPV Costs
Mainstem SFCDR Watershed Segment 01 - Previously Anticipated Remedial Actions	$351,000,000	$8,720,000	$360,000,000
Mainstem SFCDR Watershed Segment 01 - Revised Remedial Action	$13,700,000	$4,680,000	$18,400,000
Net Cost Reduction with Revised Remedial Action	**$ 337,300,000**	**$ 4,040,000**	**$ 341,600,000**

Notes:

NPV = net present value
O&M = operations and maintenance
SFCDR = South Fork Coeur d'Alene River

ATTACHMENT 4

Technical Memorandum:
Summary of Changes to Source Volumes and Typical Conceptual Designs for Alternative 3+(d) Source Sites in the Ninemile Creek Watershed

Summary of Changes to Source Volumes and Typical Conceptual Designs for Alternative 3+(d) Source Sites in the Ninemile Creek Watershed

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DATE: August 1, 2012

1.0 Introduction

This Technical Memorandum (TM) presents a summary of modifications to the selected remedial actions for source sites located within the Ninemile Creek Watershed that were included in the U.S. Environmental Protection Agency's (EPA's) Preferred Alternative identified in the *Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Mining and Metallurgical Complex Superfund Site* (EPA, 2010). The Preferred Alternative included the remedial actions identified in Alternative 3+(d), as presented in the Proposed Plan and the *Draft Final Focused Feasibility Study* [FFS] *Report, Upper Basin of the Coeur d'Alene River, Bunker Hill Mining and Metallurgical Complex Superfund Site* (CH2M HILL, 2010). Modifications to the remedial actions included in Alternative 3+(d) for source sites in the Ninemile Creek Watershed have been made based on an enhanced understanding of the physical setting and distribution of contamination within the watershed. The modifications include revised estimates of the volume of waste associated with selected source sites, and revisions to the selected remedial action typical conceptual designs (TCDs) for the selected source sites within the Ninemile Creek Watershed. These modifications will be incorporated into the Selected Remedy for the Upper Coeur d'Alene Basin that will be documented in the forthcoming Record of Decision (ROD) Amendment for the Upper Basin (EPA, in preparation).

2.0 Revisions to Source Site Waste Volume Estimations

The waste volumes for source sites within the Ninemile Creek subbasin were originally developed by the 1992 U.S. Department of the Interior Bureau of Land Management mine site assessment program, and were carried through into the Draft Final FFS Report (CH2M HILL, 2010). These volumes were updated with the results of Light Detection and Ranging (LiDAR) surveys that were conducted in 2011 to obtain topographical elevations of the ground surface of the entire Ninemile Creek Watershed, as well as other areas within the Coeur d'Alene River Basin.

The topographical survey contours obtained from the LiDAR survey were used to create a three-dimensional model of the ground surface of the Ninemile Creek Watershed. The initial lateral boundaries of each source site included in Alternative 3+(d) were loaded into the topographic surface model. Historically, at most source sites wastes were placed within the surface water drainages nearest the site. Gravity then drove the materials downhill and into the drainages during historical mining operations. Given this general placement of the waste materials, it was possible to use the topographic surface surrounding each source site to estimate a pre-mining native ground surface elevation. For each specific source site, the contours of the undisturbed area surrounding the site source area were examined to estimate the elevation of the historical drainage ways beneath the site. During this examination, an extrapolated "native" pre-mining ground surface elevation under each site source area was developed. InRoads© software was then used to estimate the volume of materials located in each source site by subtracting the ground elevation of the suspected native ground surface from the actual ground elevation determined from the LiDAR survey.

In addition, the lateral boundaries of the each source site were revised to reflect the intersection with the estimated native ground surface and the actual ground surface. This initial volumetric estimate was used to guide the locations of soil borings and test pits installed in 2011. Attachment A contains plan view and section details for the source sites that were included in this evaluation. These details indicate the original lateral extents of the source sites, the estimated native ground surface, and the revised lateral extents of the source sites. The topographic model was not used to revise the volume estimates for floodplain sediment waste types, as there was not a definable pre-mining native ground surface from which to extrapolate below the source site.

The volume estimates of waste materials associated with the Interstate-Callahan Mine/Rock Dumps (BUR053 and BUR160), the Interstate Millsite (BUR055), the Tamarack 400 Level site (BUR170), and the Success Mine Rock Dump (OSB044) were further refined using the data collected during the 2011 Ninemile Creek remedial design investigation conducted for EPA and the Successor Coeur d'Alene Custodial and Work Trust (Maul Foster & Alongi, 2011). The boring logs for soil borings and test pits were reviewed, and the depths to native materials were incorporated into the previously assumed native material surfaces. Attachment A contains plan view and section details that present the results of this analysis and show how the estimated native ground surface at each site was revised based on the additional information collected during the remedial design investigation field efforts.

Table 1 presents a summary of Ninemile Creek source sites, original waste volume estimates as reported in the Draft Final FFS Report (CH2M HILL, 2010), updated waste volumes as determined by the estimation from the LiDAR survey, and/or updated waste volumes as determined by the 2011 Ninemile Creek remedial design investigation. As shown in Table 1, the FFS total estimated volume of waste materials from Ninemile Creek source sites was approximately 1.9 million cubic yards, compared with a revised total estimated volume of approximately 1.25 million cubic yards.

3.0 Revisions to Selected TCDs for the Ninemile Creek Watershed

The LiDAR survey and the collection of data during the 2011 remedial design investigation resulted in a more refined understanding of the physical conditions and contaminant distributions within the Ninemile Creek Watershed. This better understanding of site conditions and the reduced volume of anticipated waste materials presented the opportunity to reevaluate the TCD approach for the source sites, in order to determine whether the total revised volume could be consolidated in one or more waste consolidation areas (WCAs) located within the Ninemile Creek Watershed. This would be different from the existing TCD approach, which called for the excavation of mine wastes and onsite consolidation with a low-permeability cap, seepage collection and treatment if necessary, or offsite hauling and disposal in a regional repository.

Revising the TCDs to include the WCAs would allow for a more complete remediation of the Ninemile Creek Watershed than if onsite consolidation at individual source sites and capping were to be used, as was specified in Alternative 3+(d). With the WCA approach, waste materials would be excavated down to a native soil horizon and hauled to a WCA located within the Ninemile Creek Watershed. The WCA would be located sufficiently far from surface water sources to keep the materials dry and out of contact with water. Onsite consolidation and capping of materials at individual source sites would typically require double-handling of materials to create a sufficient base for onsite consolidation and placement of mine wastes in the onsite WCA. In addition, onsite consolidation of mine wastes would require the design and development of a robust underdrain and/or surface water conveyance to prevent upstream water from infiltrating through mine wastes or coming into contact with the lower portion of the consolidated materials.

In addition, consolidation of the mine wastes at each individual site would limit the ability to restore natural functions and biological resource habitat within the site area. Removal of mine wastes down to native materials (as would be done if the wastes were being placed in a WCA) would result in a more complete removal of wastes and would increase the opportunities for habitat restoration, by others, over the entire source site. Since all the waste materials would be removed, the restored area could be converted to recreational use without restricted controls that would limit public access. Further, complete removal and consolidation of all wastes to a WCA would allow for focused development, operation, closure, and monitoring of mine wastes at a facility that was sited and operated specifically for long-term functionality, and would minimize (or even eliminate) wastes that might otherwise go to a regional repository nearer community areas.

Potential WCA sites were identified, screened, and evaluated for potential development (as summarized in the TM *Ninemile Creek Waste Consolidation Area Screening Evaluation,* CH2M HILL, 2011a). The initial screening assessment identified five potential WCAs within the Ninemile Creek Watershed for more detailed evaluation. These potential WCA development areas included:

- A ridge area between the Interstate-Callahan Mine/ Upper and Lower Rock Dumps (BUR053 and BUR160)

- A ridge east of the Tamarack Rock Dumps (BUR056)
- A ridge east of the Success Mine Rock Dump (OSB044)
- A ridge south of the existing Dayrock Mine Tailings Pile SVNRT Repository (OSB052)
- A bench east of the Rex No. 2 site (BUR054)

Each potential WCA was further evaluated for development in a two-phase detailed assessment. The first phase of the assessment, as described in the TM *Ninemile Creek Waste Consolidation Area Site Selection Evaluation* (CH2M HILL, 2011b), indicated that there is significant overall cost benefit to be derived by selecting a single WCA for development located relatively close to the remediation sites. Recommendations from the first phase of the assessment were carried into a second phase described in the TM *Ninemile Creek Sub-basin Waste Consolidation Area: Next Phase Concept Evaluations and Design Approach Recommendations* (CH2M HILL, 2012a). Based on the second phase of the assessment, the Interstate Callahan South WCA was recommended for development as the Ninemile Creek WCA to contain all anticipated waste materials excavated from individual source sites.

Based on the reduced volume of mine waste materials, the availability of a suitable area for a WCA, and increased restoration opportunities after the waste materials have been removed from the source site, EPA has revised the TCDs for selected source areas within the Ninemile Creek Watershed to optimize the use of the WCA. Table 2 presents a summary of the TCD modifications for site source areas within the Ninemile Creek Watershed.

The revised TCDs are not a significant departure from the TCDs selected in the 2002 *Record of Decision, The Bunker Hill Mining and Metallurgical Complex Operable Unit 3* (EPA, 2002) and are consistent with achieving the remedial action objectives identified for the watershed. The revised TCDs identify the complete removal of mine wastes and native materials exceeding cleanup goals and disposal in a WCA located in the Ninemile Creek Watershed, as opposed to the existing TCDs for excavation of mine wastes and onsite consolidation with a low-permeability cap and seepage collection and treatment, if necessary. As discussed in the TM *Overview of the Simplified Tool for Estimating Post-Remediation Water Quality* (CH2M HILL, 2009), each remedial action was assigned a remedial effectiveness factor (REF) for dissolved zinc load reductions. The REFs, which were assigned based on best engineering judgment, were established in the Predictive Analysis (PA) (EPA, 2007) and carried through into the simplified version of the PA. The REF for excavation and removal of source materials assumes a higher level of effectiveness than the REF for onsite capping and consolidation. As such, the revised TCDs are anticipated to result in a more substantial improvement in dissolved zinc water quality in the East Fork of Ninemile Creek. The rationale for this change is driven primarily by the significant difference between mine waste volume estimates presented in the *Final [Revision 2] Remedial Investigation Report, Coeur d'Alene Basin Remedial Investigation/Feasibility Study* (EPA, 2001) and estimates based on the results of the topographic model and field data, as well as by opportunities to conduct a more thorough restoration of the subbasin to pre-mining conditions. In addition, the source materials would be isolated from precipitation runoff, which would result in a significant decrease in the entrainment and downstream transport of metal-contaminated sediments from the source sites in the Ninemile Creek Watershed.

4.0 References

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CH2M HILL. July 2010. *Draft Focused Feasibility Study Report, Upper Basin of the Coeur d'Alene River, Bunker Hill Mining and Metallurgical Complex Superfund Site*. Prepared for U.S. Environmental Protection Agency Region 10.

CH2M HILL. October 14, 2011 (2011a). *Technical Memorandum: Ninemile Creek Waste Consolidation Area Screening Evaluation*. Prepared for U.S. Environmental Protection Agency Region 10.

CH2M HILL. December 12, 2011 (2011b). *Technical Memorandum: Ninemile Creek Waste Consolidation Area Site Selection Evaluation*. Prepared for U.S. Environmental Protection Agency Region 10.

CH2M HILL. February 22, 2012 (2012a). *Technical Memorandum: Ninemile Creek Sub-basin Waste Consolidation Area: Next Phase Concept Evaluations and Design Approach Recommendations*. Prepared for U.S. Environmental Protection Agency Region 10.

CH2M HILL. May 25, 2012 (2012b). *Technical Memorandum: Upper Coeur d'Alene Basin 2011 Focused Characterization Sampling: Results from Selected Mine and Mill Sites.* Prepared for U.S. Environmental Protection Agency Region 10.

Maul Foster & Alongi, Inc. December 22, 2011. *2011 Remedial Design Investigation Report, East Fork Ninemile Creek Basin*. Prepared for Successor Coeur d'Alene Custodial and Work Trust.

U.S. Environmental Protection Agency (EPA). September 2001. *Final [Revision 2] Remedial Investigation Report, Coeur d'Alene Basin Remedial Investigation/Feasibility Study*. Prepared by URS Greiner and CH2M HILL for EPA Region 10.

U.S. Environmental Protection Agency (EPA). September 2002. *Record of Decision, The Bunker Hill Mining and Metallurgical Complex Operable Unit 3.*

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Tables

TABLE 1

Summary of Revised Volumes for the Source Sites in the Ninemile Creek Watershed

Summary of Changes to Source Volumes and Typical Conceptual Designs for Alternative 3+(d) Source Sites in the Ninemile Creek Watershed

Source Site Number	Site Name	Waste Type	Waste Volume (FFS)	Waste Volume (LiDAR)	Waste Volume (Remedial Design Investigation)	Revised Volume (cy)	Comments
BUR052	LITTLE SUNSET MINE	Upland waste rock	4,000	17,390		17,400	Removed from the Upper Basin Selected Remedy because the site is not currently under consideration for remedial action, based on the results of focused characterization sampling conducted in 2011 (CH2M HILL, 2012b).
BUR053	INTERSTATE-CALLAHAN MINE/ROCK DUMPS	Upland waste rock (erosion potential)	692,000	266,220	111,500	111,500	
BUR054	REX NO. 2	Upland tailings	225,000			225,000	Removed from the Upper Basin Selected Remedy (remediated site).
BUR054	REX NO. 2	Upland waste rock	75,000			75,000	Removed from the Upper Basin Selected Remedy (remediated site).
BUR055	INTERSTATE MILLSITE	Floodplain sediments	5,500	108,950		30,700	
BUR055	INTERSTATE MILLSITE	Upland tailings	14,000			78,200	
BUR056	TAMARACK ROCK DUMPS	Upland waste rock (potential intermixed tailings)	293,000	276,940	253,600	253,600	
BUR058	TAMARACK NO.3	Upland waste rock	23,000	13,500		13,500	
BUR139	REX NO.1	Upland waste rock	0	5,505		5,500	
BUR140	NINEMILE CREEK IMPACTED FLOODPLAIN	Floodplain sediments	10,000			10,000	
BUR160	INTERSTATE-CALLAHAN LOWER ROCK DUMPS	Upland waste rock (erosion potential)	0	69,310	74,100	74,100	
BUR170	TAMARACK 400 LEVEL	Upland waste rock (potential intermixed tailings)	11,000	7,445	17,700	17,700	
BUR171	TAMARACK NO.5	Upland waste rock (potential intermixed tailings)	0	6,455		6,500	
BUR172	TAMARACK UNNAMED ADIT	Upland waste rock	0	4,255		4,300	
BUR173	TAMARACK MILLSITE	Upland tailings	0	5,235		5,200	

TABLE 1

Summary of Revised Volumes for the Source Sites in the Ninemile Creek Watershed

Summary of Changes to Source Volumes and Typical Conceptual Designs for Alternative 3+(d) Source Sites in the Ninemile Creek Watershed

Source Site Number	Site Name	Waste Type	Waste Volume (FFS)	Waste Volume (LiDAR)	Waste Volume (Remedial Design Investigation)	Revised Volume (cy)	Comments
OSB032	DULUTH MINE BLACKCLOUD CK	Floodplain waste rock	20,000	10,600		10,600	Removed from the Upper Basin Selected Remedy because the site is not currently under consideration for remedial action, based on the results of focused characterization sampling conducted in 2011 (CH2M HILL, 2012b).
OSB033	RUTH MINE	Upland waste rock (erosion potential)	16,000	1,890		1,900	Removed from the Upper Basin Selected Remedy because the site is not currently under consideration for remedial action, based on the results of focused characterization sampling conducted in 2011 (CH2M HILL, 2012b).
OSB038	CALIFORNIA NO.4	Floodplain waste rock	31,000	15,090		15,100	
OSB039	DAYROCK MINE	Floodplain sediments	22,000			22,000	
OSB039	DAYROCK MINE	Upland tailings	11,000			11,000	
OSB040	EF NINEMILE CK HECLA REHAB	Floodplain sediments	19,000			19,000	
OSB044	SUCCESS MINE ROCK DUMP	Floodplain sediments	10,000	154,305	166,700	4,300	
OSB044	SUCCESS MINE ROCK DUMP	Upland tailings	360,000			155,100	
OSB044	SUCCESS MINE ROCK DUMP	Upland waste rock	17,000			7,300	
OSB048	AMERICAN MINE	Upland waste rock	200			200	
OSB052	DAYROCK MINE TAILINGS PILE/SVNRT REPOSITORY	Upland tailings - inactive facilities	200,000	191,345		191,300	
OSB056	EF NINEMILE CK IMPACTED RIPARIAN	Floodplain sediments	1,600			1,600	
OSB057	EF NINEMILE CK IMPACTED RIPARIAN	Floodplain sediments	13,000			13,000	
OSB058	EF NINEMILE CK SVNRT REHAB	Floodplain sediments	1,600			1,600	
OSB059	NINEMILE CK BELOW DAYROCK MINE	Floodplain sediments	33,000			33,000	

TABLE 1

Summary of Revised Volumes for the Source Sites in the Ninemile Creek Watershed

Summary of Changes to Source Volumes and Typical Conceptual Designs for Alternative 3+(d) Source Sites in the Ninemile Creek Watershed

Source Site Number	Site Name	Waste Type	Waste Volume (FFS)	Waste Volume (LiDAR)	Waste Volume (Remedial Design Investigation)	Revised Volume (cy)	Comments
OSB060	NINEMILE CK SVNRT REHAB NEAR BLACKCLOUD	Floodplain sediments	800			800	
OSB061	BLACKCLOUD CK MILLSITE	Upland tailings	7,000			7,000	
OSB082	MONARCH MINE BLACKCLOUD CK	Floodplain waste rock	13,000			13,000	
OSB084	BLACKCLOUD CK IMPACTED RIPARIAN	Floodplain sediments	0				Removed from the Upper Basin Selected Remedy because the site is not currently under consideration for remedial action, based on the results of focused characterization sampling conducted in 2011 (CH2M HILL, 2012b).
OSB085	BLACKCLOUD CK IMPACTED RIPARIAN	Floodplain sediments	0				Removed from the Upper Basin Selected Remedy because the site is not currently under consideration for remedial action, based on the results of focused characterization sampling conducted in 2011 (CH2M HILL, 2012b).
OSB115	OPTION MINE	Upland waste rock (erosion potential)	200	280		300	
WAL006	NORTHSIDE MINE	Upland waste rock (erosion potential)	200			200	Removed from the Upper Basin Selected Remedy because the site is not currently under consideration for remedial action, based on the results of focused characterization sampling conducted in 2011 (CH2M HILL, 2012b).
WAL033	NINEMILE CK POTENTIAL TAILINGS DEPOSIT	Floodplain sediments	34,000			34,000	
		Total Volume (cy)	1,916,100			1,245,500	

Notes:

cy = cubic yards; EF = East Fork; FFS = Focused Feasibility Study
LiDAR = Light Detection and Ranging; SVNRT = Silver Valley Natural Resource Trust

TABLE 2

Summary of Revised Typical Conceptual Designs for the Source Sites in the Ninemile Creek Watershed

Summary of Changes to Source Volumes and Typical Conceptual Designs for Alternative 3+ (d) Source Sites in the Ninemile Creek Watershed

Source Site Number	Site Name	Waste Type	Alternative 3+ TCD	Alternative 3+ TCD Code	Revised TCD	Revised TCD Code
BUR052	LITTLE SUNSET MINE	Upland waste rock	Excavate and Cap	C01+C03	Removed from Upper Basin Selected Remedy	NONE
BUR053	INTERSTATE-CALLAHAN MINE/ROCK DUMPS	Upland waste rock (erosion potential)	Excavate and Cap w/Seep Collection	C01+C04	Excavate/WCA	C01+C07+HAUL-2
BUR054	REX NO. 2	Upland tailings	Impoundment Closure	C09	Remediated site	NONE
BUR054	REX NO. 2	Upland waste rock	Low-Permeability Cap	C03	Remediated site	NONE
BUR055	INTERSTATE MILLSITE	Floodplain sediments	Excavate and Repository	C01B+C08A	Excavate/WCA	C01B+C07+HAUL-2
BUR055	INTERSTATE MILLSITE	Upland tailings	Excavate and Dispose	C01+C07	Excavate/WCA	C01+C07+HAUL-2
BUR056	TAMARACK ROCK DUMPS	Upland waste rock (potential intermixed tailings)	Regrade/ Consolidate/Revegetate	C02B	Excavate/WCA	C01+C07+HAUL-2
BUR058	TAMARACK NO.3	Upland waste rock	None	NONE	Excavate/WCA	C01+C07+HAUL-2
BUR139	REX NO.1	Upland waste rock	Low-Permeability Cap	C03	Excavate/WCA	C01+C07+HAUL-2
BUR140	NINEMILE CREEK IMPACTED FLOODPLAIN	Floodplain sediments	Excavate and Repository	C01B+C08A	Excavate/WCA	C01B+C07+HAUL-2
BUR160	INTERSTATE-CALLAHAN LOWER ROCK DUMPS	Upland waste rock (erosion potential)	Excavate and Cap w/Seep Collection	C04	Excavate/WCA	C01+C07+HAUL-2
BUR170	TAMARACK 400 LEVEL	Upland waste rock (potential intermixed tailings)	Low-Permeability Cap	C03	Excavate/WCA	C01+C07+HAUL-2
BUR171	TAMARACK NO.5	Upland waste rock (potential intermixed tailings)	Low-Permeability Cap	C03	Excavate/WCA	C01+C07+HAUL-2
BUR172	TAMARACK UNNAMED ADIT	Upland waste rock	Low-Permeability Cap	C03	Excavate/WCA	C01+C07+HAUL-2
BUR173	TAMARACK MILLSITE	Upland tailings	Excavate and Dispose	C01+C07	Excavate/WCA	C01+C07+HAUL-2
OSB032	DULUTH MINE BLACKCLOUD CK	Floodplain waste rock	Excavate and Cap	C01+C03	Removed from Upper Basin Selected Remedy	NONE
OSB033	RUTH MINE	Upland waste rock (erosion potential)	Excavate and Cap	C01+C03	Removed from Upper Basin Selected Remedy	NONE
OSB038	CALIFORNIA NO.4	Floodplain waste rock	Excavate and Cap	C01+C03	Excavate/WCA	C01+C07+HAUL-2
OSB039	DAYROCK MINE	Floodplain sediments	Excavate and Repository	C01B+C08A+NONE [50]	Excavate/WCA	C01B+C07+HAUL-2
OSB039	DAYROCK MINE	Upland tailings	Excavate and Dispose	C01+C07	Excavate/WCA	C01+C07+HAUL-2

TABLE 2

Summary of Revised Typical Conceptual Designs for the Source Sites in the Ninemile Creek Watershed

Summary of Changes to Source Volumes and Typical Conceptual Designs for Alternative 3+ (d) Source Sites in the Ninemile Creek Watershed

Source Site Number	Site Name	Waste Type	Alternative 3+ TCD	Alternative 3+ TCD Code	Revised TCD	Revised TCD Code
OSB040	EF NINEMILE CK HECLA REHAB	Floodplain sediments	Excavate and Repository	C01B+C08A+NONE [89]	Excavate/WCA	C01B+C07+HAUL-2
OSB044	SUCCESS MINE ROCK DUMP	Floodplain sediments	Excavate and Repository	C01B+C08A	Excavate/WCA	C01B+C07+HAUL-2
OSB044	SUCCESS MINE ROCK DUMP	Upland tailings	Excavate and Repository	C01+C08A	Excavate/WCA	C01+C07+HAUL-2
OSB044	SUCCESS MINE ROCK DUMP	Upland waste rock	Regrade/Consolidate/Revegetate	C02A	Excavate/WCA	C01+C07+HAUL-2
OSB056	EF NINEMILE CK IMPACTED RIPARIAN	Floodplain sediments	Excavate and Repository	CO1B+C08A	Excavate/WCA	C01B+C07+HAUL-2
OSB057	EF NINEMILE CK IMPACTED RIPARIAN	Floodplain sediments	Excavate and Repository	CO1B+C08A	Excavate/WCA	C01B+C07+HAUL-2
OSB058	EF NINEMILE CK SVNRT REHAB	Floodplain sediments	Excavate and Repository	CO1B+C08A	Excavate/WCA	C01B+C07+HAUL-2
OSB059	NINEMILE CK BELOW DAYROCK MINE	Floodplain sediments	Excavate and Repository	CO1B+C08A	Excavate/WCA	C01B+C07+HAUL-2
OSB060	NINEMILE CK SVNRT REHAB NEAR BLACKCLOUD	Floodplain sediments	Excavate and Dispose	CO1B+C07	Excavate/WCA	C01B+C07+HAUL-2
OSB061	BLACKCLOUD CK MILLSITE	Upland tailings	Excavate and Dispose	CO1B+C07	Excavate/WCA	C01B+C07+HAUL-2
OSB082	MONARCH MINE BLACKCLOUD CK	Floodplain waste rock	Excavate and Cap	C01+C03	Excavate/WCA	C01+C07+HAUL-2
OSB084	BLACKCLOUD CK IMPACTED RIPARIAN	Floodplain sediments	Excavate and Repository	CO1B+C08A	Removed from Upper Basin Selected Remedy	NONE
OSB085	BLACKCLOUD CK IMPACTED RIPARIAN	Floodplain sediments	Excavate and Repository	CO1B+C08A	Removed from Upper Basin Selected Remedy	NONE
OSB115	OPTION MINE	Upland waste rock (erosion potential)	Excavate and Cap	C01+C03	Excavate/WCA	C01+C07+HAUL-2
WAL006	NORTHSIDE MINE	Upland waste rock (erosion potential)	Excavate and Cap	C01+C03	Removed from Upper Basin Selected Remedy	NONE
WAL033	NINEMILE CK POTENTIAL TAILINGS DEPOSIT	Floodplain sediments	Excavate and Dispose	C01B+C07+NONE[97]	Excavate/WCA	C01B+C07+HAUL-2

Notes:

EF = East Fork

SVNRT = Silver Valley Natural Resource Trust

TCD = typical conceptual design

WCA = waste consolidation area

ATTACHMENT A

Topographic Details and Sections of Source Sites in the Ninemile Creek Watershed

BLM Source Area Boundary
Design Surface Exterior Boundary
Existing Major Contour (100-foot interval)
Existing Minor Contour (25-foot interval)
Cross Section Alignment
Design Surface Major Contour
Design Surface Minor Contour

N
0 500 1,000 Feet

Source: 2006 1 meter imagery from the National Agriculture Imagery Program, 10 meter Digital Elevation Model

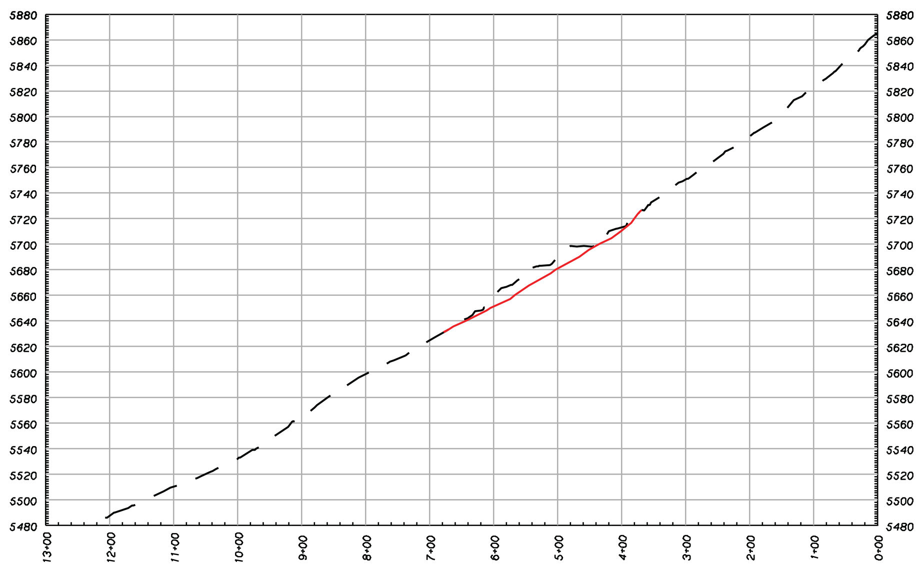
FIGURE A-1
Plan View of Ninemile Creek Watershed Source Sites (BUR052)

\\BOI31054822\CDA_UPPER_BASIN\GIS\NINEMILECREEK_MASS.MXD NINEMILECREEK_MASS.MXD JYOUNG8 8/17/2011 15:48:04

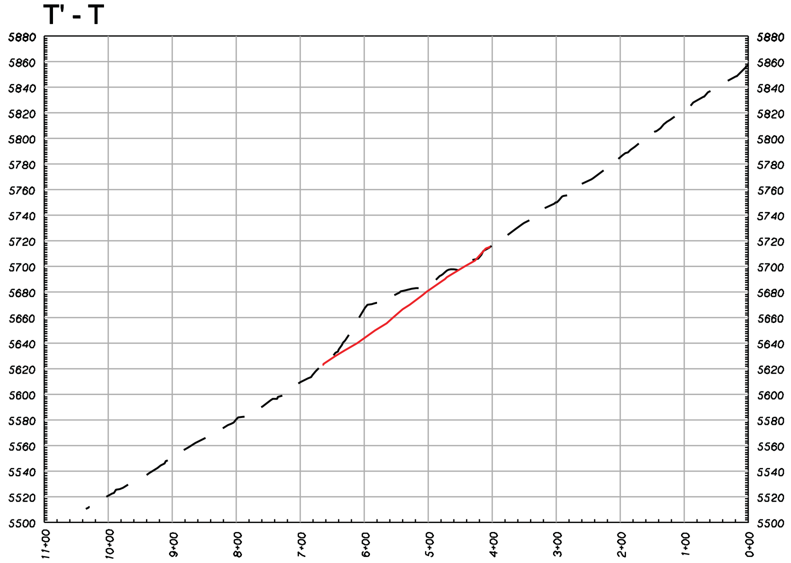
CH2MHILL

BUR052

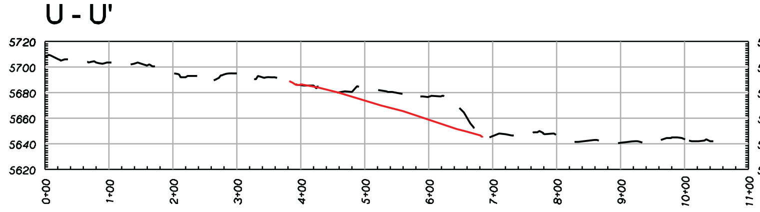
S' - S

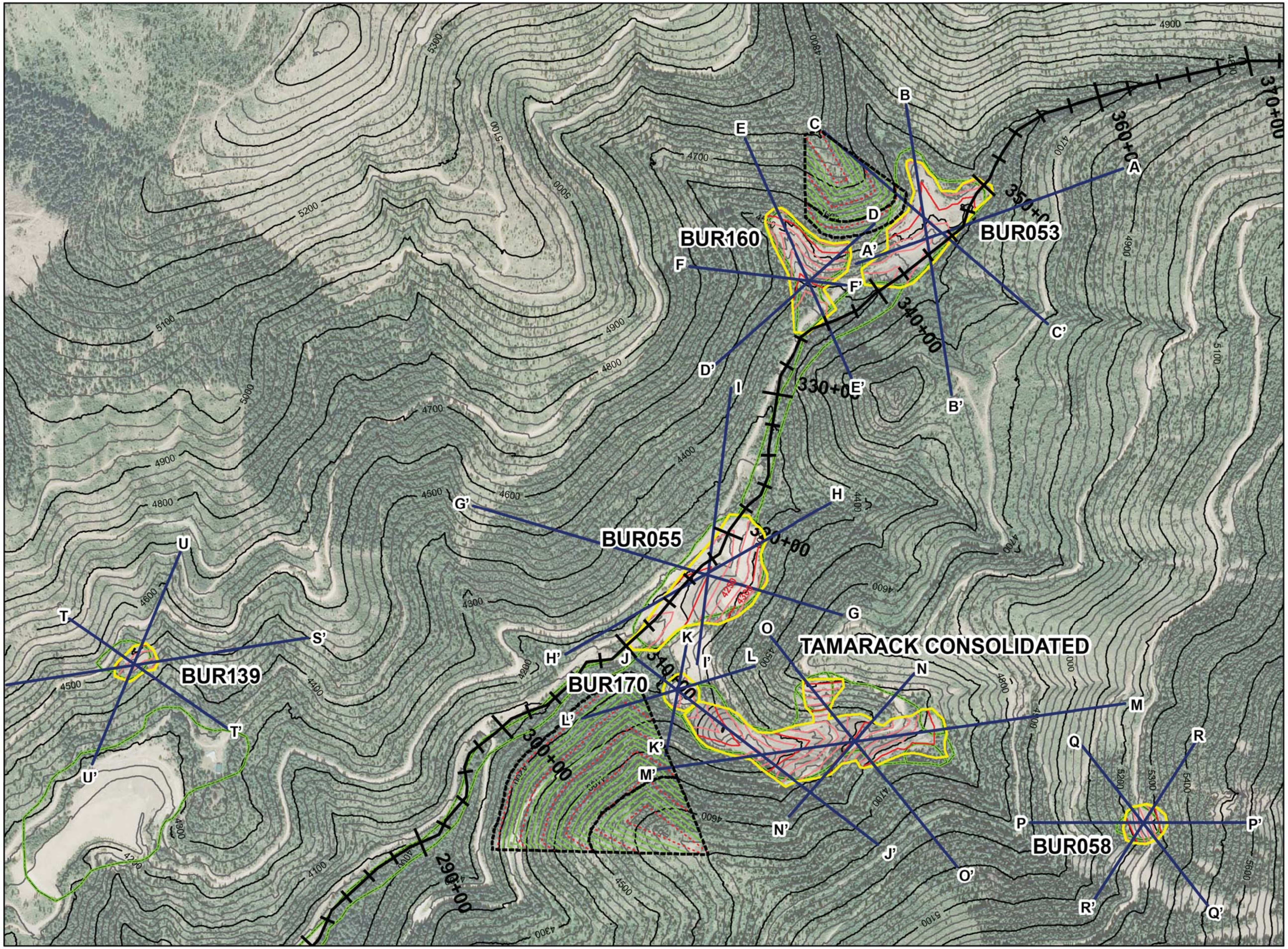


T' - T



U - U'





- BLM Source Area Boundary
- Design Surface Exterior Boundary
- Existing Major Contour (100-foot interval)
- Existing Minor Contour (25-foot interval)
- Cross Section Alignment
- Design Surface Major Contour
- Design Surface Minor Contour
- Proposed Repository Boundary
- Repository Major Contour (100-foot interval)
- Repository Minor Contour (25-foot interval)

N

0 500 1,000 Feet

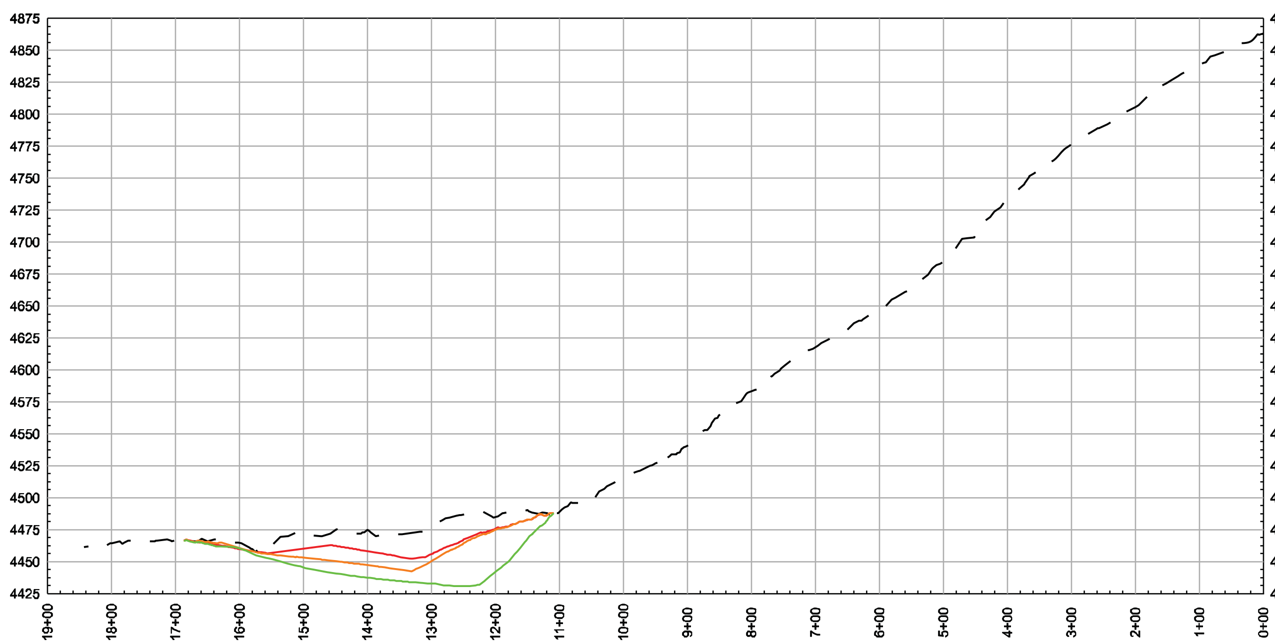
Source: 2006 1 meter imagery from the National Agriculture Imagery Program, 10 meter Digital Elevation Model

FIGURE A-2
Plan View of Ninemile Creek Watershed Source Sites (BUR053, BUR055, BUR058, BUR139, BUR160, BUR170)

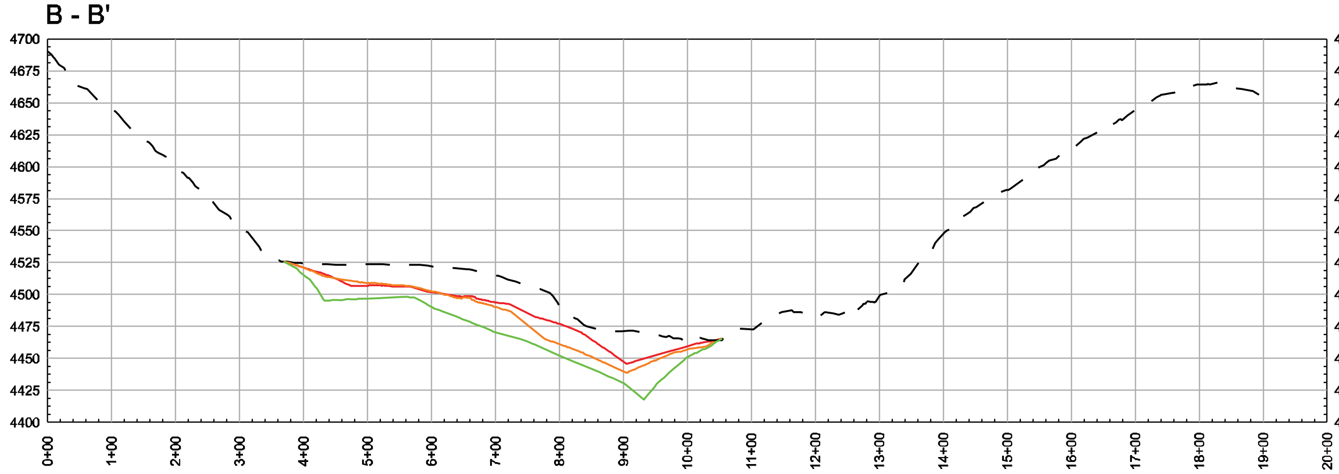
CH2MHILL

BUR053

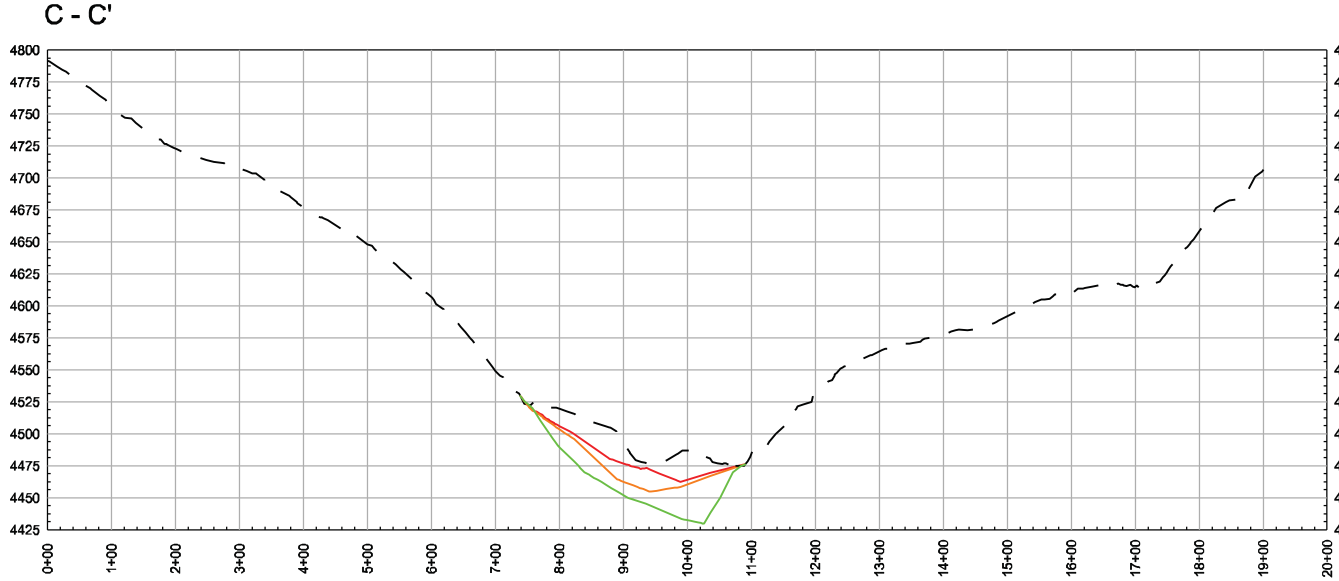
A' - A



B - B'

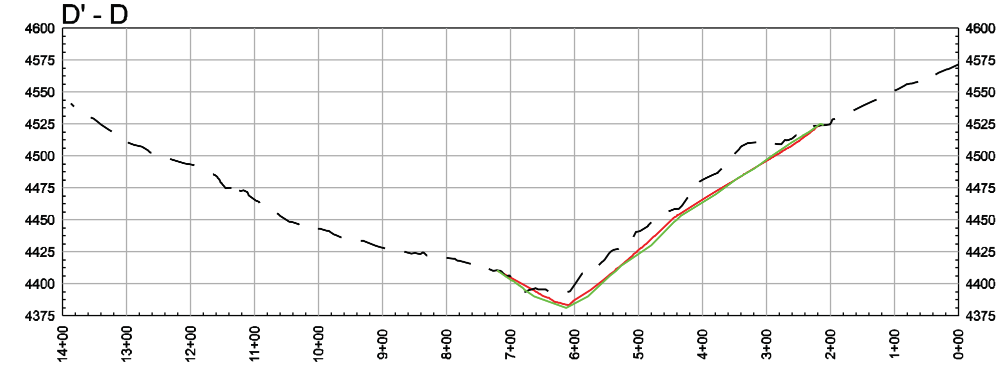


C - C'

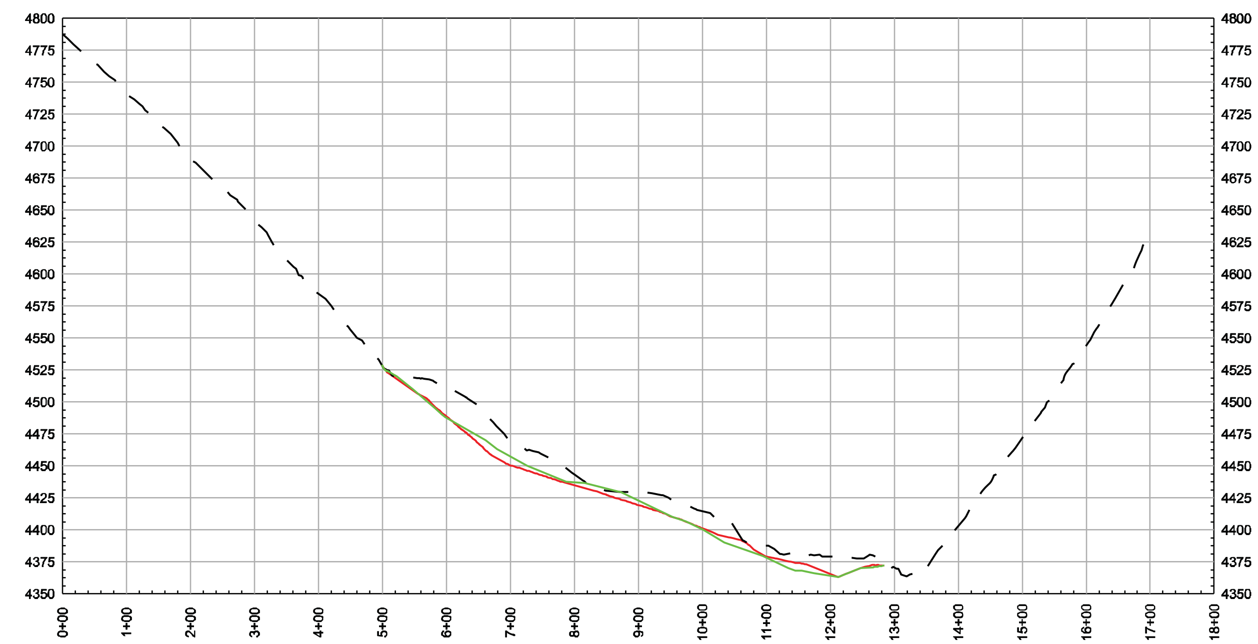


BUR160

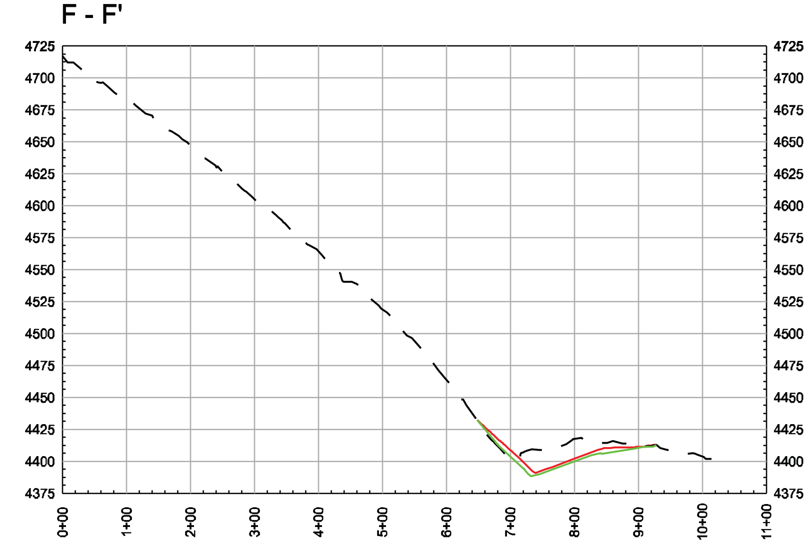
D' - D



E - E'



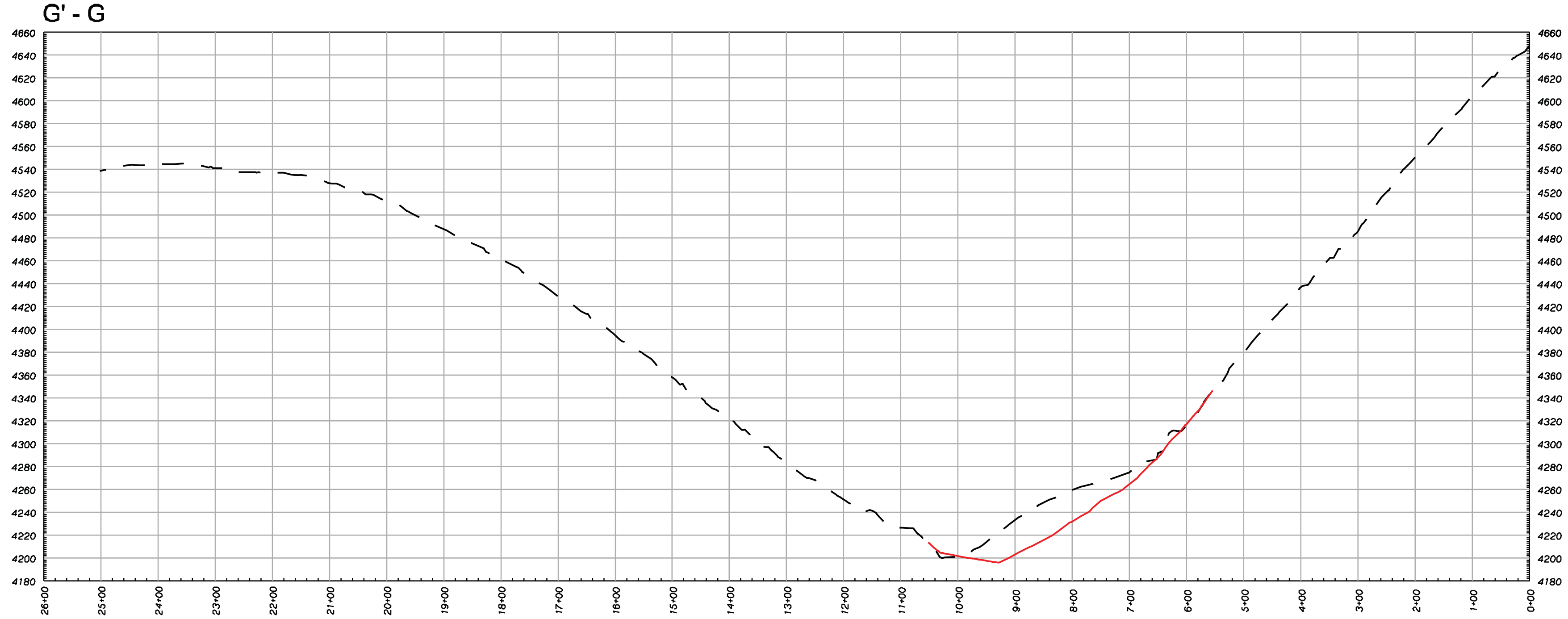
F - F'



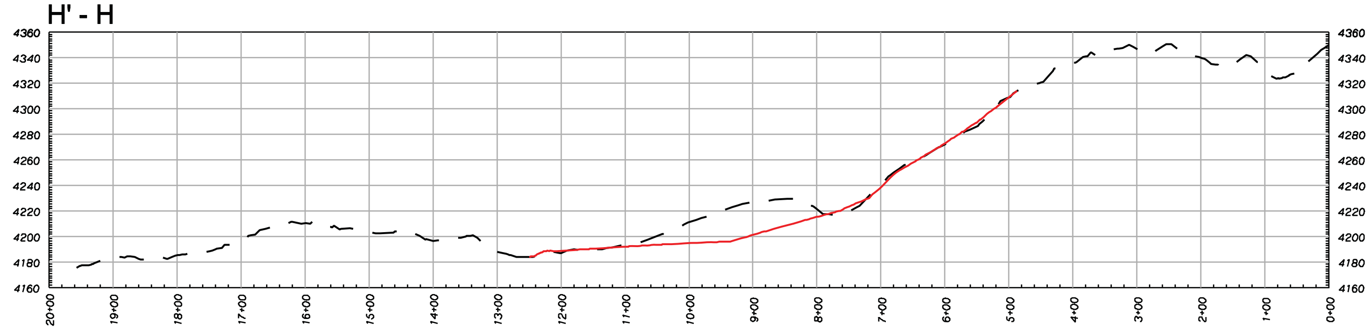
EXISTING GROUND
APPROXIMATE NATIVE GROUND SURFACE (REVISED 09/13/11)
APPROXIMATE NATIVE GROUND SURFACE (REVISED 07/29/11)
APPROXIMATE NATIVE GROUND SURFACE (REVISED 05/20/11)

BUR055

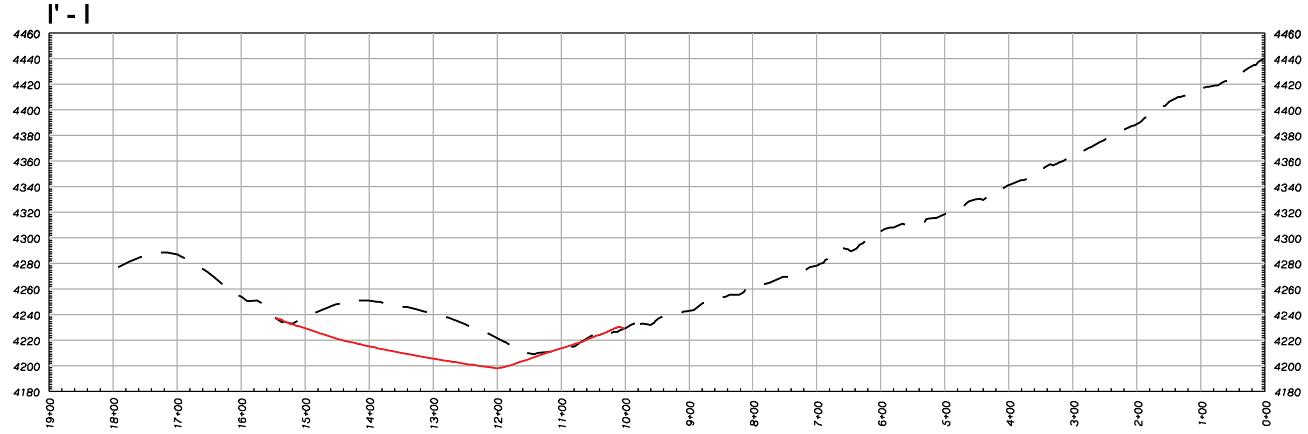
G' - G



H' - H

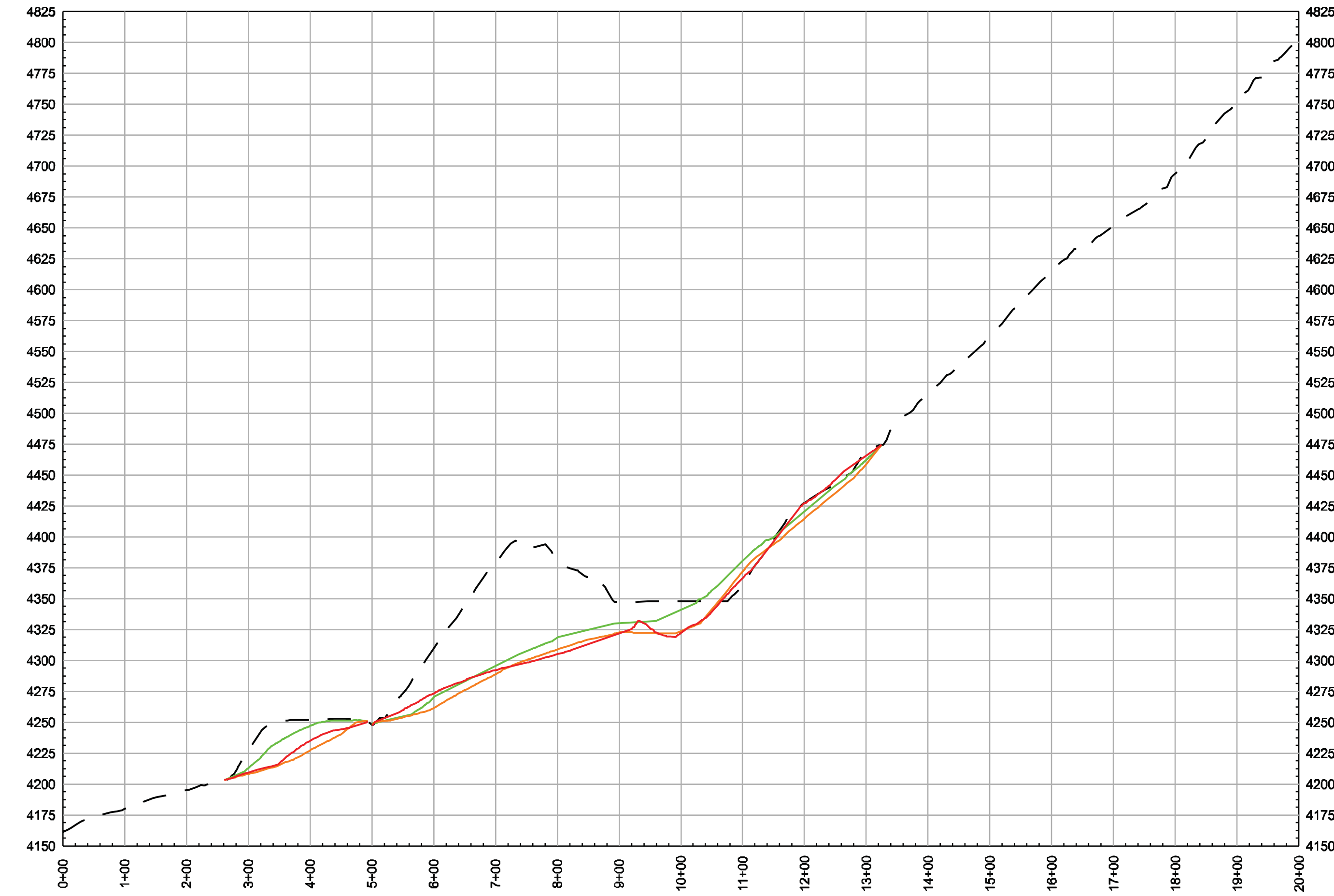


I' - I



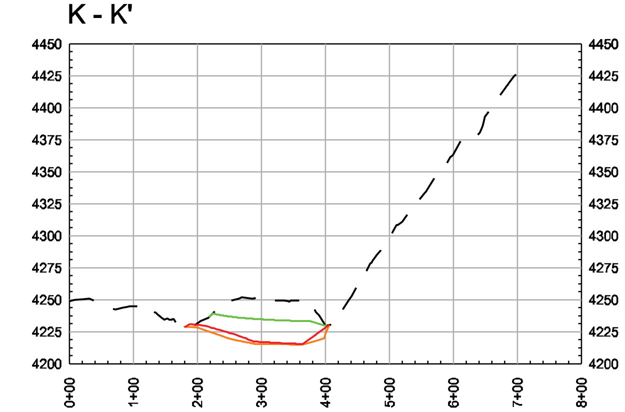
BUR170

J - J'

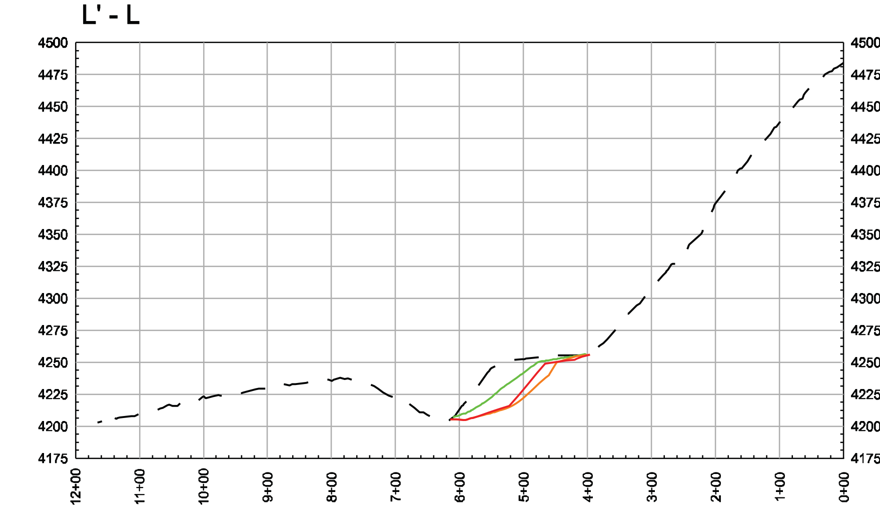


EXISTING GROUND
APPROXIMATE NATIVE GROUND SURFACE (REVISED 09/13/11)
APPROXIMATE NATIVE GROUND SURFACE (REVISED 07/29/11)
APPROXIMATE NATIVE GROUND SURFACE (REVISED 05/20/11)

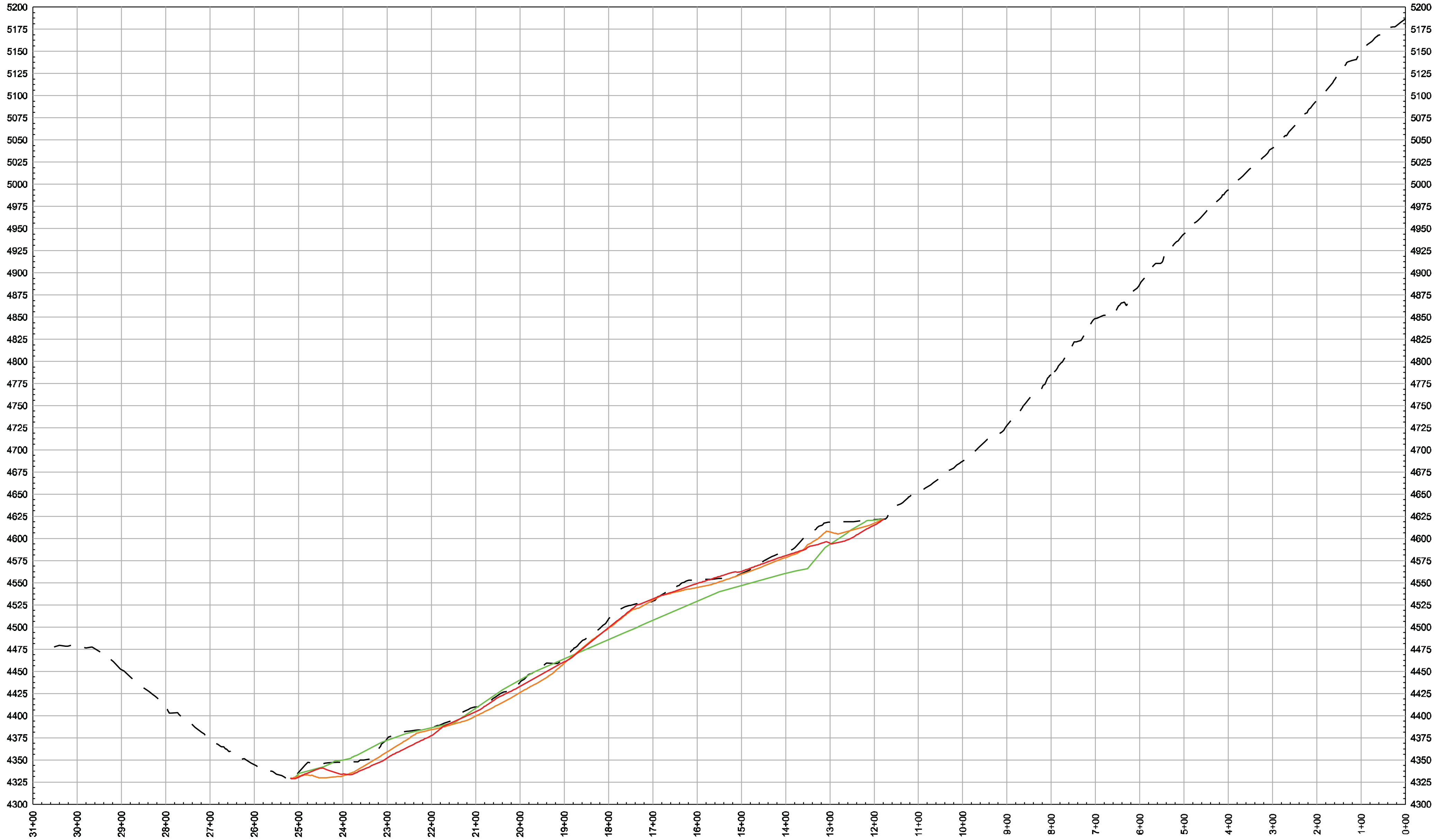
K - K'



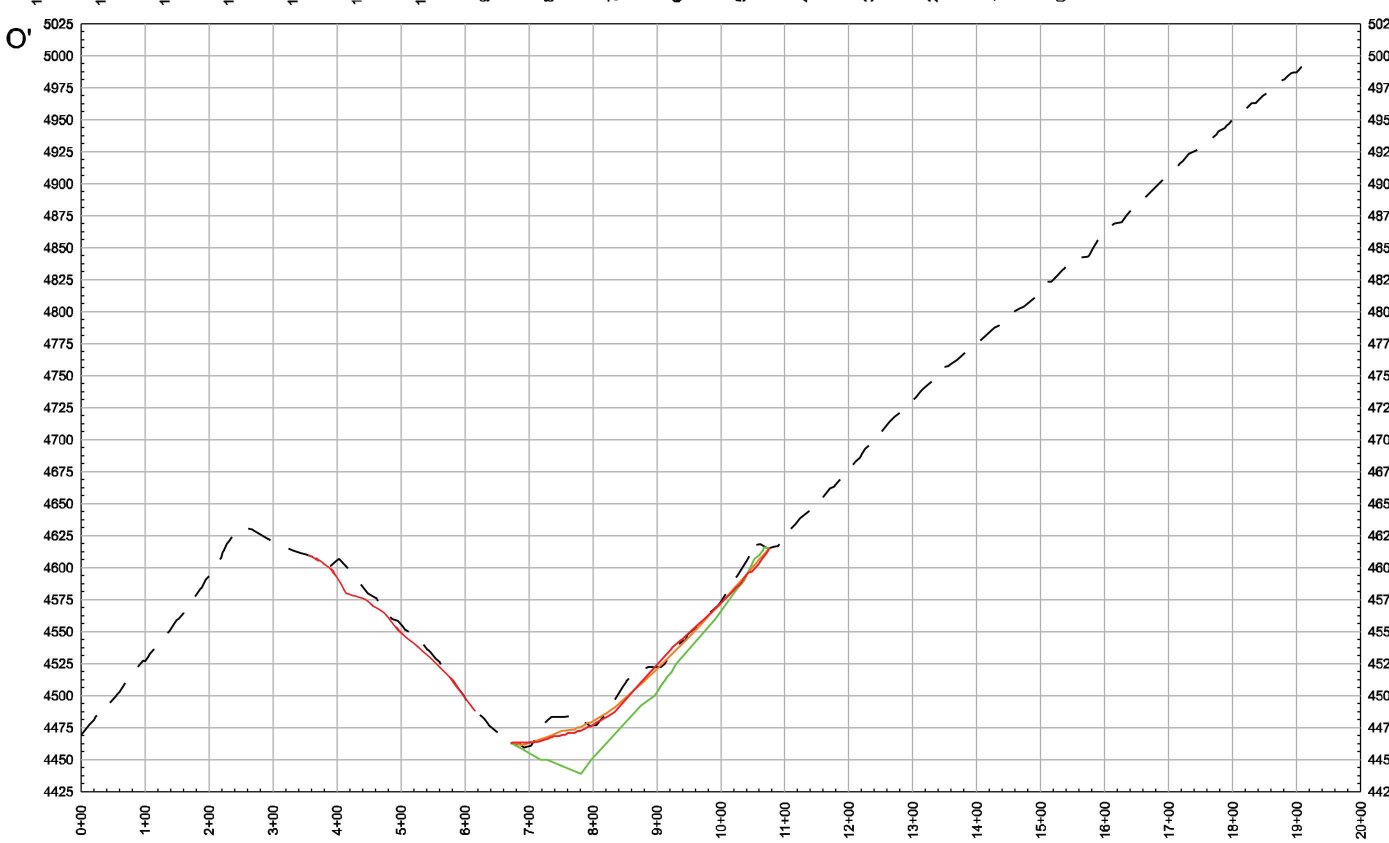
L' - L



M' - M

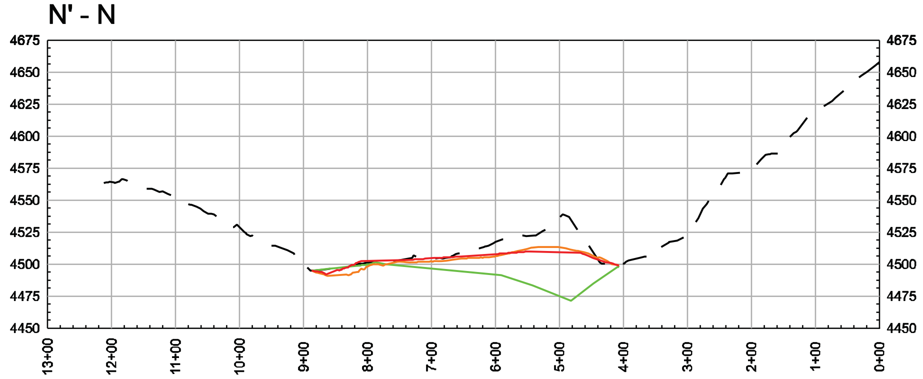


O - O'



EXISTING GROUND
APPROXIMATE NATIVE GROUND SURFACE (REVISED 09/13/11)
APPROXIMATE NATIVE GROUND SURFACE (REVISED 07/29/11)
APPROXIMATE NATIVE GROUND SURFACE (REVISED 05/20/11)

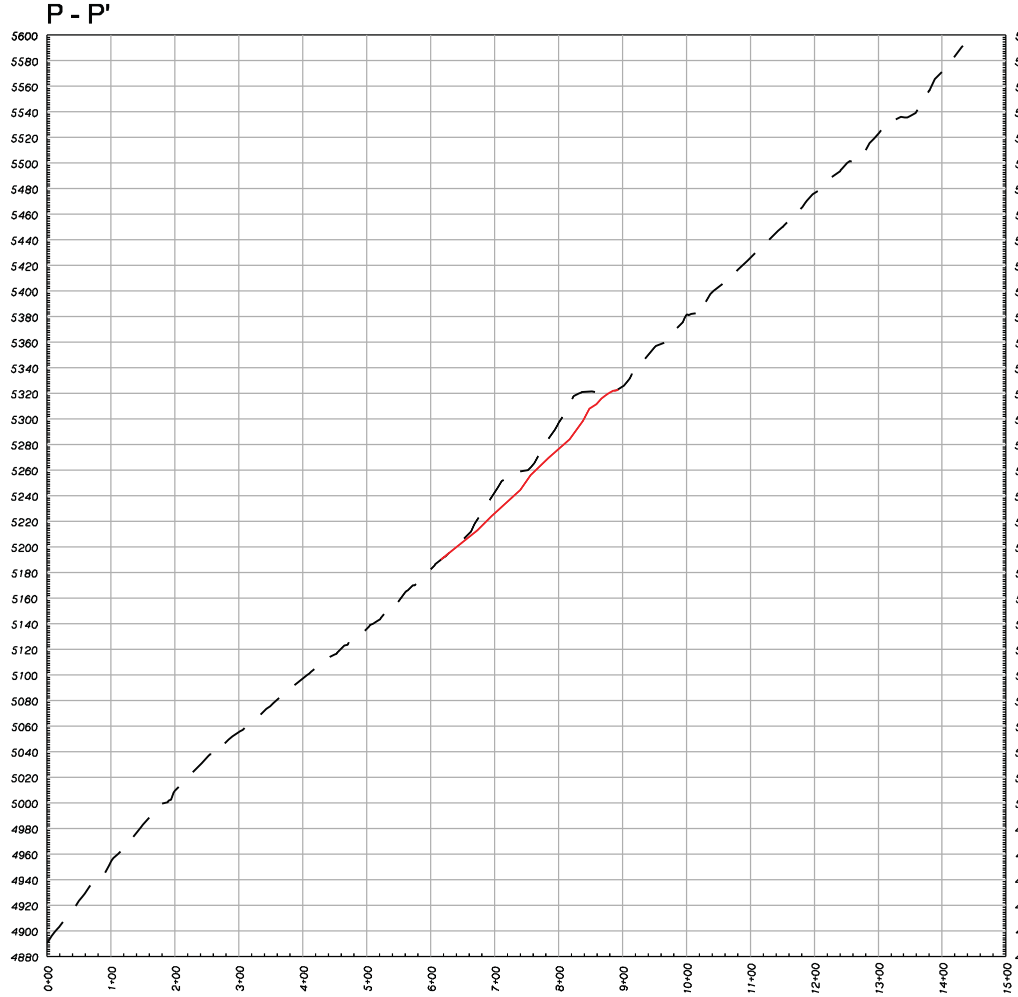
N' - N



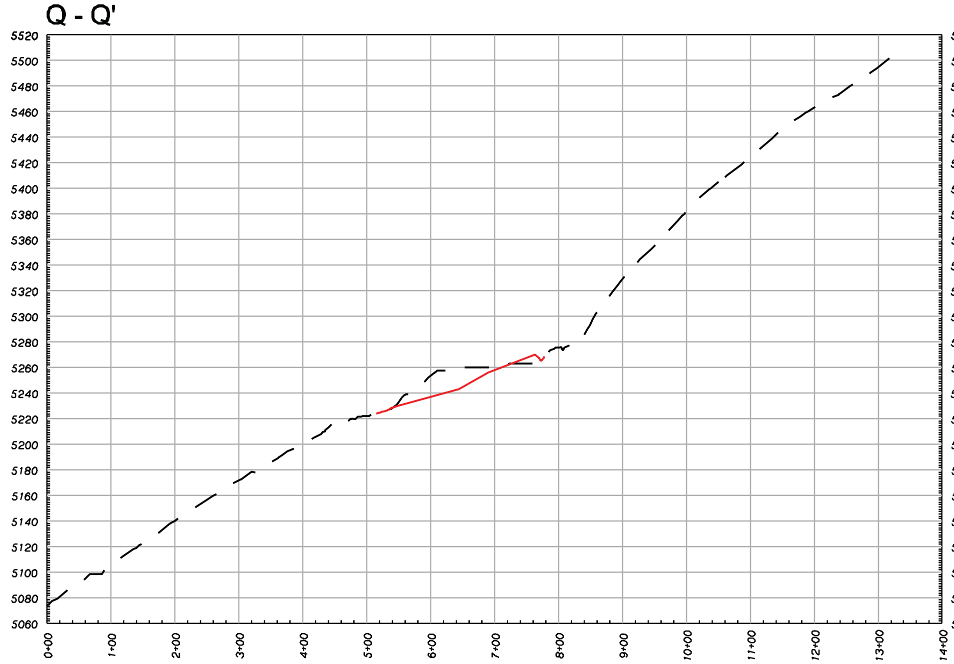
TAMARACK CONSOLIDATED

BUR058

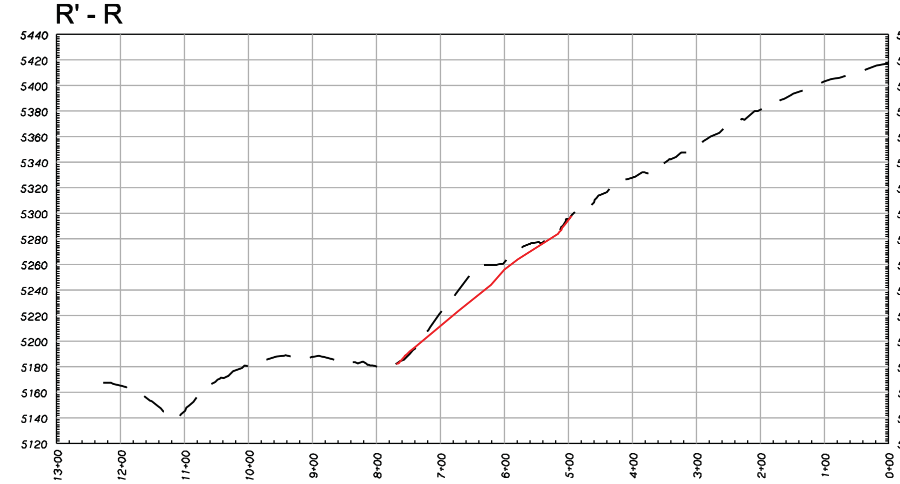
P - P'



Q - Q'

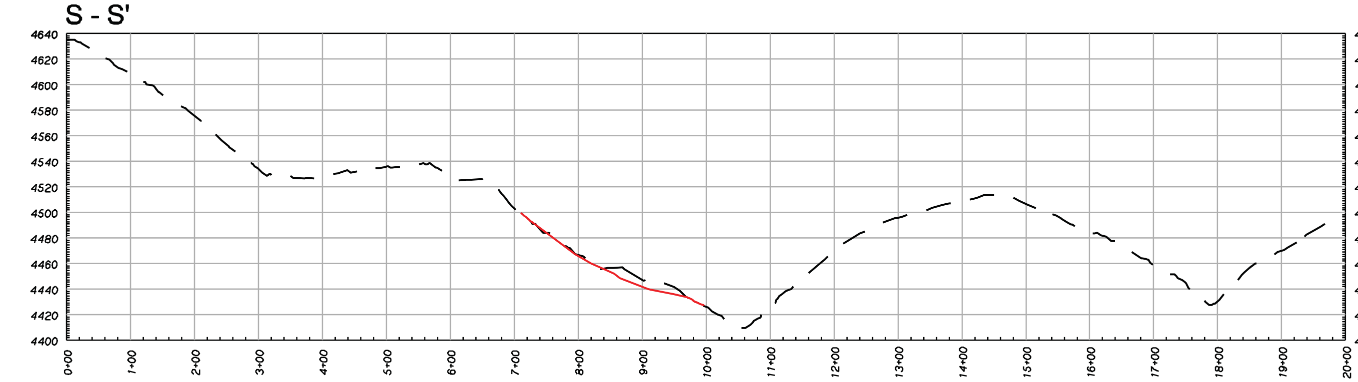


R' - R

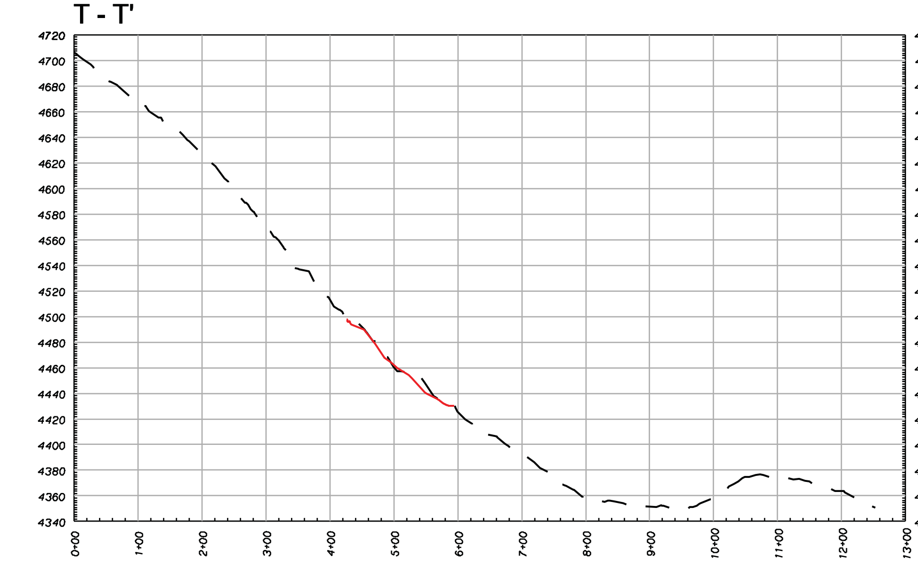


BUR139

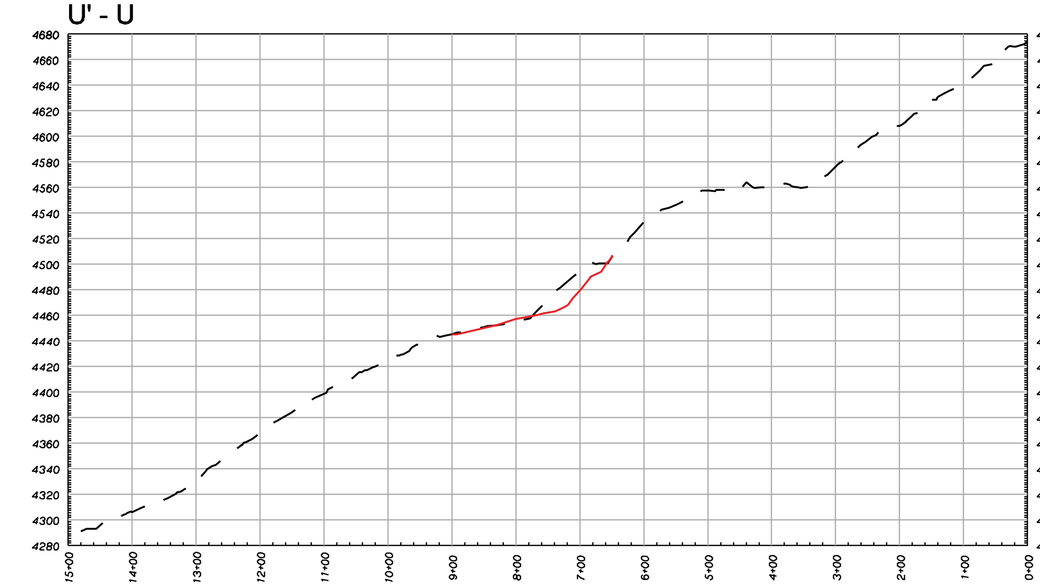
S - S'

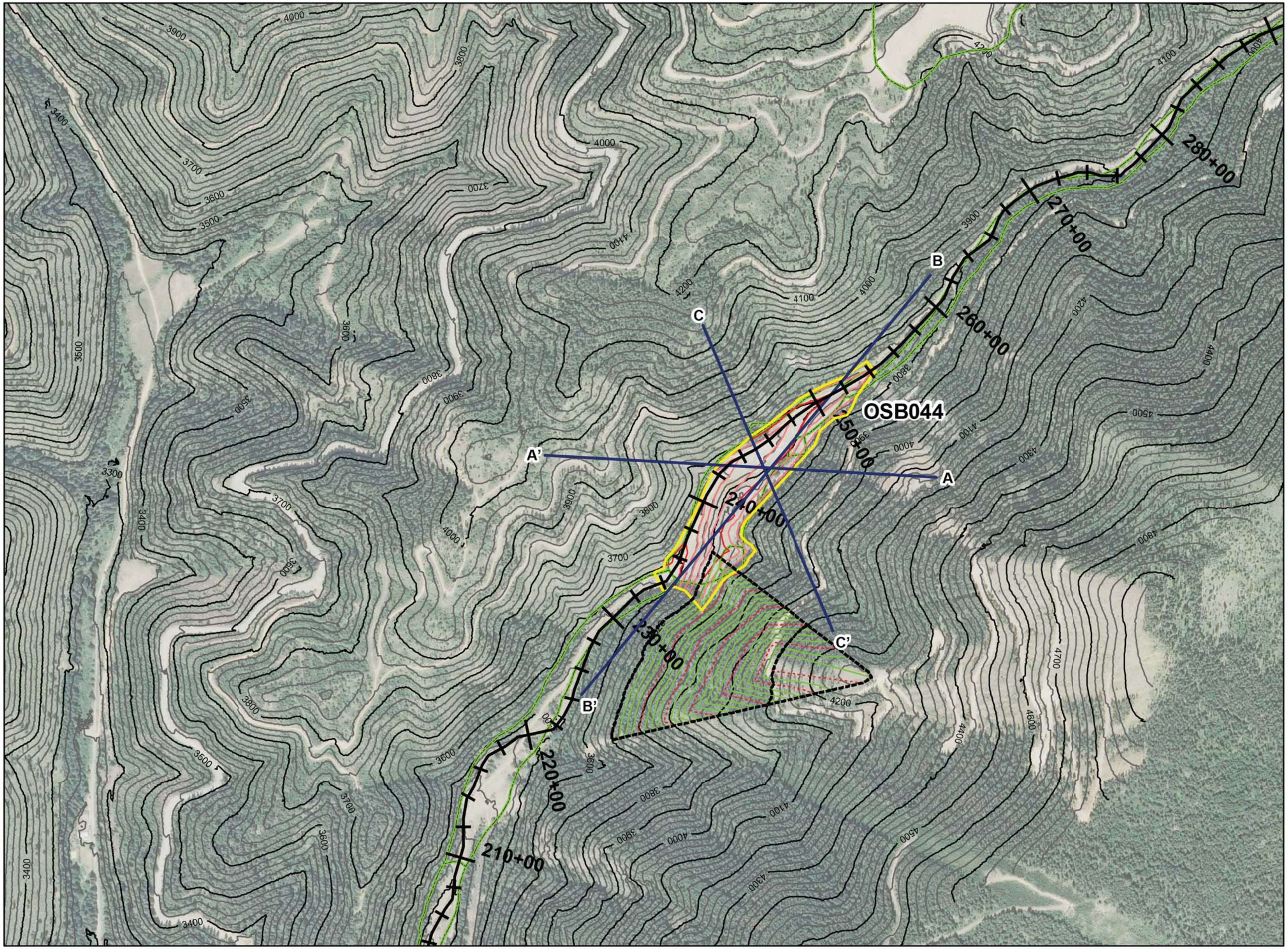


T - T'



U' - U





- BLM Source Area Boundary
- Design Surface Exterior Boundary
- Existing Major Contour (100-foot interval)
- Existing Minor Contour (25-foot interval)
- Cross Section Alignment
- Design Surface Major Contour
- Design Surface Minor Contour
- Proposed Repository Boundary
- Repository Major Contour (100-foot interval)
- Repository Minor Contour (25-foot interval)

N

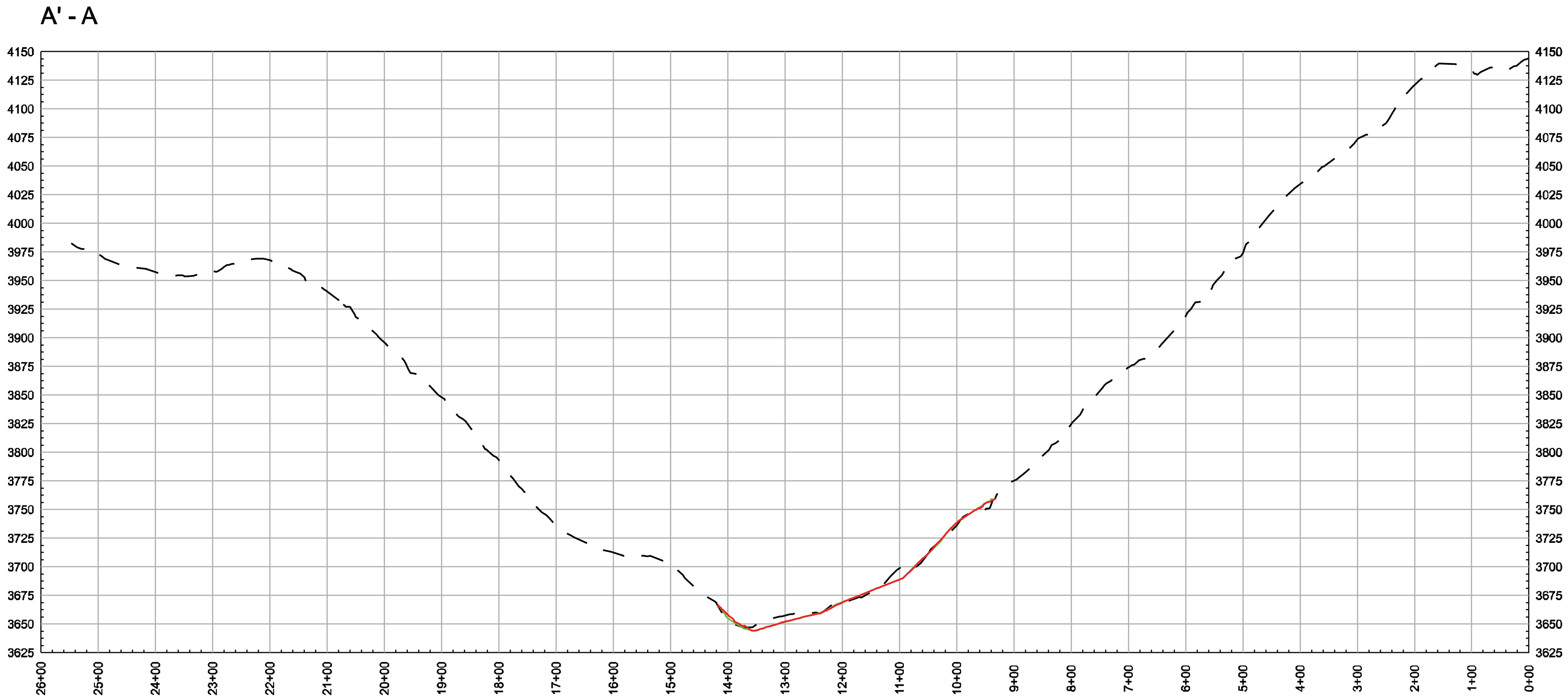
0 500 1,000 Feet

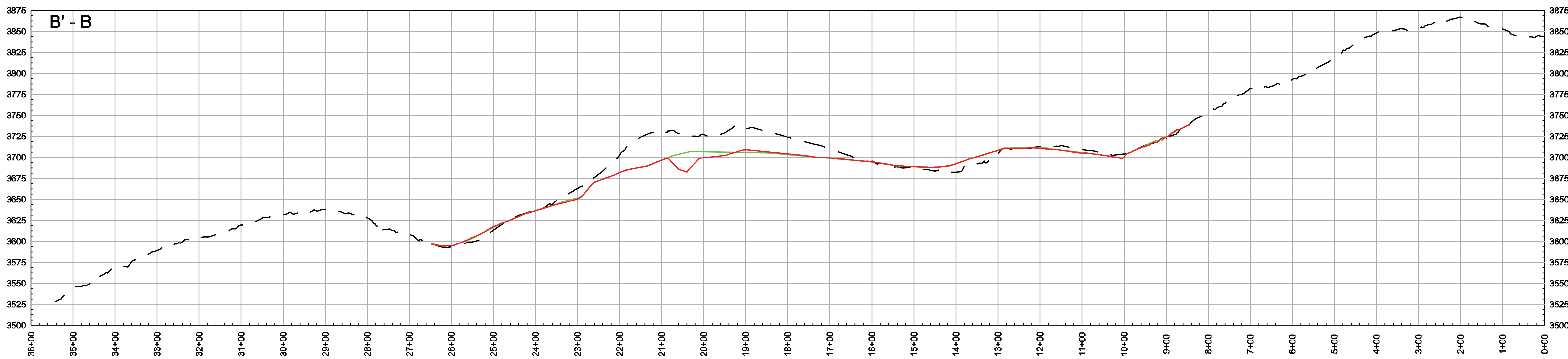
Source: 2006 1 meter imagery from the National Agriculture Imagery Program, 10 meter Digital Elevation Model

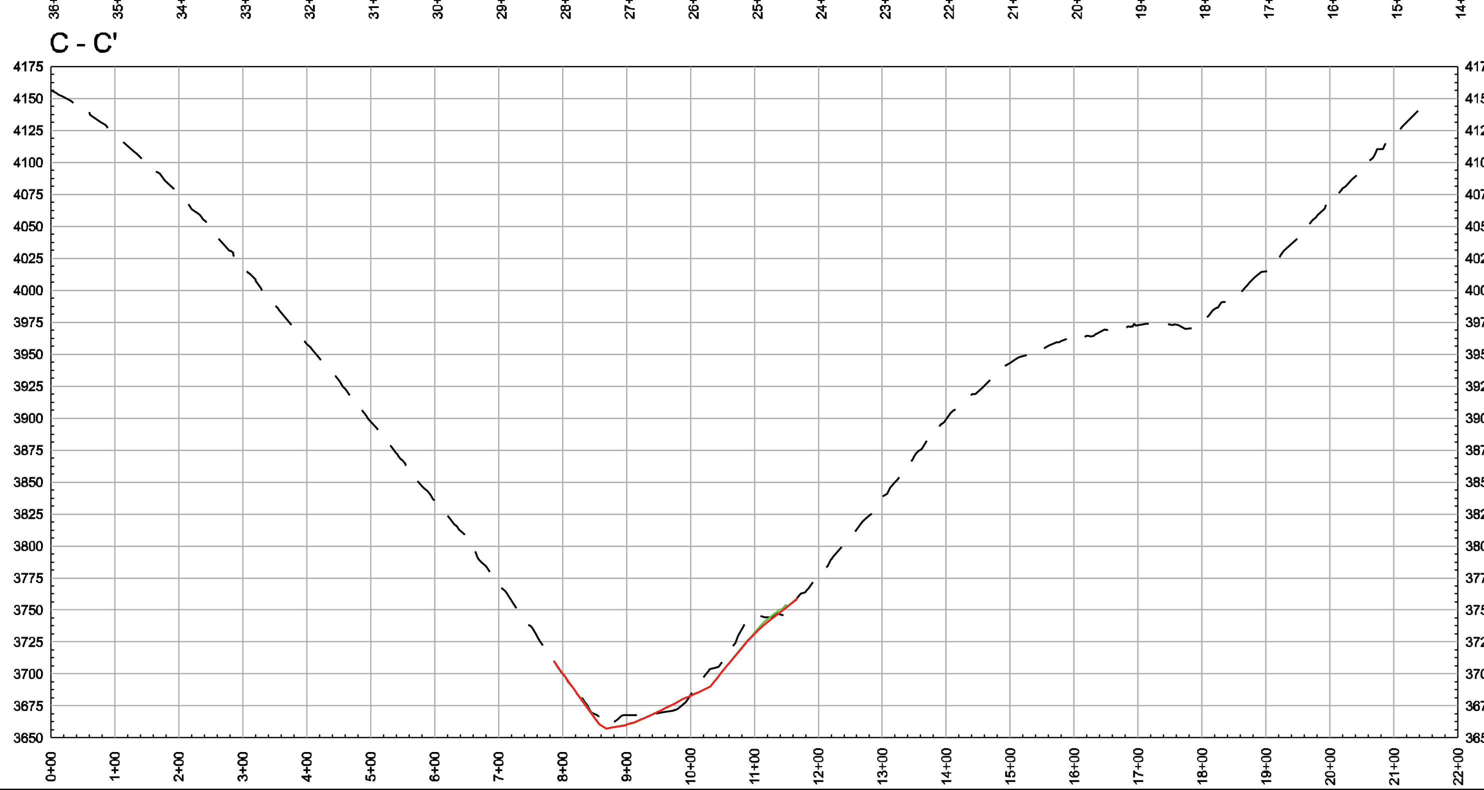
FIGURE A-3
Plan View of Ninemile Creek Watershed Source Sites (OSB044)

CH2MHILL

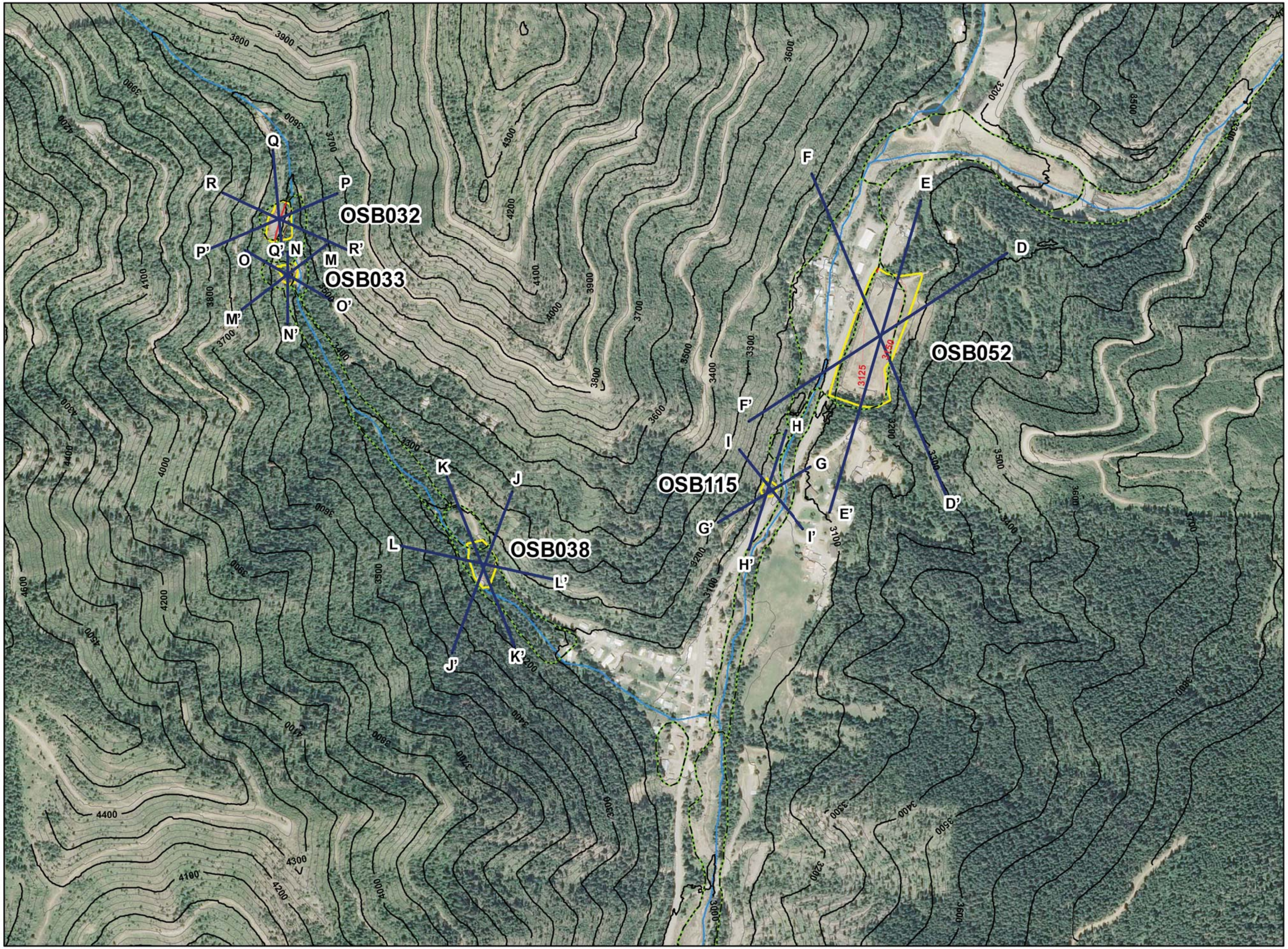
OSB044







EXISTING GROUND
APPROXIMATE NATIVE GROUND SURFACE (REVISED 09/13/11)
APPROXIMATE NATIVE GROUND SURFACE (REVISED 07/29/11)
APPROXIMATE NATIVE GROUND SURFACE (REVISED 05/20/11)



BLM Source Area Boundary
Design Surface Exterior Boundary
Existing Major Contour (100-foot interval)
Existing Minor Contour (25-foot interval)
Cross Section Alignment
Design Surface Major Contour
Design Surface Minor Contour

N
0 500 1,000 Feet

Source: 2006 1 meter imagery from the National Agriculture Imagery Program, 10 meter Digital Elevation Model

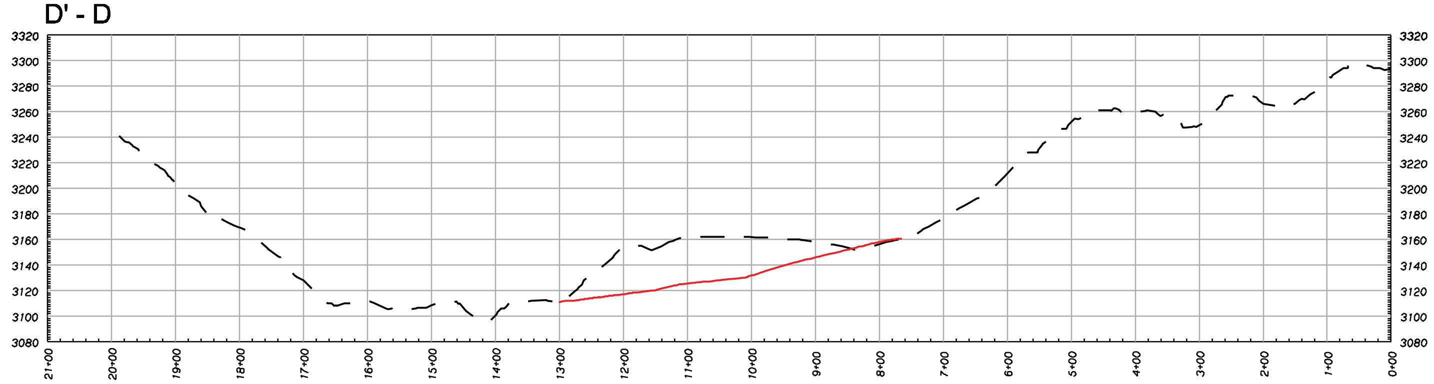
FIGURE A-4
Plan View of Ninemile Creek Watershed Source Sites (OSB032, OSB033, OSB038, OSB052, OSB115)

\\BOI31054822\CDA_UPPER_BASIN\GIS\NINEMILECREEK_MASS.MXD NINEMILECREEK_MASS.MXD JYOUNG8 8/17/2011 15:48:04

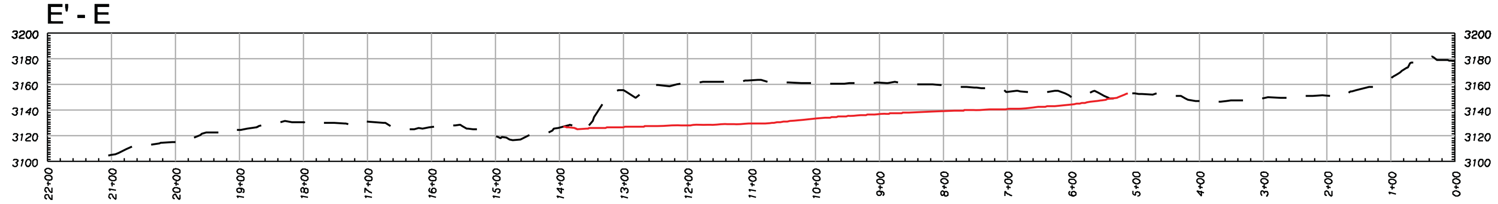
CH2MHILL

OSB052

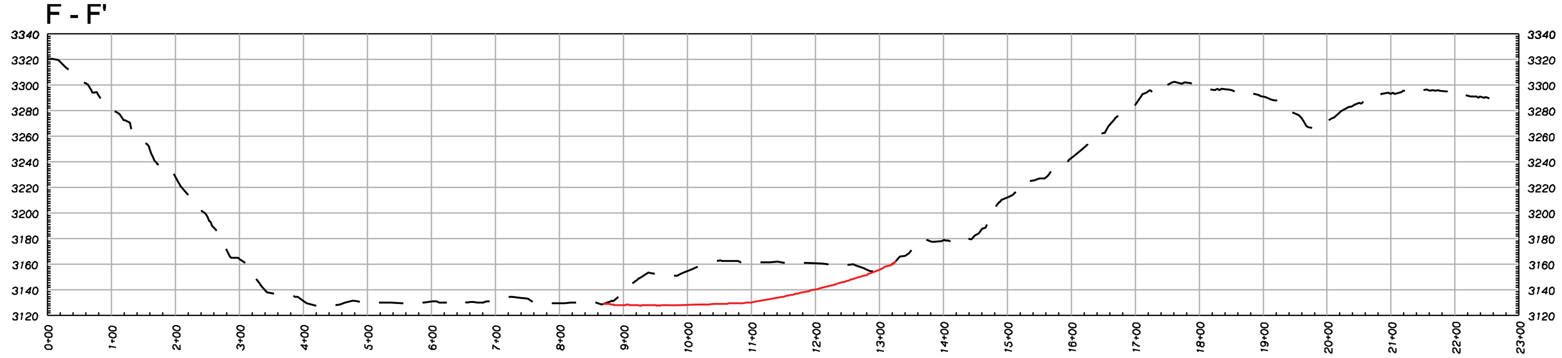
D' - D



E' - E

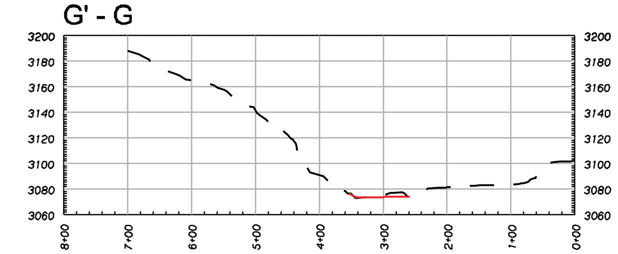


F - F'

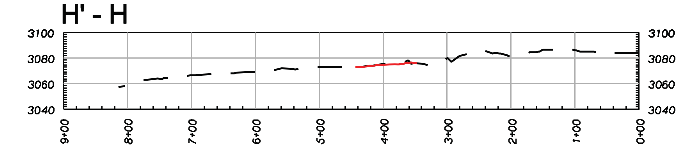


OSB115

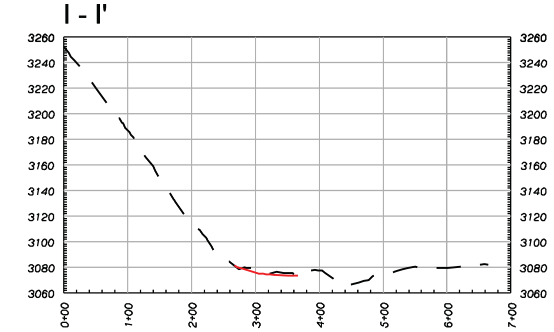
G' - G



H' - H

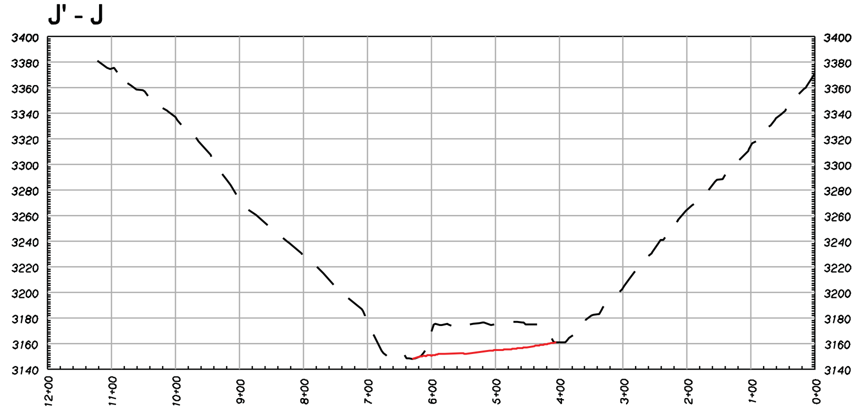


I - I'

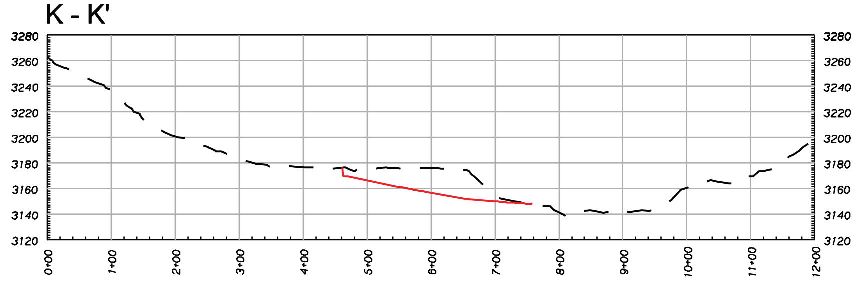


OSB038

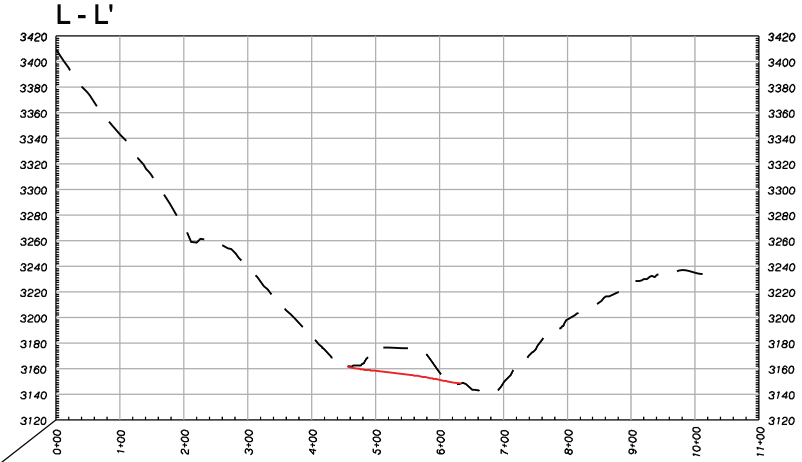
J' - J



K - K'

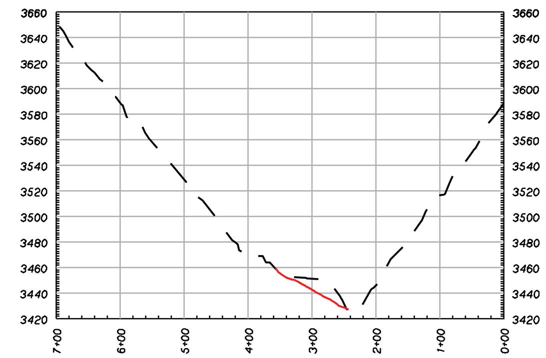


L - L'

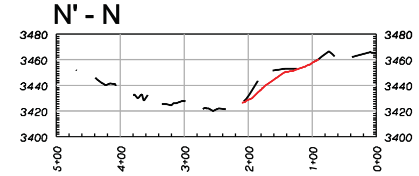


OSB033

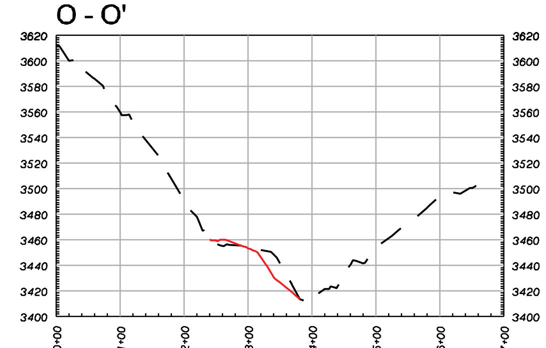
M' - M



N' - N

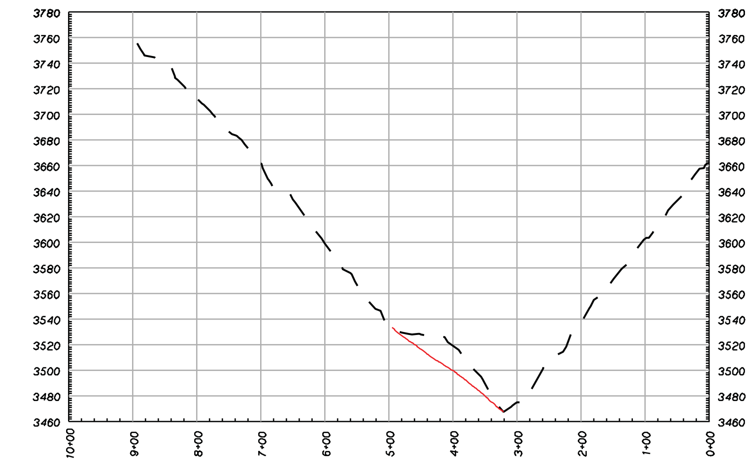


O - O'

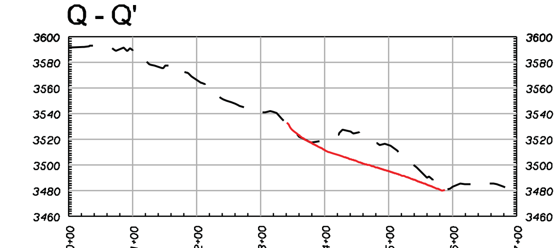


OSB032

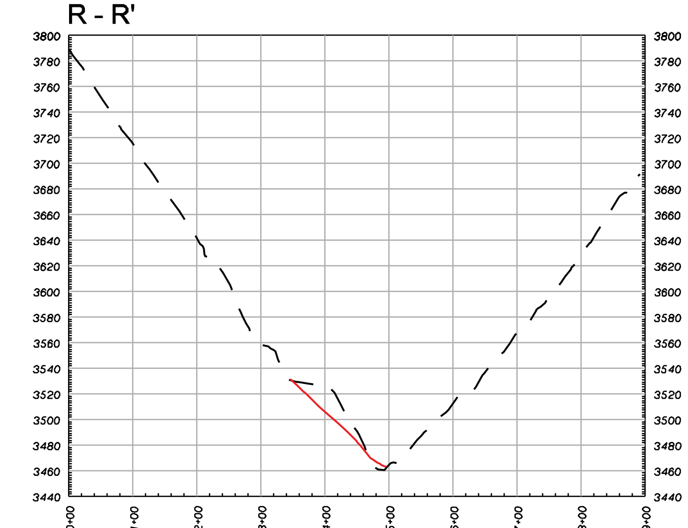
P' - P



Q - Q'



R - R'



ATTACHMENT 5

Technical Memorandum: Updates to Stream and Riparian Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

Updates to Stream and Riparian Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

PREPARED FOR: Bill Adams/U.S. Environmental Protection Agency (EPA) Region 10
Anne McCauley/EPA Region 10
Ed Moreen/EPA Region 10

PREPARED BY: Brian Tracy/SEA
Joan Stoupa/SEA
Steve Clayton/BOI

COPY TO: Rebecca Maco/SEA

DATE: July 20, 2012

1.0 Purpose and Objectives

The purpose of this Technical Memorandum (TM) is to document changes and clarify information related to the stream and riparian cleanup actions included in the Draft Final Focused Feasibility Study [FFS] Report for the Upper Basin of the Coeur d'Alene River (CH2M HILL, 2010) and the Upper Basin Proposed Plan (EPA, 2010a). This TM has been prepared, in part, to respond to public and stakeholder comments received on EPA's Preferred Alternative described in the Upper Basin Proposed Plan. After consideration of those comments, EPA decided to evaluate portions of the South Fork of the Coeur d'Alene River (SFCDR) and its primary tributaries designated for stream and riparian cleanup actions. Part of this evaluation included a field visit on June 13, 2011, which was attended by representatives from EPA, the Basin Environmental Improvement Project Commission (BEIPC), Shoshone County, and CH2M HILL.

The specific objectives of this TM are as follows:

- Summarize the methods used to select streambank stabilization approaches and typical conceptual designs (TCDs) for individual stream and riparian reaches during preparation of the 2001 Feasibility Study (FS) Report for the Coeur d'Alene Basin (EPA, 2001), as carried forward in the 2010 Draft Final FFS Report.
- Document changes to streambank stabilization approaches since the 2010 Draft Final FFS Report and the Upper Basin Proposed Plan, in conjunction with the reduction of the scope of remedial actions from those included in the Preferred Alternative in the Proposed Plan to those in the Selected Remedy to be documented in the forthcoming Upper Basin Record of Decision (ROD) Amendment (EPA, in preparation).

- Clarify the remedial design process that will occur as planned stream and riparian cleanup actions progress from the conceptual feasibility level of design to final design and implementation.

Together, these TM objectives are intended to address public and stakeholder concerns, document the changes made since the Draft Final FFS Report and Proposed Plan, and inform the decision-making process for future detailed design and cost estimating related to streambank stabilization.

2.0 Background

The 2001 FS Report defined seven watersheds in the Upper Basin of the Coeur d'Alene River. These watersheds were subdivided into 21 segments that were further subdivided into 119 stream and riparian reaches along the SFCDR and its primary tributaries. The 2001 FS Report used a high-level approach (discussed in more detail in Section 3.1) to assign TCDs for cleanup actions to the various stream and riparian reaches along the SFCDR and its tributaries. In addition, the 2001 FS Report established associated estimated quantities and unit costs for each TCD with which to prepare an FS-level cost estimate. A total of 22 Stream and Riparian Cleanup Action TCDs (then referred to as "Bioengineering TCDs") were included in the 2001 FS Report; these were grouped into six general categories to facilitate cost estimating, and they represent a range of possible methods of reducing bank erosion and associated releases of contaminants and, where possible and appropriate, improving aquatic and riparian habitat.

The corresponding portions of the 2010 Draft Final FFS Report focused primarily on escalating the TCD unit costs for stream and riparian cleanup actions that had been included in the 2001 FS Report to 2009 dollars. No new or revised Stream and Riparian Cleanup Action TCDs were included in the 2010 Draft Final FFS Report; as discussed in Section 3.4 below, one of the TCD categories in the 2001 FS Report (Current Deflectors) was subdivided into two categories.

The 2010 Upper Basin Proposed Plan included large-scale remedial actions in, and adjacent to, the SFCDR and some of its tributaries to remove contaminated wastes. These actions were primarily the same as those included in Ecological Alternative 3 in the 2001 FS Report. Once the removal component of a remedial action is completed, it is anticipated that some contamination may remain along the channel banks and riparian areas, depending on the site and the extent of the contaminated wastes. At those site-specific locations, the stream and riparian actions will serve to stabilize the banks to reduce erosion and contaminated sediment loading to the channel.

3.0 Previous Approaches Used to Assign TCDs

Section 3.1 presents the approaches used to develop and assign TCDs in the 2001 FS Report, which were carried forward into the 2010 Draft Final FFS Report as discussed in Section 3.2. Section 3.3 describes general watershed and reach characteristics, and Section 3.4 discusses the 2001 and 2010 Stream and Riparian Cleanup Action TCDs by watershed.

3.1 2001 Feasibility Study Approach

The 2001 FS Report described the purpose of the Stream and Riparian Cleanup Action TCDs (then referred to as "Bioengineering TCDs" as noted above). As quoted below, the 2001 FS Report used a high-level approach. Bioengineering TCDs were

> "…developed without the benefit of supporting hydrologic and geotechnical analyses necessary to support the design phase. They are based on available data, broad assumptions, and best professional judgment in the place of site-specific information and may change considerably as more detailed studies are conducted. The intent of this approach is not to provide a specific plan for the application of these techniques. Rather, it is to provide remedial engineers and decision makers with a general example of how they will be employed under typical conditions…for the purpose of TCD quantity estimation in the FS." (2001 FS Report, Part 3, Volume 1, page 4-14)

The approach by which specific TCD quantities (and associated costs) were assigned to the 119 reaches of the SFCDR and its primary tributaries also used a high-level approach:

> "The bioengineering process options and associated TCD quantities were based on estimates of the extent of physically impaired and/or directly impacted stream and riparian areas from aerial photographs, maps, and experience gained during site visits. The approach to developing these estimates was based on best professional judgment of the extent of measures required to accomplish the following:
>
> – Stabilize physical functions to the extent required to help control failure risks for bioengineering actions and floodplain contaminant containment and removal actions
>
> – Stabilize existing contaminant source areas that may be left in place
>
> – Rebuild and stabilize bank and floodplain areas following contaminant removal" (2001 FS Report, Part 3, Volume 1, page 4-12)

3.2 2010 Focused Feasibility Study Approach

The 2010 Draft Final FFS Report described new information and data available since 2001 that would affect planned cleanup actions for the Upper Basin. However, all the Bioengineering TCDs associated with Ecological Alternatives 3 and 4 in the 2001 FS Report were retained as Stream and Riparian Cleanup Action TCDs in the 2010 Draft Final FFS Report, and no new information related to stream and riparian cleanup actions was included. No changes were made to the Stream and Riparian Cleanup Action TCDs aside from the updated cost estimates.

3.3 Watershed and Reach Characteristics

To better understand the similarities and differences between watersheds and to help inform future reach-scale and site-specific designs, Table 1 was developed to summarize characteristics of the seven Upper Basin watersheds addressed in the 2010 Draft Final FFS Report and the Proposed Plan, and their primary subwatersheds.

As shown in Table 1, average gradients range from 1 percent in the Mainstem SFCDR Watershed to as much as 15 percent in the West Fork Big Creek subwatershed. This variability in slope, combined with local streambank conditions (i.e., vegetation, rock, and/or visible contamination), has a direct effect on the potential for bank erosion. As noted in Section 5.2, the information summarized here will continue to be refined (using more detailed data) in the subsequent design phases.

Figure 1 presents the longitudinal profiles for the watersheds and subwatersheds, and Table 2 includes the specific reach data used to generate Figure 1. These data indicate that the SFCDR and its tributaries significantly increase in gradient moving east (upstream) through the Upper Basin.

3.4 Stream and Riparian Cleanup Action TCDs by Watershed

The watershed and reach characteristics summarized above provide a context to understand the distribution and number of Bioengineering TCDs presented in the 2001 FS Report and Stream and Riparian Cleanup Action TCDs presented in the 2010 Draft Final FFS Report. As noted previously, a total of 22 separate TCDs were proposed in the 2001 FS Report, and these were grouped into six general categories. One of those categories (Current Deflectors) was subdivided into two categories to facilitate cost estimating, and summary descriptions of the resulting seven TCD categories are provided below.

- **Current Deflectors.** Current deflectors include several different types of structures constructed of wood, rock, or other materials attached to a streambank or in mid-channel, which redirect stream energy away from erodible areas. Sufficient numbers of current deflectors, properly spaced and oriented, can slow drainage rates and increase off-channel water storage, reducing flow energy in downstream areas, limiting flood damage, and preventing channel migration from outflanking shoreline stabilization structures. These structures also serve to stabilize sediment and bedload transport, and can be configured to trap migrating fine sediments.

- **Current Deflectors, Sediment Traps.** Sediment traps are added to the current deflectors described above to reduce migrating sediments in areas where sediments impinge on the ecosystem. The sediment traps may be pools that are excavated to allow sediments to gather in those areas.

- **Vegetative Bank Stabilization.** The purpose of these TCDs is to introduce a self-maintaining mechanism for improving streambank stability by planting native species adapted to riparian and streambank conditions. Banks are stabilized by root growth and above-ground vegetation that reduces stream energy. The materials used may include seeded ground cover, live cuttings, or rooted plant stock.

- **Bioengineered Revetments.** These TCDs are used to create a durable form of streambank protection that provides riparian and in-stream habitat features. Bioengineered revetments integrate a variety of bank stabilization materials including riprap, large woody debris, and live plantings. Properly designed bioengineered revetments can be used in higher-energy areas where protection of controlled source areas in the floodplain is desired.

- **Floodplain and Riparian Replanting.** Techniques for riparian zone rehabilitation generally include replanting of riparian vegetation where possible, including a diversity of native grasses, shrubs, and trees, and additional structural elements (e.g., nurse logs, snags) to provide additional site stabilization. In some cases site preparation activities including soil removal and replacement, road retirement, and soil amendments may be required. These activities are expected to be conducted in conjunction with excavation and removal of contaminated materials from the floodplain, but will also be used to stabilize areas with high erosion potential as appropriate.

- **Off-Channel Hydrologic Features.** The development of off-channel hydrologic features such as side channels, ponds, and wetlands with hydraulic connectivity to the stream channel can help moderate and stabilize the hydrology of degraded stream systems. These TCDs can be appropriate where local depressions and broad floodplain or riparian areas are present. Off-channel hydrologic features provide a variety of physical functions relevant to remedial design including retention and storage of floodwater during high-flow periods, sediment capture, and reservoirs for maintaining baseflows.

- **Channel Realignment.** These TCDs involve the use of heavy machinery to redirect and reshape stream channels to more naturally stable conditions and to recreate in-channel hydrologic features, particularly increased pool densities and volumes, to the extent possible given existing constraints. Channel stability in this context refers to hydrologic and bedload transport conditions. Channel realignment can be used in areas where large amounts of potentially unstable bedload materials are present that, if not properly addressed, could increase risks to bioengineering structures and other stabilized areas.

As presented in Tables 3 and 4 and Figure 2, the distribution of these seven TCD categories varied across the seven watersheds in the 2001 FS Report and the 2010 Draft Final FFS Report. The following patterns can be observed in Figure 2:

- The distribution of the Current Deflectors and Current Deflectors, Sediment Traps TCDs was essentially the same across all seven watersheds.

- Vegetative Bank Stabilization and Bioengineered Revetments TCDs were proposed for more than 21 and 18 miles of streambank, respectively, and were most abundant in the three watersheds with the longest stream lengths (the Upper SFCDR, Ninemile Creek, and Mainstem SFCDR Watersheds).

- The Floodplain and Riparian Replanting TCD was more common along the lower-gradient Mainstem SFCDR (downstream of River Mile 200) than in the steeper-gradient tributaries (Big Creek, Moon Creek, and Pine Creek).

- Five of the seven TCD categories were proposed for all seven watersheds, but Off-Channel Hydrologic Features were the most abundant in the Mainstem SFCDR Watershed, and Channel Realignments were only included for the Canyon Creek, Ninemile Creek, and Mainstem SFCDR Watersheds.

In general, these patterns of the TCDs by watershed suggested that upper reaches of the Mainstem SFCDR and most of the tributaries would be areas where the existing channel alignment is unchanged by remediation, and the remaining streambanks may be stabilized using the Stream and Riparian Cleanup Action TCDs. The few locations where the valley is wider, such as the Mainstem SFCDR around Osburn and the lower portions of Canyon and Ninemile Creeks, may be the only locations where the Off-Channel Hydrologic Features and Channel Realignment TCDs are appropriate.

4.0 Changes in Stream and Riparian Actions from the Preferred Alternative to the Forthcoming Selected Remedy

Section 4.1 discusses changes to stream and riparian actions from those presented in the Preferred Alternative in the Proposed Plan to those included in the Selected Remedy to be documented in the forthcoming Upper Basin ROD Amendment, resulting from a reduction in the scope of remedial actions included in the Selected Remedy. Section 4.2 discusses stakeholder comments that were made on the stream and riparian actions included for three specific watershed segments in the Preferred Alternative in the Proposed Plan, and how these comments have been addressed.

4.1 Changes to Stream and Riparian Actions Resulting from the Reduction in Scope of Remedial Actions in the Forthcoming Selected Remedy

Following consideration of public and stakeholder comments on the Preferred Alternative in the Proposed Plan and additional analysis and evaluation by EPA, EPA decided to reduce the scope of the remedial actions to be included in the forthcoming ROD Amendment and to select an interim remedy for the Upper Basin. The interim Selected Remedy will primarily focus on remedial actions at the most contaminated sites including those in the Canyon Creek and Ninemile Creek Watersheds and along the mainstem of the SFCDR, including the Bunker Hill Box (Operable Unit [OU] 2).

As part of EPA's evaluation of the Preferred Alternative in the Proposed Plan and the subsequent decision to reduce the scope of the forthcoming Selected Remedy, and in consideration of public and stakeholder comments regarding stream and riparian cleanup actions, those stream and riparian actions that are co-located with retained sediment removal actions were determined to be priority actions for inclusion in the Selected Remedy. These sediment removal actions are primarily designated for riparian areas (along rivers and creeks). Stream and riparian actions will be conducted following remedial actions in order to stabilize rivers and creeks in the remediated locations. Therefore, the forthcoming Selected Remedy will refer to these actions as stream and riparian "stabilization" actions.

Figures 3 through 9 depict the planned remedial actions (highlighting both sediment and non-sediment removal actions) relative to stream and riparian reaches for each watershed in the Upper Basin. The exact locations of stream and riparian stabilization actions will be determined during remedial design and will be co-located with sediment removal actions.

Stream and riparian stabilization actions will primarily coincide with the areas of focus for remedial actions in the forthcoming Selected Remedy: Canyon Creek, Ninemile Creek, and the Mainstem SFCDR. If no remedial actions or only non-sediment removal actions are planned for a reach, stream and riparian stabilization actions will not be included in the Selected Remedy. Table 5 lists the stream and riparian reaches that were included in the Preferred Alternative in the Proposed Plan and indicates whether the reaches will be retained in or excluded from the forthcoming Selected Remedy. The rationale for excluding individual reaches are also included in Table 5, and more details are provided in the summary of changes by watershed that is provided below.

- **No stream and riparian actions in the Upper SFCDR Watershed**. EPA has determined that stream and riparian stabilization actions are not needed in the Upper SFCDR Watershed because the forthcoming Selected Remedy will include only one sediment removal site (WAL038, located between Wallace and Mullan) and relatively few remedial actions in this watershed (see Figure 3). Because of the minimal actions planned and the stable streambanks, discussed in Section 4.2, no stream and riparian stabilization actions will be included for this watershed in the Selected Remedy.
- **All stream and riparian actions retained in the Canyon Creek Watershed.** No changes will be made to the stream and riparian actions in the Canyon Creek Watershed from the Preferred Alternative in the Proposed Plan to the forthcoming Selected Remedy (see Figure 4). Stream and riparian actions in this watershed are being retained because the Selected Remedy will include extensive sediment removal actions throughout Canyon Creek.
- **No stream and riparian actions in reach NM03-1 in the Ninemile Creek Watershed**. The forthcoming Selected Remedy will not identify any remedial actions in reach NM03-1; therefore, no stream and riparian stabilization actions will be needed for this reach. Stream and riparian stabilization actions will be conducted at the remaining reaches in the Ninemile Creek Watershed (see Figure 5).
- **Stream and riparian reaches removed from the Big Creek and Moon Creek Watersheds**. Based on the reduction of scope in the remedial actions included in the forthcoming Selected Remedy, one reach in each of these watersheds (BIG04-2 and MC01-2, respectively) that was previously identified for stream and riparian actions will no longer be included in the Selected Remedy because no remedial actions will be identified for these reaches (see Figures 6 and 7).
- **No stream and riparian actions in SFCDR reaches through Wallace.** The forthcoming Selected Remedy does not include stream and riparian stabilization actions through Wallace. It is not expected that any sediment removal actions will be conducted through this area due to existing infrastructure (a county bridge, culverts, Interstate 90 support columns, and a concrete channel). Therefore, stream and riparian stabilization actions will not be conducted.
- **No stream and riparian actions in the Pine Creek Watershed**. The forthcoming Selected Remedy will not include any stream and riparian stabilization actions for Pine Creek. With EPA's reduction of the scope of the remedial actions to be included in the Selected Remedy, relatively few sediment removal actions are identified in the Pine Creek Watershed (see Figure 8).
- **No stream and riparian actions west of Pinehurst in the Mainstem SFCDR Watershed**. The Preferred Alternative proposed stream and riparian cleanup actions in three reaches to the west of Pinehurst (MG02-10 through -12). The forthcoming Selected Remedy will not include any remedial actions in this area; therefore, stream and riparian stabilization actions west of Pinehurst will not be included in the Selected Remedy (see Figure 9).

Stream and riparian stabilization actions will be conducted at the remaining reaches in the Mainstem SFCDR Watershed east of Kellogg, as indicated in Figure 9.

The Preferred Alternative in the Proposed Plan identified 56 reaches for stream and riparian cleanup actions. Based on the changes described above, the forthcoming Selected Remedy will include 28 reaches for stream and riparian stabilization actions. This will reduce the geographic scope of stream and riparian actions by approximately 21 river miles (see Table 5).

4.2 Stakeholder Input on Stream and Riparian Actions in Three Specific Watershed Segments Along the SFCDR

Of the 119 stream and riparian reaches along the SFCDR and its tributaries, comments provided by stakeholders on the Proposed Plan and during the June 13, 2011, field visit were specific to 12 reaches located within three watershed segments along the SFCDR: the Upper SFCDR Watershed between Mullan and Wallace, the Mainstem SFCDR Watershed through Wallace, and the Mainstem SFCDR Watershed through Kellogg. Stakeholder input and changes made by EPA to the stream and riparian stabilization actions in these areas are summarized in the following sections.

4.2.1 Upper SFCDR Watershed, Segment UpperSFCDRSeg01, Reaches UG01-13 through UG01-19

These seven reaches of the SFCDR between the communities of Mullan and Wallace (see Figure 3) are a total of approximately 5 miles long; moderately steep (0.7 to 3.6 percent); well vegetated along the river corridor; and confined by steep banks, Interstate 90 (I-90), and the Trail of the Coeur d'Alenes. The Draft Final FFS Report proposed six different types of TCDs distributed throughout these seven reaches that were intended to reduce bank erosion and associated releases of contaminants and, where possible and appropriate, to improve aquatic and riparian habitat. Stakeholders commented that because these reaches are more vegetated than many reaches along the SFCDR, they are less subject to bank erosion and may not require the stream and riparian cleanup actions described in the Draft Final FFS Report.

EPA's interpretation of existing conditions in the Upper SFCDR Watershed is consistent with that of the stakeholders: specifically, relatively minimal erosion is likely occurring in the reaches between Mullan and Wallace compared with other reaches of the SFCDR due to abundant rock, riprap, and riparian vegetation. In addition, as discussed in Section 4.1, the forthcoming Selected Remedy will include relatively few sites for remedial action in these reaches compared to the actions included in the Preferred Alternative in the Proposed Plan. Therefore, stream and riparian stabilization actions in the Upper SFCDR Watershed will not be included in the Selected Remedy based on existing site conditions, stakeholder input, and the lack of co-located remedial actions.

4.2.2 Mainstem SFCDR Watershed, Segment MidGradSeg01, Reaches MG01-1 through MG01-3

These three reaches of the SFCDR through the community of Wallace (see Figure 10) are a total of approximately 1.2 miles long; have moderate gradients (0.3 to 1.4 percent); have portions confined by a concrete flood conveyance channel, steep banks, I-90, and the Trail of the Coeur d'Alenes; and include the confluences with Canyon and Ninemile Creeks. The Draft Final FFS Report proposed five different types of TCDs distributed throughout these three reaches that were intended to reduce bank erosion and associated releases of contaminants and, where possible and appropriate, to improve aquatic and riparian habitat. During the June 13, 2011, field visit, stakeholders commented that the proposed TCDs through this area may increase channel roughness and exacerbate flooding conditions. The stakeholders requested that the TCDs be revised and considered as part of a more holistic plan that also addresses flood management, urban development, fish passage, and existing infrastructure (a county bridge, culverts, I-90 support columns, and a concrete flood conveyance channel) associated with the SFCDR and the two tributaries in this area.

Stream and riparian stabilization actions in these reaches through Wallace will not be included in the forthcoming Selected Remedy because sediment removal actions are not planned through this area due to the presence of existing infrastructure. Coordination between EPA and other entities that may address flood management issues within these reaches in the future is described in Section 5.1.

4.2.3 Mainstem SFCDR Watershed, Segment MidGradSeg02, Reaches MG02-2 and MG02-3

These two reaches of the SFCDR through the community of Kellogg (see Figure 10) are located within the Bunker Hill Box (OU 2); are a total of approximately 2 miles long; have low gradients (less than 0.5 percent); are generally trapezoidal in shape with a wide main channel and small floodplain bench, some riprapped banks, and visible contamination in some banks; and include the confluences with Milo Creek and other smaller creeks. The Draft Final FFS Report did not propose any streambank stabilization TCDs for these reaches. During the June 13, 2011, field visit, stakeholders requested that additional OU 2 stream and riparian actions beyond those already conducted for the Phase 1 remedial actions in Smelterville Flats be added to EPA's Preferred Alternative described in the Proposed Plan. The stakeholders requested that these actions address not only contamination but also flood management, urban development, fish passage, and existing infrastructure (a county bridge and culverts) associated with the SFCDR and the tributaries in this area.

Stream and riparian stabilization actions through Kellogg will not be included in the forthcoming Selected Remedy because the EPA does not plan to conduct sediment removal actions in this area at this time. The Phase 1 source control remedial actions completed in OU 2 in 1997 and 1998 (EPA, 2010b) included streambank stabilization measures in the area known as Smelterville Flats (north of I-90 in the vicinity of reaches MG02-6 and MG02-7 in Figure 10). The 2010 Five-Year Review Report (EPA, 2010b), which was prepared in accordance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements, noted that the south banks of the SFCDR through the Smelterville Flats area are in excellent condition, are stable, and are performing adequately to minimize sediments entering the river. Erosion of contaminated sediments through Kellogg and located in the Bunker Hill Box has been partially addressed by actions already taken under the ROD for OU 2 (EPA, 1992), and these actions are inspected and monitored for effectiveness as part of EPA's Five-Year Review process. Under that process, EPA may identify the need for more erosion control actions within OU 2; however, none have been identified at this time. Coordination between EPA and other entities addressing flood management will be necessary prior to implementing further CERCLA remedial actions at these river reaches (see Section 5.1).

5.0 Clarification of Remedial Design Process

EPA received significant public and stakeholder comments on the Proposed Plan requesting clarification of the remedial design process, including the design of stream and riparian actions and how EPA coordinates with other entities on flood management projects. Section 5.1 discusses how EPA will coordinate with other entities for projects where flood management is an issue along the SFCDR and its tributaries. Section 5.2 clarifies the process of moving from an FS-level conceptual approach to final design for stream and riparian stabilization actions.

5.1 Coordination with Other Entities on Flood Management Projects

The forthcoming Upper Basin ROD Amendment will clarify the circumstances under which EPA can and will conduct stream and riparian stabilization actions. Under CERCLA, EPA can only address contamination issues that are associated with unacceptable risks. In the case of stream and riparian stabilization actions, CERCLA actions can address situations where EPA has determined that sources of substantial contaminated material are actively eroding a river system, through removal of this contaminated material to the extent feasible and then stabilization of the streambank to minimize further erosion.

Mitigating flooding issues in the absence of contamination is not within EPA's CERCLA authority. However, EPA is committed to coordinating and collaborating with other entities that have jurisdictional authority to address flooding issues. During implementation of the Selected Remedy, EPA will coordinate with local communities and flood control authorities, the BEIPC, the U.S Army Corps of Engineers (USACE), and the Federal Emergency Management Agency during the site characterization and design phases of the remedial actions identified in the forthcoming Upper Basin ROD Amendment to ensure that cleanup actions do not exacerbate flooding concerns along the SFCDR and its tributaries. Where planning and logistical work sequencing allow, EPA will work collaboratively with other entities performing flood control projects to coordinate the implementation of cleanup projects in a manner that provides joint benefits. As an example, if a stream and riparian reach is not a current source of contamination to the river system and modifications to the reach are planned by others for flood control purposes, and if contamination is encountered or generated as part of a flood improvement project, EPA will provide an Institutional Controls Program repository for contaminated materials.

5.2 From Conceptual TCDs to Final Design

As described above, the current stream and riparian reach locations and assigned TCDs (in the 2001 FS Report and the 2010 Draft Final FFS Report) were based on general assumptions and best professional judgment in place of site-specific information. Detailed field investigations; hydrologic, hydraulic, geomorphic, and geotechnical analyses; use of LiDAR collected in 2009; and other design-related issues will be considered in the subsequent design phase of a remedial action. Progressing from an FS-level conceptual action to a site-specific remedial design is expected to result in modifications to both the specific action location(s) and the TCD approach(es). One benefit of the overall TCD approach is that as the design progresses, a TCD can be modified, removed, and/or replaced with another TCD as a result of new data, stakeholder input, or other emergent considerations.

In 2002, USACE and three agencies in the State of Washington (Departments of Fish and Wildlife, Transportation, and Ecology) published the first in a series of aquatic habitat guidelines titled the *Integrated Streambank Protection Guidelines* [ISPG] *2003* (Washington State Aquatic Habitat Guidelines Program, 2002). The ISPG were prepared by recognized stream restoration experts with input from many agencies, and include detailed recommendations for streambank stabilization and protection methods. The TCDs included in the Draft Final FFS Report and to be included in the forthcoming Selected Remedy are conceptual designs that will be optimized during site-specific design using the ISPG or local examples of successful streambank stabilization in the Coeur d'Alene Basin.[1]

As described in the Draft Final FFS Report, insufficient information exists with which to characterize the specific sources of metals contamination affecting the streams and floodplains in some areas of the Upper Basin. Prior to implementing remedial actions, numerous pre-design and design activities will take place at a site-specific level. Depending on the site, some or all of the following activities may be included in the design process:

- Compilation and evaluation of existing site data
- Site investigation(s), including determination of the nature and extent of contamination and waste characterization
- Surveying and mapping of the site
- Evaluation of waste consolidation and material reuse opportunities
- Assessment and modeling of stormwater, surface water, and groundwater flows
- Assessment of site ownership
- Identification of easement and access requirements
- Assessment of cultural resources, as appropriate
- Review of the Endangered Species Act for potential site restrictions
- Determination of site access needs (e.g., road improvements)
- Coordinate with Natural Resource Damage Assessment (NRDA) Trustees to ensure that stream and riparian stabilization actions complement further restoration activities.

Following pre-design work, sufficient information will be available to begin site-specific remedial design. In most cases, changes from the TCDs specified in the forthcoming Upper Basin ROD Amendment to the site-specific remedial designs are anticipated to be minimal and largely related to quantities (e.g., the volume of soil requiring excavation) rather than remedial technologies. However, some significant decisions may need to be made after the ROD Amendment is issued. EPA will determine whether these warrant separate decision documentation, such as another ROD Amendment or an Explanation of Significant

[1] Many of the streambank stabilization and protection methods in the ISPG are applicable to conditions in Idaho as well as to those in Washington and, where appropriate, will be consulted during site-specific design because no corresponding guidelines are currently available for the state of Idaho.

Differences. As the overall process moves ahead, opportunities for public involvement will continue to be available via input on implementation plans, site-specific remedial design documents, and potential future decision documents.

6.0 References

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Tables

TABLE 1

Characteristics of Upper Basin Watersheds and Subwatersheds

Updates to Stream and Riparian Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

Watershed	Code	Drainage Area (square miles)	Length (miles)	Number of Reaches	Average Gradient (percent)
Upper SFCDR	UG	51	15.3	19	2%
Canyon Creek	CC	22	12.4	7	5%
Ninemile Creek	NM	12	4.9	5	4%
East Fork Ninemile Creek	NM	6	4.4	2	10%
Big Creek	BIG	30	10.2	10	5%
East Fork Big Creek	BIG	8	4.6	2	12%
West Fork Big Creek	BIG	6	3.3	2	15%
Moon Creek	MC	9	4.1	4	6%
West Fork Moon Creek	MC	4	3.2	2	10%
Pine Creek	PC	80	10.9	13	1%
West Fork Pine Creek	PC	40	5.5	4	8%
East Fork Pine Creek	PC	31	6.8	12	5%
Mainstem SFCDR	MG	59	19.8	37	1%

Note:

SFCDR = South Fork of the Coeur d’Alene River

TABLE 2

Characteristics of Stream and Riparian Reaches in Upper Basin Watersheds and Subwatersheds

Updates to Stream and Riparian Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

Watershed	Reach	Length		Average Gradient
		(feet)	(miles)	(percent)
Upper South Fork Coeur d'Alene River	UG01-1	13278	2.5	12.9%
	UG01-2	11957	2.3	3.1%
	UG01-3	2291	0.4	1.8%
	UG01-4	514	0.1	2.5%
	UG01-5	3116	0.6	2.2%
	UG01-6	3041	0.6	0.7%
	UG01-7	2613	0.5	2.9%
	UG01-8	815	0.2	0.3%
	UG01-9	3965	0.8	1.7%
	UG01-10	3076	0.6	1.7%
	UG01-11	935	0.2	0.3%
	UG01-12	8872	1.7	1.6%
	UG01-13	4868	0.9	1.2%
	UG01-14	943	0.2	2.7%
	UG01-15	3389	0.6	0.7%
	UG01-16	3002	0.6	1.9%
	UG01-17	7397	1.4	1.2%
	UG01-18	6182	1.2	1.3%
	UG01-19	719	0.1	3.6%
Canyon Creek	CC01-1	1088	0.2	1.1%
	CC01-2	6970	1.3	11.1%
	CC01-3	13610	2.6	7.8%
	CC02-1	6634	1.3	3.8%
	CC04-1	20053	3.8	3.3%
	CC05-1	2321	0.4	2.3%
	CC05-2	14553	2.8	2.3%
Ninemile Creek	NM03-1	9264	1.8	6.1%
	NM04-1	422	0.1	5.7%
	NM04-2	3715	0.7	3.2%
	NM04-3	1434	0.3	2.5%
	NM04-4	11102	2.1	2.4%
East Fork Ninemile Creek	NM01-1	8021	1.5	12.4%
	NM02-1	15106	2.9	7.1%
Big Creek	BIG02-1	5102	1.0	21.2%
	BIG02-2	3956	0.7	11.9%
	BIG02-3	3621	0.7	4.6%
	BIG02-4	3075	0.6	2.3%
	BIG02-5	713	0.1	0.8%
	BIG02-6	3985	0.8	2.8%
	BIG02-7	5943	1.1	3.6%
	BIG04-1	9988	1.9	2.8%

TABLE 2

Characteristics of Stream and Riparian Reaches in Upper Basin Watersheds and Subwatersheds

Updates to Stream and Riparian Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

Watershed	**Reach**	**Length**		**Average Gradient**
		(feet)	**(miles)**	**(percent)**
	BIG04-2	3816	0.7	1.9%
	BIG04-3	13419	2.5	1.7%
East Fork Big Creek	BIG01-1	8734	1.7	17.8%
	BIG01-2	15476	2.9	7.0%
West Fork Big Creek	BIG03-1	9390	1.8	22.6%
	BIG03-2	8279	1.6	7.9%
Moon Creek	MC02-1	6672	1.3	16.3%
	MC02-2	5587	1.1	3.1%
	MC02-3	2898	0.5	2.5%
	MC02-4	6384	1.2	1.8%
West Fork Moon Creek	MC01-1	7651	1.4	15.5%
	MC01-2	9395	1.8	4.6%
Pine Creek	PC02-5	1528	0.3	2.4%
	PC02-6	11845	2.2	1.8%
	PC02-7	2221	0.4	2.0%
	PC02-8	3229	0.6	1.4%
	PC02-9	3463	0.7	0.9%
	PC02-10	1273	0.2	2.5%
	PC02-11A	2357	0.4	1.3%
	PC02-11B	1726	0.3	0.2%
	PC02-12	4518	0.9	1.0%
	PC03-1	4064	0.8	1.0%
	PC03-2	2199	0.4	0.1%
	PC03-3	19688	3.7	0.8%
	PC03-4	2048	0.4	0.2%
West Fork Pine Creek	PC02-1	7769	1.5	16.5%
	PC02-2	12676	2.4	5.3%
	PC02-3	1346	0.3	5.8%
	PC02-4	7457	1.4	3.5%
East Fork Pine Creek	PC01-1	5327	1.0	15.0%
	PC01-2	2630	0.5	11.7%
	PC01-3	2738	0.5	6.4%
	PC01-4	4055	0.8	3.9%
	PC01-5	2491	0.5	2.4%
	PC01-6	941	0.2	3.3%
	PC01-7	2558	0.5	1.5%
	PC01-8	3315	0.6	2.3%
	PC01-9	3291	0.6	1.2%
	PC01-10	759	0.1	1.3%
	PC01-11	974	0.2	3.8%
	PC01-12	6846	1.3	1.4%
Mainstem South Fork Coeur d'Alene River	MG01-1	3015	0.6	1.4%

TABLE 2

Characteristics of Stream and Riparian Reaches in Upper Basin Watersheds and Subwatersheds

Updates to Stream and Riparian Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

Watershed	Reach	Length		Average Gradient
		(feet)	(miles)	(percent)
	MG01-2	1635	0.3	0.3%
	MG01-3	1935	0.4	0.6%
	MG01-4	5778	1.1	0.9%
	MG01-5	1311	0.2	0.8%
	MG01-6	7595	1.4	0.8%
	MG01-7	2099	0.4	2.2%
	MG01-8	4694	0.9	0.6%
	MG01-9	1115	0.2	1.0%
	MG01-10	1026	0.2	0.3%
	MG01-11	1610	0.3	1.1%
	MG01-12	3042	0.6	0.5%
	MG01-13	4529	0.9	0.8%
	MG01-14	1515	0.3	0.3%
	MG01-15	3864	0.7	0.8%
	MG01-16	2143	0.4	1.0%
	MG01-17	5480	1.0	0.4%
	MG01-18	2731	0.5	0.6%
	MG02-1	4455	0.8	0.5%
	MG02-2	7747	1.5	0.5%
	MG02-3	2990	0.6	0.0%
	MG02-3A	645	0.1	0.2%
	MG02-3B	2463	0.5	0.1%
	MG02-3C	1629	0.3	0.0%
	MG02-3D	1727	0.3	0.2%
	MG02-3E	1847	0.3	0.3%
	MG02-4	187	0.0	5.9%
	MG02-5	3180	0.6	0.9%
	MG02-6	1346	0.3	0.7%
	MG02-7	12605	2.4	0.4%
	MG02-8A	826	0.2	0.5%
	MG02-8B	471	0.1	0.0%
	MG02-8C	267	0.1	1.5%
	MG02-9	9267	1.8	0.2%
	MG02-10	1235	0.2	0.2%
	MG02-11	1092	0.2	0.1%
	MG02-12	154	0.0	0.0%

TABLE 3

Watershed Reaches Affected by Stream and Riparian Cleanup Action TCDs

Updates to Stream and Riparian Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

		Number of Watershed Reaches Affected[2]							
TCD ID	**TCD Category[1]**	**UG**	**CC**	**NM**	**BIG**	**MC**	**PC**	**MG**	**Upper Basin Total[2]**
CD-AVG	Current Deflectors	15	4	6	2	4	3	21	55
CD-SED	Current Deflectors, Sediment Traps	15	4	6	2	4	3	20	54
VBS-AVG	Vegetative Bank Stabilization	16	4	6	2	4	3	19	54
BSBR-AVG	Bioengineered Revetments	16	4	5	2	4	3	21	55
FP/RP-AVG	Floodplain and Riparian Replanting	13	4	6	1	4	3	19	50
OFFCH-AVG	Off-Channel Hydrologic Features	3		3	1		2	10	19
CH REAL-1	Channel Realignment		1	3				6	10

Notes:

[1] The TCD categories below are those used in the 2001 Feasibility Study (FS) Report (U.S. Environmental Protection Agency, 2001) and the 2010 Draft Final Focused Feasibility Study (FFS) Report (CH2M HILL, 2010).

[2] Watershed reaches affected are based on the 2001 FS Report and the 2010 Draft Final FFS Report.

BIG = Big Creek Watershed

CC = Canyon Creek Watershed

MC – Moon Creek Watershed

MG = (Mid-Grade Segment) Mainstem SFCDR Watershed

NM = Ninemile Creek Watershed

PC = Pine Creek Watershed

TCD = typical conceptual design

UG = (Upper-Grade Segment) Upper SFCDR Watershed

SFCDR = South Fork of the Coeur d’Alene River

TABLE 4

Estimated Quantities Affected by Stream and Riparian Cleanup Action TCDs, by Watershed

Updates to Stream and Riparian Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

			Watershed Quantities[2]							
TCD ID	**TCD Category[1]**	**UOM**	**UG**	**CC**	**NM**	**BIG**	**MC**	**PC**	**MG**	**Upper Basin Total[2]**
CD-AVG	Current Deflectors	EA	477	310	272	137	145	65	281	1,687
CD-SED	Current Deflectors, Sediment Traps	EA	53	35	30	16	17	8	35	194
VBS-AVG	Vegetative Bank Stabilization	LF	29,600	21,100	23,220	5,800	4,770	4,600	24,858	113,948
BSBR-AVG	Bioengineered Revetments	LF	24,231	12,670	20,020	5,800	4,480	4,600	26,452	98,253
FP/RP-AVG	Floodplain and Riparian Replanting	AC	67	71	46	7	17	16	102	326
OFFCH-AVG	Off-Channel Hydrologic Features	AC	4		1	4		8	76	93
CH REAL-1	Channel Realignment	AC		19	23				28	70

Notes:

[1] The TCD categories below are those used in the 2001 Feasibility Study (FS) Report (U.S. Environmental Protection Agency, 2001) and the 2010 Draft Final Focused Feasibility Study (FFS) Report (CH2M HILL, 2010).

[2] Watershed quantities are based on the 2001 FS Report and the 2010 Draft Final FFS Report.

BIG = Big Creek Watershed

CC = Canyon Creek Watershed

MC = Moon Creek Watershed

MG = (Mid-Grade Segment) Mainstem SFCDR Watershed

NM = Ninemile Creek Watershed

PC = Pine Creek Watershed

UG = (Upper-Grade Segment) Upper SFCDR Watershed

AC = acres

EA = each

LF = lineal feet

TCD = typical conceptual design

UOM = units of measure

TABLE 5

Summary of Differences in Stream and Riparian Actions Between the Preferred Alternative in the Proposed Plan and the Forthcoming Selected Remedy

Updates to Stream and Riparian Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

Watershed	Segment ID	Stream and Riparian Reach Included in Preferred Alternative	Reach Length (feet)	Reach Length (miles)	Notes
Included in Forthcoming Selected Remedy (a)					
Big Creek	BigCrkSeg04	BIG04-3	13,419	2.5	No change from Proposed Plan.
Canyon Creek	CCSeg02	CC02-1	6,634	1.3	No change from Proposed Plan.
	CCSeg04	CC04-1	20,053	3.8	No change from Proposed Plan.
	CCSeg05	CC05-1	2,321	0.4	No change from Proposed Plan.
		CC05-2	14,553	2.8	
Moon Creek	MoonCrkSeg02	MC02-2	5,587	1.1	No change from Proposed Plan.
		MC02-3	2,898	0.5	
		MC02-4	6,384	1.2	
Mainstem SFCDR	MIDGradSeg01	MG01-4	5,778	1.1	No change from Proposed Plan.
		MG01-5	1,311	0.2	
		MG01-6	7,595	1.4	
		MG01-7	2,099	0.4	
		MG01-8	4,694	0.9	
		MG01-9	1,115	0.2	
		MG01-10	1,026	0.2	
		MG01-11	1,610	0.3	
		MG01-12	3,042	0.6	
		MG01-13	4,529	0.9	
		MG01-14	1,515	0.3	
		MG01-15	3,864	0.7	
		MG01-16	2,143	0.4	
		MG01-17	5,480	1.0	
		MG01-18	2,731	0.5	
Ninemile Creek	NMSeg01	NM01-1	8,021	1.5	No change from Proposed Plan.
	NMSeg02	NM02-1	15,106	2.9	No change from Proposed Plan.
	NMSeg04	NM04-1	422	0.1	No change from Proposed Plan.
		NM04-2	3,715	0.7	
		NM04-3	1,434	0.3	
		Total Length	**149,079**	**28.2**	
Excluded from Forthcoming Selected Remedy					
Big Creek	BigCrkSeg04	BIG04-2	3,816	0.7	No remedial actions to be included in forthcoming Selected Remedy.
Moon Creek	MoonCrkSeg01	MC01-2	9,395	1.8	No remedial actions to be included in forthcoming Selected Remedy.
Mainstem SFCDR	MIDGradSeg01	MG01-1	3,015	0.6	No sediment removal actions will occur in these reaches because of existing infrastructure.
	MIDGradSeg01	MG01-2	1,635	0.3	
	MIDGradSeg01	MG01-3	1,935	0.4	
	MIDGradSeg02	MG02-10	1,235	0.2	No remedial actions to be included in forthcoming Selected Remedy.
	MIDGradSeg02	MG02-11	1,092	0.2	
	MIDGradSeg02	MG02-12	154	0.0	
Ninemile Creek	NMSeg03	NM03-1	9,264	1.8	No remedial actions to be included in forthcoming Selected Remedy.
Pine Creek	PineCrkSeg03	PC03-1	4,064	0.8	No sediment removal actions to be included in forthcoming Selected Remedy.
	PineCrkSeg03	PC03-2	2,199	0.4	
	PineCrkSeg03	PC03-3	19,688	3.7	

TABLE 5

Summary of Differences in Stream and Riparian Actions Between the Preferred Alternative in the Proposed Plan and the Forthcoming Selected Remedy

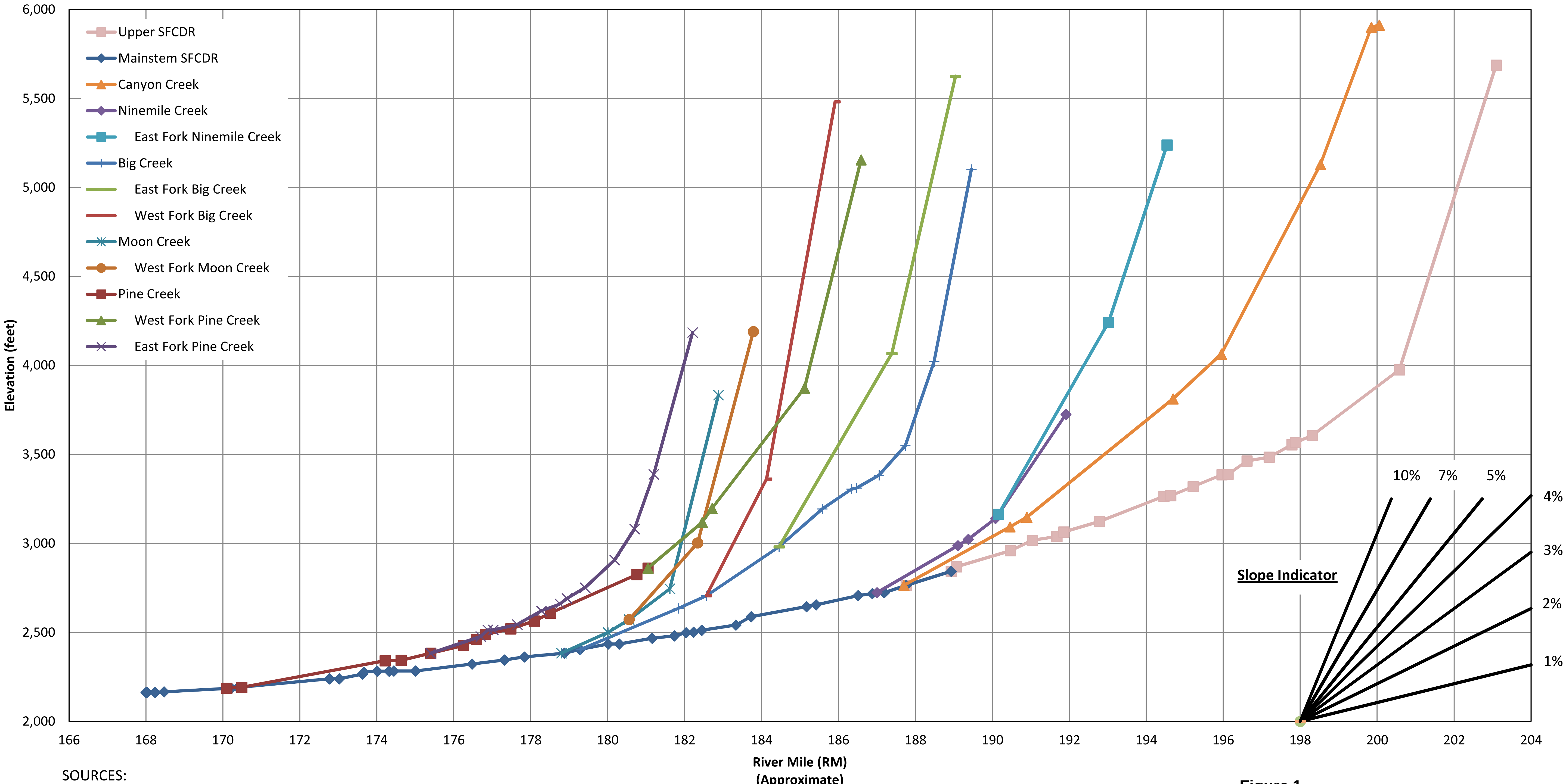
Updates to Stream and Riparian Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

Watershed	Segment ID	Stream and Riparian Reach Included in Preferred Alternative	Reach Length (feet)	Reach Length (miles)	Notes
Upper SFCDR	UpperSFCDRSeg01	UG01-4	514	0.1	No remedial actions to be included in forthcoming Selected Remedy.
		UG01-5	3,116	0.6	
		UG01-6	3,041	0.6	
		UG01-7	2,613	0.5	
		UG01-8	815	0.2	
		UG01-9	3,965	0.8	Limited remedial actions and sediment removal actions to be included in forthcoming Selected Remedy.
		UG01-10	3,076	0.6	No remedial actions to be included in forthcoming Selected Remedy.
		UG01-11	935	0.2	
		UG01-12	8,872	1.7	Limited remedial actions and sediment removal actions to be included in forthcoming Selected Remedy.
		UG01-13	4,868	0.9	
		UG01-14	943	0.2	
		UG01-15	3,389	0.6	
		UG01-16	3,002	0.6	
		UG01-17	7,397	1.4	
		UG01-18	6,182	1.2	
		UG01-19	719	0.1	
		Total Length	**110,939**	**21.0**	

Note:

(a) Stream and riparian stabilization actions will occur in isolated locations within the reaches identified.

Figures

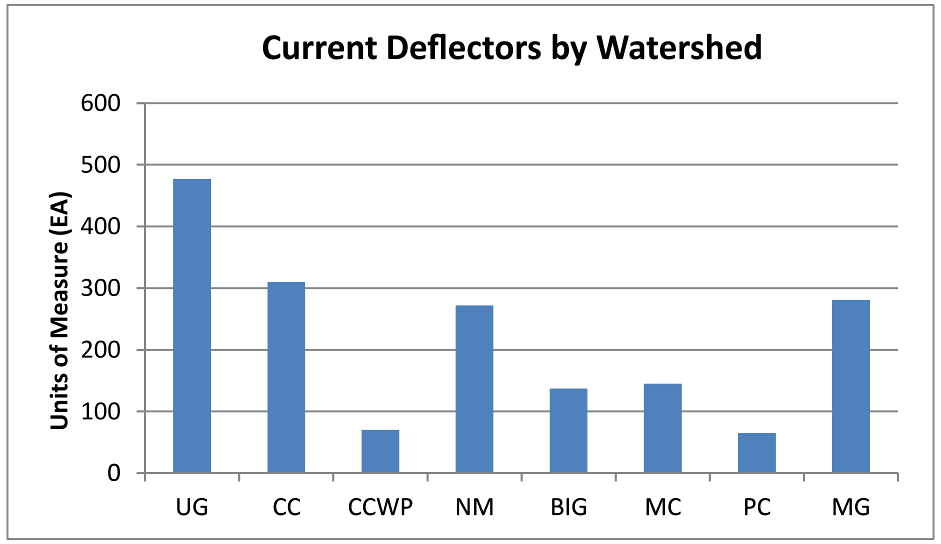


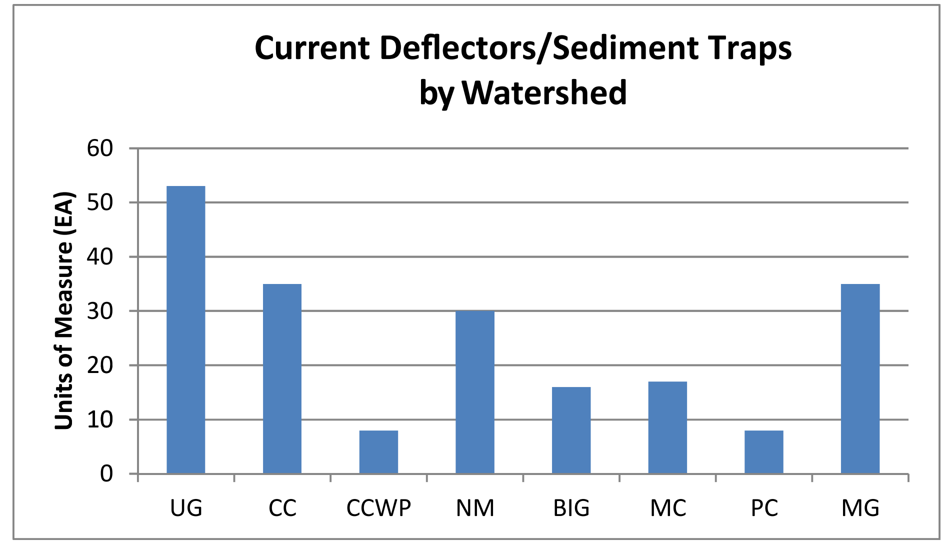
SOURCES:
Elevations:USGS 10-meter digital elevation model (DEM) obtained via download September 1, 2010); reach segments: EPA, 2001.

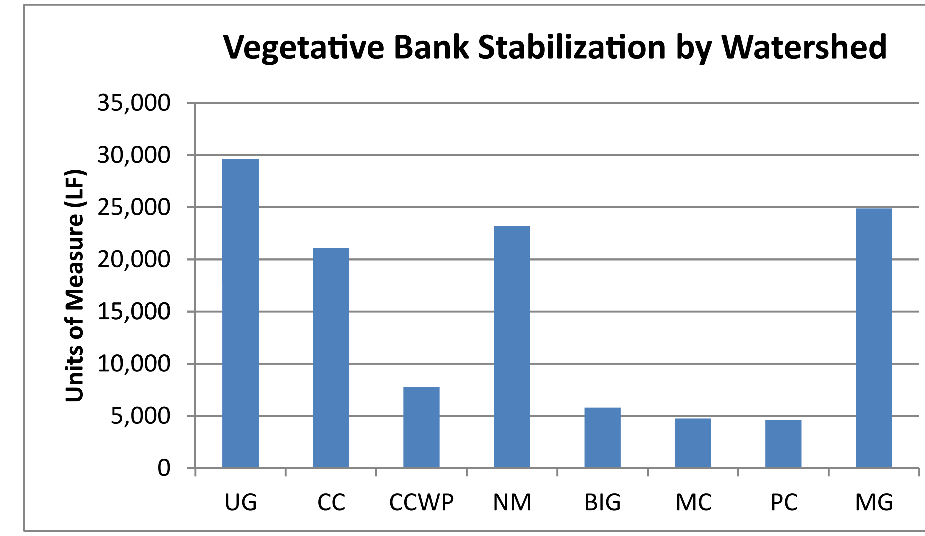
EPA = U.S. Environmental Protection Agency
SFCDR = South Fork of the Coeur d'Alene River
USGS = U.S. Geological Survey

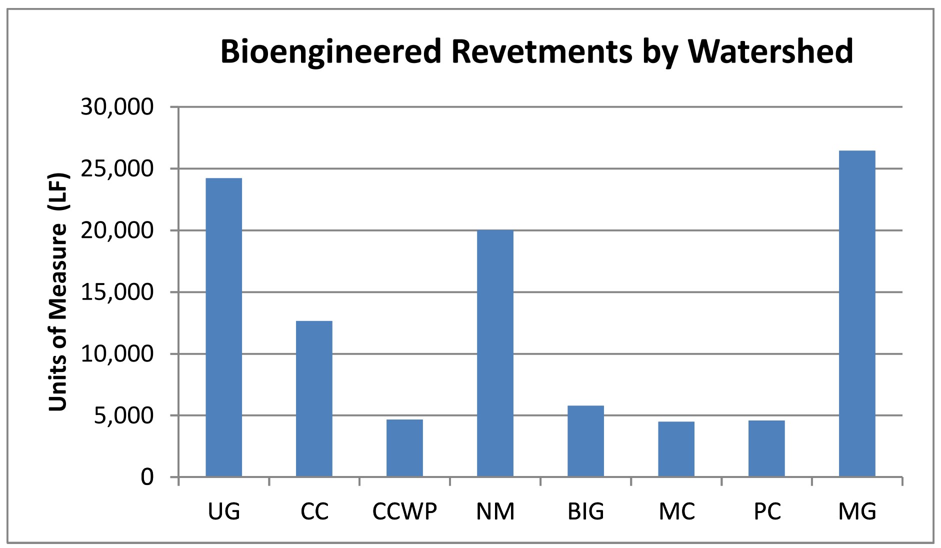
Figure 1
Longitudinal Profiles of Stream and Riparian Reaches, Upper Basin Watersheds and Subwatersheds
Updates to Stream and Riparian Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

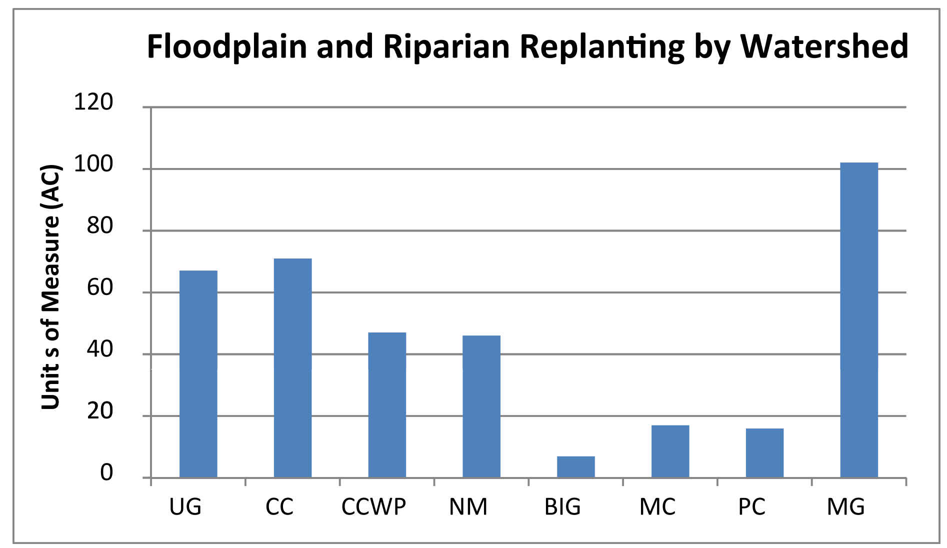
EPA

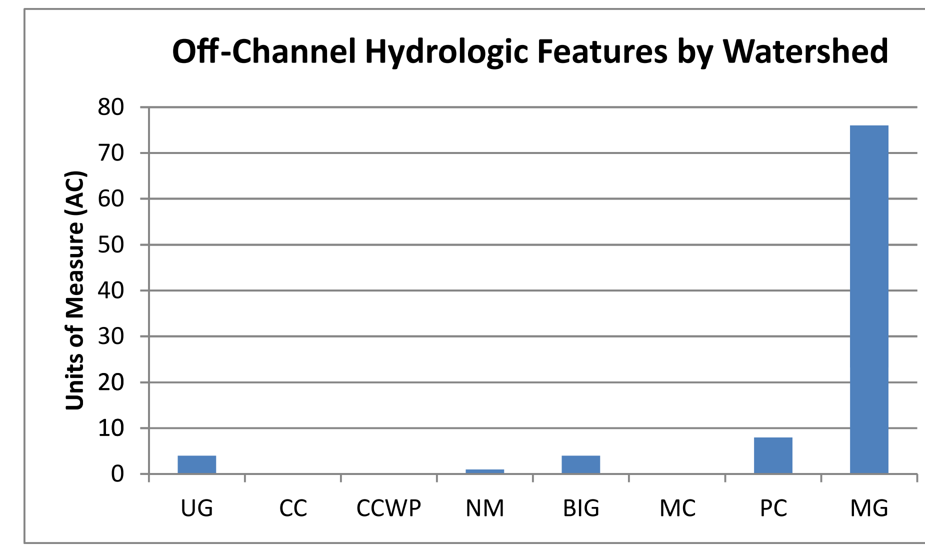


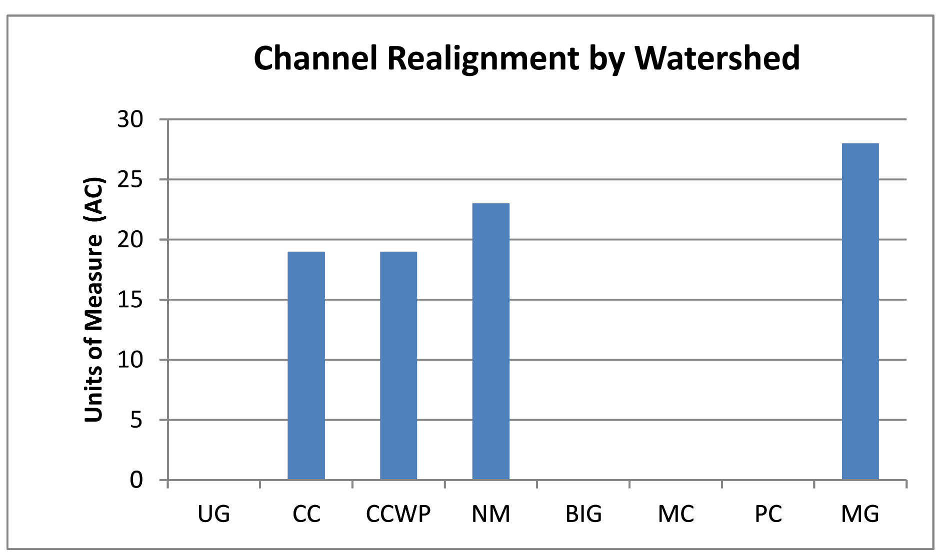










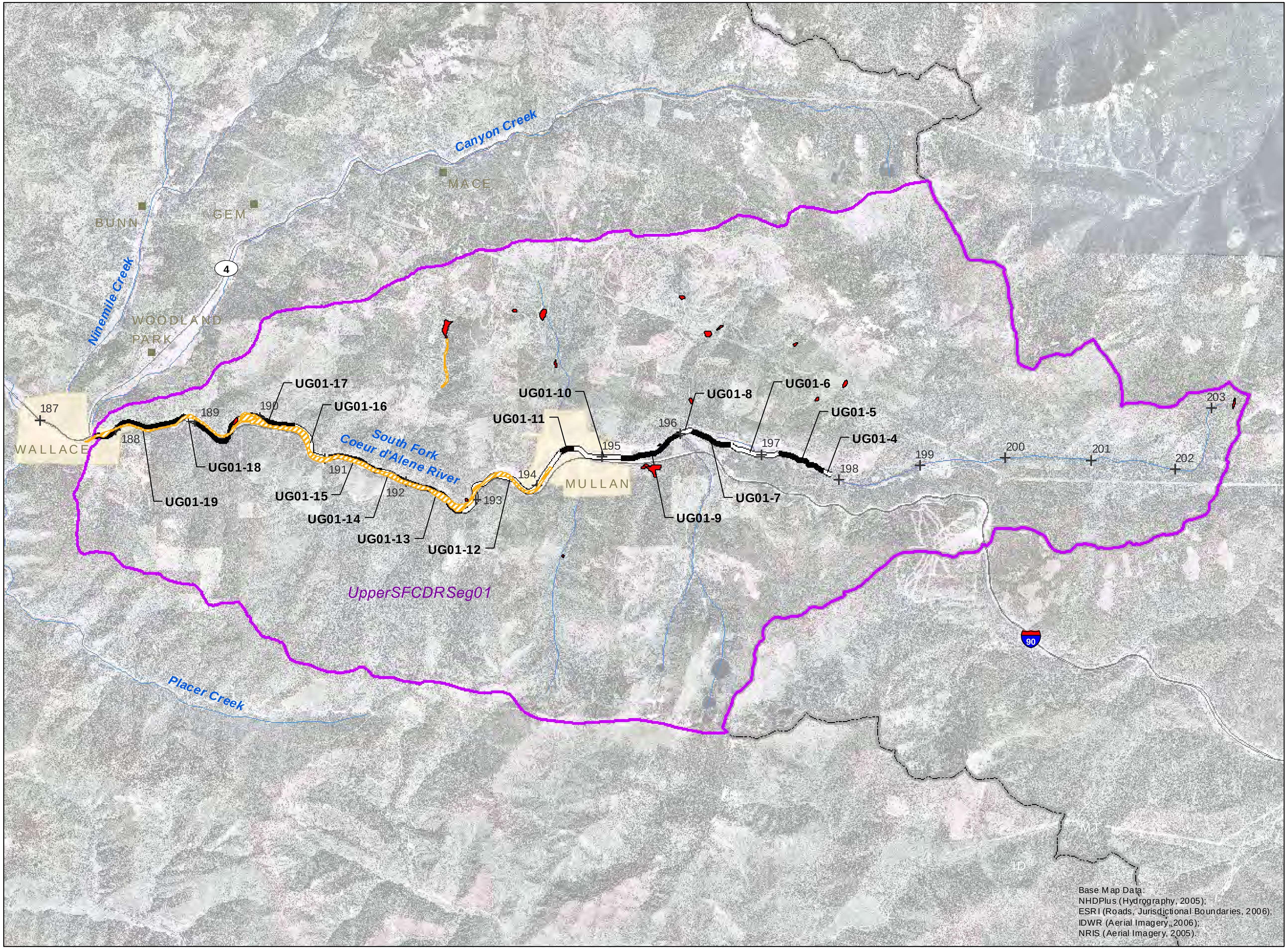


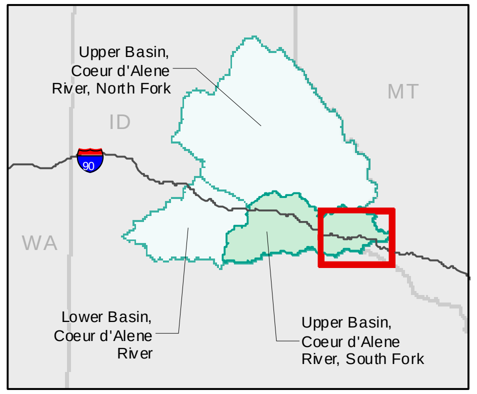
BIG = Big Creek Watershed
CC = Canyon Creek Watershed
CCWP = Canyon Creek Woodland Park
MC – Moon Creek Watershed
MG = (Mid-Grade Segment) Mainstem SFCDR Watershed
NM = Ninemile Creek Watershed
PC = Pine Creek Watershed
UG = (Upper-Grade Segment) Upper SFCDR Watershed

AC = acres
EA = each
LF = lineal feet
SFCDR = South Fork of the Coeur d'Alene River

Figure 2
Allocation of TCD Categories by Watershed, Generally Upstream to Downstream
Updates to Stream and Riparian Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

EPA





Site with Remedial Action (non-sediment removal) Included in Forthcoming Selected Remedy

Site with **Sediment Removal** Remedial Action Included in Forthcoming Selected Remedy[1]

203 River Mile

River/Creek

UG01-4 Stream and Riparian Reach Included in Alternative 3+

Watershed Segment

City Limit

State Boundary

N

0 0.5 1 2 Miles

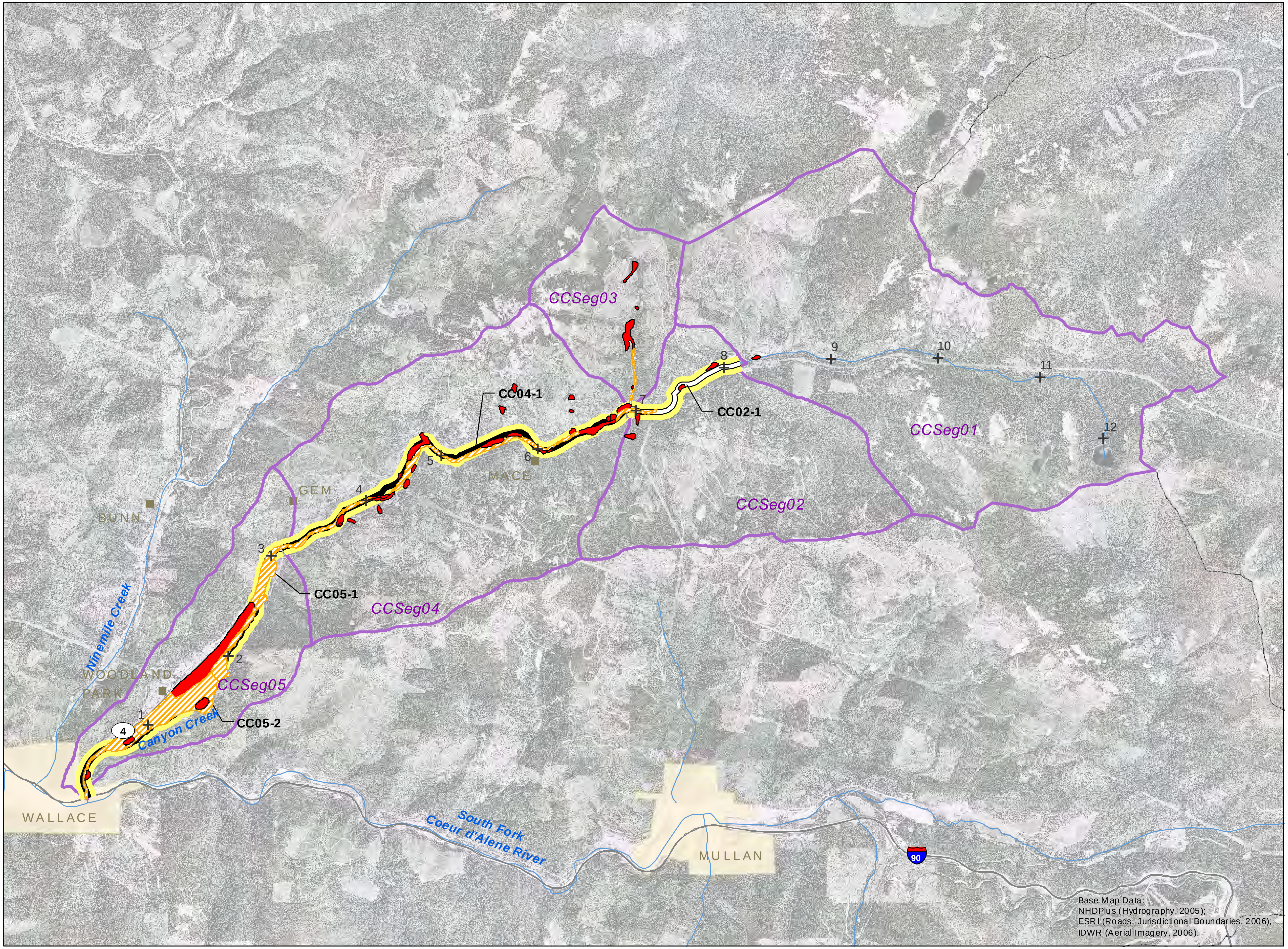
Notes:

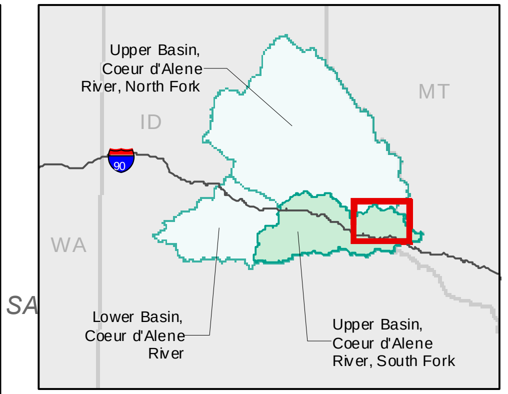
No stream and riparian stabilization actions for the Upper SFCDR Watershed will be included in the Forthcoming Selected Remedy.

[1] Sediment removal actions will occur in isolated locations within the site identified.

Figure 3
Stream and Riparian Stabilization Actions, Upper SFCDR Watershed
Updates to Stream and Riparian Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

EPA





Site with Remedial Action (non-sediment removal) Included in Forthcoming Selected Remedy

Site with **Sediment Removal** Remedial Action Included in Forthcoming Selected Remedy[1]

River Mile

River/Creek

CC05-2 Stream and Riparian Reach Included in Alternative 3+ and Forthcoming Selected Remedy

City Limit

Watershed Segment

State Boundary

N

0 0.25 0.5 1 Miles

Note:

[1] Sediment removal actions and associated stream and riparian stabilization actions will occur in isolated locations within the site identified.

Figure 4
Stream and Riparian Stabilization Actions, Canyon Creek Watershed
Updates to Stream and Riparian Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

EPA

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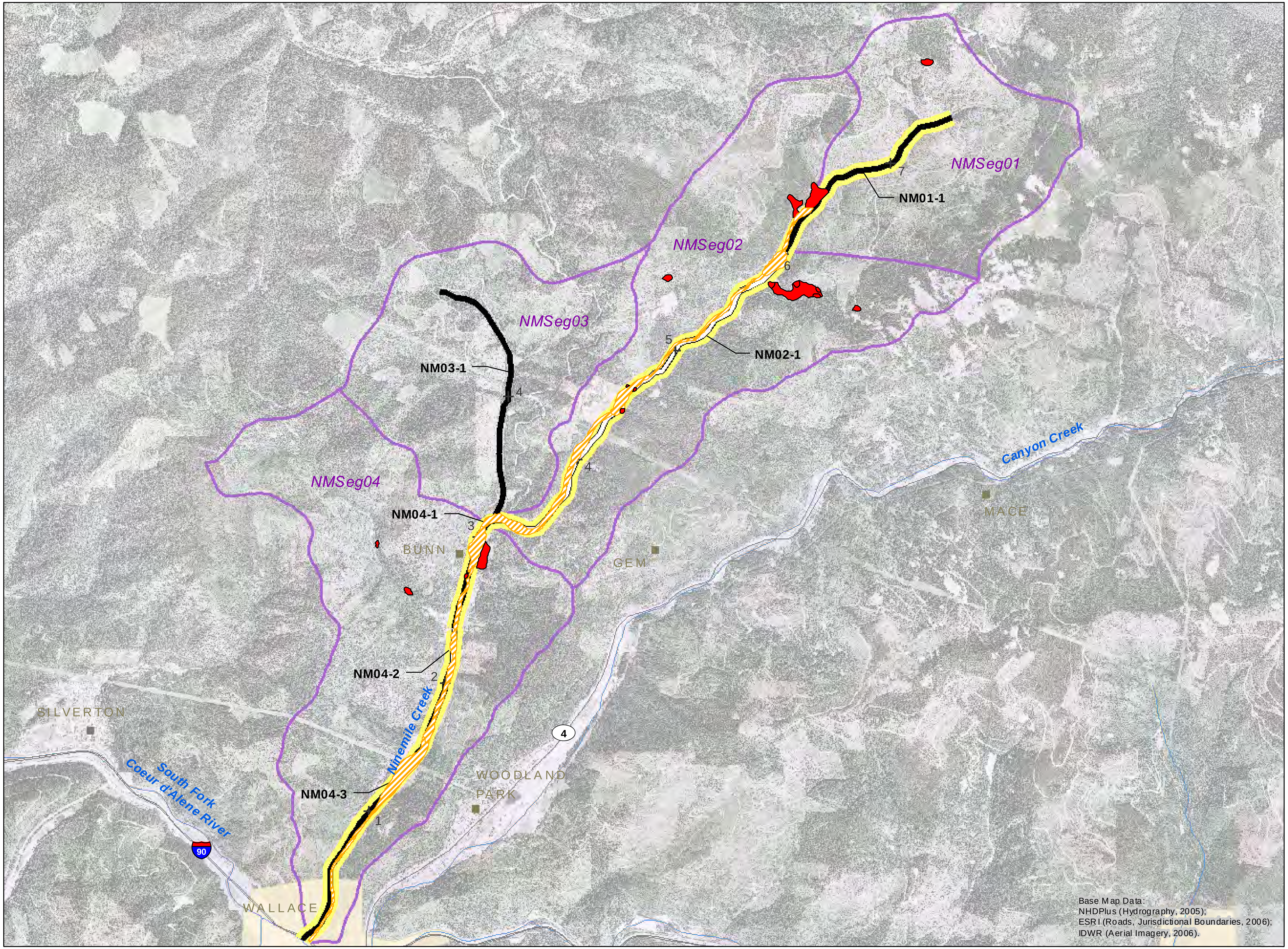
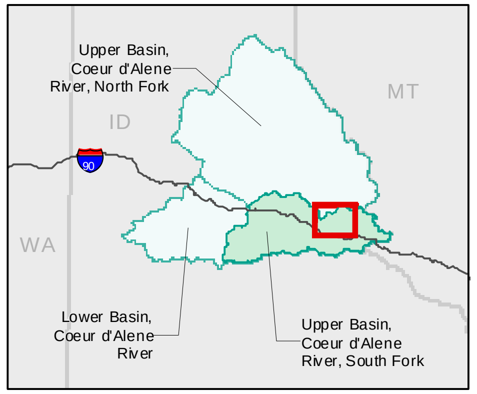




Site with Remedial Action (non-sediment removal) Included in Forthcoming Selected Remedy

Site with **Sediment Removal** Remedial Action Included in Forthcoming Selected Remedy[1]

4 River Mile

River/Creek

NM03-1 Stream and Riparian Reach Included in Alternative 3+

NM04-2 Stream and Riparian Reach Included in Forthcoming Selected Remedy

Watershed Segment

City Limit

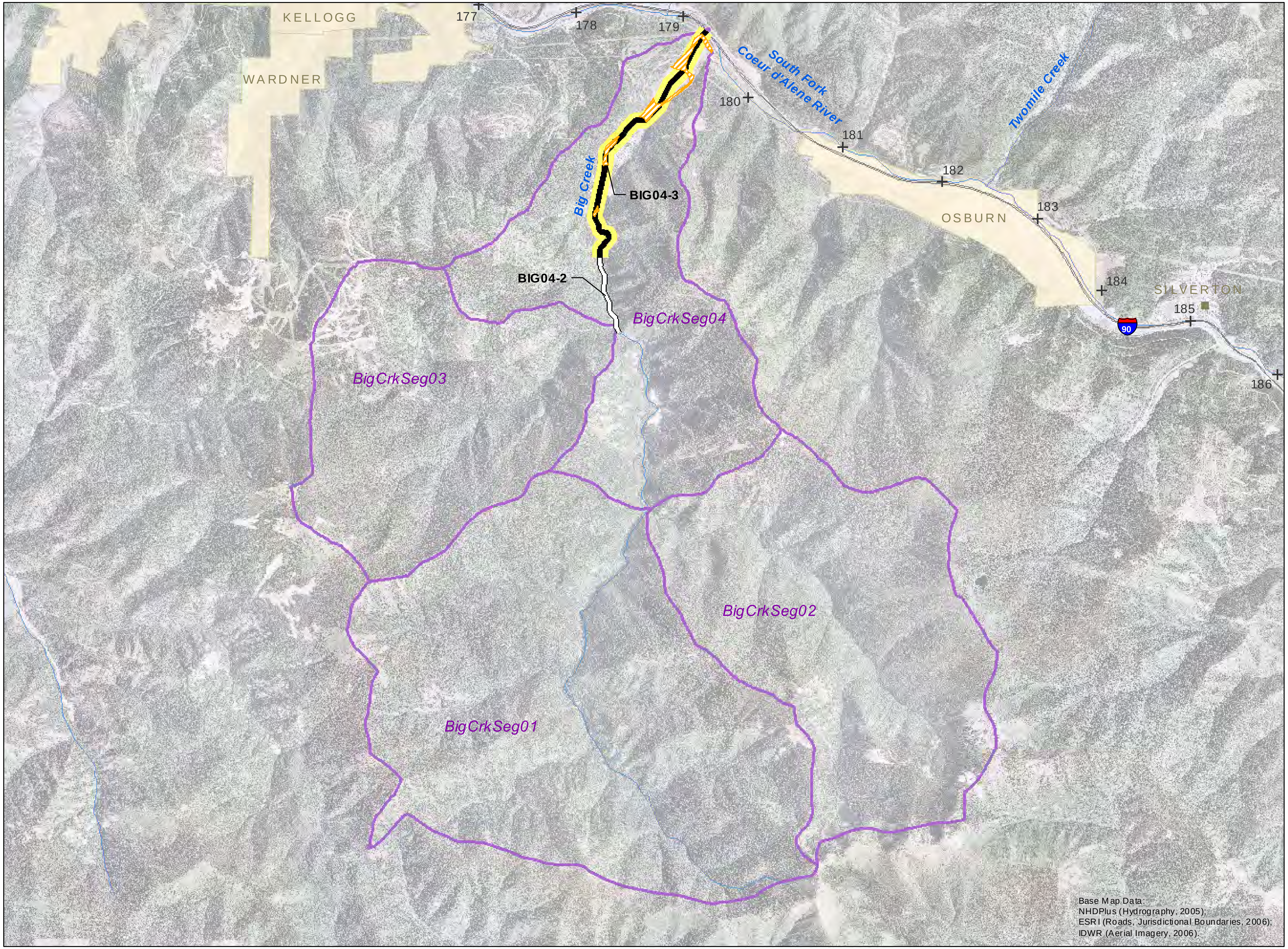
N

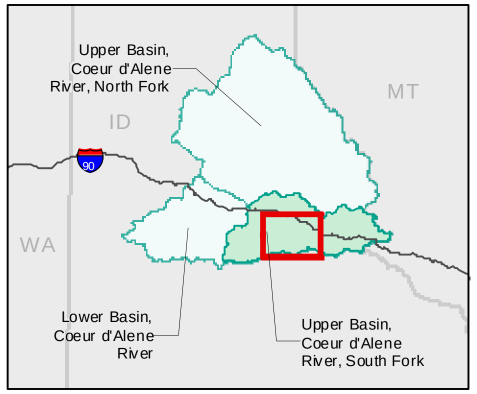
0 0.25 0.5 1 Miles

Note:

[1] Sediment removal actions and associated stream and riparian stabilization actions will occur in isolated locations within the site identified.

Figure 5
Stream and Riparian Stabilization Actions, Ninemile Creek Watershed
Updates to Stream and Riparian Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site





Site with Remedial Action (non-sediment removal) Included in Forthcoming Selected Remedy

Site with **Sediment Removal** Remedial Action Included in Forthcoming Selected Remedy[1]

180 River Mile

River/Creek

BIG04-2 Stream and Riparian Reach Included in Alternative 3+

BIG04-3 Stream and Riparian Reach Included in Forthcoming Selected Remedy

Watershed Segment

City Limit

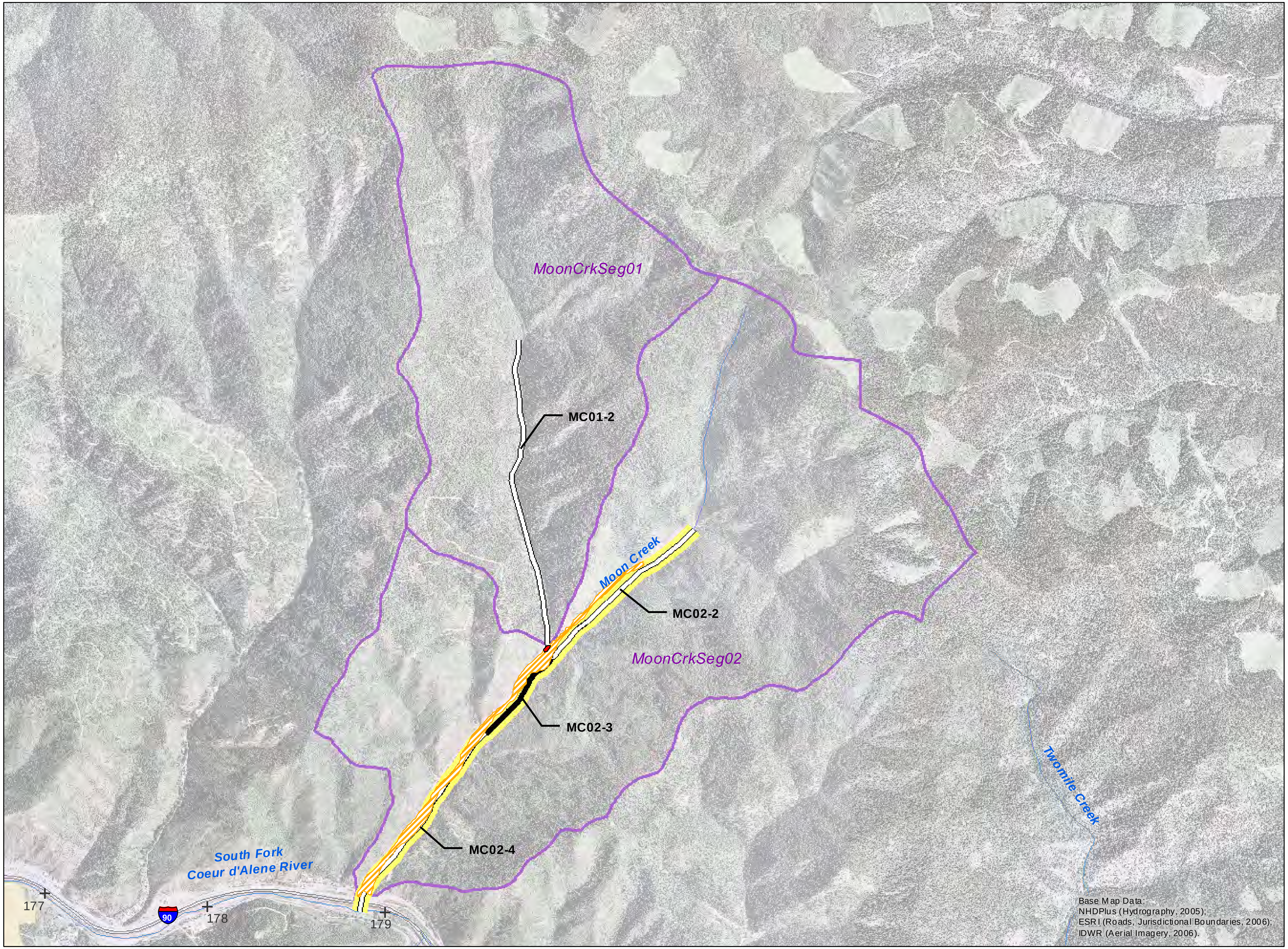
N 0 0.25 0.5 1 Miles

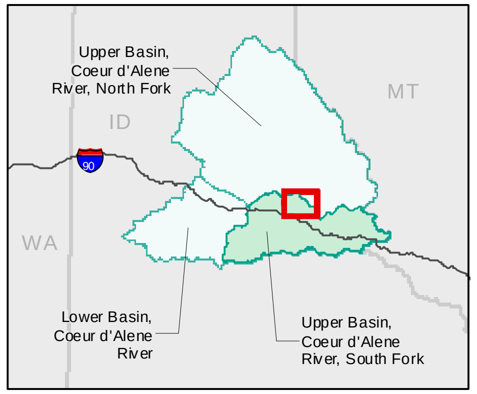
Note:

[1] Sediment removal actions and associated stream and riparian stabilization actions will occur in isolated locations within the site identified.

Figure 6
Stream and Riparian Stabilization Actions, Big Creek Watershed
Updates to Stream and Riparian Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

EPA





Site with Remedial Action (non-sediment removal) Included in Forthcoming Selected Remedy

Site with **Sediment Removal** Remedial Action Included in Forthcoming Selected Remedy[1]

179 River Mile

River/Creek

MC01-2 Stream and Riparian Reach Included in Alternative 3+

MC02-4 Stream and Riparian Reach Included in Forthcoming Selected Remedy

Watershed Segment

N 0 0.25 0.5 1 Miles

Note:

[1] Sediment removal actions and associated stream and riparian stabilization actions will occur in isolated locations within the site identified.

Figure 7
Stream and Riparian Stabilization Actions, Moon Creek Watershed

Updates to Stream and Riparian Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

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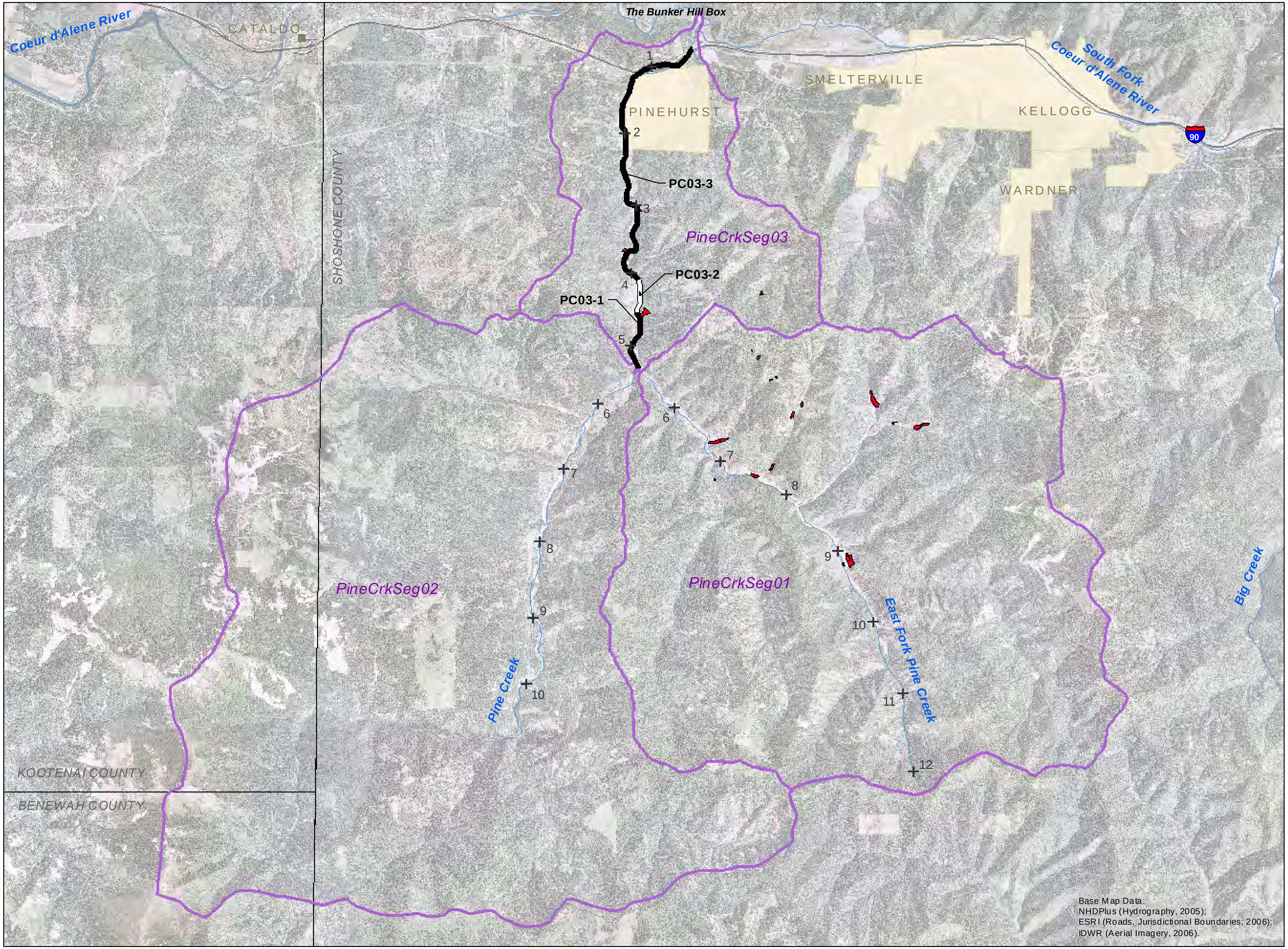

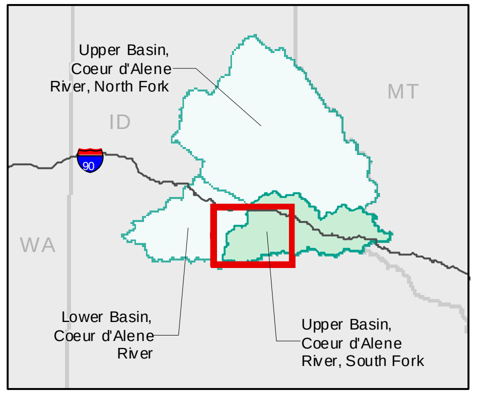

Site with Remedial Action (non-sediment removal) Included in Forthcoming Selected Remedy

Site with **Sediment Removal** Remedial Action Included in Forthcoming Selected Remedy[1]

+4 River Mile

River/Creek

PC03-1 Stream and Riparian Reach Included in Alternative 3+

Watershed Segment

City Limit

0 0.5 1 2 Miles

Notes:

No stream and riparian stabilization actions for the Pine Creek Watershed will be included in the Forthcoming Selected Remedy.

[1] Sediment removal actions will occur in isolated locations within the site identified.

Figure 8
Stream and Riparian Stabilization Actions, Pine Creek Watershed
Updates to Stream and Riparian Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

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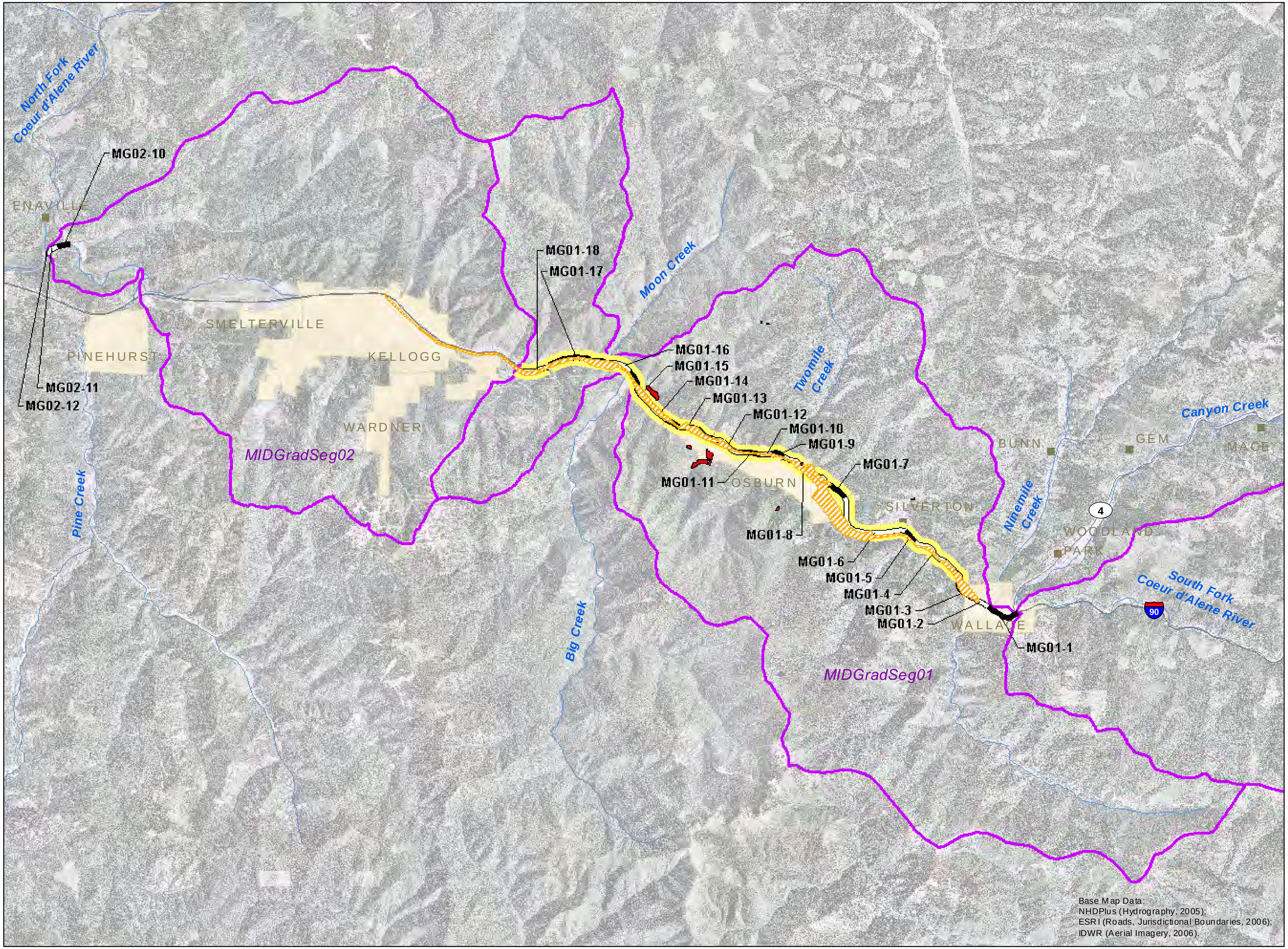

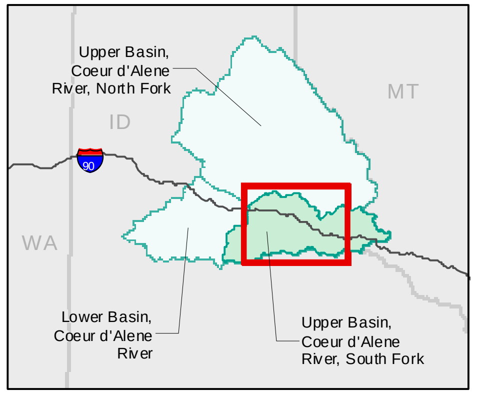

Site with Remedial Action (non-sediment removal) Included in Forthcoming Selected Remedy

Site with **Sediment Removal** Remedial Action Included in Forthcoming Selected Remedy[1]

187 River Mile

River/Creek

MG02-10 Stream and Riparian Reach Included in Alternative 3+

MG01-16 Stream and Riparian Reach Included in Forthcoming Selected Remedy

Watershed Segment

City Limit

N

0 0.5 1 2 Miles

Note:

[1] Sediment removal actions and associated stream and riparian stabilization actions will occur in isolated locations within the site identified.

Figure 9
Stream and Riparian Stabilization Actions, Mainstem SFCDR Watershed
Updates to Stream and Riparian Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

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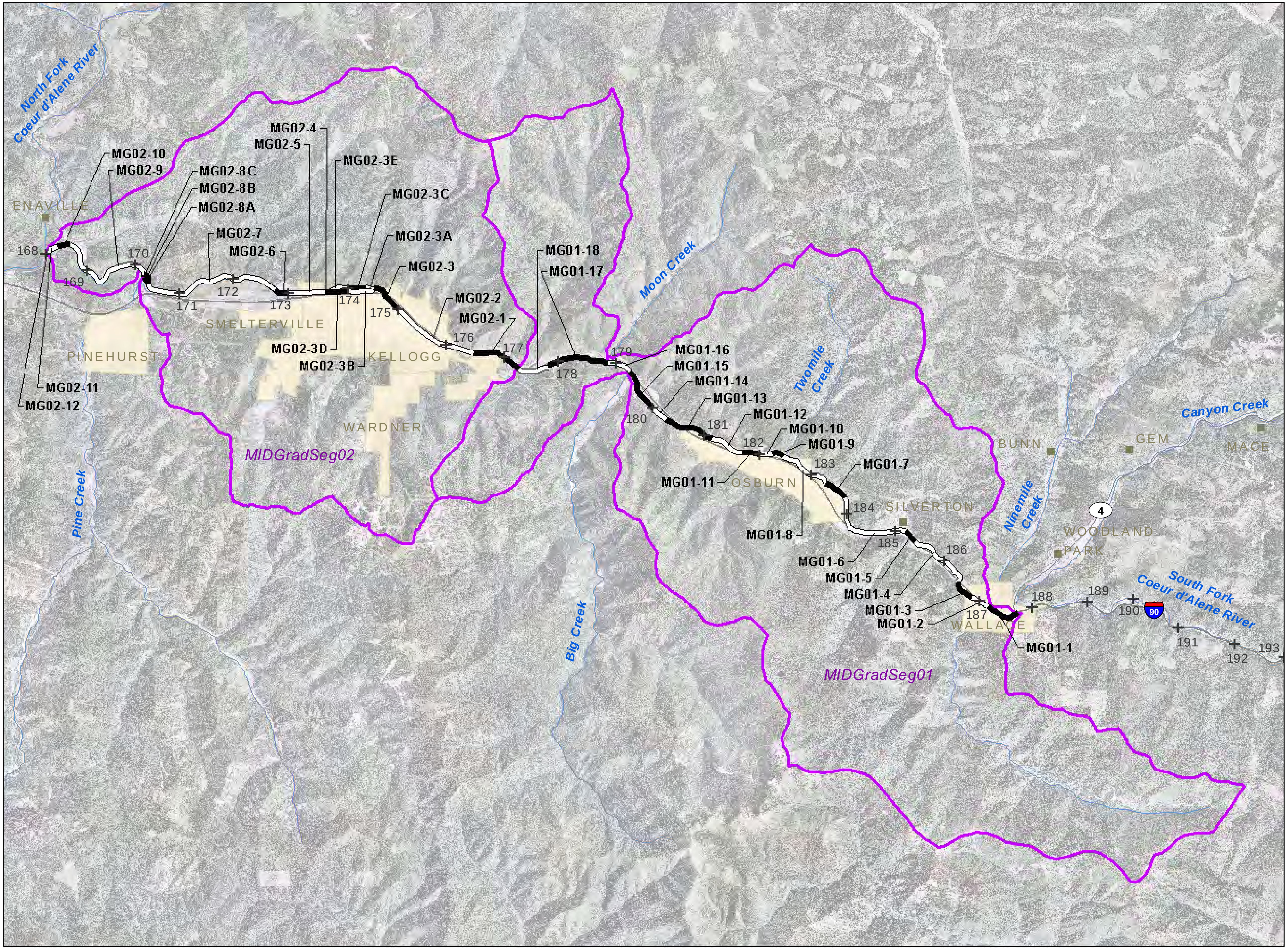

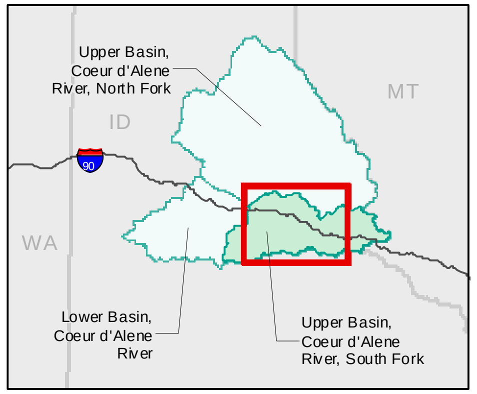

187 River Mile
River/Creek
Stream and Riparian Reach
MG01-1 (Stream and Riparian Reach ID)
Watershed Segment
City Limit

N
0 0.5 1 2 Miles

Base Map Data:
NHDPlus (Hydrography, 2005);
ESRI (Roads, Jurisdictional Boundaries, 2006);
IDWR (Aerial Imagery, 2006).

Figure 10
Stream and Riparian Reaches, Mainstem SFCDR Watershed
Updates to Stream and Riparian Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

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Contents

Acronyms and Abbreviations

°F	degree(s) Fahrenheit
µg/dL	microgram(s) per deciliter
µg/L	microgram(s) per liter
AC	acre(s)
ALD	anoxic limestone drain
AMD	acid mine drainage
ARAR	applicable or relevant and appropriate requirement
ARD	acid rock drainage
AWQC	ambient water quality criterion/criteria
BAL	Borrow Area Landfill
BEMP	Basin Environmental Monitoring Plan/Program
BEIPC	Basin Environmental Improvement Project Commission
bgs	below ground surface
BLM	U.S. Department of the Interior Bureau of Land Management
BLP	Bunker Limited Partnership
BMP	best management practice
BOD	biochemical oxygen demand
CCME	Canadian Council of Ministers of the Environment
CCP	Comprehensive Cleanup Plan
CDR	Coeur d'Alene River
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CF	cubic feet
CFR	*Code of Federal Regulations*
cfs	cubic foot/feet per second
CHU	Critical Habitat Unit
CIA	Central Impoundment Area

CLP	Contract Laboratory Program
COC	contaminant of concern
COPC	contaminant of potential concern
CPES	CH2M HILL Parametric Cost Estimating System
CSM	conceptual site model
CTP	Central Treatment Plant
CWA	Clean Water Act
cy	cubic yard(s)
cy/yr	cubic yard(s) per year
DCIRP	Drainage Control Infrastructure Revitalization Plan
DO	dissolved oxygen
DPS	distinct population segment
EA	each
EcoRA	Ecological Risk Assessment
Eco-SSL	Ecological Soil Screening Level
ECSM	Enhanced Conceptual Site Model of the Lower Coeur d'Alene Basin
EFNC	East Fork Ninemile Creek
EMP	Environmental Monitoring Plan/Program
ERA	Ecological Risk Assessment
ESA	Endangered Species Act
ESD	Explanation of Significant Differences
FEMA	Federal Emergency Management Agency
FFS	Focused Feasibility Study
FML	flexible membrane liner
FR	*Federal Register*
FRP	fiberglass-reinforced plastic
FS	Feasibility Study
ft/d	foot/feet per day
ft^2/day	square foot/feet per day
GCL	geosynthetic clay liner
GIS	geographic information system

gpm	gallon(s) per minute
GRA	general response action
HDPE	high-density polyethylene
HDS	high-density sludge
HEC	Hydrologic Engineering Centers
HEC-RAS	Hydrologic Engineering Centers-River Analysis System
HFLB	horizontal-flow limestone bed
HUC	Hydrologic Unit Code
I-90	Interstate 90
I&I	infiltration and inflow
IBHS	Idaho Bureau of Homeland Security
ICP	Institutional Controls Program
IDAPA	Idaho Administrative Procedures Act
IDEQ	Idaho Department of Environmental Quality
IDFG	Idaho Department of Fish and Game
IDHW	Idaho Department of Health and Welfare
IDTL	Initial Default Target Level
INL	Idaho National Laboratory
IP	Implementation Plan
IRP	Infrastructure and Revitalization Plan
ITD	Idaho Transportation Department
KT	Kellogg Tunnel
lb/day	pound(s) per day
lb/Kgal	pound(s) per thousand gallons
lf	linear foot/feet
LOAEL	lowest observed adverse effects level
LS	lump sum
LWD	large woody debris
MBTA	Migratory Bird Treaty Act
MCL	maximum contaminant level

MCLG	maximum contaminant level goal
mg	milligram(s)
MGD	million gallons per day
mg/kg	milligram(s) per kilogram
mg/L	milligram(s) per liter
MI	mile(s)
MOA	Mine Operations Area
msl	mean sea level
NA	not applicable or not available
NAGPRA	Native American Graves Protection and Repatriation Act
NAS	National Academy of Sciences
NBHMC	New Bunker Hill Mining Company
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NPV	net present value
NRC	National Research Council
NRIS	Natural Resource Information System
O&M	operation(s) and maintenance
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
PA	Predictive Analysis
PCB	polychlorinated biphenyl
PCR	primary contact recreation
PFT	Project Focus Team
PHD	Panhandle Health District
PI	probability interval

PPE	personal protective equipment
ppm	parts per million
PRB	permeable reactive barrier
PRG	preliminary remediation goal
PRP	potentially responsible party
PTM	Principal Threat Materials
PVC	polyvinyl chloride
PWWTP	Page Wastewater Treatment Plant
RAO	remedial action objective
RAPS	reducing and alkalinity-producing system
RCRA	Resource Conservation and Recovery Act
REM	Risk Evaluation Manual
RF	remedial effectiveness factor
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RLP	relative load potential
RM	River Mile
RMB	reactive media bed
ROD	Record of Decision
ROW	right of way
RSL	Regional Screening Level
SCA	Smelter Closure Area
SCR	secondary contact recreation
SDWA	Safe Drinking Water Act
SF	square foot/feet
SFCDR	South Fork of the Coeur d'Alene River
SL	screening level
SSL	Soil Screening Level
SMCRA	Surface Mining Control and Reclamation Act
SQuiRT	Screening Quick Reference Tables

SRB	sulfate-reducing bioreactor
SR-PRB	sulfate-reducing permeable reactive barrier
SSC	State Superfund Contract
SVNRT	Silver Valley Natural Resource Trust(ees)
SY	square yard(s)
TAL	Target Analyte List
TBC	to be considered
TBD	to be determined
TCD	typical conceptual design
TCLP	toxicity characteristic leaching procedure
THPO	Tribal Health Preservation Officer
TI	Technical Impracticability
TMDL	total maximum daily limit
TSD	Technical Support Document
TSDF	treatment, storage, and disposal facility
TSS	total suspended solids
UPRR	Union Pacific Railroad
USACE	U.S. Army Corps of Engineers
USBM	U.S. Bureau of Mines
U.S.C.	United States Code
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VHG	vertical hydraulic gradient
WENI	West End Natural Infiltration
WQA	Water Quality Assessment (Team)
WSDOT	Washington State Department of Transportation
WWTP	wastewater treatment plant
XRD	x-ray diffraction

Executive Summary

Introduction

This Focused Feasibility Study (FFS) Report presents and evaluates alternatives for cleanup of the Upper Basin of the Coeur d'Alene River in Northern Idaho, which is part of the Bunker Hill Mining and Metallurgical Complex Superfund Site (also referred to as "the Site" and "the Bunker Hill Superfund Site"). The Site was listed on the National Priorities List (NPL) in 1983 and has been assigned Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) identification number IDD048340921. The Upper Basin is the area of historical mining and industrial activities and the primary source of downstream metals contamination. For the purposes of the FFS, the "Upper Basin" includes the South Fork of the Coeur d'Alene River (SFCDR); its tributaries downstream to the confluence of the South and North Forks of the river; and the 21-square-mile Bunker Hill "Box" around the old Bunker Hill smelter where USEPA began its cleanup in the 1980s.

Under the Superfund Law, the U.S. Environmental Protection Agency (USEPA) is required to develop cleanup plans to be protective of human health and the environment, and to attain applicable or relevant and appropriate requirements (ARARs) unless waivers are invoked. The latter includes meeting all federal or more stringent state environmental standards, such as achieving state water quality standards. In addition, the Coeur d'Alene Tribe owns land in the Upper Basin, and the Tribe's environmental standards must also be met for actions taken on Tribal lands. Over the last year USEPA and others have been evaluating and discussing Bunker Hill Superfund Site cleanup activities with a view to developing a comprehensive, prioritized cleanup approach for the Upper Coeur d'Alene Basin. This has been undertaken to incorporate improved knowledge of the Upper Basin and the Box, to move forward on Phase II cleanup activities in the Box in Operable Unit 2 (OU 2), and to address National Academy of Sciences recommendations (NAS, 2005). This effort will culminate in USEPA identifying and selecting additional cleanup actions for the Upper Basin and the Bunker Hill Box in a Record of Decision (ROD) Amendment after issuance of a Proposed Plan and consideration of public comments.

To develop this FFS Report for the Upper Basin portion of the Bunker Hill Superfund Site, USEPA has worked closely with the Idaho Department of Environmental Quality, the Coeur d'Alene Tribe, local governments, the federal Natural Resource Trustees (the Bureau of Land Management [BLM], the U.S. Fish and Wildlife Service, and the U.S. Forest Service), the Spokane Tribe, the Washington Department of Ecology, local communities, and other interested parties including the Basin Environmental Improvement Project Commission ("the Basin Commission"). The Basin Commission was established by the Idaho State Legislature under the Basin Environmental Improvement Act, Idaho Administrative Procedures Act Title 39, Chapter 810.

Background

Summary of Environmental Conditions

The Coeur d'Alene Basin contains mining-contaminated areas of the Coeur d'Alene River corridor, adjacent floodplains, downstream water bodies, river tributaries, and fill areas, and the Bunker Hill "Box". The principal source of metals contamination is tailings generated from the historical milling of ore, which until 1968 were discharged to the SFCDR and its tributaries or disposed of in large waste piles. Tailings were frequently used as fill for residential and commercial construction projects. Tailings were also transported downstream, particularly during high-flow events in the SFCDR, and deposited as lenses of tailings or as tailings/sediment mixtures in the beds, banks, and floodplains of local surface water bodies. Other major sources of contamination have included waste rock and air emissions from former smelter operations.

Concentrations of mining-related metals in surface water, soil, sediments, and groundwater are elevated in many parts of the Basin, and have been associated with increased mortality and decreased survival, growth, and reproduction of various plant and animal species (Stratus Consulting, 2000; USEPA, 2001a). The toxicity of these metals has also impacted humans, with historically high blood-lead levels in children that have been significantly reduced in recent years by the Superfund cleanup efforts.

Operable Units

USEPA has designated three OUs within the Bunker Hill Superfund Site. OUs 1 and 2 are located within the Bunker Hill Box, which includes the communities where historical ore processing and smelting occurred (Kellogg, Smelterville, Wardner, and Pinehurst). OU 3 includes all areas of the Basin outside the Box where mining-related contamination is located. The OUs are summarized as follows:

Bunker Hill Superfund Site Operable Units (OUs)

OU 1	OU 1 is defined as the *populated areas* of the Bunker Hill Box because it is home to more than 7,000 residents of the towns of Pinehurst, Smelterville, Kellogg, and Wardner, as well as the unincorporated communities of Page, Ross Ranch, Elizabeth Park, and Montgomery Gulch. Residences also extend up side gulches and adjacent hillside areas. Populated-area issues of concern include residential yards, house dust, commercial properties, public use areas, and street rights of way.
OU 2	OU 2 includes the *non-populated areas* of the Bunker Hill Box. These areas include former industrial areas such as the Mine Operations Area (MOA) in Kellogg; Smelterville Flats (the floodplain of the SFCDR in the western half of the Bunker Hill Box); hillsides, creeks, and gulches; the Central Impoundment Area (CIA) in Kellogg; the Central Treatment Plant (CTP), a water treatment facility in Kellogg for acid mine drainage (AMD) and other metals-contaminated water; and the Bunker Hill Mine with its associated AMD.
OU 3	OU 3 includes all areas of the Coeur d'Alene Basin outside the Bunker Hill Box where mining-related contamination is located. OU 3 extends from near the Idaho-Montana border into the State of Washington, and includes floodplains, communities, lakes, rivers, and tributaries. Pine Creek and the portion of the SFCDR within the Bunker Hill Box are considered part of OU 3.

Substantial progress has been made in implementing the remedies selected in previous decision documents and actions for the OUs, primarily those focused on reducing the risks posed to human health by exposure to mining-related contamination:

- **OU 1:** Cleanup activities at the Bunker Hill Superfund Site first began in OU 1 because of the risks posed to human health from exposure to mine and smelter wastes. The ROD for OU 1 (USEPA, 1991a) focused on remediation of lead-contaminated soil in residential areas primarily through removals and partial removals and the installation of protective soil/vegetation barriers. The human health remedy installed by the potentially responsible parties (PRPs) for OU 1 was certified complete in 2008.
- **OU 2:** Phased cleanup activities in OU 2 began in the early 1990s. The ROD for OU 2 (USEPA, 1992) included actions to protect human health in the non-populated areas, commercial areas, and other common-use areas through removals, source control, capping, and other measures. Phase I source control actions for OU 2 are largely complete. Phase I has included removal, containment, and consolidation of extensive contamination from various areas, capping of source areas, demolition of structures, and corresponding public health response actions. This ROD also addressed some OU 1 remedial activities such as rights of way, commercial properties, and house dust.
- **OU 3:** Cleanup activities since the ROD for OU 3 (USEPA, 2002) have primarily focused on implementation of the human health remedy in community and residential areas. Prior to the 2002 ROD, limited removal actions in OU 3 were conducted by EPA and other entities such as the Silver Valley Natural Resource Trustees (SVNRT, now referred to as the Coeur d'Alene Natural Resource Trustees), USFS, IDEQ, and BLM. Implementation of the human health remedy selected for community, residential, and recreational areas in the Coeur d'Alene Basin outside the Box, presented in the ROD for OU 3, is ongoing and nearing completion. USEPA recently received additional funding through the American Recovery and Reinvestment Act of 2009 to accelerate the implementation of remaining human health cleanup activities in OU 3.

The human health remedies selected for OUs 1, 2, and 3 have functioned as designed and are protective of human health. In particular, the cleanup actions have resulted in significant and well-documented declines in children's blood lead levels. An Institutional Controls Program (ICP), administered by the Panhandle Health District, provides a locally enforced set of rules and regulations established to maintain the integrity of installed barriers[1] and to ensure that new barriers are installed during redevelopment that may occur within the administrative boundary of the ICP. In OU 2, where a phased program of remedial actions is being conducted, Phase I remedial work is largely complete as noted above. An evaluation of the effectiveness of the Phase I actions has been conducted along with studies to provide the basis for selecting appropriate Phase II actions to address long-term water quality issues.

In addition to selecting a human health remedy for community, residential, and recreational areas within OU 3, the 2002 ROD for OU 3 also selected an interim remedy for protection of the environment that focused on improving water quality, minimizing downstream

[1] Barriers are used as components of the human health remedies selected for OUs 1, 2, and 3 to prevent human contact with contaminated materials.

migration of metal contaminants, and improving conditions for fish and wildlife populations. Because a conscious decision to prioritize human health actions was made, most of the actions to protect the environment have not yet been implemented. However, USEPA has conducted some actions at mine and mill sites that addressed recreational human health as well as ecological exposures.

Remedy implementation in the three OUs has included continued studies, information gathering, monitoring, and assessment of the performance of remedial actions that have provided a greater understanding of conditions and risks in the Upper Basin. The resulting information indicates that it is necessary to augment the established remedies to ensure continued protection of human health and the environment in the Upper Basin.

Purpose and Scope of the Focused Feasibility Study

The overall purpose of the FFS was to develop and evaluate a range of alternatives that provide a comprehensive approach to remediation in the Upper Basin (remedial alternatives). The FFS has also evaluated actions to protect portions of the human health remedies selected in the RODs for the three OUs (USEPA, 1991, 1992, 2002) that are vulnerable to erosion and contamination of clean barriers (remedy protection alternatives). In addition, the FFS has refined the riparian preliminary remediation goal (PRG) for songbirds based on site-specific data collected since the issuance of the ROD for OU 3 in 2002. The alternatives have been evaluated in the FFS against seven criteria required under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA): overall protectiveness of human health and the environment; compliance with ARARs; long-term effectiveness and permanence; reduction of the toxicity, mobility, and volume of hazardous substances through treatment; short-term effectiveness; implementability; and cost. Two additional criteria (state and Tribal acceptance and community acceptance) will be evaluated in the Upper Basin ROD Amendment following the receipt of state agency, Tribal, and public comments on the Proposed Plan for the Upper Coeur d'Alene Basin.

The study area for the FFS (Figure ES-1) includes the Bunker Hill Box (OUs 1 and 2) and the Upper Basin portion of OU 3. (Figures ES-1 through ES-3 are provided following the text of this Executive Summary.) For the purposes of the FFS, the "Upper Basin" includes the SFCDR; its tributaries downstream to the confluence of the South and North Forks of the river; and the Box. The Upper Basin is the area of historical mining and industrial activities and the primary source of downstream metals contamination. As shown in Figure ES-1, the FFS study area extends approximately one mile to the west beyond the confluence of the North and South Forks of the Coeur d'Alene River to include the town of Kingston, which is one of the communities assessed in the remedy protection evaluation. The North Fork portion of the Upper Basin is not included in the FFS study area because it has been less seriously impacted by mining activities and is being addressed under CERCLA by other (non-USEPA) agencies, primarily the U.S. Forest Service. It should also be noted that the Lower Coeur d'Alene Basin is not within the scope of the FFS; in the near-term, the focus of continuing work in the Lower Basin is to fill data gaps and develop an Enhanced Conceptual Site Model that will help guide effective decisionmaking with regard to future remedial actions in the Lower Basin.

The FFS has built on previous work to develop a comprehensive remedy for human health and environmental protection within the Upper Basin. The remedial alternatives have been designed to provide a final remedy for:

- human health protection for surface water used for drinking purposes;
- ecological protection for surface water; and
- human health and ecological protection for soil, sediments, and source materials at locations where remedial actions are taken.

Further, the remedy selected in the Upper Basin ROD Amendment is expected to significantly reduce both groundwater contamination levels and the contribution of contaminated groundwater to surface water. However, given the pervasive nature of the subsurface contamination, the Preferred Alternative may not achieve the drinking water standards for groundwater at all locations. USEPA will evaluate future monitoring data to determine whether additional actions are needed or would be effective in meeting drinking water standards. If further actions would not be effective, a Technical Impracticability (TI) waiver may be warranted at specific locations where groundwater does not achieve drinking water standards.[2]

In addition, the remedy protection alternatives have been designed to address portions of the previously selected human health remedies that are vulnerable to erosion and contamination of clean barriers.

Following finalization of this FFS Report and consideration of comments on the Proposed Plan, the forthcoming Upper Basin ROD Amendment will update and add to previous cleanup plans described in the RODs for OUs 1, 2 and 3 and in other related decision documents, as necessary.

Approach to the Focused Feasibility Study

The FFS built upon the analyses presented in the *Final (Revision 2) Feasibility Study Report, Coeur d'Alene Basin Remedial Investigation/Feasibility Study* (2001 FS Report; USEPA, 2001b), the ROD for OU 3 (USEPA, 2002), the *Phase I Remedial Action Assessment Report, Operable Unit 2* (CH2M HILL, 2007), and the *Source Areas of Concern Report, Operable Unit 2* (CH2M HILL, 2008).

In the 2001 FS Report, six ecological remedial alternatives, including a no-action alternative, were evaluated to address ecological risks to waterfowl, other birds, fish, and plants in OU 3, including both the Upper and Lower Basins. Consistent with CERCLA, its implementing regulations, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), and the findings presented in the 2001 FS Report and the 2002 ROD for OU 3, USEPA has determined that it is appropriate to carry forward only the Upper Basin components of Ecological Alternatives 3 and 4 as the basis for remedial alternatives to be considered in the FFS for the Upper Basin. It was also determined that Ecological Alternatives 1, 2, 5, and 6 in

[2] Specific ARARs can be waived if appropriately justified [*Code of Federal Regulations* [CFR] 300.430(f)(1)(ii)(C)].

the 2001 FS Report would not be sufficiently protective of human health and the environment, and do not warrant further analysis.[3] Therefore, USEPA has updated and expanded Ecological Alternatives 3 and 4, using information obtained since the three RODs were issued, to develop remedial alternatives for evaluation in the FFS. The updated and expanded remedial alternatives for OU 3 are referred to as Alternatives 3+ and 4+.

This FFS Report also considers remedial alternatives for the Phase II actions of the OU 2 Remedy. Phase I work at OU 2 is largely complete; Phase II is intended to generally address issues encountered in implementing Phase I and to specifically address long-term water quality and environmental management issues.

In conjunction with the development of this FFS Report and the forthcoming Upper Basin ROD Amendment, USEPA is in the process of planning and prioritizing actions for implementation of the comprehensive remedy for the Upper Basin. The outcome of this effort will be an Implementation Plan that will prioritize and guide actions selected in the Upper Basin ROD Amendment. This Plan will be a separate "living document" from the ROD Amendment that will identify priority projects and guide cleanup actions into the future. The Implementation Plan will also use adaptive management to incorporate "lessons learned" and to guide future efforts to prioritize work. Adaptive management is a process in which decisions are made as part of an ongoing science-based process. It involves implementing, testing, monitoring, and evaluating applied strategies, and incorporating new knowledge into management approaches that are based on scientific findings. The Implementation Plan and adaptive management process will be tools to help USEPA and others make better decisions as more information becomes available on the effectiveness of initial cleanup actions, and will provide the framework for the implementation of future actions. The Implementation Plan will be routinely updated as increments of work are completed and decisions are made for new phases of work to guide future decisionmaking and help document adjustments to project priorities based on new information. USEPA will involve stakeholders and community members in the development of the Implementation Plan and during the implementation of cleanup actions.

For planning purposes, this FFS has taken the same conservative approach applied in the 2001 FS by including many sites, some of which have only limited or outdated data available. However, additional site-specific data will be collected during the design phase of the Upper Basin cleanup, and it may be determined that some sites do not require remedial action at all or that they require a smaller-scale action than identified in this FFS Report. Conversely, data collected during the design phase may indicate that more extensive actions may be required at some locations. The Implementation Plan and the adaptive management process will allow USEPA to begin near-term remedial actions in some areas where sufficient data are available and opportunities to achieve remedial action objectives are greater, rather than delaying remedial actions throughout the Upper Basin while additional data are being collected. At sites where limited data are available, pre-design data collection will occur in parallel with initial remedial actions and the cleanup plan will be refined over time in response. USEPA's approach to Upper Basin cleanup will therefore focus on refining the cleanup plan over time through a formalized adaptive management process, and with

[3] Alternative 1, the No Action Alternative, while not NCP-compliant, is evaluated in this FFS Report for comparative purposes only.

continued use and refinement of tools to assist in the prioritization of sites for remedial action.

In this FFS Report, remedial actions are evaluated for areas that are or may be subject to mining-related activities. USEPA will consider current and potential mining-related activities as it implements remedial actions in these areas. In addition, USEPA will coordinate the implementation of remedial actions, including timing, staging, and who would perform the work, with owners of property in these areas.

Consideration of these factors will help guide this important cleanup work and provide transparency on how cleanup decisions will be made, the expected outcomes, and progress towards meeting the objectives of the Upper Basin ROD Amendment.

Development of Alternatives

This section summarizes the development of the alternatives for the Upper Basin that are evaluated in this FFS Report: first the remedial alternatives, then the human health remedy protection alternatives.

Remedial Alternatives for the Upper Basin Portion of Operable Unit 3

As discussed above, the Upper Basin components of Ecological Alternatives 3 and 4 presented for the Coeur d'Alene Basin in the 2001 FS Report (USEPA, 2001b) are updated and expanded in this FFS Report in a consistent manner based on new information. The updated and expanded remedial alternatives are referred to as Alternatives 3+ and 4+ for OU 3. An overview of the source sites included in Alternatives 3+ and 4+ and their distribution in the Upper Basin is provided in Figure ES-1. Remedial alternatives for OU 2 were developed separately (as described below) and then combined with OU 3 Alternatives 3+ and 4+ to create 10 action alternatives that are evaluated in this FFS Report.

Alternatives 3+ and 4+ evaluate the same sites for potential remedies as were considered in Ecological Alternatives 3 and 4 in the 2001 FS Report. As shown below, a total of 761 sites are considered:

Sites	Alternative 3	Alternative 3+	Alternative 4	Alternative 4+
Sites with Proposed Action(s)	332	348	699	704
Sites with No Proposed Actions	429	413	62	57
Total	**761**	**761**	**761**	**761**

The differences between Ecological Alternative 3 and Alternative 3+ and between Ecological Alternative 4 and Alternative 4+ are relatively minor in terms of the number of sites that have changed from no proposed action to proposed action. Other differences result from updates to the typical conceptual designs (TCDs) for cleanup methods and the estimated volumes of materials to be addressed. Based on new information that was not available when the 2001 FS Report was published, groups of sites and associated remedial actions in OU 3 that have been modified in this FFS Report include the following:

- **Sites added on the basis of relatively high estimated dissolved metals loading to surface water.** Based on analysis of site data that were not available at the time of the 2001 FS Report, 11 sites were added to Alternative 3+ on the basis of relatively high estimated dissolved metals loading to surface water. None of these sites were included in Ecological Alternative 3 in the 2001 FS Report, and four were not included in Ecological Alternative 4.

- **Formerly and currently operating sites.** Actions at four formerly or currently operating sites were changed from "hydraulic isolation" to "hydraulic isolation and capping" in both Alternatives 3+ and 4+. These sites were acknowledged in the 2001 FS Report, but complete remedial actions were not identified.

- **Updated conceptual design for hydraulic isolation.** The method by which hydraulic isolation will be accomplished at six sites along the SFCDR was revised for Alternatives 3+ and 4+. "Hydraulic isolation using slurry walls" was replaced with "hydraulic isolation using stream liners and French drains" based on updated analysis.

- **Sites with a water treatment component.** A total of 59 sites in Alternative 3+ and 96 sites in Alternative 4+ include different water treatment TCDs than those included in Ecological Alternatives 3 and 4, respectively, in the 2001 FS Report. The updated TCDs include changes (resulting from further analysis) in the location of the centralized, active treatment plant,[4] the method of treatment for specific sites (active to semi-passive and vice versa), and the manner of providing semi-passive treatment.

- **Sites within the Pine Creek Watershed.** Based on discussions with BLM, the remedial actions identified for the Pine Creek Watershed have been modified to account for remedial work that has been completed and new data that have been collected since the 2001 FS Report was issued. In addition, several sites have been added to the list for remedial action based on recommendations provided by BLM.

- **Sites located within the Woodland Park area of Canyon Creek.** Woodland Park has been an area of focused study since the ROD for OU 3 was completed because it is a significant source of dissolved metals loading in surface water in the Upper Basin. It is also an alluvial area where, at the time when the 2002 ROD was published, the groundwater system and groundwater-surface water interactions were not well understood. The post-ROD studies included groundwater modeling, groundwater-surface water interaction studies, and water treatability studies. These studies found that the surface water treatment actions included for Woodland Park in Ecological Alternative 3 in the 2001 FS Report were not feasible. It was determined, based on groundwater modeling, that by treating groundwater with relatively high metals concentrations, remedial objectives could be achieved more efficiently. Remedial components for Alternatives 3+ and 4+ for Woodland Park have been developed based on the post-ROD studies and evaluation of remedial options.

As was the case with Ecological Alternatives 3 and 4 in the 2001 FS Report, the primary difference between Alternatives 3+ and 4+ is the extent of excavation and removal of wastes. Alternative 3+ focuses on a combination of in-place containment and excavation of wastes

[4] The 2001 FS Report proposed constructing a new high-density sludge plant for water treatment in Pinehurst. This FFS Report proposes expanding and upgrading the existing Central Treatment Plant in Kellogg.

inside the nominal 100-year floodplain, as well as wastes outside the 100-year floodplain that are probable sources of metals loading. Active and semi-passive water treatment of adit drainages and hydraulic isolation of groundwater are also included in Alternative 3+. Under Alternative 3+, an estimated average flow of 12,000 gallons per minute (gpm) of contaminated water would be treated at the Central Treatment Plant (CTP) located in Kellogg, Idaho, and an additional 800 gpm would be treated by onsite semi-passive systems.

Alternative 4+, on the other hand, focuses on complete excavation and hydraulic isolation of all wastes that are probable sources of metals loading. Wastes that are outside the 100-year floodplain and probably not significant sources of metals loading would be covered in place. Expanded use of active and semi-passive water treatment of adit drainages and hydraulic isolation of groundwater is also included in Alternative 4+. Under Alternative 4+, an estimated average flow of 14,000 gpm of contaminated water would be treated at the CTP and an additional 1,400 gpm would be treated by onsite semi-passive systems.

Estimated treated-water flow rates for Alternatives 3+ and 4+ (above) represent water from OU 3 only, and do not include the water that currently flows from the Bunker Hill Mine to the CTP, or additional water that would result from the implementation of OU 2 Phase II remedial actions (discussed below).

Remedial Alternatives for Operable Unit 2

The OU 2 Phase II remedial alternatives were developed by taking into consideration the effectiveness of the source removal, containment, and surface capping completed as part of Phase I remedial actions at OU 2. Given the surface water and groundwater concerns in OU 2, remedial alternatives with the potential to address significant portions of the remaining metals loading to the SFCDR in the Bunker Hill Box were identified for Phase II work. The development of Phase II remedial alternatives for OU 2 focused on source control, water collection and management, and water treatment actions, which were combined as applicable into the five FFS OU 2 Alternatives (a) through (e). These alternatives are summarized below.

The OU 2 Phase I effectiveness evaluation indicated that the largest source of dissolved metals contamination to groundwater and surface water in OU 2 is contaminated materials located in floodplains and beneath the populated areas and infrastructure within the OU. Because of the widespread nature of contaminated materials, USEPA’s commitment to not displace the community, and the complexity of contaminant transport within OU 2, a remedial approach focusing on groundwater-based actions was developed. To support this, a groundwater flow model was constructed, calibrated, and used to assist with the development of Phase II remedial alternatives. Model simulations were performed on all water management/collection actions, and subsequent load reductions for each action were estimated. A cost-benefit analysis was also performed for each individual action based on the cost per pound of dissolved zinc load reduction to the SFCDR.

In order to achieve compliance with the order from USEPA to capture all discharges of acid mine drainage (AMD) from the Bunker Hill Mine, all the OU 2 alternatives include the same phased water collection and management actions for the Reed and Russell Adit Tunnels (part of the Bunker Hill Mine). These actions comprise a check dam installed in each tunnel in the interior of the mine to keep the discharge from the Reed and Russell Adit Tunnels from flowing out of the adit, and instead redirect it back into the mine. If the required water quality criteria are not achieved in the residual discharge, additional measures will be implemented to collect and convey the AMD from the tunnels by constructing a collection system and pipeline that will ultimately drain, along with all other AMD from the Bunker Hill Mine, to the CTP for active treatment.

- **OU 2 Alternative (a): Minimal Stream Lining.** OU 2 Alternative (a) consists of limited stream-lining actions in losing reaches (where surface water enters underlying groundwater) of OU 2 streams to reduce recharge to the shallow alluvial groundwater system. Actions would include lining the SFCDR on the north side of the Central Impoundment Area (CIA); lining Bunker, Deadwood, and Magnet Creeks; and phased implementation of the actions for the Reed and Russell Adit Tunnels discussed above. No additional water treatment would be required under this alternative (unless needed for discharges from the Reed and Russell Adit Tunnels).
- **OU 2 Alternative (b): Extensive Stream Lining.** OU 2 Alternative (b) consists of extensive stream-lining actions in OU 2 streams to reduce recharge to the shallow alluvial groundwater system. Groundwater cutoff walls would be installed at selected locations. Actions would include lining Bunker, Government, Deadwood, and Magnet Creeks; installing slurry walls and extraction wells upgradient of tributary stream liners (except Bunker Creek) to direct groundwater into the lined channels; and phased implementation of the actions for the Reed and Russell Adit Tunnels discussed above. No additional water treatment would be required under this alternative (unless needed for discharges from the Reed and Russell Adit Tunnels).
- **OU 2 Alternative (c): French Drains.** OU 2 Alternative (c) consists of a French drain system located in the central portion of OU 2, along the northern and western ends of the CIA in the area with the highest dissolved metal load gains observed in the SFCDR. This French drain system would intercept dissolved-metals-contaminated groundwater prior to it otherwise discharging to the SFCDR. Actions would include installing a French drain along the northwest end of the CIA and to the southwest across the SFCDR valley floor, terminating on the west side of Government Gulch; conveying water collected in the French drain to the CTP for treatment; conveying the CTP effluent directly to the SFCDR in a pipeline installed on the east side of the CIA or in a pipe along Bunker Creek (instead of discharging to Bunker Creek as is currently done); and phased implementation of the actions for the Reed and Russell Adit Tunnels discussed above. An estimated average flow of 3,900 gpm of contaminated groundwater would be treated at the CTP under this alternative (in addition to current flows of AMD from the Bunker Hill Mine and waters to be added from OU 3).
- **OU 2 Alternative (d): Stream Lining/French Drain Combination.** OU 2 Alternative (d) consists of French drains, stream liners, cutoff walls, and extraction wells located in the central portion of OU 2, primarily in the area with the highest dissolved metal load gains observed in the SFCDR. Actions would include lining Government Creek; installing a slurry wall and extraction wells across Government Gulch (on the upgradient end of the liner); installing a French drain along the northwest end of the CIA and extending south across the SFCDR valley, terminating on the east side of Government Gulch; conveying water collected in the French drain to the CTP for treatment; installing extraction wells

across the mouth of Government Gulch and conveying the extracted water to the CTP for treatment; conveying the CTP effluent directly to the SFCDR in a pipeline installed on the east side of the CIA or in a pipe along Bunker Creek (instead of discharging to Bunker Creek as is currently done); and phased implementation of the actions for the Reed and Russell Adit Tunnels discussed above. An estimated average flow of 3,900 gpm of contaminated groundwater would be treated at the CTP under this alternative (in addition to current flows of AMD from the Bunker Hill Mine and waters to be added from OU 3).

- **OU 2 Alternative (e): Extensive Stream Lining/French Drain Combination.** OU 2 Alternative (e) is the most extensive water collection and management alternative, incorporating extensive stream lining of the SFCDR and its tributaries as well as French drain systems. Actions would include lining of the SFCDR and Bunker, Government, Deadwood, Magnet, Grouse, and Humbolt Creeks; installing a French drain at the north end of the CIA along the gaining reach (groundwater entering surface water) of the SFCDR, as in OU 2 Alternatives (c) and (d), and conveying the collected water to the CTP for treatment; installing a French drain extending from mid-Smelterville Flats west to the Pinehurst Narrows, and conveying the collected water to the CTP for treatment; installing slurry walls and extraction wells upgradient of tributary liners (except in Bunker Creek) to direct groundwater into the lined channels; across the SCFDR valley floor, installing a slurry wall and extraction wells at Elizabeth Park and a slurry wall at Pinehurst Narrows; and phased implementation of the actions for the Reed and Russell Adit Tunnels discussed above. An estimated average flow of 2,400 gpm of contaminated groundwater would be treated at the CTP under this alternative (in addition to current flows of AMD from the Bunker Hill Mine and waters to be added from OU 3).

The OU 2 alternatives are combined with the alternatives for OU 3 to create the 10 remedial alternatives for the Upper Coeur d'Alene Basin that are evaluated in this FFS Report [Alternatives 3+(a) through 3+(e) and Alternatives 4+(a) through 4+(e)].

Remedy Protection Alternatives

The remedy protection alternatives for the Upper Basin focus on protecting the soil remedial actions completed as part of the human health remedies selected in the RODs for OUs 1, 2, and 3 (USEPA, 1991, 1992, and 2002). The final remedies selected for OUs 1, 2, and 3 that have been implemented to date have functioned as designed and are protective of human health, as documented in the Five-Year Review Reports prepared for the Bunker Hill Superfund Site (USEPA, 2000a, 2000b, 2005). As part of the existing selected remedies, clean, protective barriers have been installed in residential, commercial, common use, and right-of-way areas to prevent direct contact and exposure to mining-related contaminants in soil. Long-term maintenance of these barriers is a key component of the success of the existing remedies. USEPA is aware of certain circumstances, however, that have the potential to adversely impact, and in limited circumstances have already impacted, the successful long-term effectiveness and permanence of the barriers installed as part of these remedies. These circumstances include inadequate infrastructure to effectively convey floodwater and surface water through communities without damaging the existing remedies.

Before developing alternatives to enhance the protectiveness of the existing remedies in the Upper Basin, the potential threat of damage posed to the remedies by localized storm events was assessed. The assessment focused on eight of the most densely populated communities in the Upper Basin: Pinehurst, Smelterville, Kellogg, Wardner, Osburn, Silverton, Wallace, and Mullan. Erosion (or scour) of clean barriers that exposes contamination and deposition of contaminated sediments on previously clean barriers are the major threats posed to the existing remedies. The threat of sediment deposition exists in the following scenarios: (1) deposition of contaminated creek sediments on protective barriers if a creek overtops its banks during a flood; (2) scour of contaminated materials below a protective barrier and deposition of these materials on a previously clean area; and (3) scour of contaminated materials from a nearby hillside or other source and deposition of these materials on previously clean barriers.

The remedy protection alternatives evaluated in the FFS Report focus on localized tributary flooding and precipitation (storm) events that may impact human health and the environment by eroding protective barriers and/or by depositing contaminated sediments in previously clean areas, thereby exposing contaminated soil and gravel to human and ecological receptors. Hydrologic and hydraulic models analyzed the total expected impact area of barrier scouring and resultant deposition of potentially contaminated sediments for 5-, 25-, and 50-year storm events. The results of these analyses were used to assess whether remedy protection projects could improve the long-term effectiveness and permanence of the in-place barriers within each community.

Two remedy protection alternatives are described in the FFS Report and are summarized as follows:

- **Alternative RP-1: No Further Action (Post-Event Response).** Alternative RP-1 would not modify any of the existing conditions in the Upper Basin to increase the current level of long-term permanence of the existing remedies. If the existing remedies were damaged during storm events and this damage posed risks to human health and/or the environment that warranted response actions to reduce the risks, USEPA and state agencies would determine the best approaches for addressing such contamination. In the event of catastrophic flooding, USEPA and other federal and state agencies would evaluate response needs as appropriate. Because various portions of the existing remedies are expected to be damaged during storm events, based on hydrologic and hydraulic analyses conducted during the FFS, Alternative RP-1 includes the estimated costs for repair of the selected remedies in the Upper Basin communities. Although detailed analyses were not conducted for the side gulches (i.e., drainages located outside the eight primary Upper Basin communities), the expected damage due to storm events was estimated based on the trends found in the hydrologic and hydraulic analyses of the Upper Basin communities.
- **Alternative RP-2: Modifications to Selected Remedies to Enhance Protectiveness (Remedy Protection Projects).** Alternative RP-2 comprises combinations of various technology and process options to protect the existing selected remedies against tributary flooding and high precipitation events up to the 50-year storm. Each community has different water conveyance infrastructure-related issues that pose risks to the existing remedies. General technologies and process options that could be applicable to remedy protection projects were developed from common engineering practice used for stormwater conveyance projects. The technologies and process options identified to mitigate the risks posed to the existing remedies in Alternative RP-2 were

determined based on current conditions in each community area, and on hydrologic and hydraulic analyses. For the purposes of this evaluation, the Alternative RP-2 remedy protection projects and estimated costs were preliminarily defined for each of the eight primary Upper Basin communities. Although detailed analyses were not conducted for side gulches, approximate costs to address problems in the side gulches were developed for Alternative RP-2 based on the trends found in the analysis of the Upper Basin communities. Easements and operations and maintenance (O&M) agreements may be a necessary component of Alternative RP-2 to ensure long-term access and functionality of the remedy protection projects. If necessary to ensure long term maintenance of the remedy protection projects, USEPA, IDEQ, and the Work Trust will also rely on local governments to ensure continued operation and maintenance as property use changes.

Evaluation and Comparison of Alternatives to CERCLA Criteria

The NCP (Section 300.430 (e)(9)(iii)) requires that the alternatives be compared with one another using nine CERCLA evaluation criteria. The purpose of the comparison is to identify the relative advantages and disadvantages of the alternatives in terms of these CERCLA criteria. These nine criteria are divided into subcategories: Threshold Criteria, Primary Balancing Criteria, and Modifying Criteria, as follows:

Threshold Criteria
1. Overall protection of human health and the environment
2. Compliance with ARARs
Primary Balancing Criteria
3. Long-term effectiveness and permanence
4. Reduction of toxicity, mobility, or volume [of hazardous substances] through treatment
5. Short-term effectiveness
6. Implementability
7. Cost of implementation
Modifying Criteria
8. State and Tribal acceptance
9. Community acceptance

The three criteria categories are based upon the role of each criterion during the evaluation and remedy selection process. The two Threshold Criteria relate directly to statutory requirements that must be satisfied by a selected alternative, as ultimately documented in a ROD. The five Primary Balancing Criteria represent the primary technical, cost, institutional, and risk factors that form the basis of the evaluation. The two Modifying Criteria will be evaluated in the ROD Amendment following the receipt of state agency, Tribal, and public comments on the Proposed Plan.

Evaluation and Comparison of the Remedial Alternatives

The evaluation and comparison of the combined remedial alternatives for OUs 2 and 3 are summarized in Figure ES-2. This figure is used to provide the reader with a "relative" comparison between remedial alternatives that are NCP-compliant. As such, differences portrayed, while visually appearing significant, can be more subtle. Past FSs for these OU areas already examined a wide range of remedial alternatives, as required by CERCLA, which demonstrated significant differences between remedial alternatives, as would be expected.

Overall Protection of Human Health and the Environment. Protection of human health and the environment is one of two threshold requirements that each alternative must meet in order to be eligible for selection as a remedy (the other being compliance with ARARs). All of the alternatives, except the No Action Alternative, would achieve the criterion of overall protection of human health and the environment.

Although this criterion is evaluated as either "meets" or "does not meet", it can be helpful to also look at the different approaches to protectiveness, in that some alternatives may be more favorable than others. For example, all of the alternatives based on Alternative 3+ may provide benefits different than Alternative 4+ regardless of which OU 2 alternative is included. The estimated implementation time frame for Alternative 4+ may be decades longer than that for Alternative 3+ and, during this time, Alternative 4+ would involve construction-related risks to workers, the community, and the environment resulting from the much larger extent of long-term construction and hauling involved. These risks are considered to outweigh the long-term benefits of the additional proposed actions compared to Alternative 3+. Alternative 4+ would also have the greatest short-term environmental effects at offsite locations where borrow materials would be obtained. Implementation time frames are shorter for Alternative 3+, and the remedial actions are less extensive and would carry fewer risks to workers, the community, and the environment.

Compliance with ARARs. Compliance with ARARs is the second threshold requirement that each alternative must meet in order to be eligible for selection as a remedy. All of the alternatives would achieve the criterion of compliance with ARARs. PRGs for soil and sediments would be met upon completion of remedial actions in all locations where remedial actions are taken under each alternative, while ARARs for surface water would be met for all the alternatives through implementation of the remedial actions and different periods of natural source reduction (described further below). As with the overall protectiveness criterion, although this criterion is evaluated as either "meets" or "does not meet", it can be helpful to also look at the differences between the initial effectiveness of each alternative in the progress towards meeting surface water quality standards (i.e., AWQC).[5]

An analysis was conducted to estimate relative post-remediation AWQC ratios and dissolved zinc load reductions in the SFCDR at Elizabeth Park and Pinehurst for each alternative, the results of which are shown in the table below.

[5] Note that maximum contaminant levels (MCLs) for drinking water are also ARARs for surface water as a drinking water source in the Upper Basin. However, the AWQC are used as an indication of compliance with surface water ARARs because, in general, the AWQC are lower than the MCLs for the site contaminants of concern.

Estimated Post-Remediation Dissolved Zinc AWQC Ratios and Load Reduction at Pinehurst

Alternative	Estimated Post-Remediation AWQC Ratio for Dissolved Zinc at Pinehurst	Estimated Post-Remediation Dissolved Zinc Load Reduction at Pinehurst
Alternative 3+(a)	2.9	940 lb/day (41%)
Alternative 3+(b)	3.0	930 lb/day (41%)
Alternative 3+(c)	1.8	1,340 lb/day (59%)
Alternative 3+(d)	1.7	1,380 lb/day (60%)
Alternative 3+(e)	1.5	1,450 lb/day (63%)
Alternative 4+(a)	2.8	1,040 lb/day (45%)
Alternative 4+(b)	2.8	1,030 lb/day (45%)
Alternative 4+(c)	1.6	1,440 lb/day (63%)
Alternative 4+(d)	1.5	1,480 lb/day (65%)
Alternative 4+(e)	1.3	1,550 lb/day (68%)
No Action Alternative	5.2	N/A

Notes:

AWQC = ambient water quality criteria

lb/day = pounds per day

N/A = not applicable

Note: For reference the estimated current average annual dissolved zinc load at Pinehurst is 2,290 lb/day.

The results of this analysis indicate that all of the action alternatives would meet the threshold criterion of compliance with ARARs for surface water, but only after a natural source depletion period, which is common to all of the alternatives. The relative period of time required between alternatives is expected to be related to the water quality improvement achieved upon the completion of remedial actions. It is important to note that this analysis was only conducted at two key locations on the SFCDR: Pinehurst and Elizabeth Park. These two locations provide an estimate of overall cleanup progress in the Upper Basin, as the Elizabeth Park location is on the SFCDR upstream of the Box and Pinehurst location is on the SFCDR near the confluence with the North Fork and at the downstream end of the Box.

It is expected that dramatic localized improvements in surface water quality would be observed throughout areas of the Upper Basin resulting from remedial actions in various watershed and tributaries to the SFCDR.

Because the No Action Alternative was only included for baseline comparison purposes and does not meet either of the Threshold Criteria (overall protection of human health and the environment, and compliance with ARARs), it is not discussed further in the following sections that discuss the remaining evaluation criteria (the Primary Balancing Criteria).

Long-Term Effectiveness and Permanence. All of the alternatives based on Alternative 4+ rank slightly higher under the criterion of long-term effectiveness than those based on Alternative 3+, regardless of which OU 2 alternative it is coupled with. Alternative 4+ would achieve the highest degree of long-term effectiveness and permanence and would result in the fewest residual risks to human health and ecological receptors. Alternative 4+ has a higher degree of permanence than Alternative 3+ as a result of the much higher volumes of contaminated materials that would be removed from the system and managed in repositories. The estimated effectiveness at the completion of remedial actions is also slightly higher for Alternative 4+ than for Alternative 3+. The differences in ranking among the OU 2 alternatives under this criterion do not outweigh the differences between Alternatives 3+ and 4+. The ranking of the OU 2 alternatives, from highest to lowest, is (e), (d), (c), (a), and (b). This ranking is based on the relative differences in estimated post-remediation load in the SFCDR.

Reduction of Toxicity, Mobility, or Volume through Treatment. All the 10 combined remedial alternatives are considered to satisfy the statutory preference for treatment. Although the treated water flow rates are relatively similar for all the alternatives, the estimated mass of dissolved zinc removed through treatment ranges from 230 to 1,500 pounds per day (lb/day). Surface water treatment would occur through both active treatment at the CTP in Kellogg and semi-passive treatment near the source sites.

OU 2 Alternatives (a) and (b) do not include treatment and, therefore, rank lower under this criterion. OU 2 Alternative (c) would treat the greatest dissolved zinc load, followed by Alternative (d) and then (e). Alternative 4+ includes greater volumes of water treated at the CTP than Alternative 3+. However, Alternative 3+ is expected to remove more contaminant mass through treatment than Alternative 4+ (330 lb/day versus 230 lb/day, respectively); therefore, Alternative 3+ ranks higher than Alternative 4+. The statutory preference for treatment is satisfied through reduction of total volume of contaminated media—in this case, surface water. The water treatment technologies to be employed would separate the metals from the water. These metals would then require disposal in repositories.

Short-Term Effectiveness. All of the alternatives based on Alternative 3+ rank higher under the criterion of short-term effectiveness than those based on Alternative 4+ because Alternative 4+ would pose much greater short-term negative impacts during construction than Alternative 3+, regardless of which OU 2 alternative it is coupled with. This is primarily due to the more extensive nature of the remedial actions that would be conducted under Alternative 4+, which would require a much longer time period to complete (up to decades longer); the similar water quality expected to be achieved after the implementation of remedial actions; and the similar time frame needed for natural source depletion to further improve water quality and achieve ARARs. The ranking of the OU 2 alternatives from highest to lowest short-term effectiveness is as follows: (d), (c), (b), (a), and (e). This ranking is based on a balance of implementation time, effectiveness, and short-term risks.

Implementability. All of the alternatives based on Alternative 3+ rank higher under the criterion of implementability than those based on Alternative 4+, because Alternative 4+ would have substantially increased technical and administrative feasibility considerations compared to Alternative 3+. Alternative 4+ has generally the same types of implementability considerations as Alternative 3+, but with much larger quantities and larger repository requirements. The ranking of the OU 2 alternatives from most to least desirable on the basis of implementability is as follows: (c), (d), (b), (a), and (e).

Cost of Implementation. Estimated costs for each remedial alternative are presented in Table ES-1. As shown, costs for alternatives based on Alternative 4+ are consistently higher than those based on Alternative 3+, regardless of which OU 2 alternative it is coupled with. The OU 2 costs are relatively small, ranging from 1 to 20 percent of the total alternative cost. The ranking of the OU 2 alternatives based on lowest to highest cost is as follows: (b), (c), (d), (a), and (e). The cost for OU 2 Alternative (a) is higher than the cost for OU 2 Alternative (b) because, although (b) includes more linear feet of stream lining, (a) includes a liner on the SFCDR that carries a significantly higher cost.

Evaluation and Comparison of the Remedy Protection Alternatives

For the remedy protection alternatives, a summary of the comparative evaluation is presented in Figure ES-3. This figure summarizes the various trade-offs between alternatives when compared to the CERCLA Threshold and Primary Balancing Criteria. The comparative analysis of the remedy protection alternatives is discussed below.

Overall Protection of Human Health and the Environment. Both Alternatives RP-1 and RP-2 would be protective of human health and the environment because the existing human health remedies have been shown to be protective (USEPA, 2005). Alternative RP-2 would be more protective of human health and the environment because it would increase the long-term effectiveness and permanence of the existing remedies by decreasing the risk of recontamination due to flooding and uncontrolled surface water flows. Alternative RP-1 would only maintain and repair the existing remedies if they were damaged or recontaminated.

Compliance with ARARs. Both Alternatives RP-1 and RP-2 can be implemented in compliance with location- and action-specific ARARs. (Chemical-specific ARARs were not included as part of this evaluation because the remedy protection alternatives would only enhance the protectiveness of the existing remedies, and do not directly address metals contamination.)

Long-Term Effectiveness and Permanence. Alternative RP-2 would increase the long-term effectiveness and permanence of the existing remedies by increasing flooding controls and localized surface water controls, thereby decreasing the risk of recontamination and damage to the remedies due to flooding and uncontrolled surface water flows. Alternative RP-1 would only maintain and repair the existing remedies if they were damaged or recontaminated.

Reduction of Toxicity, Mobility, or Volume through Treatment. Neither Alternative RP-1 nor Alternative RP-2 would include treatment and, therefore, neither would reduce the toxicity, mobility, or volume of metal contaminants through treatment.

Short-Term Effectiveness. Both alternatives would be effective in the short term because the existing remedies have proven effective in protecting human health and the environment. Alternative RP-2 would reduce the mobility of potentially contaminated sediments transported by floodwaters and surface water flows through the communities by effectively conveying floodwaters up to a 50-year storm event, thereby reducing the potential routes of exposure. Alternative RP-1 would not reduce the current mobility of contaminated sediments transported by floodwaters through the communities.

Implementability. Both Alternatives RP-1 and RP-2 are implementable, but each would have typical implementation issues that would need to be addressed. Alternative RP-1 would require clean up of recontaminated or scoured portions of the existing remedies. Contaminated sediments may also be deposited on other areas within the communities such as streets, buildings, and parking lots. The effective implementation of Alternative RP-1 would require a coordinated overall response within the communities. Administrative implementability issues would exist for Alternative RP-1 with respect to the repair and replacement of the existing remedies following storm events. These storm events cannot be predicted, and the availability of funds to repair the existing remedies and maintain their protectiveness in the future is unknown. In some cases, the repair of the protective barriers could be time-sensitive in order to maintain protectiveness and limit community residents' risk of exposure.

By comparison, Alternative RP-2 would have minimal implementability issues, except that it would be beneficial to implement the remedy protection projects during the low-flow season to minimize cost. Alternative RP-2 may have administrative implementability issues associated with O&M of the water conveyance improvement projects. Prior to construction, agreements will have to be completed regarding which state or local entity will perform O&M tasks associated with Alternative RP-2 and ensure that sufficient resources are available, or a determination will be made that a local regulatory scheme ensures performance of O&M. Additionally, there would be logistical feasibility issues associated with the construction of remedy protection projects on private property. Access and easement agreements would have to be obtained prior to the implementation of Alternative RP-2.

Cost of Implementation. Alternative RP-2 would cost less than Alternative RP-1. Table ES-1 presents a side-by-side comparison of the total costs (30-year net present value [NPV]) for Alternatives RP-1 and RP-2. The total cost (30-year NPV) for Alternative RP-1 includes the expected cost to repair and re-remediate the existing remedies based on model outputs and flood event probabilities. For Alternative RP-2, the total cost (30-year NPV) includes direct and indirect capital costs and O&M costs (30-year NPV) for construction of the remedy protection projects. Total costs for both alternatives include estimated costs for the side gulches. Detailed analyses were not conducted for the side gulches, but approximate costs were developed for both alternatives based on trends observed in the Upper Basin communities.

Next Steps

The Draft Final FFS Report and the Proposed Plan—the latter of which identifies a Preferred Alternative for the Upper Coeur d'Alene Basin—are available for a 45-day public comment period from July 12, 2010 to August 25, 2010.

The Draft Final FFS Report is presented on CD-ROM (along with the Proposed Plan and other supporting documents) because of the size of the document and the costs associated with hardcopy production and distribution. If this CD-ROM format does not enable easy review of the document, please contact USEPA to discuss other options to facilitate your review.

Comments are due to USEPA Region 10 by Wednesday, August 25, 2010. One of the files on the CD-ROM is an optional comment form which could be used to provide comments to USEPA via:

1. E-mail to cdabasin@epa.gov

2. Mail to: Coeur d'Alene Basin Team
   U.S. Environmental Protection Agency Region 10
   Mailstop ECL-113
   1200 Sixth Avenue, Suite 900
   Seattle, WA 98101

3. Comments can also be provided at the Open House and Public Meeting to be held on Wednesday, August 4, 2010 at the Shoshone Medical Center, Health and Education Center, 858 Commerce Drive, Smelterville, Idaho 83868. The Open House will take place from 5:00 to 6:30 p.m., and the Public Meeting from 7:00 to 8:30 p.m.

Following the Proposed Plan comment period, USEPA will consider and respond to all comments and plans to issue the Upper Basin ROD Amendment. The ROD Amendment will include a Responsiveness Summary with responses to comments received during the public comment period for the Proposed Plan. This decision document is anticipated to be issued in late 2010.

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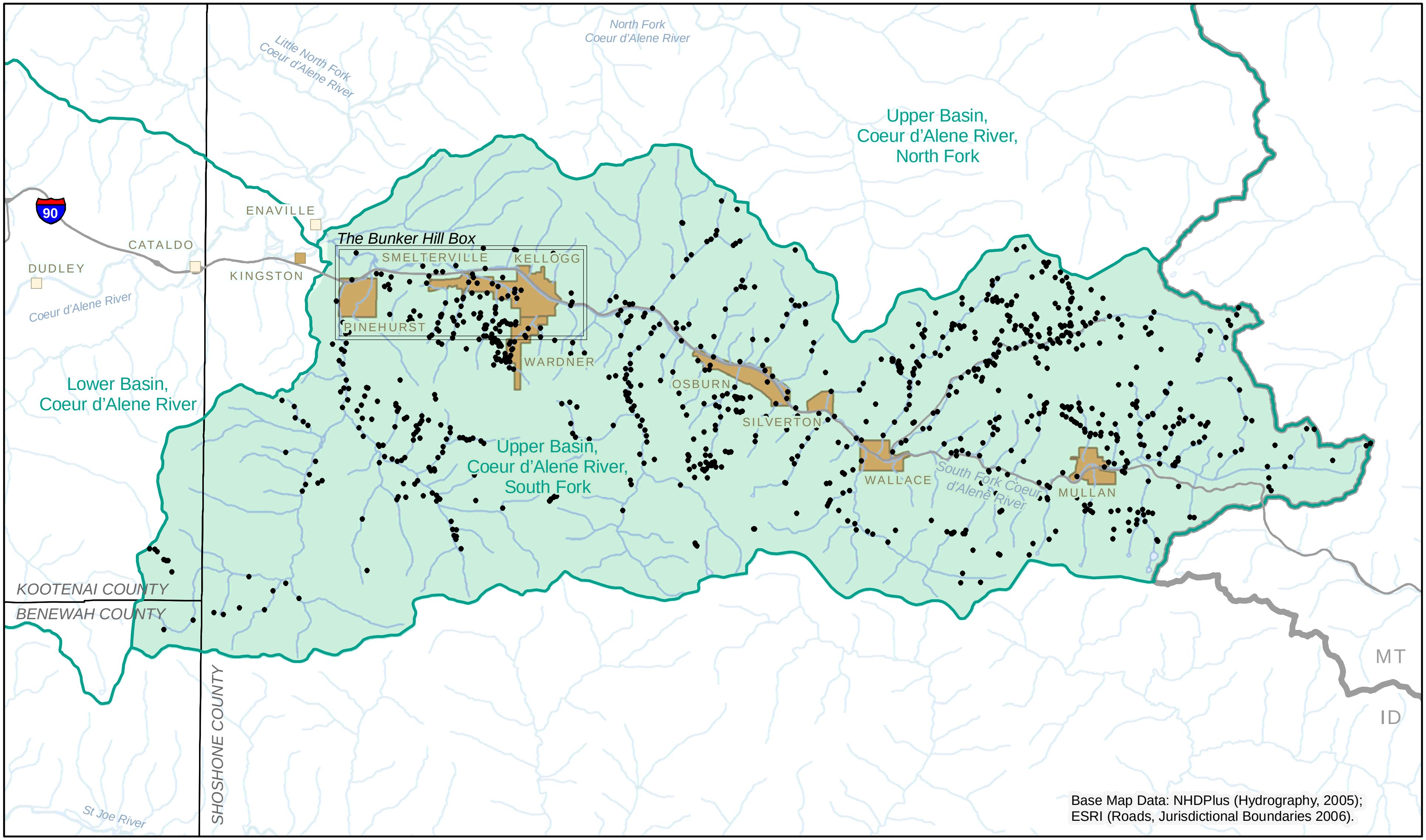
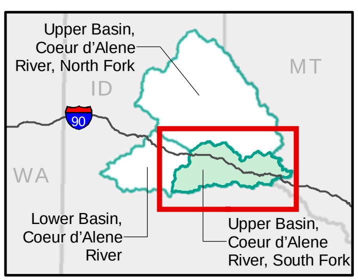
Figures





- Focused Feasibility Study Area
- Approximate Remedy Protection Study Area
- Coeur d'Alene River Subbasin Boundary
- Source Site
- River/Creek
- County Boundary
- State Boundary

Notes:
1. The Focused Feasibility Study Area includes the Bunker Hill Box (OU 1 and OU 2) and the portions of OU 3 within the Upper Basin.
2. Operable Unit 3 is defined as all contaminated areas of the Coeur d'Alene River Basin, Coeur d'Alene Lake, and the Spokane River, outside the Box.
3. Source sites are based on the inventory of source sites conducted by the Bureau of Land Management (BLM) in 1999 in support of the Remedial Investigation/Feasibility Study (RI/FS) for the Coeur d'Alene Basin (U.S. Environmental Protection Agency [USEPA], 2001a, 2001b).

N

0 1 2 4 Miles

Figure ES-1
Focused Feasibility Study Area
Focused Feasibility Study
Upper Basin of the Coeur d'Alene River
BUNKER HILL SUPERFUND SITE

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Criterion	Alternative 3+(a)	Alternative 3+(b)	Alternative 3+(c)	Alternative 3+(d)	Alternative 3+(e)	Alternative 4+(a)	Alternative 4+(b)	Alternative 4+(c)	Alternative 4+(d)	Alternative 4+(e)
Threshold Criteria										
Overall Protectiveness of Human Health and the Environment evaluates the overall protectiveness of the alternatives and describes how risks posed are eliminated, reduced, or controlled through treatment, engineering, or institutional controls.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Compliance with Applicable or Relevant and Appropriate Requirements (ARARs) evaluates whether an alternative meets federal, state, and tribal environmental statutes, regulations, and other requirements that pertain to the site, and/or whether a waiver is justified.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Primary Balancing Criteria										
Long-Term Effectiveness and Permanence considers an alternative's ability to protect human health and the environment over time.	Medium	Medium	Medium	High	High	High	High	Highest	Highest	Highest
Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment evaluates an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contamination present.	Low	Medium	High	Highest	Medium	Low	Low	High	High	Medium
Short-Term Effectiveness considers the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment during implementation.	High	High	High	High	Medium	Medium	Medium	Medium	Medium	Low
Implementability considers the technical and administrative feasibility of implementing an alternative, including factors such as the availability of goods and services.	Medium	Medium	Highest	High	Low	Low	Low	Low	Low	Lowest
Cost includes estimated present worth capital and operation and maintenance (O&M) costs. O&M costs are estimated for a 30-year period using a discount rate of 7 percent.	High	High	High	High	Medium	Lowest	Lowest	Lowest	Lowest	Lowest
Modifying Criteria										
State/Tribal Acceptance considers whether the States and Tribes agree with USEPA's analyses and recommendations, as described in the Focused Feasibility Study Report and the Proposed Plan.	**To be evaluated after comments are received on the Proposed Plan.**									
Community Acceptance considers whether the local community agrees with USEPA's analyses and the Selected Remedy. Comments received on the Proposed Plan during the public comment period are an important indicator of community acceptance.										

✓ Alternative meets this Threshold Criterion.

Comparative Ranking Symbols:

- **Highest** – The alternative is either the most favorable, compared to the other alternatives, or is equally favorable among the alternatives ranked highest.
- **High** – The alternative is highly favorable in regard to this criterion, but at least one other alternative is ranked higher.
- **Medium** – The alternative is moderately favorable (i.e., other alternatives are more or less favorable for this criterion).
- **Low** – The alternative is somewhat favorable for this criterion, but at least one alternative is ranked lower.
- **Lowest** – The alternative is either the least favorable, compared to other alternatives, or does not meet the criterion.

Figure ES-2
Overview of Comparative Analysis of Remedial Alternatives
Focused Feasibility Study
Upper Basin of the Coeur d'Alene River
BUNKER HILL SUPERFUND SITE

Criterion	Alternative RP-1	Alternative RP-2
Threshold Criteria		
Overall Protectiveness of Human Health and the Environment evaluates the overall protectiveness of the alternatives and describes how risks posed are eliminated, reduced, or controlled through treatment, engineering, or institutional controls.	✓	✓
Compliance with Applicable or Relevant and Appropriate Requirements (ARARs) evaluates whether an alternative meets federal, state, and tribal environmental statutes, regulations, and other requirements that pertain to the site, and/or whether a waiver is justified.	✓	✓
Primary Balancing Criteria		
Long-Term Effectiveness and Permanence considers an alternative's ability to protect human health and the environment over time.	● (Low)	⬤ (Highest)
Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment evaluates an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contamination present.	○ (Lowest)	○ (Lowest)
Short-Term Effectiveness considers the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment during implementation.	● (Low)	● (High)
Implementability considers the technical and administrative feasibility of implementing an alternative, including factors such as the availability of goods and services.	● (Low)	● (High)
Cost includes estimated present worth capital and operation and maintenance (O&M) costs. O&M costs are estimated for a 30-year period using a discount rate of 7 percent.	● (Low)	● (High)
Modifying Criteria		
State/Tribal Acceptance considers whether the States and Tribes agree with USEPA's analyses and recommendations, as described in the Focused Feasibility Study Report and the Proposed Plan.	**To be evaluated after comments are received on the Proposed Plan.**	
Community Acceptance considers whether the local community agrees with USEPA's analyses and the Selected Remedy. Comments received on the Proposed Plan during the public comment period are an important indicator of community acceptance.		

✓ Alternative meets this Threshold Criterion.

Comparative Ranking Symbols:

- ⬤ **Highest** – The alternative is either the most favorable, compared to the other alternatives, or is equally favorable among the alternatives ranked highest.
- ● **High** – The alternative is highly favorable in regard to this criterion, but at least one other alternative is ranked higher.
- ● **Medium** – The alternative is moderately favorable (i.e., other alternatives are more or less favorable for this criterion).
- • **Low** – The alternative is somewhat favorable for this criterion, but at least one alternative is ranked lower.
- ○ **Lowest** – The alternative is either the least favorable, compared to other alternatives, or does not meet the criterion.

Figure ES-3
Overview of Comparative Analysis of Remedy Protection Alternatives
Focused Feasibility Study
Upper Basin of the Coeur d'Alene River
BUNKER HILL SUPERFUND SITE

Tables

TABLE ES-1

Summary of Cost Estimates for Remedial Alternatives and Remedy Protection Alternatives

Focused Feasibility Study, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

Remedial Alternative	Remedial Actions	Total Capital Cost	O&M Cost (30-Year NPV)	O&M Cost (Annual Average)	Total Cost (30-Year NPV)
Alternative 3+(a)	Alternative 3+ for OU 3	$ 1,170,000,000	$ 93,600,000	$ 7,540,000	$ 1,270,000,000
	Alternative (a) for OU 2	$ 60,200,000	$ 1,190,000	$ 95,900	$ 61,400,000
	Sludge Disposal Cell	$ 5,055,000	$ 254,000	$ 20,500	$ 5,310,000
	Total	**$ 1,240,000,000**	**$ 95,000,000**	**$ 7,660,000**	**$ 1,340,000,000**
Alternative 3+(b)	Alternative 3+ for OU 3	$ 1,170,000,000	$ 93,600,000	$ 7,540,000	$ 1,270,000,000
	Alternative (b) for OU 2	$ 24,800,000	$ 1,020,000	$ 82,200	$ 25,900,000
	Sludge Disposal Cell	$ 5,055,000	$ 254,000	$ 20,500	$ 5,310,000
	Total	**$ 1,200,000,000**	**$ 94,900,000**	**$ 7,640,000**	**$ 1,290,000,000**
Alternative 3+(c)	Alternative 3+ for OU 3	$ 1,170,000,000	$ 93,600,000	$ 7,540,000	$ 1,270,000,000
	Alternative (c) for OU 2	$ 21,800,000	$ 5,790,000	$ 466,600	$ 27,600,000
	Sludge Disposal Cell	$ 7,370,000	$ 397,000	$ 32,000	$ 7,770,000
	Total	**$ 1,200,000,000**	**$ 99,800,000**	**$ 8,040,000**	**$ 1,300,000,000**
Alternative 3+(d)	Alternative 3+ for OU 3	$ 1,170,000,000	$ 93,600,000	$ 7,540,000	$ 1,270,000,000
	Alternative (d) for OU 2	$ 32,900,000	$ 6,460,000	$ 520,600	$ 39,400,000
	Sludge Disposal Cell	$ 7,330,000	$ 397,000	$ 32,000	$ 7,730,000
	Total	**$ 1,210,000,000**	**$ 100,500,000**	**$ 8,090,000**	**$ 1,310,000,000**
Alternative 3+(e)	Alternative 3+ for OU 3	$ 1,170,000,000	$ 93,600,000	$ 7,540,000	$ 1,270,000,000
	Alternative (e) for OU 2	$ 250,000,000	$ 10,000,000	$ 805,900	$ 260,000,000
	Sludge Disposal Cell	$ 6,490,000	$ 340,000	$ 27,400	$ 6,830,000
	Total	**$ 1,430,000,000**	**$ 104,000,000**	**$ 8,370,000**	**$ 1,530,000,000**
Alternative 4+(a)	Alternative 4+ for OU 3	$ 1,770,000,000	$ 144,000,000	$ 11,600,000	$ 1,910,000,000
	Alternative (a) for OU 2	$ 60,200,000	$ 1,190,000	$ 95,900	$ 61,400,000
	Sludge Disposal Cell	$ 5,480,000	$ 279,000	$ 22,500	$ 5,760,000
	Total	**$ 1,840,000,000**	**$ 145,000,000**	**$ 11,700,000**	**$ 1,990,000,000**
Alternative 4+(b)	Alternative 4+ for OU 3	$ 1,770,000,000	$ 144,000,000	$ 11,600,000	$ 1,910,000,000
	Alternative (b) for OU 2	$ 24,800,000	$ 1,020,000	$ 82,200	$ 25,900,000
	Sludge Disposal Cell	$ 5,480,000	$ 279,000	$ 22,500	$ 5,760,000
	Total	**$ 1,800,000,000**	**$ 145,000,000**	**$ 11,700,000**	**$ 1,950,000,000**
Alternative 4+(c)	Alternative 4+ for OU 3	$ 1,770,000,000	$ 144,000,000	$ 11,600,000	$ 1,910,000,000
	Alternative (c) for OU 2	$ 21,800,000	$ 5,790,000	$ 466,600	$ 27,600,000
	Sludge Disposal Cell	$ 7,880,000	$ 426,000	$ 34,300	$ 8,310,000
	Total	**$ 1,800,000,000**	**$ 150,000,000**	**$ 12,100,000**	**$ 1,950,000,000**
Alternative 4+(d)	Alternative 4+ for OU 3	$ 1,770,000,000	$ 144,000,000	$ 11,600,000	$ 1,910,000,000
	Alternative (d) for OU 2	$ 32,900,000	$ 6,460,000	$ 520,600	$ 39,400,000
	Sludge Disposal Cell	$ 7,830,000	$ 423,000	$ 34,100	$ 8,250,000
	Total	**$ 1,810,000,000**	**$ 151,000,000**	**$ 12,200,000**	**$ 1,960,000,000**
Alternative 4+(e)	Alternative 4+ for OU 3	$ 1,770,000,000	$ 144,000,000	$ 11,600,000	$ 1,910,000,000
	Alternative (e) for OU 2	$ 250,000,000	$ 10,000,000	$ 805,900	$ 260,000,000
	Sludge Disposal Cell	$ 6,930,000	$ 369,000	$ 29,700	$ 7,300,000
	Total	**$ 2,030,000,000**	**$ 154,000,000**	**$ 12,400,000**	**$ 2,180,000,000**

TABLE ES-1
Summary of Cost Estimates for Remedial Alternatives and Remedy Protection Alternatives
Focused Feasibility Study, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

Remedy Protection Alternative	Remedial Actions	Total Capital Cost	O&M Cost (30-Year NPV)	O&M Cost (Annual Average)	Total Cost (30-Year NPV)
RP-1	Upper Basin Communities[1]	$ -	$ -	$ -	$ 33,800,000
	Side Gulches[2]	$ -	$ -	$ -	$ 16,300,000
	Total	**$ -**	**$ -**	**$ -**	**$ 50,100,000**
RP-2	Upper Basin Communities[1]	$ 13,700,000	$ 4,980,000	$ 401,000	$ 18,800,000
	Side Gulches[2]	$ 10,900,000	$ 4,180,000	$ 337,000	$ 15,100,000
	Total	**$ 24,600,000**	**$ 9,160,000**	**$ 738,000**	**$ 33,900,000**

Notes:

O&M = operation and maintenance
NPV = net present value
OU 2 = Operable Unit 2
OU 3 = Operable Unit 3

[1]The costs for Alternatives RP-1 and RP-2 in the eight primary Upper Basin communities include Pinehurst, Smelterville, Kellogg, Wardner, Osburn, Silverton, Wallace, and Mullan.
[2]Side gulch costs for Alternatives RP-1 and RP-2 are approximate based on assumptions discussed in Appendix D of this FFS Report.

The above costs are presented rounded to three significant figures.

The above cost opinion is a Feasibility-Study-level estimate with a nominal accuracy of –30 percent to +50 percent (–30/+50%).

The above cost opinion is in 2009 dollars and does not include future escalation. The order-of-magnitude cost opinion shown has been prepared for guidance in project evaluation from the information available at the time of preparation. The final costs of the project will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, the final project scope, the final project schedule, and other variable factors.
As a result, the final project costs will vary from those presented above. Because of these factors, funding needs must be carefully reviewed prior to making specific financial decisions or establishing final budgets.

The OU 3 total capital cost includes the roads and bridges costs.
The NPV sludge disposal cell closure costs includes closure of the existing sludge disposal cell.
The NPV sludge disposal cell closure costs are based on the time for the existing sludge disposal cell to reach capacity.
The O&M cost (annual average) is calculated by dividing the O&M cost (30-Year NPV) by a factor of 12.409 to account for the 30 years at 7%.

SECTION 1.0

Introduction

This Focused Feasibility Study (FFS) Report presents and evaluates remedial alternatives for the Upper Basin of the Coeur d'Alene River in Northern Idaho, which is part of the Bunker Hill Mining and Metallurgical Complex Superfund Site (also referred to as "the Site" and "the Bunker Hill Superfund Site"; see Figure 1-1).[1] The Site was placed on the National Priorities List (NPL) in 1983 and has been assigned Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) identification number IDD048340921. The Site includes mining-contaminated areas of the Coeur d'Alene River corridor, adjacent floodplains, downstream water bodies, tributaries, and fill areas, as well as the 21-square-mile Bunker Hill "Box" (often referred to as "the Box") that is located in the area surrounding historical smelting operations.

The U.S. Environmental Protection Agency (USEPA) has designated three Operable Units (OUs) at the Site: the populated areas of the Box (OU 1); the non-populated areas of the Box (OU 2); and mining-related contamination in the broader Coeur d'Alene Basin exclusive of the Box (OU 3)[2]. The OUs are summarized as follows:

Bunker Hill Superfund Site Operable Units (OUs)	
OU 1	OU 1 is defined as the *populated areas* of the Bunker Hill Box because it is home to more than 7,000 residents of the towns of Pinehurst, Smelterville, Kellogg, and Wardner, as well as the unincorporated communities of Page, Ross Ranch, Elizabeth Park, and Montgomery Gulch. Residences also extend up side gulches and adjacent hillside areas. Populated-area issues of concern include residential yards, house dust, commercial properties, public use areas, and street rights of way.
OU 2	OU 2 includes the *non-populated areas* of the Bunker Hill Box. These areas include former industrial areas such as the Mine Operations Area (MOA) in Kellogg; Smelterville Flats (the floodplain of the SFCDR in the western half of the Bunker Hill Box); hillsides, creeks, and gulches; the Central Impoundment Area (CIA) in Kellogg; the Central Treatment Plant (CTP), a water treatment facility in Kellogg for acid mine drainage (AMD) and other metals-contaminated water; and the Bunker Hill Mine with its associated AMD.
OU 3	OU 3 includes all areas of the Coeur d'Alene Basin outside the Bunker Hill Box where mining-related contamination is located. OU 3 extends from near the Idaho-Montana border into the State of Washington, and includes floodplains, communities, lakes, rivers, and tributaries. Pine Creek and the portion of the SFCDR within the Bunker Hill Box are considered part of OU 3.

The study area for the FFS (Figure 1-2) includes OUs 1 and 2 and the Upper Basin portion of OU 3. For the purposes of this FFS, the Upper Basin includes the South Fork of the Coeur d'Alene River (SFCDR) and its tributaries downstream to the confluence of the South and North Forks of the river; and the Box, where USEPA began its cleanup work in the 1980s. As shown in Figure 1-2, the FFS study area comprises the Upper Basin and extends

[1] The figures and tables referenced in Volume 1 of this report are provided in Volume 2.

[2] The reaches of the South Fork of the Coeur d'Alene River and Pine Creek that pass through OU 2 are actually defined as being part of OU 3.

approximately one mile to the west beyond the confluence of the North and South Forks of the Coeur d'Alene River to include the town of Kingston.

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) prescribes a remedy selection process for sites listed on the NPL. The Feasibility Study (FS) typically serves as the mechanism to develop and evaluate a range of remedial alternatives that provide information needed by decisionmakers to help formulate a Proposed Plan, which identifies a "Preferred Alternative" for a site. Following public and stakeholder review and input on the Proposed Plan, a remedy is selected and documented in a Record of Decision (ROD). USEPA has already issued three RODs that described Selected Human Health and Ecological Remedies for contamination in the Upper Coeur d'Alene Basin:

- For OU 1, the *Record of Decision, Bunker Hill Mining and Metallurgical Complex Residential Soils Operable Unit, Shoshone County, Idaho* (ROD for OU 1; USEPA, 1991a);
- For OU 2, the *Record of Decision (ROD), Bunker Hill Mining and Metallurgical Complex, Shoshone County, Idaho* (ROD for OU 2; USEPA, 1992); and
- For OU 3, the *Record of Decision, Bunker Hill Mining and Metallurgical Complex Operable Unit 3* (ROD for OU 3, also referred to as "the Interim ROD for OU 3" and "the Interim ROD"; USEPA, 2002b).

A ROD Amendment for the Upper Basin will be prepared based on the analyses presented in this FFS Report, the Preferred Alternative presented in the Proposed Plan, and consideration of public comments on the Proposed Plan and associated documents. The ROD Amendment will modify existing and identify additional remedial actions for the Box and the Upper Basin, building on the Selected Remedies identified in the RODs for OUs 1, 2, and 3. In addition, the ROD Amendment will provide enhanced protection of human health and the environment for portions of Selected Human Health Remedies that are vulnerable to erosion of clean barriers. Therefore, both potential remedial actions and measures to protect existing remedies are presented and evaluated in this FFS Report, and will be summarized in the Proposed Plan.

USEPA has conducted the FFS in accordance with CERCLA, and this FFS Report has been prepared following the regulations that implement the provisions of CERCLA: the National Oil and Hazardous Substances Pollution Contingency Plan (known as the NCP), *Code of Federal Regulations* (CFR) Title 40 Part 300. The methods used to prepare this FFS Report were also consistent with USEPA guidance as defined in the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA, 1988b).

The following sections discuss the following:

- the impetus for the FFS (Section 1.1), including the status of the existing Selected Human Health and Ecological Remedies and new information that has become available since the RODs for OUs 1, 2, and 3 were issued;
- the study's purpose and objectives (Section 1.2) and scope (Section 1.3);
- the approach to conducting the study (Section 1.4);

- the FS process in general, and its focused implementation with regard to the Upper Coeur d'Alene Basin (Section 1.5); and
- the organization of this FFS Report (Section 1.6).

1.1 Impetus for the Focused Feasibility Study

The previous FS Reports and RODs prepared for the three OUs at the Bunker Hill Superfund Site identified various remedies and cleanup actions. The 1991 ROD for OU 1 selected a final Human Health Remedy for the populated areas of the Box and focused on remediation of lead-contaminated soil in residential areas. The 1992 ROD for OU 2 addressed the non-populated, non-residential areas of the Box, developed prioritized cleanup actions to protect human health and the environment, and selected a final Ecological Remedy for surface water and groundwater. This ROD also addressed some OU 1 remedial activities such as rights of way, commercial properties, and house dust. The 2002 ROD for OU 3 selected a final Human Health Remedy for community and residential areas, including identified recreational areas, an interim remedy of prioritized actions for protection of the environment in the Coeur d'Alene Basin and final actions for protection of human health and the environment in the Spokane River in Washington State (upstream of the Upriver Dam). The ROD for OU 3 did not include remedial actions in Coeur d'Alene Lake because state, Tribal, federal, and local governments are addressing this area outside the Superfund process using separate legal authorities under CERCLA.

USEPA is updating its cleanup plan for the Upper Coeur d'Alene Basin using its improved knowledge of conditions in the Upper Basin and in response to a National Academy of Sciences review of the ROD for OU 3 (NAS, 2005). USEPA's preferred alternative for the Upper Basin will be identified in the Proposed Plan and, after consideration of public comments, a revised cleanup plan will be selected in the ROD Amendment. The revised cleanup plan will provide a comprehensive approach for addressing mining-related contamination in all three OUs in the Upper Basin. As noted above, the ROD Amendment will also include additional actions to enhance the protectiveness and permanence of the Selected Human Health Remedies that have been and continue to be implemented in the Upper Basin. This FFS has followed a systematic process, in accordance with the NCP, for the analysis of potential remedial actions and remedy protection measures to be included in the Proposed Plan and ROD Amendment.

Sections 1.1.1 and 1.1.2 describe the current status of the Selected Human Health and Ecological Remedies for the Upper Basin and why modification of these remedies is needed. Section 1.1.3 summarizes the data collection efforts and studies that have been conducted since the RODs for OUs 1, 2, and 3 were issued, the results of which have been used in the FFS to update prior analyses and to develop and evaluate new and enhanced remedial alternatives.

1.1.1 Status of the Selected Human Health Remedies

The human health remedy installed by the potentially responsible parties (PRPs) for OU 1 was certified complete in 2008. The Selected Human Health Remedy for the Bunker Hill Box, presented in the ROD for OU 2 (USEPA, 1992), has not been fully implemented but is nearing completion. Implementation of the Selected Human Health Remedy for community and residential areas in the Coeur d'Alene Basin exclusive of the Box, presented in the ROD for OU 3 (USEPA, 2002b), is ongoing but unfinished. USEPA recently received additional funding through the American Recovery and Reinvestment Act of 2009 (commonly referred to as the Stimulus or the Recovery Act) to accelerate the implementation of remaining human health cleanup activities in the Coeur d'Alene Basin.

Periodic reviews conducted to date show that the final Selected Human Health Remedies for OUs 1, 2, and 3 have functioned as designed and are protective of human health. For example, the Superfund cleanup actions have resulted in significant and well-documented declines in children's blood lead levels, as measured by blood lead concentrations within the communities where cleanup actions have been implemented (USEPA, 2005b). In addition, institutional controls have been put into place to ensure the protection of human health pending the identification of a final remedy for groundwater, soil, and sediments. These include actions such as fencing and signage to limit human access to contaminated areas, closure of water supply wells in the Bunker Hill Box, sampling of private wells, and provision for alternative water supplies as necessary.

At the same time, USEPA is aware of certain circumstances that have the potential to adversely affect the successful long-term functioning of the Selected Human Health Remedies (as well as the Selected Ecological Remedies for the three OUs). In general, the circumstances of concern are associated with overland water flow from precipitation events and tributary flooding that erode clean barriers and/or deposit contaminated sediments in clean areas. Clean barriers have been installed to prevent exposure to mining- and smelting-related contaminants through direct contact, and long-term maintenance of these barriers is a key component of the Selected Human Health Remedies. An Institutional Controls Program (ICP)[3] has been established to provide a locally enforced set of rules and regulations to maintain the integrity of installed barriers and to ensure that new barriers are installed during redevelopment that may occur within the administrative boundary of the ICP. Some components of the existing surface water conveyance infrastructure in Upper Basin communities also serve to protect the clean barriers. Although some communities have sought resources to improve their water conveyance systems, available resources often are not sufficient to safeguard the remedies that have been implemented for protection of human health and the environment.

Protection of human health continues to be a vital part of USEPA's work at the Bunker Hill Superfund Site. USEPA has therefore evaluated drainage issues in Upper Basin communities and circumstances that may erode or degrade clean barriers and/or contaminate clean areas. This evaluation led to consideration in this FFS of actions that enhance the protectiveness of the Selected Human Health Remedies for OUs 1 and 2 and the Upper Basin portion of OU 3.

This approach to remedy protection is consistent with USEPA's adaptive management approach to the Bunker Hill Superfund Site, which involves identifying and evaluating remedy modifications and making adjustments to the cleanup approach, through design, implementation or decision documents as appropriate, when needed based on new

[3] Idaho Administrative Procedures Act (IDAPA) 41.01.01, Rules of Panhandle Health District (PHD) 1, is the promulgated rule establishing the ICP. It describes PHD's authority and the ICP's scope and intent.

information. Where possible, this FFS evaluates specific actions that could be taken to protect the Selected Human Health Remedies.

1.1.2 Status of the Selected Ecological Remedies

The Selected Ecological Remedy for the Bunker Hill Box is documented in the ROD for OU 2 and is being implemented by USEPA and the Idaho Department of Environmental Quality (IDEQ) using a phased approach, which was developed by these agencies following the bankruptcy of the major potentially responsible party (PRP) for the Bunker Hill Superfund Site in 1994. A Comprehensive Cleanup Plan (CCP) developed as part of the 1995 State Superfund Contract (SSC) for OU 2 (USEPA and Idaho Department of Health and Welfare [IDHW], 1995) defined the phased path forward for remedy implementation at OU 2. Since then, two OU 2 ROD Amendments (USEPA, 1996d, 2001e) and two Explanations of Significant Differences (ESDs; USEPA, 1996a, 1998) have been issued. The 1996 ROD Amendment changed the remedy for Principal Threat Materials (PTM) from chemical stabilization to containment. The 2001 ROD Amendment addressed acid mine drainage (AMD) issues within OU 2. To date, USEPA and the State of Idaho have not concluded negotiations on an SSC amendment that would allow for full implementation of the 2001 ROD Amendment. The two ESDs clarified portions of the Selected Remedy for OU 2.

Phase I work at OU 2 is largely complete. The focus was on remedial actions aimed at removal and consolidation of extensive contamination from various areas, demolition of structures, development and implementation of an ICP for OUs 1 and 2, future land use development, and public health response actions. Phase I work also included support of studies for long-term water quality improvement and evaluation of the effectiveness of the source removal, containment, and surface capping completed as part of Phase I remedial actions at OU 2. The latter evaluation is documented in the *Phase I Remedial Action Assessment Report, Operable Unit 2* (CH2M HILL, 2007d), the *Final Phase I Remedial Action Characterization Report for the Bunker Hill Mining and Metallurgical Complex Superfund Site OU2* (TerraGraphics and Ralston Hydrologic Services, 2006), and the *Source Areas of Concern Report, Operable Unit 2* (CH2M HILL, 2008a), and set the stage for consideration of Phase II remedial alternatives for OU 2 in this FFS. Phase II is generally intended to address any shortcomings encountered in implementing Phase I and will specifically address long-term water quality and environmental management issues.

For OU 3, the Selected Ecological Remedy presented in the 2002 ROD is an *interim* remedy based upon a prioritized subset of the numerous actions included in Ecological Alternative 3 in the *Final (Revision 2) Feasibility Study Report, Coeur d'Alene Basin Remedial Investigation/Feasibility Study* (2001 FS Report; USEPA, 2001d). Both Ecological Alternatives 3 and 4 in that FS Report included NCP-compliant remedial actions and provided a foundation upon which to develop the alternatives evaluated in this FFS.

1.1.3 New Information Supporting the Development and Evaluation of Remedial Alternatives

Since the RODs for OUs 1, 2, and 3 were issued (and the ROD for OU 2 was amended), data collection and pre-remediation studies have continued. A considerable body of information is now available for updating prior analyses, developing and evaluating enhanced remedial alternatives, and selecting a final remedy for the Upper Basin. In addition, information is now available with which to evaluate alternatives to protect and maintain the existing Selected Human Health and Ecological Remedies for OUs 1 and 2 and the Upper Basin portion of OU 3. Key studies contributing to this body of information have included:

- additional investigation of both surface water and groundwater quality and flow and the fate and transport of dissolved metals in the Upper Basin, including ongoing monitoring under the OU 3 Basin Environmental Monitoring Program (BEMP; USEPA, 2004) and the OU 2 Environmental Monitoring Program (EMP; CH2M HILL, 2006b), and by the U.S. Geological Survey (USGS; Donato, 2006);
- the NAS review of the ROD for OU 3 (NAS, 2005);
- enhancement of the probabilistic model used in the 2001 FS Report (USEPA, 2001d) to develop both a Predictive Analysis tool for post-remediation metals loading to the SFCDR (USEPA, 2007) and a simplified version of this tool (CH2M HILL, 2009n). These enhancements were made, in part, in response to NAS comments on the probabilistic model (NAS, 2005);
- detailed assessment of the effectiveness to date of Phase I remedial actions conducted in OU 2 (CH2M HILL, 2007d, 2008a; TerraGraphics and Ralston Hydrologic Services, 2006);
- post-remediation monitoring at the Golconda, Rex, Woodland Park, Success, and Constitution sites (all located within OU 3) as part of the Coeur d'Alene Basin Remedial Action Monitoring Program (CH2M HILL, 2009m);
- development of a numerical groundwater flow model for the SFCDR Watershed (CH2M HILL, 2009d);
- detailed assessments of the Bunker Hill Box, the Woodland Park area in the Canyon Creek Watershed, and the Osburn Flats area, including studies of groundwater-surface water interactions and characterization of aquifer properties (CH2M HILL, 2007b, 2009a through 2009e, 2009g through 2009j, and 2009l);
- assessment of surface water and groundwater data collected under both high-flow and low-flow conditions in the SFCDR Watershed (CH2M HILL, 2009f);
- treatability testing of both active and passive treatment technologies in Canyon Creek and evaluation of passive technologies at the Success and Nevada Stewart mines (CH2M HILL, 2006c; McCloskey, 2005);
- bench-scale experiments conducted by Idaho National Laboratory (INL) that have contributed to an improved understanding of the fate and transport of dissolved metals in the Upper Basin (INL, 2007, 2009); and
- hydrologic and hydraulic modeling completed to define the portions of the Selected Human Health Remedies (protective barriers) that are potentially at risk during storm events (see Appendix G in this FFS Report). Portions of the existing surface water conveyance systems contributing to that risk were also identified.

Thus, a significant volume of new and more detailed information and data are available to support further development of the findings presented in the 2001 FS Report (USEPA, 2001d) and the evaluation of remedial alternatives and remedy protection alternatives. USEPA is now in the position to build upon the prior FS Reports and RODs for OUs 1, 2, and 3, incorporating the body of information now available to improve the feasibility analysis of remedial actions and remedy protection actions in this FFS.

1.2 Study Purpose and Objectives

The purpose of the FFS is to develop and evaluate a range of comprehensive alternatives that would (1) provide a final remedy for human health protection for surface water used for drinking purposes, (2) provide a final remedy for ecological protection for surface waters, (3) provide a final remedy for human health and ecological protection for soil, sediments, and source materials at locations where remedial actions are taken, (4) reduce groundwater contamination levels and the contribution of contaminated groundwater to surface water, and (5) prevent unacceptable risks to human health and the environment resulting from erosion and degradation of protective clean barriers. Objectives of the FFS are as follows:

- **Evaluate and present up-to-date information on water quality issues and sources of surface water contamination in the Upper Basin, including the Bunker Hill Box.** In this FFS Report, current site environmental conditions are described; remedial alternatives are developed and evaluated; and the potential benefits of remedial actions throughout the Upper Basin (including the Box) are evaluated on a watershed basis. The potential environmental benefits of proposed remedial actions for surface water in the Upper Basin are assessed in terms of the estimated resulting water quality at the SFCDR monitoring stations SF-271 (at Pinehurst, Idaho) and SF-268 (at Elizabeth Park, Idaho).
- **Address NAS recommendations.** As noted previously, the NAS conducted a review of the ROD for OU 3 and documented the results of that review in *Superfund and Mining Megasites: Lessons from the Coeur d'Alene River Basin* (NAS, 2005). Since the ROD for OU 3 was issued in 2002, USEPA has continued to support data collection efforts throughout the Coeur d'Alene Basin, particularly in the Upper Basin. The additional data have served to improve USEPA's understanding of the Upper Basin, and enabled USEPA to address (in this FFS Report) key NAS recommendations with respect to the fate and transport of dissolved metals in the subsurface and the role that groundwater plays in contaminant loading to surface water.
- **Update previous FS evaluations with new information.** To reflect USEPA's improved knowledge of conditions in the Upper Basin, this FFS Report has been prepared to update the evaluations of NCP-compliant ecological alternatives that were presented in the 2001 FS Report (USEPA, 2001d). Updates to the previous evaluations have included the following:
  - Incorporation of new monitoring data and estimates of site-specific metals loading to surface water into the assessment of the potential environmental benefits of the alternatives;

- Use of a numerical groundwater model developed and calibrated for the SFCDR Watershed (CH2M HILL, 2009d) to evaluate groundwater-surface water interactions and potential remedial actions for specific areas (Woodland Park in the Canyon Creek Watershed, and the Bunker Hill Box); and
- Review and revision of typical conceptual designs (TCDs) and associated cost estimates presented in the 2001 FS Report based on new information, including revisions of water treatment TCDs based on data obtained from treatability testing and cost-benefit analyses conducted for Woodland Park (CH2M HILL, 2007b).

- **Move forward on Phase II cleanup at OU 2.** As discussed previously, a two-phase remediation approach was established for OU 2 (USEPA and IDHW, 1995). Phase I, now largely complete, focused on source control and removal activities. The effectiveness of Phase I actions has been assessed and is documented in the *Phase I Remedial Action Assessment Report, Operable Unit 2* (CH2M HILL, 2007d) and the *Source Areas of Concern Report, Operable Unit 2* (CH2M HILL, 2008a). Potential Phase II remedial actions for OU 2 are evaluated in this FFS Report and build on the assessment of the effectiveness of Phase I actions to address long-term water quality and environmental management issues.
- **Evaluate a range of comprehensive remedial alternatives for the Upper Basin.** The remedial alternatives evaluated in this FFS Report would eventually meet surface water cleanup goals for the SFCDR and all of its major tributaries. In some areas, surface water cleanup goals would be met soon after remedial actions are implemented; in other areas, the achievement of water quality goals would take longer. Ultimately, the remedial actions would result in the attainment of water quality goals without further cleanup action and would provide significant improvements to water quality throughout the Upper Basin. Some reliance on natural source depletion to achieve cleanup goals for surface water would be necessary for even the most aggressive of the remedial alternatives. The Upper Basin encompasses a vast (300-square-mile) geographic area with dispersed contamination throughout, some of which has been buried beneath towns and roadways, significantly increasing the challenges and costs of remediation. Cleanup goals for soil, sediments, and source materials would be met upon completion of remedial actions at locations where remedial actions are taken and would accomplish loading reductions in surface water and groundwater. In addition, the remedial alternatives would significantly reduce both groundwater contamination levels and the contribution of contaminated groundwater to surface water. However, given the pervasive nature of the subsurface contamination, the remedial actions may not achieve the drinking water standards for groundwater at all locations. USEPA will evaluate future monitoring data to determine whether additional actions are needed or would be effective in meeting drinking water standards. If further actions would not be effective, a Technical Impracticability (TI) waiver may be warranted at specific locations where groundwater does not achieve drinking water standards[4].
- **Refine the riparian preliminary remediation goal (PRG) for the protection of songbirds.** An Ecological Risk Assessment (EcoRA) for the Coeur d'Alene Basin was

[4] Specific ARARs can be waived if appropriately justified [Code of Federal Regulations [CFR] 300.430(f)(1)(ii)(C)].

completed in 2001 (CH2M HILL and URS Greiner, 2001). Since that time, additional site-specific data have been collected that can be used to refine the PRG for the protection of songbirds. Relative to other avian receptors, songbirds are highly exposed to soil contamination. The revised PRG for songbirds is incorporated into the PRGs for remedial actions in the Upper Basin.

- **Evaluate flooding and precipitation events that may erode clean barriers or contaminate clean areas.** Remedy protection alternatives evaluated in this FFS Report would address localized tributary flooding and precipitation events that may substantially affect human health and the environment by eroding clean barriers or contaminating clean areas, thereby making contaminated soil and gravel potentially available for direct contact by humans and ecological receptors.[5]

1.3 Scope of the Study

Both the geographic and technical scope of the FFS are discussed in the following sections.

1.3.1 Geographic Scope of the Study

The geographic scope, or "study area", for the FFS is defined as including mining- and smelting-contaminated areas within the watershed of the SFCDR from its headwaters in Montana downstream to Kingston, Idaho (Figure 1-2). This area includes the Bunker Hill Box (OUs 1 and 2) and the Upper Basin portion of OU 3, and extends westward from the confluence of the North and South Forks of the Coeur d'Alene River to include the town of Kingston, which is one of the communities assessed as part of the remedy protection evaluation. The remedial alternatives described and evaluated in this FFS Report address sites within the SFCDR Watershed to the downstream point of Pinehurst and do not extend beyond to Kingston. The alternatives include actions for human health and environmental protection in OUs 1, 2, and 3.

It is important to note that the Lower Basin of the Coeur d'Alene River is _not_ within the scope of this FFS. Since the ROD for OU 3 was issued (USEPA, 2002b), the primary focus of remedial actions in the Lower Basin has been human-health-focused cleanup actions (in residences, recreational areas, and other common use areas) and the Lower Basin agriculture-to-wetland conversion project. This approach has provided clean recreational and waterfowl feeding areas and allowed time to further refine the understanding of the Lower Basin. This improved understanding of Lower Basin sediment transport processes is essential to the evaluation of the complex remedial actions necessary to address contaminated sediments. USEPA is continuing to support data collection and analysis efforts in the Lower Coeur d'Alene Basin to provide an improved understanding of sediment transport and deposition in the Lower Basin and to support the evaluation of specific remedial alternatives.

In the near term, the focus of continued work in the Lower Basin will be to fill data gaps and to finalize and refine an Enhanced Conceptual Site Model (ESCM), including sediment transport modeling that will help guide effective decisionmaking regarding future remedial actions in the Lower Basin. The ESCM represents an updated working hypothesis of the

[5] Not all future flooding or precipitation events are addressed by the FFS, as discussed in Section 1.3.2..

Lower Basin based upon computational modeling, data collection, and studies that have been performed since the 2001 FS Report for the Coeur d'Alene Basin was issued (USEPA, 2001d). The intent of this work is to develop a better understanding of the physical processes that drive the mobilization and transport of sediments, especially those processes related to river hydraulics, sediment transport, and geomorphology. These processes play key roles in the movement of sediment and lead contamination into, within, and from the Lower Basin. A better understanding of these processes will enable USEPA to examine appropriate remedies for ecological protection in the Lower Basin. Similar to the evaluation for the Upper Basin, presented later in this FFS Report, the Lower Basin work will likely include review of the remedial actions identified in Ecological Alternatives 3 and 4 in the 2001 FS Report with a view to USEPA's anticipated issuance of a future ROD Amendment for the Lower Basin. In addition to the Lower Basin, other areas not within the geographic scope of the FFS are:

- the North Fork Coeur d'Alene River Watershed, which is not included because it has been less seriously impacted by mining activities and is being addressed under CERCLA by other (non-USEPA) agencies, primarily the U.S. Forest Service;
- Coeur d'Alene Lake, which is being addressed outside the Superfund process by state, Tribal, federal, and local governments through revision of the *Coeur d'Alene Lake Management Plan* (IDEQ and Coeur d'Alene Tribe, 2009). The Tribe and the State of Idaho have adopted the revised plan and are now beginning to conduct the "core elements" of the Lake Management Plan. These include monitoring, conducting a nutrient inventory, and assessing the need for a public outreach program; and
- dispersed recreational areas along the Spokane River, where the State of Washington is implementing remedial actions under the ROD for OU 3 (USEPA, 2002b).

The scope of the FFS is defined not only in geographic terms but also in terms of its technical scope, including the types of risks addressed and associated design objectives of the alternatives. The technical scope of the study is discussed in the following section.

1.3.2 Technical Scope of the Study

The technical scope of the FFS is focused on the development and evaluation of remedial alternatives and remedy protection alternatives that would reduce risks to human health and the environment that are present in the Upper Basin as a result of mining-related contamination. Many complex and interwoven factors contribute to the overall risks in the Upper Basin, and not all of these factors are directly addressed by the alternatives described and evaluated in this FFS Report. A discussion of factors not addressed by the alternatives is presented below, along with a summary of the specific scopes of the remedial and remedy protection alternatives.

1.3.2.1 Factors Not Addressed by the Alternatives

Factors that are not within the technical scope of the alternatives developed in this FFS Report include SFCDR and Pine Creek flooding, contaminated materials beneath paved roadways, and infiltration and inflow (I&I) of contaminated groundwater into sanitary sewer lines. Each of these factors is discussed below

SFCDR and Pine Creek Flooding

The Upper Basin ROD Amendment will select specific remedial actions at specific locations. Included in the ROD Amendment will be remedy protection actions identified for specific locations that are intended to enhance the long-term protectiveness of the human health remedies already being implemented in OUs 1, 2, and 3. The ROD Amendment will not select remedial actions intended to prevent potential damage to the remedies from flooding in the main channel of the SFCDR and Pine Creek. Protection against flooding of the SFCDR and Pine Creek, is a complex, system-wide problem that will require substantial involvement and investment on the part of a range of local, state, and federal entities. Pine Creek is a large tributary to the SFCDR, and flooding of the creek is highly dependent on flow conditions in the SFCDR system; therefore, protection against flooding in Pine Creek will require coordination with additional entities, as will protection against flooding in the SFCDR. USEPA is committed to participating in efforts to more fully understand the SFDCR system, including Pine Creek, and ways in which various entities can contribute to the management of flooding problems. Nevertheless, and as described below, measures will be taken during implementation of the remedy selected in the ROD Amendment to address remedy protection concerns related to flooding in Pine Creek and the SFCDR.

"Remedy protection" as used in this FFS is focused on keeping clean areas clean by addressing uncontrolled overland water flow from tributary flooding, rainstorms, and rapid snowmelt runoff that can erode clean barriers or leave behind contaminated sediments. This approach is consistent with one of the primary goals of the human health cleanup, which is to create barriers that are durable and protective of human health. The remedy protection measures included in this FFS Report are in direct response to the types of barrier damage observed in communities from frequent high-precipitation events and certain recommendations included in the NAS report (NAS, 2005). These measures will enhance the long-term protectiveness of the Selected Human Health Remedies. USEPA and IDEQ have incorporated local drainage control in remedial activities in the past on a site-by-site basis to ensure that the remedies remain viable, but potential damage to large portions of the remedies from major flooding has not been addressed.

During site characterization and remedial design of remedy protection, source control, and water quality projects, USEPA will coordinate with local communities and the Basin Environmental Improvement Project Commission[6] to ensure that associated flooding concerns along the SFCDR and Pine Creek are addressed by the appropriate entity or entities. Where planning and logical work sequencing allow, USEPA will work collaboratively with other entities conducting flood control projects to coordinate the implementation of cleanup projects in a manner that provides joint benefits. In addition, USEPA will ensure that implementation of the selected remedy will comply with applicable or relevant and appropriate requirements (ARARs) and will refer to information "to be considered" (TBCs) including those official documents that address flooding, such as Executive Order 11988, Protection of Floodplains (see Table 4-5 accompanying Section 4.0 in this FFS Report). Among other things, Executive Order 11988 requires federal agencies

[6] The Basin Environmental Improvement Project Commission, commonly referred to as "the Basin Commission", was established by the Idaho State Legislature under the Basin Environmental Improvement Act (Idaho Administrative Procedures Act [IDAPA] Title 39, Chapter 810).

undertaking actions within a floodplain to minimize potential harm to or within floodplains and avoid long- and short-term adverse impacts with modifications to floodplains. Thus, as remedial actions are implemented within the floodplains of the SFCDR and Pine Creek, efforts will be undertaken to comply with the mandate of this Executive Order.

Flooding of the SFCDR and Pine Creek that inundates the Upper Basin communities with fast-moving water would likely result in damage that affects the protectiveness of remedial barriers. This type of flooding would likely also damage private and public property and create a safety hazard to residents. The locally-developed *Shoshone County Multi-Jurisdictional Hazards Mitigation Plan* ("the Plan"; Shoshone County et al., 2009) can be used to illustrate the potential damage in terms of value to property and remediation work in the 100-year floodplain. The Plan shows that, in the City of Kellogg and associated rural areas, public and private property in the 100-year floodplain has an estimated value of $108.2 million. The Plan also shows estimated re-remediation costs to be $19.7 million. In the City of Pinehurst and associated rural areas, the estimated value of at-risk property is $56.8 million and re-remediation costs are estimated at $11.3 million. Even though flooding of this magnitude has not occurred since the Bunker Hill Superfund Site was placed on the NPL, the history of extensive flooding indicates that flood control is an issue important to the cleanup program and local communities. During its Five-Year Reviews of the completed portions of the Superfund cleanup (USEPA, 2000a, 2000d, 2005b), USEPA evaluated risks of flooding and related threats to the remedies and recommended follow-up actions, resulting in the evaluation of remedy protection projects in this FFS and identification of specific remedy protection projects in the forthcoming Upper Basin Proposed Plan. USEPA will continue to evaluate such risks to the Superfund cleanup in future Five-Year Reviews. However, comprehensive flood control is a complex multi-jurisdictional issue that exceeds the expertise and regulatory authority of USEPA's and IDEQ's cleanup programs and the local communities.

Therefore, the Basin Commission, consistent with its authority, agreed in November 2009 to take a leadership role in evaluating flooding issues associated with the SFCDR and Pine Creek. Flooding is a large, system-wide concern for which a comprehensive review and plan are required to ensure that work with the greatest flood protection potential is ultimately implemented. The Basin Commission has engaged a range of entities with the combined required expertise and regulatory jurisdiction. These entities include the U.S. Army Corps of Engineers, the Federal Emergency Management Agency, the Idaho Bureau of Homeland Security, USEPA, and IDEQ. USEPA and IDEQ are committed to assisting the commission-led activities to evaluate and plan actions relative to dealing with SFCDR and Pine Creek flooding issues. A funding source for the Commission-led activities will need to be established. If these efforts identify actions that would meet Superfund remedy requirements, USEPA can define and select these activities in future decision documents (e.g., the Upper Basin ROD Amendment).

Contaminated Materials Beneath Paved Roadways

The RODs for OUs 1, 2, and 3 addressed remediation of rights of way (ROWs)[7] in the Bunker Hill Box and the Coeur d'Alene Basin, as appropriate to respond to risks to human

[7] ROWs are defined in the current RODs as all state, county, local, and private roads.

health.[8] The RODs allow ROWs to be remediated such that they provide barriers to underlying metals contamination. Many ROWs have been remediated as residential and commercial properties have been cleaned up in Box and Basin communities. However, USEPA and IDEQ recognize that some pre-existing paved roadways may not provide adequate long-term barriers to underlying contaminated materials, and that local and state entities are responsible for the long-term road development and maintenance efforts. Additionally, USEPA and IDEQ acknowledge that the operation of trucks associated with the human health cleanup has impacted some roads within the Bunker Hill Superfund Site. As a result, the agencies are developing an approach under the current RODs to address this issue collaboratively with local, county, and state entities responsible for providing and maintaining roadways in their communities. The objective of this effort is to develop and implement a strategy that ensures the long-term effectiveness of barriers installed in ROWs and aligns with the transportation and maintenance needs of Box and Basin communities.

Infiltration and Inflow

USEPA and IDEQ have evaluated whether I&I of contaminated groundwater into sanitary sewer lines results in increased metal loadings to surface water bodies within the Upper Basin. I&I can result in difficulties for treatment plants in meeting discharge requirements for metals, but are a lesser source of metals to surface waters than other source sites under consideration for cleanup actions. As a result, no cleanup actions relative to sanitary sewer systems are included in this FFS Report.

1.3.2.2 Scope of the Remedial Alternatives

Mining-contaminated media pose risks to human health and ecological resources in the Upper Basin. The remedial alternatives developed and evaluated in this FFS Report address these ecological risks and human health risks. The specific contaminated media include surface water, groundwater, soil, sediments, and source materials; of these, contaminated surface water, soil, sediments, and source materials are directly addressed by the remedial alternatives presented in this report. In addition to achieving water quality goals for dissolved metals in surface water, each remedial alternative would also reduce particulate lead in the SFCDR and its tributaries. As previously discussed, groundwater contamination levels and the contribution of contaminated groundwater to surface water would also be reduced by each of the remedial alternatives.

1.3.2.3 Scope of the Remedy Protection Alternatives

The remedy protection alternatives developed and evaluated in the FFS would maintain or enhance the protectiveness of the Selected Human Health Remedies included in the RODs for OUs 1, 2, and 3. Specifically, human health risks would be reduced by reducing the threats to clean barriers installed in accordance with the Selected Remedies. Therefore, each alternative would meet the CERCLA Threshold Criteria of overall protection of human health and the environment and compliance with ARARs.

It should be noted that the range of remedy protection actions evaluated in this FFS Report does not address the three broad categories of infrastructure-related issues that are

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[8] See Section 9.2, “Residential Soils Remedy” in the ROD for OU 1 (USEPA, 1991a), page 9-2; Section 9.2.6, “Rights-of-Way”, in the ROD for OU 2 (USEPA, 1992), page 9-11; and Section 12.1.1, “Description of the Selected Remedy”, in the ROD for OU 3 (USEPA, 2002b), page 12-8.

discussed in Section 1.3.2.1: potential flood damage to implemented human health remedies that may be caused by future flooding of the SFCDR or Pine Creek; potential future exposure to contaminated materials that lie beneath existing paved roadways; and actions to upgrade sanitary sewer lines to prevent I&I of contaminated groundwater into local sanitary sewer treatment systems.

1.4 Study Approach

Sections 1.4.1 and 1.4.2 describe the approach to the FFS in terms of remedial actions and remedy protection actions, respectively. The general FS process under CERCLA and the specific process used in this FFS are described in Section 1.5.

1.4.1 Remedial Actions

In developing the FFS, USEPA relied in part on the analyses presented in the 2001 FS Report (USEPA, 2001d), the ROD for OU 3 (USEPA, 2002b), the *Phase I Remedial Action Assessment Report, Operable Unit 2* (CH2M HILL, 2007d), the *Final Phase I Remedial Action Characterization Report for the Bunker Hill Mining and Metallurgical Complex Superfund Site OU2* (TerraGraphics and Ralston Hydrologic Services, 2006), and the *Source Areas of Concern Report, Operable Unit 2* (CH2M HILL, 2008a). In the 2001 FS Report, six remedial alternatives were evaluated to address ecological risks posed to waterfowl, other birds, fish, and plants in the Upper and Lower Basins. The six ecological alternatives were as follows:

- Alternative 1, No Action;
- Alternative 2, Contain/Stabilize with Limited Removal and Treatment;
- Alternative 3, More Extensive Removal, Disposal, and Treatment;
- Alternative 4, Maximum Removal, Disposal, and Treatment;
- Alternative 5, State of Idaho Cleanup Plan; and
- Alternative 6, Mining Companies Cleanup Plan.

The ROD for OU 3 predicted that reductions in metals concentrations would occur much sooner under the most aggressive and protective ecological alternatives (3 and 4). These two alternatives would address many more sources of contamination than the other alternatives and, in turn, would provide greater environmental and human health protection. Water quality conditions predicted at the completion of remediation would be considerably better under Ecological Alternatives 3 and 4, which would also provide substantially greater protection of the environment and shorter times to achieve compliance with the ARARs for OU 3. The ROD for OU 3 also predicted that, relative to the other ecological alternatives, Alternatives 3 and 4 would result in more than twice the reduction of metal loadings in surface water immediately following implementation of the actions.

Based upon the comparative analysis presented in the ROD for OU 3, USEPA determined that Ecological Alternative 3 (More Extensive Removal, Disposal, and Treatment) represented the best balance of trade-offs for a long-term cleanup approach, and would best meet the requirements for protection of the environment and compliance with the ARARs. The ROD for OU 3 included an interim ecological remedy that was a prioritized subset of the numerous actions included in Ecological Alternative 3. This interim remedy included cleanup actions that would be both technically and administratively implementable and would achieve significant reduction in residual risks relative to its cost.

As discussed previously, given the NAS recommendations (NAS, 2005) and new information regarding Upper Basin conditions, USEPA is refining its long-term cleanup plan for the Upper Basin, and this FFS Report provides the basis for the refined cleanup plan. Section 300.430(e)(9) of the NCP specifies that a "detailed analysis should be conducted on the limited number of alternatives that represent viable approaches to remedial action after evaluation in the screening stage." Based upon the NCP and the findings presented in the 2001 FS Report and the 2002 ROD for OU 3, USEPA has determined that it is appropriate to carry forward only the Upper Basin components of Ecological Alternatives 3 and 4 as the basis for remedial alternatives to be considered in the FFS for the Upper Basin. USEPA has also determined that Ecological Alternatives 1, 2, 5, and 6 in the 2001 FS Report would not be sufficiently protective of human health and the environment, and therefore do not warrant further analysis. Carrying forward both Ecological Alternative 3 and the more extensive cleanup contemplated under Ecological Alternative 4 into this FFS is consistent with previous consideration of the CERCLA evaluation criteria and with the level of cleanup that will be necessary to meet the ARARs for the Upper Basin. USEPA has therefore updated Ecological Alternatives 3 and 4 using information obtained since the three RODs were issued to develop remedial alternatives for evaluation in the FFS.

This FFS Report updates and expands Ecological Alternatives 3 and 4 for OU 3 in a consistent manner based on new information. **The updated and expanded remedial alternatives for OU 3 are developed in Section 6.0 of this FFS Report, and are referred to as Alternatives 3+ and 4+**.

One of the primary updates described in this FFS Report is for the Woodland Park (in Canyon Creek) components of Ecological Alternatives 3 and 4. The process by which the Woodland Park components of these alternatives are updated is described in Appendix E. The remedial options evaluated for Woodland Park include both source control actions, based on those included in Ecological Alternatives 3 and 4 in the 2001 FS Report, and groundwater-focused actions, based on the remedial component evaluations conducted for the area in 2007 (CH2M HILL, 2007b). These groundwater-focused actions make use of USEPA's improved understanding of surface water-groundwater interactions and the fate and transport of dissolved metals in this area as the result of a hydrogeologic study conducted in Canyon Creek in 2006 (CH2M HILL, 2007a).

The remedial alternatives for OU 2 will form the basis for the OU 2 Phase II Remedy to be included in the forthcoming Upper Basin ROD Amendment. As discussed previously, Phase I work at OU 2 is largely complete; Phase II is generally intended to address any shortcomings encountered in implementing Phase I and to specifically address long-term water quality and environmental management issues. The focus of the OU 2 Phase I actions was on removal and consolidation of soil, sediments, and source materials and evaluation of the effectiveness of these actions in improving water quality. The focus of the Phase II actions is on achieving ARARs in surface water in OU 2.

Five Phase II remedial alternatives for OU 2 are developed in Section 6.0 of this FFS Report, and include:

- OU 2 Alternative (a) – Minimal Stream Lining;
- OU 2 Alternative (b) – Extensive Stream Lining;
- OU 2 Alternative (c) – French Drains;
- OU 2 Alternative (d) – Stream Lining/French Drain Combination; and
- OU 2 Alternative (e) – Extensive Stream Lining/French Drain Combination.

The OU 2 alternatives are developed separately and **then combined with Alternatives 3+ and 4+ for OU 3 to create the following ten (10) remedial alternatives for the Upper Coeur d'Alene Basin that are evaluated in Sections 7.0 and 8.0 of this FFS Report**, along with a No Action Alternative:[9]

- **Alternative 3+(a) –** Comprises Alternative 3+ for OU 3 and Alternative (a) for OU 2.
- **Alternative 3+(b) –** Comprises Alternative 3+ for OU 3 and Alternative (b) for OU 2.
- **Alternative 3+(c) –** Comprises Alternative 3+ for OU 3 and Alternative (c) for OU 2.
- **Alternative 3+(d) –** Comprises Alternative 3+ for OU 3 and Alternative (d) for OU 2.
- **Alternative 3+(e) –** Comprises Alternative 3+ for OU 3 and Alternative (e) for OU 2.
- **Alternative 4+(a) –** Comprises Alternative 4+ for OU 3 and Alternative (a) for OU 2.
- **Alternative 4+(b) –** Comprises Alternative 4+ for OU 3 and Alternative (b) for OU 2.
- **Alternative 4+(c) –** Comprises Alternative 4+ for OU 3 and Alternative (c) for OU 2.
- **Alternative 4+(d) –** Comprises Alternative 4+ for OU 3 and Alternative (d) for OU 2.
- **Alternative 4+(e) –** Comprises Alternative 4+ for OU 3 and Alternative (e) for OU 2.

Figure 1-3 illustrates the development of the 10 remedial alternatives.

1.4.2 Remedy Protection Actions

The alternatives evaluated in this FFS Report for the protection of existing human health remedies have been developed to allow for analysis of the no further action and active remedy protection alternatives against the NCP criteria and comparison with each other. These analyses include the benefits (such as protection of human health and the environment, compliance with ARARs, and long-term effectiveness) and the costs of taking no further action and the benefits and costs of taking action to protect the Selected Human Health Remedies for OUs 1 and 2 and the Upper Basin portion of OU 3. As noted previously, hydrologic and hydraulic modeling was conducted to use as a basis for the development and evaluation of remedy protection alternatives.

This FFS Report therefore develops and evaluates two remedy protection alternatives that would maintain the protectiveness of the Selected Human Health Remedies for OU 1, OU 2, and the Upper Basin portion of OU 3. **These remedy protection alternatives are developed and evaluated in Section 9.0 of this FFS Report, and are called Alternatives RP-1 and RP-2**:

- **Alternative RP-1 –** No Further Action (Post-Event Response)

[9] Although Alternative 1 (No Action) in the 2001 FS Report was already determined by USEPA to be not sufficiently protective of human health and the environment, a No Action Alternative has been included in this FFS Report for comparison purposes..

- **Alternative RP-2 –** Modifications to Selected Remedies to Enhance Protectiveness (Remedy Protection Projects)

1.4.3 Implementation Planning

In conjunction with the development of the FFS Report and the subsequent ROD Amendment, USEPA is in the process of planning and prioritizing actions for implementation of the comprehensive remedy for the Upper Basin. The outcome of this effort will be an Implementation Plan that will prioritize and guide the actions selected in the Upper Basin ROD Amendment. The Implementation Plan will be a "living document", separate from the ROD Amendment, that will identify priority projects and guide cleanup actions into the future. It will identify distinct phases of cleanup work from the ROD Amendment that will be conducted in the near term. These actions will then be evaluated to determine whether cleanup goals are being met. USEPA will develop and modify the Implementation Plan in close cooperation with state agencies, other federal agencies, Tribal representatives, and other involved parties, including the Coeur d'Alene Basin Natural Resource Trustees.

The Plan will use adaptive management to incorporate "lessons learned' and to guide future efforts to prioritize work. Adaptive management is a process wherein decisions are made as part of an ongoing science-based process. It involves testing, monitoring, and evaluating applied strategies, and incorporating new knowledge into management approaches that are based on scientific findings. The Implementation Plan and the adaptive management process will be tools to help USEPA and others make better decisions as more information becomes available on the effectiveness of initial cleanup actions, and will provide the framework for the implementation of future actions. The Implementation Plan will be updated and modified on a regular basis to guide future decisionmaking and to determine when sufficient actions have been taken to meet the objectives of the Upper Basin ROD Amendment.

For planning purposes, this FFS has taken the same conservative approach applied in the 2001 FS by including many sites, some of which have only limited or outdated data available. However, additional site-specific data will be collected during the design phase of the Upper Basin cleanup, and it may be determined that some sites do not require remedial action at all or that they require a smaller-scale action than identified in this FFS Report. Conversely, data collected during the design phase may indicate that more extensive actions may be required at some locations. The adaptive management approach will allow USEPA to begin near-term remedial actions in some areas where sufficient data are available and opportunities to achieve remedial action objectives are greater, rather than delaying remedial actions throughout the Upper Basin while additional data are being collected. At sites where limited data are available, pre-design data collection will occur in parallel with initial remedial actions and the cleanup plan will be refined over time in response. USEPA's approach to Upper Basin cleanup will therefore focus on refining the cleanup plan over time through a formalized adaptive management process, and with continued use and refinement of tools to assist in the prioritization of sites for remedial action.

The Implementation Plan will consider a number of key factors such as metals loading to surface water, the potential for recontamination of clean areas, and the degree to which each remedial action is expected to reduce risks to human health and the environment. Other factors to be considered include whether water treatment would be required, whether repository space[10] is needed, whether restoration work is planned, construction staging and design needs, coordination with local infrastructure or public works projects, potential environmental issues associated with the actions (e.g., the impacts of access roads), erosion potential, accessibility to children, and local community and stakeholder input. Another important consideration will be the amount of funding available on an annual basis. USEPA recognizes the importance of securing sufficient resources to implement the upcoming Upper Basin ROD Amendment and other cleanup actions throughout the Coeur d'Alene Basin. Therefore, the Implementation Plan will document assumptions made about annual funding levels, including how recent Asarco settlement funds may be used to implement actions.

USEPA, consistent with its guidance, considered reasonably foreseeable future land uses in the Upper Basin during development of this FFS Report. During the implementation planning process and design of remedial actions, USEPA will consider a wide range of site-specific issues that will affect the implementation of the cleanup. These include (but will not be limited to) current and future use, access, impacts to local residences, and impacts to ongoing or future site development such as mining activity. In addition, such things as timing of the action, staging, coordination with other work in the area, and coordination with the entity that would perform the work will be considered.

USEPA recognizes that mining and mineral processing have played an important role in the development of the Silver Valley. USEPA also recognizes that mining and mineral activities are likely to continue for the foreseeable future. USEPA intends to manage its Superfund responsibilities in the Upper Basin in a manner that will allow for responsible mining and mineral processing activities as well as exploration and development. Provided that environmental conditions are not exacerbated and that USEPA's ability to implement cleanup is not impeded, USEPA expects that future mining-related activities can be conducted in a manner that will not impair or interfere with the implementation of cleanup actions or the protectiveness of any implemented cleanup actions. USEPA intends to work with entities interested in conducting mine and mineral processing activities to ensure that these activities and cleanup are responsibly implemented.

1.5 Focused Feasibility Study Process

As noted previously, this FFS Report has been prepared using methods consistent with the NCP and with USEPA guidance. An overview of the CERCLA FS process is presented in Section 1.5.1 and is followed by descriptions of how this process has been focused in this FFS for the development and evaluation of remedial alternatives (Section 1.5.2) and remedy protection alternatives (Section 1.5.3).

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[10] USEPA and IDEQ have already solicited public input on repository siting, recognizing that repositories for containing waste materials should be sited at locations that meet the needs of the local residents as well as the needs of the overall cleanup. IDEQ has been leading the repository siting process for potential Basin repositories. This process has included many public meetings and workshops where citizens have been provided the opportunity to provide comment on both the siting process and the specific sites being considered. As additional repositories are needed to implement the selected remedy, a similar repository siting process will be conducted.

1.5.1 Overview of the CERCLA Feasibility Study Process

Based on the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA, 1988b), FSs conducted under CERCLA should generally contain three phases: the development of alternatives, screening of the alternatives, and detailed analysis of the alternatives. The first two phases are typically conducted simultaneously and are interrelated. The detailed analysis includes evaluating the alternatives individually and comparing them against each other.

Development and Screening of Alternatives

Alternatives are developed by assembling combinations of technologies to address the media to which they would be applied. This process consists of the following general steps:

1. Develop remedial action objectives (RAOs).
2. Develop general response actions (GRAs).
3. Identify sites, volumes, or areas to which GRAs may be applied.
4. Identify and screen the technology types applicable to each GRA, and eliminate those that cannot be implemented technically at the site.
5. Identify and evaluate technology process options to select a representative process for each technology type retained for consideration.
6. Assemble the selected representative technologies into alternatives representing a range of treatment and containment actions.
7. Screen the alternatives, as appropriate.

Detailed Analysis of the Alternatives

During the detailed analysis, the alternatives retained from the screening process are further defined as necessary, analyzed in detail with respect to CERCLA evaluation criteria, and compared against one another. The specific steps are summarized as follows:

- Further define alternatives as necessary.
- Analyze each alternative against CERCLA evaluation criteria, specifically the Threshold Criteria and Primary Balancing Criteria:[11]
  - The Threshold Criteria relate to the statutory requirements that each alternative must satisfy in order to be eligible for selection. They consist of overall protection of human health and the environment, and compliance with ARARs.
  - The Primary Balancing Criteria are the technical criteria upon which the detailed analysis is primary based. They consist of long-term effectiveness and permanence;

[11] Two additional CERCLA evaluation criteria, state and Tribal acceptance and community acceptance, are called Modifying Criteria and are addressed as part of the remedy selection process in the Proposed Plan and ROD (in this case, the Upper Basin ROD Amendment). As it reviews public and stakeholder comments on the Proposed Plan, USEPA will evaluate its Preferred Alternative in terms of the Modifying Criteria and will consider all of these factors in selecting the remedy that will be described in the Upper Basin ROD Amendment.

reduction of the toxicity, mobility, or volume [of hazardous substances] through treatment; short-term effectiveness; implementability; and cost.

- Conduct a comparative analysis of the alternatives. This involves comparing the alternatives against one another, again using the CERCLA Threshold Criteria and Primary Balancing Criteria.

1.5.2 The Process for the Remedial Alternatives in this Focused Feasibility Study

As discussed previously, this FFS has built upon previous work by focusing on the two most protective and NCP-compliant ecological remedial alternatives for OU 3 that were presented and evaluated in the 2001 FS Report (USEPA, 2001d). Ecological Alternatives 3 and 4 for OU 3 have been updated with current information to create two primary remedial alternatives that are evaluated in this FFS Report: Alternatives 3+ and 4+. Phase II remedial alternatives for OU 2 have been incorporated into these as five "sub-alternatives" ("a" through "e") that represent the OU 2 alternatives , as described in Section 1.4.1 and shown in Figure 1-3. A No Action Alternative is also included for comparison purposes. As described in Sections 6.0 through 8.0, these remedial alternatives have been developed and evaluated using the CERCLA process outlined in Section 1.5.1. An evaluation has also been conducted of remedial options for the Woodland Park area of Canyon Creek (see Appendix E); based on this evaluation, a refined set of actions has been identified for Woodland Park and incorporated into the broader remedial alternatives for the Coeur d'Alene Basin.

For the Upper Basin portion of OU 3, nearly all of the sites that were included in Ecological Alternatives 3 and 4 in the 2001 FS Report have been included in this FFS Report, and few or no changes have been made in the identified remedial actions. For these sites, the previous remedial actions were reviewed and determined to still be applicable, and the cost estimates for implementation have been updated to reflect current design assumptions and the value of 2009 dollars. For some sites, new information warranted reconsideration of the remedial actions included in Ecological Alternatives 3 and 4. A complete description of the changes from Ecological Alternative 3 to Alternative 3+ and from Ecological Alternative 4 to Alternative 4+ is provided in Section 6.0 of this FFS Report.

1.5.3 The Process for the Remedy Protection Alternatives in this Focused Feasibility Study

As discussed previously, the remedy protection alternatives were developed to enhance the long-term effectiveness of the Selected Human Health Remedies for OUs 1 and 2 and the Upper Basin portion of OU 3. Two remedy protection alternatives have been developed: RP-1, No Further Action (Post-Event Response), and RP-2, Modifications to Selected Remedies to Enhance Protectiveness (Remedy Protection Projects). These alternatives are evaluated using the CERCLA Threshold and Primary Balancing Criteria, although the remedy protection alternatives do not modify the existing Selected Remedies and the Selected Remedies already meet the Threshold Criteria. The evaluation in Section 9.0 of this FFS Report shows that the No Further Action and Remedy Protection Projects alternatives are differentiated principally by the Primary Balancing Criteria, particularly long-term effectiveness and cost.

1.6 Report Organization

This FFS Report is presented in four volumes. **Volume 1** contains an Executive Summary of the report, this introductory Section 1.0, and the following additional sections:

- **Section 2.0, Site Background,** describes the regulatory setting for the FFS, summarizes previous cleanup actions and studies, and describes ongoing data collection efforts;
- **Section 3.0, Site Environmental Conditions,** describes environmental conditions in the Upper Basin, focusing on contamination in surface water, groundwater, and sediments. The description of environmental conditions in this FFS Report uses data collected through August 2009 to supplement the 1991-1999 data used in the 2001 FS Report (USEPA, 2001d).
- **Section 4.0, Refinement of Remedial Action Objectives (RAOs), Potentially Applicable or Relevant and Appropriate Requirements (ARARs), and Preliminary Remediation Goals (PRGs),** provides an updated summary of the RAOs, potential ARARs, and PRGs for the Upper Coeur d'Alene Basin. These are based on current regulations and guidance and were taken into account during the development and evaluation of the remedial alternatives and remedy protection alternatives for the Upper Basin.
- **Section 5.0, Development of Typical Conceptual Designs (TCDs),** presents the TCDs that are included in the remedial alternatives for the Upper Basin. A TCD is a conceptual design for a component of a remedial action consisting of a representative assemblage of technologies and process options; therefore, TCDs are used as building blocks for assembling remedial alternatives for feasibility-level analysis. The TCDs presented in this FFS Report include some that were initially developed in the 2001 FS Report and have been retained for use with little or no modification, and others that have been developed to support the development and evaluation of remedial alternatives in this FFS Report.
- **Section 6.0, Development of Remedial Alternatives,** describes the methodologies used in the development of remedial alternatives for the Upper Basin. This section includes the changes made to Ecological Alternatives 3 and 4 presented in the 2001 FS Report to identify the components of Alternatives 3+ and 4+ for the Upper Basin portion of OU 3;the development of Phase II remedial alternatives for OU 2; and the ultimate development of the combined remedial alternatives that are evaluated in this FFS Report.
- **Section 7.0, Description and Evaluation of Remedial Alternatives,** provides descriptions of the remedial alternatives on a per-watershed basis and evaluates each alternative in terms of CERCLA evaluation criteria.
- **Section 8.0, Comparative Analysis of Remedial Alternatives,** compares the remedial alternatives with one another in terms of the same CERCLA evaluation criteria.
- **Section 9.0, Development and Evaluation of Remedy Protection Alternatives,** describes and evaluates the remedy protection alternatives developed in the FFS to

protect and maintain the Selected Human Health Remedies for OUs 1 and 2 and the Upper Basin portion of OU 3, as identified in the RODs for those OUs.

- **Section 10.0, References,** lists in full the references cited in the preceding sections.

Volume 2 contains the figures and tables referenced in the text of Volume 1, organized by section. In **Volumes 3 and 4**, the following appendices present supplemental information and data:

Volume 3:

- **Appendix A, Groundwater Modeling Analysis**
- **Appendix B, Predictive Analysis Methodology and Results**
- **Appendix C, Typical Conceptual Design (TCD) Schematics**
- **Appendix D, Cost Analysis Documentation**

Volume 4:

- **Appendix E, Development of Updated Woodland Park Components of Ecological Alternatives 3 and 4**
- **Appendix F, Remedial Options Considered But Not Evaluated in the Focused Feasibility Study**
- **Appendix G, Human Health Remedy Protection: Hydrologic Risk Characterization and Project Development**

SECTION 2.0

Site Background

This section describes the regulatory setting of the Bunker Hill Superfund Site, summarizes previous and current cleanup actions and studies within the area addressed in the Focused Feasibility Study (FFS) (defined in Section 1.0), and describes ongoing data collection efforts within the FFS study area.

2.1 Regulatory Setting

As discussed in Section 1.0, the U.S. Environmental Protection Agency (USEPA) has identified three Operable Units (OUs) at the Bunker Hill Superfund Site: the populated areas of the Bunker Hill "Box" (OU 1); the non-populated areas of the Box (OU 2); and mining-related contamination in the broader Coeur d'Alene Basin exclusive of the Box (OU 3).[1] Primary technical and decision documents related to these OUs have included:

- Remedial Investigation/Feasibility Study (RI/FS) for OU 1:
  - *Residential Soil Feasibility Study for the Bunker Hill CERCLA* [Comprehensive Environmental Response, Compensation, and Liability Act] *Site Populated Areas Remedial Investigation/Feasibility Study (RI/FS)* (CH2M HILL, 1991)
- Record of Decision (ROD) for OU 1:
  - *Record of Decision, Bunker Hill Mining and Metallurgical Complex Residential Soils Operable Unit, Shoshone County, Idaho* (USEPA, 1991a)
- RI/FS for OU 2:
  - *Bunker Hill Superfund Site Remedial Investigation Report, Volumes I, II, and III* (McCulley, Frick, and Gilman, 1992a)
  - B*unker Hill Superfund Site Feasibility Study Report, Volumes I, II, III, and Associated Technical Memoranda* (McCulley, Frick, and Gilman, 1992b)
- ROD for OU 2:
  - *Record of Decision (ROD), Bunker Hill Mining and Metallurgical Complex, Shoshone County, Idaho* (USEPA, 1992) (Although not in the title, this ROD for OU 2 addressed the non-populated areas of the Bunker Hill Superfund Site, as well as aspects of the populated areas that were not addressed in the 1991 ROD for OU 1.)
  - *Explanation of Significant Differences for Revised Remedial Actions at the Bunker Hill Superfund Site, Shoshone County, Idaho* (USEPA, 1996a)

[1] The reaches of the South Fork Coeur d'Alene River and Pine Creek that pass through OU 2 are actually defined as being part of OU 3.

  - *Amendment to the Record of Decision for the Bunker Hill Mining and Metallurgical Complex (Non-Populated Areas) Superfund Site* (USEPA, 1996d)
  - *Explanation of Significant Differences for Revised Remedial Actions at the Bunker Hill Superfund Site OU 2, Shoshone County, Idaho (*USEPA, 1998)
  - *Record of Decision Amendment: Bunker Hill Mining and Metallurgical Complex Acid Mine Drainage, Smelterville, Idaho* (USEPA, 2001e)
- RI/FS for OU 3:
  - *Final (Revision 2) Remedial Investigation Report, Coeur d'Alene Basin Remedial Investigation/Feasibility Study* (USEPA, 2001c)
  - *Final (Revision 2) Feasibility Study Report, Final Coeur d'Alene Basin Remedial Investigation/Feasibility Study (*USEPA, 2001d)
- ROD for OU 3 (often referred to as "the Interim ROD for OU 3"):
  - *Record of Decision, The Bunker Hill Mining and Metallurgical Complex Operable Unit 3* (USEPA, 2002b)

This FFS builds upon previous work to develop a comprehensive remedy for human health and ecological protection in the Upper Basin of the Coeur d'Alene River, to evaluate measures to protect and enhance existing remedies, and to refine the riparian preliminary remediation goal (PRG) for the protection of songbirds in the Upper Basin. Upon completion of this FFS, a Proposed Plan and a ROD Amendment will be prepared to document the Selected Remedy for the Upper Basin. The ROD Amendment will update and revise the previous cleanup plans described in the RODs for OUs 1, 2, and 3 and in other decision documents, as necessary. Figure 2-1 presents a flow chart illustrating the various decision documents for the Bunker Hill Superfund Site and how they relate to this FFS.

In addition to this FFS Report, the Proposed Plan, and the Upper Basin ROD Amendment, a separate Implementation Plan will be prepared that will describe the adaptive management approach for the Upper Basin and include a standardized method for the prioritization of actions for implementation. The Implementation Plan will be a "living document" that will be revised on a regular basis as more information is gained from cleanup actions taken.

The primary technical and decision documents listed above are summarized in the following subsections to provide additional context for the FFS effort.

2.1.1 Record of Decision for Operable Unit 1

A summary of the ROD for OU 1 (USEPA, 1991a) is presented in the *Bunker Hill Populated Areas Operable Unit First Five-Year Review Report* (USEPA, 2000a). The primary goal of the Selected Remedy presented in the ROD for OU 1 was to reduce children's intake of lead from soil and dust sources to achieve less than 5 percent of children with blood lead levels of 10 micrograms per deciliter (µg/dL) or greater, and less than 1 percent of children exceeding a blood lead level of 15 µg/dL. The cleanup strategy to achieve these goals consisted of:

- Implementing a lead health intervention program for local families;
- Remediating all residential yards, commercial properties, and rights of way (ROWs) that had soil lead concentrations greater than 1,000 milligrams per kilogram (mg/kg);
- Achieving a geometric mean of less than 350 mg/kg for yard-soil lead concentrations in each residential community within OU 1;
- Controlling fugitive dust, and stabilizing and capping contaminated soil throughout the Bunker Hill Box (OUs 1 and 2);
- Achieving a geometric mean of 500 mg/kg or less for interior house-dust lead levels for each community, with no individual house-dust level exceeding 1,000 mg/kg; and
- Establishing an Institutional Controls Program (ICP) to maintain protective barriers over time, and to ensure that future land use and development are compatible with the Selected Remedy for OU 1.[2]

The human health remedy installed by the potentially responsible parties (PRPs) for OU 1 was certified complete in 2008. In general, the remediation has been effective in capping contamination but may not be sustainable in areas such as road shoulders and alleys, where heavy use may cause degradation of the protective caps.

2.1.2 Record of Decision for Operable Unit 2

The ROD for OU 2 was published by USEPA in 1992. Since then, two amendments to this ROD (USEPA, 1996d, 2001e) and two Explanations of Significant Differences (ESDs) (USEPA, 1996a, 1998) have been published. The remedial actions selected in the ROD were based on findings from the RI/FS (McCulley, Frick, and Gilman, 1992a, 1992b), which was conducted by the Bunker Hill Superfund Site's major potentially responsible parties (PRPs).

The ROD for OU 2 set forth priority cleanup actions to protect human health and the environment. Cleanup actions called for a series of source removals, surface capping, reconstruction of surface water creeks, demolition of abandoned milling and processing facilities, engineered closures for wastes consolidated onsite, revegetation efforts, remediation of commercial properties and ROWs, and treatment of contaminated water collected from various site sources.

In 1994, the Site's major PRP filed for bankruptcy. This affected how the cleanup actions selected in the ROD for OU 2 would be implemented, as the responsibility for implementation of the Selected Remedy for OU 2 shifted to USEPA and the State of Idaho. The State of Idaho determined that, under the changed circumstances, whereby CERCLA would require the State to be responsible for 100 percent of operation and maintenance (O&M) costs after the remedy was complete, the PRP-proposed remedy implementation strategy for OU 2 was unacceptable. As a result, the State and USEPA negotiated an alternative phased approach to OU 2 remedy implementation that focused more on source control actions with minimal O&M requirements, and less on remedial approaches that included long-term treatment options, as originally developed by the PRPs. This led to a

[2] The ICP has since been expanded to include institutional controls within OU 2 and OU 3.

two-phased remedy implementation approach, rather than the previously planned remedy implementation.

Phase I of the remedy implementation included extensive source removal and stabilization efforts, demolition activities, community development initiatives, development and initiation of an ICP, remedial actions that supported future land use development, and public health response actions. Also included in Phase I were additional investigations to provide the necessary information to resolve long-term water quality issues, including technology assessments and pilot studies, evaluation of the success of source control efforts, development of site-specific water quality and effluent-limiting performance standards, and formulation of defined O&M plans and a future remedial action implementation schedule. Interim control and treatment of contaminated surface water, collected seeps, and acid mine drainage (AMD) were also included in Phase I of the remedy implementation. The 2001 ROD Amendment (USEPA, 2001e) determined that treatment of AMD and other contaminated site waters would occur at the Central Treatment Plant (CTP) in Kellogg, Idaho.

Phase I remediation began in 1995, and source control and removal activities are complete. A summary of the Phase I remedial actions is presented in the *Phase I Remedial Action Assessment Report, Operable Unit 2, Bunker Hill Mining and Metallurgical Superfund Site* (CH2M HILL, 2007d) and in the *Final Phase I Remedial Action Characterization Report for the Bunker Hill Mining and Metallurgical Complex Superfund Site OU2* (TerraGraphics and Ralston Hydrologic Services, 2006). Phase I remedial actions have resulted in a significant improvement in groundwater and surface water quality within OU 2 and the South Fork of the Coeur d'Alene River (SFCDR); however, PRGs for groundwater and surface water within OU 2 have not yet been achieved (PRGs are defined in Section 4.0 of this FFS Report).

The 1996 ROD Amendment for OU 2 (USEPA, 1996d) changed the remedy for Principal Threat Materials (PTM) from chemical stabilization to containment. The 2001 ROD Amendment for OU 2 (USEPA, 2001e) addressed AMD issues within the OU 2 boundaries and included provisions for the active treatment of affected waters at the CTP in Kellogg. To date, USEPA and the State of Idaho have not concluded negotiations on a State Superfund Contract (SSC) amendment that allows for full implementation of the 2001 ROD Amendment for OU 2. Time-critical components of this ROD Amendment have been implemented, however, to avoid potential catastrophic failure of the aging CTP and to provide for emergency mine water storage (USEPA and Idaho Department of Environmental Quality [IDEQ], 2003). These time-critical activities focused on preventing discharges of AMD to Bunker Creek and the SFCDR. Until an SSC amendment is signed allowing full implementation of the 2001 ROD Amendment for OU 2, control and treatment of AMD and its impact on water quality will continue to be issues. USEPA and the State of Idaho are continuing to discuss the SSC amendment and the long-term obligations associated with the full mine water remedy.

The two ESDs did not change the Selected Remedy for OU 2; rather, they clarified portions of the remedy. The 1996 ESD (USEPA, 1996a) addressed differences associated with placement of waste and demolition materials in the Smelter Closure Area (SCA). The 1998 ESD (USEPA, 1998) addressed differences associated with the stabilization and removal of contaminated materials located in the tributary gulches within OU 2; the USEPA financial contribution to the lower Milo Creek/Wardner/Kellogg pipeline system; placement of mine wastes from outside OU 2 into the Central Impoundment Area (CIA); and other components of the Selected Remedy for OU 2.

The effectiveness evaluation of the Phase I source control and removal activities in meeting the water quality improvement objectives of the 1992 ROD for OU 2 (CH2M HILL, 2007d) was used during this FFS to determine appropriate Phase II implementation strategies and actions. In addition, although the goals of the ROD for OU 2 did not include the protection of ecological receptors, additional actions are considered as part of the Phase II remedy in this FFS within the context of Site-wide cleanup goals. Both ROD and SSC amendments are required prior to the implementation of Phase II remedial actions within OU 2.

2.1.3 Remedial Investigation/Feasibility Study for Operable Unit 3

From 1997 through 2001, USEPA collected samples of soil, sediments, groundwater, surface water, and other environmental media (e.g., indoor dust, lead-based paint, and garden produce) from the Upper and Lower Basins and conducted an RI/FS for the overall Coeur d'Alene Basin (USEPA, 2001c, 2001d) to support the remedy that was selected in the Interim ROD for OU 3 (USEPA, 2002b). The overall study area for the OU 3 RI included four specific geographic areas:

- The Upper Basin east and west of the Bunker Hill Box, which includes the communities of Mullan, Wallace, Burke, Osburn, and Silverton; the SFCDR to its confluence with the North Fork of the Coeur d'Alene River; and Canyon Creek, Ninemile Creek, Big Creek, Moon Creek, and Pine Creek;
- The Lower Basin, which includes the communities of Kingston, Cataldo, and Harrison; the Coeur d'Alene River west of the confluence of the North and South Forks; and adjacent lateral lakes, floodplains, and associated wetlands;
- Coeur d'Alene Lake; and
- The Spokane River between the Washington-Idaho state line and Upriver Dam.

The risks posed to human health and the environment as a result of historical mining contamination were evaluated in developing the remedial alternatives. Six ecological alternatives were developed for the Upper and Lower Basins in the 2001 FS Report (USEPA, 2001d):

- Alternative 1: No Action;
- Alternative 2: Contain/Stabilize with Limited Removal and Treatment;
- Alternative 3: More Extensive Removal, Disposal, and Treatment;
- Alternative 4: Maximum Removal, Disposal, and Treatment;
- Alternative 5: State of Idaho Cleanup Plan; and
- Alternative 6: Mining Companies Cleanup Plan.

Based upon the comparative analysis presented in the ROD for OU 3, USEPA determined that Ecological Alternative 3 (More Extensive Removal, Disposal, and Treatment) represented the best balance of trade-offs for a long-term cleanup approach, and would best meet the requirements for protection of the environment and compliance with the ARARs. Ecological Alternative 3 targets most contaminant sources in the Basin outside Coeur d'Alene Lake through excavation, consolidation, disposal, capping, and treatment. This alternative was not the most aggressive and costly cleanup alternative evaluated in the FS, but was the remedy that offered the fewest short-term impacts on the communities, was most implementable, and was the least costly alternative that met the statutory and regulatory requirements (USEPA, 2001d). In addition, human health alternatives were developed for residential and community areas of the Upper and Lower Basins. Sets of alternatives were developed for each of the primary potential exposure media (soil, drinking water, household dust, and aquatic food sources).

2.1.4 Interim Record of Decision for Operable Unit 3

The Selected Remedy for OU 3 includes remedial actions for (1) protection of human health in the communities and residential areas, including identified recreational areas, of the Coeur d'Alene Basin upstream of Coeur d'Alene Lake (the Upper and Lower Basins); (2) protection of the environment in the Upper and Lower Basins; and (3) protection of human health and the environment in areas of the Spokane River.

The Selected Remedy for OU 3 includes a complete remedy for protection of human health. For protection of the environment, the Selected Remedy identifies approximately 30 years of prioritized actions in areas of the Basin upstream of Coeur d'Alene Lake. These prioritized actions would provide measurable, tangible benefits to humans and environmental receptors (e.g., fish and birds) within a relatively short time frame in the areas addressed. Furthermore, the actions would provide a good balance among the priorities identified by stakeholders (the States, the Tribes, the federal natural resource trustees, and the public). The prioritized actions for protection of the environment constitute an *interim* ecological remedy for OU 3.

Certain potential exposures to human health outside the communities and residential areas of the Upper and Lower Basins are not addressed by the Interim ROD for OU 3. These potential exposures include:

- Recreational use at areas within the Upper and Lower Basins where cleanup actions are not implemented pursuant to the Interim ROD for OU 3;
- Subsistence lifestyles, such as those traditional to the Coeur d'Alene and Spokane Tribes; and
- Potential future use of groundwater that is currently contaminated with metals.

In addition, a remedy for Coeur d'Alene Lake is not included in the Interim ROD for OU 3; however, the ROD does state that USEPA will evaluate conditions at Coeur d'Alene Lake in future Five-Year Reviews. State, Tribal, federal, and local governments have developed a revised Lake Management Plan outside the Superfund process using separate regulatory authorities (IDEQ and the Coeur d'Alene Tribe, 2009).

For environmental protection in the Upper Basin, three priorities for remediation were identified:

- Dissolved metals in surface water (particularly zinc and cadmium) having harmful effects on fish and other aquatic life;

- Lead in soil and sediments present in the beds, banks, and floodplains of the river system having harmful effects on waterfowl and other wildlife; and
- Particulate lead in surface water that is transported downstream and is a continuing source of contamination for the Coeur d'Alene River, Coeur d'Alene Lake, and the Spokane River. Lead transported in particulate form in the river has affected recreational areas in the Lower Basin and the Spokane River, resulting in posted health advisory signs at beaches and swimming areas. During flood events, lead transported by the river also affects the wetlands and floodplains.

The Interim ROD for OU 3 addresses the entire Coeur d'Alene Basin (i.e., all of OU 3). This FFS addresses issues in the Upper Coeur d'Alene Basin but does not address all issues within the geographic scope of the Interim ROD for OU 3. The geographic scope of the FFS is described in Section 1.3.1 of this FFS Report.

2.2 Previous and Current Cleanup Actions

Substantial progress has been made in implementing the remedies selected in previous decision documents and actions for the three OUs, primarily those focused on reducing the risks posed to human health by exposure to mining-related contamination:

OU 1: Cleanup activities at the Bunker Hill Superfund Site first began in OU 1 because of the risks posed to human health from exposure to mine and smelter wastes. The ROD for OU 1 (USEPA, 1991a) focused on remediation of lead-contaminated soil in residential areas primarily through removals and partial removals and the installation of protective soil/vegetation barriers. The human health remedy installed by the potentially responsible parties (PRPs) for OU 1 was certified complete in 2008.

OU 2: Phased cleanup activities in OU 2 began in the early 1990s. The ROD for OU 2 (USEPA, 1992) included actions to protect human health in the non-populated areas, commercial areas, and other common-use areas through removals, source control, capping, and other measures. Phase I source control actions for OU 2 are largely complete. Phase I has included removal, containment, and consolidation of extensive contamination from various areas, capping of source areas, demolition of structures, and corresponding public health response actions. This ROD also addressed some OU 1 remedial activities such as rights of way, commercial properties, and house dust.

OU 3: Cleanup activities since the ROD for OU 3 (USEPA, 2002b) have primarily focused on implementation of the human health remedy in community and residential areas. Prior to the 2002 ROD, limited removal actions in OU 3 were conducted by USEPA and other entities such as the Silver Valley Natural Resource Trustees (SVNRT, now referred to as the Coeur d'Alene Natural Resource Trustees), the U.S. Forest Service (USFS), IDEQ, and the Bureau of Land Management (BLM). Implementation of the selected human health remedy for community, residential, and recreational areas in the Coeur d'Alene Basin outside the Box, presented in the ROD for OU 3, is ongoing and nearing completion. USEPA recently received additional funding through the American Recovery and Reinvestment Act of 2009 to accelerate the implementation of remaining human health cleanup activities in OU 3.

Table 2-1 presents a summary of the specific remedial actions that have been conducted within OU 2 and the Upper Basin portion of OU 3, some of which are still ongoing, along with specific references (where available) for additional information. Remedial actions for OU 1 are not included in Table 2-1 because OU 1 is not within the scope of the remedial alternatives developed and evaluated in this FFS Report. As indicated in the table, many of the remedial actions are also described in the *Five-Year Review Report: Second Five-Year Review for the Bunker Hill Mining and Metallurgical Complex Superfund Site, Operable Units 1, 2, and 3, Idaho and Washington* (USEPA, 2005b). Figures 2-2 and 2-3 present timelines of removal and remedial actions conducted in OU 2 and OU 3, respectively.

The volumes of materials removed and acres capped during the remedial actions in OU 2, as detailed in Table 2-1, are summarized as follows:

- Approximately 4 million cubic yards of contaminated materials were removed and consolidated in the SCA, CIA, and Page repositories. Structures were demolished at Government Gulch and in the Mine Operations Area.
- Approximately 818 acres were capped to eliminate direct exposure to contaminants.

Similarly, materials removed during remedial actions in the Upper Basin portions of OU 3, as detailed in Table 2-1, are summarized as follows:

- Approximately 1.4 million cubic yards of contaminated materials were removed and placed in the Big Creek Repository, the Woodland Park Repository, the Osburn Tailings Pond mine-waste repository, the Day Rock Repository, and the CIA.
- Structures were demolished at the Coeur d’Alene Mill and Silver Crescent and Charles Dickens Mine sites.

2.3 Previous Studies

Table 2-2 presents a summary of studies that have been conducted within the Upper Basin from 2001 to the present. Table 2-2 also includes references to where additional information on each specific study can be found (the full references are provided in Section 10.0 of this FFS Report). The purpose of this summary is to identify findings from studies conducted within OUs 2 and 3 since completion of the 2001 FS Report (USEPA, 2001d) that have been used to support the development of alternatives for this FFS. Previous studies focused on obtaining data useful for developing and refining subbasin-specific conceptual site models (CSMs), conducting pilot- and bench-scale treatability studies, obtaining data on aquifer properties, and evaluating treatment technologies for future remedial actions. The majority of studies conducted within OU 2 and OU 3 since 2001 have focused on developing a better understanding of the groundwater system, how the surface water and groundwater interact, and the fate and transport of metals in the subsurface. The relative lack of information in each of these areas was raised as an issue during the National Academy of Sciences’ review of cleanup in the Coeur d’Alene Basin (NAS, 2005). A number of the studies summarized in Table 2-2 address recommendations outlined in the NAS review.

The NAS review excluded the Bunker Hill Box, but did consider OU 2 in some detail due to its proximity to and connection with the Coeur d’Alene Basin. This review was performed to consider the scientific and technical practices used in development of human health and ecological risk assessments, remedial planning, and decisionmaking. As the result of the review, NAS presented recommendations that were considered in development of this FFS, including acquiring an improved understanding of the distribution, fate, and transport of dissolved metals in the groundwater and surface water systems; considering groundwater treatment approaches; developing predictive tools to assess the effectiveness of remedial actions; and improving the use of the adaptive management approach.

2.4 Ongoing Data Collection Efforts

Table 2-3 presents a summary of ongoing data collection programs within the Upper Basin and future monitoring activities that are currently planned. The existing programs are primarily associated with the Environmental Monitoring Program (EMP) for OU 2, the Basin Environmental Monitoring Program (BEMP) for OU 3, and the Coeur d'Alene Basin Remedial Action Monitoring Program, which are described in Sections 2.4.1 through 2.4.3, respectively. The monitoring programs use parameters and monitoring frequencies that are anticipated to be sensitive to potential rates of change in environmental conditions in the Upper Basin. Additional discrete studies have been conducted and are summarized in Table 2-2. Monitoring program planning for the future is discussed in Section 2.4.4.

2.4.1 Environmental Monitoring Program for Operable Unit 2

The EMP for OU 2 (USEPA, 2006) was developed to guide the collection, analysis, and interpretation of data on surface water and groundwater quality and biological resources to assess the effectiveness of the overall Phase I remedial actions conducted in OU 2. The EMP was designed to provide data relative to the following monitoring objectives for OU 2:

- Evaluate tributaries to the SFCDR within OU 2 with respect to compliance with federal requirements for ambient water quality criteria (AWQC).
- Evaluate groundwater within OU 2 with respect to compliance with federal requirements for maximum contaminant levels (MCLs).
- Evaluate potential impacts to SFCDR water quality from tributaries and groundwater within OU 2.
- Evaluate the cumulative effect of Phase I remedial actions with respect to groundwater, surface water, and ecological conditions.
- Provide data for Five-Year Reviews of remedy effectiveness as required by CERCLA.
- Improve the understanding of processes and variability within OU 2 to assist in Phase I remedial action evaluations and Phase II remedial action design and implementation.

Phase I remedial-action-specific effectiveness monitoring plans were established and used to evaluate the larger Phase I remedial actions within OU 2 with respect to their performance standards and RAOs. Such monitoring plans were developed for the Phase I remedial actions that were intended to have demonstrable impacts on OU 2 water quality. These actions addressed areas including:

- the SCA;
- the CIA;
- Bunker Creek;
- Government Gulch; and
- Smelterville Flats.

2.4.2 Basin Environmental Monitoring Program for Operable Unit 3

The major goal of the BEMP (USEPA, 2004) is to monitor and evaluate the progress of the Selected Remedy for OU 3 in terms of improving ecosystem conditions. Consistent with that goal, the BEMP provides data relative to the following Basin-wide monitoring objectives:

- Assess the long-term status and trends of surface water, soil, sediments, and biological resource conditions in the Coeur d'Alene Basin.
- Evaluate the effectiveness of the Selected Remedy.
- Evaluate progress toward cleanup benchmarks.
- Provide data for CERCLA-required Five-Year Reviews of the progress of remedy implementation.
- Improve the understanding of Basin processes and variability to, in turn, improve the effectiveness and efficiency of subsequent remedial action implementation.

The BEMP includes monitoring of surface water, soil, sediments, and biological resources. Groundwater monitoring is not included in the BEMP because Basin-wide groundwater cleanup is not addressed in the Interim ROD for OU3 (USEPA, 2002b).

2.4.3 Coeur d'Alene Basin Remedial Action Monitoring Program

The Coeur d'Alene Basin Remedial Action Monitoring Program began in 2007 and is ongoing (CH2M HILL, 2007c). The objective of the monitoring program is to develop and implement remedial-action-specific monitoring programs to guide the collection of groundwater and surface water data at five remedial action sites located in the Upper Basin: Canyon Creek, Constitution Mine, Golconda Mine, Rex Mine, and Success Mine. The specific objectives of the monitoring program are to (1) assess the long-term status and trends of heavy metals contamination in surface water and shallow groundwater, and (2) evaluate the effectiveness of remedial actions.

2.4.4 Monitoring Program Planning for the Future

USEPA is currently in the planning phases of combining the various monitoring programs throughout the Upper and Lower Basins. The intent of combining the programs is to optimize Basin-wide monitoring to improve efficiency and functionality, and to ensure that sufficient data are collected to track the ecological conditions within the context of CERCLA remedial actions. The combined Basin-wide monitoring program will more holistically assess the Coeur d'Alene Basin, and will provide information to support the adaptive management process for the site. Monitoring is a key component of the adaptive management process, which will be employed to ensure that the monitoring program is periodically updated (on a Basin-wide level) to reflect past data, new information and understanding, and changing conditions based on future remedial actions.

SECTION 3.0

Site Environmental Conditions

3.1 Introduction

This section provides an overview of the current environmental conditions within the South Fork of the Coeur d'Alene River (SFCDR) Watershed (referred to herein as the Upper Basin, as discussed in Section 1.0). This section builds on the work completed as part of the *Final (Revision 2) Feasibility Study Report, Coeur d'Alene Basin Remedial Investigation/Feasibility Study* (2001 FS Report; U.S. Environmental Protection Agency [USEPA], 2001d) and incorporates additional study results and monitoring data obtained from 2000 to 2009. In addition to data from the Remedial Investigation/Feasibility Study (RI/FS) for the Coeur d'Alene Basin (USEPA, 2001c, 2001d), specific sources of data used in this analysis include the Basin Environmental Monitoring Program (BEMP) for Operable Unit 3 (OU 3), the Environmental Monitoring Program (EMP) for OU 2, the Coeur d'Alene Basin Remedial Action Monitoring Program, U.S. Geological Survey (USGS) gauging station data as reported on the USGS website, and the results of discrete sampling events.

This section is organized as follows:

- **Section 3.1, Introduction,** describes the purpose, scope, and organization of this section;
- **Section 3.2, Physical Setting,** describes physiography, climate, geology, hydrology, and hydrogeology of the Upper Basin (including OU 2 and OU 3 upstream from the confluence of the SFCDR and the river's North Fork);
- **Section 3.3, Nature and Extent of Contamination,** presents an overview of the generation and dispersion of mining waste materials in the Upper Basin, discusses current contaminant sources within the Upper Basin, and describes the mechanisms that control contaminant releases from these sources;
- **Section 3.4, Contaminant Fate and Transport,** describes the surface water and groundwater systems and the current distribution of contaminants within these systems. This section includes discussions of the linkages between the physical setting, the nature and extent of contamination, and the current distribution of contaminants within the surface water and groundwater systems; and
- **Section 3.5, Summary of Site Conditions,** outlines the site history and lists the main findings of this section.

3.2 Physical Setting

This section contains brief summary descriptions of regional physical information and provides an overview of physical processes occurring within the Upper Basin. Descriptions of regional physiography, climate, geology, hydrology, and hydrogeology are included.

Watershed-specific details on these processes are discussed for some individual watersheds. Additional details are available in the 2001 RI and FS Reports (USEPA, 2001c, 2001d).

3.2.1 Physiography

The SFCDR Watershed occupies approximately 300 square miles of land surface in the Panhandle of northern Idaho (See Figures 1-1 and 1-2 in Section 1.0). The SFCDR flows approximately 35 miles from its headwaters in the Bitterroot Mountains to its confluence with the North Fork of the Coeur d'Alene River near Enaville. The topographic relief in the watershed is approximately 4,000 feet, with elevations ranging from 2,160 feet above mean sea level (msl) near the confluence of the SFCDR and the North Fork of the Coeur d'Alene River to 6,000 to 7,000 feet above msl in the Bitterroot Mountains. The SFCDR upstream from Wallace and its major tributaries are characterized by narrow, steep-walled (V-shaped) canyons with high relief. West of Wallace, the SFCDR canyon transitions to wider valleys with lower topographic gradients.

3.2.2 Climate

Kellogg, Idaho, is the location of the most complete local climate history within the Upper Basin. The National Weather Service station at Kellogg (Station 104831) has a period of record from 1905 to the present. Here, average monthly high and low temperatures range from 85 and 50 degrees Fahrenheit (°F) in August to 35 and 20 °F in January, respectively. The normal mean annual precipitation observed at Kellogg is approximately 31 inches per year; the months of November, December, and January are the wettest (over 3.5 inches per month average). July and August are typically the driest months, with an average of about 1 inch per month. Precipitation in December and January typically falls as snow, and the valley floor sees an average of 54 inches of snow per year. These precipitation levels are recorded on the valley floor and can be considerably higher in the surrounding higher elevation hillsides (CH2M HILL, 2000).

3.2.3 Geology

Bedrock in the Upper Basin includes some igneous intrusive dikes and stocks, but consists primarily of about 1-billion-year-old sedimentary formations of the late Precambrian Belt Supergroup. The Belt Supergroup is at least 60,000 feet thick and has been slightly metamorphosed on a regional scale. This has resulted in the formation of argillite or slate from shale and the formation of quartzite from sandstone. The rocks were originally deposited as sediments in a northwest-trending elongated trough extending through north and central Idaho, western Montana, southeastern British Columbia, and Alberta.

In the Coeur d'Alene District, the Belt Supergroup has been divided into six formations, the oldest being the Prichard Formation and the youngest being the Striped Peak Formation. Thorough descriptions of relevant formations and additional structural geology and the major characteristics and economic importance of these formations as hosts for the ore deposits in the Coeur d'Alene Basin are provided in the 2001 RI and FS Reports (USEPA, 2001c and 2001d). The description of the formations and rock types includes details regarding the nature and relative abundances of sulfide and carbonate minerals, which influence metals transport and pH in downgradient sediments and receiving waters.

The primary mineralization is located along the east-west-trending Osburn Fault. The principal ore minerals are galena (lead sulfide), sphalerite (zinc sulfide), and tetrahedrite (arsenic-antimony sulfide with varying proportions of copper, iron, zinc, and silver).

Unconsolidated sediments overlay bedrock on the valley floors and are a mixture of sand, silt, clay, gravels, cobbles, and boulders resulting from the erosion of bedrock, reworked glacial deposits, and recent volcanic ash. The various types of alluvial deposits have been grouped together as Quaternary alluvium. Alluvium thickness is about 30 to 60 feet along most of the SFCDR, increasing to over 120 feet in OU 2. Some stratification of sediment sizes is typically observed (i.e., variably continuous layers of coarser and finer sizes) and commonly occurs as isolated to continuous zones of coarse sand and gravel. The most prominent example of stratification is a 10- to-60+-foot-thick fine-grained layer bisecting the OU 2-lower Pine Creek sediments into upper and lower regions.

Included within the Quaternary alluvium are tailings and related materials produced by mining activities. Tailings and tailings-bearing sediment of the mining era often overlie Quaternary alluvium of the pre-mining era, but in many areas thorough mixing has occurred. Tailings are discussed further in Section 3.3.1.2.

3.2.4 Hydrology

This section describes the surface water hydrology of the SFCDR basin extending upstream from the confluence with the North Fork of the Coeur d'Alene River to the headwaters in the Bitterroot Mountains. The discussion focuses on the mainstem of the SFCDR, the three major tributaries to the SFCDR having the greatest number of mines and mill sites (Canyon Creek, Ninemile Creek, and Pine Creek), and the three largest tributaries in OU 2 (within the Bunker Hill "Box" shown in Figure 3-1): Milo Creek, Government Creek (in Government Gulch), and Bunker Creek. The individual monitoring stations discussed are a subset of the BEMP monitoring network, with BEMP station numbers noted in parenthesis (USEPA, 2004). For the purposes of this discussion and because of its hydrologic characteristics, the portion of the SFCDR from its headwaters downstream to Wallace, Idaho, is discussed in the section addressing the major tributaries (Figure 3-1).

Since the beginning of mining activities in the 1880s, channels of the SFCDR and associated tributaries have been altered by both natural processes and anthropogenic activities. Deposition of silt- to sand-sized tailings directly into streams increased the sediment load and created downstream sedimentation and contamination problems. Coarser jig tailings tended to choke and elevate the streambed, and the finer flotation tailings enabled widespread distribution of contaminants both downstream and across floodplains.

The introduction of the railroad and riprap to protect settlements and other infrastructure limited the lateral extent where area streams could migrate. Construction of Interstate 90 (I-90) began during the 1960s, and the SFCDR channel was further armored and typically confined to a narrow channel on one side of the valley.

Base flows in area streams typically occur from mid-summer through early fall, with peak flows occurring during spring runoff, typically during May. Sudden snowmelts driven by warm winds and/or rain-on-snow events tend to create the largest peaks in the hydrographs, which can occur anytime in the winter.

The discussion of the Upper Basin hydrology is presented in the following three subsections: the SFCDR below Wallace (Section 3.2.4.1), the major tributaries of the SFCDR and the SFCDR reach above Wallace (Section 3.2.4.2), and the tributaries flowing into the SFCDR within OU 2 (Section 3.2.4.3). The discussion is based on monitoring at six surface water monitoring stations in the Upper Basin: Station CC-288 at the mouth of Canyon Creek, Station NM-305 at the mouth of Ninemile Creek, Station SF-208 on the SFCDR above Mullan, Station SF-268 on the SFCDR at Elizabeth Park, Station SF-271 on the SFCDR at Pinehurst, and Station PC-339 on Pine Creek (Figure 3-1). These stations are both stream discharge and water quality sampling locations that are maintained by USGS for USEPA as part of the BEMP for OU 3 and the EMP for OU 2.

3.2.4.1 South Fork of the Coeur d'Alene River below Wallace

This section describes the hydrology of the SFCDR from Wallace downstream to the confluence with the North Fork of the Coeur d'Alene River. Many of the riverbanks in this area have been armored or protected from erosion with vegetation, embankments, barbs (structures that extend into the stream channel to deflect flow away from erodible banks), and weirs. In some areas, channel width is large enough to permit the development of a braided bedform. Wetlands are also present in areas of lower river gradients and channel braiding. The quantity of sediment transported, as well as the particle size, increases at larger stream discharges. Sediment sources in these channels are typically from bank erosion, channel migration, channel bed material remobilization, and sediment from the upper watersheds and tributary streams.

The following subsections describe the hydrology of the SFCDR where it enters OU 2 (Elizabeth Park) and where it exits OU 2 (Pinehurst).

Elizabeth Park (Station SF-268)

Station SF-268 is located approximately 3 miles downstream from Osburn Flats and 2 miles upstream from Kellogg (Figure 3-1). This sampling station is located at the eastern (upstream) boundary of OU 2 and is therefore representative of discharge conditions in the SFCDR as it enters OU 2. USGS maintains a gauging station at this location (No. 12413210) with a period of record from 1987 through the present.

Average base flows of approximately 80 cubic feet per second (cfs) occur here during September and October, and average daily peak flows of approximately 1,000 cfs usually occur during May. Average daily flows of more than 1,000 cfs have occurred from November through May. Maximum average daily flows of more than 2,000 cfs have occurred during several different months.

Pinehurst (Station SF-271)

Station SF-271 is located at the western (downstream) boundary of OU 2 and is therefore representative of discharge conditions in the SFCDR as it exits OU 2. This station is located downstream from Pine Creek so is influenced by the typically cleaner water from Pine Creek. The USGS gauging station at this location (No. 12413470) has a period of record from late 1987 through the present.

The hydrograph of Station SF-271 is typical for the SFCDR between Wallace and the confluence with the North Fork of the Coeur d'Alene River with regards to the timing of peak and base flows (Figure 3-2). The rising limb of the hydrograph (the transition from low-flow conditions to high-flow conditions) is usually short and steep and the falling limb of the hydrograph (the transition from high-flow conditions to low-flow conditions) is usually prolonged over several months. Average base flow of approximately 100 cfs occurs in September and October, and average daily flows of over 1,000 cfs occur from March through June (Figure 3-2). Maximum average daily flows of more than 3,000 cfs have occurred during several different months.

3.2.4.2 Major Tributaries to the South Fork of the Coeur d'Alene River

This section discusses the major Upper Basin tributary watersheds of Canyon Creek, Ninemile Creek, and Pine Creek as well as the SFCDR above Wallace. Canyon Creek and Ninemile Creek are heavily affected by mining activities, while Pine Creek is less affected. Moon Creek, Placer Creek, and Big Creek have also been affected to a lesser extent by mining activities and contribute relatively clean water and sediments to the SFCDR (see Figure 3-1).

Mullan (Station SF-208)

Sampling station SF-208 is located approximately one mile upstream from the town of Mullan (see Figure 3-1). The SFCDR above Mullan more resembles the high gradient tributary streams of the area. The USGS gauging station at this location (No. 12413040) has a brief record from October 1998 through April 2000. In addition to the continuous USGS record, "snapshot" measurements have been taken at this location since 1991.

Based on the limited record, average base flows of approximately 10 to 20 cfs occur here during September and October. In 1999, peak average daily flows of 380 cfs and 237 cfs occurred in May and June, respectively. The watershed above Mullan has a relatively low level of impact from mining or mining-related activities.

Canyon Creek (Station CC-288)

Canyon Creek enters the SFCDR at Wallace, where the USGS gauging station (No. 12413125) has a period of record from late 1998 through the present (Figures 3-1 and 3-3). In addition to the continuous USGS record in Figure 3-3, snapshot measurements have been taken at this station since 1991.

The entire Canyon Creek Watershed occupies approximately 22 square miles of land surface, and Canyon Creek flows approximately 12 miles from its headwaters in the Bitterroot Mountains to its confluence with the SFCDR at Wallace. The elevation change in the watershed is approximately 4,000 feet, ranging from 6,700 feet above msl in the Bitterroot Mountains to 2,750 feet above msl at the confluence with the SFCDR. Base flow in Canyon Creek of approximately 10 cfs occurs during September and October. High flows typically occur in May, with daily averages ranging from 100 to several hundred cfs.

The Canyon Creek drainage area contains numerous mines and mill sites, and the creek is severely impacted by historical mining or mining-related activities.

Ninemile Creek (Station NM-305)

Ninemile Creek enters the SFCDR at Wallace downstream from Canyon Creek (see Figure 3-1). The USGS gauging station here (No. 12413130) has an intermittent record spanning from October 1998 to October 2003 and from October 2007 to November 2008. In addition to the USGS record, snapshot measurements have been taken here since 1991. Base flow on Ninemile Creek of less than 4 cfs occurs from September to December. Daily average flows peak at approximately 100 cfs during March, April and/or May.

The Ninemile Creek drainage area contains numerous mines and mill sites and is severely impacted by historical mining or mining-related activities.

Pine Creek (Station PC-339)

Pine Creek enters the SFCDR near the downstream end of OU 2, and Station PC-339 is located on Pine Creek where it enters OU 2 approximately 2 miles upstream from the creek's confluence with the SFCDR (see Figure 3-1). The USGS gauging station here (No. 12413445) has a period of record from late 1997 through the present.

Base flow in Pine Creek of approximately 11 cfs occurs during August, September, and October (Figure 3-4). Average peak flows of approximately 400 cfs occur during April and May. Maximum average daily flows of more than 1,000 cfs have occurred during all months except June through October.

Portions of the Pine Creek drainage area contain numerous mines and mill sites and are severely impacted by mining wastes, and other portions are relatively pristine.

3.2.4.3 Tributaries within OU 2

OU 2 contains several small but hydrologically important tributaries. The three most significant tributaries within OU 2 are discussed below.

Milo Creek

The Milo Creek Watershed, which is not currently gauged, drains an approximately 4-square-mile area located above the towns of Wardner and Kellogg and discharges into the SFCDR within Kellogg. The upper portion of Milo Creek contains forested and clear-cut areas, the Silver Mountain Ski Resort, and many areas disturbed by historical mining. In the upper reaches of the watershed, three forks of Milo Creek (West, South, and Upper) join to form the mainstem of the creek. Each of these forks flows in steep and narrow canyons. The watershed crests at Wardner Peak at an elevation of approximately 6,300 feet above msl and drops to 2,300 feet above msl in Kellogg.

Since the advent of mining activities in the Coeur d'Alene Basin, the Upper Milo Creek Watershed has primarily supported mining and logging. A large surface depression resulting from underground block-caving mining techniques is located in the western portion of the Upper Milo Creek Watershed and is referred to as the Guy Cave Area. West Milo Creek flows into this surface depression and drains into the Bunker Hill underground mine workings. In addition, several faults are located in the Upper Milo Creek Watershed and cross the various forks of Milo Creek. It is believed that these fault zones and the proximity of the extensive Bunker Hill mine workings beneath this area result in significant surface water infiltration into the mine workings. This previously clean surface water is then altered through chemical reactions with pyrite and oxygen to form acid mine drainage (AMD) that eventually requires treatment for metals removal at the Central Treatment Plant (CTP) in Kellogg.

Currently, all known AMD-impacted water from mine workings in Milo Gulch are conveyed to the CTP through the mine workings, with the exception of drainage from the Reed and Russell adits. In the 2001 ROD Amendment for OU 2 (USEPA, 2001e), the mine owner is required to ensure that these discharges are captured and routed back into the mine workings. Since at least 2004, AMD-impacted water from these adits has been discharging to Milo Creek. In September 2009, discharge from the adits under base-flow conditions was 0.17 cfs. The discharge from these adits would be expected to be greater under higher flow conditions.

In 1998, after a large flood event resulting in considerable downstream damage, a permanent concrete sediment basin was installed between Upper and Lower Milo Creeks that connected to a new buried piping system that replaced pipe that had failed during the 1997 flood. This new basin traps sediment and bedload (sediment, gravel, and rocks transported by the force of moving water) and directs creek flow into twin 54-inch pipes beneath the towns of Wardner and Kellogg before discharging to the SFCDR.

Government Creek

Government Gulch is the historical location of several ore processing and acid/fertilizer producing facilities that have since been demolished and removed as part of the OU 2 Phase I remedial actions. At the time of ore processing, the middle portion of Government Creek, which historically flowed down the center of the gulch in a meandering pattern, was re-routed to the west side of the gulch into a shotcrete channel in order to provide space for the zinc plant and phosphoric acid plant. The Phase I remedial actions reconstructed Government Creek so that it once again flows down the middle of the gulch in a meandering pattern, into a culvert system under McKinley Avenue, and eventually beneath I-90 to discharge to the SFCDR.

Surface water flow is monitored intermittently on Government Creek. The peak average daily discharge recorded at this station was 16.2 cfs in May 2002, and base flow is estimated to be between 1 and 2 cfs. The majority of discharge recorded at this station occurs in the spring and summer and can be attributed to snowmelt and seasonal precipitation. A significant amount of surface water-groundwater interaction occurs within Government Gulch, with losing conditions (stream water infiltrates into the ground) occurring in the upper reaches of the gulch and gaining conditions (groundwater flows into the stream) occurring nearer to the gulch mouth. After Government Creek leaves Government Gulch and traverses the SFCDR valley floor, it loses a significant amount of its discharge (up to 30 percent) to the underlying groundwater system under base-flow conditions (CH2M HILL, 2006a).

In 2007, the developer of the golf course property located to the east of Government Gulch constructed a catchment pond in the Government Creek channel near the former Zinc Plant location and began to divert water from Government Creek for the golf course. The quantity of diverted water has not been reported, and the resulting impacts of the diversion of surface water from Government Creek on groundwater and surface water conditions have not yet been evaluated.

Bunker Creek

Prior to placement of mine waste in the area, the SFCDR flowed along most of the current Bunker Creek channel. Uncontrolled dumping of coarse tailings, fine-grained tailings (slimes), mine waste rock, and granulated smelter slag occurred in the Bunker Creek corridor. With construction of the Central Impoundment Area (CIA) in 1928, a drainage ditch (Bunker Creek) was constructed to convey drainage from tributaries located on the south side of the valley (Portal Gulch, Railroad Gulch, Deadwood Gulch, and Magnet Gulch) around the CIA to the SFCDR. The drainage ditch originated to the east of the CTP, flowed west along the base of the CIA, and then angled north at the western end of the CIA before flowing into a culvert system beneath I-90 to its discharge to the SFCDR.

Because the ditch was unlined and constructed on top of waste materials that filled in the historical SFCDR channel, a significant amount of water from Bunker Creek infiltrated to the underlying groundwater system. As part of the OU 2 Phase I remedial action, some of the contaminated materials underlying the Bunker Creek channel were removed and approximately 7,600 linear feet of the Bunker Creek channel was reconstructed. During the design of the Phase I remedial action for Bunker Creek, it was decided that a constructed liner was not needed due to the low permeability of underlying materials based on the results of geotechnical characterization activities (Spectrum Engineering, 1996). The Bunker Creek channel was reconstructed into a more natural stream corridor and currently receives flow from several sources including stormwater, drainage from a portion of western Kellogg, effluent discharge from the CTP, and surface water from Portal, Railroad, Deadwood, and Magnet Gulches. Currently, the CTP is the only National Pollutant Discharge Elimination System (NPDES)-regulated point source discharge to Bunker Creek.

Low flow on Bunker Creek as it enters the SFCDR is approximately 1 to 2 cfs, with high flows reaching about 30 cfs. During the Phase I Remedial Action Assessment, it was determined that the Bunker Creek channel continues to exchange a significant amount of discharge with the underlying groundwater system, gaining and/or losing, depending on the specific reach and flow conditions (high vs. low) (CH2M HILL, 2007d). The large amount of discharge gained and lost in Bunker Creek suggests that in-place streambed materials are not impermeable enough to prevent interaction of groundwater and surface water in the Bunker Creek corridor (CH2M HILL, 2007d).

3.2.5 Hydrogeology

This section discusses the general occurrence and flow of groundwater in the Upper Basin, followed by site-specific discussions of the larger and more relevant alluvial aquifers in the Upper Basin: Woodland Park, Osburn Flats, and within the Bunker Hill Box (Figure 3-1).

3.2.5.1 General Hydrogeology of the Upper Basin

In general, two predominant hydrogeologic flow regimes are present within the Upper Basin: groundwater within fractured bedrock (Belt Supergroup Series, quartzites, and argillites), and groundwater within fine to coarse alluvial deposits within the SFCDR and its major tributary valleys.

Bedrock Aquifers

Groundwater flow through fractures and/or faults is the most important component of flow in bedrock aquifers, because the permeability of the unfractured native bedrock is very low. As a result, topographic relief and the orientation of spatially continuous, permeable fractures or fracture zones dictate the direction of regional flow. Local to subregional bedrock aquifer flow systems develop within individual tributary basins. Recharge to the bedrock system occurs predominantly via snowmelt and direct precipitation infiltration in the higher elevations. Discharge from bedrock aquifers occurs within the valley bottom areas, either as discrete seeps or as subsurface recharge to the valley floodplain alluvial deposits. In areas where underground mining has occurred, the mined-out area can serve as a human-made zone of groundwater discharge that can cause localized desaturation within a cone of depression around the mine workings.

Alluvial Aquifers

Alluvial aquifers occur in the valley fill sediments and are typically shallow, unconfined, and long and narrow in dimension. These aquifer systems generally have relatively steep hydraulic gradients, similar to the gradient of the local topography and streams, and are sustained by stream loss or groundwater discharge from the bedrock aquifer system. Groundwater flow in these shallow alluvial aquifer systems tends to parallel the course of the surface water flow. In wider areas of the alluvial valley, preferential groundwater flow pathways associated with historical stream channels may be present. Hydraulic conductivity is typically related to grain size and sorting, with coarser and more uniform deposits having relatively high values (tens to thousands of feet per day) and finer grained or poorly sorted deposits having relatively lower values. Although mountain streams tend to create well-sorted coarse deposits, the distribution of hydraulic conductivity does not necessarily follow the pattern of current stream networks because of historical meandering and anthropogenic channel alterations.

Groundwater-Surface Water Interaction

A high degree of hydraulic interaction exists between the shallow alluvial groundwater and surface water. The nature of the interaction is spatially and temporally variable. In general, streams tend to be gaining in areas where the alluvial valley narrows, and losing in areas where the alluvial valley widens. Shorter scale exchange typically occurs on the scale of pool and riffle sequences.

The nature of groundwater-surface water interaction usually is seasonally dependent. When the stream level (stage) is high (i.e., during spring runoff), there is typically more flow from the stream to the groundwater than during low-level (stage) conditions (i.e., late summer base flow), when groundwater discharge to streams is typically at its highest. The nature of groundwater-surface water interactions can change abruptly during the rising limb of hydrographs (i.e., from gaining to losing), and transitions are slower on the falling limbs (i.e., from losing to gaining).

3.2.5.2 Woodland Park

Woodland Park is a relatively flat, broad valley along Canyon Creek, about 2 miles in length starting 0.5 mile upstream from the confluence of Canyon Creek with the SFCDR (Figure 3-5). In the upper reaches beyond Woodland Park, Canyon Creek is characterized by a high stream gradient within a deeply incised V-shaped canyon, but near Woodland Park the gradient decreases and Canyon Creek opens into a U-shaped canyon. The area was populated early during the onset of mining and currently has approximately 100 residences.

Woodland Park has an extensive monitoring network of more than 50 wells and stream gauges (Figure 3-5). Twenty-one of these were installed during the Canyon Creek Hydrologic Study in 2006 (CH2M HILL, 2007a).

Hydrogeologic Units and Groundwater Occurrence

The extent of the alluvial aquifer upstream from the Woodland Park area is limited, with small alluvial deposits along the banks of Canyon Creek banks generally less than 15 feet thick. In the Woodland Park area, the alluvial aquifer becomes significantly thicker, up to 50 feet through the center of the valley (Figure 3-6). The aquifer thins as Canyon Creek approaches the confluence with the SFCDR and as the bedrock comes to within 5 feet of the surface.

The alluvial aquifer within Woodland Park had been previously described as a multi-aquifer system, with more permeable alluvial deposits representing shallow and deep aquifers that are separated by discontinuous silty layers representing a leaky aquitard (URS, 2004). However, observations of lithologic samples collected during the drilling of 15 wells at the site in spring 2006 did not reveal any significant lithology changes between the shallow and deeper portions of the alluvial aquifer (CH2M HILL, 2007a). The boring logs indicate that the entire alluvial profile consists of deposits of clayey gravel to gravely clay with no indication of more permeable aquifers or less permeable aquitards. However, significant groundwater elevation differences are observed between wells screened in the upper portion (5 to 15 feet below ground surface [bgs]) versus the lower portion (25 to 30 feet bgs) of the alluvial aquifer. These data suggest that it is more likely that the alluvial aquifer is characterized as a single highly stratified water-bearing unit, with preferential flow in the horizontal direction and strong vertical gradients (upward and downward in different areas of the aquifer). The hydraulic conductivity estimates range from less than 5 feet per day (ft/d) to about 60 ft/d, with higher values along the longitudinal center of the valley (CH2M HILL, 2007a).

Groundwater Flow

Recharge to the Woodland Park aquifer includes infiltration of precipitation, hillside runoff, tributary surface water inflow, tributary groundwater inflow, recharge from Canyon Creek in losing reaches, and upgradient aquifer inflow. Discharge from the Woodland Park aquifer includes evapotranspiration, discharge to Canyon Creek in gaining reaches, and downgradient groundwater outflow to the main SFCDR valley aquifer. The amount of exchange with the local bedrock aquifer is unknown.

Groundwater generally flows parallel to Canyon Creek and/or the axis of the valley (see Figure 3-5). Groundwater elevations in the alluvial aquifer fluctuate seasonally, with the lowest groundwater levels toward the end of the dry season (September and October). The highest groundwater levels are observed during spring as the basin is recharged by precipitation, snowmelt, adit drainage, and leakage from losing reaches of Canyon Creek. From the end of the dry season, groundwater levels begin to rise with the onset of precipitation in the fall, and eventually reach a quasi-steady state in which subsequent recharge is balanced by groundwater discharge to streams, and further recharge is rejected. Once a steady-state condition is reached, the groundwater levels remain relatively stable, with minor fluctuations caused by stage changes in Canyon Creek. The timing of when this relatively steady-state condition is reached varies from year to year, depending on the timing and intensity of the fall precipitation events.

Groundwater-Surface Water Interaction

The groundwater and surface water systems are coupled, with stream stage clearly influencing water levels in several wells. Approximate locations of gaining and losing reaches of the SFCDR within Woodland Park were identified based on groundwater seepage studies conducted at base-flow conditions in 1999 (Barton, 2002) and 2006 (CH2M HILL, 2007a). The locations of these areas are in general agreement with the gaining and losing reaches computed by the groundwater flow model and shown in Figure 3-5. During base-flow conditions, Canyon Creek gains approximately 0 to 3 cfs from groundwater inflow in Woodland Park (see Figure 3-5). During base-flow conditions, the total groundwater-surface water exchange through the aquifer is about 3 cfs (CH2M HILL, 2007a).

3.2.5.3 Osburn Flats

Osburn Flats is a relatively flat section of the SFCDR valley that stretches approximately 2 miles along the SFCDR, with a maximum cross-valley width of approximately 3,000 feet (Figure 3-7). The valley floor is at an elevation of about 2,500 feet above msl and is home to approximately 1,500 people in the town of Osburn (also known as Osburn City). The history of Osburn Flats closely follows the history of hard rock mining in the area. A large portion of the eastern side of the valley was occupied by a plank-and-pile dam during the early 1900s, which was installed to slow the downstream migration of mining wastes.

Use of Groundwater

Historically, groundwater in Osburn was used for domestic and municipal use. In the 1970s, however, testing of area wells revealed extensive zinc and cadmium contamination in shallow groundwater, and it was determined that the groundwater in the Osburn area was not fit for human consumption. Since then, municipal water supply has been provided by wells in the North Fork Coeur d'Alene River drainage area near Enaville. The only known current use of groundwater in Osburn is by Zanetti Brothers for gravel mining operations.

Hydrogeologic Units and Groundwater Occurrence

The groundwater monitoring network in Osburn Flats consists of more than 40 wells, most installed in 2008 (CH2M HILL, 2009e, 2009j). Groundwater occurs within the unconsolidated deposits of the Osburn Valley as the dominant groundwater flow system within Osburn Flats. Although these materials overlie water-bearing fractured and faulted bedrock, the groundwater flow system associated with these features is thought to be insignificant compared with the alluvial aquifer system.

Figure 3-8 shows a conceptual cross section of Osburn Flats. The alluvial unit consists primarily of silty to clayey sand and gravel, with scattered lenses of clean, well to poorly graded sand and gravel with occasional cobbles. The water table is relatively shallow, and depth to water increases from about 10 feet bgs near the SFCDR to more than 20 feet bgs in the southern sections of the valley. The saturated thickness of the alluvial aquifer varies from about 10 to 30 feet during low-flow conditions and increases with a rising water table during the spring runoff.

Average hydraulic conductivity values range from 600 to 4,700 ft/d, with a median of 1,300 ft/d (CH2M HILL, 2009j). There are no apparent spatial trends in hydraulic conductivity distribution. These hydraulic conductivity values and the lack of a spatial pattern (at the scale observed) are consistent with typical heterogeneous alluvial deposits of coarse sand and gravel.

Groundwater Flow

Recharge to the Osburn Flats aquifer includes infiltration of precipitation, hillside runoff, tributary surface water inflow, tributary groundwater inflow, recharge from the SFCDR (losing reaches), and upgradient aquifer inflow. Discharge from the Osburn Flats aquifer includes evapotranspiration, discharge to the SFCDR (gaining reaches), and downgradient groundwater outflow. The amount of exchange with the local bedrock aquifer is unknown.

Groundwater generally flows parallel to the axis of the valley and toward the SFCDR (Figure 3-7). During high-flow events, the stage of the SFCDR rises more quickly than groundwater levels, with subsequent increased flow from the river to the groundwater. The SFCDR in the Osburn Flats area has the lowest hydraulic gradient on the SFCDR upstream from OU 2, an observation consistent with the generally flat topography, and groundwater hydraulic gradients are roughly the same as gradients on the SFCDR.

Groundwater-Surface Water Interaction

Approximate locations of gaining and losing reaches of the SFCDR within Osburn Flats were identified based on groundwater seepage studies conducted at base-flow conditions in 1999 (Barton, 2002) and 2008 (CH2M HILL, 2009g). The locations of these areas are in general agreement with the gaining and losing reaches computed by the groundwater flow model and shown in Figure 3-7. During base-flow conditions, the eastern losing section loses about 10 to 15 cfs, the central gaining section gains approximately 10 cfs, the central losing section loses about 2 to 5 cfs, and the far western area gains approximately 8 cfs (CH2M HILL, 2009g, 2009l). Overall, the Osburn Flats reach appears to be gaining approximately 5 cfs during base-flow conditions.

3.2.5.4 Operable Unit 2

The OU 2 groundwater monitoring network consists of more than 100 wells (Figure 3-9). The RI characterization monitoring network established in 1987 represents the first systematically designed and frequently sampled monitoring network within OU 2. The RI monitoring network was first sampled in 1987 and continued to be sampled on a quarterly basis until 1992, when it was discontinued as a result of the bankruptcy of the Potentially Responsible Parties (PRPs). The water quality monitoring network was reestablished by USEPA and the State of Idaho in 1996. During implementation of Phase I remedial actions (1996 to 2000), several of the original RI groundwater monitoring wells were destroyed or abandoned in areas of extensive cleanup. Changes in the monitoring network have occurred since this time, including the establishment of new groundwater and surface water monitoring locations and the abandonment of others.

To more effectively evaluate the impacts of the OU 2 Phase I cleanup activities and gather data to assess the need for additional cleanup actions, USEPA and the Idaho Department of Environmental Quality (IDEQ) expanded the groundwater monitoring network in 2002 with 23 new monitoring wells (CH2M HILL, 2003), in 2006 with 10 new monitoring wells (SCS Engineers, 2006) following a long-term monitoring network optimization effort (Parsons, 2006), and in 2008 with 36 piezometers to address data gaps identified in the Source Areas of Concern Report (CH2M HILL, 2008a).

Use of Groundwater

There are no municipal supply wells within OU 2. However, the City of Kingston maintains a municipal production well in the lower aquifer downstream from the confluence of the SFCDR and the North Fork of the Coeur d'Alene River, and the City of Pinehurst maintains a municipal production well in the lower portion of the Pinehurst aquifer. Water quality in these areas has historically been of high quality and free of contamination and, while these areas are technically hydraulically connected to the lower aquifer in OU 2, they are not considered threatened by conditions within OU 2.

Hydrogeologic Units and Groundwater Occurrence

Most of the information presented in this section is summarized from the more extensive evaluation of hydrogeology presented in the updated OU 2 Conceptual Site Model Report (CH2M HILL, 2006a).

The unconsolidated alluvial materials in the SFCDR valley represent the dominant groundwater flow system within OU 2. Although these materials overlie water-bearing fractured and faulted bedrock, the groundwater flow system associated with these bedrock features is thought to be insignificant compared to the alluvial aquifer system.

Groundwater within OU 2 occurs in the mainstem SFCDR valley, upland tributary valleys, and, to some extent, colluvium and slope wash materials associated with the surrounding hillsides (Figure 3-9). Following are general descriptions of these groundwater systems.

Mainstem SFCDR Valley Groundwater System. The mainstem SFCDR valley groundwater system contains the following four distinct hydrogeologic units, shown as a longitudinal cross section in Figure 3-10:

- A relatively thick, unconfined alluvial sand and gravel unit that is present in the eastern portion of OU 2 where the confining unit is not present. This unit consists primarily of silty to clayey sand and gravel, with scattered lenses of clean, well to poorly graded sand and gravel with occasional cobbles. Depth to groundwater in this unit ranges from approximately 8 to 10 feet bgs.
- An upper, unconfined alluvial sand and gravel unit associated with the mainstem SFCDR valley and defined by the presence of the confining unit that underlies this upper alluvial unit. This unit varies in total thickness, from less than 10 feet near the valley walls to upwards of 40 feet near the Pinehurst Narrows at the west end of OU 2. An upper tailings/alluvium mixture horizon is present at many locations above the natural alluvium. In some instances, the upper aquifer may be locally confined where the tailings/alluvium layer contains finer grained materials. Depth to groundwater in the upper aquifer ranges from approximately 10 to 25 feet bgs.
- A middle lacustrine silt/clay confining unit associated with the mainstem SFCDR valley that separates the upper and lower coarse-grained alluvial sand and gravel units. The confining unit is not present at the eastern boundary of OU 2 and is estimated to begin somewhere between the mouths of Portal and Milo Gulches. The confining unit thickens to the west from this location and to approximately 65 feet at the Pinehurst Narrows near the western boundary of OU 2. The silt/clay content appears to increase from east to west, and the confining unit appears to show no evidence of stratification.
- A lower, confined alluvial unit associated with the mainstem SFCDR valley and defined by the presence of the confining unit that overlies this lower alluvial unit. This unit consists primarily of well to poorly graded gravel with sand and scattered zones of silty/clayey gravel with sand, and varies in thickness from approximately 20 to 40 feet across OU 2. The piezometric surface in wells completed within this lower unit ranges

from approximately 10 to 30 feet bgs and is generally within a few feet of the upper alluvial unit near co-located well pairs.

Comparison of hydraulic conductivity between the upper and lower aquifers suggests that the upper aquifer exhibits relatively higher hydraulic conductivity than the lower aquifer. The confining unit hydraulic conductivity values are several orders of magnitude lower than the upper and lower aquifers.

The upgradient and downgradient boundaries of the mainstem valley aquifer interface with OU 3. At the upgradient boundary, the alluvial aquifer is approximately 50 feet thick and 400 feet wide (CH2M HILL, 2006a). At the downgradient boundary, the lacustrine confining layer is present and about 65 ft thick. The upper unconfined aquifer is about 50 feet thick, the lower confined aquifer about 30 feet thick, and both about 300 feet wide (CH2M HILL, 2006a).

Upland Tributary Groundwater Systems. The upland tributary groundwater systems are located in the hillsides and gulches that discharge to the mainstem SFCDR valley groundwater system. These systems are generally unconfined or semi-confined colluvial/ alluvial units.

Hillside Groundwater. Hillside soils are generally less than 2 feet thick and consist of gravelly silt and clay with very cobbly clay subsoils extending, in some cases, more than 5 feet to bedrock. Groundwater is present in these soils on a localized basis, and the presence of groundwater is generally dictated by precipitation and snowmelt.

Groundwater Flow

Mainstem SFCDR Valley Groundwater System. Recharge to the upper aquifer includes infiltration of precipitation, hillside runoff, tributary surface water inflow, and tributary groundwater inflow; recharge from the SFCDR (losing reaches); upgradient inflow at the OU 2 boundary; upward vertical leakage from the lower aquifer through the confining unit; and leakage through improperly abandoned, constructed, or maintained production wells that penetrate the confining unit.

The primary sources of recharge to the lower, confined aquifer unit include upgradient inflow east of the confining unit pinch-out, leakage from the upper aquifer through the confining unit, and leakage through improperly abandoned, constructed, or maintained production wells that penetrate the confining unit.

Discharge from the upper aquifer unit includes evapotranspiration, discharge to the SFCDR (gaining reaches), downgradient outflow at the western boundary of OU 2, downward vertical leakage into the confining unit, and leakage through improperly abandoned, constructed, or maintained production wells that penetrate the confining unit.

Discharge from the lower aquifer includes downgradient outflow at the western boundary, upward vertical leakage to the confining unit, and leakage through improperly abandoned, constructed, or maintained production wells that penetrate the confining unit.

In general, groundwater within the mainstem SFCDR valley flows from east to west through OU 2 (Figures 3-9 and 3-10). In the upper aquifer, interactions with upland tributary groundwater systems (described below) and the SFCDR and its tributaries result in varying localized groundwater flow pathways and directions.

Groundwater elevations in the unconfined aquifers generally fluctuate on a seasonal basis in response to precipitation and snowmelt. Typically, groundwater elevations are at their highest in the spring and early summer and lowest in the fall and winter. Groundwater elevations near the SFCDR tend to correlate with the stage of the river. Groundwater elevations observed in wells completed in the lower, confined aquifer are relatively more constant and muted compared to the upper, unconfined aquifer, with seasonal fluctuations of up to 3 feet.

The site-wide horizontal gradient from the eastern to the western boundary in both the upper and lower aquifers is approximately 0.004 to 0.005. During low-flow conditions, the horizontal gradient in the eastern half of OU 2, near Kellogg and the CIA, slightly decreases to approximately 0.0036, and in the lower alluvial unit the gradient increases to 0.0078. The seasonal gradient increase in the lower unit for the Kellogg area is not clearly understood. In comparison to the eastern half of OU 2, the Smelterville Flats area gradient is much flatter and exhibits minimal seasonal variation and minimal to no variation between hydrogeologic units.

Head differences at vertical well pairs indicate that vertical gradients correspond to changes in the width of the valley. Progressing down-valley from east to west, upward gradients are generally observed where the valley width decreases, and downward gradients are generally observed where the valley width increases. Vertical gradients in the mouth of Government Creek are downward. The vertical gradients appear to be consistently upward or downward regardless of the season, suggesting that seasonal water table elevation changes are relatively consistent spatially in both aquifers.

Upland Tributary Groundwater Systems. Groundwater in the tributary groundwater systems generally flows north-south following tributary valley alignment at relatively steep hydraulic gradients. Hydraulic conductivities measured in the upland tributary groundwater systems are generally much lower than those observed in the mainstem SFCDR valley aquifers.

Hillside Groundwater. Groundwater is present in these soils on a localized basis, and the presence of groundwater is generally dictated by precipitation and snowmelt.

Groundwater-Surface Water Interaction

This section presents known information regarding surface water and groundwater interaction within OU 2. It has been determined in several studies that the interaction of groundwater and surface water is a significant factor affecting contaminant fate and transport within OU 2 and the potential exposure of human and ecological receptors to contaminants of concern (COCs).

Mainstem SFCDR Valley Groundwater System. Figure 3-9 shows the approximate locations of gaining and losing reaches of the SFCDR within OU 2. The locations of the gaining and losing reaches are based on base-flow groundwater modeling results (CH2M HILL, 2009c), which are in general agreement with groundwater seepage studies conducted under base-flow conditions in 1991 (McCulley, Frick, and Gilman, 1991); 1999 (Barton, 2002); 2003 (CH2M HILL, 2004); 2006 and 2007 (CH2M HILL, 2008a); and 2008 (CH2M HILL, 2009c).

Under base-flow conditions, the SFCDR is supplied mostly from groundwater sources. It is likely that the transitions between gaining and losing reaches and magnitude of discharge gained or lost observed under base-flow conditions are different from those observed under higher flow conditions.

Groundwater discharge to the SFCDR within OU 2 occurs primarily in the areas within OU 2 where the mainstem valley is decreasing in width. Under base-flow conditions, approximately 5 to 6 cfs are discharged from groundwater to surface water in the gaining reach of the SFCDR located to the north of the CIA. These estimates are based on the results of field measurements and groundwater modeling, which show good agreement. In the western portion of OU 2 (Smelterville Flats), groundwater discharge based on field measurements under base-flow conditions has ranged between 9 and 23 cfs, whereas groundwater modeling results estimate groundwater discharge in the range of 3 cfs. The discrepancy between these two methods is likely due to a number of factors that affect both field measurements (changes in the river cross section, error in discharge measurements in deeper segments of the stream, the impact of the Pine Creek drainage) and groundwater models (insufficient groundwater elevation information near the gaining reach, outdated topographic information).

Government Creek was observed to lose a significant amount of discharge to the upper aquifer as it travels across the valley floor during the 2003 groundwater seepage study (CH2M HILL, 2004). The amount of discharge lost from Government Creek during the 2003 study was 0.4 to 0.9 cfs. This equaled 30 to 60 percent of the total discharge measured in Government Creek at the mouth of Government Gulch, prior to entering the valley floor. It would be expected that other tributaries within OU 2 also lose discharge to the upper aquifer under base-flow conditions.

Bunker Creek is bounded by the south–facing slope of the CIA and the southern margin of the SFCDR valley and flows along the approximate former paleochannel of the SFCDR (Figure 3-9). Contaminated materials were excavated from the Bunker Creek channel, and the bottom of the channel was lined with riprap as part of Phase I remedial actions. Bunker Creek was observed to lose a significant amount of discharge to the upper aquifer based on discharge measurements collected during the 2003 groundwater seepage study. During the study, the CTP discharged between 2.3 and 3 cfs. Discharge measured in Bunker Creek prior to discharging to the SFCDR averaged 1.3 cfs. This represents a 1 to 1.7 cfs loss (43 to 57 percent of CTP flow) of Bunker Creek discharge to the upper aquifer in this area.

Upland Tributary Groundwater Systems. Discharge records from Government Creek and groundwater monitoring data from Government Gulch groundwater wells are the only data suitable for evaluating the interaction of tributary surface water with upland tributary groundwater systems. Discharge data have been collected in the upland portion of Government Creek and near the gulch mouth as part of the Hillsides Monitoring Program. Review of these data indicates that Government Creek gains discharge from the Government Gulch groundwater system and smaller tributaries and seeps within the gulch.

3.3 Nature and Extent of Contamination

The long history of mining activities within the Upper Basin, combined with the dynamic and complex hydrologic system and anthropogenic modifications to that system, have resulted in widespread and commingled sources of contamination. This section summarizes the historical generation and dispersion of mining wastes and describes the COCs, the sources for the COCs, and the mechanisms that control the release of contaminants to the environmental system.

3.3.1 Generation and Dispersion of Mining Wastes

This section focuses on the generation and distribution of waste products of the mining industry in the Coeur d'Alene Mining District. Detailed discussion of the individual mines and processing facilities is available in the *Current Status, Conceptual Site Model, Operable Unit 2, Bunker Hill Mining and Metallurgical Complex Superfund Site* (CH2M HILL, 2006a), and the 2001 RI and FS Reports (USEPA, 2001c, 2001d).

3.3.1.1 Mine Wastes

The Bunker Hill Superfund Site is within one of the largest historical mining districts in the world, the Coeur d'Alene Mining District, also known as the Silver Valley. Commercial mining for lead, zinc, silver, and other metals began in the Silver Valley in 1883. The region surrounding the SFCDR has produced more than 97 percent of the ore mined in the Coeur d'Alene Basin (Science Applications International Corporation, 1993). More than 1,000 mining- or milling-related features have been identified in the region surrounding the SFCDR (BLM, 1999).

Heavy metals contamination in soil, sediment, surface water, and groundwater from over 100 years of mining, milling, smelting, and associated modes of transportation has affected both human health and the environment in many areas throughout the Bunker Hill Superfund Site. The principal sources of metals contamination have been air emissions from smelter operations, waste rock (uncrushed rock that was removed from a mine but not processed for metals due to low metals content), and tailings (relatively high-metal concentration waste stream from ore processing, discussed in detail in Section 3.3.1.2). AMD, which is metal-affected drainage from mine portals, is another important source contamination from mine waste. AMD is produced when the infiltration of water and air combine with exposed metal- enriched areas within underground mine workings and which results in discharge of acidic, metal-laden water. The same processes can take place on metal-enriched materials removed from mines (e.g., waste rock) and is typically referred to as acid rock drainage (ARD).

Air emissions of metal oxides, including lead and sulfur dioxide, occurred from the Bunker Hill lead and zinc smelters in Kellogg and Smelterville until their shutdown in 1981. These emissions affected areas near and downwind of the smelter and zinc plant and caused catastrophic deforestation of surrounding hillsides.

Mine tailings and waste rock were frequently used as fill for residential and commercial construction projects. Tailings were also transported downstream, particularly under high-flow conditions, and deposited as lenses of tailings or as tailings/sediment mixtures in the bed, banks, floodplains, and lateral lakes of the Coeur d'Alene River Basin and in Coeur d'Alene Lake. Spillage from railroad operations also contributed to contamination across the area.

The quantity of tailings alone in the system is massive, with approximately 62 million tons of tailings discharged to the Coeur d'Alene basin since mining began (USEPA, 2001c). Assuming that 1 cubic foot of tailings weighs approximately 125 pounds, if all the tailings discharged to the river were piled on a football field (approximately 100 yards by 50 yards), the pile would reach more than 4 miles high. Recognizing that the mining waste discharged to the river has been commingled with clean sediment, which then itself becomes contaminated, the total amount of contaminated material in the basin is significantly greater than 62 million tons (USEPA, 2001c). The estimated total mass and extent of affected materials including lower basin sediments exceeds 100 million tons dispersed over thousands of acres (USEPA, 2001c). Over time, groundwater also became contaminated with metals.

3.3.1.2 Tailings

As ore processing and milling methods evolved over time, so did the nature of the waste products (tailings). The first mills used large stamps that pulverized the ore and jig tables that separated the heavier silver- and lead-rich portions from the "worthless" portion called jig tailings. Jig tailings were coarse-grained (up to 3 inches in diameter), and were typically disposed of in floodplains or stream channels. This process was not efficient, and the tailings contained high quantities of recoverable metals by today's standards. In particular, the jig processing method did not allow for economically viable separation of zinc, which jig tailings contained in abundance.

The more efficient flotation method of ore processing was introduced in the early 1910s. This process required much finer grinding than the jig method, resulted in much finer tailings, and was widely adopted by the late 1930s. The adoption and improvement of flotation techniques gradually increased metal recoveries, particularly of zinc, and allowed mines to process larger amounts of lower grade ores. This resulted in production of larger quantities of finer-grained tailings (fine sand and finer grain sizes) with lower metal content. However, the finer grain size resulted in flotation tailings being more readily dispersed than jig tailings, thus more extensively covering local floodplains during flood events and more easily traveling downstream. Although the grain size and metal content of flotation tailings are lower than for jig tailings, the greater surface area of flotation tailings can result in increased exposure to weathering processes and substantial releases of metals to surface water and groundwater.

In the late 1950s, separation methods were developed to allow the sand-sized fraction of the flotation tailings to be separated from the finer grained materials. The sand-sized fraction was often used as backfill (sand filling) within abandoned mine workings. The remaining flotation tailings were often referred to as "slimes" because of the consistency of the saturated silt and clay-sized particles.

3.3.1.3 Impoundments

Direct deposit of tailings to streams resulted in the widespread distribution of metals-laden materials in the Coeur d'Alene Basin. Impoundments were eventually created to either prevent the downstream migration of contamination in the SFCDR, or to prevent the release of tailings to the SFCDR by storing waste in permanent repositories.

In-Stream Impoundments

In the early 1900s in response to complaints from downstream landowners, the Mine Owners Association built plank-and-pile dams at Osburn Flats, at Pinehurst Narrows at the western end of the Bunker Hill Box on the SFCDR, and at the southern end of Woodland Park on Canyon Creek. The dams served to temporarily reduce the downstream migration of tailings, and the resultant reservoirs covered hundreds of acres, eventually filling primarily with jig tailings.

The dams were breached by flooding and high flows multiple times. Despite the resumed fluvial transport of large amounts of impounded material after the dam breaches, large tailings deposits remained behind the remnants of the dams. During the 1920s, a portion of jig tailings in some of the impoundments were recovered and processed using the flotation method. During the 1940s, significant quantities of metals were recovered from the old tailings deposits using a modified “sink-float” method. Silver recovery from the Osburn tailings in the 1940s was the second largest source of silver in the district. Reprocessing of impounded tailings was completed by the early 1960s. Despite these reprocessing activities, considerable tailings were left in place along the streams because of the great thicknesses that were present in these areas.

Although not within the Upper Basin, the tailings deposits in the Cataldo Flats area deserve mention. These were the largest deposition of tailings in the lower Coeur d’Alene River. A dredge operated by mining companies pumped water and fine tailings scoured from the river bottom to a dump area adjacent to the river. The State of Idaho estimates that approximately 34.5 million tons of mixed alluvium and tailings were dredged from the river between 1933 and 1967, with the resultant piles covering over 2,000 acres in the Mission Flats area (USEPA, 2001c).

Permanent Impoundments

In addition to the plank-and-pile dams, more permanent impoundments were created to store mining waste. The largest of these was the CIA, which began operations in 1928 as an unlined repository for flotation tailings from the Bunker Hill ore concentration mills. Prior to the placement of materials, the area within the current CIA footprint was a low-lying floodplain area that contained vegetation similar to that observed in marsh or wetland environments. Therefore, it is likely that the basal portion of the CIA is located either below the groundwater table or within the zone of groundwater elevation fluctuations. Over time, the CIA developed into an approximately 200-acre impoundment for tailings, mine waste, gypsum, slag, other process waste, and water and AMD from the Bunker Hill Mine. As part of the OU 2 Phase 1 remedial actions, the top of the CIA was capped with a low-permeability geomembrane cover system except for the approximately 5-acre CTP sludge pond area (because this area was in use and CTP operations could not be halted).

Mining activities in this area and construction of the CIA effectively moved the SFCDR channel from the south side of the valley to the north side of the valley. The pre-1900s SFCDR channel was approximately the same as the current Bunker Creek channel. This repository and the Page tailings impoundment (constructed in 1926) effectively ended the direct discharge of tailings from OU 2 sources to the SFCDR, although upstream mines and mills continued to dispose of tailings directly to the SFCDR until 1968.

Other large impoundments include Page Pond in the western portion of OU 2 (approximately 85 acres), the Osburn Tailings Pond (approximately 60 acres), the Lucky Friday Ponds between Wallace and Mullan (approximately 55 acres), the Sunshine Mine/Mill Ponds in Big Creek (approximately 66 acres) and the Hecla-Star Tailings Ponds in Woodland Park (approximately 62 acres). Under the Superfund cleanup program, waste repositories have been established at both the Page Ponds and the former Sunshine Ponds.

3.3.2 Contaminants of Concern

This section identifies the COCs within the Upper Basin. COC designation is based on the potential for a chemical to adversely affect human and ecological receptors. The potential for adverse effects is determined by comparison with numerical concentration criteria for the COCs on a media-specific basis. The discussion below describes the physical and chemical properties of the COCs that govern their fate and transport in environmental media within the Upper Basin. The COCs for the Upper Basin include arsenic, cadmium, lead, mercury, and zinc. As with other Bunker Hill site evaluations, this document uses dissolved zinc in surface water and groundwater and total lead in surface water as indicators to identify potential sources resulting in negative effects on SFCDR water quality; other COCs have been discussed in detail elsewhere (USEPA, 2001c; CH2M HILL, 2006a, 2007d, and 2009f). Although the nutrient phosphorus is not identified as a COC, it is included in this discussion because of its relevance to SFCDR water quality in the Coeur d'Alene Basin and the downstream Coeur d'Alene Lake (USEPA, 2002b).

Potentially applicable or relevant and appropriate requirements (ARARs) for zinc and lead are identified in Section 4.0 of this FFS Report. Site-specific ambient water quality criteria (AWQC) for ecological protection for the SFCDR basin were developed by the State of Idaho and have been adopted by USEPA. Therefore, the surface water AWQC applicable to the Upper Basin are SFCDR Subbasin-Specific Criteria (Idaho Administrative Procedures Act [IDAPA] 58.01.02.285). Reference to AWQC in this FFS Report refers to these standards. Maximum contaminant levels (MCLs) for drinking water are also potential ARARs for surface water as a drinking water source in the Upper Basin. Comparison of MCLs and AWQC (Tables 4-3 and 4-4 in Section 4.0 of this FFS Report) show that, for all COCs except arsenic, the AWQC is lower than the corresponding MCL. However, arsenic is not frequently detected at concentrations above the MCL in the Upper Basin and therefore is not a focus of the surface water quality discussion.

The properties of the COCs as they relate to the air pathway are not discussed in detail in this section. This is because the cessation of industrial operations within the Upper Basin, and the large number of Phase I remedial actions that have been implemented, have greatly reduced the potential for air dispersion and transport to act as a significant contaminant transport pathway.

3.3.2.1 Lead

Lead is found in nature as a component of various minerals. Some, such as galena, cerussite, and anglesite, are economically important sources of lead within the Coeur d'Alene Mining

District. Lead is a stable metal in most environments and generally shows a very limited solubility and mobility in slightly acidic to alkaline waters.

The chemistry of lead in aqueous solution is highly complex because this element can be found in multiple forms. In the environment, the divalent form is the stable ionic species of lead. The amount of lead in surface waters depends on the pH and the dissolved salt content of the water. The solubility of lead increases significantly under acidic conditions. Precipitation of lead can be an important control at pH values above approximately 5.5. Usually, little detectable lead will remain in solution at pH greater than 6.0. Where present, hydroxide, carbonate, sulfide and, more rarely, sulfate can act as solubility controls in precipitating lead from surface water by forming coordination complexes with lead. The stability of the complexes varies with pH. The biotransformations involving lead generally consist of biomethylation and complexation.

Sorption is a dominant process affecting the mobility and distribution of lead in the environment. Sorption is influenced by factors such as pH, redox conditions, particulate iron concentration, availability and type of ligands, and the concentration of lead in solution. Dissolved ionic lead has an affinity with sorption to ferric hydroxides, as well as clays.

Thus, a significant fraction of lead that is present in neutral or near-neutral river water, such as in the SFCDR and its tributaries, is expected to be in an undissolved form, which can consist of (1) colloidal particles or larger undissolved particles of lead carbonate, lead oxide, lead hydroxide, or other lead compounds; (2) sorbed ions; or (3) surface coatings on sediment mineral particles. It also can be carried as a part of suspended living or nonliving organic matter in water.

3.3.2.2 Zinc

Zinc is widely distributed in the environment, and AWQC for zinc are exceeded throughout the Upper Basin, generally at levels toxic to aquatic organisms. The sulfide mineral sphalerite is the primary mineral form of zinc. Zinc occurs in the environment mainly in the +2 oxidation state. As one of the most mobile of the heavy metals, zinc is readily transported in most natural waters and can occur in both suspended and dissolved forms in surface water. Generally, at lower pH values, zinc remains as the free ion. The free ion tends to be adsorbed and transported by suspended solids in unpolluted waters. In polluted waters in which the concentration of zinc is high, removal of zinc by precipitation of the hydroxide is possible, particularly when the pH is greater than 8.0. Dissolved zinc may occur as the free (hydrated) zinc ion or as dissolved complexes and compounds with varying degrees of stability. Zinc also can form compounds with the common ligands and anions in surface waters, such as sulfate and carbonate, and is soluble in neutral and acidic solutions.

Sorption is a dominant reaction, resulting in the enrichment of zinc in suspended and bed sediments. Zinc in aerobic waters is partitioned into sediments through sorption onto hydrous iron and manganese oxides, clay minerals, and organic material. The hydroxides and hydrous oxides of iron and manganese are often components of the clay fraction of sediments and often exist as coatings on the surfaces of other minerals. Zinc may co-precipitate with hydrous oxides when reduced iron or manganese oxides are oxidized. The efficiency of these materials in removing zinc from solution varies according to their concentrations, pH, redox potential (Eh), salinity, nature and concentrations of complexing ligands, and concentration of zinc. Zinc tends to sorb more readily at a high pH (pH >7) than at a low pH. In natural waters, complexing agents, such as humic acid, can bind zinc. The stability of the zinc complex depends on the pH of the water and the nature of the complex.

Zinc that is sorbed to particulate matter in sediments can undergo various reactions that liberate and remobilize zinc back into the water phase. Changes in pH or redox can cause desorption of the zinc from oxide or hydroxide surfaces, solubilization of inorganic zinc from the sediment layer, and/or dissociation of bound organic complexes of zinc present in the sediment and subsequent release into the water phase.

Zinc is an essential nutrient and occurs in the tissues of organisms, even at normal ambient water and soil concentrations. Zinc can bioaccumulate in some aquatic organisms. Microcosm studies indicate, in general, that zinc does not biomagnify through food chains. Although zinc actively bioaccumulates in aquatic systems, biota appear to represent a relatively minor sink compared to sediments.

3.3.2.3 Phosphorus

Phosphorus is an essential nutrient for plants and animals, typically derived from inorganic phosphate rocks. Phosphorus was entrained in the waste stream of the phosphoric acid/fertilizer plant, much of which was impounded at the A-4 Gypsum Pond and other subsequently relocated repositories within the area of the CIA and in Magnet Gulch (Figure 3-9). It is often a limiting nutrient that controls phytoplankton growth in streams and lakes. Increased loading of phosphorus to lakes and streams increases algae and rooted aquatic plant growth through a process known as eutrophication. When this organic material decomposes, it consumes oxygen dissolved in the water. Depletion of dissolved oxygen (anoxia) concentrations in lake bottom waters or streams can promote geochemical processes that release certain mining-related hazardous substances, such as zinc, from sediments. Anoxia will also lead to the release of additional nutrients that stimulate production of algae and rooted aquatic plants and can lead to a cycle that is difficult or impossible to interrupt and that has harmful effects on water quality.

3.3.3 Contaminant Sources

This section presents general descriptions of the primary and secondary sources of contamination within the Upper Basin. For the purpose of this section, primary sources include sources or potential sources consisting of contaminated material directly and intentionally placed within the Upper Basin. Secondary sources include contaminated materials transported by natural processes from their original source locations to their current locations. Contaminant fate and transport are discussed in Section 3.5.

In 1999 BLM created a “mine site data layer” in support of the 2001 RI/FS. This data layer includes locations and approximate areal extent (in geographic information system [GIS] format) of mining-related disturbances, a list of waste types observed, and estimates of volume and area for each waste type at each location. The locations identified in this data layer are widespread in the Upper Basin, extending up nearly every drainage area (Figure 3-11) (USEPA, 2001c, 2001d). Several of the sources depicted in Figure 3-11 are not discrete locations, but rather diffuse sources extending along river and creek segments. A site on the BLM mine site data layer indicates a mining-related disturbance area and may not always indicate the presence of hazardous materials at the site. Classification of the sites by BLM was a limited effort to define disturbance categories, including "adits" and small shafts (prospects) for sites that might have open workings and holes that would be "physical hazards". The site mapping was done more extensively on BLM and U.S. Forest Service (USFS) lands than on private lands. Therefore, private lands may have mine sites with contamination that are not captured in the BLM mine site data layer. Because of the limited inventory on private lands, it is possible that additional sites requiring remediation will be discovered during the implementation period. Despite these limitations of the mine site data layer, this resource remains the most complete set of information available regarding the physical attributes of the sites.

3.3.3.1 Primary Sources

Primary sources include sources and potential sources of contamination that were directly discharged from mining operations. The primary sources in the Upper Basin are:

- Mine workings—shafts and adits: Groundwater and surface water that enter mine workings can become contaminated through contact with various minerals within the mines;
- Waste rock: Rock derived from mining activities (not considered ore, but may be mineralized);
- Tailings: Discarded fractions of processed ores containing residual metals;
- Concentrates and other process wastes: Ore concentrates, unprocessed ore, and other wastes related to mining; and
- Artificial fill: Mining wastes intentionally placed as fill (e.g., for railroads, roadways and structures).

Of these, tailings represent the principal and most mobile source of metals contamination in the Upper Basin. The dispersion of tailings into alluvium and floodplain deposits created the largest and most widespread secondary source of contamination in the Upper Basin.

3.3.3.2 Secondary Sources and Affected Media

Secondary sources of contamination include sources of contamination that are a result of the release of contaminated materials from primary sources. These include contaminated alluvium and floodplain deposits, suspended and bedload sediment, groundwater, and surface water.

Alluvium and Floodplain Deposits

Alluvium and floodplain deposit sources are by far the most dynamic and widespread contaminant sources in the Upper Basin, spreading across the floodplains and valleys of the SFCDR, Canyon Creek, Ninemile Creek, and other SFCDR tributaries. These sediment deposits also underlay developed and/or capped areas in OU2, Osburn Flats, and Woodland Park. This is a direct result of the contaminant release mechanisms associated with these and other sources, the ability of these contaminant sources to be mobilized and relocated, and anthropogenic relocation of tailings to facilitate development of cities, properties, roadways, and other community infrastructure.

Extensive sediment sampling occurred in the Upper Basin during the RI for the Coeur d'Alene Basin (USEPA, 2001c). Since the RI, sediment sampling data from the Upper Basin have been collected recently during two sampling events. The first sampling event was documented in the *Technical Memorandum: OU2 Direct Push Field Investigation Summary* (CH2M HILL, 2009a). The purpose of this investigation was to collect additional data in selected areas of OU 2 identified in the *Source Areas of Concern Report, Operable Unit 2, Bunker Hill Mining and Metallurgical Complex Superfund Site* (CH2M HILL, 2008a). The results of this effort were as follows:

- In general, the upper 12 feet of sediment in the eastern portion of OU 2 was highly disturbed and contained mixtures of native materials and mine and mill wastes. In the western portion of OU 2, the disturbed thickness was less and likely resulted from the large number of remedial actions and from the historic recovery of tailings in this area.
- The highest cadmium concentrations generally coincided with the tailings-affected sediments in the areas from the Silver Mountain Resort parking lot west through the Bunker Creek corridor. The vertical extent of elevated cadmium concentrations was also consistent with lithologic observations of disturbed sediments as described previously. Elevated cadmium concentrations were observed in all areas investigated in OU 2.
- The highest lead concentrations present in subsurface sediments coincided with the observed tailings-affected sediments. Elevated lead concentrations were observed in most areas investigated in OU 2.
- Elevated zinc concentrations were observed in sediments from most borings advanced in OU 2. These concentrations coincide with lithologic observations of tailings-affected sediments in this area.

The second sampling event collected additional data in the Osburn Flats area and was documented in the *Technical Memorandum: Operable Unit 3 Direct-Push Field Investigation Summary, Bunker Hill Mining and Metallurgical Complex Superfund Site* (CH2M HILL, 2009i). The highest concentrations of lead (24,300 milligrams per kilogram [mg/kg]) and zinc (25,200 mg/kg) in sediments were generally in the area of impoundment behind the old plank-and-pile dam, and other areas along the current SFCDR channel. The highest concentrations were generally found in the upper 5 feet of soil, although the maximum in some borings was found as deep as 12 to 14 feet bgs. In general, sediment concentrations are lowest in the central portion of Osburn Flats, toward the southern side of the valley.

Stream Channel Sediments

The BEMP focuses on obtaining representative samples of surficial stream bed sediments from the edge of creeks and rivers that are deposited during annual high stream flow events. Sixteen sediment sampling stations are included in the BEMP and consist of locations in the SFCDR and its tributaries in the Upper Basin, the lower Coeur d'Alene River, and a depositional area of the Spokane River.

The BEMP locations extend from downstream from OU 2 to Upper Ninemile Creek and the SFCDR above Mullan. Figure 3-12 shows lead concentrations in sediment for 2004 to 2008 at four SFCDR locations, three Ninemile Creek locations, Canyon Creek, and Pine Creek. Lead concentrations are generally higher in the smaller sized fraction, and decline in the downstream direction with the exception of the SFCDR at Mullan, at Pine Creek, and on the

East Fork Ninemile Creek. The site-specific benchmark cleanup criterion of 530 mg/kg[1] lead in soil and sediment for protection of songbirds and waterfowl is exceeded at all SFCDR stations below Mullan and in Canyon Creek and Ninemile Creek. In addition, the mortality threshold for waterfowl (1,800 mg/kg; Beyer et al., 2000) is also exceeded at these locations. The SFCDR sediments above Mullan have very low lead concentrations. Lead concentrations on Pine Creek are also low, despite mining operations upstream, perhaps due to dilution from unmined or poorly mineralized tributaries of Pine Creek. Concentrations appear to be decreasing over time at most stations, with the exception of the SFCDR stations (except Mullan) and within the silt-sized fraction in the Lower East Fork of Ninemile Creek.

Figure 3-13 shows zinc concentrations in sediment for 2004 to 2008 at the same locations. Zinc concentrations are generally higher in the silt-sized fraction, and are more erratic year to year than lead. As with lead, concentrations are much higher in Ninemile and Canyon Creeks than in the SFCDR, and much higher in the lower SFCDR than at Pine Creek or the upper SFCDR (Mullan). Only at Ninemile Creek and the SFCDR above Mullan do zinc concentrations appear to be declining. Concentrations measured at Pinehurst are erratic.

Groundwater and Surface Water

Groundwater and surface water are contaminated throughout the Upper Basin and are discussed in detail in Section 3.4. Contaminants are released as groundwater and surface water moves through primary and secondary sources, discussed in greater detail in Section 3.3.4.

Sources of Phosphorus

Sources of phosphorus have not been extensively studied. Potential Upper Basin sources for phosphorus include the wastewater treatment plant in Mullan and specific areas within OU 2. The areas within OU 2 thought to contribute to phosphorus in the SFCDR include the A-4 Gypsum Pond area, the subsurface in the area of the former phosphoric acid/fertilizer plant in Government Gulch, and the Page and Smelterville wastewater treatment plants (CH2M HILL, 2008a).

3.3.4 Contaminant Release Mechanisms

This section describes mechanisms that release contaminants from primary and secondary sources within the Upper Basin. Contaminant release via air is not discussed in this document because of the significant number of remedial actions that have taken place within the Upper Basin that have effectively reduced the availability of contaminants to be transported by air-related mechanisms.

Contaminant release within the Upper Basin is controlled primarily by the movement of surface water and groundwater within the environmental system. Figure 3-14 shows the process model for contaminant sources and release mechanisms operating within the Upper Basin. Included in Figure 3-14 are inputs and release mechanisms that act on the primary and secondary sources and result in contaminant migration and potential exposure to

[1] The site-specific benchmark cleanup criterion of 530 mg/kg lead is based on the lowest adverse effects level (LOAEL) for waterfowl (USEPA, 2002b) determined during the risk assessment. Additional discussion of this criterion and its application to songbirds is provided in Section 4.0 of this FFS Report.

receptors, where primary release mechanisms act on primary sources and secondary release mechanisms act on secondary sources.

The following subsections discuss contaminant release mechanisms in terms of chemical processes and dissolution (Section 3.3.4.1), physical release processes (Section 3.3.4.2), and release rates for the chemical/dissolution and physical processes (Section 3.3.4.3). The discussion does not differentiate between primary and secondary release mechanisms.

3.3.4.1 Chemical Processes and Dissolution

Chemical processes and dissolution as discussed here represent the various processes that result in the chemical transformation and/or dissolution of COCs as a result of the movement of water. This discussion includes common oxidation and adsorption reactions, types of water movement that lead to release and transport of contaminants through chemical reactions and dissolution, and initial results from laboratory experiments involving Upper Basin sediments.

Oxidation Reactions

The oxidation of iron sulfides leads to AMD. In a strict sense, AMD refers to reactions that occur within a mine or mineshaft, but the reactions described may also occur on materials that have been removed from the mine and are dispersed in the environment (e.g., waste rock used as fill). In general, for AMD to be created, a combination of mineralization, mineral exposure to air and water, and bacteria capable of facilitating sulfide oxidation are required. Iron sulfide (pyrite) is oxidized to sulfate and ferrous iron by oxygen present in air. Ferrous iron is oxidized to ferric iron, often catalyzed by bacteria, which in turn can directly oxidize more pyrite. The oxidation of pyrite releases hydrogen ions (acid) and associated metals and sulfate. This series of reactions generates metal salts on the reaction zones of the minerals, and, as water is introduced in greater quantities through the infiltration of precipitation, snowmelt, groundwater, or surface water, the salts are washed from the reaction zones, dissolved, and transported away from the source materials, carrying the acid, metals, and sulfate.

Lead and zinc are among the most widespread and highly concentrated contaminants found in both primary and secondary contaminant sources and affected media. These metals (as well as others) have the common attribute of occurring as relatively insoluble sulfide minerals within ore that generally do not form acid upon oxidation but do release soluble metals in the presence of water and atmospheric oxygen. Lead is released in soluble (dissolved) form from galena, but is quickly sorbed to organic and inorganic materials, such as sediment and suspended solids, in surface waters of near neutral pH. Zinc released in soluble form does not tend to remineralize in surface water and groundwater, but is subject to pH-driven adsorption and desorption reactions as described in the next section.

Adsorption Reactions

Dissolved metals such as zinc adsorb (attach) and desorb (detach) from mineral surfaces according to changes in concentration and several environmental variables, including but not limited to pH, redox state, and temperature. Adsorption reactions involving metals can occur on the surface of minerals (such as iron oxy-hydroxides, clay minerals, or carbonate minerals), and on organic molecules. The minerals may be part of the aquifer matrix or exist as suspended particles. These reactions are highly complex, and COC-specific details were presented in Sections 3.2.2.1 (for lead) and 3.2.2.2 (for zinc). Changing environmental conditions, such as those that occur between high-flow and low-flow conditions, may influence adsorption reactions and the aqueous transport of COCs.

Movement of Water Through Sources

The movement of water through source materials can alter the geochemical environment surrounding the source materials and facilitate the chemical reactions that result in transport of COCs. This generally results in the release of dissolved zinc and to a lesser extent dissolved lead, and in some cases may lead to the precipitation of COCs.

Typically, water moving through source materials is the result of the infiltration of precipitation and snowmelt, the infiltration of surface water, groundwater discharge to surface water, and groundwater elevation fluctuations. These are summarized in the following subsections.

Infiltration of Precipitation and Snowmelt. Infiltration of precipitation and snowmelt through contaminant sources is a major contaminant release mechanism for all sources, with the exception of areas in which contaminated materials have been consolidated and capped with impermeable covers. In general, contaminant sources located above the water table undergo geochemical reactions in the presence of water and oxygen that produce soluble metal salts on reaction zones. These metal salts are flushed from the reaction zones by the infiltrating water and are eventually transported to groundwater. After the soluble metal salts are washed from the reaction zones, the geochemical reactions continue to produce additional metal salts.

Infiltration of Surface Water. Surface water infiltrates to the groundwater from the losing reaches of the SFCDR and tributaries. Similar to the infiltration of precipitation, infiltration of surface water through source materials such as tailings and tailings/alluvium mixtures will result in the transport of dissolved metals from these sources to groundwater.

Groundwater Discharge to Surface Water. Groundwater discharges to surface water in gaining reaches of the SFCDR and certain areas of upland tributary valleys. As groundwater discharges to surface water in these areas, it may pass through contaminant sources and releases dissolved metals. In most streams of OU 2, contaminant concentrations of some dissolved metals, including zinc, are above AWQC as a result of impacts from groundwater discharge to streams.

Groundwater Elevation Fluctuations. Groundwater elevations in the upper aquifer may undergo significant fluctuations depending on location, precipitation, aquifer recharge, and infiltration of surface water. These fluctuations result in a zone within the aquifer that experiences seasonal saturation. As discussed above, geochemical reactions in source materials result in the formation of metal salts on reaction zones within contaminant sources. For groundwater fluctuations to act as contaminant release mechanisms, it is necessary that the seasonally saturated zone of the aquifer and the location of contaminant sources coincide. This is more likely in areas where relatively thick zones of the tailings/ alluvium mixtures occur. Areas in which contaminant sources are above the zone of groundwater fluctuation will produce metal salts; however, release mechanisms for these salts are dominated by the infiltration of precipitation or surface water.

Laboratory Experiments

The Idaho National Laboratory (INL) investigated the nature of contamination and contaminant mobility in sediments from the Woodland Park area of Canyon Creek (INL, 2007), and Osburn Flats and OU 2 (INL, 2009). These investigations examined the effects of various aqueous solutions on metals release from sediments. The results of these studies provide some experimental insight into the mobility of contaminants in sediments exposed to water.

In both studies, sediments were collected to depths of 9 to 10 feet bgs in areas affected by mining contamination. The 2009 study evaluated data from three OU 2 borings (all near the CIA) and one Osburn Flats boring. The Canyon Creek study evaluated data from three locations. The methodologies of both studies were generally similar, with exceptions as noted below.

In leaching tests, the sediments were exposed to solutions with pH ranging from 2 to 7 (in both studies), with deionized water under varying redox conditions (oxic and anoxic) (2009 study only), and differing ionic strength solutions (2007 study only). All measured constituents generally leached progressively more as the solutions became more acidic. The results of the redox leaching experiments were highly variable and site specific. Lead and zinc usually acted similarly, with increased leaching under oxic conditions in sediments from Osburn Flats and one OU 2 location, increased leaching under anoxic conditions in sediments from another OU 2 location, and at very similar rates for either redox condition in sediments from the third OU 2 location. Leaching of lead and zinc was generally not influenced by the ionic strength of the leaching solutions (Canyon Creek).

In the 2009 sequential extraction tests, sediments were exposed to various solutions to determine the percent of metals in different forms:

1. ion-exchangeable,
2. carbonate form (acid-soluble),
3. bound to organic materials and hydrous oxides, and
4. the residual component.

The results were highly variable at different locations and at different depths. In general, lead was present in roughly equal portions of forms 2, 3, and 4, with a lesser fraction of the ion-exchangeable form 1. Zinc was found the least in form 1, slightly more in form 2, even more in form 3, and mostly in form 4 (INL, 2009). These results (for Osburn Flats and OU 2 sediments) are similar to the findings of the Canyon Creek study, which used slightly different methodologies (INL, 2007). The Canyon Creek study had five extraction steps, where procedures were used to identify separately the organic-bound and hydrous oxide-bound components. The ionic strength extraction studies with Canyon Creek sediments indicated that, although high ionic strength solutions increased the extraction of major ions (i.e., aluminum, calcium, magnesium), there was little to no influence on the amount of lead or zinc leached (INL, 2007).

In general, the sequential extraction experiments generally showed that cadmium was present in a more easily leachable form than were zinc and lead, with lead being more easily leachable than zinc. This follows from the general geochemical behavior of these metals. Zinc is typically much more mobile in the aqueous phase than lead and cadmium, with a lower tendency towards adsorbing onto mineral surfaces. As a result, the zinc that is present in solid form tends to be associated with more recalcitrant source minerals such as oxides, sulfides, and silicates. Because zinc is resistant to leaching out of these minerals, adsorbed cadmium and lead are expected to be more leachable because they are associated with exchange sites and more poorly crystallized, acid-soluble mineral phases.

The results of the INL studies indicate that there is a strong correlation between metal leaching from sediments and decreasing pH. The observed groundwater and surface water data bear out this relationship, with higher metals concentrations associated with lower pH (typically around 5) water as opposed to samples with near-neutral pH (7). Where pH decreases, the concentrations of lead and cadmium would be expected to rise more than zinc, because there is more zinc already in aqueous form and the solid forms of zinc are more resistant to leaching.

3.3.4.2 Physical Release Processes

Contaminants can also be mobilized through physical processes such as mass wasting or slumping and moving water in the form of stream flow, overland flow, and precipitation. Only exposed sources are subject to such contaminant transport. In addition, exposed sources act as direct exposure pathways to humans and wildlife.

During rain-on-snow events, rapid snowmelt, and seasonal periods of elevated precipitation, overland flow can entrain contaminant source material. Water flowing over unstabilized soils and contaminant sources can result in eroding these sources and eventual transport to surface water bodies. As discussed in Section 3.1.4, Upper Basin streams flow at peak discharge during these events, which in turn causes peak channel migration and bank erosion. High-water, high-energy streams entrain and transport contaminated materials from the channel banks and deposit them downstream in floodplains and slackwater areas.

3.3.4.3 Contaminant Release Rates

The overall rate of contaminant release depends on the characteristics of the contaminated material and the nature of the surrounding environment. Mobilization of sources by water can result in rapid release and distribution of contaminants. Periodic erosion or small-scale disturbances of waste materials (i.e., mass wasting or slumping) over time can expose new mineral surfaces to environmental conditions favorable to chemical breakdown. The following subsections examine the factors that determine the contaminant release rates, long-term contaminant release trends, and the longevity of mine waste impacts on water quality.

Factors Affecting Contaminant Release Rates

Key considerations for water quality in the Upper Basin are the rate at which sulfide minerals are oxidized, the associated release of trace metals, and the rate at which these weathering byproducts enter surface water and groundwater. The rate of metal release from mine wastes depends on numerous variables including the amount and form of pyrite, the amount of trace minerals present, oxygen concentrations and flux, pH, ferric iron concentrations, humidity, catalytic agents such as manganese, the water flushing frequency, and the presence, types, and concentrations of bacteria. Generally speaking, the highest rates occur in fine-grained high-pyritic wastes with exposure to ample oxygen and moisture and with frequent hydraulic flushing. An example is the Flood-Stanly Ore Body of the

Bunker Hill Mine, the most pyritic ore body in the SFCDR Watershed. For a given pyrite and trace metal content, the rate is generally controlled by the particle size and associated surface area, the availability of oxygen and moisture, and the frequency of flushing. Thus, everything being equal except particle size, tailings will release metals faster than waste rock. However, because tailings typically have higher pyrite and trace metal content than waste rock, metal release is even higher from these wastes.

The release rate of trace metals from mines via acidic drainage depends on the same factors, with the chemistry of the adit discharge representing the aggregate effect of processes throughout the upgradient mine workings. In a typical underground mine setting, sulfide source minerals are usually abundant but unevenly distributed and metals discharge rates are variable due to source distribution and seasonal water infiltration rates.

Long-Term Metal Release Rates and Trends

The rate of metal release in the long term—i.e., over many decades or centuries—is dependent on the controlling factors described above. Assuming the wastes stay static and are not disturbed, moved, or changed with respect to water and air exposure, and that effective total surface area and mineralogy stay constant, the long-term rate of metal release would be expected to stay constant. In this instance, the “effective total surface area” is defined as the total surface area of mine wastes upstream from a monitoring location.

However, this hypothetical situation is not realistic, because most Upper Basin mine wastes are not static. Nature—via storms and floods—and mankind—via construction, mining, and other intrusive actions—will over time cause wastes to be moved, redistributed, exposed, or covered. The sum effect could either increase or decrease the metal release rate.

In addition, if disturbances do not occur, the rate of weathering of each different source type (waste rock, tailings, adit drainage, floodplain sediments) is different, and the rate of weathering for a single source type depends on its location and exposure to air and water. At some point, the weathering of each individual source will slow as the available pyrite is reduced, the available surface area diminishes, or the flux of air or water is reduced, such as by a change in waste permeability. Given the large inherent differences in the sources, it is apparent that the rate of change will be different for each, and the aggregate effect when measured at a downstream SFCDR monitoring station will be dependent on how the weathering of the various upstream sources independently changes. Given the large number of sources and the many waste types, rates of weathering will be highly variable over time. In general, similar sources that are more exposed to weathering will release trace metals faster than those that are less exposed. Over time the more exposed sources will become more depleted and will emit fewer contaminants. In contrast, the rate of weathering of sources less exposed will not decline so quickly, which will tend to slow improvement in water quality at a monitoring location. This inherent heterogeneity of the various sources complicates the ability to predict weathering rates.

The scenario just presented is likely analogous to what has occurred at the mouth of Canyon Creek over the last 15 years as a result of cleanup work conducted by the Silver Valley Natural Resource Trust (SVNRT) in the mid-1990s. This cleanup work consisted of considerable excavation of floodplain sediments containing appreciable pyrite mineralogy and consolidation of those wastes in the Woodland Park repository, which abuts a hillside in the back of a small drainage area. The large-scale work resulted in the removal of many sources that were weathering, which reduced the metal load at the creek mouth yet simultaneously exposed wastes to weathering that had been previously more isolated. During construction, the waste repository was not hydraulically isolated from the adjacent drainage, resulting in seepage through the back of the pile and the emergence of acidic metal-laden springs near the repository toe. Although the net effect, based on a little more than a decade of monitoring, has been an apparent reduction in metal load at the mouth of Canyon Creek, the disturbance has caused a significant shift in the overall rate of weathering. Because the wastes are now more consolidated, the overall weathering rate is likely slower, but weathering may occur for a longer duration.

Longevity of Mine Waste Impacts on Water Quality

The longevity of mine waste impacts on water quality varies considerably between mine waste sites and is largely dependent on the type of mineralogy; the type, magnitude, and distribution of wastes; and the other factors discussed previously. Some historical mine waste sites in the world have been affecting water quality for hundreds or thousands of years. Examples include Greek and Roman mines, and even some that predate those cultures. Examples that are thousands of years old are the mines in the Rio Tinto region of Spain (Davis et al., 2000); the copper mines of Cyprus, including the Skouriotissa; and the Wheal Jane area of Wales. Although the extent and severity of water quality impacts that occurred during the historical working of these mines cannot be quantified, it is very likely—given their relatively large scale at the time, the high content of sulfide mineralogy, and the richness of their metal content—that these mines began affecting local water quality soon after development. Mining has also occurred in these areas in more modern times, but some of the ancient mine wastes continue to negatively affect water quality after thousands of years.

A relevant U.S. example of projected long-term negative impacts is the Iron Mountain Mine near Redding, California. This mine dates back only about 150 years, but it is expected to discharge very strong AMD containing high concentrations of cadmium, copper, zinc, and other metals for thousands of years (Nordstrom, 2010). This mine consists of large underground workings, an open pit, and considerable waste rock and tailings areas. Although the AMD from the underground workings accounts for the largest portion of the metal load, the waste rock piles and tailings have been leaching for many decades with no indication of abatement.

3.4 Contaminant Fate and Transport

This section describes the current understanding of contaminant fate and transport within the Upper Basin surface water and groundwater system. The basis for this understanding is:

- the physical setting of the Upper Basin, which dictates the movement and interaction of surface water and groundwater described in Section 3.2;
- the physical and chemical properties of the COCs for the Upper Basin as described in Section 3.3);
- contaminant sources and mechanisms for releases of contaminants to surface water and groundwater within the Upper Basin as discussed in Section 3.3;

- remedial actions conducted within the Upper Basin and their expected impact on the physical setting, the nature and extent of contamination, and contaminant release mechanisms as discussed in Section 2.0; and
- surface water and groundwater monitoring data collected as part of water quality monitoring efforts in the Upper Basin as discussed in Section 3.4.2.

As detailed in Table 2-1 in Section 2, dozens of remedial actions have been implemented over the last two decades, with the bulk of them performed in the late 1990s through 2002. To provide a framework for assessing contaminant fate and transport as indicated by water quality changes over time, three time periods are delineated as follows:

- Pre-Remediation: before October 1, 1995;
- Active Remediation: from October 1, 1995, to September 30, 2002; and
- Post-Remediation: October 1, 2002, to present.

These date ranges may differ from those used in previous reports that focused on smaller areas. For example, the Phase 1 Remedial Action Assessment Report for OU 2 (CH2M HILL, 2007d) defined the active remediation period as being from early 1994 to early 2000.

Changes in water quality over time are discussed separately below for surface water (Section 3.4.1) and groundwater (Section 3.4.2), based on measured changes in water quality over time at various locations throughout the Upper Basin.

The long-term fate of contamination in the Upper Basin is not explicitly addressed. The prediction of long-term water quality trends and specific water quality in the distant future is subject to considerable uncertainty, stemming from the complex weathering rates and the change in these rates for the numerous mine waste types and source sites in the SFCDR Basin. Site-specific exposure to seasonal wetting and water flux, as well as variations in particle surface area, iron sulfide content, trace metal content, air diffusion, and other factors control the release of contaminants from mine wastes. Using relatively short-term and location-specific water quality to predict long-term trends and metal concentrations at points in time is fraught with considerable uncertainty in a system as contaminated and complex as the SFCDR Basin, particularly when the wastes are disturbed by nature or cleanup.

3.4.1 Surface Water Quality

This section discusses water quality criteria, examines the phenomena of diel fluctuations of dissolved metals in streams, and reviews current and historical water quality conditions at a key subset of surface water quality monitoring stations. Figure 3-1 shows the six Upper Basin key surface water monitoring locations that are focused on in this discussion for illustration of Upper Basin conditions: Stations CC-288 at the mouth of Canyon Creek, NM-305 at the mouth of Ninemile Creek, SF-208 above Mullan on the SFCDR, SF-268 on the SFCDR at Elizabeth Park, SF-271 on the SFCDR at Pinehurst, and PC-339 on Pine Creek 2 miles upstream from the confluence with the SFCDR. This section focuses on dissolved zinc and total lead as representative, indicator COCs; most other dissolved COCs behave similarly to dissolved zinc, and total lead is representative of suspended metals. Phosphorus is also discussed.

3.4.1.1 Ambient Water Quality Criteria

For dissolved metals such as zinc, Idaho surface water standards for ecological protection are based on AWQC. AWQC are a potential ARAR for surface water quality, and the use of AWQC removes much of the discharge-driven variability because they are calculated using discharge-dependent hardness.

The AWQC used in the RI/FS for the Coeur d'Alene Basin (USEPA, 2001c, 2001d) were the USEPA-approved Idaho and Washington water quality standards. In 2002, the State of Idaho established site-specific AWQC values for dissolved zinc, cadmium, and lead in the SFCDR watershed. The SFCDR-specific values are applicable to all surface water in the Upper Basin (upstream from the confluence with the North Fork). The USEPA-approved Idaho and Washington water quality standards are still applicable to surface water downstream from the confluence of the North Fork and SFCDR.

The AWQC ratio is the concentration of a chemical in surface water divided by the ambient water quality criterion. An AWQC ratio of one or less indicates that the water quality criteria are met. The AWQC ratios are less variable than measured concentrations or calculated loads, and are not correlated with discharge except at very high discharges (USEPA, 2004). Therefore, in this section, water quality is discussed primarily in terms of AWQC ratio (although some discussion does focus on concentration and load).

3.4.1.2 Diel Fluctuations

Diel changes in stream chemistry (changes that occur over 24-hour cycles) are widespread and well-documented phenomena and are known to occur on the SFCDR (Nimick et al., 2003) and in other mountain streams (Fuller et al.,1999; Nimick et al., 2003, 2005, 2007). Diel fluctuations in dissolved metal concentrations are driven by several processes, including natural changes in temperature, pH, redox, and photosynthetic processes in the stream bed environment that affect in-stream geochemical conditions (Nimick et al., 2003). The predominant mechanisms are likely pH and, to a lesser extent, temperature-dependent adsorption reactions and photosynthetic-driven biofilm uptake of metals during the day and release at night (Nimick et al., 2003, Morris et al., 2006). The pH drives adsorption reactions by changing the charge on metal hydroxide surfaces, with higher pH resulting in more negative surface charges, increased cation adsorption, and decreased anion adsorption (Nimick et al., 2003). These processes are very sensitive to pH, with dramatic changes in adsorptive capacity changing over 1 pH unit for some minerals.

Nimick et al. (2003) demonstrated that several dissolved metals in the SFCDR near Pinehurst exhibited diel fluctuations, including cadmium, manganese, nickel, and zinc. Dissolved zinc concentrations in the SFCDR varied by as much as 43 percent over a 12-hour period, with maximum concentrations typically observed around 6 a.m. and the lowest concentrations around 5 p.m. to 6 p.m. This has implications for sampling regimes that begin sampling downstream locations in the morning and work upstream during the course of the day.

Diel changes in SFCDR surface water quality parameters and dissolved metal concentrations were evaluated as a component of the 2008 Groundwater-Surface Water Interaction Study (CH2M HILL 2009g). Diel effects were measured at several locations in the Upper Basin during low-flow conditions in 2008 (CH2M HILL, 2009f). Findings were similar to those of Nimick et al. (2003). At Station SF-268 on September 5, 2008, dissolved zinc decreased 23 percent over 12 hours (from 6:45 a.m. to 6:45 p.m.). Over the same time period, hardness decreased 12 percent and the dissolved zinc AWQC ratio decreased 17 percent.

Ideally, observed dissolved metals concentrations would be normalized for diel effects according to the time of day of sample collection. However, due to the site-specific and temporally variable nature of diel dissolved metals concentration fluctuations (i.e. from day to day, depending on factors such as the weather), this is not possible. Therefore, historically data have not been adjusted for diel variability except those collected in the Osburn Flats Groundwater-Surface Water Interaction Study (CH2M HILL, 2009g). Therefore, diel fluctuations remain an inherent source of uncertainty for all surface water dissolved metals data interpretation.

3.4.1.3 Total Lead in Upper Basin Streams

Lead is primarily transported in water as a particulate or colloid and measured from unfiltered water samples as total lead (which also includes any dissolved lead), and referred to here for simplicity as particulate lead (since the dissolved fraction is typically minor). The AWQC for lead are measured as dissolved lead, not particulate lead. Particulate lead is typically mobilized during high-energy, high-flow conditions as increased sediment becomes entrained in streams. Unfortunately, stream discharge is difficult to measure during high flows, and depth- and width-integrated sampling regimes are difficult if not impossible to follow. Thus, data collected during high-flow conditions are generally subject to greater uncertainty than those collected under low-energy, low-flow conditions (when fewer lead-bearing particulates are typically transported).

Figure 3-15 shows data from Station SF-271, which are typical for the Upper Basin in that total lead concentrations are usually greatest on the rising limb of the hydrograph and decrease with time as sediment sources are depleted, flows decrease, and stream energy dissipates. As discussed above, during first-flush and/or rain-on-snow events, sediments are mobilized from nearby hillsides and smaller floodplains by overland flow and from the near-channel floodway, channel banks, and channel beds by elevated in-stream flows. Clearly, much of the eroded sediments are sources of lead.

Figure 3-16 shows a map view of total lead concentrations in surface water during high-flow conditions in May 2008. The timing of sample collection in relation to stream flow conditions is very important when interpreting total lead data in streams. On the SFCDR, the peak daily discharge in May 2008 occurred on May 18, 2008. Concentrations in the SFCDR at Stations SF-239 (80 µg/L) and SF-254A (109 µg/L) are not directly comparable with those at SF-268 (1,560 µg/L) because SF-239 and SF-254A were sampled on the falling limb of the hydrograph (May 23, ~3,000 cfs), and SF-268 was sampled 5 days previously, at the peak of the hydrograph (May 18, ~ 6,000 cfs). The bulk of erosion and suspended sediment transport typically occurs during periods of increasing flow (rising limb of hydrograph) and peak flow, and suspended loads often decrease during times of decreasing flow (falling limb of hydrograph). Thus, the differences in total lead concentrations are quite sensitive to differences in flow condition.

In May 2008, peak discharge in Canyon Creek and Ninemile Creek occurred on May 19, 2008, and May 18, 2008, respectively. In Canyon Creek, total lead concentrations steadily increased from above Mace to Gem to nearly 1,000 micrograms per liter (µg/L) (996 µg/L at Station CC-504, May 19, 2008), but then dropped to 343 µg/L at the mouth of Canyon Creek (Station CC-288, May 17, 2008). In Ninemile Creek, concentrations steadily increased in the downstream direction, with an anomalous drop near Bunn, from less than 2 µg/L in the headwaters to 1,300 µg/L at the mouth of Ninemile Creek (Station NM-305, May 17, 2008).

3.4.1.4 Dissolved Zinc

Contrary to total lead, dissolved metal concentrations in the SFCDR and its tributaries are inversely related to discharge (USEPA, 2004), with higher concentrations normally occurring during low-flow conditions and lower concentrations occurring during high-flow conditions. Data collected at Pinehurst are typical of Upper Basin streams, with the dissolved zinc concentrations typically varying by about one order of magnitude over the course of any year, with the higher concentrations occurring under low-flow conditions (Figure 3-17). This is because, during low-flow conditions, groundwater recharge is the predominant source of water to surface water, and groundwater has elevated dissolved zinc in many areas. This is further described in Section 3.4.2.

Similar to total lead, the dissolved zinc load (calculated from concentration and discharge data) fluctuates primarily with discharge in the Upper Basin, with higher loads occurring under high-flow conditions. At Station SF-271, again as a representative example of conditions in the Upper Basin, seasonally higher loads typically occur during spring when flows are highest, with annual loads varying by about one order of magnitude (Figure 3-18).

As discussed in Section 3.4.1.1, an AWQC ratio of 1.0 or less for a regulated constituent denotes compliance. Dissolved zinc AWQC ratios for the Mullan (Station SF-208), Canyon Creek, Ninemile, Elizabeth Park, Pine Creek, and Pinehurst water quality monitoring stations for the pre-, active, and post-remediation time periods are presented in Figures 3-19 to 3-24, respectively. Values at Station SF-208 were the lowest measured, and, with the exception of an anomalous event in 1998, have remained well below the AWQC. Zinc AWQC ratios are elevated during all time periods at Canyon Creek and Ninemile Creek, rarely dropping below 10. Values at Elizabeth Park and Pinehurst are similar, with values dropping mostly below 6 in recent years. Values at Pine Creek vary between 1 and 3 in recent years.

Figure 3-25 shows the distribution of AWQC ratios at these locations for different key time periods. The different time periods are defined as prior to September 15, 1995; between September 15, 1995, and October 1, 2002 (during which time several significant remedial actions were undertaken); and after October 1, 2002, through 2009. The box plots group the data by each time period for each location (top of figure), and scatter plots show the general trend over time (below the box plots). Both the box plots and the scatter plots generally show decreasing AWQC ratio trends over time. These results are consistent with previous studies such as Donato (2006), where statistically significant decreasing trends were observed for dissolved zinc at Pinehurst (Station SF-271) for the period 1991 to 2004. These improvements are due, in part, to remedial actions completed in the Upper Basin, including OU 2 Phase I remedial actions, which comprised the majority of remediation completed during the 1995 to 2002 time frame. The box plots and scatter plots also show the variability in the data between locations and through time, which is consistent with the complexity of the interactions among upland sources, floodplain contaminated sediments, groundwater, and surface water, and with how remedial actions affect those interactions.

In order to evaluate the effect that groundwater and surface water inputs to the SFCDR through OU 2 have on SFCDR water quality, data from Elizabeth Park (Station SF-268) were compared with water quality data from Station SF-270a, located just upgradient from the Pine Creek confluence. SF-270a is a relatively new station, with data collection beginning in October 2008. During seven sampling events, from October 16, 2008 through August 5, 2009, dissolved zinc increased an average of 79 percent between SF-268 and SF-270a, and dissolved zinc load increased an average of 80 percent. Water hardness increased an average of 40 percent, mitigating the dissolved zinc increase to result in an average increase of the dissolved zinc AWQC ratio of 44 percent (average 1.7 units). Station SF-270a is used for comparison to Station SF-268 in this case rather than long-term stations SF-270 or SF-271 because both of the latter stations are located on the SFCDR, downstream from the confluence with Pine Creek, and are therefore heavily influenced by Pine Creek's cleaner water.

Dissolved zinc AWQC ratios in the tributaries within OU 2 have changed between the pre- and post-Phase I remediation time period, with substantial changes occurring in Milo Creek and Government Creek. In Milo Creek, the dissolved zinc AWQC ratio in 1987 was 0.04, well below the 1.0 ratio denoting compliance with the AWQC. In 2008 and 2009, the AWQC ratios increased to 12 and 39, respectively. The increase in AWQC ratio at this location is likely primarily attributable to changes in conditions at the Reed and Russell adits. In 1987, the mine owner was controlling the AMD discharging from the adits by rerouting them to the Bunker Hill mine workings for treatment at the CTP. Since that time, the mine owner has allowed the AMD from these adits to discharge directly to Milo Creek, resulting in a large degradation of water quality in Milo Creek and subsequently downstream in the SFCDR.

In Government Creek, the dissolved zinc AWQC ratio in 1987 was 64. Following the implementation of Phase I remedial actions in Government Gulch, the AWQC ratio decreased to 22 in 2008. Although this is a large reduction, the AWQC ratio in Government Creek remains elevated far above 1.0.

To provide a Basin-wide perspective, the maximum dissolved zinc AWQC ratios after October 2002 for all stream locations are shown in Figures 3-26 (site-wide) and 3-27 (within OU 2). The highest values are found in Canyon Creek, Ninemile Creek, and OU 2. Several tributaries with identified source sites were not sampled during this time period.

3.4.1.5 Phosphorus

Review of available SFCDR total and dissolved phosphorus data for the 2006 to 2007 time period suggests that phosphorus concentrations are related to discharge, with greater concentrations occurring under greater discharge in most cases (CH2M HILL, 2008a). There are insufficient data available with which to further evaluate sources of phosphorus and their relative impacts on the SFCDR. However, areas within OU2 thought to contribute to phosphorus in the SFCDR include the A-4 Gypsum Pond area, the former phosphoric acid/fertilizer plant in Government Gulch, and the Page Pond area.

3.4.1.6 Summary of Surface Water Quality

In general, water quality observed at Mullan (Station SF-208) and in lower Pine Creek (Station PC-339) is much better than water quality observed at other locations within the Upper Basin. Although significant mining activities have occurred in the areas upstream from these locations, the mineralization of these areas is somewhat different (typically a lower degree of pyrite mineralization). Therefore, water quality at these locations, with respect to dissolved metals, is generally better. These and other upstream areas are important in diluting impacted surface water and play a major role in Upper Basin water quality (USEPA, 2001c, 2001d).

The most mining-affected areas are OU 2 and the SFCDR tributaries Canyon Creek and Ninemile Creek. Some improvements in water quality have been made over the last several years, but water quality remains seriously impaired. Surface water quality during base-flow conditions is no exception, and, because groundwater input makes up the much of the flow during base-flow conditions, groundwater quality in the major alluvial aquifers is examined in regards to affects on surface water quality.

3.4.2 Groundwater Quality and Impact on Surface Water Quality

Section 3.4.1 detailed the trends in surface water quality and illustrated that, during low-flow conditions, water quality exceeds the AWQC in all but the least mining-affected or mineralized upland tributaries. Section 3.2.5 discussed groundwater flow in the Upper Basin and described how, during base-flow conditions, groundwater inputs to streams become more important. This section discusses current groundwater quality with respect to dissolved zinc in the major alluvial aquifers in the Upper Basin—Woodland Park, Osburn Flats, and OU 2—and discusses the effects of groundwater-surface water interaction on surface water quality. Data presented in this section are from the *2008 High-Flow and Low-Flow Surface Water Study Report, Upper Basin of the South Fork Coeur d'Alene River* (CH2M HILL, 2009f).

In general, groundwater quality in the major aquifers of the Upper Basin has been affected to the point that groundwater use is prohibited or not suitable for domestic and municipal use, with the exception of the Pinehurst aquifer. Although monitoring wells in the upper reaches of Pine Creek have detected mining-related contamination, wells in the Pinehurst aquifer generally have good water quality and provide water for the community of Pinehurst.

3.4.2.1 Woodland Park

Groundwater Concentrations

Dissolved zinc concentrations in Woodland Park groundwater are shown in Figure 3-28. The highest concentrations are more than 20 mg/L and are below the SVNRT Canyon Creek Tailings Repository, with other areas of high zinc concentrations downgradient from the Hecla-Star Tailing Ponds. These areas are near gaining sections of Canyon Creek, and all are upgradient from the location of the former plank dam that impounded mine tailings.

Groundwater Effect on Surface Water Quality

The September 2006 study of groundwater-surface water interaction in Woodland Park determined that groundwater discharge to Canyon Creek in Woodland Park increased the surface water load of dissolved zinc by approximately 100 pounds per day (lb/day) (CH2M HILL, 2007a). This is about 26 percent lower than found in a similar study from September 1999. Possible reasons for the reduction include:

- lower discharge in 2006 and inferred lower groundwater levels;
- the SVNRT remedial actions (1997-1998) performed within the Canyon Creek basin (primarily in Woodland Park) consisted of removal and consolidation of metal-rich tailings and mine wastes; this might have resulted in a decreased amount of leachable metals available to affect surface water and groundwater at the site; and
- different magnitude diel changes or sampling times that occurred during the different sampling events.

As noted in Section 3.4.1.1, dissolved zinc AWQC ratios are a more appropriate metric for evaluating surface water quality. Data from the September 2006 groundwater-surface water interaction study were used to calculate changes in the dissolved zinc AWQC ratio through Woodland Park. From the upstream station (A1) to the downstream station (A7), the dissolved zinc concentrations increased from about 745 μg/L to 2350 μg/L (215 percent increase), and zinc AWQC ratios increased from 8.0 to 21.8 (173 percent increase), with the largest AWQC ratio increases occurring in the reaches between Stations A1 and A1.2 (8.0 to 13.2) and Stations A4E and A6 (16.4 to 21.1) (see Figure 3-5 for locations). These reaches are noted as primarily gaining reaches in Figure 3-5.

Some of the calculated increase in the AWQC ratio may be due to diel fluctuations, because samples are collected from downstream to upstream over the course of the day and zinc concentrations usually decrease over the course of the day. However, data from a diel study at Station A6 on October 13, 2006, indicated that dissolved zinc concentrations decreased by about 24 percent from 7 a.m. to 4 p.m. (CH2M HILL, 2007a), far less than the 215 percent increase observed through Woodland Park noted above.

The large increase in the zinc AWQC ratio through Woodland Park suggests that any remedial strategy in Canyon Creek needs to include groundwater remediation.

3.4.2.2 Osburn Flats

Groundwater Concentrations

Concentrations of dissolved zinc in Osburn Flats groundwater ranged from 5.9 to 3,910 μg/L and are shown in Figure 3-29. In general, the higher zinc concentrations were found in the area previously affected by the former plank dam that impounded tailings, the area downgradient from the tailings dam (approximate location of the Osburn Zanetti Gravel Operation), the area near the Osburn Tailings Pond, and the affected floodplain area of the U.S. Bureau of Mines (USBM) test plots. Groundwater concentrations of zinc were lowest along the south side of Osburn Flats.

Groundwater Effect on Surface Water Quality

A detailed study of metals loading to the SFCDR under low-flow conditions in September 2008 determined that the surface water load for zinc increased approximately 56 lb/day due to groundwater discharge from the area under the old tailings impoundment, resulting in an increase in zinc concentrations in the SFCDR (CH2M HILL, 2009f, 2009g). In other gaining reaches in Osburn Flats, stream flow increased without concurrent increases in surface water zinc concentrations as a result of groundwater concentrations being roughly equal to SFCDR concentrations, resulting in an increased load of zinc to the stream (CH2M HILL, 2009h). These conclusions are similar to those of Barton (2002).

Data from the 2008 Groundwater-Surface Water Interaction Study was used to calculate changes in the dissolved zinc AWQC ratio through Osburn Flats. From the upstream station (Site B-1Alt) to the downstream station (Site B-8), the dissolved zinc concentrations increased from about 630 µg/L to 950 µg/L (51 percent increase), and zinc AWQC ratios increased from 4.3 to 6.2 (43 percent increase), with the largest AWQC ratio increases occurring in the reaches between Stations B3 and B-5Alt (4.8 to 5.9) (see Figure 3-7 for locations). This reach is noted as a primarily gaining reach in Figure 3-7.

Some of the calculated increase in the AWQC ratio may be due to diel fluctuations, because samples are collected from downstream to upstream over the course of the day. The diel data collected as Station SF-268 (about 3 miles downstream from Osburn Flats) and discussed in Section 3.4.1.2 suggest that diel fluctuations cannot account for all of the variability in the Osburn Flats data: zinc concentrations at SF-268 decreased by about 23 percent, and the zinc AWQC ratio decreased 17 percent, both values substantially lower than changes noted throughout Osburn Flats.

Groundwater input to the SFCDR does not result in the dramatic increase in zinc AWQC ratios as seen in Woodland Park, but does result in a degradation of water quality.

3.4.2.3 Operable Unit 2

This section summarizes current groundwater quality conditions in OU 2. The fall 2008 dataset was selected for this summary because the dataset represents a monitoring event in which groundwater quality data were collected from an expanded monitoring network, including the majority of monitoring wells within OU 2 as well as piezometers installed as part of the OU 2 Direct Push Investigation (CH2M HILL, 2009a). In addition, groundwater-surface water interaction monitoring in the SFCDR and major tributaries within OU 2 was conducted during this time period. The fall 2008 dataset represents the most recent and thorough snapshot of current water quality conditions within OU 2. Additional information on OU2 groundwater quality may be found in the updated OU 2 CSM Report (CH2M HILL, 2006a); the *Phase 1 Remedial Action Assessment Report, Operable Unit 2* (CH2M HILL, 2007d), which includes a statistical analysis of water quality data; the *Source Areas of Concern, Operable Unit 2* (CH2M HILL, 2008a); the *OU 2 Direct Push Investigation* (CH2M HILL, 2009a); and the *OU 2 2008 Groundwater/Surface Water Interaction Monitoring Data Summary* (CH2M HILL, 2009c).

Groundwater Concentrations

Dissolved zinc concentrations in groundwater in the fall of 2008 are shown in Figure 3-30. As noted in the hydrogeology section, the alluvial aquifer in the far eastern portion of OU 2 is relatively thin and does not support a large amount of groundwater flow. In this area, surface water from the SFCDR is losing to the groundwater system. Dissolved zinc concentrations are generally less than 2 mg/L from the eastern boundary of OU 2 (near monitoring wells BH-SF-E-0001, 2, and 3) moving west towards the city of Kellogg. Dissolved zinc concentrations in groundwater begin to increase after this point, and surface water lost from the SFCDR begins to migrate through contaminated materials and flows to the west. As noted earlier, a historical SFCDR channel is present along the southern portion of the valley in OU 2 that was filled in with mine wastes. This historical channel is co-located with the current Bunker Creek channel in many areas. Some of the most elevated dissolved zinc concentrations detected within OU 2 (13.4 to 28.1 mg/L) occur in this area along the direction of groundwater flow.

In the western portion of OU 2, dissolved zinc concentrations are generally lower than those observed in the eastern portion of OU 2 with a few exceptions in the far western portion of Smelterville Flats (monitoring well BH-SF-W-PZ-05, 16.8 mg/L) and in the Page Pond area (BH-SF-W-0119-U, 14.9 mg/L). As discussed in Section 2.0, a considerable amount of contaminated material removal (1.2 million cubic yards) occurred in the Smelterville Flats area.

Dissolved zinc data for OU 2 groundwater were analyzed for trends using Mann-Kendall analysis, where trends with confidence limits of greater than 95 percent were classified as either “increasing” or “decreasing” (Figure 3-31). The results indicate that dissolved zinc concentrations are stable in most wells and that decreasing locations out-number increasing locations by more than 3 to 1 (Figure 3-31). This agrees with conclusions of the Remedial Action Assessment Report, which concluded that while groundwater quality in OU 2 was still severely degraded throughout the majority of OU 2, overall trends were decreasing, and substantial improvements have been made since the onset of remedial actions (CH2M HILL, 2007d).

In some areas of OU 2, increasing dissolved zinc trends were observed, particularly in monitoring wells located between the SFCDR and the CIA (see Figure 3-31). These increasing trends may be due to changes in groundwater flow directions, groundwater flux rates, or water table elevations that may or may not be a result of remedial actions such as contaminant removal and source site work conducted in the SFCDR between 1999 and 2003 or a result of the capping of the CIA (CH2M HILL, 2007d).

Overall, Figure 3-31 shows that the dissolved zinc concentrations observed in OU 2 groundwater are generally improving, especially in the western half of OU 2 where extensive removal actions have been conducted.

Groundwater-Surface Water Interaction

As noted in earlier sections, the groundwater-surface water interaction within OU 2 is significant in both volumes exchanged as well as the impact on SFCDR water quality. As noted above, dissolved zinc concentrations in groundwater have generally decreased as a result of Phase I remedial actions, especially in the western portion of OU 2. However, contaminant contributions from groundwater to the SFCDR within OU 2 remain relatively large and have a large negative impact on SFCDR water quality.

To compare pre-remediation conditions and current conditions within OU 2, findings regarding the contribution of dissolved zinc load from groundwater to surface water within OU 2 were compared for 1987 and 2008. Results from the groundwater model for base-flow conditions are also discussed. Although both the 1987 and 2008 datasets were collected under base-flow conditions, they are still somewhat different. In 1987, flow conditions were considerably lower than those measured in 2008. At Elizabeth Park, discharge was measured as 52 cfs in 1987 versus 83 cfs in 2008. Therefore, the load contributions in 1987 are likely understated when compared to 2008 load contributions.

During low-flow conditions in 1987, dissolved zinc load contributions from groundwater in the eastern and western gaining reaches were estimated by comparing stream discharge and concentration data from different locations, bracketing the gaining sections of the SFCDR in OU 2. This study estimated that approximately 420 and 150 lb/day entered the eastern and western gaining reaches, respectively. In 2008, a similar study estimated the contributions from groundwater in the eastern and western gaining reaches to be 330 and 100 lb/day, respectively. Taking into account the lower discharge in 1987 than 2008, this suggests that a relatively large load reduction occurred in OU 2 as a result of Phase I remedial actions. However, the remaining load contribution remains quite large and still results in poor water quality in the SFCDR.

The OU 2 groundwater model, using 2008 groundwater concentrations under base-flow conditions, estimates load contributions during low flow from the eastern and western gaining reaches to be approximately 450 and 91 lb/day, respectively. Because the groundwater flow model uses completely different methods to compute loading estimates, these estimates are not considered to be directly comparable to field based estimates. Rather, the model results support the findings that several hundred pounds of zinc per day are currently entering the SFCDR in OU2 during low flow conditions.

Changes in zinc AWQC ratio through OU 2 were discussed in Section 3.4.1.4. Significant increases in the AWQC ratio through OU 2 were observed during the pre-remediation and active remediation time periods, but not during the post-remediation time period (Figure 3-25). However, this improvement—the lack of additional degradation through the reach—is likely due to improved groundwater quality as well as reductions in contamination reaching the SFCDR through OU 2 streams.

3.5 Summary of Site Conditions

The Bunker Hill Superfund Site is within one of the largest historical mining districts in the world, the Coeur d'Alene Mining District, also known as the Silver Valley. Mining and mining-related toxic waste material has been dispersed throughout nearly every aspect of the environmental system: the air (historically), soils, sediments, surface water, and groundwater. This has adversely affected human health and environmental resources throughout the area.

The principal source of metals contamination was tailings generated from historical milling of ore that were discharged to the SFCDR and its tributaries or confined in large waste piles onsite. Other major sources included waste rock and past air emissions from smelter operations. Tailings were frequently used as fill for residential and commercial construction projects. Tailings were also transported downstream, particularly during high-flow events, and deposited as lenses of tailings or as tailings/sediment mixtures in the bed, banks, and floodplains of local surface water bodies. The estimated total mass and extent of impacted materials (primarily sediments) exceeds 100 million tons dispersed over thousands of acres

(USEPA, 2001c). Over time, groundwater also became contaminated with metals and now serves as a source of contamination to streams. Air emissions occurred from ore-processing facilities in Kellogg and Smelterville. Although both the lead smelter and zinc plant had engineering controls to reduce air-borne particulates, significant metals deposition still occurred together with deposition of sulfur dioxide emissions. These emissions affected areas near the smelter and zinc plant and deforested surrounding hillsides. Smelter operations ceased in 1981, but limited mining and milling operations continued onsite from 1988 to 1991, and small-scale mining operations continue today.

Mining-related metal concentrations in surface water, soil, sediment, and biotic tissues are elevated throughout many parts of the Upper Basin and have been associated with increased mortality and decreased survival and growth of various plant and animal species throughout the Upper Basin (Stratus Consulting, 2000). Adverse effects of metals on survival, growth, and reproduction of ecological receptors are directly due to the toxicity of metals. Toxic effects of mining-related hazardous substances are evaluated in detail in the *Final Ecological Risk Assessment, Coeur d'Alene Basin Remedial Investigation/Feasibility Study* (CH2M HILL and URS Greiner, 2001).

Dozens of extensive and costly remedial actions have been taken to date in the Upper Basin (see Section 2.0), and improvements in the environmental system have been made. Despite this, contaminant levels in affected streams, soils/sediments, and groundwater remain at levels that are toxic to native organisms. Specific findings of this section include the following:

- COCs for groundwater and surface water systems include arsenic, cadmium, lead, mercury, and zinc. Lead and zinc are discussed specifically as representative contaminant metals. Zinc typically enters aquatic systems through dissolution reactions, whereas lead is associated with particulates and typically transported in sediment or as a colloid.
- Surface water is generally clean upgradient from sources and degrades significantly upon contact with mining wastes.
- Surface water quality for dissolved zinc has generally been improving in the Upper Basin (including OU 2), but remains severely impaired on the SFCDR mainstem and several tributaries.
- Large loads of particulate lead are transported through the Upper Basin primarily during high-water events, creating toxic sediment deposits along the SFCDR and its tributaries.
- Lead concentrations in sediments remain very high in the impacted areas of the Upper Basin. The site-specific benchmark cleanup criterion of 530 mg/kg lead in soil and sediment for protection of songbirds and waterfowl is exceeded at all SFCDR stations below Mullan and in Canyon Creek and Ninemile Creek. In some areas, soil lead concentrations are well in excess of the benchmark cleanup criterion.
- Surface water quality in Canyon Creek has improved but remains poor; at the mouth of Canyon Creek (Station CC-288), AWQC ratios vary from 10 to 30 (compared to an

AWQC-compliant dissolved zinc ratio of one or less)). Dissolved zinc AWQC ratios are much higher in some upstream reaches in Canyon Creek.

- Surface water quality in Ninemile Creek has improved but remains poor; at the mouth of Ninemile Creek (Station NM-305), dissolved zinc AWQC ratios range from about 10 to 25. Dissolved zinc AWQC ratios are much higher in some upstream reaches in Ninemile Creek.
- Surface water quality in the Upper SFCDR begins to slightly exceed the AWQC for dissolved zinc below Mullan, and degrades considerably when Canyon Creek and Ninemile Creek enters, with dissolved zinc AWQC ratios between 3 and 6 at both SF-271 (Pinehurst) and SF-268 (Elizabeth Park).
- Water quality in the SFCDR degrades considerably as the stream passes through OU 2. Recent data indicate that, in the SFCDR through OU 2, dissolved zinc concentrations and loads increase about 80 percent and zinc AWQC ratios increase about 44 percent.
- Groundwater in three major aquifers (Woodland Park, Osburn Flats, and OU 2) is severely affected and contributes to surface water contamination. Water in these aquifers is not suitable for domestic use because of the contamination.
- The majority of the dissolved zinc load in Canyon Creek in the Woodland Park area comes from contaminated groundwater in this reach. For example, groundwater input from the Woodland Park aquifer raised the zinc AWQC ratio in Canyon Creek by 171 percent, from 8.0 to 21.8, during base-flow conditions in 2008.
- Groundwater plays a significant role in metals loading to the SFCDR in Osburn Flats. For example, groundwater input from the Osburn Flats aquifer raised the zinc AWQC ratio in the SFCDR by 43 percent, from 4.3 to 6.2, during base-flow conditions in 2008.

SECTION 4.0

Identification of Remedial Action Objectives (RAOs), Potentially Applicable or Relevant and Appropriate Requirements (ARARs), and Preliminary Remediation Goals (PRGs)

This section identifies remedial action objectives (RAOs), potentially applicable or relevant and appropriate requirements (ARARs), and preliminary remediation goals (PRGs) for the Focused Feasibility Study (FFS) for the Upper Basin of the Coeur d'Alene River. General response actions (GRAs) are also identified in this section in the context of RAOs.

RAOs are general descriptions of what a cleanup under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) is expected to accomplish. GRAs are common remedial actions that satisfy the RAOs and may include treatment, containment, removal, disposal, institutional actions, or a combination of these. Section 121(d) of CERCLA requires attainment of federal and state ARARs. "Applicable requirements mean those cleanup standards, standards of control, or other substantive environmental protection requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site"(Section 300.5 of the National Oil and Hazardous Substances Pollution Contingency Plan [known as the NCP], 55 *Federal Register* [FR] 8814). "Relevant and appropriate" requirements mean those environmental requirements such as cleanup standards that address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site (40 *Code of Federal Regulations* [CFR] 300.400(g)(2)). A requirement that is relevant and appropriate may not meet one or more jurisdictional prerequisites for applicability but may still make sense at the site, given the circumstances of the site and the release.

PRGs are standards by which aspects of a cleanup under CERCLA may be measured with a view toward achieving the RAOs (see Table 4-1). They include potential ARARs, potential to-be-considered (TBC) information, and risk-based concentrations of chemicals in environmental media that have been brought forward from the risk assessment conducted for the site. PRGs are initial points of focus using readily available toxicity and exposure factor information, frequently used standards (e.g., ARARs), and reasonable exposure assumptions. PRGs provide preliminary risk reduction targets that a remedial alternative must meet to achieve the criteria set forth in Section 300.430(e)(9)(iii) of the NCP. PRGs and ARARs are considered preliminary or potential until final remediation goals and ARARs are documented in a Record of Decision (ROD) or a ROD Amendment.

4.1 Remedial Action Objectives and General Response Actions

Section 300.430(e)(2)(i) of the NCP specifies that RAOs be developed to address contaminants of concern (COCs), media of concern, potential receptors, exposure pathways, and remediation goals. RAOs developed for the FFS are presented in Table 4-1 with GRAs that may be employed as appropriate. These RAOs provide a basis for evaluating the capability of the response actions to achieve compliance with potential ARARs or an intended level of risk protection. The focus of this FFS is the development and evaluation of remedial alternatives for surface water, soil, sediments, and source materials. The remedial alternatives are not designed to provide a final remedy for groundwater.

As discussed in Section 1.0 of this FFS Report, the forthcoming ROD Amendment for the Upper Coeur d'Alene Basin will augment the remedies selected in the three previous RODs that were issued for Operable Units (OUs) 1, 2, and 3. In addition, the ROD Amendment will identify actions necessary to ensure that the Selected Human Health and Ecological Remedies are protected from erosion and/or contaminated sediment re-deposition. Potential remedial actions are evaluated in this FFS Report and will be summarized in the Proposed Plan.

Examples of GRAs considered in the FFS for human health and ecological protection include containment, treatment, removal, and disposal. Examples of GRAs considered in the FFS to protect remediated or clean areas from erosion and contaminated sediment deposition include creek channel and drainage system improvements, diversion structures, road and hillside modifications, and monitoring.

4.2 Potentially Applicable or Relevant and Appropriate Requirements (ARARs)

The ARARs identification process presented in this section is based on CERCLA guidance (*Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final* [U.S. Environmental Protection Agency (USEPA), 1988b]; the *CERCLA Compliance with Other Laws Manual: Interim Final* [USEPA, 1988a]; and the *CERCLA Compliance with Other Laws Manual - Part II* [USEPA, 1989a]). As described in Section 1.0, the study area for the FFS (Figure 1-2) includes OUs 1 and 2 and the Upper Basin portion of OU 3. For this evaluation, the Upper Basin watershed includes the South Fork of the Coeur d'Alene River (SFCDR); their tributaries downstream to the confluence where the South and North Forks of the river meet; and the Bunker Hill "Box", where USEPA began its cleanup work in the 1980s. The FFS study area extends approximately one mile to the west beyond the confluence of the North and South Forks to include the town of Kingston. The study area includes the SFCDR but not the North Fork.

Many of the remedial alternatives evaluated in this FFS Report are comparable to remedial actions selected for OUs 2 and 3. Similarly, potential ARARs presented in this FFS Report are analogous to ARARs identified in decision documents for OUs 2 and 3 and are expected to be applied to remedies selected in the forthcoming Upper Basin ROD Amendment.

USEPA is working closely with the Idaho Department of Environmental Quality (IDEQ), the Basin Environmental Improvement Project Commission, the Coeur d'Alene Tribe, other federal, state, and local agencies, and local community members on this complex cleanup effort, including the development of ARARs for this FFS.

The Coeur d'Alene Tribe owns land in the Upper Basin and may obtain other parcels as part of *de minimu*s settlements and other agreements. Indian Tribal requirements are potential ARARs for CERCLA response actions taken on Tribal lands and are treated consistently with state requirements provided they meet the eligibility criteria for state ARARs, i.e., those that are promulgated (legally enforceable and of general applicability), are more stringent than federal requirements, are identified in a timely manner, and are potential ARARs. (See the preamble to the NCP, 55 FR at 8741-8742; Section 300.5 of the NCP, 55 FR at 8816, for a definition of Indian Tribe; and the *Revised Interim Final Guidance on Indian Involvement in the Superfund Program*, USEPA, 1989b.)

The Coeur d'Alene Tribe has developed proposed water quality standards based on current USEPA guidelines and Tribal goals. Once approved by USEPA, these standards will apply to all Reservation Treatment-as-a-State (TAS) Waters. Currently these proposed standards represent TBC information for the Upper Basin.

CERCLA Section 121 requires that any applicable or relevant and appropriate standard be met, or a waiver justified. **Applicable requirements** are those substantive environmental standards that specifically address the situation at a CERCLA site. **Relevant and appropriate requirements** are determined by a two-step process. First, to assign relevance, it must be determined whether the requirement addresses problems or situations sufficiently similar to the circumstances of the proposed response action. Second, for appropriateness, a determination is made as to whether the requirement would also be well suited to the conditions of the site. In evaluating the relevance and appropriateness of a requirement, the eight comparison factors in 40 *Code of Federal Regulations* (CFR) 300.400(g)(2), "Identification of Applicable or Relevant and Appropriate Requirements," are considered:

(i) The purpose of the requirement and the purpose of the CERCLA action;

(ii) The medium regulated or affected by the requirement and the medium contaminated or affected at the CERCLA site;

(iii) The substances regulated by the requirement and the substances found at the CERCLA site;

(iv) The actions or activities regulated by the requirement and the remedial action contemplated at the CERCLA site;

(v) Any variances, waivers, or exemptions of the requirement and their availability for the circumstances at the CERCLA site;

(vi) The type of place regulated and the type of place affected by the release or CERCLA action;

(vii) The type and size of structure or facility regulated and the type and size of structure or facility affected by the release or contemplated by the CERCLA action; and

(viii) Any consideration of use or potential use of affected resources in the requirement and the use or potential use of the affected resource at the CERCLA site.

To-be-considered information, or "TBCs", are often identified with ARARs because they are helpful in selecting or implementing remedies. TBCs, however, are not legally enforceable and are not ARARs. Frequently, TBCs come from federal, state, and tribal environmental and public health agencies' advisories, guidance, and proposed standards.

ARARs are evaluated to determine whether they apply to chemical-specific, location-specific, or action-specific circumstances related to CERCLA response actions. These categories are defined as follows.

- Chemical-specific requirements are usually health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of site cleanup levels that are protective of human health and ecological receptors.
- Location-specific requirements are restrictions placed on the concentration of dangerous substances or the conduct of activities solely because they occur in special geographic areas.
- Action-specific requirements are usually technology- or activity-based requirements or limitations triggered by the remedial actions performed at the site.

Only the substantive requirements (e.g., compliance with numerical standards, use of control/containment equipment, etc.) associated with ARARs apply to CERCLA onsite activities. According to CERCLA Section 121[e][1], ARARs associated with administrative requirements, such as permitting, are not applicable to CERCLA onsite activities. In general, the CERCLA permitting exemption will be extended to all remedial activities conducted in the Upper Basin.

4.2.1 Potential Chemical-Specific ARARs

As stated above, chemical-specific ARARs generally set numeric risk-based concentration limits or discharge limitations for specific chemicals within environmental media. When a specific chemical is subject to more than one discharge or exposure limit, the more stringent of the requirements is typically used. Narrative descriptions of potential federal, and State of Idaho chemical-specific regulations and guidance for the protection of ecological receptors and human health are provided in the following sections by media. Table 4-2 presents potential chemical-specific ARARs and TBCs for human health and ecological receptors within the Upper Basin of the Coeur d'Alene River.

4.2.1.1 Soil and Sediments

Soil in the Upper Basin contains elevated concentrations of metals including arsenic, copper, cadmium, lead, mercury, and zinc. USEPA has determined that lead is the main risk driver for human health and ecological receptors in soil. Currently, there are no promulgated federal and state chemical-specific criteria that are considered ARARs for soil in the Coeur d'Alene River Basin.

TBC references for soil include guidance provided by USEPA, the National Oceanic and Atmospheric Administration (NOAA), and the State of Idaho. USEPA references include

Soil Screening Guidance: User's Guide (1996b), *Soil Screening Guidance: Technical Background Document* (1996b) and *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (2002c). In 2008, the human health risk-based screening levels (SLs) used in USEPA Region 9 PRGs were combined with similar SLs used by USEPA Regions 3 and 6 into the *Regional Screening Levels* [RSLs] *for Chemical Contaminants at Superfund Sites* (USEPA, 2008b). For ecological receptors, there is the *Guidance for Developing Ecological Soil Screening Levels* (Eco-SSLs; USEPA, 2005a). The ecological SSLs are not designed to be used as cleanup levels but as risk-based cleanup information for contaminants found in soil.

In November 2008, NOAA updated its Screening Quick Reference Tables (also known as "SQuiRT") as a reference tool that contains concentrations for inorganic and organic contaminants in various environmental media including soil (NOAA, 2008). NOAA presents the table values as preliminary screening concentrations only, and does not endorse their use as cleanup criteria.

IDEQ's *Idaho Risk Evaluation Manual* (REM; IDEQ, 2004) describes an integrated risk evaluation process for managing chemical releases, assists in determining whether corrective action is required, and provides methods to derive site-specific cleanup levels necessary to protect human health and the environment. Soil and groundwater screening values provided in Appendix 5 of the REM, "Initial Default Target Levels" [IDTLs], have statewide applicability. In 2008, rulemaking was initiated by IDEQ to formalize critical elements of the REM that are pertinent to the evaluation of petroleum release sites. The effective date of this rule is expected after adjournment of the 2009 legislative session, if the rule has been approved. The remainder of the REM is still considered as guidance and is a potential TBC for soil in this FFS.

Per the State of Idaho approach, if the maximum media-specific concentrations at a site do not exceed the IDTLs, a site may be a candidate for closure, or perhaps, limited monitoring. If the maximum soil or ground water concentrations exceed the IDTLs, the responsible party may either adopt the IDTLs as cleanup levels and develop a risk management plan to achieve these levels, or perform a risk evaluation. IDTLs are based on human health exposure pathways but are also used for ecological risk evaluations. Exposures to ecological receptors, threatened and endangered species, and habitats such as wetlands and other sensitive environments must be thoroughly evaluated using the REM approach. Where an ecological threat may exist due to a release, the responsible party must perform an ecological evaluation as part of a Risk Evaluation-1 (development of site-specific risk estimates to representative receptors for each COC) or a Risk Evaluation-2 (possible collection of site-specific data). In this risk evaluation process, protection of surface waters and streams is independent of the evaluation of ecological risks.

Because lead is the main risk driver in soil, USEPA has identified it as the preferred metal to be used as an indicator contaminant for some aspects of the Upper Basin cleanup. Lead concentrations in impacted soil are typically 3,500 to 4,000 milligrams per kilogram (mg/kg) and higher (USEPA, 2001c). The Ecological Risk Assessment (EcoRA) conducted as part of the Remedial Investigation/Feasibility Study (RI/FS) for the Coeur d'Alene Basin (CH2M HILL and URS Greiner, 2001) and the ROD for OU 3 (USEPA, 2002b) identified the lack of site-specific riparian songbird data and a corresponding protective cleanup level of songbirds as two data gaps that should be addressed. As a result, a riparian songbird study was conducted by the U.S. Fish and Wildlife Service (USFWS; Hansen, 2007), and a Focused

EcoRA was prepared (CH2M HILL, 2006e). Given the absence of promulgated criteria for metals in soil, and using the results from these studies with other relevant information, USEPA has made a risk-management-based determination to use a site-specific protective value of 530 mg/kg for lead in soil, to be protective of riparian songbirds in the Coeur d'Alene Basin. In addition to being protective of both avian and human health, this is a consistent protective value that provides operational clarity and efficiency for the ecological remedial design and cleanup decisions. For more information on the determination of this value, refer to Attachment 4-1.

Like soil, sediments in the Upper Basin contain elevated concentrations of metals. There are no federal or state promulgated human health and ecological standards or criteria for freshwater sediments. TBCs for sediments include the USEPA Regional SLs, NOAA's SQuiRT, and the State of Idaho REM screening values. Other potential TBCs may include *Prediction of Sediment Toxicity using Consensus-Based Freshwater Sediment Quality Guidelines* (USEPA, 2000b), the Canadian Council of Ministers of the Environment's (CCME's) *Protocol for the Derivation of Canadian Sediment Quality Guidelines for the Protection of Aquatic Life* (1995), and USEPA's ECOTOX database for single chemical toxicity information for aquatic and terrestrial life.

Given the absence of promulgated criteria for metals in sediments in the ROD for OU 3 (USEPA, 2002b), USEPA has made the risk-management-based decision to use the site-specific protective value of 530 mg/kg for lead in soil or sediment (see Attachment 4-1).

4.2.1.2 Groundwater

Groundwater in both the Bunker Hill Box and the Upper Coeur d'Alene Basin is a potential drinking water source. As a result, the State of Idaho's Rules for Public Drinking Water Systems (Idaho Administrative Procedures Act [IDAPA] 58.01.08.50) and Ground Water Quality Rule (IDAPA 58.01.11), and Federal National Primary Drinking Water Standards (40 CFR Parts 141-143) are potentially relevant and appropriate.

The remedy selected in the ROD for OU 3 (USEPA, 2002b) was expected to result in improvements to groundwater quality, but not necessarily restore it to beneficial uses as outlined in the NCP. The Selected Remedy for OU 3 did not include specific actions for groundwater in shallow unconfined aquifers within the mining and smelting impacts area of the Upper Basin. As Section 3.0 of this FFS Report describes, there is extensive subsurface contamination under the Upper Basin communities, roadways and other infrastructure. The actions evaluated in this FFS Report are expected to reduce groundwater contamination levels and also to reduce the contribution of contaminated groundwater to surface water. However, given the pervasive nature of the subsurface contamination, it is expected to be very challenging to achieve the maximum contaminant levels (MCLs) in Upper Basin groundwater. Accordingly, achieving MCLs and non-zero MCL goals (MCLGs) in this groundwater is also outside the scope of the forthcoming ROD Amendment for the Upper Basin.

To the extent that groundwater is known or is likely to discharge to surface water, surface water quality regulations are also potential ARARs for groundwater in the Upper Basin. At the point of groundwater discharge to surface water, federal MCLs/MCLGs and National Recommended Water Quality Criteria (also commonly referred to as ambient water quality criteria [AWQC]) developed under Section 304(b) of the Clean Water Act (CWA) may be relevant and appropriate [40 CFR 300.430(e)(5)(E)]. The State of Idaho's Ground Water Quality Rule (IDAPA 58.01.11) and Rules for Public Drinking Water Systems (IDAPA 58.01.08.50) are also potentially relevant and appropriate. The state's Groundwater Quality Rule establishes minimum requirements to maintain and protect groundwater quality, and applies to all activities with the potential to degrade groundwater quality. Idaho's Rules for Public Drinking Water Systems control and regulate public water systems, in part, by adopting national primary drinking water regulations that are no less stringent than the federal regulations in effect under 40 CFR Part 141. These rules provide a degree of assurance that public systems that use either groundwater or surface water are protected from contamination and maintained free from contaminants that may injure the health of the consumer. Idaho Water Quality Standards (IDAPA 58.01.02) are also potentially applicable at the point of groundwater discharge to surface water. Table 4-3 lists the Idaho Primary and Secondary Ground Water Constituent Standards and the MCLs and MCLGs for the metals of interest in the Upper Basin.

4.2.1.3 Surface Water

Surface water quality is regulated for the protection of human health and aquatic life at the federal and state level. The federal Recommended Water Quality Criteria developed under Section 304(a) of the CWA [40 CFR 300.430(e)(5)(E)] are potentially relevant and appropriate for surface water in the Upper Basin. Aquatic life criteria developed under Section 304(a) of the CWA are identified as national guidance and are intended to be protective for most aquatic communities in the United States.

Idaho Water Quality Standards (IDAPA 58.01.02) are potentially applicable for aquatic life and human health. Many of these standards limit chemical toxicity as well as parameters such as turbidity and temperature for the protection of bull trout rearing and spawning, salmonid spawning, and aquatic life (cold water biota) (IDAPA 58.01.02.250). The State rules also provide for variances and short-term activity exemptions from its numeric standards (IDAPA 58.01.02.260). Variances can be granted by the Idaho Department of Health and Welfare (IDHW) for individual pollutants if the standard is unattainable, based on one or more criteria. Exemptions allow exceedances of the water quality standards under circumstances identified in the rules (e.g., dredge and fill activities) (IDAPA 58.01.02.080). The State also can establish site-specific water quality criteria under certain conditions (IDAPA 58.01.02.275). The Idaho Water Quality Standards also include a non-point source narrative standard that requires that knowledgeable and reasonable measures be taken to protect the waters of the state during activities that can cause non-point pollution (IDAPA 58.01.01.b.c). Federal and State of Idaho water quality criteria for aquatic life and human health are presented in Table 4-4 for water hardnesses of 30, 50, and 100 milligrams per liter (mg/L) to cover the approximate range of conditions that are expected to be encountered in the Upper Basin.

Surface water in both the Bunker Hill Box and the Upper Coeur d'Alene Basin is also a potential drinking water source. As a result, the State of Idaho's Rules for Public Drinking Water Systems (IDAPA 58.01.08.50) and the Federal National Primary Drinking Water Standards (40 CFR Parts 141-143) are potentially relevant and appropriate. Table 4-5 includes potential chemical-specific ARARs for surface water used as drinking water, which include MCLs, MCLGs, and State of Idaho criteria for public water systems using surface water resources.

4.2.2 Potential Location-Specific ARARs

Location-specific ARARs are those requirements that relate to the geographical position or physical conditions of a site. They may limit the type of remedial action that can be implemented, or they may impose additional constraints on some remedial actions. Location-specific ARAR examples include requirements that protect historic, religious, cultural and archaeological properties and resources, and requirements that protect ecological and environmental resources.

While the ROD for OU 2 (USEPA, 1992) included a final remedy to restore groundwater to its maximum beneficial use, it also recognized that groundwater contamination "may be especially persistent in the immediate vicinity of contaminant sources." The ROD also noted that the ability to achieve this cleanup goal at all points throughout the valley aquifer system cannot be determined until the remedy is fully implemented.

In 1989 the Idaho Department of Water Resources (IDWR) established an Area of Drilling Concern for groundwater within the entire Coeur d'Alene River Basin to protect public health in recognition of the existing groundwater contamination. An "Area of Drilling Concern" is designated by the IDWR to protect public health or to prevent waste and contamination of ground or surface water, or both, because of factors such as aquifer pressure, vertical depth to the aquifer, or warm or hot groundwater, or because of the presence of contaminated groundwater or surface waters Aquifer areas designated as an Area of Drilling Concern have additional well construction requirements that must be followed. The statute applies both to new wells being drilled and to modifications of existing wells.

Potential location-specific ARARs and TBCs for ecological receptors in the Upper Basin are presented in Table 4-6. Some key ARARs that relate to or affect remedial actions in the Upper Basin are briefly discussed below. For example, Section 7 of the Endangered Species Act (ESA) requires federal agencies to consider whether their actions will jeopardize the existence of species that are listed as threatened or endangered in a consultation with USFWS or the National Marine Fisheries Service (NMFS). The federal threatened and endangered species that are found in the project area were evaluated in the EcoRA conducted in 2001 (CH2M HILL and URS Greiner, 2001) and included the bull trout (*Salvelinus confluentus*) (threatened), bald eagle (*Haliaetus leucocephalus*) (threatened), Ute ladies' tresses (*Spiranthes diluvialis*) (threatened), gray wolf (*Canis lupus*) (endangered), and lynx (*Lynx canadensis*) (threatened). Since 2001, the status of some of these species has changed:

- **Bull Trout** — The Coeur d'Alene River Basin is within the historical range for the bull trout. Reports of bull trout sightings in the lateral lakes and the North Fork Coeur d'Alene River have been documented and verified by both Idaho Department of Fish and Game (IDFG) and USFWS fisheries biologists. On January 14, 2010, USFWS proposed to revise the designation of critical habitat for the bull trout under the ESA. The entire Coeur d'Alene River Basin is designated as Critical Habitat Unit (CHU) Number 29, changed from the 2002 designation of CHU 14, Coeur d'Alene Lake Basin.

The Coeur d'Alene River Basin provides spawning, rearing, foraging, migratory, connecting, and overwintering habitat. Under the ESA, critical habitat identifies geographic areas that contain features essential for the conservation of a listed species and other areas which USFWS believes are essential for the conservation of the species. Critical habitat designations provide extra regulatory protection to areas that may require special management considerations, and the habitats are then prioritized for recovery actions.

- **Bald Eagle** — The bald eagle was removed from the list of threatened and endangered species on August 8, 2007. It is still protected under the Bald and Golden Eagle Protection Act (Eagle Act), which makes it illegal to "take" (i.e., kill, wound, pursue, shoot, shoot at, poison, capture, trap, collect, molest, or disturb) bald or golden eagles. "Disturb" is defined as "to agitate or bother a bald or golden eagle to a degree that caused, or is likely to cause, based on the best scientific information available, (1) injury to an eagle, (2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or (3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior." The Eagle Act prohibits unregulated take. The bald eagle also remains protected under the Migratory Bird Treaty Act (MBTA).
- **Canada Lynx** — The Canada lynx remains protected as a threatened species throughout its range, which includes the state of Idaho. However, on February 24, 2009, USFWS announced a revised critical habitat designation for the Canada lynx. Under the ESA, critical habitat consists of geographic areas that contain features essential for the conservation of a threatened or endangered species and may require special management or protection or considerations. In northeastern Idaho, the revised critical habitat for Idaho appears to be limited to portions of Boundary County, which is not within the Upper Basin.

On May 1, 2009, the USFWS Idaho Field Office responded to USEPA's request for a list of threatened and endangered species and critical habitat that may occur in the vicinity of the South Fork of the Coeur d'Alene River and its tributaries. USFWS identified the gray wolf (*Canis lupis*) as endangered and the bull trout (*Salvelinus confluentus*) as threatened at the time of USEPA's request. The only critical habitat identified was that for the bull trout, which included the main stem of the Coeur d'Alene River below the confluence of the South and North Forks.

On January 22, 2010, the USFWS Idaho Field Office updated the list, indicating to USEPA that the gray wolf was delisted from the ESA.

The final rule regarding the identification of a distinct population segment (DPS) of the gray wolf in the Northern Rocky Mountains and the removal of these wolves, including those within the state of Idaho, from protection under the ESA (FR 15070, Vol. 74, No. 62) was published in April 2009. According to USFWS, the wolf population in the Northern Rocky Mountains is biologically recovered and no longer meets the legal requirements to remain listed under the ESA. The success of gray wolf recovery efforts in these areas has contributed to expanding populations of wolves that no longer require the protection of the ESA. IDFG is now responsible for the management of the DPS under the State's 2008 Wolf

Population Management Plan. IDFG is charged by statute (Idaho Code §36-103(a)) with the management of Idaho's wildlife.

Also, on January 10, 2010 USFWS proposed a final rule to expand the bull trout's critical habitat in the western United States.[1] In Idaho, this proposed rule will extend the critical habitat designation to include the entire Coeur d'Alene River Basin. The comment period for this proposed final rule closed in April 2010.

In addition to the list of threatened and endangered species, USFWS maintains a list of "species of concern", the Bureau of Land Management (BLM) maintains a "special status species" list, and other federal agencies maintain similar lists. These species are not protected specifically under the ESA, but the lists of these species may be TBCs for remedial actions within the Upper Basin. The state of Idaho does not have an endangered species act for animals, but does legally recognize endangered, threatened and specially protected species in the state per Idaho Administrative Code 13.01.06. In addition, IDFG maintains a state list of Species of Special Concern that may be a TBC for Upper Basin remedial actions.

The entire Coeur d'Alene Basin is located within the Pacific migratory flyway that provides important habitat for migratory birds, particularly waterfowl. The MBTA (16 U.S.C. 703 et seq.) makes it unlawful to "hunt, take, capture, kill" or take various other actions adversely affecting migratory birds, including raptors, shorebirds, waterfowl, and passerines (see 50 CFR 10.13 for list of protected migratory birds) without prior approval by the U.S. Department of the Interior. The MBTA protects migratory bird species, including individual birds, their nests, and their eggs. Under the MBTA, permits may be issued to take (e.g., for scientific research) or kill migratory birds (e.g., hunting licenses). The mortality of migratory birds due to ingestion of contaminated sediments is not a permitted take under the MBTA. This statute and its implementing regulations are potentially applicable to remedial actions that impact migratory bird species within the Upper Basin (e.g., road construction, or tree and underbrush cutting and clearing that destroy nests and eggs). A related TBC is Executive Order 13186 of 2001, *Responsibilities of Federal Agencies to Protect Migratory Birds.*

The Fish and Wildlife Coordination Act of 1978 and the Fish and Wildlife Conservation Act of 1980 are potentially applicable throughout the Upper Basin because these laws provide protection to streams, wetlands, and waterbodies and non-game fish and wildlife and their habitats. Remedial actions that modify streams or other water bodies greater than 10 hectares (approximately 24 acres) require provisions to ensure fish and wildlife protection.

IDFG has promulgated requirements to protect game animals, non-game, and threatened or endangered species under *Classification and Protection of Wildlife* (IDAPA 13.01.06) and *Rules Governing the Importation, Possession, Release, Sale, or Salvage of Wildlife*. The lists of protected species are provided in Tables 2-4 through 2-8 of the EcoRA conducted in 2001 (CH2M HILL and URS Greiner, 2001).

Actions to protect against flooding and surface flows may involve in-stream work or actions within floodplains. Section 404 of the CWA applies to the dredging or filling of navigable

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[1] *Federal Register*, March 23, 2010 (Volume 75, Number 55), Proposed Rules, pp. 13715-13716. Department of the Interior, Fish and Wildlife Service, 50 CFR Part 17, "Endangered and Threatened Wildlife and Plants; Revised Designation of Critical Habitat for Bull Trout in the Coterminous United States".

waters (e.g., stream removals, bank stabilization, riparian repairs, floodplain cleanup actions, and so forth). The South Fork Coeur d'Alene River and its tributaries are considered to be navigable waters. The U.S. Army Corps of Engineers (USACE) typically implements Section 404 through the issuance of permits that set conditions on dredging or filling activities. Section 401 of the CWA requires that USEPA receive a water quality certification from the State of Idaho for Section 401 activities to demonstrate that they comply with state water quality standards. Permit requirements do not apply to CERCLA remedial actions, but substantive requirements issued by USEPA under Section 404 of the CWA (40 CFR Part 230) may be applicable to remedial alternatives that involve dredging of sediments and "special aquatic sites," which are defined to include wetlands. These requirements include considering alternatives with less adverse impacts and prohibiting discharges that would result in exceedance of surface water quality standards, exceedance of toxic effluent standards, and jeopardy to threatened or endangered species. IDEQ, the agency that oversees Section 401 certification for the State of Idaho, has not developed state-specific criteria for wetlands and, instead, relies on the USACE to determine whether impacted wetland areas fall under its jurisdiction.

Substantive requirements of Idaho's Stream Channel Alteration Rules (Title 42, Chapter 38, Idaho Code, IDAPA 37.03.07) are potentially applicable to actions that alter the natural configuration of a stream channel or wetlands. This includes removal of material from the stream channel and emplacement of material or structures in or across the stream channel where the material or structure has the potential to affect flow within the channel. Similarly, any artificial barrier that is or will be 10 feet or more in height or has an impounding capacity at a maximum storage elevation of 50 acre-feet are subject to the State's Rules and Regulations for Safety of Dams (Idaho Code Title 42, Chapter 17, IDAPA 37.03.06). Maintenance and repair of ditches, embankments, easements and rights of way are subject to Idaho's Irrigation and Drainage—Water Rights and Reclamation requirements (Idaho Code Title 42, Chapter 12). The Idaho Lake Protection Act (Idaho Code 58, Chapter 13, IDAPA 20.03.04) regulates work on or above a lake bed and below the ordinary high water mark, and may include certain wetlands. Work subject to these requirements includes riprap and breakwaters.

Under Executive Order 11988, *Floodplain Management*, and Executive Order 11990, *Protection of Wetlands*, federal agencies are required to consider proposed actions on wetlands and floodplains. The substantive requirements of these Orders to evaluate and avoid adverse impacts are potential TBCs for remedial actions to wetlands and within the 100-year floodplain zone.

Under Section 106 of the National Historic Preservation Act (NHPA), USEPA must provide the Advisory Council on Historic Preservation established under Title II of this Act a reasonable opportunity to comment with regard to actions that may impact historic properties, cultural resources, or landmarks. The NHPA also requires that federal agencies consider the effects of their actions on properties on or eligible for the National Register of Historic Places. The NHPA and the Native American Graves Protection and Repatriation Act (NAGRPA) are potential location-specific ARARs for ground-disturbing activities. NAGPRA requires that federal agencies halt work and contact the appropriate authorities should human remains, funerary objects, or cultural resources be discovered. The Coeur d'Alene and Spokane Tribes have monitored field sampling activities for cultural resources in the Coeur d'Alene River Basin. During this project, the Coeur d'Alene Tribe's Tribal Historical Preservation Officer (THPO) will be involved in all activities that involve excavation as implementation proceeds.

4.2.3 Potential Action-Specific ARARs

Action-specific ARARs generally set performance, design, or other similar controls or restrictions on particular kinds of activities. A list of potential action-specific ARARs and TBCs for ecological receptors in the Upper Basin is presented in Table 4-7.This list of requirements is expected to expand and change as specific actions are selected to accomplish a remedy. Action-specific requirements do not in themselves determine the remedial alternative; rather, they indicate how, or to what level, a selected alternative must be achieved. Potential action-specific ARARs that could be pertinent to remedial activities in the Upper Basin include air emission and control requirements from release points of remediation equipment and actions, and solid (and possibly hazardous) waste identification and management requirements.

IDAPA 37.03.09, Well Construction Standards Rules, are also potentially applicable for the installation of monitoring and injection wells as necessary to accomplish the remedy. The Idaho Forest Practices Act (Title 42 Chapter 38-13, Idaho Code), its implementing regulations, Rules Pertaining to the Idaho Forest Practices Act (IDAPA 20.02.01), and the Idaho Safety of Dams Rules (IDAPA 37.03.06) specify requirements for road construction, stream crossings and diversions, and soil and stream protection that may be relevant and appropriate to remedial actions. The Idaho Stream Channel Protection Act (IDAPA 37.03.07) and the Idaho Lakes Protection Act (IDAPA 20.03.04) may also be also relevant and appropriate. Potential TBCs for remedial actions include the State of Idaho's Non-Point Source Management Plan (December 1999) that coordinates restoration and water quality improvement plans and includes best management practice (BMP) design, implementation, monitoring, and maintenance schedules for non-point-source-impacted surface waters and groundwaters. Another potential TBC is *Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites* (USEPA, 2002a).

4.2.3.1 RCRA Subtitle C and Mining Waste

Because the source of contamination in the Upper Basin was mining practices, management requirements (accumulation, treatment, disposal, etc.) for mining wastes under the Resource Conservation and Recovery Act (RCRA) Subtitle C (hazardous wastes) and Subtitle D (solid wastes; see Section 3.2.3.2) are important to consider. When RCRA was amended in 1980, Congress exempted certain mining and mineral processing wastes ("Bevill wastes," named for the senator who sponsored the amendment) from Subtitle C requirements. In 40 CFR 261.4(b)(7), USEPA specifically defined mining wastes from the extraction, beneficiation, and some processing of ores and minerals as solid waste exempt from hazardous waste requirements. Extraction and beneficiation wastes include the following lead and zinc mining wastes (USEPA, 1995):

- Waste rock—includes wastes from overburden and mine development rock. Overburden wastes are usually disposed of in unlined piles; mine development rock is often used onsite for road and other construction uses. It is also stored in unlined onsite piles or in underground openings.

- Mine water—includes all water that collects in surface or underground mines due to groundwater seepage or inflow from surface water or precipitation.
- Concentration wastes—includes wastes from beneficiation operations used to concentrate mineral ores and their respective wastes including flotation system tailings (liquids and solids) and waste slurries from milling and gravity concentration operations.

If other mining wastes are encountered during Coeur d'Alene Basin remediation that do not meet the Bevill exemption, they will need to be characterized for their solid and potentially hazardous waste properties and managed accordingly.

4.2.3.2 RCRA Subtitle D and Mining Waste

Although Bevill wastes are not hazardous wastes, USEPA has determined that they are solid wastes as defined in 40 CFR 261.2 (54 FR 36614, September 1, 1989) and thus are subject to Subtitle D requirements. RCRA Subtitle D provides for state and local governments to be the primary regulators for the management of solid waste, although there are general federal requirements in 40 CFR Part 257. In Idaho, solid waste requirements, including the management, processing, waste handling, and disposal of non-municipal solid waste, are promulgated in IDAPA 58.01.06, Solid Waste Management Rules and Standards, and are potentially applicable.

RCRA Subtitles C and D and State of Idaho solid waste and surface mining requirements that address the design and performance standards for landfills and waste disposal, and which are potentially relevant and appropriate or TBC to the proposed consolidation of remediation wastes, are included in Table 4-7.

4.2.3.3 Principle Threat Waste

The NCP establishes an expectation that USEPA will use treatment to address the principal threats posed by a site wherever practicable (NCP§300.430(a)(1)(iii)(A)). Where USEPA determines that it is not practicable to use treatment to address principal threat materials (PTM), they may be transported offsite, consistent with the Off-Site Disposal Rule, 40 CFR 300.440, or managed safely onsite, consistent with all ARARs identified in this document. This may include containment and consolidation in a PTM cell that includes a secure liner system.

PTM are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained and/or would present a significant risk to human health or the environment should exposure occur (USEPA, 1991c). Additional information for defining principal threat wastes can be found in the USEPA guidance entitled *A Guide to Principal Threat and Low Level Threat Wastes* (USEPA, 1991c). The guidance notes that identification of PTM is made on a site-specific basis and is intended to help streamline and focus the remedy selection process.

PTM in the Coeur d'Alene Basin may include, for example, metal concentrates spilled during mill operations or in transport to smelters. They may also exist at other undetermined locations in the Upper Basin. The following concentrations were used to define principal threat wastes in the Bunker Hill Box (USEPA, 1992) and OU3 (USEPA, 2002b):

Parameter	PTM Concentration (ppm)
Antimony	127,000
Arsenic	15,000
Cadmium	71,000
Lead	84,600
Mercury	33,000

ppm = parts per million

PTM = Principal Threat Materials

These concentrations were developed by USEPA based upon an evaluation of the acute toxicity of contaminants of concern at the Bunker Hill Superfund Site (USEPA, 1991d).

If PTM are encountered during remedy implementation, these materials would be managed in a manner that is protective of human health and the environment and consistent with the NCP. Additional site characterization sampling will likely be required as part of the remedial design process. The resulting data will be reviewed to determine the presence of PTM and, if found, the volume of the PTM will be determined, as will the necessary management and disposal approach.

4.3 Preliminary Remediation Goals

PRGs are standards by which aspects of a cleanup under CERCLA may be measured with a view toward achieving the RAOs (see Table 4-1). They include potential ARARs, potential TBCs, and risk-based concentrations of chemicals in environmental media that have been brought forward from the risk assessment conducted for the site. PRGs are initial points of focus using readily available toxicity and exposure factor information, frequently used standards (e.g., ARARs), and reasonable exposure assumptions.

PRGs for the environmental media in the Upper Basin are presented in Tables 4-8 through 4-12. Final site-specific action or cleanup levels developed for the Upper Basin will be established in the forthcoming ROD Amendment and may differ from the PRGs presented in these tables. PRGs for soil for the protection of terrestrial biota are presented in Table 4-8; PRGs for soil for the protection of aquatic birds and mammals are presented in Table 4-9; and PRGs for sediment for the protection of aquatic organisms are provided in Table 4-10. For soil and sediment, the site-specific lead cleanup goal of 530 mg/kg, selected by USEPA , is the principal PRG for protection of birds and is consistent with human health protection.

Table 4-11 presents PRGs for surface water based on the protection of human health and aquatic organisms, and Table 4-12 presents PRGs for surface water used as drinking water. For surface water, AWQC and MCLs are both the principal ARARs and PRGs for protection of the human health and the aquatic environment. AWQC, adjusted for hardness for specific metals, were identified as the PRGs for surface water in the 2001 EcoRA (Table 5-10, CH2M HILL and URS Greiner, 2001) and have been updated based on current regulations and guidance. The 2001 EcoRA also presented a water-borne concentration that represents the lowest chronic effects level of metals that may affect aquatic plants. However, this effects level for plants is a screening-level benchmark that is not as robust as the AWQC, which also take into account the protection of aquatic plants. Therefore, the AWQC are considered adequately protective for aquatic organisms.

Attachment 4-1
Development of Preliminary Remediation Goal for Lead in Soil and Sediment in the Coeur d'Alene Basin, for Protection of Songbirds

ATTACHMENT 4-1

Development of Preliminary Remediation Goal for Lead in Soil and Sediment in the Coeur d'Alene Basin, for Protection of Songbirds

Background

Elevated concentrations of metals are pervasive in the soil, sediments, surface water and groundwater in the Coeur d'Alene Basin. These conditions are well-documented and pose substantial risks to the plants and animals that inhabit the Basin (Stratus Consulting, 2000; U.S. Environmental Protection Agency [USEPA], 2001; CH2M HILL and URS Greiner, 2001; USEPA, 2002; National Academy of Sciences [NAS], 2005). There are no promulgated cleanup criteria or standards that are considered applicable or relevant and appropriate (ARARs) for the soil or sediments in the Coeur d'Alene Basin (USEPA, 2002). Since lead is the main risk driver in the soil and sediments, USEPA has identified lead as the preferred metal to be used as an indicator contaminant for some aspects of the cleanup. Background lead concentrations in the soil and sediments in the Lower Basin and Upper Basin are estimated to be 47.3 milligrams per kilogram (mg/kg) and 171 mg/kg, respectively, based on the 90th-percentile statistic, whereas lead concentrations in the impacted soil and sediments are typically 3,500 to 4,000 mg/kg and higher, particularly in the Upper Basin (USEPA, 2001).

Given the absence of promulgated criteria for metals in soil and sediment in the Interim Record of Decision (ROD) for Operable Unit 3 (OU 3) (USEPA, 2002), USEPA made a risk management decision to use a site-specific protective value of 530 mg/kg lead in sediment as the benchmark cleanup level for the protection of waterfowl. This value was based upon data collected in the Coeur d'Alene Basin and is also within the range of potentially protective values from the literature and other sites. While the cleanup level of 530 mg/kg lead in soil and sediment may not be fully protective of aquatic birds and mammals, it will address 95 percent of the habitat area. Only 5 percent of the impacted area in the Lower Basin is estimated to have lead concentrations between 530 mg/kg and background. For these reasons, USEPA believed that selection of 530 mg/kg lead as the benchmark cleanup criterion for soil and sediment is technically the best alternative to protect waterfowl. In its review of USEPA's scientific and technical practices in the Coeur d'Alene Basin, NAS noted that 530 mg/kg lead in sediments is "a reasonable number based on the science to date." (NAS, 2005, p. 316). The report also noted that "this value is supported by substantial field evaluation of lead effects on waterfowl in the Coeur d'Alene Basin" (*ibid.*).

Songbird Exposure Study

The 2001 Ecological Risk Assessment for the Coeur d'Alene Basin (2001 Basin EcoRA; CH2M HILL and URS Greiner, 2001) noted that songbirds in riparian areas were at high risk of lead exposure and adverse effects. The 2001 Basin EcoRA also noted that site-specific exposure data for songbirds were not available. While many data gaps existed, this data gap was determined to be a priority in both the 2001 Basin EcoRA and the 2002 ROD. To address this data gap, USEPA established an Interagency Agreement with the U.S. Fish and Wildlife Service (USFWS) to conduct an evaluation of exposure and effects of lead-contaminated soil on migratory songbirds. The songbird study (Hansen, 2007) was conducted to document exposure, pathways, and potential toxic effects of contaminated soil on ground-feeding songbirds. The ground-feeding songbirds included in the study were American robin (*Turdus migratorius*), song sparrow (*Melospiza melodia),* and Swainson's thrush (*Catharus ustulatus*). These three species were selected because they are relatively abundant in the Basin, previous data for these species had been collected (Blus et al., 1995; Audet et al., 1999; Johnson et al., 1999), and the 2001 Basin EcoRA concluded that these three species were at relatively high risk. These songbirds spend much of the spring and early summer feeding on invertebrates in and on the ground. Consequently, their feeding activity may allow or promote the ingestion of soil, which in some areas of the Coeur d'Alene River Basin contain high concentrations of lead. Ingestion of lead-contaminated sediments has already been shown to cause mortality and other toxic effects in waterfowl inhabiting the Basin (Blus et al., 1999; Beyer et al., 2000; Henny et al., 1999; Sileo et al., 2001). The songbird study was conducted to provide data for incorporation into a risk analysis to determine whether songbirds were at risk of lead exposure and effects, and to determine the lead concentrations in soil associated with potential adverse effects.

Focused Riparian Songbird Ecological Risk Assessment

Following collection of the site-specific data by USFWS, USEPA engaged a contractor, CH2M HILL, to perform a focused EcoRA to integrate the site-specific riparian songbird data collected by USFWS with other available data in the 2001 Basin EcoRA to evaluate risks to songbirds. The focused EcoRA prepared by CH2M HILL used the site-specific lead concentrations in blood, liver, and ingesta from the USFWS songbird study, plus soil data associated with the tissue sampling locations and other locations in the Coeur d'Alene Basin (CH2M HILL, 2006). Lead is used as an indicator of the other metals (e.g., arsenic, cadmium, zinc, etc.) typically present in contaminated soil and sediments at the site. The focused EcoRA follows USEPA guidance (USEPA 1997, 1999) and is also consistent with the approach of, and extensively relies upon, the 2001 Basin EcoRA. The focused EcoRA updated the evaluation of risks from lead to riparian songbirds in the Coeur d'Alene Basin and developed site-specific preliminary remediation goals (PRGs) for lead in soil that are protective of riparian songbirds to address the previously identified data gap.

When establishing cleanup goals, USEPA must account for the presence of special-status species and migratory birds protected under the Migratory Bird Treaty Act where the level of protection should be greater than for population-level endpoints. In accordance with USEPA guidance, Superfund remedial actions generally should not be designed to protect organisms on an individual basis but to protect local populations and communities of species (USEPA, 1999). The guidance indicates that the exception is designated protected-status resources, such as listed or candidate threatened and endangered species or treaty-protected species that could be exposed to site releases which should be protected such that effects to individuals are minimized. Based upon the aforementioned USEPA guidance, the 2001 Basin EcoRA established assessment endpoints on the basis of migratory birds and threatened or endangered species within the Basin. The effects levels for these endpoints were established to minimize adverse effects on individuals that may be exposed in a population by considering no-effects or minimal-effects levels of metals for the receptor species. Since the songbirds in the Basin are migratory, consistent with USEPA risk assessment guidance and the 2001 Basin EcoRA, it is appropriate to protect migratory songbirds such that effects to individual songbirds in a population are minimized, as well as to protect them at the population level.

The 2001 Basin EcoRA included PRGs for terrestrial species such as birds and mammals as well as terrestrial plants and invertebrates and soil processes occurring in the upland and riparian habitats. Species that occur in riparian or upland habitats were identified as "terrestrial", and PRGs were calculated on the basis of soil. PRGs were separately developed for aquatic receptors. The 2001 Basin EcoRA included a soil PRG for lead developed for terrestrial biota (plants, invertebrates, and microbial processes combined) based upon literature-derived toxicity data. In setting remedial goals, PRGs are often determined by levels of contaminants that would be protective of the most sensitive ecological receptor that is exposed to a particular medium. Within the Coeur d'Alene Basin, these values were often lower than background values for soil, sediment and surface water. As a result the recommended PRGs in the areas where background levels of metals exceed potential effect levels, the PRGs default to the background levels. As noted above, the 90th-percentile soil-sediment background lead concentration in the Upper Basin is 171 mg/kg. In the 2001 Basin EcoRA, the lead PRG for terrestrial soil biota at a population/community level is 450 mg/kg. The wildlife PRGs to minimize effects to individuals - and at the population level range from 2.5 mg/kg to 522 mg/kg.

The 2001 Basin EcoRA did identify as a key data gap the lack of site-specific exposure data available for songbirds. Relative to other terrestrial receptors, songbirds are generally highly exposed to soil contamination. This is because many songbirds ingest soil invertebrates, which are themselves highly exposed to contaminants in soil, thereby incorporating the invertebrates' metal burden. Songbirds may also incidentally consume soil while foraging and thereby be exposed to additional contaminants. Finally, because they breed in contaminated floodplain habitats, they have a high residence time during a critical life stage (reproduction). As a consequence of these factors, a PRG value that is protective of songbirds is also likely to be protective of other terrestrial avian species.

Evaluation

The USFWS songbird study (Hansen, 2007) and the focused EcoRA (CH2M HILL, 2006) confirm that songbirds in the Coeur d'Alene Basin are accumulating lead in blood and liver tissue from ingesting lead-contaminated soil. This soil is likely consumed incidentally with food items such as terrestrial invertebrates. The songbird study and the focused EcoRA both examined a range of exposure levels of lead in liver and blood including subclinical, clinical, and severe clinical values. Lowest observed adverse effects level (LOAEL) and ED20 values were also estimated based on dietary exposure to lead in ingesta. The subclinical level represents a minimal level of effect but is not as conservative as a no-effect level. The USFWS songbird study indicated that soil lead concentrations less than 581 mg/kg would be protective of subclinical effects in roughly 50 percent of exposed song sparrows. The focused EcoRA found that the lowest PRG obtained for any species' exposure effect-measure combination was 490 mg/kg lead in soil for subclinical effects due to lead in the blood of American robins.

As is noted earlier, the ROD for OU 3 includes a site-specific lead cleanup level of 530 mg/kg in sediment for the protection of waterfowl (USEPA, 2002). The cleanup value protective of waterfowl is bracketed by the songbird PRGs determined by USFWS and in the focused EcoRA. Furthermore, the 530 mg/kg lead cleanup value is also within 18 percent and 1.5 percent respectively of the soil biota and wildlife population PRG values identified in the 2001 Basin EcoRA (450 and 522 mg/kg, respectively). The 530 mg/kg cleanup level is reasonably bracketed by both the site-specific songbird PRG values and the soil biota and wildlife population PRGs and will be protective of songbirds.

The ROD for OU 3 also establishes an action level for lead in soil of 700 mg/kg (i.e., 700 parts per million [ppm]) to protect human health. Practically, there is very little difference between the 700 ppm human health cleanup value and the 530 ppm action level in terms of the areas where cleanup would be required and the areal extent of the cleanup actions. Hence, a site-specific cleanup level of 530 mg/kg lead in soil for protection of songbirds will also be consistent with the human health cleanup approach.

When USEPA cleans up an area, it will not be seeking to dilute the current 3,000+ mg/kg soil down to 530 mg/kg. Instead, USEPA will typically excavate and consolidate contaminated soils and then install a clean cap over the consolidated contaminated material. Hence it is likely that in remediated areas, the resulting condition will be lower than 530 mg/kg lead. Furthermore, while remedial actions are implemented to address lead exposure, other metal contaminants that are present will also be addressed by the remedial actions.

Given the potentially broad application of a sediment/soil cleanup number at the Bunker Hill Superfund Site and the relative comparability of waterfowl and songbird-protective values, there is substantial efficiency gained by having a single site-specific protective level. Having a consistent sediment/soil cleanup level for protection of songbirds and waterfowl will ease remedy design and implementation.

Considering the above evaluation, USEPA has made a risk-management determination that a site-specific lead cleanup level of 530 mg/kg in soil would be protective of songbirds in the Coeur d'Alene Basin.

Conclusion

The 2001 Basin EcoRA (CH2M HILL and URS Greiner, 2001) and the ROD for OU 3 (USEPA, 2002) identified the lack of site-specific riparian and riverine songbird data and a protective cleanup level as data gaps that should be addressed. Based upon the findings of the site-specific data gathered in the USFWS songbird study (Hansen, 2007) and the focused EcoRA prepared by CH2M HILL (2006), and other relevant information, USEPA has made a made a risk-management based determination that a site-specific soil lead cleanup level of 530 mg/kg will be protective of songbirds in the Coeur d'Alene Basin. This cleanup number is also consistent with the human health approach. In addition to being protective of both waterfowl and songbirds, as well as of human health, a consistent cleanup level provides operational clarity and efficiency for the ecological remedial design and cleanup actions.

During the remedial design process, USEPA will use best professional judgment to determine the extent of the soil in vegetated areas that may need to be remediated to protect songbirds. USEPA will first identify cleanup areas based on impacts to surface water quality. In most instances, this will be conducted with a visual field inspection and review of water quality data. After the cleanup areas have been defined, USEPA will use the riparian soil cleanup number to identify specific locations within the cleanup area where a clean barrier needs to be installed to protect songbirds. In some contaminated areas, robust vegetation is established and the decaying plant litter may serve as a protective buffer that reduces the risk exposure pathway and availability to any underlying contaminated soil. Removal of such an established ecosystem to address the soil contamination may not be the most effective or practical remedial approach. During the remedial design process, USEPA would rely upon an initial visual inspection of a mine site targeted for cleanup to evaluate habitat conditions such as vegetation and soil cover conditions. This step would be followed by statistical evaluation of the soil sampling data collected from this site area, along with habitat quality assessment, to determine the extent of the cleanup action and area for potential application of the cleanup number protective of songbirds of 530 mg/kg lead in soil. The relationship between habitat quality and lead content in soil will be considered to develop a practical remedial approach with the least impact to higher-quality habitat wherever possible. The prospects for recontamination (e.g., by flooding) will also be considered in determining the appropriate timing for cleanup.

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SECTION 5.0

Development of Typical Conceptual Designs (TCDs)

A typical conceptual design (TCD) is a conceptual design for an element of a remedial action consisting of a representative assemblage of technologies and process options. TCDs are used as building blocks for assembling remedial alternatives that, in this case, will address major areas of the Upper Coeur d'Alene Basin. TCDs are used to help develop alternatives, including estimated costs, that can be subjected to feasibility-level evaluations. The use of TCDs in remedial alternatives is not intended to limit the technologies and process options ultimately selected during remedial design. The *Final (Revision 2) Feasibility Study Report for the Coeur d'Alene Basin Remedial Investigation/Feasibility Study, Part 3, Ecological Alternatives* (2001 FS Report; U.S. Environmental Protection Agency [USEPA], 2001d) employed a TCD-based approach because the size and complexity of the Upper Coeur d'Alene Basin make it impractical to develop site-specific conceptual designs covering the many, diverse sources of contamination. To take advantage of, and build on, the work done during the 2001 FS, a consistent approach using TCDs is followed in this Focused Feasibility Study (FFS) Report.

Many TCDs identified as part of Ecological Alternatives 3 and 4 in the 2001 FS Report have been retained for re-use in this FFS. Most of these TCDs were adopted "as-is" for this FFS with little or no technical revision, although their estimated costs were escalated to 2009 costs. In general, these TCDs retain the TCD identifier codes originally assigned to them in the 2001 FS Report.

In addition, new or substantially-revised TCDs have been developed for remedial components not covered by TCDs from the 2001 FS. These were assigned new TCD codes.

The sustainability of the remedial actions must be considered at all stages of remediation including at the feasibility-study level (USEPA, 2009b). Green remediation is defined as the practice of considering all environmental effects of remedy implementation and incorporating options to maximize new environmental benefit of cleanup actions. There are a number of best management practices available in published USEPA documents to help guide this process. The best management practices of green remediation help balance key elements of sustainability. These key elements—resource conservation, material intensity, and energy efficiency—are echoed throughout USEPA's technology primer, *Green Remediation: Incorporating Sustainable Environmental Practices into Remediation of Contaminated Sites* (USEPA, 2008a). As further guidance, USEPA has developed five recommended elements for greener cleanups (USEPA, 2009a). The five elements are:

1. Minimize Total Energy Use and Maximize Use of Renewable Energy.
2. Minimize Air Pollutants and Greenhouse Gas Emissions.
3. Minimize Water Use and Impacts to Water Resources.
4. Reduce, Reuse, and Recycle Material and Waste.
5. Protect Land and Ecosystems.

These five recommended elements are incorporated into the TCDs via sustainability actions. Table 5-1 describes each TCD and includes relevant sustainability actions, which are described in the "Sustainability Legend". For example, to minimize total energy use, many TCDs will follow sustainability action E1, "Reduce idling of trucks and equipment."

It is also important to consider sustainability at larger scales than the TCD level. The sustainability for the actions considered at the site level, the alternatives level, and the program level will be considered as the selection of actions progresses. A simple example of a program-level sustainable action is to produce documents electronically to reduce paper consumption. Another action that could be implemented at a larger scale (i.e., the site, watershed, or program scale) is the development of renewable energy sources to serve electrical demands.

This section summarizes the TCDs that have been retained from the 2001 FS Report, and describes the new and revised TCDs developed during this FFS. All the TCDs considered in the FFS are listed in Table 5-1. Schematics illustrating the TCDs are provided in Appendix C of this FFS Report. Cost estimates for the TCDs are developed in Appendix D and summarized in Table 5-2.

5.1 Source Control TCDs

Figures C-1 through C-10 in Appendix C are schematics of the Source Control TCDs. Detailed descriptions of the design cost assumptions are provided in Appendix D.

5.1.1 Retained TCDs

Retained TCDs for Source Control (referred to as Removal and Containment TCDs in the 2001 FS Report) include (Table 5-1)[1]:

- Regrade/Consolidate/Revegetate (C02a, C02b, C02c)
- Low-Permeability Caps (C03, C04, C05)
- Impoundment Closure (C09)
- Haul to Repository (HAUL-2)

5.1.2 New/Revised TCDs

New and revised Source Control TCDs include (Table 5-1):

- Excavation (C01, C01b)
- Waste Consolidation Areas (C06, C07)
- Repository (C08a)

C01, C01b – Excavation. Excavation TCDs C01 and C01b were revised to include revegetation of areas disturbed during excavation.

C06 and C07 – Waste Consolidation Areas. Waste consolidation areas will serve for consolidation or placement of wastes from specifically-identified sources such as mine and

[1] In the 2001 FS Report, TCDs C01 through C09 were numbered C1 through C9. For the purposes of the project database that has been developed as part of this FFS, zeros have been added to these TCD codes to enable database sorting of the TCDs in numerical sequence.

millsite remedial actions. They will typically not accept Institutional Controls Program (ICP) wastes. The local consolidation areas will be a critical mode of waste management near waste source areas to facilitate construction of reliable, effective, protective, and cost-effective remedies for these sites. The local consolidation areas will be located adjacent to or near the waste source areas, which will generally necessitate that they are sited high in the side drainages, away from the South Fork of the Coeur d'Alene River (SFCDR) valley. The local consolidation areas will be designed to reliably contain waste materials, prevent releases of contaminants to the air, surface water, and groundwater, and be compliant with applicable or relevant and appropriate requirements (ARARs), but will not be subject to the four-step repository siting and design provisions outlined in Section 12.5 of the Record of Decision (ROD) for Operable Unit 3 (OU 3).

C08 – Repository. Repositories will be located within or proximal to the SFCDR valley. They will be designed to accept both Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedial action and ICP wastes. The repositories will be subject to the four-step siting and design process outlined in Section 12.5 of the ROD for OU 3.

The need for bottom liners and leachate collection at repositories and local consolidation areas would be determined during remedial design based on site-specific conditions. Once full, the storage facilities would be covered with a low-permeability cap.

The improvement and construction of roads and bridges are applied as 15 percent of the direct capital cost for each alternative. Therefore, roads and bridges are not specifically called out as TCDs.

5.2 Water Collection, Conveyance, and Management TCDs

Figures C-11 through C-20 in Appendix C show these TCDs. Detailed descriptions of the design cost assumptions are provided in Appendix D.

5.2.1 Retained TCDs

Retained TCDs for Water Collection, Conveyance, and Management (referred to as Removal, Containment, and Active Treatment TCDs in the 2001 FS Report) include (Table 5-1):

- Adit Drainage Collection (C10)
- 6-inch Gravity Pipeline (PIPE-1)
- 12-inch Gravity Pipeline (PIPE-2)
- 24-inch Gravity Pipeline (PIPE-3)

5.2.2 New/Revised TCDs

New and revised TCDs for Water Collection, Conveyance, and Management include (Table 5-1):

- Hydraulic Isolation Using Slurry Wall (C11a through C11j)
- Stream Lining (C14a through C14c)
- French Drains (C15a through C15d)
- Extraction Wells (C17a through 17e)

- SFCDR Diversion (C18) and I-90 Crossing (C19)
- Check Dam (C20)
- 36-inch Gravity Pipeline (PIPE-4)
- Pressurized Pipeline (PRESSURE-PIPE-1 through PRESSURE-PIPE-4)
- Pump Stations (PUMP-1 through PUMP-5)

Detailed descriptions of the design cost assumptions are provided in Appendix D. This section discusses each of these new and revised TCDs in more detail.

- **C11a - Hydraulic Isolation Using Slurry Wall (15 feet deep, no drain).** This TCD is similar to C11 in the 2001 FS Report (Hydraulic Isolation Using Slurry Wall). This slurry wall is made of a 10 percent soil-bentonite mix. The excavated waste is all sent to the repository, TCD C08a.

  The TCD developed for hydraulic isolation would be implemented by constructing a vertical slurry wall through the contaminated groundwater zone and into a low-permeability soil or rock layer. A slurry wall would be constructed by excavating a relatively narrow trench that is filled with a bentonite-water mixture (mud) to prevent collapse of the trench walls. A low-permeability soil-bentonite slurry would then be placed from the bottom up, displacing the lighter mud out of the trench. Portland cement is often added to the slurry to decrease the permeability. Deep soil mixing and a vibratory beam are also candidate slurry wall construction methods that may be considered during design.

  The implementability of a slurry wall would be affected by the presence of boulders, which can severely impede excavation. Slurry wall construction costs can escalate if the depth to the low-permeability layer exceeds about 30 to 50 feet. Figure C-12 shows a typical slurry wall. Other types of barriers can be used depending on site conditions, including sheet pile walls and pressure grout walls. While a specific barrier was chosen here for costing purposes, care should be taken during design to assess the most appropriate barrier for site conditions. For example, in a relatively high-energy flow environment where the stream has greater potential to meander and scour, a sheet pile barrier that is offset from a stream bank may have longer durability than a slurry wall, as the slurry wall would be more susceptible to degradation.

- **C11b** – Hydraulic Isolation Using Slurry Wall (20 feet deep, no drain). This TCD is the same as C11a except that it is 20 feet deep.

- **C11c** – Hydraulic Isolation Using Slurry Wall (30 feet deep, no drain). This TCD is the same as C11a except that it is 30 feet deep.

- **C11d** – Hydraulic Isolation Using Slurry Wall (40 feet deep, no drain). This TCD is the same as C11a except that it is 40 feet deep.

- **C11e** – Hydraulic Isolation Using Slurry Wall (45 feet deep, no drain). This TCD is the same as C11a except that it is 45 feet deep.

- **C11f** – Hydraulic Isolation Using Slurry Wall (50 feet deep, no drain). This TCD is the same as C11a except that it is 50 feet deep.

- **C11g** – Hydraulic Isolation Using Slurry Wall (50 feet deep, no drain, soil cement). This TCD is the same as C11a except that it is 50 feet deep and constructed with soil cement.
- **C11h** – Hydraulic Isolation Using Slurry Wall (15 feet deep, with drain). This TCD is the same as C11a except that it includes a French drain at the bottom of the slurry wall.
- **C11i** – Hydraulic Isolation Using Slurry Wall (20 feet deep, with drain). This TCD is the same as C11h except that it is 20 feet deep.
- **C11j** – Hydraulic Isolation Using Slurry Wall (30 feet deep, with drain). This TCD is the same as C11h except that it is 30 feet deep.
- **C14a** – Stream Lining (10 feet wide). This TCD is similar to C12 from the 2001 FS Report (Hydraulic Isolation Using Lined Channel), but it separates out stream lining from French drains. The liner in C14a would be polyvinyl chloride (PVC) or high-density polyethylene (HDPE) and a geotextile with an anchor trench, whereas the liner assumed in C12 was a geosynthetic clay liner (GCL) or concrete. The PVC liner would be placed over a sand bedding and topped with gravel. The geotextile would be placed over the gravel layer and keyed into the anchor trench. Riparian cleanup and stream stabilization measures would be used to protect the liner, stabilize the channel, and provide habitat. The liner for C14a is 10 feet wide. Figure C-13 shows a typical design of a channel liner. The channel depth is assumed to be 50 percent of the channel width. The actual depth-to-width ratio of the lined channel may vary if there are significant changes in flow rate (in cubic feet per second [cfs]), natural topography (slope), and channel bends. Other factors will be considered for higher-gradient streams such as pool-drop areas, meanders, off-channel spillways to engineered flood retention areas, and bioengineering for habitat. Note that while a 45-mil liner is currently used for TCDs C14a and C14b, the actual liner thickness should be determined based on site-specific characteristics. The flexibility and strength of the liner need to be taken into account. While the material cost of the 80-mil liner is double that of the 45-mil liner, the overall increase to the TCD is only approximately 5 percent due to the other material, labor, and equipment costs associated. Care should be taken during design to ensure that there will be negligible liner lift. To help prevent liner lift, the liner is designed to be keyed into an anchor trench, and riprap is also to be placed over the geotextile. Site-specific conditions, especially at gaining reaches, need to be evaluated to ensure that the design will prevent liner lift.
- **C14b** – Stream Lining (20 feet wide). This TCD is the same as C14a except that it is 20 feet wide.
- **C14c** – Stream Lining (100 feet wide). This TCD is the same as C14a except that it is 100 feet wide and an 80-mil liner is used.
- **C15a** – French Drain (10 feet below ground surface [bgs]). This TCD has been separated out from a number of previous TCDs where it was a process option. For the purpose of costing the French Drain TCDs, it is assumed that the French drains would be installed to a depth of 5 feet below the water table. The actual depth of the French drain must be optimized to consider the normal high-water level of the adjacent stream in relationship to the water-table depth adjacent to the stream. The French drain must not accept excessive stream flow discharging to the adjacent alluvial aquifer, yet must receive most

or all of the impacted groundwater that discharges to a section of stream. Accordingly, the depth of the French drain will vary by site and reach of stream. This TCD assumes installation of the French drain at a depth of 10 feet bgs.

The trench excavation would be lined with a filter fabric to minimize silt migration into the collection system. A single-pipe system would be used. Figure C-14 shows a typical design of a French drain. Water collected by the French drain system would be collected in a sump and then either conveyed via gravity pipeline or pumped to a water treatment system for treatment and subsequent discharge. Water collected upstream of the Central Treatment Plant (CTP) in Kellogg, Idaho could generally be conveyed via gravity pipeline. Water collected downstream of the CTP would require pumping and conveyance via pressurized pipeline. Figure C-20 shows the TCDs PUMP-1 through PUMP-5 where the sump and piping are illustrated. Refer to the TCD descriptions below.

- **C15b** – French Drain (15 feet bgs). This TCD is the same as C15a except that the French Drain is at a depth of 15 feet bgs.
- **C15c** – French Drain (20 feet bgs). This TCD is the same as C15a except that the French Drain is at a depth of 20 feet bgs.
- **C15d** – French Drain (25 feet bgs). This TCD is the same as C15a except that the French Drain is at a depth of 25 feet bgs.
- **C17a**– Extraction Well (20 feet deep, 6-inch-diameter pipe). Extraction wells would be used to collect contaminated groundwater for treatment and intercept metals-laden groundwater prior to discharge into a surface-water body. Extraction wells may also be used in conjunction with hydraulic isolation slurry walls (TCDs C11a through C11 j) to relieve hydraulic pressure on the slurry walls. This TCD assumes 6-inch-diameter pipe and that the wells are 20 feet deep. The TCD includes extraction pumps, electrical wiring, and controls. Figure C-15 shows a typical design of a system of multiple extraction wells.
- **C17b** – Extraction Well (40 feet deep, 6-inch-diameter pipe). This TCD is the same as C17a except that the depth is 40 feet bgs.
- **C17c** – Extraction Well (50 feet deep, 6-inch-diameter pipe). This TCD is the same as C17a except that the depth is 50 feet bgs.
- **C17d** – Extraction Well (50 feet deep, 10-inch-diameter pipe). This TCD is the same as C17a except that the depth is 50 feet bgs and the pipe diameter is 10 inches.
- **C17e** – Extraction Well (70 feet deep, 10-inch-diameter pipe). This TCD is the same as C17d except that the depth is 70 feet bgs.
- **C18** – SFCDR Diversion. This TCD is designed to temporarily divert the SFCDR so that a slurry wall can be installed across the valley floor. This includes a cofferdam with a series of pumps and a conveyance pipeline to transport the SFCDR water to a downstream location. Figure C-16 shows a typical design of a temporary diversion of the SFCDR.

- **C19** – I-90 Crossing. This TCD is designed to temporarily remove part of Interstate 90 so that a slurry wall can be installed across the interstate. Figure C-17 shows a typical design of an I-90 crossing.
- **C20** – Check Dam. This TCD is intended to prevent the flow of Bunker Hill mine water into the Reed and Russell Tunnels and out of the adit openings. The check dams would be constructed in the interior of the mine to a height sufficient to back up the water and divert it back into the mine for transport out of the Kellogg Tunnel and to the Central Treatment Plant. Materials to construct the check dams would be based on the specific water chemistry of the mine water. Figure C-18 shows a typical design for a check dam.
- **PIPE-4 – 36-inch Gravity Pipeline.** This TCD is similar to the retained TCDs PIPE-1, PIPE-2, and PIPE-3 (Figure C-19). This TCD is intended to convey water to the CTP. It is assumed that the CTP would be located to enable conveyance by gravity flow to the extent possible. The pipeline is assumed to consist of below-grade HDPE pipe. PIPE-4 assumes 36-inch-diameter pipe to be used as the main to the CTP.
- **PRESSURE-PIPE-1** – Pressurized Pipeline – <6-inch-diameter. This TCD includes below-grade HDPE pipe for pumped water. Figure C-19 shows a typical design of pressure piping.
- **PRESSURE-PIPE-2** – Pressurized Pipeline – 6- to 14-inch-diameter. This TCD is the same as PRESSURE PIPE-1 except that the pipe diameter is 6 to 14 inches.
- **PRESSURE-PIPE-3** – Pressurized Pipeline – >14-inch-diameter. This TCD is the same as PRESSURE PIPE-1 except that the pipe diameter is >14 inches.
- **PRESSURE-PIPE-4** – Pressurized Pipeline – 3-inch-diameter, Cherry Raise. This TCD is designed to convey AMD back into the mine. The pressurized pipeline will convey water from a pump station down the Cherry Raise to the 9 Level. The pipeline is assumed to consist of below-grade HDPE pipe and to be installed within the pipe compartment of Cherry Raise.
- **PUMP-1** – Pump Station – 0.14 million gallons per day (MGD). This TCD is designed to pump water collected from French drains to a treatment facility. Figure C-20 shows typical designs of pump stations.
- **PUMP-2** – Pump Station – 1.4 MGD. Similar to PUMP-1, this TCD is designed to pump water collected from French drains to a treatment facility. PUMP-2, however, includes a control building and a programmable logic computer in addition to the wet well and stainless-steel pumps.
- **PUMP-3** – Pump Station – 3.9 MGD. This TCD is the same as PUMP-2 except the pumping capacity is 3.9 MGD.
- **PUMP-4** – Pump Station – 6.3 MGD. This TCD is the same as PUMP-2 except the pumping capacity is 6.3 MGD.
- **PUMP-5** – Pump Station – 6.5 MGD. This TCD is the same as PUMP-2 except the pumping capacity is 6.5 MGD.

5.3 Water Treatment TCDs

Figures C-21 through C-24 in Appendix C are schematics of the Water Treatment TCDs. Detailed descriptions of the design cost assumptions are provided in Appendix D.

5.3.1 Retained TCDs

None of the Water Treatment TCDs in the 2001 FS Report have been retained.

5.3.2 New/Revised TCDs

New information has become available since the FS was completed in 2001 as a number of studies have been conducted. These studies include: (1) apatite testing at Success and Nevada Stewart Mines; (2) sulfate-reducing bioreactor (SRB) testing at Gem Portal and Woodland Park; (3) high density sludge (HDS) testing at Woodland Park; (4) Bench-scale inorganic reactive media testing (Canyon Creek Phase II Treatability Study work); and (5) paper evaluation of the proposed HDS-Actiflo combined process as part of the Canyon Creek Treatability Study work.

Therefore, a focused preliminary screening of water treatment options was performed to select options for the development of Water Treatment TCDs (Table 5-3). Each remedy was screened based on effectiveness, implementability, and relative cost. A numerical score was given to each remedy to more easily view the scoring. Remedies that scored a total of 2 or higher were retained. The water treatment options selected (retained) in this preliminary screening effort, and their designated TCD codes, are as follows (Table 5-1):

- **WT01** – Centralized High Density Sludge (HDS) Treatment at Central Treatment Plant (CTP). Centralized active water treatment at the Bunker Hill CTP in Kellogg, Idaho, using an HDS process with granular media filtration. Note that WT01 does not include a sludge pond, but the costs for a sludge pond will be added onto each alternative based on the volume of sludge that each alternative would produce;

- **WT02** – Onsite Semi-Passive Water Treatment Using Lime Addition and Settling Pond(s);

- **WT03** – Onsite Semi-Passive Water Treatment Using Sulfate-Reducing Bioreactor (SRB) System; and

- **WT04a and WT04b** – *In situ* Semi-Passive Groundwater Treatment Using Sulfate-Reducing Permeable Reactive Barrier (SR-PRB). An *in situ* alkalinity-generating PRB is discussed in Appendix F but is not included as a TCD at this time. There would be need for laboratory and field pilot testing before implementing this option. This option would add alkalinity to the groundwater as it flows through the PRB (containing an alkaline material such as limestone) raising pH slightly, thereby enhancing adsorption of dissolved metals to iron oxy-hydroxide precipitates downgradient of the PRB and reducing metals loading to the stream.

Each of these TCDs is described below.

5.2.3.1 Centralized HDS Treatment at CTP (WT01)

Centralized water treatment at the CTP would be applicable for source area waters from Operable Units (OUs) 2 and 3 that (a) represent appreciable metals loading to the SFCDR (generally, waters with elevated dissolved zinc concentrations and appreciable flow rates, and also acidic to some degree), and (b) emanate from locations that are reasonably convenient for connection to conveyance piping to the CTP.

The CTP currently treats acid mine drainage (AMD) from the Bunker Hill Mine (in addition to a relatively insignificant amount of water from two nearby mine waste consolidation areas). The CTP is configured as an HDS treatment system (Figure C-21). It is currently operated in low-density sludge mode, but is capable of HDS operation. The CTP has a hydraulic capacity of approximately 5,000 gallons per minute (gpm) and an average flow of approximately 1,500 gpm; consequently, there is excess (unused) treatment capacity during much of the year, although there may be little or no surplus capacity during the highest-flow periods. Flow from the Bunker Hill Mine to the CTP may decrease in the future due to the West Fork Milo Creek stream diversion and other source control measures. In-mine storage may also be an option for allowing treatment of other OU 2/OU 3 waters during high-flow times.

The *Record of Decision Amendment: Bunker Hill Mining and Metallurgical Complex Acid Mine Drainage, Smelterville, Idaho* (2001 ROD Amendment; USEPA, 2001e) identified the need for the CTP to be upgraded to improve efficiency and increase reliability, and to achieve lower concentrations of metals in the plant's discharge to better meet current water quality standards. Therefore, some improvements are needed due to the 2001 ROD Amendment, not just the potential expansion. The requirements and costs for expanding and upgrading the CTP to allow treatment of higher flows of water from other OU 2/OU 3 source areas have been evaluated in Attachment D-1 to Appendix D. These include improvements to meet current Idaho water quality standards. The principal capital improvements required are:

- Replacement of the existing aeration basin (the B Reactor) with one or two mixed/aerated tanks;
- Replacement of the existing rapid mix tank (the A Reactor) with a new mixed tank (of improved size and design);
- Upsizing of the thickener feed piping, thickener effluent launder, and thickener effluent drop box;
- Installation of a media filtration system including filters, clearwell for backwash water storage, backwash pumps, spent backwash return pumps and piping, and a filter building; and
- Demolition of the existing polishing pond to provide space for the filtration system.

Incremental operation and maintenance (O&M) requirements for treating other OU 2/OU 3 waters consist primarily of additional lime, polymer, power, and equipment maintenance. On a per-unit-volume-treated basis, the O&M cost of treatment is much lower for other OU 2/OU 3 site waters than for Bunker Hill Mine water because the former are more dilute (lower metals concentrations), require fewer chemicals for treatment (less acidic), and produce less sludge.

Conceptual design assumptions and estimated capital and operating costs for these CTP flow capacities have been developed and are described in Attachment D-1 to Appendix D. These cost estimates were escalated to 2009 costs for this FFS. A few unit costs, quantities, and interpolations to develop the cost curves were also revised, but the main change was the escalation to 2009 costs. These details are provided in Appendix D. Centralized treatment of water at the CTP would also require construction of water collection structures and a pipeline to convey waters from the source areas to the plant location; however, collection structure and pipeline costs are covered under separate TCDs.

A sludge pond would also be required for TCD WT01. Sludge management and additional pond construction were addressed in the 2001 ROD Amendment (USEPA, 2001e), which stated if additional sludge disposal capacity is needed and offsite disposal is not cost-effective, a single 10-year disposal bed would be constructed in the CIA. The length of time until the existing sludge pond would be full depends on the contaminant load that WT01 would receive. The load would vary by alternative. This is accounted for in the cost of closing the existing sludge pond and building a new sludge pond. Therefore, the costs for sludge ponds associated with WT01 have been applied at an alternative level, and no TCD has been created for the sludge pond.

5.2.3.2 Onsite Semi-Passive Water Treatment Using Lime Addition and Settling Pond(s) (WT02)

An onsite semi-passive lime treatment system may be applicable for OU 2/OU 3 waters that contain elevated metals concentrations (e.g., dissolved zinc) but are too remote or have too low a flow rate to warrant piping to the CTP for centralized treatment. It may be better suited than the other semi-passive treatment options (e.g., WT03 or WT04) for "high-strength" waters that are very acidic and/or contain particularly high concentrations of dissolved metals. This water treatment option requires vehicular access for delivery of lime, and collection of water in a pipe or channel (e.g., adit discharge or water collected in a French drain). The O&M requirements for this water treatment option are relatively low.

The TCD for this semi-passive lime treatment system (Figure C-22) consists of:

- Aquafix® (or equivalent) lime dosing equipment. This is a non-electrical lime storage and feed system consisting of a lime bin/hopper, a screw auger feeder, and a water wheel. The water wheel, driven by a small flow of water piped to the wheel, powers the auger causing addition of dry lime to the water stream. The lime addition rate can be adjusted to neutralize water acidity and achieve a selected treatment pH. Once adjusted, lime feed is roughly flow-proportional. Aquafix equipment comes in a range of sizes and lime storage capacities.

- A conveyance channel containing the water flow. This open channel or stream runs from the lime addition point to the settling ponds, and incorporates features (such as rock rip-rap and/or cascades) to promote mixing and aeration of the water, to effect lime dissolution and oxidation of reduced iron and manganese.

- Settling pond(s). Metal hydroxide solids would be removed by gravity sedimentation at one or more settling ponds. Use of two (or more) settling ponds is often preferable to one, because it allows one to be taken offline for cleanout while the other is online for treatment. Settling ponds can be operated in series or in parallel, and are sized to allow adequate retention time for solids settling plus additional volume for long-term sludge storage (between cleanout events). This TCD includes two settling ponds for costing purposes. The solids in the offline pond could be dewatered in place and removed for offsite disposal.
- Discharge. The pond overflow pipe or channel would be used to convey treated water to the effluent discharge point.

Influent water collection and conveyance via pipe or channel are not included in this TCD.

There are challenges associated with the implementation of TCD WT02. The settling of suspended solids is important to ensure that there is no carry-over. The solids will settle slowly, so it is important to have relatively large settling ponds. The pH fluctuation can also present challenges as the control of the treatment pH is not precise. The winter weather may cause difficulties in delivering lime to the site, conducting monitoring, or providing maintenance, as roads may become difficult to travel. A building with a propane tank for heating has been added to the cost estimate to ensure that the Aquifix system does not freeze over the winter. Sustainable heating solutions such as solar will be considered on a site-by-site basis during the design phase.

Overall, it is anticipated that TCD WT02 could provide 80 percent treatment. Challenges associated with semi-passive treatment should be considered during design to optimize treatment.

5.2.3.3 Onsite Semi-Passive Water Treatment Using SRB System (WT03)

An onsite semi-passive treatment system may be applicable for OU 2/OU 3 waters that contain elevated metals concentrations (e.g., dissolved zinc) but are too remote or have too low a flow to warrant piping to the CTP for centralized treatment. An SRB system would be best suited for treatment of waters that are mildly to moderately acidic and contain moderate concentrations of dissolved metals. This water treatment option requires collection of water in a pipe or channel (e.g., adit discharge, seep water, or water collected in a French drain). Influent water collection and piping are included in other TCDs.

There are several possible semi-passive treatment system configurations, and the appropriate configuration depends on the influent water chemistry. Different options were considered in developing TCD WT03 which included adding a reducing and alkaline producing system before WT03, using an anoxic limestone drain instead of SRB ponds, and adding a horizontal flow limestone bed after the SRB ponds. Pilot testing of semi-passive SRB treatment of Canyon Creek groundwater (pH 4.5-6.5, dissolved Zn ~20 milligrams per liter [mg/L]) demonstrated efficient removal of zinc and cadmium (CH2M HILL, 2006a). This pilot plant was consistent with the configuration chosen for WT03 (Figure C-23), in that influent flowed directly into the SRB vessel.

An organic compound liquid drip system is also under review. A continuous drip system with methanol was found to out perform the manure-based SRB in the Gem Portal Study

(Asarco, 2004), but this type of SRB is less passive because the organic substrate system must be maintained. This process will be considered alongside the SRB system using organic media. A full cost estimate has not been prepared as this is still in the preliminary stages.

It is assumed that TCD WT03 would be appropriate for the water chemistry at most OU 2/OU 3 sites where semi-passive SRB treatment was employed. Consequently, for the purposes of this FEFS, TCD WT03 consists of the configuration shown in Figure C-23, which is assumed to be representative of the various configurations that might be used for onsite semi-passive water treatment. The TCD for this semi-passive water treatment system consists of:

- SRB vessels. One or more lined, in-ground basins or tanks are filled with organic media such as a mixture of wood chips, manure compost, straw, and/or other materials. Limestone (or dolomite) is often added to the media to provide additional alkalinity. As water flows through the SRB vessel, anaerobic biodegradation of media organics by sulfate-reducing bacteria reduces sulfate in the influent water to sulfide, and metals precipitate as solid metal sulfides. Use of two (or more) SRBs is often preferable to one, because it allows one to be taken offline for maintenance while the other is online for treatment. Multiple SRB stages may also be used to conform to site topography.
- A passive aeration channel. This channel conveys water from the SRBs to an aerobic polishing pond, and incorporates features (such as rock rip-rap and/or cascades) to promote aeration and oxidation of ferrous iron.
- An aerobic polishing pond. One or more ponds (depending on site constraints) are designed to remain aerobic and provide sufficient retention time for removal of undesirable byproducts in SRB effluent (which might include biochemical oxygen demand [BOD], solids, nutrients, sulfides, odors, iron, manganese and arsenic).
- An aerobic wetland. A small aerobic wetland is often used in conjunction with an aerobic pond for polishing treatment of suspended solids.
- Discharge. The effluent pipe or channel would be used to convey treated water to the discharge point.

As with TCD WT02, there are challenges associated with the implementation of TCD WT03. The performance of the aerobic polishing pond and wetland are important to ensure that discharge standards are met. The pH fluctuation can also present challenges. For WT03, the winter weather may cause difficulties accessing the site for monitoring or maintenance as roads may become difficult to travel.

Overall, it is anticipated that TCD WT03 could provide 80 percent treatment. Challenges associated with semi-passive treatment should be considered during design to optimize treatment.

5.2.3.4 *In Situ* Semi-Passive Groundwater Treatment Using SR-PRB (WT04a and WT04b)

An *in situ* treatment system may be applicable for OU 2/OU 3 groundwater that contains elevated metals concentrations (e.g., dissolved zinc) but is too remote or too dilute to warrant collection and piping to the CTP for centralized treatment, and is not readily amenable to passive collection and *ex situ* semi-passive SRB treatment. This water treatment option does not require collection of water in a pipe or channel; rather, treatment is effected as groundwater flows through a PRB oriented perpendicular to the groundwater flow direction. This water treatment option probably would only be appropriate for sites where the groundwater flow velocity is less than about 4 feet/day, because the required PRB width would become too great and it would be more feasible to collect the water for onsite (*ex situ*) semi-passive treatment. Consequently, due to the high groundwater flow rates and constraining topography, this option may not be applicable for many OU 2/OU 3 sites.

This TCD consists of a PRB installed in a trench positioned so that it intercepts the flow of contaminated groundwater emanating from a source area (Figure C-24). The PRB length is chosen based on the width of the contaminant plume. The PRB extends vertically to the depth of bedrock or to a relatively impermeable layer vertically bounding the contaminated groundwater. WT04a assumes a 10-foot-deep PRB; WT04b assumes a 40-foot-deep PRB. The PRB width is selected to provide sufficient retention time for the sulfate-reducing reactions to occur (as described above). The PRB trench is filled with media using the same types of materials as used in a semi-passive SRB vessel (see WT03), although the media must be more permeable than the surrounding formation to avoid bypass.

Since metals will tend to precipitate within the PRB media causing permeability to decrease, O&M assumptions should include removal/replacement of media every 15 years.

There are some challenges associated with the implementation of TCD WT04. In a sulfate-reducing-PRB application, it is not easy to implement post-treatment for byproduct removal (analogous to that provided by an aerobic polishing pond/wetland in an *ex situ* SRB system). The PRB is also subject to clogging or fouling that would result in a loss of permeability. These challenges should be considered during design to optimize treatment.

5.4 Human Health TCDs

The Human Health TCDs were developed to decrease human exposure to mining-related waste materials at waste piles and millsites. Separate figures are not included in Appendix C for these Human Health TCDs because existing TCD schematics visually represent these TCDs, as described below.

5.4.1 Retained TCDs

Retained TCDs for human health protection include (Table 5-1):

- Upland Waste Pile Soil Cover (HH-2)
- Millsite Decontamination (HH-3)
- Millsite Demolition/Disposal (HH-4).

The cover used for TCD HH-2 would be similar to that used in TCD C02a, Regrade/Consolidate/Revegetate. See Figure C-2, which shows the cover details. TCD HH-2 also includes a perimeter fence.

The actions for TCD HH-3 include excavating and hauling contaminated wastes to a repository. Figure C-1 (Excavation, TCDs C01 and C01b) and Figure C-10 (Haul to Repository, TCD HAUL-2) illustrate these actions. This TCD also includes a perimeter fence.

Buildings and structures would be removed under TCD HH-4. This TCD includes excavation of contaminated soil (shown in Figure C-1 [Excavation, TCDs C01 and C01b]) and hauling to a repository (Figure C-8 [Repository, TCD C08a] and Figure C-10 [Haul to Repository, TCD HAUL-2]) or to a waste consolidation area (Figure C-7 [Waste Consolidation Area Above Flood Level, TCD C07]). This TCD also includes an onsite cover similar to the cover in TCD C02a (see Figure C-2 [Regrade/Consolidate/Revegetate, TCDs C02a through C02c]).

5.4.2 New/Revised TCDs

There are no new or revised Human Health TCDs.

5.5 Stream and Riparian Cleanup Action TCDs

Figures C-25 through C-31 in Appendix C are schematics of the Stream and Riparian Cleanup Action TCDs. Detailed descriptions of the design cost assumptions are provided in Appendix D.

5.5.1 Retained TCDs

Retained Stream and Riparian Cleanup Action TCDs (referred to as Bioengineering TCDs in the 2001 FS Report) are shown in Figures C-25 through C-31 and include (Table 5-1):

- Current Deflectors (CD-AVG)
- Current Deflectors, Sediment Traps (CD-SED)
- Vegetative Bank Stabilization (VBS-AVG)
- Bioengineered Revetments (BSBR-AVG)
- Floodplain and Riparian Replanting (FP/RP-AVG)
- Off-Channel Hydrologic Features (OFFCH-AVG) and Channel Realignment (CH-REAL-1)

The stream and riparian cleanup action TCDs would be implemented following any excavation, regrading, or waste consolidation planned for the area. Depending on the site, there may or may not be contaminants remaining at depth when the stream and riparian cleanup actions are implemented. The objective of the stream and riparian cleanup action TCDs would be to improve bank and stream stability, thereby reducing erosion and sediment loading to the stream. Following the implementation of stream and riparian cleanup actions at many sites, the Natural Resource Trustees would then conduct restoration activities to further improve ecosystem function. The *Stream Habitat Restoration Guidelines* co-published by the Washington Departments of Fish and Wildlife and Ecology and the U.S. Fish and Wildlife Service (Saldi-Caromile et al., 2004) can be referenced during the design phase of the project to optimize the implementation of these TCDs.

5.5.2 New/Revised TCDs

There are no new or revised Stream and Riparian Cleanup Action TCDs.

SECTION 6.0

Development of Remedial Alternatives

This section describes the development of remedial alternatives for the Upper Basin of the Coeur d'Alene River, beginning with an overview of the section and a description of the approach and methodology used. The remedial alternatives are described in detail in Section 7.0, and are evaluated in Sections 7.0 and 8.0 of this Focused Feasibility Study (FFS) Report.

6.1 Overview

The objectives of this section are as follows:

- Describe the development of remedial alternatives for Operable Unit 3 (OU 3) and identify the sites within OU 3 that would be addressed by these alternatives.
- Identify and document changes to the lists of OU 3 sites and associated remedial actions that were included in Ecological Alternatives 3 and 4 in the *Final (Revision 2) Feasibility Study Report, Coeur d'Alene Basin Remedial Investigation/Feasibility Study* (2001 FS Report; U.S. Environmental Protection Agency [USEPA], 2001d).
- Describe the development of Phase II remedial alternatives for Operable Unit 2 (OU 2).
- Present the set of remedial alternatives for the Upper Coeur d'Alene Basin that are assembled from the alternatives for OUs 2 and 3 and evaluated in later sections of this FFS Report.

Detailed descriptions of the remedial alternatives for the Upper Basin are provided in Section 7.0, along with the analysis of each alternative against evaluation criteria specified by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The remedial alternatives are compared with each other in Section 8.0.

As discussed in Section 1.0, Ecological Alternatives 3 and 4 presented for the Coeur d'Alene Basin in the 2001 FS Report are updated and expanded in this FFS Report for the Upper Basin in a consistent manner based on new information. The updated and expanded remedial alternatives are referred to in this report as Alternatives 3+ and 4+ for OU 3. The methodology used to develop these alternatives is described in Section 6.2, and an overview of the sites included in Alternatives 3+ and 4+ is provided in Figure 3-11 accompanying Section 3.0. The source of the site IDs and names for the sites included in Alternatives 3+ and 4+ is the inventory of source sites conducted by the Bureau of Land Management (BLM) in 1999 in support of the Remedial Investigation/Feasibility Study (RI/FS) for the Coeur d'Alene Basin.

Also as discussed in Section 1.0, Phase II remedial alternatives for OU 2 are developed separately from those for OU 3. The methodology used to develop the alternatives for OU 2 is described in Section 6.3, and areas targeted by these alternatives in the Bunker Hill "Box" are shown in Figure 3-11. The remedial alternatives developed for OU 2 are as follows:

- OU 2 Alternative (a) – Minimal Stream Lining
- OU 2 Alternative (b) – Extensive Stream Lining
- OU 2 Alternative (c) – French Drains
- OU 2 Alternative (d) – Stream Lining/French Drain Combination
- OU 2 Alternative (e) – Extensive Stream Lining/French Drain Combination

The alternatives for OU 2 are combined with Alternatives 3+ and 4+ for OU 3 to create the following 10 remedial alternatives for the Upper Coeur d'Alene Basin that are evaluated in Sections 7.0 and 8.0 (along with a No Action Alternative that is included for comparison purposes in accordance with CERCLA guidance):

Alternative	Description
Alt. 3+(a)	OU 3 Alternative 3+ (More Extensive Removal, Disposal, and Treatment) and OU 2 Alternative (a) – Minimal Stream Lining
Alt. 3+(b)	OU 3 Alternative 3+ and OU 2 Alternative (b) – Extensive Stream Lining
Alt. 3+(c)	OU 3 Alternative 3+ and OU 2 Alternative (c) – French Drains[1]
Alt. 3+(d)	OU 3 Alternative 3+ and OU 2 Alternative (d) – Stream Lining/French Drain Combination[1]
Alt. 3+(e)	OU 3 Alternative 3+ and OU 2 Alternative (e) – Extensive Stream Lining/French Drain Combination
Alt. 4+(a)	OU 3 Alternative 4+ (Maximum Removal, Disposal, and Treatment) and OU 2 Alternative (a) – Minimal Stream Lining
Alt. 4+(b)	OU 3 Alternative 4+ and OU 2 Alternative (b) – Extensive Stream Lining
Alt. 4+(c)	OU 3 Alternative 4+ and OU 2 Alternative (c) – French Drains[1]
Alt. 4+(d)	OU 3 Alternative 4+ and OU 2 Alternative (d) – Stream Lining/French Drain Combination[1]
Alt. 4+(e)	OU 3 Alternative 4+ and OU 2 Alternative (e) – Extensive Stream Lining/French Drain Combination

Figure 6-1 depicts the development of the 10 remedial alternatives. For OU 3, the majority of sites that were included in Ecological Alternatives 3 and 4 in the 2001 FS Report have been included in this FFS Report with few or no changes to the proposed remedial actions. The analysis provided in the 2001 FS Report documented that both of these alternatives were National Oil and Hazardous Substances Pollution Contingency Plan (NCP) compliant for surface water, soil, sediments, and source materials. The retention of the majority of sites and remedial actions from the 2001 FS Report is appropriate because, in general, the remedial actions identified in that report have not yet been implemented, and environmental conditions have not changed significantly since 2001. An evaluation of current environmental conditions is presented in Section 3.0 of this FFS Report; current conditions are compared to historical conditions, and trends (where statistically significant) are discussed. The data and interpretation presented in Section 3.0 support the conclusion that, although there have been some changes in dissolved metals concentrations and loading in surface water and groundwater since the 2001 FS Report was issued, in most cases these

[1] A limestone permeable reactive barrier (PRB) is a possible option to the French drain included in this alternative. This option is described in Section 6.3.2.3.

changes in water quality are not significant enough to warrant the revision of the sites and remedial actions identified for Ecological Alternatives 3 and 4 in that report. The nature and extent of contamination in soil and sediments in the Upper Basin are assumed to be similar to those that were documented in the RI/FS. Relatively few data have been collected since that time with which to assess potential changes.

There are some cases, however, in which sites and remedial actions included in Ecological Alternatives 3 and 4 have been modified in this FFS Report. These modifications have been made on the basis of new information that has been obtained since 2001. The sources and types of new information are outlined in Section 1.1.3 and have resulted in the following:

- An improved understanding of hydrogeologic conditions, particularly in Woodland Park (within the Canyon Creek Watershed) and Osburn Flats;
- Development of a numerical groundwater model for the South Fork Coeur d'Alene River (SFCDR) Watershed (CH2M HILL, 2009d) that can be used to quantitatively assess the effectiveness of remedial actions targeting groundwater; and
- The development of a simplified Predictive Analysis tool (CH2M HILL, 2009m), derived from the probabilistic approach used in the 2001 FS Report, that can be used to estimate source-specific metals loading to surface water based on current water quality monitoring data.

Based on this new information, groups of sites and associated remedial actions in OU 3 that have been modified in this FFS Report include the following:

- **"New" sites.** Eleven mine, mill, and floodplain sites have been added to Alternatives 3+ and 4+ on the basis of relatively high estimated dissolved metals loading to surface water. None of these sites were included in Ecological Alternative 3 in the 2001 FS Report, and four were not included in Ecological Alternative 4. Therefore, remedial actions have not previously been developed for these sites, and site-specific information is not available with which to conduct a detailed alternatives analysis. Instead, an analytical approach using typical conceptual designs (TCDs) and waste types is used in this report, consistent with that used during the preparation of the 2001 FS Report. This process is described further in Section 6.2.1.
- **Formerly and currently operating sites.** Some known source areas are present at sites that either were operating at the time of the 2001 FS Report or are currently in operation. These sites were acknowledged in the 2001 FS Report but, in most cases, a complete remedial action was not identified. In this FFS Report, remedial actions are identified for all source area sites included in the remedial alternatives, regardless of their operational status.
- **Sites with a water treatment component.** Sites that have source materials involving water, such as adits with drainage, seeps, or groundwater, are reevaluated in this FFS Report with regard to water treatment only. (Actions identified in the 2001 FS Report have been retained for all other source materials at these sites.) This FFS Report uses a revised set of TCDs for water treatment, based on updated information developed since the 2001 FS Report, and a new methodology for the application of Water Treatment TCDs has been developed as described in Section 6.2.1.2. The current Water Treatment

TCDs include both centralized, active treatment at the CTP and onsite semi-passive treatment using several different technologies. In some cases, it may be possible to "keep clean water clean" and reduce or eliminate the flow of contaminated water from these sources through water diversion measures, thereby reducing the amount of water requiring treatment. The type of site-specific information needed to evaluate whether such water diversion measures are possible for a given site is not available at this time. Therefore, in the FFS, all contaminated waters included in the remedial alternatives are addressed by applying one of the Water Treatment TCDs. The potential for water diversion measures to reduce the water treatment burden will be evaluated on a site-specific basis during pre-design activities.

- **Sites located in the Woodland Park area within the Canyon Creek** W**atershed.** The components of Ecological Alternatives 3 and 4 that were specific to the Woodland Park area of Canyon Creek have been updated based on site-specific information obtained since the 2001 FS Report was issued. The process used to update the Woodland Park components of Ecological Alternatives 3 and 4 is described in Appendix E of this FFS Report.

- **Sites located along the SFCDR between Wallace and Elizabeth Park.** These sites were initially assigned the Hydraulic Isolation Using Slurry Wall TCD (C11) under Ecological Alternative 3 in the 2001 FS Report. In this FFS Report, the specified remedial action remains hydraulic isolation; however, based on an updated analysis, it would be accomplished using stream lining (TCDs C14a through C14c) and French drains (TCDs C15a through C15d) rather than with the slurry walls with drains associated with TCD C11. Stream lining was substituted for slurry walls on the basis that (a) a stream liner, if well maintained, could be highly effective in providing hydraulic isolation, and that (b) it could be difficult to install a slurry wall such that a high degree of effectiveness would be achieved and maintained. For a slurry wall to have a high degree of effectiveness, it would need to be continuously keyed in to the confining layer (bedrock) over very long distances (up to 10 miles). Although the hydraulic isolation TCDs are now based on stream liners rather than slurry walls, this selection should be considered a representative process option only; the actual selection of process options would take place during the design phase. During design, it may be determined that, at some locations, slurry walls would be preferred over stream liners to achieve hydraulic isolation of stream reaches. In addition to the modification of hydraulic isolation TCDs, the numerical groundwater model for the SFCDR Watershed has been used to refine the estimates of groundwater flow rates to the drains and load reductions to the SFCDR associated with these actions.

- **Sites within the Pine Creek Watershed.** Based on discussions with BLM, the remedial actions identified for the Pine Creek Watershed have been modified to account for remedial work that has been completed and new data that have been collected since the 2001 FS Report was issued. In addition, several sites have been added to the list for remedial action, based on recommendations provided by BLM.

Each of these groups of sites and associated remedial actions is discussed in the context of specific source sites in Sections 6.2.2 through 6.2.8, which are organized by Upper Basin watershed (the Upper SFCDR, Canyon Creek, Ninemile Creek, Big Creek, Moon Creek, Pine Creek, and Mainstem SFCDR Watersheds, respectively).

Phase I work at OU 2 is largely complete; Phase II is intended to address shortcomings encountered in implementing Phase I as well as specific long-term water quality and environmental management issues. For OU 2, as discussed in Section 1, the remedial alternatives developed and evaluated in this FFS Report will form the basis for the OU 2 Phase II Remedy that will be included in the forthcoming Record of Decision (ROD) Amendment for the Upper Coeur d'Alene Basin.

The remainder of this section further describes the development of Alternatives 3+ and 4+, and how these alternatives differ from Ecological Alternatives 3 and 4 in the 2001 FS Report. Sections 6.2 and 6.3 describe the development of the remedial alternative components for OU 3 and OU 2, respectively. The development of the alternative components for the two OUs is discussed separately because of the different methodologies that were used to arrive at the set of source sites and the associated remedial actions included in each.

6.2 Development of Remedial Alternatives for OU 3

6.2.1 Methodology

The initial development of the remedial alternatives for OU 3 is detailed in the 2001 FS Report. For the majority of sites included in NCP-compliant Ecological Alternatives 3 and 4, the remedial actions specified in the 2001 FS Report have been retained. As discussed above, there are several categories of sites for which the remedial actions have been reevaluated in this FFS Report: new sites, formerly and currently operating sites, sites with a water treatment component, sites located in Woodland Park, sites located along the SFCDR between Wallace and Mullan, and sites located within the Pine Creek Watershed. The methodologies for assigning remedial actions to new sites, formerly and currently operating sites, and sites with a water treatment component are discussed in Sections 6.2.1.1 and 6.2.1.2. Also included below are a summary of the approach taken for stream and riparian cleanup actions (Section 6.2.1.3), and the development of plans for roads and bridges to support waste hauling during remedial action implementation as well as ongoing operation and maintenance (O&M) of sites (Section 6.2.1.4). The updated components of Alternatives 3+ and 4+ for Woodland Park are summarized in Section 6.2.3.

6.2.1.1 Source Area Actions: New Sites, and Formerly and Currently Operating Sites

Most of the sites that either have been added to Ecological Alternatives 3 and 4 for this FFS, or are formerly or currently operating sites, were not assigned remedial actions in the 2001 FS Report, and therefore require remedial action analysis in this FFS Report. The remedial action analysis was only required for 16 of the 348 sites in Alternative 3+, and for five of the 704 sites in Alternative 4+. This section presents the methodologies for identifying remedial actions for source materials at these sites. (The methodology for the development of water treatment approaches at these sites, where water requiring treatment is present, is described in Section 6.2.1.2.) The methodologies presented in this section are based on those used in the 2001 FS Report, and are used to identify remedial actions for sites in a manner consistent with their source material types and the other sites already included in Alternatives 3+ and 4+. Source materials can include a variety of solid waste types that can be described under the following three broad categories: mine tailings, tailings-impacted floodplain sediments, and waste rock. The approach used in this FFS Report for selecting TCDs for these waste types is described below.

Tailings and Tailings-Impacted Floodplain Sediments

Tailings are present within impoundments, in unimpounded piles, and intermixed with floodplain sediments or waste rock. They contain high concentrations of metals and are potentially significant sources of metals loading to surface water and groundwater. They are present throughout the Upper Basin both in floodplain areas and upland areas. Table 6-1 presents the TCDs that are applied to impounded tailings, unimpounded tailings, and tailings-impacted floodplain sediments in Alternatives 3+ and 4+.

Waste Rock

Waste rock typically contains lower concentrations of metals than tailings, and as such the TCDs identified are not as aggressive as the more costly TCDs used for tailings. Actions for waste rock are applied based on the potential for erosion or leaching during flooding events. Typically, upland waste rock does not have significant erosion or leaching potential and would receive no action, but it can also be a potential loading source if located immediately adjacent to or partially within a watercourse. Sites located adjacent to or partially within a watercourse are designated as “upland waste rock (erosion potential)” and are assigned the same TCDs as sites designated “floodplain waste rock”. By definition, floodplain waste rock is located within the floodplain and subject to erosion or leaching by flooding. Waste rock can also be impacted by tailings. Sites where a mill was present were generally assumed to contain some waste rock with intermixed tailings, and were assigned more protective TCDs. Table 6-2 presents the TCDs applied to waste rock in Alternatives 3+ and 4+.

6.2.1.2 Water Treatment

The water treatment approach for this FFS, in terms of water sources included and water treatment technologies applied, comprises the following two steps: (1) determine whether a water source will be treated under a given alternative, and (2) identify the most appropriate water treatment approach for each water source. A third step in the process, adaptive management, will be conducted after the Upper Basin ROD Amendment is completed and will consist of collection of site data and re-evaluation of steps (1) and (2) based on those data and sitewide implementation planning considerations. This section describes each of these steps and the process used in this FFS Report to update the list of water sources and associated water treatment approaches for Alternatives 3+ and 4+.

The water treatment approach in this FFS Report is based on the approach used in the 2001 FS. However, the TCDs for water treatment in this FFS Report (Section 5.0) have been updated since the 2001 FS Report based upon evaluations conducted since the ROD for OU 3 (often referred to as “the Interim ROD”; USEPA, 2002b) was issued. With a new set of water treatment options to work with, each water source is re-evaluated and the most appropriate water treatment approach applied.

Step 1: Treatment versus No Treatment

The basis for the list of sites included for water treatment under Alternatives 3+ and 4+ is the list of sites included for water treatment under Ecological Alternatives 3 and 4 in the 2001 FS. A summary of the process used in the 2001 FS to determine whether a site is or is not to receive treatment under a given alternative is presented below. Updates to the list of water sources included for treatment in Alternatives 3+ and 4+ in this FFS Report are also discussed in this section.

2001 FS Methodology

The screening criteria used to determine whether a water source would be included for treatment in the 2001 FS Report were based on attenuation potential, estimated flow rates, and estimated dissolved metals concentrations relative to AWQC for all contaminants of concern (COCs) at the site. As discussed in Sections 3.0 and 4.0, COCs for the site include arsenic, cadmium, copper, lead, mercury, and zinc. The screening criteria are different for Ecological Alternatives 3 and 4, with more stringent criteria (treatment for lower-concentration waters) applied under Alternative 4.

Flow rate and concentration data for the majority of water sources evaluated are limited. In many cases, there are no data. Where flow rate data are not available, a flow rate of 0.1 cubic feet per second (cfs) (45 gallons per minute [gpm]) was assumed for the screening. Where dissolved metals concentration data are not available, professional judgment was used to determine whether a water source would receive treatment.

Water sources with estimated average flow rates of less than 0.1 cfs would receive treatment under Alternative 4+ if concentrations exceeded AWQC, and would receive treatment under both Alternatives 3+ and 4+ if concentrations exceeded ten times the AWQC. Water sources with flow rates greater than or equal to 0.1 cfs would receive treatment under both Alternatives 3+ and 4+ if concentrations exceeded AWQC. Therefore, the difference in the list of water sources to be treated under Alternatives 3+ and 4+ is only with respect to the low-flow (less than 45 gpm) water sources, of which all exceeding AWQC would be treated under Alternative 4+, but only those exceeding ten times the AWQC would be treated under Alternative 3+.

Comparison to the dissolved zinc AWQC was the first step in the screening process, as zinc is generally used as an indicator metal for other dissolved species. If dissolved zinc concentrations were sufficiently low for a given water source such that treatment would not be provided based on zinc alone, analytical data for other COCs (if available) were also reviewed and compared to the screening criteria to determine whether another parameter was present at sufficiently high concentration to warrant treatment.

There is one exception to this general methodology related to the treatment of seeps. Many seeps are located adjacent to source materials slated for capping, surface water diversion, or groundwater diversion under one or both of the alternatives. The assumption was made that such actions would eliminate the seeps and the need for water treatment. Consequently, water treatment is not included for many seeps.

Methodology Updates for this FFS Report

The screening criteria applied in the 2001 FS and updated for this FFS Report are summarized in Table 6-3. Updates to the 2001 FS methodology for this FFS Report include the following:

- **Update AWQC to current values.** Since the 2001 FS, site-specific (for the SFCDR Watershed) AWQC for zinc, cadmium, and lead have been developed. AWQC for arsenic, copper, and mercury remain based on the Statewide AWQC as site-specific

AWQC have not been developed for these parameters. The AWQC for dissolved cadmium, copper, lead, and zinc are a function of hardness. The AWQC for dissolved arsenic and mercury are not a function of hardness. The hardness data available from the 2001 FS Report, as well as subsequent studies, for adits and seeps were reviewed and, given the limited hardness data, an assumed typical value for hardness of 30 milligrams per liter as calcium carbonate (mg/L as $CaCO_3$) was used to calculate the AWQC. For example, the site-specific AWQC for dissolved zinc at 30 mg/L hardness is 88 micrograms per liter (µg/L). This value is higher than the Statewide AWQC for dissolved zinc in surface water that was in effect at the time of the 2001 FS Report (43 µg/L). The modification in AWQC for zinc since the 2001 FS has resulted in the removal of two sites (BUR128 and KLE067) from Alternative 3+ and two sites (BUR053 and BUR128) from Alternative 4+ from the lists of sites included for treatment. The change in AWQC for cadmium and lead did not result in any changes to the list of water sources included for treatment.

- **Review analytical data collected for water sources since the 2001 FS to determine whether adjustments should be made to the list of waters for treatment.** The only water quality or flow data for seeps and adit discharges that have been collected since the 2001 FS are the data from the 2008 High-Flow/Low-Flow Surface Water Study (CH2M HILL, 2009f). In that study, 21 adits and seeps were sampled, once during the high-flow period in the spring, and once during the low-flow period in the fall. These data were reviewed and, in general, concentrations were lower than indicated by historical data. However, since these data represent only two data points, a conservative approach was taken, and water sources were not removed from the list for treatment if concentrations detected during the study were below screening levels. Additional data will need to be collected for all water sources prior to design to adequately characterize both flow and concentrations from each water source.
- **Apply updated screening criteria to water sources that have been added to Alternatives 3+ and 4+ and were not evaluated in the 2001 FS.** The updated screening criteria in Table 6-3 were used to evaluate the water sources present at the additional sites not originally included in Ecological Alternatives 3 and 4 in the 2001 FS Report. Of the sites added, two were found to include water sources. Available data for these sources were compared with the screening criteria in Table 6-3. Neither of the new water sources includes flows or concentrations above screening levels and, therefore, neither source has been added for treatment under Alternative 3+ or 4+.

In summary, the only changes made to the list of water sources included for treatment in the 2001 FS were that three sites (BUR128, KLE067, and MAS052) in Ecological Alternative 3 and four sites (BUR053, BUR128, MAS052, and MAS067) in Ecological Alternative 4 were removed from the lists of sites for treatment. BUR128 and KLE067 were removed on the basis of the current AWQC for dissolved zinc, which is roughly two times higher than the AWQC in effect at the time of the 2001 FS. MAS052 and MAS067 were removed based on input from BLM that no water has been observed flowing from these areas. Table 6-4 presents the list of water sources evaluated for treatment in Alternatives 3+ and 4+ and includes notes with additional information related to the screening.

Step 2: TCD Selection

Sites that were identified as needing treatment in Step 1 were evaluated to identify the appropriate treatment technology for each site. Available water chemistry data, including adit drainage and seep data collected in 2008 during the High-Flow/Low-Flow Surface Water Study, were compared with the treatment requirements for each technology. Where more than one technology was expected to provide effective treatment, the determination was made on the basis of least cost. The Water Treatment TCDs are summarized as follows:

- **WT01** – Centralized High-Density Sludge (HDS) Treatment at Central Treatment Plant (CTP) (centralized active water treatment at the Bunker Hill CTP in Kellogg, Idaho, using an HDS process with granular media filtration);
- **WT02** – Onsite Semi-Passive Water Treatment Using Lime Addition and Settling Pond(s);
- **WT03** – Onsite Semi-Passive Water Treatment Using Sulfate-Reducing Bioreactor (SRB) System; and
- **WT04a and WT04b** – *In situ* Semi-Passive Groundwater Treatment Using Sulfate-Reducing Permeable Reactive Barrier (SR-PRB).

All of the above TCDs are described in Section 5.0 and Table 5-1, and WT01 is described in detail in Attachment D-1 to Appendix D. Estimated capital, O&M, and 30-year net present value (NPV) costs for WT02, WT03, and WT04 are summarized in Table 5-2.

The first step in the TCD selection process was to determine which treatment processes are expected to be effective for which sites. Because the effectiveness of TCD WT04a/b is highly dependent on site-specific hydrologic conditions that, at this time, are not well understood for the vast majority of sites, it is not considered further for application to specific sites. However, WT04a/b has the potential to provide a lower cost of treatment than other onsite options (TCDs WT02 and WT03) and may be considered an option after site-specific pre-design data are collected. Bench and/or pilot-scale testing of WT04a/b would need to be conducted to confirm effectiveness prior to selection and full-scale implementation. Based on a review of the available analytical, flow rate, and site data, all three of the remaining TCDs (WT01, WT02, and WT03) are expected to provide effective treatment for all sites.

Since all three of the retained TCDs could provide effective treatment, the next step is to select the least costly onsite treatment option (WT02 or WT03, referred to hereafter as "semi-passive" options), for comparison with centralized, active treatment at the CTP (WT01, referred to hereafter as "active" treatment), so that the least costly TCD overall can be identified for each site. Based on the cost estimates provided in Table 5-2, WT03 provides the least costly semi-passive option for all but the highest flow rates considered, under which conditions WT02 is expected to be least costly.

The site-by-site comparison of semi-passive costs (WT02 or WT03) versus active costs (WT01) is based on the total 30-year NPV cost (capital and O&M). Costs for WT01 include the total 30-year NPV cost of conveyance piping to connect the source site with the main conveyance line, which is assumed to be constructed within the utility corridor along Interstate 90 (I-90) between the CTP (in Kellogg) and Wallace. The main pipeline is assumed to extend to Wallace based on the findings of the Remedial Component Screening effort for the Woodland Park area of Canyon Creek (CH2M HILL, 2007b). In that document, the costs of various onsite treatment options versus piping to the CTP for treatment of Woodland Park groundwater were evaluated. The findings were that, even if the entire cost of the pipeline from Wallace to Kellogg was attributed to the Woodland Park actions, treatment of collected groundwater at the CTP would still be the least costly option. In reality, the main pipeline from Wallace to the CTP would be used to convey water from multiple sites, not only the Woodland Park area, within the Upper Basin, and the cost associated with the pipeline would be shared by these multiple sites. The current cost comparison of onsite treatment (WT02 or WT03) versus centralized treatment (WT01) therefore includes conveyance piping costs from the source to the main conveyance line along I-90, but does not include costs for construction of the main conveyance line as these costs would be shared among multiple sites.

Both the semi-passive and active treatment costs are based on the flow rate of the discharge. As is standard practice, the maximum flow rate of the discharge was used to calculate the capital portion of the costs, and the average flow rate of the discharge was used to calculate the O&M portion. In the case where there were no maximum flow data, the maximum flow rate was assumed to be twice the average flow rate. This assumption was based on review of available average and maximum flow rate data which, in general, are found to often empirically differ by about a factor of two. In addition, costs for conveyance were added to the active treatment cost based on the distance from the site to the main conveyance line assumed to exist along I-90 between the CTP and Wallace.

Direct comparison of treatment costs for WT01 and WT02/WT03 shows that for treatment costs alone, WT01 is the least costly option. However, when the cost of conveyance piping to the main conveyance line is taken into account, semi-passive treatment (WT02/WT03) becomes the least-costly option for some sites located farther up in the watershed.

Following the TCD selection, described above, the implementability of all treatment determinations was reviewed and adjustments were made, in some cases, based on professional judgment. This implementability evaluation was primarily focused on two specific factors: the physical constraints of the site (area, slope) in comparison to area requirements for semi-passive treatment, and the changes required at the CTP to receive the additional water from OU 3 (and OU 2).

Site characteristics such as available area, topography, and location (in terms of distance from the watershed and floodplain) are significant considerations in determining a preferred water treatment technology for a site. The semi-passive treatment options, TCDs WT02 and WT03, use treatment ponds that are sized based on flow rate and retention time. The size of the treatment pond required provides a screening mechanism to identify sites at which site area may be a limiting factor for treatment options. WT02 requires smaller treatment ponds than WT03 and, although WT03 was the least costly semi-passive treatment option for certain sites, limited site area required that WT02 be selected for these sites. Based on this screening, three sites that were initially identified to receive semi-passive treatment were found to be lacking enough area to support the required treatment ponds for either WT02 or WT03. Piping to active treatment at the CTP was then selected for these sites. The changes required at the CTP to accommodate the increased flows were also assessed, the details of this assessment are provided in Section 7.2.4.

Step 3: Adaptive Management

The list of water sources and treatment technologies developed for each alternative in Steps (1) and (2) above is based on available data. In many cases, no data are available and the determinations are made on professional judgment alone. During implementation, one of the higher-priority tasks will be to collect low-flow and high-flow data at each of these water sources and gain a better understanding of actual flows, concentrations, and metals loads that may require treatment. Steps (1) and (2) above will then be reconsidered based on this improved dataset.

The implementation planning process will also be critical in determining if and how a water source is to be treated. During this process, a sequencing and schedule for implementation of specific actions will be developed. Depending on the specific locations slated for action in the near-term as part of this process, the cost-effectiveness comparisons of onsite versus central treatment may change from the necessary assumption in this FFS that all actions would be implemented at roughly the same time. For example, if the pipeline will be nowhere near a specific water source for decades and other actions are planned nearby in the near-term, onsite semi-passive treatment would be reconsidered.

Water Treatment Summary

The sites evaluated as part of this water treatment evaluation are located within various watersheds in the Upper Basin. Sections 6.2.2 through 6.2.8 present the sites and remedial actions included in Alternatives 3+ and 4+ within each watershed, including water treatment actions. In addition, sites evaluated for water treatment and the results of that evaluation in terms of selected TCDs and the extent of the CTP conveyance lines, are depicted on figures by watershed that are referenced in Sections 6.2.2 through 6.2.8. During the implementation period, additional source-specific data will be collected and used to refine the list of sites for treatment and specific treatment technologies to be employed.

6.2.1.3 Stream and Riparian Cleanup Actions

In addition to the remedial options specified for source sites, Ecological Alternatives 3 and 4 in the 2001 FS Report included actions for bank and stream stabilization through stream and riparian cleanup actions that were then referred to as "bioengineering actions." These cleanup actions were identified for specific reaches of the SFCDR and Upper Basin tributaries and were not directly correlated to specific source sites. Ecological Alternatives 3 and 4 used the same set of stream and riparian cleanup actions for each reach; the distinction between the alternatives was the degree to which the cleanup actions were applied. These cleanup actions include the following TCDs as described in Section 5.0:

- **Current Deflectors (CD-AVG) –** To alter stream flow direction, directing stream energy away from erodible areas, or to prevent channel migration from outflanking shoreline stabilization structures.
- **Current Deflectors, Sediment Traps (CD-SED) –** To reduce sediments in areas where they impinge on the ecosystem. It should be noted that an evaluation of large-scale sediment traps along Canyon Creek and the SFCDR near Smelterville Flats was conducted in support of this FFS, and the results of this evaluation are documented in Appendix F of this FFS Report. This evaluation demonstrated that relatively long hydraulic retention times (which translate into large Basin volumes) are required to

effect significant reductions in suspended sediment concentrations. In the case of Canyon Creek and the SFCDR, the area and depth requirements for effective sedimentation basins were not implementable within the space available. The sediment traps included in the Stream and Riparian Cleanup Action TCDs are much smaller-scale than those evaluated for Canyon Creek and the SFCDR, although they may have some of the same effectiveness and implementability concerns. Therefore, pilot testing of the sediment trap concept would be conducted to evaluate effectiveness prior to large-scale implementation.

- **Vegetative Bank Stabilization (VBS-AVG) –** To introduce a self-maintaining mechanism for improving bank stability by planting native species adapted to stream banks.
- **Bioengineered Revetments (BSBR-AVG) –** To create a durable form of bank protection that provides riparian and in-stream habitat features.
- **Floodplain and Riparian Replanting (FR/RP-AVG) –** To provide site stabilization.
- **Off-Channel Hydrologic Features (OFFCH-AVG) –** To help moderate and stabilize the hydrology of degraded stream systems.
- **Channel Realignment (CH REAL-1) –** To reshape the stream channel to a more naturally stable condition and to recreate in-channel hydrologic features, particularly increased pool density and volume.

All the stream and riparian cleanup actions specified for Ecological Alternatives 3 and 4 in the 2001 FS Report have been retained in this FFS Report, and are summarized on a watershed basis in Sections 6.2.2 through 6.2.8. The new information that has become available since the 2001 FS Report was issued, upon which many of the updates to Ecological Alternatives 3 and 4 are based, does not include information that could be used to refine the proposed stream and riparian cleanup actions. Although some study of bank stability has been conducted in Smelterville Flats by the Idaho Department of Environmental Quality (IDEQ), the results of this study may inform the design process at some sites but cannot be used to refine the Stream and Riparian Cleanup Action TCDs to be applied throughout the Upper Basin. On this basis, the evaluations in the 2001 FS Report are still considered applicable at the feasibility study phase. The actual actions implemented at specific locations would be selected based on site-specific information during the remedial design phase.

6.2.1.4 Roads and Bridges

The 2001 FS Report evaluated access roads on a watershed segment basis, not on a site-by-site basis. In that report, it was assumed that Ecological Alternative 4 would require access to every site within a watershed. Geographic information system (GIS) coverage and U.S. Geological Survey (USGS) quad maps were used to locate existing roads and determine the length of new access roads to all the sites in each segment. Because Ecological Alternative 3 required access to only a portion of the sites in Ecological Alternative 4, half the length of the access roads calculated for Ecological Alternative 4 was assumed for Ecological Alternative 3 in the 2001 FS Report.

In this FFS, a factor approach is used to estimate costs for roads and bridges. Total costs for roads and bridges were assumed to be equal to 15 percent of the direct capital costs for each alternative. This value is inclusive of O&M costs. A factor approach was used due to the high degree of uncertainty related to these costs. An inventory of road conditions throughout the Basin has not been conducted, and it is therefore difficult to precisely estimate the length of roads needing construction or improvements to support the implementation of alternatives. Available GIS information can provide an understanding of the location of existing roads, but does not provide information related to the condition of those roads. Further, the order in which actions are implemented will greatly affect actual costs of roads and bridges and will not be determined until the Implementation Plan is completed around the same time as the ROD Amendment is completed (currently planned for late 2010). The percentage used (15 percent) is based on a comparison of estimated road costs and remedial action costs for Ninemile Creek and Canyon Creek, areas where the current condition of existing roads is better known and estimates of road costs are considered to be more reliable.

6.2.2 Upper SFCDR Watershed

The Upper SFCDR flows west from its headwaters to the confluence with Canyon Creek at Wallace, Idaho, and drains an area of approximately 51 square miles. The Upper SFCDR Watershed extends 15 miles from River Mile (RM) 188 on its western edge to RM 203 on its eastern edge (Figure 6-2).

The Upper SFCDR Watershed consists of one segment (UpperSFCDRSeg01) that has been divided into nineteen reaches (UG01-1 through -19) using the same segment and reach designations as in the 2001 FS Report. These reaches were referred to as “bioengineering reaches” in the 2001 FS Report because they were created to support the discussion and application of Stream and Riparian Cleanup Action TCDs to the stream; in this FFS Report they are referred to as “stream and riparian cleanup reaches.” Figure 6-2 shows the one segment of the Upper SFCDR and the stream and riparian cleanup reaches for that segment. Stream and Riparian Cleanup Action TCDs for the Upper SFCDR reaches identified in the 2001 FS Report (and referred to then as “bioengineering actions”) were retained for this FFS and are listed in Table 6-5.

All of the sites located within the Upper SFCDR Watershed under Alternatives 3+ and 4+ are shown in Figure 6-3 (the eastern portion of the Watershed) and 6-4 (the western portion). Table 6-6 lists the sites and the selected TCDs for Alternatives 3+ and 4+. In most cases, the TCDs are the same as those included in Ecological Alternatives 3 and 4 in the 2001 FS Report. Where TCDs have been updated for Alternatives 3+ or 4+, rationales for the updates are provided as notes in the table. These sites include WAL077, which was added to Alternative 3+ on the basis of loading, and MUL020, MUL037, and MUL058, which are all tailings ponds associated with the Lucky Friday Operation that was operational at the time of the 2001 FS Report. Sites that were operating at the time of the 2001 FS were not assigned a complete set of remedial actions in the 2001 FS Report. These sites are still considered active; however, sites identified as being potential sources of significant metals loading based on the source materials present are assigned a complete set of remedial actions in this FFS Report, regardless of operational status. USEPA will consider current and potential mining-related activities as it implements remedial actions in these areas. In addition, USEPA will coordinate the implementation of remedial actions, including timing, staging, and who would perform the work, with owners of property in these areas.

Remedial actions have been completed at the Golconda Mine and Millsite (MUL001, MUL002, and WAL077); however, the potential need for additional actions remains to be assessed. Therefore, the actions included in Alternatives 3+ and 4+ have been retained.

6.2.2.1 Alternative 3+

A total of 83 sites within the Upper SFCDR Watershed are included in Alternative 3+. Of these, 82 sites were included in Ecological Alternative 3 in the 2001 FS Report, and one additional site (WAL077, Golconda Tailings) has been included based on relatively high estimated pre-remediation metals loading. Within the 83 total sites, 28 water sources were evaluated for Alternative 3+ in accordance with the water treatment methodology described in Section 6.2.1; these sites are shown in Figure 6-5 along with the associated water treatment TCD for each site.

6.2.2.2 Alternative 4+

Alternative 4+ includes all of the Alternative 3+ sites as well as additional sites, for a total of 180 sites within the Upper SFCDR Watershed. All of these sites were included in Ecological Alternative 4 in the 2001 FS Report, and no sites have been added. The Golconda Tailings site (WAL077) that was added to Alternative 3+ on the basis of estimated dissolved metals loading was already a component of Ecological Alternative 4 in the 2001 FS Report; therefore, under Alternative 4+ it is not an "added" site. Within the 180 sites, 33 water sources were evaluated for Alternative 4+ in accordance with the water treatment methodology described in Section 6.2.1; these sites are shown in Figure 6-6 along with the associated water treatment TCD for each site.

6.2.3 Canyon Creek Watershed

Canyon Creek flows south to its confluence with the SFCDR at Wallace, and drains an area of approximately 22 square miles. The Canyon Creek Watershed extends 12 miles from RM 0 at its confluence with the SFCDR to RM 12 at its headwaters.

The Canyon Creek Watershed has been divided into five segments (01 through 05) using the same segment designations as in the 2001 FS Report. Figure 6-7 shows the segment and reach breakdown for the Canyon Creek Watershed. Stream and Riparian Cleanup Action TCDs for the Canyon Creek reaches identified in the 2001 FS Report (as bioengineering actions) were retained for this FFS and are listed in Table 6-7.

All the sites located within the Canyon Creek Watershed under Alternatives 3+ and 4+ are shown in Figure 6-8, and Figures 6-9 through 6-13 present more detailed views of the sites within Segments 01 through 05, respectively. Table 6-8 lists the sites and the selected TCDs for Alternatives 3+ and 4+. In most cases, the TCDs are the same as those included in Ecological Alternatives 3 and 4, respectively, in the 2001 FS Report. Where TCDs have been updated for Alternatives 3+ or 4+, the rationales for the modifications are provided as notes in the table. These sites are BUR094, BUR119, BUR120, BUR124, and BUR125, which were added to Alternative 3+ on the basis of estimated dissolved metals loading, and all sites located within Woodland Park (Segment 05), which were part of the update to the

Woodland Park components of Ecological Alternatives 3 and 4, described in Appendix E of this FFS Report.

The Woodland Park components of Ecological Alternatives 3 and 4 were updated based on site information that has been collected since the 2001 FS Report was completed. Due to the absence of direct discharges from tributaries to the Woodland Park reach of Canyon Creek, nearly all of the creek's dissolved metals load gain through Woodland Park is from groundwater. Since the 2001 FS Report was completed, a substantial number of additional studies (summarized in Section E.2.3 in Appendix E) have been completed throughout Canyon Creek and within Woodland Park to better understand the groundwater system and how it interacts with surface water. The most relevant of these studies to this FFS was the Canyon Creek Hydrologic Study (CH2M HILL, 2007a), which included groundwater elevation measurements, groundwater quality sampling, aquifer testing, analysis of groundwater-surface water interaction, and the development of a numerical groundwater model. The groundwater model was subsequently used to evaluate remedial options in the Remedial Component Screening effort for the Woodland Park area of Canyon Creek (CH2M HILL, 2007b).

These recent studies, combined with data obtained during ongoing monitoring programs, provided a basis for the evaluation of remedial alternatives to address the impact of groundwater on surface water in the Woodland Park area. In addition, more accurate predictions of the dissolved metals load reduction potentially achieved by remedial alternatives can now be made using the groundwater model (see Appendix A). These data and the groundwater model were not available at the time of the 2001 FS Report, in which Ecological Alternatives 3 and 4 relied largely upon source control actions and, in the case of Alternative 3, upon hydraulic isolation of Canyon Creek and surface water treatment to reduce metals loading to the creek. The updated components of Alternatives 3+ and 4+ for Woodland Park are presented below.

6.2.3.1 Alternative 3+

The updated components of Alternative 3+ for Woodland Park include the following (the locations of the referenced sites are shown in Figure 6-13, and the components are shown in Figure 6-14):

- **Targeted excavation and disposal of contaminated surface soil and sediments.** These actions include shallow excavation of floodplain sediments at sites OSB047, WAL010, WAL011, and WAL040. Shallow source excavation would consist of excavation of contaminated materials to approximately 2 feet below ground surface (bgs) and placement of the excavated materials in a regional repository. The objective of the shallow source control actions would be to reduce surface contamination (to a depth of 2 feet bgs) in the identified areas to below 530 milligrams per kilogram (mg/kg) of lead, which is the ecological PRG for lead established in Section 4.0. Contaminated materials present at depths below 2 feet bgs would be addressed via groundwater collection and treatment.

- **Complete excavation and disposal of contaminated soil and sediments (surface and deep).** Numerous source control remedial actions were evaluated and, of those, three were estimated to provide significantly higher ratios of estimated reduction in the dissolved metals load to Canyon Creek to total 30-year NPV cost. These actions included upland tailings excavation at site WAL039, floodplain sediment excavation at site WAL040, and floodplain artificial fill excavation at site WAL081. These three sites are located downstream from the Silver Valley Natural Resource Trust (SVNRT) Repository and the locations of proposed groundwater-based remedial actions.

- **Stream liners and French drains.** A combination of stream liners and French drains would be installed along Canyon Creek to reduce dissolved metals loading to the creek and to collect metals-contaminated water. The stream liners and French drains would be placed at locations that would maximize dissolved metals load reduction in the creek and minimize cost by (a) intercepting metals-contaminated groundwater that would otherwise discharge to Canyon Creek, and (b) reducing the mobilization, transport, and mass flux of dissolved metals in the groundwater system by reducing stream leakage from losing portions of Canyon Creek. Figure A-32 (in Appendix A of this FFS Report) presents the locations of simulated gaining and losing stream reaches within Canyon Creek under base-flow conditions. The locations of stream liners and French drains included in this alternative were optimized during the remedial alternative screening process. The French drains would be placed along Canyon Creek, beginning near the Hecla-Star Tailings Ponds and extending downstream to site WAL040. A cutoff drain would also be placed on the north side of site WAL040, and a French drain would be located around the SVNRT Repository. Water collected by the French drains would be conveyed via pipeline to the CTP in Kellogg for treatment. Lining of Canyon Creek would occur from the Hecla-Star Tailings Ponds to immediately downstream from the SVNRT Repository.

- **Water treatment.** Collected groundwater would be treated at the CTP. Collected water would be conveyed to the CTP via a gravity pipeline (unpressurized) to be constructed within the utility corridor along I-90.

Not including Woodland Park, a total of 56 sites within the Canyon Creek Watershed are included in Alternative 3+. Of these, 51 sites were included in Ecological Alternative 3 in the 2001 FS Report, and an additional five sites have been included based on relatively high estimated pre-remediation metals loading (BUR094, BUR119, BUR120, BUR124, and BUR125). Within the 56 total sites, 20 water sources were evaluated for Alternative 3+ in accordance with the water treatment methodology described in Section 6.2.1; these sites are shown in Figure 6-15 along with the associated water treatment TCD for each site.

6.2.3.2 Alternative 4+

The Woodland Park components of Alternative 4+ are nearly identical to the those included in Ecological Alternative 4 in the 2001 FS Report, which are depicted on Figure 7-4 (accompanying Section 7.0) for reference. The only change that has been made to the Woodland Park components of Ecological Alternative 4 is related to the water treatment technology identified for the single adit discharge receiving treatment, i.e., the Canyon Silver (Formosa) Mine (WAL011) adit discharge. Rather than the passive treatment identified in Ecological Alternative 4, this adit discharge would be connected to the conveyance pipeline to the CTP for treatment under Alternative 4+. This conveyance pipeline would extend beyond Woodland Park, servicing adit discharges in upstream areas. Since the pipeline would already be located in Woodland Park, the least costly treatment option for the Canyon Silver Mine adit discharge would be connection to the conveyance pipeline and water treatment at the CTP.

No significant changes were made to the Woodland Park actions included in Ecological Alternative 4. The post-ROD studies have focused on resolving areas of uncertainty related to actions included in Ecological Alternative 3 (upon which the Selected Remedy presented in the Interim ROD for OU 3 [USEPA, 2002b] is based), rather than those specifically related to Ecological Alternative 4 actions. However, there is no new information suggesting that significant changes are warranted to Ecological Alternative 4 actions that were different than those for Ecological Alternative 3

Not including Woodland Park, Alternative 4+ includes all of the Alternative 3+ sites, as well as additional sites, for a total of 111 sites within the Canyon Creek Watershed. All of these sites were included in Ecological Alternative 4 in the 2001 FS Report, and no sites have been added. Within the 111 sites, 35 water sources were evaluated for Alternative 4+ in accordance with the water treatment methodology described in Section 6.2.1; these sites are shown in Figure 6-16 along with the associated water treatment TCD for each site.

6.2.4 Ninemile Creek Watershed

Ninemile Creek flows south to its confluence with the SFCDR at Wallace, and drains an area of approximately 12 square miles. The Ninemile Creek Watershed extends 7 miles from RM 0 at its confluence with the SFCDR to RM 7 at the headwaters of the East Fork of the Coeur d'Alene River.

The Ninemile Creek Watershed has been divided into four segments (01 through 04) using the same segment designations as in the 2001 FS Report. Figure 6-17 shows the segment and reach breakdown for the Ninemile Creek Watershed. Stream and Riparian Cleanup Action TCDs for Ninemile Creek reaches identified in the 2001 FS Report (as bioengineering actions) were retained for this FFS and are listed in Table 6-9.

All the sites located within the Ninemile Creek Watershed in Alternatives 3+ and 4+ are shown in Figure 6-18, and Figures 6-19 through 6-22 present more detailed views of the sites within Segments 01 through 04, respectively. Table 6-10 lists the sites and the selected TCDs for Alternatives 3+ and 4+. In most cases, the sites and TCDs are the same as those included in Ecological Alternatives 3 and 4, respectively, in the 2001 FS Report.

Three sites for which TCDs have been modified in this FFS Report are noted in Table 6-10, and the rationales for the modifications are provided as notes in the table. One modified site is OSB048, which was added to Alternative 3+ on the basis of estimated dissolved metals loading. This site was already included in Ecological Alternative 4 in the 2001 FS Report. Two additional sites, OSB084 and OSB085, were also added to Alternatives 3+ and 4+ on the basis of relatively high particulate lead loading from recent monitoring data.

Remedial actions have been completed at Rex Mine (BUR054 and BUR139); however, the potential need for additional actions remains to be assessed. Therefore, the actions included in Alternatives 3+ and 4+ have been retained for now. Partial implementation of remedial actions was also completed at Success Mine (BUR060, BUR061, BUR062, OSB044, and OSB089) prior to the Interim ROD for OU 3. Alternatives 3+ and 4+ include actions to complete remediation at this site – the same set of actions that were included in the 2001 FS Report.

6.2.4.1 Alternative 3+

A total of 36 sites within the Ninemile Creek Watershed are included in Alternative 3+. Of these, 33 sites were included in Ecological Alternative 3 in the 2001 FS Report, and three additional sites (OSB048, OSB084, and OSB085) have been included based on relatively high estimated pre-remediation metals loading. Within the 36 total sites, 16 water sources were evaluated for Alternative 3+ in accordance with the water treatment methodology described in Section 6.2.1; these sites are shown in Figure 6-23 along with the associated water treatment TCD for each site.

6.2.4.2 Alternative 4+

Alternative 4+ includes all of the Alternative 3+ sites, as well as additional sites, for a total of 67 sites within the Ninemile Creek Watershed. Of these, 65 sites were included in Ecological Alternative 4 in the 2001 FS Report, and two additional sites (OSB084 and OSB085) have been included based on relatively high estimated pre-remediation metals loading. Within the 67 sites, 19 water sources were evaluated for Alternative 4+ in accordance with the water treatment methodology described in Section 6.2.1; these sites are shown in Figure 6-24 along with the associated water treatment TCD for each site.

6.2.5 Big Creek Watershed

Big Creek flows north to its confluence with the SFCDR between Osburn and Kellogg, Idaho, and drains an area of approximately 30 square miles.

The Big Creek Watershed has been divided into four segments (01 through 04) using the same segment designations as in the 2001 FS Report. Figure 6-25 shows the segment and reach breakdown for the Big Creek Watershed. Stream and Riparian Cleanup Action TCDs for Big Creek reaches identified in the 2001 FS Report (as bioengineering actions) were retained for this FFS and are listed in Table 6-11.

All the sites located within the Big Creek Watershed in Alternatives 3+ and 4+ are shown in Figure 6-26, and Figures 6-27 through 6-30 present more detailed views of the sites within Segments 01 through 04, respectively. Table 6-12 lists the sites and the selected TCDs for Alternatives 3+ and 4+. In most cases, the TCDs are the same as those included in Ecological Alternatives 3 and 4, respectively, in the 2001 FS Report. Sites for which TCDs have been modified in this FFS Report are noted in Table 6-12, and the rationales for the modifications are provided as notes in the table. One site, KLE024 (Sunshine Tailings Pond), was considered active at the time of the 2001 FS Report and is not operating at this time (although it has not been closed and may reopen in the future). The TCDs have been modified for this site in this FFS Report to provide a complete set of remedial actions, regardless of operational status.

6.2.5.1 Alternative 3+

A total of 19 sites within the Big Creek Watershed are included in Alternative 3+. All of these sites were included in Ecological Alternative 3 in the 2001 FS Report, and no additional sites have been included. Within the 19 sites, 5 water sources were evaluated for

Alternative 3+ in accordance with the water treatment methodology described in Section 6.2.1; these sites are shown in Figure 6-31 along with the associated water treatment TCD for each site. No sites are slated for treatment at the CTP.

6.2.5.2 Alternative 4+

Alternative 4+ includes all of the Alternative 3+ sites, as well as additional sites, for a total of 54 sites within the Big Creek Watershed. All of these sites were included in Ecological Alternative 4 in the 2001 FS Report and no sites have been added. Within the 54 sites, 8 water sources were evaluated for Alternative 4+ in accordance with the water treatment methodology described in Section 6.2.1; these sites are shown in Figure 6-32 along with the associated water treatment TCD for each site. No sites are slated for treatment at the CTP.

6.2.6 Moon Creek Watershed

Moon Creek flows south to its confluence with the SFCDR between Osburn and Kellogg, and drains an area of approximately 9 square miles.

The Moon Creek Watershed has been divided into two segments (01 and 02) using the same segment designations as in the 2001 FS Report. Figure 6-33 shows the segment and reach breakdown for the Moon Creek Watershed. Stream and Riparian Cleanup Action TCDs for Moon Creek reaches identified in the 2001 FS Report (as bioengineering actions) were retained for this FFS and are listed in Table 6-13.

All the sites located within the Moon Creek Watershed in Alternative 3+ and 4+ are shown in Figure 6-34, and Figures 6-35 through 6-36 present more detailed views of the sites within Segments 01 and 02, respectively. Table 6-14 lists the sites and the selected TCDs for Alternatives 3+ and 4+. The sites and TCDs are the same as those included in Ecological Alternatives 3 and 4, respectively, in the 2001 FS Report, and no changes have been made.

6.2.6.1 Alternative 3+

A total of seven sites within the Moon Creek Watershed are included in Alternative 3+. All of these sites were included in Ecological Alternative 3 in the 2001 FS Report, and no sites have been added. No water sources are located within the Moon Creek Watershed.

6.2.6.2 Alternative 4+

Alternative 4+ includes all of the Alternative 3+ sites, as well as additional sites, for a total of 10 sites within the Moon Creek Watershed. All of these sites were included in Ecological Alternative 4 in the 2001 FS Report, and no sites have been added. No water sources are located within the Moon Creek Watershed.

6.2.7 Pine Creek Watershed

Pine Creek flows north to its confluence with the SFCDR near Pinehurst, Idaho, and drains an area of approximately 77 square miles. The watershed extends 10 miles from RM 0 at its confluence with the SFCDR to RM 10 at its headwaters. At RM 5 the East Fork splits off and continues another 7 miles to RM 12.

The Pine Creek Watershed has been divided into three segments (01 through 03) using the same segment designations as in the 2001 FS Report. Figure 6-37 shows the segment and reach breakdown for the Pine Creek Watershed. Stream and Riparian Cleanup Action TCDs for Pine Creek reaches identified in the 2001 FS Report (as bioengineering actions) were retained for this FFS and are listed in Table 6-15.

All the sites located within the Pine Creek Watershed in Alternatives 3+ and 4+ are shown in Figure 6-38, and Figures 6-39 through 6-41 present more detailed views of the sites within Segments 01 through 03, respectively. Table 6-16 lists the sites and the selected TCDs for Alternatives 3+ and 4+. In most cases, the TCDs are the same as those included in Ecological Alternatives 3 and 4, respectively, in the 2001 FS Report. Sites for which TCDs have been modified in this FFS Report are noted in Table 6-16, and the rationales for the modifications are provided as notes in the table. These sites include KLW077, KLW079, KLW080, and MAS081, which were added to Alternative 3+ and 4+; and MAS025 which was added to Alternative 3+. KLW077 and KL079 were added on the basis of estimated dissolved metals loading. KLW080, MAS025, and MAS081 were added based on recommendations provided by BLM. Additionally, several remedial actions at sites have been modified based on remedial work conducted by the BLM in Pine Creek since the 2001 FS Report was issued. Waste sources at sites where remedial actions were modified include the adit drainage at MAS052; the seep at MAS067; floodplain sediments at MAS040, MAS041, MAS042, MAS043, MAS045, MAS046 and MAS047; upland waste rock at MAS014 and KLW080; and floodplain waste rock at KLW077, KLW079, MAS025 and MAS081.

The adit drainage at MAS052 was initially on the list of sites in Alternative 3+ and 4+ and the seep at MAS067 was initially on the list of sites in Alternative 4+ earmarked to receive water treatment. Both sites have been removed from that list based on input from BLM that no water has been observed flowing from these areas. Since the 2001 FS Report was issued, IDEQ has completed floodplain stabilization efforts including the regrading and planting of the stabilized areas at MAS040, MAS041, MAS042, and MAS043. BLM excavated and removed floodplain tailings materials from parts of public lands in the MAS045 Highland Creek impacted riparian zone in 1999 and has also done extensive regrading, stabilization and plantings. Some remediation work was also conducted at MAS046. To account for the work at sites MAS040, MAS041, MAS042, MAS043, MAS045, and MAS046, the total volume of floodplain sediments was reduced by 70 percent and excavation and disposal were specified for the remaining 30 percent. At MAS047, East Fork Pine Creek, BLM has done extensive stream stabilization and plantings but the only tailings removals were done at and around the millsites; BLM does not know of areas with floodplain tailings materials that could be removed. Therefore, the total volume of contaminated floodplain sediments was reduced by 100 percent and actions were eliminated completely for floodplain sediments at site MAS047. BLM input indicates that MAS014 and KLW080 contain waste rock dumps that are located along the edge of the floodplain and could be a potential source. Likewise, MAS025 contains floodplain waste rock and intermixed tailings that should be examined and considered for removal. BLM has regraded and stabilized MAS081 and has tried some limited revegetation; this site requires further application of topsoil and revegetation. Actions were assigned to the waste materials at these sites in both Alternatives 3+ and 4+.

There are additional sites where BLM has performed remedial actions; however, further evaluation is needed to assess the completeness of these actions, and the TCDs for Ecological Alternatives 3 and 4 in the 2001 FS Report were retained for these sites. Remedial actions have been completed at Constitution Mine and Millsite (sites MAS027, MAS048, MAS049, and MAS050); however, the potential need for additional actions remains to be assessed. Therefore the actions included in Alternative 3+ and 4+ have been retained.

6.2.7.1 Alternative 3+

A total of 70 sites within the Pine Creek Watershed are included in Alternative 3+. Of these, 65 sites were included in Ecological Alternative 3 in the 2001 FS Report, and an additional five sites (KLW077, KLW079, KLW080, MAS025, and MASi-081) have been included based on relatively high estimated pre-remediation metals loading or recommendations from BLM. One site (MAS047) was included in Ecological Alternative 3 in the 2001 FS Report but has not been included in Alternative 3+. Within the 70 total sites, 25 water sources were evaluated for Alternative 3+ in accordance with the water treatment methodology described in Section 6.2.1; these sites are shown in Figure 6-42 along with the associated water treatment TCD for each site. No sites are slated for treatment at the CTP.

6.2.7.2 Alternative 4+

Alternative 4+ includes all of the Alternative 3+ sites, as well as additional sites, for a total of 112 sites within the Pine Creek Watershed. Of these, 108 were included in Ecological Alternative 4 in the 2001 FS Report, and an additional four sites (KLW077, KLW079, KLW080, and MAS081) have been included based on relatively high estimated pre-remediation metals loading or recommendations from BLM. One site (MAS047) was included in Ecological Alternative 4 in the 2001 FS Report but has not been included in Alternative 4+. Within the 112 total sites, 29 water sources were evaluated for Alternative 4+ in accordance with the water treatment methodology described in Section 6.2.1; these sites are shown in Figure 6-43 along with the associated water treatment TCD for each site. No sites are slated for treatment at the CTP.

6.2.8 Mainstem SFCDR Watershed

The SFCDR mainstem flows west from Wallace to its confluence with the North Fork Coeur d'Alene River near the town of Enaville. The Mainstem SFCDR Watershed extends 20 miles from RM 168 on its western edge to RM 188 on its eastern edge. The Bunker Hill Box, a 7-mile by 3-mile box centered on the former location of the Bunker Hill smelters and other mining-related industrial activities, is located within the Mainstem SFCDR Watershed. However, the Bunker Hill Box (which includes OUs 1 and 2) is not discussed as part of this section. The development of remedial alternatives for OU 2 is discussed in Section 6.3. Four sites (KLW061, KLW062, KLW070, and KLW095) located in Milo Gulch are in close proximity to and potentially impacted by the actions proposed for OU 2. However, these sites fall outside the Bunker Hill Box boundary and therefore are included with the OU 3 sites.

The Mainstem SFCDR Watershed has been divided into two segments (01 and 02) using the same segment designations as in the 2001 FS Report. Figure 6-44 shows the segment and reach breakdown for the Mainstem SFCDR Watershed. Stream and Riparian Cleanup Action TCDs for SFCDR mainstem reaches identified in the 2001 FS Report (as bioengineering actions) were retained for this FFS and are listed in Table 6-17.

All the sites located within the Mainstem SFCDR Watershed in Alternative 3+ and 4+ are shown in Figure 6-45, and Figures 6-46 through 6-48 present more detailed views of the sites within Segments 01 and 02, respectively. Table 6-18 lists the sites and the selected TCDs for Alternatives 3+ and 4+. In most cases, the TCDs are the same as those included in Ecological Alternatives 3 and 4, respectively, in the 2001 FS Report. Sites for which TCDs have been modified in this FFS Report are noted in Table 6-18, and the rationales for the modifications are provided as notes in the table. These sites are WAL001 and OSB119, which were considered operational in the 2001 FS Report.

Additional data pertaining to groundwater-surface water interactions in the Osburn Flats area were collected in 2008 and applied to the SFCDR Watershed groundwater flow model (CH2M HILL, 2009d). Results of this modeling (described in Appendix A of this FFS Report) were used to estimate the effectiveness of hydraulic isolation actions along the SFCDR (stream lining and French drains).

6.2.8.1 Alternative 3+

A total of 65 sites within the Mainstem SFCDR Watershed are included in Alternative 3+. All of these sites were included in Ecological Alternative 3 in the 2001 FS Report, and no sites have been added. Within the 65 sites, 22 water sources were evaluated for Alternative 3+ in accordance with the water treatment methodology described in Section 6.2.1; these sites are shown in Figure 6-49 along with the associated water treatment TCD for each site.

6.2.8.2 Alternative 4+

Alternative 4+ includes all of the Alternative 3+ sites, as well as additional sites, for a total of 158 sites within the Mainstem SFCDR Watershed. All of these sites were included in Ecological Alternative 4 in the 2001 FS Report, and no sites have been added. Within the 158 sites, 24 water sources were evaluated for Alternative 4+ in accordance with the water treatment methodology described in Section 6.2.1; these sites are shown in Figure 6-50 along with the associated water treatment TCD for each site.

6.2.9 Summary of Remedial Alternatives

Alternatives 3+ and 4+ consider the same sites for potential remedies as were considered in Ecological Alternatives 3 and 4, respectively, in the 2001 FS Report. As shown below, a total of 761 sites have been considered.

Sites	Alternative 3	Alternative 3+	Alternative 4	Alternative 4+
Sites with Proposed Action(s)	332	348	699	704
Sites with No Proposed Actions	429	413	62	57
Total	**761**	**761**	**761**	**761**

The differences between Ecological Alternative 3 and Alternative 3+, and between Ecological Alternative 4 and Alternative 4+ are relatively minor in terms of the number of sites that changed from no proposed action to proposed action. Other differences include updates to the TCDs and the estimated volumes of materials to be addressed. The differences are discussed in more detail in the following sections.

6.2.9.1 Comparison of Ecological Alternative 3 and Alternative 3+

An overview of the changes from Ecological Alternative 3 to Alternative 3+, including the affected sites, is provided in Table 6-19. The changes include:

- **Sites added on the basis of relatively high estimated dissolved metals loading to surface water.** Based on analysis of site data (as previously discussed in this section and in Section 3.0) that were not available at the time of the 2001 FS Report, 11 sites were added to Alternative 3+ on the basis of relatively high estimated dissolved metals loading to surface water. None of these sites were included in Ecological Alternative 3 in the 2001 FS Report.
- **Formerly and currently operating sites.** Actions at four former or currently operating sites were changed from hydraulic isolation to hydraulic isolation and capping. These sites were acknowledged in the 2001 FS Report, but a complete remedial action was not identified.
- **Updated conceptual design for hydraulic isolation.** The method by which hydraulic isolation of streams will be accomplished was revised for Alternative 3+. Hydraulic isolation by slurry walls was replaced with hydraulic isolation using stream liners and French drains based on an updated analysis.
- **Sites with a water treatment component.** A total of 59 sites include different water treatment TCDs for Alternative 3+. The updated TCDs include changes (resulting from further analysis), in the location of the centralized, active treatment plant[2], the method of treatment for specific sites (active to semi-passive and vice versa), and the manner of providing semi-passive treatment.
- **Sites within the Pine Creek Watershed.** Based on discussions with BLM, the remedial actions identified for \ the Pine Creek Watershed have been modified to account for remedial work that has been completed and new data that have been collected since the 2001 FS Report was issued. In addition, several sites have been added to the list for remedial action, based on recommendations provided by BLM.

6.2.9.2 Comparison of Ecological Alternative 4 and Alternative 4+

An overview of the changes from Ecological Alternative 4 to Alternative 4+, including the affected sites, is provided in Table 6-20. The changes include:

- **Sites added on the basis of relatively high estimated dissolved metals loading to surface water.** Based on analysis of site data (as previously discussed in this section and in Section 3.0) that were not available at the time of the 2001 FS Report, four sites were added to Alternative 4+ on the basis of relatively high estimated dissolved metals loading to surface water.
- **Former and currently operating sites.** These changes are identical to those made for Alternative 3+.

[2] The 2001 FS Report proposed constructing a new high-density sludge plant for water treatment in Pinehurst. The FFS remedial alternatives include expanding and upgrading the existing CTP in Kellogg.

- **Sites with a water treatment component.** A total of 96 sites include different water treatment TCDs for Alternative 4+. The updated methodologies include changes, resulting from further analysis, in the location of the centralized, active treatment plant, the method of treatment for specific sites (active to semi-passive and vice versa), and the manner of providing semi-passive treatment.
- **Updated conceptual design for hydraulic isolation.** The method by which hydraulic isolation of streams will be accomplished was revised for Alternative 4+, similar to Alternative 3+. Hydraulic isolation by slurry walls was replaced with hydraulic isolation using stream liners and French drains based on an updated analysis.
- **Sites within the Pine Creek Watershed.** Based on discussions with BLM, the remedial actions identified for the Pine Creek Watershed have been modified to account for remedial work that has been completed and new data that have been collected since the 2001 FS Report was issued. In addition, several sites have been added to the list for remedial action, based on recommendations provided by BLM.

6.3 Development of Remedial Alternatives for OU 2

6.3.1 Introduction

This section describes the development of remedial alternatives for the OU 2 Phase II remedy. For the reasons given below, the development of remedial alternatives for OU 2 is significantly different in methodology than the development of remedial alternatives for OU 3 discussed in Section 6.2. The remedial alternatives for OU 2 are not based on previously evaluated alternatives (as is the case for OU 3). Instead, the OU 2 remedial alternatives have been developed by taking into consideration the OU 2 Phase I remedial actions completed by USEPA and the Idaho Department of Environmental Quality (IDEQ) to date and the effectiveness of those actions, and identifying new remedial actions which have the potential to address significant portions of the remaining metals load to the SFCDR in the Bunker Hill Box. In this section, general response actions and process options are identified and screened on the basis of cost, effectiveness, and implementability. General response actions include source control, water management/collection, and water treatment. The most promising process options identified are combined to form the remedial alternatives for OU 2 which are then evaluated, along with the remedial alternatives for OU 3, in Sections 7.0 and 8.0 of this FFS Report.

6.3.1.1 Background

A phased approach to remedy implementation was adopted for OU 2 based on an agreement between USEPA and the State of Idaho in the State Superfund Contract (SSC) (USEPA and Idaho Department of Health and Welfare, 1995). The Phase I remedy was implemented between 1994 and 2005, followed by remedial action effectiveness monitoring and effectiveness analysis as described in the *Phase I Remedial Action Effectiveness Report, Operable Unit 2* (CH2M HILL, 2007d). Descriptions of the phased approach for remedy implementation, and references to supporting evaluation documents, are presented in Sections 1.0 and 2.0 of this FFS Report. The results of the Phase 1 effectiveness analysis were shared with the Basin Commission, the Technical Leadership Group, and the Citizen's

Coordinating Council, and were posted on USEPA's website as results became available. A Project Focus Team (PFT), specific to OU 2 and composed of interested stakeholders, was established to focus on these incremental evaluations. The OU 2 PFT has recently been integrated into the Upper Basin PFT and continues to meet regularly to discuss project direction.

The results of the Phase I evaluation guided the identification of the remaining source areas of concern within OU 2, which are presented in the *Source Areas of Concern Report, Operable Unit 2* (CH2M HILL, 2008a). Additional information was gathered on these source areas for use in development of potential remedial actions in subsequent investigations, such as those documented in the *Technical Memorandum: OU2 Direct Push Field Investigation Summary* (CH2M HILL, 2009a) and the *Technical Memorandum: Bunker Creek Pilot Study Summary* (CH2M HILL, 2009b). The source areas were identified based on a detailed analysis of OU 2 monitoring data and the overall impacts measured in the SFCDR. Results of this data analysis suggest the largest source of dissolved metals contamination to groundwater and surface water at OU 2 is contaminated materials located in floodplains and beneath the populated areas and infrastructure within the OU. Because of the widespread nature of contaminated materials, USEPA's commitment to not displace the community, and the complexity of contaminant transport within OU 2, a remedial approach focusing on groundwater-based actions was developed. To support this, a groundwater flow model was constructed, calibrated, and used to assist with the development of Phase II remedial alternatives.

6.3.1.2 Scope and Objectives

The remedial alternatives for OU 2 have been developed to achieve applicable or relevant and appropriate requirements (ARARs) for surface water, which are defined using AWQC developed by the State of Idaho and site-specific to the SFCDR. This design objective is consistent with the remedial action objective (RAO) for surface water identified in the ROD for OU 2 (USEPA, 1992), which is to achieve ARARs in the tributaries to the SFCDR. This RAO was intended to limit the impact of contamination in OU 2 on the SFCDR.

6.3.2 General Response Actions and Process Options

This section introduces general response actions and process options for improving SFCDR water quality through OU 2. The OU 2 Water Quality Assessment (WQA) Team consisting of USEPA, the State of Idaho, and the larger Upper Basin PFT identified core concepts to guide the Phase II remedy development. These core concepts include:

- Keep clean water clean.
- Reduce or prevent groundwater and surface water interaction to reduce mobilization of subsurface contamination.
- Evaluate remedial alternatives under base-flow conditions because higher dissolved metals concentrations are present during such low-flow conditions, and low flow is a stable flow regime that allows effectiveness to be monitored.
- Prevent erosion of contaminated materials.

- Develop remedies that are not inconsistent with community development plans.
- Everything else being equal, focus on actions with low O&M costs.

These core concepts were intended to guide development of a Phase II remedy that meets RAOs, but also satisfies State of Idaho and community stakeholder interests.

General response actions selected for evaluation were based on the assessment of current source areas and the known contaminant release and transport mechanisms identified in the *Source Areas of Concern Report, Operable Unit 2* (CH2M HILL, 2008a). Figure 6-51 shows an overview of the OU2 area. Pervasive metals contamination remains in broad areas of the subsurface soil in OU 2 and cannot be readily addressed. This extensive subsurface soil contamination serves as a source of groundwater contamination. The interaction of surface water and groundwater at OU 2 represents the major contaminant release and transport mechanism within the OU and the Upper Basin as a whole. The general response actions evaluated are intended to reduce the release and transport of contaminants as a result of groundwater and surface water interaction, and consist of:

- Source control
- Water collection/management (including acid mine drainage [AMD] from the Reed and Russell Adit Tunnels)
- Water treatment

These general response actions and associated process options are summarized in the following sections.

6.3.2.1 Source Control

Source control actions were considered as part of the Phase II evaluation; however, the Phase I enhanced source control options removed, consolidated, and capped the majority of source materials that can be readily accessed without significant impacts to communities and infrastructure in OU 2. Based on available information, contaminated materials impacting SFCDR water quality in OU 2 are dispersed throughout the floodplain beneath populated areas and infrastructure features. The widespread and deep nature of this source of contamination makes it difficult to identify discrete areas where contaminated floodplain materials are affecting water quality (CH2M HILL, 2008a). Therefore, additional source control options similar to the Phase I actions (such as, excavation, consolidation, and capping) either would not be effective in achieving RAOs or are not feasible because of the need to significantly impact the communities or infrastructure. On this basis, source control actions were not included in the development of Phase II alternatives. However, source materials encountered incidental to remedy implementation will be excavated during the implementation of remedial actions. Source materials excavated during remedial action construction that cannot be managed near the source (such as used for backfill) will be disposed of at the regional repository.

The SFCDR is the conduit for transport and deposition of contaminated materials from the Upper Basin to downstream areas during higher flow regimes. Mitigating sediment transport and deposition processes in the form of a sedimentation basin in Smelterville Flats was evaluated. However, the retention times necessary to result in effective sediment capture in this area would require a sedimentation basin that is significantly larger than the available area in Smelterville Flats. Therefore, a sedimentation basin in the Smelterville Flats area was not included in the development of Phase II alternatives. The sedimentation basin analysis conducted for Smelterville Flats is documented in Appendix F of this FFS Report.

6.3.2.2 Water Collection and Management

Water collection and management actions evaluated for inclusion in the OU 2 Phase II remedy are discussed below, and include passive and active groundwater collection, passive surface water management (stream lining), passive groundwater diversion, and management of AMD from the Reed and Russell Adit Tunnels.

Passive Groundwater Collection

The goal of passive groundwater management in OU 2 is to intercept contaminated groundwater that would otherwise discharge to the SFCDR. Passive groundwater collection in OU 2 would be accomplished using French drains. French drains were evaluated in the areas of OU 2 with the highest dissolved metals loading to the SFCDR from groundwater.

Active Groundwater Collection

The goal of active groundwater collection in OU 2 is to intercept contaminated groundwater for active treatment at the CTP, but also to reduce hydraulic pressure upgradient of groundwater diversion structures. Active groundwater collection in OU 2 would be accomplished using extraction wells. Active management of groundwater will also be employed using a pump station in conjunction with a passive groundwater collection option (i.e., a French drain).

Passive Surface Water Management

The goal of passive surface water management is to eliminate the infiltration of surface water to the groundwater system in losing reaches (those where surface water migrates to groundwater) of the SFCDR and its tributaries in OU 2. Infiltrating surface water mobilizes and transports dissolved metals present in contaminated materials in the vadose zone to the groundwater system, which could in turn discharge to surface water downstream. Passive surface water management would be accomplished by lining sections of streams that are losing water to the groundwater system throughout the year.

Passive Groundwater Diversion

The goal of passive groundwater diversion is to reduce the amount of relatively clean groundwater contacting contaminated materials, resulting in reduced mobilization and transport of contaminants. Groundwater would be diverted into a passive surface water collection structure (i.e., a stream liner). Passive groundwater diversion would be accomplished using a sub-surface vertical cutoff wall consisting of bentonite or concrete slurry or sheet pile walls. An active or passive groundwater collection technology would be used in conjunction with the groundwater diversion structure to collect groundwater on the upgradient side of the wall, and discharge that water to the downstream channel which would be lined to prevent loss back into groundwater. The specific types and dimensions of a vertical cutoff wall would be determined during design on a site-by-site basis.

Acid Mine Drainage Management

The AMD management remedy prescribed in the 2001 ROD Amendment (USEPA, 2001e) requires Bunker Hill Mine AMD to be collected within the mine and treated at the CTP in

Kellogg, Idaho. The Bunker Hill Mine owner is also under order from USEPA to capture all discharges from the mine and convey them to the Kellogg Tunnel for eventual treatment at the CTP. However, the Bunker Hill Mine owner is not in compliance with this order, and AMD from the Reed and Russell Adit Tunnels is currently discharging into Milo Creek and impacting the creek's water quality.

Even though AMD was addressed in the 2001 ROD Amendment (USEPA, 2001e), changes in conditions (collapse of portions of the tunnels and accessibility issues) have created the need to include actions for discharges from the Reed and Russell Adit Tunnels in this FFS Report.

Four options were evaluated to achieve Bunker Hill AMD compliance with respect to the Reed and Russell Adit Tunnel flows. Since all Bunker Hill AMD requires conveyance and treatment at the CTP, all options screened for AMD management would result in equivalent effectiveness. Therefore, only cost and implementability were considered as part of this screening process. Screening-level cost estimates (–50 percent to +100 percent) were developed for each process option, per EPA guidance. Cost estimates were subsequently refined for options that were retained for incorporation into remedial alternatives to provide a higher level of accuracy (–30 percent to +50 percent) appropriate for detailed feasibility study analysis. The following four options to achieve AMD compliance were included in the screening:

- **Option 1: Install check dams within the Reed and Russell Adit Tunnels at the interior of the mine.** Check dams would be installed near the back of the Reed and Russell Adit Tunnels to back water up about 6 feet in elevation to promote drainage into deeper mine workings for eventual collection and discharge via the Kellogg Tunnel to the CTP for treatment. Access to the check dam areas would occur from the interior of the mine (via either the Cherry Raise or the Kellogg Tunnel) because portions of both the Reed and Russell Adit Tunnels have collapsed. This option is assumed to incur no O&M costs as the check dams are assumed to last in perpetuity. Therefore, the total capital cost is equal to the total cost (30-year NPV) for this option and is estimated at $163,000. It is anticipated that residual flow (via infiltration into the tunnels downstream of the check dams) will occur following implementation of this option. The quality of this water will be monitored to determine whether it meets ARARs.

- **Option 2: Convey the AMD to the Cherry Raise and down to the 9 Level.** The Reed and Russell Adit Tunnel flows would be combined and pumped about 1,000 feet southwest (upgradient) to the Cherry Raise, and then would flow by gravity down the raise about 1,000 feet to the 9 Level of the Bunker Hill Mine. The Cherry Raise is presently operated and maintained by the current Bunker Hill Mine owner; therefore, costs to maintain the Cherry Raise are not included for this option. Pipeline installation from the Reed Tunnel adit to the Cherry Raise will require consideration of existing remedial actions within the Milo Creek corridor. The estimated total capital cost for this option is $0.55 million. The O&M cost (30-year NPV) is estimated to be $82,000 ($6,600 annual average). The total cost (30-year NPV) for this option is estimated at $0.64 million.

- **Option 3: Convey the AMD directly to the CTP.** The Reed and Russell Adit Tunnel flows would be combined and conveyed directly to the CTP via a gravity pipeline system. The pipeline (about 15,000 feet long) would be installed through existing infrastructure of the Town of Wardner and the City of Kellogg. The estimated total capital cost for this option is about $1.92 million. The O&M cost (30-year NPV) is $0.25 million ($20,000 annual average). The total cost (30-year NPV) for this option is estimated at $2.2 million.

- **Option 4: Convey the AMD back into the Reed Tunnel via active pumping.** The Reed and Russell Adit Tunnel flows would be combined and pumped into the Reed Tunnel and discharged with existing mine water near the Mule Raise. An unknown length of the Reed Tunnel has collapsed as noted above, so rehabilitation of this tunnel would also be required for this option. Tunnel rehabilitation costs (for 200 linear feet of tunnel) were obtained from the *Bunker Hill Mine Water Presumptive Remedy* (CH2M HILL, 1999) and updated to 2009 dollars. The estimated total capital cost for this option is $0.60 million. The estimated O&M cost (30-year NPV) (including tunnel O&M) is $0.44 million ($35,000 annual average). The total cost (30-year NPV) for this option is estimated at $1.04 million.

Following the screening of the four process options above, USEPA and the State of Idaho identified a phased approach to mitigate the Reed and Russell Adit Tunnel discharge. In the first phase, Option 1 (above) would be implemented due to its lower cost (no anticipated O&M costs) and favorable implementability. If residual discharge from the Reed and Russell Adit Tunnels exceeded ARARs and required treatment, then the option of conveying the AMD to the Cherry Raise and down to the 9 Level (Option 2) would be implemented as the second phase.

The Cherry Raise is presently operated and maintained by the current Bunker Hill Mine owner, and implementation of Option 1 would not require the considerable cost of tunnel rehabilitation required as part of other options. Option 2 would convey the AMD to the 9 Level, which is the same level as the Kellogg Tunnel and which drains all other AMD from the mine to the CTP. This two-phase remedial action is included as part of each of the five OU 2 alternatives discussed in Section 6.3.4.

6.3.2.3 Water Treatment

Water treatment options evaluated for inclusion in the OU 2 Phase II remedy are discussed below and include active water treatment at the CTP in Kellogg and, onsite, passive water treatment using an *in situ* permeable reactive barrier (PRB). Other water treatment options considered for OU 3 water sources include several onsite semi-passive treatment processes (TCDs WT02, WT03, and WT04a/b, discussed in Section 6.2.1.2). These onsite water treatment options were not considered for OU 2 waters requiring treatment because of the close proximity of all OU 2 water sources to the CTP. The onsite water treatment options evaluated would be significantly more costly than conveying the collected water the relatively short distance to the CTP for treatment.

Active Water Treatment at the Central Treatment Plant

Contaminated groundwater collected as part of the OU 2 Phase II remedy will require water treatment. Water treatment could be accomplished at the existing CTP in Kellogg with upgrades that would increase the capacity and meet discharge requirements. The CTP has demonstrated its effectiveness at removing metals from AMD from the Bunker Hill Mine over many years. In addition to the existing treatment capacity at the CTP, it is feasible to expand the CTP to accommodate higher flow rates for treatment. The potential expansion of the CTP to treat other waters is discussed in *Issues Associated with CTP Expansion for Other OU2/OU3 Source Waters* (CH2M HILL, 2006f), and is also addressed in Section 7.0 of this FFS Report as part of the description of remedial alternatives. Additional information is also provided in Attachment D-1 to Appendix D. The CTP would also be upgraded to meet the Idaho Site-Specific AWQC for the SFCDR, which it currently does not consistently meet. This upgrade would consist of the addition of media filtration for improved removal of particulate metals.

Passive Water Treatment: Permeable Reactive Barrier

As considered in the OU 2 area, the goal of passive water treatment is to intercept and treat contaminated groundwater that would otherwise discharge to the SFCDR. Passive water treatment would be achieved in-situ using a PRB that introduces alkalinity to the subsurface. The PRB would be located in a position to intercept groundwater containing elevated concentrations of dissolved metals prior to discharging to the SFCDR, and would need to be keyed into the confining unit. Passive water treatment was evaluated in the areas of OU 2 with the highest dissolved metals loading to the SFCDR from groundwater. The evaluation of PRBs for potential application in OU 2 is described in Appendix F of this FFS Report. The evaluation in Appendix F demonstrates that the estimated cost of treatment using this type of PRB is very similar to the estimated cost of a French drain and water treatment at the CTP. While the costs may be similar, there is considerable technical and financial risk associated with the PRB because its effectiveness remains to be demonstrated in bench- and pilot-scale studies. Based on the results of this evaluation, the PRB has not been retained for direct inclusion in the remedial alternatives but is discussed throughout this FFS Report in conjunction with the remedial alternatives for OU 2 as a potential option requiring additional study.

6.3.3 Methodology for Development of Alternatives

Development of remedial alternatives for OU 2 was an iterative process among USEPA, IDEQ, and other parties. Alternatives were developed with a primary focus of improving SFCDR water quality, conforming to the core concepts listed in Section 6.3.2, and ensuring accordance with the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA, 1988b).

Remedial alternative development focused on the general response actions discussed above (source control, water collection and management, and water treatment) and considered current metals loading rates to the SFCDR, and the core concepts listed in Section 6.3.2. As noted above, remedial options within OU 2 considered in this FFS are one component of an overall cleanup approach for OU 2 that is already underway. Evaluation of remedial alternatives has been conducted in prior FSs (McCulley, Frick, and Gilman, 1992a, 1992b); Selected Remedies have been documented in existing RODs, ROD Amendments, and Explanations of Significant Differences (USEPA, 1992, 1996a, 1996d, 1998, 2001e); and remedial action effectiveness to date has been evaluated (CH2M HILL, 2007d) and has informed the identification of remedial actions to be included for OU 2 in this FFS. Five potential alternatives were identified based on the general response actions and process options previously discussed:

- Alternative (a) – Minimal stream lining;
- Alternative (b) – Extensive stream lining;
- Alternative (c) – French drains;
- Alternative (d) – Stream lining/French drain combination; and
- Alternative (e) – Extensive stream lining/French drain combination

Each potential alternative comprised a specific combination of actions in specific locations. Each individual action that was a component of an alternative was then evaluated in isolation, and the effectiveness (in terms of estimated reduction in dissolved metals load to the SFCDR), cost, and implementability were assessed so that the components of each alternative could be optimized.

Table 6-21 presents the costs and estimated load reductions for the individual water collection and management components of the five alternatives initially identified. Implementability considerations are also presented. Alternative water treatment components are not included in this evaluation because all collected waters are proposed to be treated at the CTP. Individual actions determined to have a low ratio of load reduction to cost and/or to be difficult to implement were eliminated from further consideration. Favorable individual actions were retained to form the five remedial alternatives for OU 2 that are summarized in Section 6.3.4.

The estimates of load reduction presented in Table 6-21 were developed using the groundwater flow model (CH2M HILL, 2009d). The model was employed to assist with alternatives development and evaluation by estimating remedial action or alternative effectiveness (i.e., load reduction to the SFCDR). The purpose of the application of the groundwater flow model to OU 2 was to define the water budget, estimate metals loading to the SFCDR, and estimate the metals load reduction to the SFCDR that would be achieved by the implementation of various water management options (i.e., stream lining and French drains). The metals loading estimates from the groundwater system to the SFCDR allowed for the prioritization of source areas in OU 2 requiring action and prioritization of remedial actions for these source areas, which are based on the estimated effectiveness or load reduction to the SFCDR. Supporting documentation of the groundwater modeling analyses is provided in Appendix A of this FFS Report.

Model simulations were performed on all water management/collection actions, and subsequent load reductions for each action were estimated. Screening-level cost estimates (–50 percent to +100 percent accuracy) were prepared simultaneously with the groundwater flow model simulations. Cost estimates for individual actions were developed according to *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (USEPA, 2000c) for screening-level costs. A cost-benefit analysis was performed for each individual action based on the cost per pound of dissolved zinc load reduction to the SFCDR (Table 6-21).

Based on the results of the screening evaluation presented in Table 6-21, the WQA Team refined the individual components of each alternative to arrive at the remedial alternatives for OU 2 that are evaluated in this FFS Report, which are summarized in Section 6.3.4 and described in detail in Section 7.

6.3.4 Summary of OU 2 Alternatives Developed for Evaluation

The five alternatives developed for evaluation for the OU 2 Phase II remedy are summarized below.

6.3.4.1 OU 2 Alternative (a): Minimal Stream Lining

OU 2 Alternative (a) consists of limited stream-lining actions in losing reaches of OU 2 streams to reduce recharge to the shallow alluvial groundwater system. The overall goal of this alternative is to reduce the mobilization, transport, and mass flux of dissolved metals in the groundwater system by reducing stream leakage from losing portions of the SFCDR and tributaries, which would ultimately protect surface water downstream. To achieve this goal, losing stream reaches were selected for lining. Figure A-24 in Appendix A presents the locations of simulated gaining and losing stream reaches within OU 2 under base-flow conditions. This alternative was developed to provide a limited passive action alternative without water treatment. The locations of stream liners included in this alternative are based on the low O&M and minimal water management option identified during the OU 2 remedial alternative screening process, and were optimized during this screening process. Table 6-22 summarizes the lined stream sections and other remedial actions included in OU 2 Alternative (a), and Figure 6-52 illustrates the stream liners included in this alternative.

The following actions and TCDs would be implemented as part of OU 2 Alternative (a):

- Line the SFCDR from Elizabeth Park to the transition zone from the losing to gaining reach along the northeast portion of the Central Impoundment Area (CIA).
- Line Bunker Creek from the headwaters to the Interstate 90 (I-90) culvert.
- Line Deadwood Creek and Magnet Creek from the gulch mouths to the confluence with Bunker Creek.
- Phased implementation of the Reed and Russell Adit Tunnel actions discussed in Section 6.3.2.2.
- TCDs: C10, C14a, C14b, C14c, C20, PIPE-1, PUMP-1, PRESSURE-PIPE-1, and PRESSURE-PIPE-4.

6.3.4.2 OU 2 Alternative (b): Extensive Stream Lining

OU 2 Alternative (b) consists of extensive stream lining actions in OU 2 streams to reduce recharge to the shallow alluvial groundwater system. Groundwater cutoff walls would be installed at select locations as part of this alternative. The overall goal of OU 2 Alternative (b) is to (more extensively than OU 2 Alternative (a)) reduce the mobilization, transport, and mass flux of dissolved metals in the groundwater system to the extent practicable, with no groundwater treatment, by reducing stream leakage from losing portions of tributaries to the SFCDR, which would ultimately protect surface water downstream. To achieve this goal, losing stream reaches were selected for lining. Figure A-24 in Appendix A presents the locations of simulated gaining and losing stream reaches within OU 2 under base-flow conditions. Similar to OU 2 Alternative (a), the locations of stream liners included in this alternative are based on the objective of low O&M and minimal water management identified during the OU 2 remedial alternative screening process, and were optimized during this process. The OU 2 Alternative (b) remedial actions are summarized in Table 6-23 and illustrated in Figure 6-53.

The following actions and TCDs would be implemented as part of OU 2 Alternative (b):

- Line Bunker Creek from the headwaters to the I-90 culvert.
- Line Government Creek from the Galena Ridge Pond (upgradient of former zinc plant) to the I-90 culvert, and install a slurry wall and extraction wells across Government Gulch upgradient of the stream liner.
- Line Deadwood Creek and Magnet Creek from the headwaters to the confluence with Bunker Creek.
- Install slurry walls and extraction wells upgradient of tributary stream liners (except Bunker Creek) to direct groundwater into the lined channels. The extraction wells would relieve hydraulic pressure upgradient of the slurry wall, and discharge groundwater into the stream liner.
- Phased implementation of the Reed and Russell Adit Tunnel actions discussed in Section 6.3.2.2.
- TCDs: C10, C11b, C11d, C14a, C14b, C17a, C17b, C20, PIPE-1, PUMP-1, PRESSURE-PIPE-1, and PRESSURE-PIPE-4.

6.3.4.3 OU 2 Alternative (c): French Drains

OU 2 Alternative (c) consists of a French drain system located in the central portion of OU 2 in the area with the highest dissolved metal load gains observed in the SFCDR. This French drain system would intercept dissolved-metals-contaminated groundwater prior to discharging to the SFCDR. The OU 2 Alternative (c) components are summarized in Table 6-24 and illustrated in Figure 6-54.

The following actions and TCDs would be implemented as part of OU 2 Alternative (c):

- Install a French drain along the northwest end of the CIA spanning the gaining reach of the SFCDR. A PRB approach was evaluated as a potential option for OU 2 Alternative (c) water treatment instead of active collection using a French drain (see Appendix F). The PRB may be an effective option to reduce metals loading to the SFCDR; however, the effectiveness of the PRB in removing metals load is uncertain, and there are implementability and operational concerns. Bench and pilot testing of this option would be required to evaluate the uncertainties before determining whether this approach could be incorporated into this alternative.
- Install a French drain extending southwest from the drain above across the SFCDR valley floor, terminating on the west side of Government Gulch. Convey collected water to the CTP for treatment.
- Convey the CTP effluent directly to the SFCDR in a pipeline (instead of discharging to Bunker Creek as is currently done), to prevent this water from infiltrating from the unlined Bunker Creek channel into the groundwater system for collection in the French drain and re-treatment by the CTP. For costing purposes, it was assumed that this

pipeline would be installed on the east side of the CIA; however, other configurations, such as a gravity flow pipeline parallel to Bunker Creek. will also be evaluated during design.

- Phased implementation of the Reed and Russell Adit Tunnel actions discussed in Section 6.3.2.2.
- TCDs: C10, C15c, C15d, C20, WT01, PIPE-1, PUMP-1, PUMP-5, PRESSURE-PIPE-1, PRESSURE-PIPE-3, and PRESSURE-PIPE-4.

6.3.4.4 OU 2 Alternative (d): Stream Lining/French Drain Combination

OU 2 Alternative (d) consists of French drains, stream linings, cutoff walls, and extraction wells located in the central portion of OU 2, primarily in the area with the highest dissolved metal load gains observed in the SFCDR. Similar to OU 2 Alternatives (a) and (b), the overall goal of stream lining is to reduce the mobilization, transport, and mass flux of dissolved metals in the groundwater system to the extent practicable by reducing stream leakage from Government Creek. Figure A-24 in Appendix A presents the locations of simulated gaining and losing stream reaches within OU 2 under base-flow conditions. This alternative would reduce groundwater recharge and intercept dissolved-metals-contaminated groundwater for treatment prior to discharging to the SFCDR. The OU 2 Alternative (d) components are presented in Table 6-25 and illustrated in Figure 6-55.

The following actions and TCDs would be implemented as part of OU 2 Alternative (d):

- Line Government Creek from the Galena Ridge Pond (upgradient of former zinc plant) to the I-90 culvert. Install a slurry wall and extraction wells across the gulch upgradient end of the liner. The extraction wells would relieve hydraulic pressure upgradient of the slurry wall and discharge clean groundwater into the stream liner.
- Install a French drain along the northwest end of the CIA spanning the gaining reach of the SFCDR (as in OU 2 Alternative (c)). Convey collected water to the CTP for treatment. Similar to OU 2 Alternative (c), a PRB was evaluated as a potential option for OU 2 Alternative (d) water treatment instead of active collection using a French drain (Appendix F). The PRB may be an effective option to reduce metals loading to the SFCDR; however, the effectiveness of the PRB in removing metals load is uncertain, and there are implementability and operational concerns. Bench and pilot testing of this option would be required to evaluate the uncertainties before determining whether this approach could be incorporated into this alternative.
- Install a French drain extending south from the drain above across the SFCDR valley, terminating on the east side of Government Gulch. (Unlike OU 2 Alternative (c), which extends to the west side, this alternative terminates on the east side because of the Government Gulch action described below.) Convey collected water to the CTP for treatment.
- Install extraction wells across the mouth of Government Gulch. Convey the extracted water to the CTP for treatment.
- Convey the CTP effluent directly to the SFCDR in a pipeline (instead of discharging to Bunker Creek as is currently done), to prevent this water from infiltrating from the

unlined Bunker Creek channel into the groundwater system for collection in the French drain and re-treatment by the CTP. For costing purposes, it was assumed that this pipeline would be installed on the east side of the CIA; however, other configurations, such as a gravity flow pipeline parallel to Bunker Creek, will also be evaluated during design.

- Phased implementation of the Reed and Russell Adit Tunnel actions discussed in Section 6.3.2.2.
- TCDs: C10, C11b, C14b, C15c, C15d, C17a, C17c, WT01, C20, PIPE-1, PUMP-1, PUMP-4, PRESSURE-PIPE-1, PRESSURE-PIPE-3, and PRESSURE-PIPE-4.

6.3.4.5 OU 2 Alternative (e): Extensive Stream Lining/French Drain Combination

OU 2 Alternative (e) is the most extensive water collection and management alternative, incorporating extensive stream lining of the SFCDR and its tributaries, as well as French drain systems. The OU 2 Alternative (e) components are presented in Table 6-26 and illustrated in Figure 6-56.

The following actions and TCDs would be implemented as part of OU 2 Alternative (e):

- Line the entire length of the SFCDR from Elizabeth Park to the Pinehurst Narrows.
- Line Bunker Creek from the headwaters to the I-90 culvert.
- Line Government Creek from the Galena Ridge pond (upgradient of former zinc plant) to the I-90 culvert.
- Line Deadwood Creek and Magnet Creek from the headwaters to the confluence with Bunker Creek.
- Line Grouse Creek and Humboldt Creek from the gulch mouths to the SFCDR.
- Install a French drain at the north end of the CIA along the gaining reach of the SFCDR, as in Alternatives (c) and (d). Convey collected water to the CTP for treatment.
- Install a French drain extending from mid-Smelterville Flats west to the Pinehurst Narrows. Convey collected water for treatment at the CTP.
- Install slurry walls and extraction wells upgradient of tributary liners (except Bunker Creek) to direct groundwater into the lined channels. Also install slurry walls and extraction wells across the SFCDR valley floor at Elizabeth Park and Pinehurst Narrows (slurry wall only). The extraction wells would relieve hydraulic pressure upgradient of the slurry wall and discharge groundwater into the stream liner.
- Phased implementation of the Reed and Russell Adit Tunnel actions discussed in Section 6.3.2.2.
- TCDs: C10, C11b, C11d, C11f, C11g, C14a, C14b, C14c, C15a, C15d, C17a, C17b, C17c, C17d, C18, C19, C20, WT01, PIPE-1, PUMP-1, PUMP-2, PUMP-3, PRESSURE-PIPE-1, PRESSURE-PIPE-2, PRESSURE-PIPE-3, and PRESSURE-PIPE-4.

SECTION 7.0

Description and Evaluation of Remedial Alternatives

This section presents the description and evaluation of remedial alternatives for the Upper Basin of the Coeur d'Alene River, beginning with a summary of the alternatives followed by a detailed description and evaluation of each alternative against criteria specified by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The remedial alternatives are compared with each other in Section 8.0.

7.1 Overview and Summary of Remedial Alternatives

As described in Section 6.0, the alternatives for Operable Unit (OU) 2 are combined with Alternatives 3+ and 4+ for OU 3 to create the following 10 remedial alternatives for the Upper Basin of the Coeur d'Alene River.

Alternative	Description
Alt. 3+(a)	OU 3 Alternative 3+ (More Extensive Removal, Disposal, and Treatment) and OU 2 Alternative (a) – Minimal Stream Lining
Alt. 3+(b)	OU 3 Alternative 3+ and OU 2 Alternative (b) – Extensive Stream Lining
Alt. 3+(c)	OU 3 Alternative 3+ and OU 2 Alternative (c) – French Drains
Alt. 3+(d)	OU 3 Alternative 3+ and OU 2 Alternative (d) – Stream Lining/French Drain Combination
Alt. 3+(e)	OU 3 Alternative 3+ and OU 2 Alternative (e) – Extensive Stream Lining/French Drain Combination
Alt. 4+(a)	OU 3 Alternative 4+ (Maximum Removal, Disposal, and Treatment) and OU 2 Alternative (a) – Minimal Stream Lining
Alt. 4+(b)	OU 3 Alternative 4+ and OU 2 Alternative (b) – Extensive Stream Lining
Alt. 4+(c)	OU 3 Alternative 4+ and OU 2 Alternative (c) – French Drains
Alt. 4+(d)	OU 3 Alternative 4+ and OU 2 Alternative (d) – Stream Lining/French Drain Combination
Alt. 4+(e)	OU 3 Alternative 4+ and OU 2 Alternative (e) – Extensive Stream Lining/French Drain Combination

The No Action Alternative was rejected in the Interim ROD for OU3 (USEPA, 2002b) because it is not NCP-compliant. However, the No Action alternative is included in this evaluation of alternatives for comparison purposes only. Overall, the differences between Alternatives 3+ and 4+ lie in the relative aggressiveness of the application of the proposed actions. Alternative 3+ focuses on a combination of in-place containment and excavation of wastes inside the nominal 100-year floodplain, as well as wastes outside the 100-year floodplain that are probable sources of metals loading. Active and semi-passive water treatment of adit drainages and hydraulic isolation of groundwater are also included in

Alternative 3+. Alternative 4+ focuses on complete excavation and hydraulic isolation of all wastes that are probable, significant sources of metals loading. Wastes that are outside the 100-year floodplain and probably not significant sources of metals loading would be covered in place. Expanded use of active and semi-passive water treatment of adit drainages and hydraulic isolation of groundwater are also included in Alternative 4+.

The specific objectives of this section are as follows:

- Describe the components of each remedial alternative for OU 3 (Alternatives 3+ and 4+), summarizing the proposed actions for each, and then providing a description of each alternative by watershed.
- Summarize the components of each remedial alternative for OU 2 [Alternatives (a) through (e)], previously discussed in Section 6.0, in addition to describing the Central Treatment Plant (CTP) and how it would be updated and expanded to accommodate OU 2 and OU 3 waters given the proposed actions.
- Describe the CERCLA evaluation criteria and the methods used to estimate remedial action effectiveness.
- Evaluate each of the 10 remedial alternatives against the CERCLA evaluation criteria (the No Action Alternative is also included for comparative purposes only).

7.2 Description of Remedial Alternatives

7.2.1 OU 3 Alternative Components (Alternatives 3+ and 4+)

Table 7-1 presents a summary of the quantities of waste materials addressed by the various remedial actions in Ecological Alternatives 3 and 4 presented in the 2001 Feasibility Study (FS) Report (USEPA, 2001d), and in Alternatives 3+ and 4+ presented in this Focused Feasibility Study (FFS) Report. The purpose of including 2001 FS Ecological Alternatives 3 and 4 in the table is to highlight the differences between the remedial actions identified for those alternatives and the remedial actions proposed for Alternatives 3+ and 4+ in this FFS Report. For an even comparison, the quantities of wastes (sediments, tailings, waste rock, and pounds per day of zinc in adit discharges, groundwater, and seeps) at each site would need to be identical in both studies. However, estimates of the waste materials at some sites have changed since the 2001 FS (as described in detail in Section 6.0). Therefore, in order to provide an even comparison, the most recent waste material quantities for all alternatives are shown in Table 7-1.

In Table 7-1 and subsequent tables like it, groundwater is not included because the numerical groundwater model, developed since the 2001 FS Report, has been used to refine the estimates of groundwater flow rates and load reductions for Alternatives 3+ and 4+, making comparisons to Ecological Alternatives 3 and 4 impractical. Additional details about the numerical groundwater model are presented in Section 7.3.2.1 and Appendix A.

Note that an overview of the similarities and differences between the components of the OU 3 alternatives presented in the 2001 FS Report and in those presented in this FFS Report is provided in Section 6.2.9, and is not repeated here.

7.2.1.1 Summary of Alternative 3+ Actions

Table 7-2 presents a summary of the remedial action types that would be applied to the waste material quantities in Alternative 3+. Alternative 3+ actions are summarized as follows:

- **Excavation and Disposal** – Approximately 2.5 million cubic yards (cy) of waste rock, tailings, and floodplain sediments would be consolidated and placed in repositories (typical conceptual design [TCD] C08a). Approximately 2.1 million cy of waste rock, tailings, and floodplain sediments would be placed in waste consolidation areas (TCD C07). For the purposes of cost estimating, a bottom liner for collection of leachate during the dewatering period has been included for repositories but not for waste consolidation areas. The need for bottom liners and leachate collection at repositories and waste consolidation areas would be determined during remedial design based on site-specific conditions. Once full, all repositories would be capped with a low-permeability cover system.

- **Hydraulic Isolation** – Hydraulic isolation actions would be implemented at existing tailings impoundment facilities to reduce groundwater flow through an estimated 1.8 million cy of tailings within the facilities. These actions would be completed to a depth so as to also hydraulically isolate the 1.4 million cy of floodplain sediments that lie underneath and surround these facilities. Approximately 6 miles of Canyon Creek near Woodland Park and the South Fork Coeur d'Alene River (SFCDR) between Wallace and Elizabeth Park would also be hydraulically isolated using a combination of stream liners (TCDs C14b and C14c) and French drains (TCD C15b) to decrease dissolved metals loads from contaminated groundwater. This hydraulic isolation of stream reaches would address loadings from an estimated 2.3 million cy of floodplain sediments. Groundwater would be collected and conveyed to the CTP (see Section 7.2.4) for active treatment, followed by discharge to the SFCDR.

- **Capping, Regrading, and Revegetating** – Approximately 1.4 million cy of waste rock would be regraded, consolidated, and revegetated (TCDs C02a through C02c) as part of Alternative 3+. Approximately 4.1 million cy of waste rock would be consolidated and covered with a low-permeability cap (TCDs C03 through C05). These actions would provide a higher level of containment than TCDs C02a through C02c for the majority of waste rock with significant loading potential (due to proximity to surface water). Approximately 5.3 million cy of currently impounded tailings would be further contained by closing the existing inactive impoundments (TCD C09). A number of additional source sites would be provided with soil covers to further reduce the potential for unacceptable human exposures. Abandoned structures posing significant potential for unacceptable human exposures would be decontaminated, to the extent practicable, and/or fenced. For cost estimating purposes, it is assumed that 15 waste piles and 5 structures would be addressed by these actions.

- **Collection and Treatment of Adit Discharge, Seeps, and Groundwater** – Drainage from 21 adits would be collected and actively treated at the CTP (TCD WT01). Drainage from 36 additional adits and one seep would be semi-passively treated (TCDs WT02 and WT03). Groundwater would be collected in the Woodland Park area of Canyon Creek and along the SFCDR between Wallace and Elizabeth Park. All collected groundwater would be treated at the CTP (TCD WT01). Estimated average and maximum flows and dissolved zinc loads undergoing treatment for Alternative 3+ are provided in Table 7-3.

- **Stream and Riparian Cleanup Actions** – Stream and riparian cleanup actions would be used along approximately 250,000 feet of stream banks, along with floodplain and riparian plantings covering approximately 330 acres. Approximately 1,800 current deflectors would be installed, with approximately 10 percent configured to serve as sediment traps. The more extensive removals of contaminated floodplain sediments would provide the opportunity for establishment of off-channel hydrologic units (such as wetlands). Approximately 100 acres of off-channel hydrologic units would be constructed within the Upper Basin. For cost estimating purposes, an estimated 4,000 cy per year of contaminated sediments accumulating in sediment traps would periodically be dredged and disposed of.

- **Upgrade and Expansion of the CTP** – Expansion and upgrades of the CTP are required to meet water quality standards and to treat additional flows. CTP expansion and upgrades will be implemented in a two-phased approach as generally outlined in the CTP Master Plan in the *Record of Decision Amendment: Bunker Hill Mining and Metallurgical Complex Acid Mine Drainage, Smelterville, Idaho* (USEPA, 2001e) and based on the required capacity of the CTP to treat the additional waters. During Phase 1, all components of the CTP will be upgraded to achieve the maximum capacity of the selected alternative, except for the B Reactors and media filters. The B Reactors will be sized to one-half of the maximum design flow, one each installed during Phase 1 and Phase 2. The media filters will be installed as needed based on operating capacity of the CTP, but will require installation during both phases. A complete description of issues related to the use of the CTP in this alternative is provided in Section 7.2.4.

As noted above, Alternative 3+ focuses on a combination of in-place containment and excavation of wastes inside the nominal 100-year floodplain, as well as wastes outside the 100-year floodplain that are probable sources of metals loading. Because waste would be left in place, institutional controls may be necessary to protect the integrity of the proposed actions, ensure agency access, or prevent human exposures after remedial actions are implemented. There is an existing Institutional Control Program (ICP) and, for the purposes of this FFS, it is assumed that it applies to all waste left in place within the Bunker Hill Superfund site ICP boundary, including the source area actions that would be implemented as part of Alternative 3+. The ICP was adopted by the Idaho State Legislature and is administered by the Panhandle Health District. It provides a locally enforced set of rules and regulations established to maintain the integrity of installed barriers and to ensure that new barriers are installed during redevelopment that may occur within the administrative boundary of the ICP. Among other things, the ICP also issues permits for work that may encounter mine waste contaminated material, stipulates mine waste contaminated material handling procedures and disposal, and trains and certifies contractors prior to working with potentially contaminated materials. USEPA would evaluate whether the existing ICP administered by the Panhandle Health District is adequate or whether additional institutional controls would be needed to ensure the protectiveness of any implemented remedy.

7.2.1.2 Summary of Alternative 4+ Actions

Table 7-4 presents a summary of the remedial action types that would be applied to waste material quantities in Alternative 4+. Alternative 4+ actions are summarized as follows:

- **Excavation and Disposal** – Approximately 13 million cy of waste rock, tailings and floodplain sediments would be consolidated and placed in repositories (TCD C08a). Approximately 1.9 million cy of waste rock, tailings, and floodplain sediments would be placed in waste consolidation areas (TCD C07). For the purposes of cost estimating, a bottom liner for collection of leachate during the dewatering period has been included for repositories but not for waste consolidation areas. The need for bottom liners and leachate collection at repositories and waste consolidation areas would be determined during remedial design based on site-specific conditions. Once full, all repositories would be capped with a low-permeability cover system.

- **Hydraulic Isolation** – The SFCDR between Mullan and Elizabeth Park would be hydraulically isolated using a combination of slurry walls (TCD C11j), stream liners (TCDs 14b and 14c), and French drains (TCD 15b) to decrease dissolved metals loads from contaminated groundwater. This hydraulic isolation of stream reaches would address loadings from an estimated 2.0 million cy of floodplain sediments. Groundwater would be collected and conveyed to the CTP for active treatment, followed by discharge to the SFCDR. Groundwater containment actions would also be taken at tailings impoundment facilities, addressing the 920,000 cy of floodplain sediments that lie underneath and surround these facilities.

- **Capping, Regrading, and Revegetating** – Approximately 3.9 million cy of waste rock would be regraded, consolidated, and revegetated. Approximately 20,000 cy of waste rock would be consolidated and covered with a low-permeability cap. These actions would provide a higher level of containment than TCDs C02a through C02c for the majority of waste rock with significant loading potential (due to proximity to surface water). A number of additional source sites would be provided with soil covers to further reduce the potential for unacceptable human exposures. All abandoned structures posing significant potential for unacceptable human exposures would be decontaminated, to the extent practicable, and/or fenced. As with Alternative 3+, for cost estimating purposes, it was assumed that 15 waste piles and five structures would be addressed by these actions.

- **Collection and Treatment of Adit Discharge, Seeps, and Groundwater** – Drainage from 32 adits would be collected and actively treated at the CTP (TCD WT01). Drainage from 51 additional adits and 1 seep would be semi-passively treated (TCDs WT02 and WT03). Groundwater would be collected in the Woodland Park area of Canyon Creek and along the SFCDR between Wallace and Elizabeth Park. All collected groundwater would be treated at the CTP. Estimated average and maximum flows and dissolved zinc loads undergoing treatment for Alternative 4+ are provided in Table 7-5.

- **Stream and Riparian Cleanup Actions** – Stream and riparian cleanup actions would be used along approximately 290,000 linear feet of stream banks, along with floodplain and riparian plantings covering approximately 560 acres. Approximately 2,200 current deflectors would be installed. The extensive removals of contaminated floodplain sediments would provide greater opportunities for creation of off-channel hydrologic units (such as wetlands). Approximately 210 acres of off-channel hydrologic units would be constructed within the Upper Basin. As a result of the extensive removals of contaminated sediments, sediment traps (and associated long-term dredging) are not included in Alternative 4+.

- **Upgrade and Expansion of the CTP** - Expansion and upgrades of the CTP are required to meet water quality standards and to treat additional flows. CTP expansion and upgrades will be implemented as described above for Alternative 3+. A complete description of issues related to the use of the CTP in this alternative is provided in Section 7.2.4.

Alternative 4+ focuses on more complete excavation and hydraulic isolation of all wastes that are probable, significant sources of metals loading; however, wastes that are outside the 100-year floodplain and probably not significant sources of metals loading would be covered in place. Therefore, institutional controls may be necessary to protect the integrity of the proposed actions, ensure agency access, or prevent human exposures after remedial actions are implemented. Like Alternative 3+, it is assumed that the existing ICP would apply to all waste left in place within the Bunker Hill Superfund site ICP boundary, including the source area actions that would be implemented as part of Alternative 4+. USEPA would evaluate whether the existing ICP administered by the Panhandle Health District is adequate or whether additional institutional controls would be needed to ensure the protectiveness of any implemented remedy.

7.2.2 Description of Alternatives 3+ and 4+ by Watershed

This section summarizes the modifications from Ecological Alternatives 3 and 4 to Alternatives 3+ and 4+ for each of the seven key watersheds. Each section includes a revised number of sites with proposed actions and presents tables summarizing the waste material quantities to be addressed.

Figures 7-1 through 7-14 depict the proposed actions (excluding water treatment approaches) associated with Alternatives 3+ and 4+ for each watershed.[1] The symbology on the figures reflects remedial action types, which are groupings of remedial action for the known source materials at each site. In many cases there is more than one source material associated with a proposed action, hence the development of symbols to capture multiple TCDs. The TCDs for the various waste materials at each site are provided in the tables developed for Section 6.0, beginning with Table 6-6.

7.2.2.1 Upper SFCDR Watershed

The 2001 RI and FS Reports identified 182 source sites in the Upper SFCDR Watershed (USEPA 2001c, 2001d). These sources include an estimated 1.2 million cy of metals-impacted sediment, 1.2 million cy of tailings, 3.2 million cy of waste rock, and 27 adits with drainage. A summary of the quantities of waste addressed using different types of remedial actions under Alternatives 3+ and 4+ for the Upper SFCDR Watershed is presented in Table 7-6,

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[1] Water treatment approaches for Alternatives 3+ and 4+ are shown in Figures 7-15 through 7-24, which are introduced as part of the OU 2 Alternatives discussed in Section 7.2.3.

along with a summary of the quantities of waste addressed under Ecological Alternatives 3 and 4 in the 2001 FS for comparison. Overviews of the remedial actions in the Upper SFCDR Watershed included in Alternatives 3+ and 4+ are provided in Figures 7-1 and 7-2, respectively.

Alternatives 3+ and 4+ consider the same sites for potential remedies for the Upper SFCDR Watershed as did Ecological Alternatives 3 and 4 in the 2001 FS Report. These proposed actions are described in detail in Section 5.1.1.3 of the 2001 FS Report and are also included as part of the summaries provided in Section 7.2.1 above. The following table lists the number of sites with proposed actions and no proposed actions for Ecological Alternatives 3 and 4 and FFS Alternatives 3+ and 4+.

Number of Sites within Upper SFCDR Watershed	Alt. 3	Alt. 3+	Alt. 4	Alt. 4+
Sites with Proposed Action(s)	82	83	180	180
Sites with No Proposed Actions	100	99	2	2
Total	**182**	**182**	**182**	**182**

For the Upper SFCDR Watershed, the differences between Ecological Alternative 3 and Alternative 3+ and between Ecological Alternative 4 and Alternative 4+ are relatively minor in terms of the number of sites that changed from no proposed action to proposed action. The differences include:

- One site (WAL077) was added to Alternative 3+ on the basis of relatively high estimated dissolved metals loading. This site was already a component of Ecological Alternative 4 in the 2001 FS Report; therefore, it is also included in Alternative 4+.
- Three sites associated with the Lucky Friday Operation (MUL020, MUL037, and MUL058) were associated with an operational facility at the time of the 2001 FS Report and, on that basis, were not assigned a complete set of remedial actions. These sites are still considered active; however, sites identified as being sources of significant metals loading are assigned a complete set of remedial actions in this FFS Report, regardless of operational status.
- Remedial actions have been completed at Golconda Mill and Mine site (MUL001 and MUL002), but the potential need for additional actions remains to be assessed; therefore, Alternative 3+ and 4+ actions have been retained for now.
- The same water sources identified for treatment in Ecological Alternatives 3 and 4 in the 2001 FS Report are included in Alternatives 3+ and 4+, respectively, as sources of water to be treated. However, the water treatment TCDs applied to those water sources have been re-evaluated and are different from those applied in the 2001 FS.

In addition to the remedial actions discussed above, the same suite of stream and riparian cleanup TCDs included under Ecological Alternatives 3 and 4 in the 2001 FS Report has been included in Alternatives 3+ and 4+, respectively.

The stream and riparian cleanup TCDs identified for the Upper SFCDR Watershed begin in the vicinity of Larson at approximate River Mile 197, and intensify in the downstream direction as the degree of physical impacts increases from mining-related activities and other sources of disturbance. The intent of the stream and riparian cleanup actions is to provide a means for stabilizing the structure and physical functions of the stream channel with structural additions to moderate stream hydrology, stabilize bedload and sediment transport, and to stabilize actively eroding stream banks. Bank stabilization and other treatments would be broadly applied, including contaminated areas not directly associated with source sites. Stream and riparian cleanup TCDs are less intensive in areas where extensive riprap is already in place. However, in some areas riprap may overlie contaminated material proposed for excavation and removal. The stabilization of these areas following removal with stream and riparian cleanup TCDs may be appropriate. A detailed description of these actions can be found in Section 5.1.1.2 in the 2001 FS Report.

7.2.2.2 Canyon Creek Watershed

The 2001 RI and FS Reports identified 125 source sites in the Canyon Creek Watershed (USEPA, 2001c, 2001d). These sources include an estimated 590,000 cy of metals-impacted sediment, 2.8 million cy of tailings, 2.4 million cy of waste rock, and 27 adits with drainage.

The Canyon Creek Watershed includes Woodland Park (Segment 05). An updated set of remedial actions has been developed for Woodland Park for both Alternative 3+ and Alternative 4+. The need for and process by which this update of remedial actions was conducted is described in detail in Appendix E of this FFS Report.

A summary of the quantities of waste addressed using different types of remedial actions under Alternatives 3+ and 4+ for the Canyon Creek Watershed, including Woodland Park, is presented in Table 7-7, along with a summary of the quantities of waste addressed under Ecological Alternatives 3 and 4 in the 2001 FS Report for comparison. Overviews of the remedial actions in the Canyon Creek Watershed included in Alternatives 3+ and 4+ are provided in Figures 7-3 and 7-4, respectively.

Alternatives 3+ and 4+ consider the same sites for potential remedies for the Canyon Creek Watershed as those outlined in Ecological Alternatives 3 and 4 in the 2001 FS Report. These proposed actions are described in detail in Section 5.1.2.3 in the 2001 FS Report and are included as part of the summaries provided in Section 7.2.1 above. The following table lists the number of sites with proposed actions and no proposed actions for Ecological Alternatives 3 and 4 and FFS Alternatives 3+ and 4+.

Number of Sites within Canyon Creek Watershed	Alt. 3	Alt. 3+	Alt. 4	Alt. 4+
Sites with Proposed Action(s)	63	68	123	123
Sites with No Proposed Actions	62	57	2	2
Total	**125**	**125**	**125**	**125**

For the Canyon Creek Watershed, the differences between Ecological Alternative 3 and Alternative 3+ and between Ecological Alternative 4 and Alternative 4+ include:

- Five sites (BUR094, BUR119, BUR120, BUR124, and BUR125) were added to Alternative 3+ on the basis of relatively high estimated dissolved metals loading. These data were not available for the 2001 FS Report. These sites were already a component of Ecological Alternative 4 in the 2001 FS Report and are therefore also included in Alternative 4+.
- For Woodland Park, Alternative 3+ actions include stream lining, French drains for groundwater collection, and targeted source control actions. These Alternative 3+ actions differ from Ecological Alternative 3 actions in that they involve less excavation and disposal, no surface water treatment, and the addition of groundwater collection and treatment. Alternative 4+ actions include the same source control actions included in Ecological Alternative 4. The only difference between Alternative 4+ and Ecological Alternative 4 for Woodland Park is the technology for treatment of the Canyon Silver (Formosa) Mine adit discharge. Passive treatment was the proposed technology in Ecological Alternative 4, and active treatment at the CTP is proposed in Alternative 4+.
- The same water sources identified for treatment in Ecological Alternatives 3 and 4 in the 2001 FS Report are included in Alternatives 3+ and 4+, respectively, as sources of water to be treated. However, the water treatment TCDs applied to those water sources have been re-evaluated and are different from those applied in the 2001 FS.

In addition to the remedial actions discussed above, the same suite of stream and riparian cleanup TCDs included under Ecological Alternatives 3 and 4 in the 2001 FS Report have been included in Alternatives 3+ and 4+, respectively.

The stream and riparian cleanup TCDs identified for the Canyon Creek Watershed begin in CCSeg02 and increase in intensity in the downstream direction as the degree of physical degradation of aquatic and riparian habitats increases. The purpose of these TCDs is to moderate the flashy hydrology of the stream system, stabilize bedload mobility and transport processes, and rebuild and stabilize the stream channel and banks in CCSeg04 and CCSeg05 where extensive degradation of the stream channel, riparian zone, and floodplain is present. These actions would also include stabilization and replanting of the riparian zone to speed the regrowth of riparian vegetation. The excavation of contaminated floodplain sediments would create trenches and depressions that could be used to develop off-channel hydrologic features (e.g., wetlands). A detailed description of these actions can be found in Section 5.1.2.2 in the 2001 FS Report.

7.2.2.3 Ninemile Creek Watershed

The 2001 RI and FS Reports identified 70 source sites in the Ninemile Creek Watershed (USEPA, 2001c, 2001d). These sources include an estimated 150,000 cy of metals-impacted sediment, 820,000 cy of tailings, 1.7 million cy of waste rock, and 15 adits with drainage. A summary of the quantities of waste addressed using different types of remedial actions under Alternatives 3+ and 4+ for the Ninemile Creek Watershed is presented in Table 7-8, along with a summary of the quantities of waste addressed under Ecological Alternatives 3 and 4 in the 2001 FS for comparison. Overviews of the remedial actions in the Ninemile Watershed included in Alternatives 3+ and 4+ are provided in Figures 7-5 and 7-6, respectively.

Alternatives 3+ and 4+ consider the same sites for potential remedies for the Ninemile Creek watershed as those outlined in Ecological Alternatives 3 and 4 in the 2001 FS Report. These proposed actions are described in detail in Section 5.1.3.3 in the 2001 FS Report and are included as part of the summaries provided in Section 7.2.1 above. The following table lists the number of sites with proposed actions and no proposed actions for Ecological Alternatives 3 and 4 and FFS Alternatives 3+ and 4+.

Number of Sites within Ninemile Creek Watershed	Alt. 3	Alt. 3+	Alt. 4	Alt. 4+
Sites with Proposed Action(s)	33	36	65	67
Sites with No Proposed Actions	37	34	5	3
Total	**70**	**70**	**70**	**70**

For the Ninemile Creek Watershed, the differences between Ecological Alternative 3 and Alternative 3+ and between Ecological Alternative 4 and Alternative 4+ are relatively minor in terms of the number of sites that changed from no proposed action to proposed action. The differences include:

- One site (OSB048) was added to Alternative 3+ on the basis of relatively high estimated dissolved zinc loading from recent monitoring data. This site was already a component of Ecological Alternative 4 in the 2001 FS Report and therefore is also included in Alternative 4+.
- Two sites (OSB084 and OSB085) were also added to Alternatives 3+ and 4+ on the basis of relatively high particulate lead loading from recent monitoring data.
- Remedial actions have been completed at one site, Rex Mine (BUR054). However, the potential need for additional actions remains to be assessed; therefore, the Alternative 3+ and 4+ actions have been retained for now.
- The same water sources identified for treatment in Ecological Alternatives 3 and 4 in the 2001 FS Report are included in Alternatives 3+ and 4+, respectively, as sources of water to be treated. However, the water treatment TCDs applied to those water sources have been re-evaluated and are different from those applied in the 2001 FS.

In addition to the remedial actions discussed above, the same suite of stream and riparian cleanup TCDs included under Ecological Alternatives 3 and 4 in the 2001 FS Report have been included in Alternatives 3+ and 4+, respectively. These stream and riparian cleanup TCDs apply throughout the majority of the Ninemile Creek Watershed, but exclude the majority of NMSeg03 above the confluence with East Fork Ninemile Creek (NMSeg02). Extensive degradation of physical watershed functions exists throughout these segments, generally intensifying in the downstream direction. The purposes of these actions would be to moderate the flashy hydrology of the stream system, stabilize bedload mobility and transport processes, and rebuild and stabilize the stream channel and banks in NMSeg04 where extensive degradation is present in the stream channel and riparian zone structure. These actions would also include replanting of the floodplain and riparian zone to speed revegetation. The development of off-channel hydrologic features (e.g., wetlands, side channels) would also be included where excavation and removal of contaminated floodplain sediments would allow for the development of such features. A detailed description of these actions can be found in Section 5.1.3.3 in the 2001 FS Report.

7.2.2.4 Big Creek Watershed

The 2001 RI and FS Reports identified 68 source sites in the Big Creek Watershed (USEPA, 2001c, 2001d). These sources include an estimated 200,000 cy of metals-impacted sediment, 1.3 million cy of tailings, 800,000 cy of waste rock, and 7 adits with drainage. A summary of the quantities of waste addressed using different types of remedial actions under Alternatives 3+ and 4+ for the Big Creek Watershed is presented in Table 7-9, along with a summary of the quantities of waste addressed under Ecological Alternatives 3 and 4 in the 2001 FS Report for comparison. Overviews of the remedial actions in the Big Creek Watershed included in Alternatives 3+ and 4+ are provided in Figures 7-7 and 7-8, respectively.

Alternatives 3+ and 4+ consider the same sites for potential remedies for the Big Creek Watershed as those outlined in Ecological Alternatives 3 and 4 in the 2001 FS Report. These proposed actions are described in detail in Section 5.1.4.3 in the 2001 FS Report and are included as part of the summaries provided in Section 7.1 above. The following table lists the number of sites with proposed actions and no proposed actions for Ecological Alternatives 3 and 4 and FFS Alternatives 3+ and 4+.

Number of Sites within Big Creek Watershed	Alt. 3	Alt. 3+	Alt. 4	Alt. 4+
Sites with Proposed Action(s)	19	19	54	54
Sites with No Proposed Actions	49	49	14	14
Total	**68**	**68**	**68**	**68**

For the Big Creek Watershed, the differences between Ecological Alternative 3 and Alternative 3+ and between Ecological Alternative 4 and Alternative 4+ are relatively minor in terms of the number of sites that changed from no proposed action to proposed action. The differences include:

- One site (KLE024, Sunshine Tailings Pond) was considered active at the time of the 2001 FS Report and, on that basis, was not assigned a complete set of remedial actions. This site is not operating at this time (although it has not been closed and may reopen in the future). The TCDs have been modified for this site in this FFS Report to provide a complete set of remedial actions.
- The same water sources identified for treatment in Ecological Alternatives 3 and 4 of the 2001 FS are included in Alternatives 3+ and 4+, respectively, as sources of water to be treated. However, the water treatment TCDs applied to those water sources have been re-evaluated and are different from those applied in the 2001 FS.

In addition to the remedial actions discussed above, the same suite of stream and riparian cleanup TCDs included under Ecological Alternatives 3 and 4 in the 2001 FS Report have been included in Alternatives 3+ and 4+, respectively.

No stream and riparian cleanup actions have been identified for BigCrkSeg01, BigCrkSeg02, or BigCrkSeg03. Limited areas of contamination have been identified, and stream channel and riparian zone conditions appear to be intact. Some limited areas of bank stabilization and riparian revegetation may be required if contaminant excavation and removal actions are identified. Stream and riparian cleanup actions have been identified for BigCrkSeg04 in the area downstream from the confluence with West Fork Big Creek (BigCrkSeg03). These actions include structural additions to the stream channel to moderate stream flow and stabilize bedload and sediment transport processes (including the use of sediment traps as appropriate), stabilization of eroding and erodible bank areas, and riparian and floodplain revegetation where existing conditions allow. A detailed description of these actions can be found in Section 5.1.4.2 in the 2001 FS Report.

7.2.2.5 Moon Creek Watershed

The 2001 RI and FS Reports identified 14 source sites in the Moon Creek Watershed (USEPA, 2001c, 2001d). The largest sources are located in the East Fork Moon Creek drainage. Completed removal actions have resulted in containment of the majority of these materials. Uncontained volumes of sediment, tailings, waste rock, and adit drainage are relatively small. A summary of the quantities of waste addressed using different types of remedial actions under Alternatives 3+ and 4+ for the Moon Creek Watershed is presented in Table 7-10 along with a summary of the quantities of waste addressed under Ecological Alternatives 3 and 4 in the 2001 FS Report for comparison. Overviews of the remedial actions in the Moon Creek Watershed included in Alternatives 3+ and 4+ are provided in Figures 7-9 and 7-10, respectively.

Alternatives 3+ and 4+ consider the same sites for potential remedies for the Moon Creek Watershed as those outlined in Ecological Alternatives 3 and 4 in the 2001 FS Report. These proposed actions are described in detail in Section 5.1.5.3 in the 2001 FS Report and are included as part of the summaries provided in Section 7.2.1 above. The following table lists the number of sites with proposed actions and no proposed actions for Ecological Alternatives 3 and 4 and FFS Alternatives 3+ and 4+.

Number of Sites within Moon Creek Watershed	Alt. 3	Alt. 3+	Alt. 4	Alt. 4+
Sites with Proposed Action(s)	7	7	10	10
Sites with No Proposed Actions	7	7	4	4
Total	**14**	**14**	**14**	**14**

For the Moon Creek Watershed, there are no differences between either Ecological Alternative 3 and Alternative 3+ or Ecological Alternative 4 and Alternative 4+, and there are no sites with water components that required evaluation for treatment.

In addition to the remedial actions discussed above, the same suite of stream and riparian cleanup TCDs included under Ecological Alternatives 3 and 4 in the 2001 FS Report have been included in Alternatives 3+ and 4+, respectively.

Stream and riparian cleanup actions would be conducted in the Moon Creek Watershed downstream from zones of mining-related impacts where physical conditions are currently degraded. These actions would occur downstream from removal actions previously conducted by USFS to clean up contaminated areas associated with mining activities in MoonCrkSeg02 and would be designed to complement existing actions. This area includes the Charles Dickens and Silver Crescent Mill sites and associated source sites (KLE078, KLE041, KLE076, KLE077, KLE012), as described by Ridolfi (1996). Actions would include placement of current deflectors, bioengineered revetments, and vegetative bank stabilization to moderate stream flow and stabilize sediment and bedload transport processes, stabilize eroding and erodible stream banks, and re-engineer and stabilize stream banks and riparian areas after contaminant excavation and removal. Revegetation would be conducted in floodplain and riparian areas where remedial excavation would occur. Off-channel hydrologic features (e.g., wetlands) would be constructed in areas where extensive remedial excavation presents opportunities for development. A detailed description of these actions can be found in Section 5.1.5.2 in the 2001 FS Report.

7.2.2.6 Pine Creek Watershed

The 2001 RI and FS Reports identified 129 source sites in the Pine Creek Watershed (USEPA, 2001c, 2001d). These sources include an estimated 35,000 cy of metals-impacted sediment, 200,000 cy of tailings, 1.2 million cy of waste rock, and 20 adits with drainage. A summary of the quantities of waste addressed using different types of remedial actions under Alternatives 3+ and 4+ for the Pine Creek Watershed is presented in Table 7-11, along with a summary of the quantities of waste addressed under Ecological Alternatives 3 and 4 in the 2001 FS Report for comparison. Overviews of the remedial actions in the Pine Creek Watershed included in Alternatives 3+ and 4+ are provided in Figures 7-11 and 7-12, respectively.

Alternatives 3+ and 4+ consider the same sites for potential remedies for the Pine Creek Watershed as those outlined in Ecological Alternatives 3 and 4 in the 2001 FS Report. These proposed actions are described in detail in Section 5.1.6.3 in the 2001 FS Report and are included as part of the summaries provided in Section 7.2.1 above. The following table lists the number of sites with proposed actions and no proposed actions for Ecological Alternatives 3 and 4 and FFS Alternatives 3+ and 4+.

Number of Sites within Pine Creek Watershed	Alt. 3	Alt. 3+	Alt. 4	Alt. 4+
Sites with Proposed Action(s)	66	71	109	113
Sites with No Proposed Actions	63	58	20	16
Total	**129**	**129**	**129**	**129**

For the Pine Creek Watershed, the differences between Ecological Alternative 3 and Alternative 3+ and between Ecological Alternative 4 and Alternative 4+ include:

- Two sites (KLW077 and KLW079) were added to Alternatives 3+ and 4+ on the basis of relatively high loading from recent monitoring data.

- Two sites (MAS052 under Alternatives 3+ and 4+ and MAS067 under Alternative 4+ only) were initially on the list of sites earmarked to receive water treatment, but have been removed from that list based on input from the Bureau of Land Management (BLM) (as described in Section 6.0).
- Remedial actions completed, as reported by BLM, include excavation of approximately 70 percent of the total volumes of floodplain sediments at six sites (MAS040, MAS041, MAS042, MAS043, MAS045, and MAS046). Excavation and disposal actions in Alternatives 3+ and 4+ were modified to remove the remaining estimated 30 percent.
- Input from BLM indicated that there were no floodplain sediments at MAS047. Therefore, the total volume of floodplain sediments was reduced by 100 percent and actions were eliminated completely for floodplain sediments at MAS047.
- Input from BLM indicated that remedial actions should be considered at MAS014, MAS025, and KLW080 due to the proximity of waste materials to the floodplain. BLM has completed remedial actions at MAS081, but this site requires further revegetation. Actions were assigned to the waste materials at these sites for both Alternative 3+ and Alternative 4+.
- Remedial actions have been completed at Constitution Mine and Mill site (MAS027, MAS048, MAS049, MAS050). However, the potential need for additional actions remains to be assessed; therefore, the Alternative 3+ and 4+ actions have been retained for now.
- The same water sources identified for treatment in Ecological Alternatives 3 and 4 in the 2001 FS Report are included in Alternatives 3+ and 4+, respectively, as sources of water to be treated. However, the water treatment TCDs applied to those water sources have been re-evaluated and are different from those applied in the 2001 FS.

In addition to the remedial actions discussed above, the same suite of stream and riparian cleanup TCDs included under Ecological Alternatives 3 and 4 in the 2001 FS Report have been included in Alternatives 3+ and 4+, respectively.

Stream and riparian cleanup TCDs have been identified only for the limited area of PineCrkSeg03 that lies outside the OU 2 boundary, from the confluence of East Fork Pine Creek and the mainstem to approximately 1.2 miles downstream. No stream and riparian cleanup actions would be conducted in PineCrkSeg01 where extensive removal actions have been implemented by BLM. A detailed description of these actions can be found in Section 5.1.6.2 in the 2001 FS Report.

7.2.2.7 Mainstem SFCDR Watershed

The 2001 RI and FS Reports identified 173 source sites in the Mainstem SFCDR Watershed (USEPA, 2001c, 2001d), not including the Bunker Hill Box (OU 1 and OU 2). These sources include an estimated 4.7 million cy of metals-impacted sediment, 4.5 million cy of tailings, 2.1 million cy of waste rock, and 14 adits with drainage. A summary of the quantities of waste addressed using different types of remedial actions under Alternatives 3+ and 4+ for the Mainstem SFCDR Watershed is presented in Table 7-12, along with a summary of the quantities of waste addressed under Alternatives 3 and 4 in the 2001 FS for comparison.

Overviews of the remedial actions in the Mainstem SFCDR Watershed included in Alternatives 3+ and 4+ are provided in Figures 7-13 and 7-14, respectively.

Alternatives 3+ and 4+ consider the same sites for potential remedies for the Mainstem SFCDR Watershed as those outlined in Ecological Alternatives 3 and 4 in the 2001 FS Report. These proposed actions are described in detail in Section 5.1.7.3 in the 2001 FS Report and are included as part of the summaries provided in Section 7.1 above. The following table lists the number of sites with proposed actions and no proposed actions for Ecological Alternatives 3 and 4 and FFS Alternatives 3+ and 4+.

Number of Sites within Mainstem SFCDR Watershed	Alt. 3	Alt. 3+	Alt. 4	Alt. 4+
Sites with Proposed Action(s)	65	65	158	158
Sites with No Proposed Actions	108	108	15	15
Total	**173**	**173**	**173**	**173**

For the Mainstem SFCDR Watershed, the differences between Ecological Alternative 3 and Alternative 3+ and between Ecological Alternative 4 and Alternative 4+ are relatively minor in terms of the number of sites that changed from no proposed action to proposed action. The differences include:

- Two sites (OSB119 and WAL001) were considered active at the time of the 2001 FS Report and, on that basis, were not assigned a complete set of remedial actions. The TCDs have been modified for these sites in this FFS Report to provide a complete set of remedial actions.
- The assumptions for flow, metal concentrations, and remedial actions for six sites (KLE040, KLE048, KLE049, OSB065, OSB120, and WAL004) along the SFCDR with groundwater/surface water interactions were revised based on the results of the numerical groundwater flow model and field investigations, which were not available at the time of the 2001 FFS Report.
- The same water sources identified for treatment in Ecological Alternatives 3 and 4 in the 2001 FS Report are included in Alternatives 3+ and 4+, respectively, as sources of water to be treated. However, the water treatment TCDs applied to those water sources have been re-evaluated and are different from those applied in the 2001 FS.

In addition to the remedial actions discussed above, the same suite of stream and riparian cleanup TCDs included under Ecological Alternatives 3 and 4 in the 2001 FS Report have been included in Alternatives 3+ and 4+, respectively.

A watershed-based approach to stream and riparian cleanup actions would be applied to the Mainstem SFCDR Watershed, including the entirety of MidGradSeg01 and those portions of MidGradSeg02 outside the boundaries of OU 2.[2]

The stream and riparian cleanup actions would be intended to moderate the flashy hydrology of the stream system and to create a stable channel and floodplain morphology through the use of structural improvements to stabilize bedload and sediment transport processes. These actions would consist of the stabilization of stream banks, including the rebuilding of bank structure following contaminant excavation in some areas, and the stabilization and replanting of the floodplain and riparian zone to encourage regrowth of vegetation where conditions allow. The development of off-channel hydrologic features such as side channels, ponds, and wetlands would also be conducted where excavation and removal of floodplain contaminants creates depressions that provide development opportunities. These features would increase the hydraulic capacity of the floodplain, moderating the stream flow of the system and reducing the potential for erosive damage to remediated areas. In addition to the stabilizing effect these actions would have on the physical structure and functions of the stream system and floodplain, they would also improve ecological conditions for species and ecological communities of concern. A detailed description of these actions can be found in Section 5.1.7.2 in the 2001 FS Report.

In addition to the actions described above for OU 3, remedial alternatives in OU 2 are also included within the Mainstem SFCDR Watershed. These remedial alternatives are described in Section 7.2.3 below.

7.2.3 OU 2 Alternative Components [Alternatives (a) through (e)]

OU 2 Alternatives (a) through (e) consist of the following:

OU 2 Alternative (a) – Minimal Stream Lining
OU 2 Alternative (b) – Extensive Stream Lining
OU 2 Alternative (c) – French Drains
OU 2 Alternative (d) – Stream Lining/French Drain Combination
OU 2 Alternative (e) – Extensive Stream Lining/French Drain Combination

The components of these alternatives are discussed in detail in Section 6.3 and are part of a phased approach to remedy implementation. The Phase I remedy was implemented, and the results of the Phase I evaluation (CH2M HILL, 2007d; TerraGraphics and Ralston Hydrologic, 2006; CH2M HILL, 2008a) guided the identification of the remaining source sites of concern within OU 2 to be addressed as a part of Phase II. The focus of the Phase II remedial alternatives presented in this report is on dissolved metals contamination of groundwater and surface water. These OU 2 alternative components were not based on previously evaluated alternatives (as is the case for OU 3). Instead, they were developed by

[2] The OU 2 boundary in MidGradSeg02 extends from the upstream end of the segment at Montgomery Creek downstream to the confluence of Bear Creek and the SFCDR.

taking into consideration the source removal remedial actions completed to date and the effectiveness of those actions, and then identifying new remedial actions that have the potential to address significant portions of the remaining metals load to the SFCDR in the Bunker Hill "Box" (the Box).

The remedial alternative development focused on general response actions consisting of source control, water collection and management, and water treatment that were combined into the five potential OU 2 Alternatives (a) through (e). These alternatives are described in detail in Sections 6.3.4.1 through 6.3.4.5 for Alternatives (a) through (e), respectively. In addition, Figures 6-51 through 6-55 in Section 6.0 of this report depict the layout of OU 2 Alternatives (a) through (e), respectively.

Although each of the five OU 2 alternatives propose varying degrees of response actions, one water collection and management action—the Reed and Russell adit discharge—is same in each of the five alternatives. The action proposed for the Reed and Russell adit discharge is described in Section 6.3.2.2.

Figures 7-15 through 7-19 depict the water collection and treatment approaches for OU 3 Alternative 3+ as well as Alternatives (a) through (e) for OU 2. Figures 7-20 through 7-24 depict the water collection and treatment approaches for OU 3 Alternative 4+ and the five OU 2 alternatives.

7.2.4 Central Treatment Plant

The CTP is a major component of all alternatives considered in this FFS Report. Figures 7-15 through 7-24 present the water treatment approach for each remedial alternative (Alternatives 3+(a) through 3+(e) and Alternatives 4+(a) through 4+(e), respectively). The figures include all sites planned for active treatment at the CTP and the anticipated extent of conveyance pipelines. The location of sites planned for semi-passive onsite treatment is also depicted on the figures.

This section provides an overview of key elements of the anticipated upgrade of the CTP and the expansion of the CTP that would be needed to support any of the remedial alternatives considered in this FFS. The 2001 Bunker Hill Mine Water Management Remedial Investigation/Feasibility Study (RI/FS; USEPA, 2001c, 2001d) included plans to upgrade the CTP to provide consistent achievement of National Pollutant Discharge Elimination System (NPDES) discharge requirements. While some components of the OU 2 ROD Amendment were implemented by USEPA in 2003-2004, some upgrades have not been conducted. Due to funding constraints, the State of Idaho has not been able to sign a State Superfund Contract to allow full implementation of the water treatment upgrades. These upgrades need to comply with NPDES discharge requirements whether or not additional flows are sent to the CTP as a result of remedial actions in the Upper Basin. The CTP does not currently have sufficient capacity to treat any flows from any of the proposed remedial alternatives to levels consistent with applicable or relevant and appropriate requirements (ARARs), and would require expansion prior to, or in parallel with, implementation of the remedies that have a water treatment component.

7.2.4.1 History and Current Status of CTP

The current layout of the CTP and related features is shown in Figure 7-25. A CTP was built by the Bunker Hill Mining Company in 1974. Acid mine drainage (AMD) and Bunker Hill Mine Complex waters were stored in an unlined pond on top of the CIA before being decanted to the CTP. When the smelter closed in 1981, the Central Impoundment Area (CIA) was no longer needed to impound wastewater from the Complex, although surface runoff from the Complex and AMD from the mine was still routed to the CIA before treatment. Sludge that formed during the treatment process was also disposed of in unlined ponds on top of the CIA.

Ownership of the mine and surface facilities passed through a number of companies during the more than 100-year history of the site and finally ended up under the direction of the New Bunker Hill Mining Company (NBHMC). However, NBHMC did not purchase the CTP. Bunker Limited Partnership (BLP), and then the Gulf and Pintlar corporations as creditors of BLP, continued to operate the CTP using money from a trust fund established as part of the BLP bankruptcy. The federal and state governments assumed operation of the CTP in November 1994, following the bankruptcy of the Gulf and Pintlar corporations. In that same year, USEPA issued a Unilateral Administrative Order to NBHMC directing the company to keep the mine pool pumped to an elevation below the level of the South Fork to prevent discharges to the river, to convey mine water to the CTP for treatment unless an alternative form of treatment was approved, and to provide for emergency mine water storage within the mine. The CTP was operated by the BLP, under the direction of USEPA, from November 1994 to February 1996 using money from the BLP trust fund. At that time, it was determined that the BLP trust fund monies would be better spent on ongoing site cleanup.

Since February 1996, the ongoing treatment of AMD has been conducted and funded by the federal and state governments. The U.S. Army Corps of Engineers (USACE) currently operates the CTP for USEPA, including all associated mine water infrastructure components external to the mine. Those components include the AMD collection ditch at the Kellogg Tunnel Portal (the main entrance to the mine), the AMD conveyance pipelines going to the CTP and the Lined Pond (a 7-million-gallon lined AMD storage pond), the Lined Pond, the CTP, and the sludge disposal bed located on the CIA used for treatment residuals. The NBHMC is currently operating the Bunker Hill Mine and maintaining its infrastructure, including the AMD collection ditches within the mine, the mine pool pumping system used to pump the lower workings water to the 9 Level (the main operations level, which drains AMD out through the Kellogg Tunnel ditch system), and the Kellogg Tunnel itself.

The CTP was originally designed to use lime high-density sludge (HDS) treatment technology. This process uses lime to remove acidity and to precipitate the dissolved metals as hydroxides, which creates solids known as "sludge." The HDS process creates sludge of much higher density than conventional lime treatment. HDS sludge dewaters to a greater extent and requires much less disposal space than conventional lime sludge, thereby significantly reducing cost.

While originally designed as an HDS plant, the CTP must currently be operated in a "low-density sludge" mode that prevents the formation of true HDS. This is because the granular media filters, needed for polishing excess suspended solids from the thickener overflow, have been removed. The granular media filters were an older style that is no longer used and were removed because they did not work well and were maintenance intensive. Not having filters limits the amount of sludge that can be internally recycled in the CTP, and thus limits the sludge density obtainable. Filters are also needed to allow the CTP to consistently meet its current discharge standards established by an expired NPDES permit.[3] Excess solids periodically overflow into the plant effluent, increasing the concentration of zinc beyond discharge standards. New discharge standards, in conformance with current Idaho water quality standards, were established for the CTP as part of the Mine Water ROD Amendment (USEPA, 2001e). These new standards will be adopted once filters are constructed. Filter construction would also allow the plant to be operated in HDS mode.

The CTP currently treats AMD from the Bunker Hill Mine and a small amount of other site waters that are conveyed to the lined surface impoundment (Lined Pond). The AMD is conveyed from the Kellogg Tunnel (KT) portal where it flows into a concrete channel, passes through a Parshall flume for flow measurement, and then enters a buried high-density polyethylene (HDPE) pipeline that conveys it either directly to the CTP or to the Lined Pond depending on pipeline valve settings. The Lined Pond is a central collection reservoir for site waters. It collects the mine water, discharge from an old mine water pipeline, wash water from a vehicle decontamination station (West Decon Station), leachate from the smelter area Principal Threat Materials (PTM) closure, monitoring well development water, water from below the lead smelter closure area, and drainage from the smelter closure cover toe drain (although this is typically dry). The mine water and the discharge from the old mine water pipeline flow by gravity into the pond via separate pipelines. The Sweeny/004 pump station pumps the flow from the West Decon Station to the pond. The leachate from the PTM closure, the water from below the lead smelter closure area, and water from the smelter closure cover toe drain flow by gravity through a common pipeline to the pond.

The mine water flow from the Bunker Hill Mine is the largest of all flows currently treated at the CTP. On average it consists of more than 90 percent of all site waters being treated. The mine water also is the most contaminated of the site waters—it contains the highest concentration of dissolved metals, requires the most treatment chemicals, and generates the most sludge on a per-gallon basis.

The current design capacity of the CTP is about 5,000 gallons per minute (gpm), and its annual average flow is roughly 1,500 gpm; consequently, the CTP has excess (unused) treatment capacity during the lower flow periods of the year.

The CTP currently discharges into unlined Bunker Creek. Bunker Creek is an undesignated water body within the SFCDR Watershed. Under Idaho's water quality standards, beneficial uses for undesignated water bodies include cold-water biota (i.e., protection of freshwater aquatic life) and primary contact recreation (PCR) or secondary contact recreation (SCR).

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[3] Note that the CTP is operating under CERCLA, so that an NPDES permit is not needed (only the substantive requirements of NPDES need to be met). The plant operates under the expired permit because, until the improvements stipulated in the Mine Water ROD Amendment are made, it cannot consistently meet current water quality standards. Once those improvements are in place, the plant will be expected to meet current standards. An NPDES permit will not be issued, due to the plant's role in a CERCLA remedy, but it will need to comply with the same requirements as if a permit were issued.

Bunker Creek discharges into the SFCDR water body unit P-1, as defined in the State of Idaho water quality standards.

Since the 2002 Mine Water ROD Amendment (USEPA, 2001e) was issued, USEPA and the State of Idaho have moved forward with a number of CTP improvements specified in the CTP Master Plan in USEPA (2001e). The following improvements were performed as part of time critical actions taken to replace the most failure-prone equipment and plant systems:

- Replaced and upgraded the lime storage and feeding system;
- Refurbished the thickener;
- Updated the plant electrical system;
- Constructed a new control building and updated the plant control system, including new alarm systems;
- Increased the hydraulic capacity to 5,000 gpm by replacing the pipeline between the thickener and the polishing pond;
- Installed a backup diesel electrical generator and sound deadening enclosure; and
- Installed a new sludge recycle pump and a new disposal pipeline from the CTP to the unlined sludge disposal cell on top of the CIA.

Components of the CTP that have not been upgraded and are included in the CTP Master Plan include:

- Installation of 2,500-gpm of filters and associated piping and pump stations, and a new building to house the filters;
- Construction of a new A Reactor (sludge conditioning tank/rapid mix tank)
- Construction of a new B Reactor to replace the aeration basin
- Upgrade of the existing polymer makeup system
- Upgrades of remaining sludge recycling and wasting pumps
- Installation of an influent flow meter and replacement of the effluent Parshall flume

7.2.4.2 Addition of Other OU 2/OU 3 Waters to the CTP

Active water treatment at the CTP is proposed for both OU 2 and OU 3 site waters (groundwater and adit discharge) as part of all alternatives under evaluation. The quantity of water to be treated will be determined by the alternative selected: 3+ or 4+ for OU 3, and any water treatment alternative selected for OU 2. Active water treatment is included in OU 2 alternatives (c), (d), and (e).

Table 7-13 presents the estimated average and peak flows for sources included in Alternatives 3+ and 4+, including estimated flows from the Woodland Park French drains; the French drains in OU 2 Alternatives (c), (d), and (e); and the Bunker Hill Mine water.

Estimated total peak flows for active treatment at the CTP range from about 24,000 gpm [Alternative 3+(a)/(b)] to about 31,000 gpm [Alternative 4+(e)]. The combined peak flows for each alternative, including the Bunker Hill Mine water, are necessary for evaluating the anticipated design capacity of the CTP.

Water chemistry of the additional OU 2 and OU 3 waters is important for assessing treatment costs. The general chemistry parameters known as "lime demand" and "solids formed" are useful for this purpose. Lime demand and solids formed data provide an indication of the lime required to treat a unit volume and the quantity of sludge produced during treatment. All of the metals of concern are amenable to treatment by lime precipitation, which is the primary CTP treatment process, and the quantity of dissolved metals treated is typically proportional to the lime demand.

Available lime demand and solids formed data were used to generate an estimated total lime demand and solids formed for the combined OU 2 and OU 3 waters, including the Bunker Hill Mine water, and are presented in Table 7-14. The calculated lime demand ranges from about 1.2 to 1.6 pounds per thousand gallons (lb $Ca(OH)_2$/Kgal). The calculated solids formed ranges from about 1.1 to 1.5 lb/Kgal. These are relatively dilute compared to the Bunker Hill Mine water, which has an average lime demand of about 8.2 lb/Kgal and an average solids formed of about 8.6 lb/Kgal.

7.2.4.3 Canyon Creek Treatability Study

The additional OU 2 and OU 3 waters slated for CTP treatment in Alternatives 3+ and 4+ are much more dilute in concentration and acidity than the Bunker Hill Mine AMD that the CTP predominantly treats. To evaluate the impact of treating significantly more dilute waters, the lime neutralization/HDS treatment process to be used was evaluated in a 2005 treatability study (CH2M HILL, 2006c) using two pilot plants, one in which only Canyon Creek groundwater was treated, and one in which a mixture of Canyon Creek groundwater and Bunker Hill Mine AMD was treated.

The results showed that the more dilute waters could be effectively treated in terms of both sludge and effluent quality. The pilot plant treating Canyon Creek groundwater only developed significantly denser sludge than conventional lime neutralization systems. The system reached an equilibrium thickener underflow sludge concentration of 10 to 12 percent solids (by weight), which is considerably higher than the typical ~ 1 to 3 percent solids obtained by conventional treatment. The higher the sludge percent solids, the lower the volume of sludge requiring disposal and the lower the long-term cost.

The pilot plant treating a combination of Canyon Creek groundwater and Bunker Hill AMD (in a 2:1 volume ratio) developed a denser sludge with an equilibrium sludge solids concentration of about 25 percent solids. This was due to the higher unit volume of dissolved metals contributed by the mine water and resulting improvement of lime adsorption on recycle sludge—a key requirement for successful HDS process performance. The CTP currently generates sludge consisting of 1 to 5 percent solids due to the sludge recycle limitations described previously.

Both pilot plants achieved high removal efficiencies for dissolved cadmium and zinc. Removal of dissolved zinc, which comprised most of the target metals mass, was greater than 99 percent in both systems. At system equilibrium, dissolved cadmium and zinc concentrations were less than the expected CTP discharge limits, while total cadmium and zinc concentrations routinely exceeded these limits, indicating the need for media filtration of the effluent.

The treatability study demonstrated that the lime neutralization/HDS treatment process can meet the discharge targets over the full anticipated range of influent strengths observed in OU 2 and OU 3. However, media filters would be required to meet discharge limits.

Tests performed during this study were used to evaluate whether the current CTP thickener is adequately sized for treatment of the additional Canyon Creek water. Results indicate the existing CTP thickener could process up to approximately 30,000 gpm of combined OU 2 and OU 3 waters, which includes the Bunker Hill Mine AMD. Addition of media filters would be needed to reduce the effluent total suspended solids (TSS) and associated suspended metal.

7.2.4.4 Treatment Performance

7.2.4.4.1 Anticipated Lime Usage and Sludge Generation

Table 7-14 presents the anticipated lime demand and solids formed and subsequent lime usage and sludge generation rates for the combined OU 2 and OU 3 waters, including the Bunker Hill Mine water, to be treated at the CTP for each alternative. These lime usage and sludge generation rates were calculated using available lime demand and solids formed data as described in Section 7.2.4.2 above. The sludge properties were interpolated using known properties of the existing CTP sludge and the sludge properties measured during the Canyon Creek groundwater treatability study. The lime usage and sludge generation rates presented in Table 7-14 represent the annual average usage and generation rates following implementation of all active water treatment components of each potential alternative. The active treatment components will likely be implemented over a number of years, and the actual time until the full usage and generation rates is reached will depend on the implementation time frame. Therefore, the volume of sludge produced annually and requiring disposal will depend not only on the flow rates and aggregate chemistry entering the CTP, but also on the timing of when individual sources are treated.

7.2.4.4.2 Discharge Limits

The treated CTP effluent currently discharges to Bunker Creek and comprises much of the flow in Bunker Creek, particularly its headwaters, during the lower flow periods of the year. CWA controls are generally imposed on discharges to waters of the United States through NPDES permits, which are issued on an individual basis in the Coeur d'Alene Basin by USEPA Region 10. Because discharges from the CTP occur within the Superfund site and are part of Superfund cleanup actions, an NPDES permit is not required. However, the discharge must meet the substantive requirements of ARARs, including the provisions of the CWA, identified as part of the Superfund cleanup process for the site.

The current CTP discharge requirements (Table 7-15) are pursuant to an expired NPDES permit (Permit No. ID 000007-8) for the CTP, which was effective from October 1986 and expired in October 1991. Future CTP expansion and upgrades to treat additional OU 2 and OU 3 waters will require the CTP discharge to meet new effluent limits. The new effluent limits, as well as the current limits, are provided in the *CTP Discharge Quality and Monitoring*

Plan (CH2M HILL, 2007g) and presented in Table 7-16. The CWA, state and federal regulations, and USEPA's 1991 *Technical Support Document for Water Quality-Based Toxics Control* (USEPA, 1991b) were used as guidelines for developing these limits. In general, the CWA requires that the effluent limits for a particular pollutant be the more stringent of either technology-based limits or water quality-based limits. USEPA evaluates the technology-based limits to determine whether they are adequate to ensure that water quality standards are met in the receiving water. If the limits are not adequate, USEPA develops more stringent water quality-based limits. Water quality-based limits are established to prevent exceedances of the Idaho water quality standards in the receiving waters. The water quality-based limits are for pH, dissolved oxygen (DO), temperature, and metals. The concentration-based limits for TSS are technology based.

Table 7-16 lists the maximum daily and monthly limits as a concentration. The maximum daily and monthly limit in pounds per day would be determined during remedy implementation and would be based on actual treatment capacity and the phase of CTP improvements.

7.2.4.5 CTP Upgrades to Treat Combined OU 2/OU 3 Waters

Expansion and upgrades to the CTP are required to meet water quality standards and to treat the additional flows from OU 2 and OU 3 sources regardless of which alternative is selected as the Preferred Alternative. CTP expansion and upgrades will be implemented in a two-phased approach as outlined in the CTP Master Plan and based on the required capacity of the CTP to treat the OU 2 and OU 3 waters. The phased approach of the CTP Master Plan was designed for the treatment of Bunker Hill Mine AMD; however, even though the capacity of the CTP will significantly increase with the additional OU 2 and OU 3 waters, the objectives of the CTP Master Plan remain unchanged. These objectives include:

- Provide acceptable effluent quality that is compliant with the site-specific Idaho water quality standards and other applicable requirements;
- Minimize sludge production;
- Provide system reliability; and
- Provide acceptable capital and operating costs.

Table 7-17 lists the components of the CTP requiring upgrade or expansion and identifies the implementation of each component in the two phases of planned expansion. During Phase 1, all components of the CTP except for the two B Reactors and media filters will be upgraded to achieve the maximum hydraulic capacity of the selected alternative. The B Reactors will each be sized for one-half of the maximum design flow; one each installed during Phase 1 and Phase 2. The media filters will be installed as needed based on the operating capacity of the CTP and the timing of when source waters are to be treated.

Components of the existing CTP that do not require upgrades and are sufficient for use in the expanded CTP to treat the combined OU 2 and OU 3 waters include the thickener tank, thickener rake drive and rake, control building, and the lime system. Depending on the total electrical load, a second backup power generator may be needed.

Estimated costs (capital and operation and maintenance [O&M]) for each alternative for CTP expansion and upgrades are presented in Table 7-18; these costs do not include the cost of treating the Bunker Hill Mine water. These costs are based on the information presented in Attachment D-1 to Appendix D in this FFS Report.

7.2.4.6 CTP Operations

Components of the Selected Remedy requiring active treatment at the CTP will be monitored and controlled from the existing control room of the CTP. The current CTP control building was constructed in 2006, and the plant control system has the capability, after expansion, to monitor and control the components (pump stations, conveyance pipeline valves, adit drainage) and flows of the additional source waters.

The CTP operators will centrally control many of the water collection and conveyance systems from the CTP control room. The controls will include the capability to independently adjust the flows, stop the flow from single sources or groups of sources, or divert the flows into the Lined Pond. This will be necessary during peak runoff if flows exceed CTP capacity, or when the CTP may be offline for repair.

Operational labor is expected to increase only slightly compared to current staffing levels following implementation of the CTP expansion and upgrades for treatment of additional OU 2 and OU 3 waters. The CTP components (i.e., lime system, polymer makeup system, and system controls) will be largely automated, thereby reducing labor. Additional lime and polymer (which is used to enhance solids settling in the thickener) will be required, and additional sludge will be generated, as described below.

7.2.4.7 Sludge Management

Table 7-14 presents the estimated annual sludge generation rates from the CTP[4] for each potential alternative. The estimated dewatered volume of sludge generated by the 10 alternatives ranges from about 8,900 to 15,000 cubic yards per year (cy/yr). The alternatives with treatment of OU 2 groundwater would produce about 12,000 to 14,000 cy/yr of dewatered sludge. Actual sludge generation will depend on the water chemistry of the combined OU 2 and OU 3 waters, and the volume of water treated.

Under current operating conditions, the existing unlined sludge disposal cell on top of the CIA will reach capacity in about 12 years (2022). The cell would be filled in about 3 to 5 years if all potential Alternative 3+ and 4+ waters were treated. The actual time until the existing capacity is reached will depend on the implementation schedule of the Selected Remedy (i.e., how quickly additional flows are added to the CTP).

Future sludge management actions would need to be planned and implemented, including closure of the existing unlined sludge disposal cell and construction of a new lined cell on the CIA, consistent with the 2001 Mine Water ROD Amendment as follows:

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[4] In addition to sludge generated at the CTP, treatment residuals will be generated from the onsite semi-passive systems, although the volumes generated (190 cy/y for Alternative 3+ and 330 cy/yr for Alternative 4+) are relatively small compared with the volumes of sludge generated at the CTP.

1. Execute upgrades to the CTP to enable operation in HDS mode. These upgrades will significantly reduce the volume of sludge produced compared to the current mode of operation;
2. Reevaluate whether additional regional sludge disposal capacity has become available as part of the Upper Basin (OU 3) cleanup efforts that would make offsite disposal more cost-effective. If so, pursue offsite sludge disposal. If not, construct one 10-year disposal bed on the CIA and close the existing sludge disposal area using a capping system similar to the rest of the CIA;
3. Reconsider Step 2 before the construction of additional sludge beds on the CIA.

Unless more economical disposal is identified, when the existing sludge disposal cell nears capacity, a new lined disposal cell would be constructed atop the CIA at the southeast end near the CTP. Although the 2001 Mine Water ROD Amendment specifies construction of a 10-year cell, a longer-term cell having more capacity may be more cost-effective and would be considered during remedy design. The new cell would be lined with a polyvinyl chloride (PVC) or HDPE (or equivalent) low-permeability liner system. A drainage system would be installed to collect water that drains from the sludge. This water would be piped to the CTP for treatment. The existing unlined disposal cell would be capped with a low-permeability liner similar to the remaining CIA. Before the capacity of this new cell is reached, the availability of a more cost-effective sludge disposal method would be assessed. If no other method is available, another new cell would be constructed and the prior cell would be capped when full. Costs were developed for constructing a new lined disposal cell having a 30-year life, O&M of this cell, and closure of the existing disposal cell. These are shown in Table 7-19.

7.3 Evaluation of Remedial Alternatives

This section presents the evaluation of each Upper Basin alternative against the CERCLA threshold criteria and primary balancing criteria. An assessment of the modifying criteria (state, Tribal, and community acceptance) will be presented in the ROD Amendment for the Upper Coeur d'Alene Basin. This section is organized as follows:

- **Section 7.3.1:** Discussion of each CERCLA evaluation criterion;
- **Section 7.3.2:** Description of the methods used for the remedial action effectiveness evaluation, including discussions of the numerical groundwater model and the Predictive Analysis; and
- **Sections 7.3.3 through 7.3.13:** Analysis of the alternatives with respect to CERCLA criteria for each of the 10 remedial alternatives and the No Action Alternative.

For each alternative, the analysis is conducted separately for the OU 3 and OU 2 components of the alternative and then for the combined alternative. The analysis has been divided in this manner to reduce repetition within this section since the OU 3 components of Alternatives 3+(a), 3+(b), 3+(c), 3+(d), and 3+(e) are identical. Similarly, the OU 3 components of Alternatives 4+(a), 4+(b), 4+(c), 4+(d), and 4+(e) are identical. Analysis of the OU 3 components of Alternative 3+ is presented in Section 7.3.2 [Alternative 3+(a)] but is not repeated as part of the discussion of Alternatives 3+(b), 3+(c), 3+(d), and 3+(e). Analysis of the OU 3 components of Alternative 4+ is presented in Section 7.3.7 [Alternative 4+(a)].

7.3.1 CERCLA Evaluation Criteria

As discussed in Section 1.0 of this FFS Report, there are nine CERCLA evaluation criteria [Section 300.430 (e)(9)(iii) of the National Contingency Plan (NCP)]. These nine criteria are subdivided into three categories: Threshold Criteria, Primary Balancing Criteria, and Modifying Criteria. The nine CERCLA criteria, grouped by category, are as follows:

Threshold Criteria
1. Overall protection of human health and the environment
2. Compliance with ARARs

Primary Balancing Criteria
3. Long-term effectiveness and permanence
4. Reduction of toxicity, mobility, or volume through treatment
5. Short-term effectiveness
6. Implementability
7. Cost of implementation

Modifying Criteria
8. State and Tribal acceptance
9. Community acceptance

The three criteria categories are based on the role of each criterion during the evaluation and remedy selection process. The two Threshold Criteria relate directly to statutory requirements that must be satisfied by a selected alternative,[5] as ultimately documented in a ROD. The five Primary Balancing Criteria represent the primary technical, cost, institutional, and risk factors that form the basis of the evaluation. The two Modifying Criteria will be evaluated in the ROD Amendment following the receipt of state agency, Tribal, and public comments on the FFS Report and the Proposed Plan.

Since the two Modifying Criteria are not evaluated in the FFS, seven CERCLA criteria guide the evaluation presented in this FFS Report. The basis for the evaluation of the seven criteria is discussed in the following subsections. A summary of the nine CERCLA criteria is also provided in Table 7-20.

[5] Specific ARARs can be waived if appropriately justified [40 *Code of Federal Regulations* [CFR] 300.430(f)(1)(ii)(C)].

7.3.1.1 Overall Protection of Human Health and the Environment

Remedial alternatives are assessed to determine whether they can adequately protect human health and the environment. A Selected Remedy must be protective of human health and the environment. This mandatory threshold requirement is the primary objective of the remedial program. The criterion of overall protection of human health and the environment is an integration of the balancing criteria (particularly long-term effectiveness and permanence and short-term effectiveness) as well as compliance with ARARs. The integration includes consideration of how risks posed through each exposure pathway are eliminated, reduced, or controlled by the alternative—by treatment, engineering controls, institutional controls, or combinations of treatment and controls. Evaluation of this criterion also includes consideration of whether any unacceptable short-term or cross-media effects are posed by an alternative.

The evaluation provides a unified assessment of the balancing criteria and includes focused consideration of the rapidity, reliability, and permanence of the protection provided by each alternative. The combined effect of containment, treatment, and institutional controls is evaluated considering that a period of natural source depletion following completion of remedial action would be required to reach remediation goals and be fully compliant with ARARs.

7.3.1.2 Compliance with ARARs

Remedial alternatives are assessed to determine whether they attain ARARs under federal environmental laws and state environmental or facility siting laws, or whether they provide justification for invoking a waiver. In addition, the Coeur d'Alene Tribe owns land in the Upper Basin, and the Tribe's environmental standards must also be met for actions taken on Tribal lands. A selected remedy must either attain ARARs or justify the invocation of a waiver.. ARARs include cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that are either:

1. "Applicable" and specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a cleanup site, or
2. "Relevant and appropriate" and address problems or situations sufficiently similar to those encountered at the site that their use is suited to the particular site.

ARARs are divided into three primary categories: chemical-specific, location-specific, and action-specific. In general, chemical- and location-specific ARARs provide the basis for determining the objectives and goals of remedial action, whereas the action-specific ARARs provide the basis for determining how the remedial action will be carried out. Potential chemical-specific, location-specific, and action-specific ARARs used in the evaluation are identified in Section 4.0.

Post-remediation water quality, and therefore, compliance with ARARs, was assessed in the FFS using the numerical groundwater model for the SFCDR Watershed (CH2M HILL, 2009d) and the Predictive Analysis (USEPA, 2007). A description of the process by which remedial action effectiveness is evaluated is presented in Section 7.3.2.

7.3.1.3 Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence criterion relates to the magnitude of residual risks following remedy implementation and the adequacy and reliability of controls related to maintaining remedy effectiveness over time. Generally, the following factors are considered in the assessment of long-term effectiveness and permanence:

- Nature and magnitude of residual risks remaining from untreated waste or treatment residuals remaining at the end of remedial activities. The residual risks are considered from the standpoints of volume or concentration and potential for exposure of environmental receptors. The characteristics of the residuals or untreated waste are considered in terms of their persistence, toxicity, mobility, and propensity (if any) to bioaccumulate;
- The type, degree, and adequacy of long-term management required for untreated waste and treatment residuals, including engineering controls, institutional controls, monitoring, and operation and maintenance;
- Long-term reliability of the engineering and institutional controls, including uncertainties associated with land disposal of residuals and untreated wastes; and
- Potential need for replacement of the remedy and the continuing need for repairs to maintain the performance of the remedy.

Residual metals loading in surface water following remedy implementation, and therefore, long-term effectiveness and permanence, were assessed in the FFS using the numerical groundwater model for the SFCDR Watershed (CH2M HILL, 2009d) and the Predictive Analysis (USEPA, 2007). A description of the process by which remedial action effectiveness is evaluated is presented in Section 7.3.2.

7.3.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The treatment criterion relates to the statutory preference for treatment technologies that permanently reduce the toxicity, mobility, or volume of hazardous substances as their principal element. Satisfaction of this preference occurs for inorganic chemicals when treatment is used to reduce the principal threats at a site through reduction of the total mass of toxic contaminants, irreversible reduction in contaminant mobility, or reduction of total volume of contaminated media. Generally, the following factors are considered in the assessment of this criterion:

- Treatment processes and the materials to be treated;
- Amount of hazardous contaminants to be destroyed or treated;
- Degree of expected reduction in contaminant toxicity, mobility, or volume;
- Degree to which the treatment is irreversible; and
- Quantity and type of residuals that will remain following treatment, considering their persistence, toxicity, and mobility.

The statutory preference (but not necessarily the criterion) for reduction of toxicity, mobility, or volume through treatment is satisfied when treatment is used for the "principal threats" at the site. The NCP establishes an expectation that treatment will be used to address the principal threats posed by a site wherever practicable [40 Code of Federal

Regulations [CFR] 300.430(a)(1)(iii)(A)]. Where USEPA determines that it is not practicable to use treatment to address principal threat wastes, such waste may be transported offsite, consistent with the Off-Site Disposal Rule, 40 CFR 300.440, or managed safely onsite, consistent with all potential ARARs identified in this document. This may include containment and consolidation in a repository cell that includes a secure liner system.

USEPA has also established an expectation for use of engineering controls, such as containment, for waste that poses a relatively low, long-term threat or where treatment is impracticable [40 CFR 300.430(a)(1)(iii)(B)]. The extent of satisfaction of the preference is documented in the ROD, based on the Selected Remedy.

The "principal threat" concept is applied to the characterization of source materials. A source material is a material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to groundwater, surface water, or air, or acts as a source for direct exposure. Principal threat materials (PTM) are source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained and/or would present a significant risk to human health or the environment should exposure occur. PTM in the Coeur d'Alene Basin may include, for example, metal concentrates spilled during mill operations or in transport to smelters. They may also exist at other undetermined locations in the Upper Basin.

Each alternative is evaluated for the degree of reduction of toxicity, mobility, or volume through treatment. Note that alternatives that do not include treatment could still satisfy the statutory preference for treatment if (1) no principal threats are present, or (2) treatment is found to be impracticable.

7.3.1.5 Short-Term Effectiveness

The short-term effectiveness criterion relates to potential effects of the alternative during the construction and implementation phase of the remedy until remedial action objectives have been met. Each alternative is evaluated in terms of its effectiveness in protecting human health and the environment during this construction and implementation phase. The following factors that are potentially present during remedy construction and implementation are considered:

- Short-term risks that might be posed to the community (e.g., traffic-related risks from trucking of excavated material through a community to a repository) and the potential mitigation than can (or cannot) be used during construction and implementation;
- Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures (e.g., airborne dust controls to minimize worker exposure to airborne contaminants);
- Potential environmental impacts of the remedial action (e.g., adverse short-term impacts on aquatic organisms or habitat due to excavation of contaminated media)[6] and the

[6] This could be a major concern for extensive floodplain excavations that may result in significant erosion/deposition and metal mobilization or destruction of habitat. The magnitude and duration of any such effects would depend on the remedial action and where and how it was implemented, including the nature and extent of mitigation measures.

effectiveness and reliability of available mitigation measures during construction and implementation; and

- Time until response objectives are achieved, including remedial action objectives and any specific threats.

A description of the process by which remedial action effectiveness is evaluated is presented in Section 7.3.2.

7.3.1.6 Implementability

The implementability criterion relates to the technical and administrative feasibility of implementing an alternative and the availability of services and materials required for implementation. In general, the technical feasibility, administrative feasibility, and availability factors evaluated for each alternative are as follows:

- **Technical Feasibility**
  - Degree of difficulty or uncertainty associated with construction and operation of the technology associated with the alternative
  - Expected operational reliability of the technologies associated with the alternatives and the ability to undertake additional or supplemental action, if required
  - Extent to which innovative or untried technologies are used, and associated risks or needed treatability studies (this could include *in situ* and *ex situ* semi-passive water treatment systems)
  - Ability to monitor the effectiveness of the alternative, including potential exposure risks should monitoring not detect a "failure" of the alternative
- **Administrative Feasibility**
  - Ability and time required to meet the substantive requirements of (or otherwise obtain) any necessary approvals or permits from regulatory agencies
  - Activities needed to coordinate with other agencies and Tribe(s)
- **Availability of Services and Materials**
  - Availability of necessary equipment and skilled workers
  - Available capacity and location of needed treatment, storage, and disposal services
  - Availability of prospective technologies under consideration
  - Availability of (clean) backfill and topsoil

It may be anticipated that some alternatives could have significant problematic implementability issues related to regional implementation of large-scale repositories, active water treatment facilities, hydraulic isolation (use of groundwater cut-off walls and stream liners with collection and treatment of groundwater), and extensive removals (and backfilling or replacement) of impacted sediments in floodplains (in rivers, wetlands, or lakes).

7.3.1.7 Cost of Implementation

The estimated cost of implementation for each alternative is developed on a present value basis. Estimated costs include the sum of direct capital costs, indirect capital costs, and O&M costs, as follows:

- **Direct Capital Costs** – Capital costs consist of direct and indirect capital costs. Direct capital costs are commonly referred to as construction costs and consist of the equipment, labor, and materials necessary to install remedial actions. Direct capital costs specifically include costs associated with containment, treatment, or the removal, transport and disposal of affected media, including soil, sediment, and water.

- **Indirect Capital Costs** – Indirect capital costs consist of expenditures required to complete the implementation of a remedial alternative, including contingency costs that are not included as a direct capital cost. Such indirect capital costs include general requirements (e.g., mobilization and demobilization, quality assurance/quality control, temporary facilities, bonds, and insurance), engineering, construction management, and contract administration. Although these indirect capital costs may be referred to as "nonconstruction" and overhead costs, they are required to implement the remedy. The contingency cost is calculated as a percentage of the sum of direct capital costs plus the nonconstruction and overhead portion of the indirect capital costs. The contingency cost is an estimate of costs not otherwise included in the direct and indirect costs. It is an allowance for potential costs associated with adverse site, design, or construction conditions not otherwise anticipated in the cost estimate. The contingency does not include any potential future remedial action costs associated with failure of the remedy to perform within expected limits.

- **Operation and Maintenance Costs** – Annual O&M costs consist of post-construction costs necessary for continued effectiveness of the remedial action. O&M costs do not include a contingency for potential future remedial actions costs associated with failure of the remedy to perform within expected limits. Annual O&M costs do include:

  - Operating labor, materials, utilities, and administration
  - Disposal of treatment residues (e.g., sludge from water treatment plant operation)
  - Routine and special maintenance
  - Rehabilitation as structures or equipment wear out or fail over time
  - Insurance, taxes, licensing fees, or the like
  - Long-term monitoring, including planning, sampling, analysis, and reporting
  - Periodic site reviews[7] of the remedy

The total cost of each alternative is represented as a net present value (NPV) cost. The net present value cost is the sum of the direct and indirect capital costs and the net present value of the annual O&M cost over the period of performance of the alternative. Because remedial actions have not been staged or phased over time in the FFS, all capital costs are considered net present value costs assuming year 2009 dollars. Consistent with current CERCLA guidance, estimates of O&M present worth costs assume a discount rate of

[7] Site reviews must be conducted at least every 5 years if wastes above health-based levels remain within the site.

7 percent[8] and a 30-year period of performance. Consistent with RI/FS guidance (USEPA 1988b), the goal of the FFS cost estimate is to achieve an accuracy of approximately –30 percent to +50 percent on the present value cost of each alternative as a whole.

7.3.2 Remedial Action Effectiveness Evaluation

Remedial action effectiveness was evaluated in this FFS using both the numerical groundwater models (CH2M HILL, 2007a, 2009d) and the Predictive Analysis (USEPA, 2007). In general, the groundwater models were used to estimate metals load reductions for actions involving groundwater collection, and the Predictive Analysis was used to estimate load reductions for remaining actions within the alternatives. The following subsections describe the groundwater model, and how it was used to support analyses in the FFS, and the Predictive Analysis, including how the Predictive Analysis and groundwater model results are integrated with one another to estimate post-remediation water quality for each alternative.

The Predictive Analysis was used to estimate post-remediation loads under average annual conditions. Therefore, the groundwater models also were used to develop load reduction estimates for average annual conditions to allow integration of the two sets of results. However, there are advantages and disadvantages in using average annual conditions to assess future water quality. These advantages and disadvantages are also discussed below in Section 7.3.2.2.5, where model uncertainties are presented.

7.3.2.1 Numerical Groundwater Model

The National Academy of Sciences (NAS) conducted a review of the Interim ROD for OU 3 and documented the results of that review in *Superfund and Mining Megasites: Lessons from the Coeur d'Alene River Basin* (NAS, 2005). The study concluded that, although adequate characterization of the extent of metals contamination in soil, sediment, and surface water was presented, the major source of dissolved metals to the surface water system, groundwater discharge, was not characterized or fully addressed. In conducting the RI/FS for the Coeur d'Alene Basin, USEPA recognized the importance of groundwater, particularly as a transport medium for releasing hazardous substances to the surface water system, and the complexities of gaining or losing reaches of streams in this transport. However, the agency did not specifically seek to characterize the groundwater systems or select comprehensive cleanup remedies for groundwater. Instead, it primarily focused on the sources of contamination and the surface waters that ultimately received these contaminants. In response to the NAS concerns and to better understand the complex contaminant transport systems, it was determined that it would be useful to develop a quantitative tool that could be used to evaluate the spatially varying components of the water budget and dissolved metals loading budget.

Two numerical groundwater flow models were developed, and both use the same modeling platform: one for the Canyon Creek Watershed (CH2M HILL, 2007a), and one for the

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[8] A discount rate, which is similar to an interest rate, is used to account for the time value of money. In accordance with USEPA guidance, the specified rate of 7 percent is intended to represent a "real" discount rate in that it approximates the marginal pre-tax rate of return on an average investment in the private sector in recent years and has been adjusted to eliminate the effect of expected inflation.

SFCDR Watershed (CH2M HILL, 2009d). This was done to better characterize the distribution of dissolved metals loading from the groundwater system under current conditions and to evaluate various remedial actions. Specific objectives of the groundwater modeling effort included:

- Characterizing the hydrogeology of the SFCDR Watershed
- Developing a quantitative representation of stratigraphy and aquifer properties throughout the SFCDR Watershed
- Quantifying the distribution and extent of surface water/groundwater interaction
- Developing water budgets for selected areas of the SFCDR Watershed
- Developing dissolved metals loading budgets for selected areas of concern within the Upper Basin

The following subsections discuss groundwater model development, estimates of baseline-dissolved metals loading from groundwater to surface water, and remedial alternative simulations conducted using the models.

7.3.2.1.1 Groundwater Model Development

Full groundwater flow model documentation is presented in the *Canyon Creek Hydrologic Study Report* (CH2M HILL, 2007a) and *South Fork of the Coeur d'Alene River Watershed: Basinwide Groundwater Flow Model Documentation* (CH2M HILL, 2009d). A detailed description of updates to the groundwater flow models that have been performed subsequent to preparation of the documents cited above is included in Appendix A of this FFS Report. Both groundwater flow models were constructed using the MicroFEM© modeling package (Hemker and Nijsten, 2003), an integrated groundwater modeling software program developed in the Netherlands. MicroFEM was chosen as the modeling platform for both the Canyon Creek and SFCDR Watersheds because the finite-element gridding algorithm allowed for the construction of model grids covering large geographic areas with very fine node spacing in areas of interest and coarser node spacing in more distal areas of the model. This allowed for development of modeling tools that not only provided very high resolution estimates of the distribution and magnitude of dissolved metals loading in areas where remedial actions were considered, but also incorporated the variability of hydrologic processes throughout the SFCDR Watershed.

The Canyon Creek Watershed model grid consists of 42,086 surface nodes and 83,785 elements in each of the five model layers. Nodal spacing was refined to as little as 2 feet in the vicinity of groundwater monitoring well clusters, 20 feet in the Woodland Park area, and as much as approximately 850 feet near the model boundary. The lateral extent of the model grid represents the approximate extent of the Canyon Creek Watershed, roughly 22 square miles, as defined by the topographic divide (ridgeline). The five model layers were divided to simulate aquifer systems in the alluvium, the weathered bedrock horizon, and the bedrock system.

The SFCDR Watershed model grid consists of 134,545 surface nodes and 268,631 elements in each of the six model layers. Nodal spacing was refined in areas to as little as 25 feet in areas where analysis of remedial actions was anticipated. The lateral extent of the model grid represents the approximate extent of the SFCDR Watershed, roughly 300 square miles, as defined by the topographic divide (ridgeline). The six model layers were divided to simulate aquifer systems in the alluvial systems of the SFCDR and major tributary valleys, the weathered bedrock horizon, and the bedrock system.

The distribution of physical properties implemented in the numerical models such as ground surface elevation, saturated alluvial thickness, and hydraulic conductivity were developed using available measured data.

Better definition of the nature and magnitude of the surface water/groundwater interaction in key areas of the SFCDR basin was a primary objective of this modeling effort. To achieve this objective, the MicroFEM© wadi-package (a two-way head-dependent boundary condition) was used to simulate loss from and groundwater discharge to streams and tailings ponds within the model domains. Stream and pond elevations were interpolated from U.S. Geological Survey (USGS) contours included on quad sheets, or digitized topographic maps, or site-specific survey data. The effects of subsurface groundwater interception drains was also a key component of many of the remedial actions evaluated using the modeling tools. The MicroFEM© drain-package (a one-way head-dependent boundary condition) was used to estimate the effectiveness of the French drains used in remedial action scenarios.

Groundwater flow model calibration is a process in which the ability of the model to replicate a series of measured data is tested. This process ensures that the numerical models accurately replicate the hydrologic processes observed in the watersheds, and that they are reliable tools to forecast future hydraulic conditions in response to changes in the natural system that may occur with the implementation of remedial actions. Both groundwater flow models were initially calibrated to base-flow hydrologic conditions. This was done because, during the late summer/fall, most significant surface water runoff contributions to streamflow cease, and the majority of the remaining flow in the streams is sustained by groundwater discharge. Both the Canyon Creek and SFCDR Watershed models were calibrated to a series of observed base-flow hydrologic characteristics (complete descriptions of model construction and base-flow calibration can be found in CH2M HILL [2007a] and CH2M HILL [2009d]).

In order to evaluate the effectiveness of the various remedial actions under a variety of hydrologic conditions, the numerical models were also calibrated to additional flow conditions. In addition to the initial base-flow calibration, the models were calibrated to steady-state conditions under the 7Q10[9] (approximately 68 cubic feet per second [cfs]) and 90 percent (approximately 1,290 cfs) flow conditions, as defined for the SFCDR stream gauge at Pinehurst. As a final calibration step, both numerical models were calibrated to transient flow conditions observed between July 1, 2008, and June 30, 2009. This calibration step provided estimates of average annual dissolved metals loads that were integrated into the Predictive Analysis, as described in Section 7.3.2.2. Targets used during the calibration to the various hydrologic conditions include:

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[9] 7Q10 is defined as the lowest average 7-consecutive-day low flow with an average recurrence frequency of once in 10 years.

- **Base-Flow Calibrations**: Base flow measured in Canyon Creek at the USGS gauging station near the mouth[10] during fall 2006 and the SFCDR at the USGS Pinehurst[11] gauge during fall 2008;
- **Base-Flow Calibrations**: Groundwater elevations measured in monitoring wells and piezometers during fall 2006 (Canyon Creek) and fall 2008 (SFCDR);
- **Base-Flow Calibrations**: Horizontal and vertical hydraulic gradients;
- **Base-Flow Calibrations**: Observed gaining and losing stream reaches of Canyon Creek and the SFCDR measured during base-flow groundwater/surface water interaction studies;
- **7Q10 Calibrations:** Groundwater elevations measured in monitoring wells during fall 2001 (SFCDR);
- **7Q10 Calibrations:** Base flow measured in Canyon Creek at the USGS gauging station near the mouth and the SFCDR at the USGS Pinehurst gauge during fall 2001;
- **90th Percentile Calibrations:** Groundwater elevations measured in monitoring wells and piezometers on April 20, 2009 (Canyon Creek and SFCDR);
- **Transient Annual Calibrations:** Average daily groundwater elevations measured in monitoring wells and piezometers between July 1, 2008, and June 30, 2009 (Canyon Creek and SFCDR);
- **All Calibrations**: Response of the aquifer system to high-stage events during the spring 2006 (Canyon Creek) and spring 2008 (SFCDR) runoff periods was used to refine estimates of streambed properties for all hydrologic conditions; and
- **All Calibrations**: Response of the aquifer system to short-term aquifer tests in the Woodland Park area of the Canyon Creek Watershed model was used to refine estimates of aquifer properties.

A full description of the various steady-state and transient calibrations is provided in Appendix A.

7.3.2.1.2 Baseline Dissolved Metals Loading to Surface Water

The calibrated groundwater flow models were used to develop estimates of the water budget components in the Bunker Hill Box, Osburn Flats, and Woodland Park and the resulting baseline dissolved metals loadings to Canyon Creek and the SFCDR. The numerical models described herein are groundwater flow models only; therefore, metals transport and geochemical reactions are not directly simulated. The methodology that was used to develop estimates of dissolved metals loading to specific segments of Canyon Creek and the SFCDR uses a combination of simulated groundwater discharge rates to the surface water system and measured dissolved metals concentrations in groundwater monitoring

10 http://waterdata.usgs.gov/nwis/nwisman/?site_no=12413125&agency_cd=USGS

11 http://nwis.waterdata.usgs.gov/id/nwis/nwisman/?site_no=12413470&agency_cd=USGS

wells and piezometers. This methodology assumes that (a) dissolved zinc can be used as a surrogate for other metals (i.e., the reaches with the greatest zinc loads are also areas with the highest cadmium loads), and (b) there is no change in dissolved metals concentrations in groundwater between the location of the groundwater monitoring well and the area of groundwater discharge into the stream (i.e., metals transport in the groundwater system is conservative between the monitoring well and groundwater discharge area to streams).

As described in the Canyon Creek Hydrologic Study (CH2M HILL, 2007a), the Woodland Park area of the Canyon Creek Watershed was divided into 12 reaches based on the distribution of monitoring wells within the area. Analytical data from fall 2006 were used for loading estimates for the Canyon Creek Watershed for all flow conditions, because this represents the most recent and comprehensive groundwater-sampling program. A similar methodology was used to estimate dissolved metals loadings to the SFCDR within the Box. The SFCDR and tributary streams were divided into 29 reaches based on the distribution of groundwater monitoring wells and piezometers adjacent to the streams. Dissolved zinc concentration datasets that were used for the various steady state and transient simulations were:

- 7Q10 - fall 2008 groundwater sampling event
- Base flow – fall 2008 groundwater sampling event
- 90 percent flow – spring 2009 groundwater sampling event
- Transient average annual – spring 2009 data: 7/1/2008 through 7/31/2008 and 3/15/2009 through 6/30/2009; fall 2008 data: 8/1/2008 through 3/14/2008.

These datasets were considered to be generally representative of the flow conditions and sufficient to account for a reasonable range of conditions. The dissolved zinc loads under base-flow conditions that were estimated using the model-based methodology described above were also compared with more traditional loading calculations derived from field measurements. The field-based loading estimates were obtained by computing the difference between the calculated dissolved metals load upstream and downstream from a particular stream reach using field-measured surface water flow estimates and surface water metals concentrations. This comparison of field-based and model-based load estimates provides a measure of the consistency between the two independent load estimation methodologies. These comparisons performed on both the Woodland Park area of Canyon Creek and the Osburn Flats and Bunker Hill Box areas of the SFCDR suggest relatively good agreement between model-derived and field-derived estimates of dissolved metals loads to surface water.

7.3.2.1.3 Simulations of Remedial Alternatives

Groundwater components of the remedial alternatives were simulated using the Canyon Creek and SFCDR Watershed groundwater flow models. A complete description detailing how the components of the alternatives were implemented in the model simulations is provided in Appendix A. The modeling simulations were performed to obtain an estimate of the relative effectiveness of each of the alternatives at reducing the dissolved metals loading to Canyon Creek or the SFCDR. The effectiveness of each alternative was estimated by running a model simulation with a remedy in place and comparing the results with a baseline no-action simulation. The difference in metal loading between the two simulations was assumed to be the benefit of implementing that particular alternative. Other information obtained from the model simulations was estimated drain flows and treatment plant loads for the various remedial alternatives evaluated.

7.3.2.2 Predictive Analysis

The Predictive Analysis was used to provide approximations of the effects of specific upstream remedial alternatives on downstream metal loadings for use in evaluating and comparing the alternatives. Because the Predictive Analysis was developed prior to this FFS, Section 7.3.2.2.1 provides a description of its history and background. Sections 7.3.2.2.2 and 7.3.2.2.3, respectively, discuss the conceptual design of the Predictive Analysis and the modifications to the Predictive Analysis that were made to specifically support this FFS. The results of the Predictive Analysis are summarized in Section 7.3.2.2.4 and include estimates of pre- and post-remediation dissolved zinc loads in surface water, percent load reductions, and predicted post-remediation ambient water quality criteria (AWQC) ratios.

Section 7.3.2.2.5 discusses the uncertainties related to Predictive Analysis results. This section is important in that limitations in the empirical monitoring data (including sources, source volumes, and dissolved metals loading), coupled with the assignment of model parameters such as relative loading potential and treatment effectiveness (based on best professional judgment), result in considerable estimation uncertainties. As a result, the modeled predictions should be considered approximations.

Detailed documentation of the use of the Predictive Analysis for this FFS is provided in Appendix B.

7.3.2.2.1 History and Background of the Predictive Analysis

The Predictive Analysis was initially developed to support the evaluation of alternatives in the 2001 FS, and was subsequently used to support evaluations in the Proposed Plan and Interim ROD for OU 3. These analyses included two modeled locations, Pinehurst and Harrison, and did not account for dissolved metals sources in OU 2. Documentation for the Predictive Analysis (referred to as the Probabilistic Analysis at the time) was initially provided in a 2001 Technical Memorandum titled *Probabilistic Analysis of Post-Remediation Metal Loading* (URS Greiner, 2001b).

The Predictive Analysis was evaluated as part of the program review conducted by NAS (NAS, 2005, Appendix F). When the pre-publication NAS review report was released, a response to both the review and criticism of the PAT contained in Appendix F of the NAS report was prepared. This response document, NAS Appendix F Errors of Fact (EOF) (URS, 2005), includes a point-by-point discussion of the issues raised by NAS and identifies substantive errors in the NAS review that were not corrected in the subsequent final NAS report. Further, USEPA sought an independent review of the PAT by a well-known leader in the field of probabilistic modeling, Dr. Gregory B. Baecher, University of Maryland, A.J. Clark School of Engineering (College Park, MD). The independent review validated the approach used by USEPA and its use in the evaluation and comparison of alternatives. This review culminated in a second technical memorandum, *A Predictive Analysis for Post-Remediation Metals Loading* (USEPA, 2007), which provided clarification and additional documentation related to the Predictive Analysis, but the fundamentals of the analysis have remained unchanged since its initial development for the 2001 FS.

The Predictive Analysis was designed to serve as a dynamic tool that could be updated as the remedial program progressed to support adaptive management decisions. In particular, empirical data obtained over time will enable evaluations of assumptions used in the Predictive Analysis, as well as comparisons with predicted results. In addition to its use in this FFS, it is envisioned that the tool will also be used to support reporting for the Basin Environmental Monitoring Program (BEMP), to support analyses in future Five-Year Reviews, and to inform refinement of the remedial action implementation schedule.

7.3.2.2.2 Conceptual Design of the Predictive Analysis

At its core, the Predictive Analysis is a mass balance analysis based on pre-remediation loads and estimated remedial action effectiveness, and it comprises the following steps:

1. **Estimate total pre-remediation (current) loading from all sources located between two surface water-monitoring locations.** For this analysis, dissolved zinc is used as an indicator metal. The change in load between two points is estimated by subtracting the upstream measured load from the downstream measured load. This load is assumed to represent the combined loading from all sources located between the two monitoring points.

   In this FFS, the Predictive Analysis is used to evaluate dissolved metals loading at two monitoring locations on the SFCDR within the Site that are considered to be representative of the system as a whole: Elizabeth Park (Station SF-268) and Pinehurst (Station SF-271). SF-268 is located near the upstream end of the Box and is influenced by areas upstream from the Box, including six of the seven key watersheds (Upper SFCDR, Canyon Creek, Ninemile Creek, Mainstem SFCDR, Big Creek, and Moon Creek), as shown in Figure 7-26. SF-271 is located downstream from both the Box and the confluence of Pine Creek with the SFCDR and is influenced by the entire Upper Basin area. For Elizabeth Park (SF-268), the upstream point is the headwaters of the SFCDR (assumed to contain zero load), and the downstream point is Elizabeth Park. For Pinehurst (SF-271), the upstream point is Elizabeth Park, and the downstream point is Pinehurst. These two modeled locations are depicted in Figure 7-26.

2. **Estimate the pre-remediation (current) load from specific waste types and volumes located between two monitoring locations.** Step 1 above provides the total estimated load from all waste types located between two monitoring points. In Step 2, the load attributed to direct discharge of adit drainages, seeps, and groundwater is first subtracted from the total difference in load, and then the remaining difference in load is apportioned to specific waste types and volumes located between the two monitoring locations.

   The apportioning of load is done using the total volume of waste types and their respective relative load potential (RLP) estimates. Each waste type is assigned a different RLP based on professional judgment estimates of its proportional “loading strength”. The RLP values used for different waste types were first defined in the 2001 FS and remain unchanged in this analysis. The RLP of a given source type is an index of the average contribution of metal (zinc) load from that source type to the SFCDR per cy of source material per year. The RLP expresses the relative propensity of a source type to contribute metal load to the river. The source judged to have the highest propensity is assigned an RLP of 1.0, and other source types are scaled proportionately, with values ranging from 0.0 to 1.0. The RLP for water sources (adits, seeps, and groundwater) is 1.0 and is based on the assumption that these sources are discharging directly to surface water such that all contaminant mass present in the source water eventually becomes present in surface water. The RLP values for remaining sources range from 1.000 on the high end for floodplain sediments to 0.003 on the low end for upland waste rock without loading potential. At the end of Step 2, the difference in load between the two points is apportioned to specific waste types and volumes located between those two points, such that the sum of all waste type-specific loads is equal to the measured load between the two locations.

3. **Estimate the post-remediation load and AWQC ratio from specific waste types and volumes located between two monitoring locations for each alternative.** Each remedial alternative includes multiple types of remedial actions (e.g., excavation and disposal, capping, regrading, and revegetation) applied to specific volumes of waste. For each alternative, the reduction in load for each waste type is estimated using remedial effectiveness factors (RFs) based on professional judgment. The RFs reflect the fraction of load remaining from a given source after remediation. For example, if the effectiveness of an action is assumed to be 99 percent, the RF would be 0.01 (1 - 0.99). RF values range from 0.0 to 1.0, where remedial actions having high effectiveness are given low RF values, and remedial actions with low effectiveness are given high RF values. For example, "no action" has an RF of 1.0. The RFs were first defined in the 2001 FS and remain unchanged in this analysis, with one exception. The RF for waste rock capping was changed from 0.22 to 0.05, giving it a higher effectiveness. The RFs are aggregated by source type and applied to the total volume of source material located between two monitoring locations to estimate the post-remediation load in the SFCDR.

   The effectiveness of all remedial action types is estimated using the RF approach with the exception of groundwater actions (French drains, stream liners, extraction wells, slurry walls). Post-remediation load reductions for groundwater actions are estimated using the numerical groundwater model, as described above. Known SFCDR flow rates can then be used to calculate estimated post-remediation metals concentrations and AWQC ratios for dissolved zinc. The AWQC ratio for dissolved zinc is the equivalent of the concentration divided by the AWQC; an AWQC ratio of 1 (or less) means that the potential surface water ARAR has been met.

4. **Cumulative summation of post-remediation loadings**. Step 4 aggregates the post-remediation loadings from each contamination source into a cumulative summation. Estimation uncertainty about that sum is also cumulated for estimation error propagated at each step of the modeling process.

5. **Modeling of natural source depletion.** The Predictive Analysis also includes a component that can be used to estimate the effects of natural source depletion on dissolved metals loading over time as a function of a decay rate. However, the natural source depletion component was not used in the FFS analysis because the prediction of long-term water quality trends and specific water quality in the SFCDR Watershed in the distant future is subject to considerable uncertainty at this time. This uncertainty

stems from the complex weathering rates and the changes in these rates for the numerous mine waste types and source areas in the watershed.[12] It is anticipated that the PAT source depletion component will be updated on an ongoing basis, based on BEMP statistical analyses, and will be used during remedy implementation, including adaptive management.

While the "core" of the Predictive Analysis is a mass balance analysis, the "shell" of the Predictive Analysis is the quantification of probability and uncertainty associated with the core estimates. Uncertainty in the Predictive Analysis is estimated by assessing the uncertainty in the Predictive Analysis input parameters and then propagating those input uncertainties to corresponding uncertainties in the output. This calculated uncertainty in the output is expressed by best estimates (means) and probability distributions. The Predictive Analysis results presented in this section are "best estimates". Eighty percent probability intervals associated with the best estimates are also presented. Appendix B provides a more detailed discussion of uncertainty and how it is incorporated into the inputs and outputs of the Predictive Analysis, including probability distributions.

7.3.2.2.3 Modifications to the Predictive Analysis Needed to Support the FFS

The original Predictive Analysis was designed to support the 2001 FS and the Interim ROD for OU 3 (USEPA, 2002b). A number of modifications to the Predictive Analysis were necessary to support the evaluation of alternatives in this FFS. These modifications were implemented to:

1. **Add Elizabeth Park as a modeled location.** A new model spreadsheet was developed, based on the one previously developed for Pinehurst. The new spreadsheet for Elizabeth Park was designed so that effectiveness of remedial actions proposed in the Box could be distinguished from those upstream from the Box in OU 3.

2. **Update "current" water quality conditions.** Current water quality conditions in terms or pre-remediation loads were updated as described under Step 1 of the Conceptual Design of the Predictive Analysis, above.

3. **Update source types, volumes, and remedial actions.** The source types and volumes identified in the RI/FS (USEPA, 2001c, 2001d) for the Upper Basin are the same as those used in this FFS with the exception of some adjustments to the pre-remediation volumes of contaminated materials in Pine Creek based on discussions with BLM as described in detail in Section 6.0. However, some of the remedial actions associated with those sources have changed (i.e., Alternative 3+ and 4+ actions are slightly different from 2001 FS Ecological Alternative 3 and 4 actions). Revised Predictive Analysis input tables summarizing remedial actions by source type were prepared for this FFS are included in Appendix B, based on the information provided in tables in this Section 7.0.

4. **Integrate estimates of load reduction from groundwater model (where appropriate).** The numerical groundwater models for Canyon Creek and the SFCDR represent the

[12] A description of natural source depletion processes is provided in Section 3.0 of this FFS Report. Site-specific exposure to seasonal wetting and water flux, as well as variations in particle surface area, iron sulfide content, trace metal content, air diffusion, and other factors, control the release of contaminants from mine wastes. The effect of cleanup actions further complicates these predictions.

most accurate tools currently available for estimating effectiveness of groundwater-based remedial actions. These groundwater models were not yet constructed when the Predictive Analysis was initially developed to support the 2001 FS, and, therefore, the Predictive Analysis required modification to allow for integration of groundwater model results into the overall estimates of post-remediation water quality. The process by which load reduction estimates were developed using the groundwater model is described in Appendix A. In simple terms, the Predictive Analysis was modified by removing the 2001 FS estimates of load reduction for groundwater-based actions and replacing them with the more accurate load reduction estimates derived from the numerical groundwater model. The integration of the groundwater model results and the Predictive Analysis is further described in Appendix B.

7.3.2.2.4 Predictive Analysis Results for This FFS

The results of the Predictive Analysis are summarized in Table 7-21, which shows pre-remediation load estimates, post-remediation load estimates, and post-remediation AWQC ratios, at both Elizabeth Park and Pinehurst. The purpose of the Predictive Analysis is to estimate the relative effects on surface water quality that may be expected as a result of implementing each alternative. This section is organized into the following subsections:

- Pre-Remediation Load Estimates;
- Pre-Remediation AWQC Ratios;
- Post-Remediation Dissolved Zinc Load, Load Reductions, and AWQC Ratios; and
- Comparison of Results to those of the 2001 FS.

Pre-Remediation Load Estimates. As shown in Table 7-21, the current average annual pre-remediation dissolved zinc loads at Elizabeth Park and Pinehurst (which are the same as the No Action Alternative values) are estimated to be approximately 1,260 pounds per day (lb/day) and 2,290 lb/day, respectively. These estimates are based on data collected between 2001 and August 2009. It should be noted that the pre-remediation loading values for both Elizabeth Park and Pinehurst in this FFS Report are lower than the values used in the 2001 FS, indicating a continued trend of decreasing load in the SFCDR, likely a result of previous remedial actions described in Table 2-1 of this FFS, and to a lesser degree, natural source depletion. In the 2001 FS, the pre-remediation loads were approximately 1,280 lb/day and 2,920 lb/day for Elizabeth Park and Pinehurst, respectively. The current estimates as compared with the 2001 estimates indicate a 2 percent reduction in load for Elizabeth Park and a 22 percent reduction in load for Pinehurst.

The difference in metals load in the SFCDR between Elizabeth Park and Pinehurst is reflective of loading from sources in the Box and Pine Creek, and decreased significantly between 2001 and 2009 as a result of extensive remedial action in this area. The difference in loading between Elizabeth Park and Pinehurst based on current data is approximately 1,030 lb/day, versus 1,640 lb/day for the 2001 FS, or a reduction of 37 percent for this segment representing the Box and Pine Creek. This reduction is presumed to be the result of the Phase 1 OU 2 actions by USEPA (TerraGraphics and Ralston Hydrologic, 2006; CH2M HILL, 2007d; CH2M HILL, 2008a), BLM actions in Pine Creek, and to a lesser degree, natural source depletion. The current estimates indicate that the Box and Pine Creek are now contributing approximately 45 percent of the total load at Pinehurst. The remaining load at Pinehurst (55 percent) is then attributable to sources upstream from Elizabeth Park.

Pre-Remediation AWQC Ratios. Although the metals load in the SFCDR generally increases in the downstream direction, the AWQC ratio does not necessarily follow the same pattern, and, in the case of comparing the current calculations for AWQC ratios at Elizabeth Park and Pinehurst, it does not. The calculated pre-remediation AWQC ratios at Elizabeth Park and Pinehurst are 5.5 and 5.2, respectively.

As described in Section 3.0 of this FFS Report, the flow in the SFCDR fluctuates significantly throughout the year, with peak flow values that can be approximately two orders of magnitude higher than base (low) flow values. Due to the magnitude of change during these periods, the high-flow conditions influence the average annual condition significantly. During high-flow periods, the load in the SFCDR increases but the AWQC ratio generally decreases as a result of the influx of large volumes of relatively low-concentration water. The average annual AWQC ratio at Pinehurst is lower than that calculated for Elizabeth Park because large volumes of relatively low-concentration water are entering the SFCDR between Elizabeth Park and Pinehurst during high-flow periods, and because of the large hardness load imparted by the CTP lime-treated effluent (lime contains considerable calcium hardness). This result is consistent with observations included in the *Phase I Remedial Action Assessment Report* (CH2M HILL, 2007d), which is based on data collected through 2006.

Post-Remediation Dissolved Zinc Loads, Load Reductions, and AWQC Ratios. Table 7-21 shows the estimated post-remediation dissolved zinc loads, load reductions, and AWQC ratios for Elizabeth Park and Pinehurst under the various alternatives. In this case, “post-remediation” refers to the time at which all source control actions have been completed and all water treatment actions have been implemented and are fully functioning.[13] Estimates of post-remediation dissolved zinc load in the SFCDR are depicted in Figures 7-27 and 7-28 for Elizabeth Park and Pinehurst, respectively, under the various alternatives. Figures 7-29 and 7-30 present estimated post-remediation AWQC ratios for Elizabeth Park and Pinehurst, respectively. Note that the timing of the post-remediation predictions for the No Action Alternative and the action alternatives is different because the No Action Alternative predictions are reflective of current conditions, whereas each of the action alternatives would take several decades to complete (the times required to implement each alternative are discussed later, beginning in Section 7.3.4).[14]

As indicated in Table 7-21, the Predictive Analysis estimates that dissolved zinc load reductions at Elizabeth Park (upstream from the Box and Pine Creek) would be 59 and 66 percent for Alternatives 3+ and 4+, respectively. For Pinehurst, which includes the OU 2 and Pine Creek alternatives, predicted percent reductions range from 41 to 68 percent across the 10 action alternatives. AWQC ratios at remedy completion are predicted to be 1.9 and 1.6 at Elizabeth Park for Alternatives 3+ and 4+, respectively. Across the 10 action alternatives, predicted AWQC ratios at Pinehurst range from 1.3 to 3.0. It is also important to note that it is anticipated there would be dramatic localized increases in surface water

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[13] Treatment of adit discharges, seeps, and groundwater may be required for many years following completion of source control actions.

[14] With any of the alternatives, it is assumed that high-priority sources for action would be targeted early, so it is anticipated that disproportionally greater effects of the remedy would be seen during the earlier portions of the implementation period.

quality throughout many areas of the Upper Basin as a result of the proposed actions, but these cannot easily be quantified.

The estimated post-remediation loads and AWQC ratios for each of the alternatives are significantly improved in comparison to the estimates made in the 2001 FS for Ecological Alternatives 3 and 4 at Pinehurst (Elizabeth Park was not evaluated in the 2001 FS using the Predictive Analysis).[15] The lower post-remediation dissolved loads and AWQC ratios estimated in this FFS are the result of several compounding factors, including:

- **Lower pre-remediation loads.** As noted above, the pre-remediation load at Pinehurst based on data through 2009 is 22 percent lower than the value used in the 2001 FS (based on data through 1999).
- **Higher AWQC for dissolved zinc**. The current site-specific AWQC value for dissolved zinc is approximately twice what it was at the time of the 2001 FS Report. AWQC values are calculated based on hardness (described in more detail in Section 7.3.2.2.5). Hence, the AWQC ratio using the current AWQC would drop by a factor of approximately 2 from this change alone. Note that an AWQC ratio of 1.0 under the new site- specific AWQC is equivalent to an AWQC ratio of 1.0 under the old standard because toxicity testing using national protocols was done to develop the site-specific AWQC. Therefore, the new AWQC is higher in concentration, but still protective.

7.3.2.2.5 Uncertainty Related to Predictive Analysis Results

This section highlights key points regarding the uncertainty of the Predictive Analysis results with respect to the evaluation and comparison of alternatives. The method for quantifying known uncertainties is presented first, followed by a qualitative discussion of uncertainty related to the representativeness of predicted post-remediation loads and AWQC ratios under variable surface water flow conditions.

A complete discussion of quantifiable uncertainty related to the Predictive Analysis is provided in Appendix B.

Quantifying Known Uncertainties. Known uncertainties related to the Predictive Analysis results for the FFS were quantified using probability intervals (PIs). Known uncertainties include:

- Limited information regarding source volumes, source types, and leaching potentials (source profile information and RLPs)
- Estimates of future remedial performance (relates to RFs)
- Natural variability of overall and location-specific basin conditions (related to pre-remediation loads)

The known uncertainties were quantified by mathematically propagating the uncertainty of the input variables, as measured by their coefficients of variation, through the Predictive Analysis model to the output variables (USEPA, 2007). Based on statistical analysis and

[15] See Table 5.4-2 in the 2001 FS Report (USEPA, 2001d).

interpretation of historical (pre-remediation) loadings and load ratios calculated for Upper Basin monitoring locations (BEMP data), the uncertainties in the post-remediation estimates were assumed to follow lognormal probability distributions, consistent with the historical BEMP data. These probability distributions can then be used to quantify the estimated accuracy and precision (both based on known uncertainties only) of the post-remediation estimates using PIs. PIs are used for probabilistic estimates in the same way as confidence intervals are used for estimates of statistical parameters.[16] The higher the probability associated with the PI (e.g., 80 percent or 90 percent), the more accurate the estimate is considered; the wider the interval, the lower the precision. Conversely, higher precision means lower accuracy.

In the end, only data collected and interpreted over time to monitor the results of remediation will be used to define actual changes in water quality. These findings will be used to inform the Adaptive Management process and the prioritization of the specific actions for implementation.

Uncertainty as a Result of Variable Flow Conditions. The Predictive Analysis was updated to incorporate pre-remediation dissolved zinc load estimates using current data and based on expected values and coefficients of variation (CVs). The expected values are based on average conditions, whereas low-flow and high-flow conditions are represented in the variability estimate inputs to the Predictive Analysis (to the extent that low-flow and high-flow conditions are represented in the empirical data upon which input values are based), including the uncertainty corresponding to specific flow conditions.

The following paragraphs provide a qualitative discussion of load reduction and AWQC ratios as a function of flow and discuss how the effectiveness of remedial actions may differ under variable flow conditions.

Load Reduction as a Function of Surface Water Flow. The current understanding of fate and transport of dissolved metals in the SFCDR Watershed is described in Section 3.0. Based on this current understanding, there are two dominant sources of dissolved metals load to the SFCDR and its tributaries:

1. **Groundwater Loading** – The flow of contaminated groundwater (a secondary source) to surface water in "gaining" reaches of the SFCDR and its tributaries; and
2. **Non-Groundwater Loading** – Non-groundwater sources that include, but are not limited to, surface water runoff that has come into contact with contaminated surface materials, tributary flow, flows from adits and seeps, riverbed loading, and riverbank storage releases under declining ("losing") surface water flow conditions.

Groundwater modeling has shown that, over a wide range of surface water flow conditions, the net dissolved metals load to surface water from groundwater remains relatively constant (Appendix A). During low-flow periods (late summer/early fall) when there is very little, if any, precipitation occurring, groundwater movement plays a significant role in transporting

[16] For example, an 80 percent confidence interval (80% CI) on a statistical estimate for a population average would be bounded by the 90 percent upper confidence level (UCL), and the 90 percent lower confidence level (LCL). Because Predictive Analysis estimates are probabilistic, not statistical, "confidence intervals" are replaced by "probability intervals" with UCLs and LCLs replaced by "nonexceedance," or NE, estimates.

dissolved metals to surface water, especially in alluvial areas, such as Woodland Park, Osburn Flats, and the Bunker Hill Box.

In contrast, during high-flow periods (typically late winter to spring), non-groundwater mechanisms dominate and the total dissolved metals load in surface water generally increases substantially with surface water flow.[17] For example, the increase in loading through the Box from a 7Q10 flow[18] up to a 90th percentile flow is roughly one order of magnitude (for comparison, average annual conditions are estimated to be equivalent to a 69th percentile flow). Therefore, the *percent* load reduction of the groundwater actions is highest under low-flow conditions and lowest under high-flow conditions.

Each remedial alternative evaluated in this FFS is composed of a different combination of groundwater and non-groundwater actions and includes hundreds of individual remedial actions. At this time, sufficient data do not exist for estimating the potential effectiveness of all of these actions individually, and in concert with one another, over the complete range of potential flow conditions. Such an evaluation would also need to consider the quantity and location of contaminated materials left in place under each alternative, so that the leaching potential of these materials as a function of flow could be included in the evaluation. It is anticipated that the relationship between leaching, loading, and flow will continue to be evaluated, particularly as additional monitoring data are collected and trends are assessed.

AWQC Ratio as a Function of Surface Water Flow. The AWQC ratio as a function of flow is of interest because the AWQC ratio is indicative of the actual conditions that aquatic receptors are exposed to, and the State of Idaho AWQC apply to all flow conditions down to a 7Q10 flow (IDAPA 58.01.02, Section 210.03).

The way in which flow affects the dissolved zinc AWQC ratio is complicated because the AWQC is a calculated value that includes hardness as an input.[19] Hardness is proportional to AWQC (higher hardness values result in higher AWQC values), but inversely proportional to flow (that is, higher hardness values are typically observed under lower flow conditions and lower hardness values are observed under higher flow conditions).

At low-flow conditions, dissolved metals *concentrations* are typically higher because the surface water is dominated by contaminated groundwater. As noted above, with lower flow the hardness value is typically higher, which translates into a higher AWQC value. In contrast, under high-flow conditions, dissolved metals concentrations are diluted by input of cleaner rain and snowmelt runoff. Thus, at higher flows, the metal concentrations are lower due to dilution but the hardness is also lower, which effectively lowers the AWQC. The net result is that, given the current dissolved zinc loading from both groundwater and non-groundwater sources, the AWQC ratios generally show little change over differing flow conditions.

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17 Note that groundwater versus non-groundwater loading mechanisms may vary among the tributaries as compared to the SFCDR.

18 The 7Q10 flow is defined as the lowest average 7 consecutive day low flow with an average recurrence frequency of once in 10 years determined hydrologically.

19 The following formula represents the SFCDR-specific AWQC for dissolved zinc: $AWQC = e^{(0.6624 * \ln(hardness) + 2.2235)}$. AWQC for other metals are calculated using different equations.

However, the degree to which groundwater contributes to dissolved zinc loading is expected to change in response to the various proposed groundwater-based actions. The load removed as a result of groundwater-based actions is expected to fluctuate somewhat in response to hydrologic conditions but remain relatively constant in comparison to the significant fluctuations in metals load observed in the SFCDR over the course of the water year. Therefore, the percent load reduction from these groundwater-based actions would be highest at low flow (when the total load in the river is lowest) and lowest at high flow (when the total load in the river is highest). Similarly, the relationship between dissolved zinc load, concentration, AWQC, and flow suggests that, for groundwater-based actions, the effect on the AWQC ratio may be more significant at lower flows and less significant at higher flows. Given the complexity of the sources and different processes that affect AWQC ratios (dilution, reduction in hardness, and reduction in percentage load reduction for groundwater-based actions), the net effect of these processes is difficult to predict, and will vary between the SFCDR and the tributaries. The relationship between AWQC ratio and flow will continue to be evaluated, particularly as additional monitoring data are collected and trends are assessed.

7.3.3 No Action Alternative

The No Action Alternative is described in the following sections for the CERCLA threshold criteria and primary balancing criteria.

7.3.3.1 Overall Protection of Human Health and the Environment

Under the No Action Alternative, no treatment or engineering controls would be used to control contaminant transport processes, including leaching and erosion of tailings, waste rock, contaminated sediments, contaminated soil, and transport of contaminated groundwater to surface water. These processes would continue to result in uncontrolled releases of metals, including cadmium, lead, and zinc, from sources in the Upper Basin to the SFCDR and its tributaries. The No Action Alternative includes no actions to address potential human health risks associated with direct contact or ingestion of contaminated media at source sites or abandoned structures.

The No Action Alternative would include no actions to eliminate, reduce, or control exposures of ecological receptors to contaminants. Hence, unacceptable risks to ecological receptors, including fish, aquatic macroinvertebrates, terrestrial receptors, and birds, would continue to exist for the foreseeable future. Potential human health risks associated with uncontrolled exposure to tailing piles and other contaminated materials would also remain unabated.

Completed and ongoing removal actions that have been undertaken by others may result in decreased contaminant loadings from some sources; however, the long-term effectiveness of these actions in reducing future loadings is uncertain. The ongoing transport of contaminants from the Upper Basin would result in continued recontamination of sediments and surface water in the Lower Basin and other downstream areas.

Ecological recovery of riverine and riparian habitats in the Upper Basin would continue to be limited by the direct toxic effects of contaminants and by the secondary impacts of these contaminants on the physical components of the ecosystem. Contaminant levels in surface waters are currently limiting to fish and aquatic macroinvertebrates, and contamination in floodplain soils may be limiting to recovery of terrestrial receptors and riparian vegetation in many areas. Stream channel and bank instability due to mining-related impacts would continue to impede ecological recovery of riverine habitats.

Because no actions would be taken, there would be no short-term risks to workers, the community, or the environment associated with construction. However, remedial action objectives (RAOs) would not be achieved for surface water for some time. The No Action Alternative would result in continued exceedances of potential chemical-specific ARARs that are designed to protect human health and the environment, including state and federal water quality criteria.

In summary, the No Action Alternative does not meet the threshold criterion of overall protection of human health and the environment.

7.3.3.2 Compliance with ARARs

Metal concentrations in surface water, including cadmium, lead, and zinc, currently exceed federal and state AWQC throughout the entire SFCDR below Mullan, and in Canyon Creek, Ninemile Creek, and other major tributaries. The results of the Predictive Analysis (as described in Section 7.3.2.2.4) are used to evaluate compliance with potential surface water ARARS in terms of achieving an AWQC ratio equal to one for the Upper Basin. Dissolved zinc was used as the indicator chemical for this evaluation.

The estimated value of the present dissolved zinc loading at Pinehurst is approximately 2,290 lb/day. The estimated AWQC ratio is 5.2. The No Action Alternative includes no actions in Upper Basin portions of OU 3 or in the Box to reduce dissolved metals loadings or surface water concentrations; however, metals loading is expected to slowly decline as a result of natural source depletion. The No Action Alternative includes no actions to reduce metals concentrations in soil, sediment, or groundwater. Exceedances of potential ARARs for these media would likely continue for much longer than exceedances of potential ARARs for surface water would.

In summary, the No Action Alternative does not meet the threshold criterion of compliance with ARARs.[20]

7.3.3.3 Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence of the No Action Alternative is discussed below in the context of (1) the expected magnitude of residual risk and (2) the adequacy and reliability of engineering and institutional controls.

7.3.3.3.1 Magnitude of Residual Risk

The primary ecological risks identified in the baseline Ecological Risk Assessment (CH2M HILL and URS Greiner, 2001) include actual and potential adverse effects on waterfowl, mammals, fish, aquatic organisms, amphibians, and vegetation. These are associated with direct exposure to metals as well as secondary impacts of habitat

[20] An alternative that does not meet an ARAR under federal environmental or state environmental or facility siting laws may only be selected under certain circumstances as identified in the NCP (40 CFR 300.430(f)(1)(ii)(C).

degradation. The No Action Alternative would include no actions to eliminate, reduce, or control exposures of ecological receptors to contaminants. Hence, unacceptable risks to ecological receptors would continue to exist for the foreseeable future.

Although no CERCLA cleanup actions would be taken, future contaminant loading could be affected by removal actions that have been undertaken by others, potential future changes in the status of operational mining facilities, and natural source depletion processes.

The overall effectiveness of the alternatives can be quantified in terms of the expected reduction in metals loads. Under the No Action Alternative, no remedial actions would occur and there would be no load reduction associated with cleanup. Potential future closures of active tailings impoundments may decrease loadings; conversely, reactivation of currently inactive mining facilities may increase loadings. As previously discussed, natural source depletion processes will result in load reduction and reduction in residual risk over the long term.

Existing risk is primarily associated with contaminated media acting as a source of dissolved metals loading to aquatic environments. Significant amounts of contaminated sediments are present in floodplains throughout the Upper Basin resulting in groundwater and subsequent surface water contamination. Under the No Action Alternative, the magnitude of existing risk to aquatic receptors is expected to slowly decline as a result of natural source depletion. However, the magnitude of existing risks to human and terrestrial receptors would remain essentially unchanged for much longer because no actions would be taken to mitigate these risks and the rate of natural source depletion would be significantly slower than in surface water. In addition, the ongoing transport of contaminants from the Upper Basin would result in continued recontamination of sediments and surface water in downstream areas within the Lower Basin.

No actions would be taken under the No Action Alternative to address physical and biological habitat functions that have been degraded by mining-related hazardous substances. Phytotoxicity of floodplain soils would continue to limit revegetation of riparian areas, in turn limiting the recovery of riparian wildlife species. Riparian zone instability would contribute to ongoing stream bank instability and erosion, bedload mobility and increased channel migration, loss and simplification of habitat structure, and degraded temperature regimes. These conditions would continue to limit recovery of aquatic and riparian fish and wildlife species.

Any human health risks associated with direct contact and ingestion of metals would remain unabated under the No Action Alternative.

Because this alternative would result in metals remaining onsite at concentrations above levels that allow for unlimited use and unrestricted exposure, a review would be conducted at least every 5 years, in accordance with the NCP [300.430(f)(4)(ii)].

7.3.3.3.2 Adequacy and Reliability of Controls

No engineering or institutional controls are included in the No Action Alternative.

7.3.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

The No Action Alternative provides no treatment to reduce the toxicity, mobility, or volume of contaminated material. Principal threat wastes would not be treated; therefore, the No Action Alternative would not satisfy the statutory preference under CERCLA that USEPA use treatment to address the principal threats posed by a site wherever practicable.

7.3.3.5 Short-Term Effectiveness

Under the No Action Alternative, no cleanup actions would be taken, and thus there would be no short-term risks to workers, the community, or the environment associated with construction. However, RAOs for soils and source materials, groundwater, surface water, and sediments would not be achieved. Similarly, in the absence of remedial action, the natural successional recovery of physical habitat structure to levels approaching ecological goals for the system is not anticipated to occur for centuries.

7.3.3.6 Implementability

Because the No Action Alternative includes no actions, it is not evaluated for implementability.

7.3.3.7 Cost

No remediation costs are associated with the No Action Alternative.

7.3.4 Alternative 3+(a)

Alternative 3+(a) is discussed below with respect to the seven CERCLA threshold and balancing criteria. The OU 3 component (Alternative 3+, More Extensive Removal, Disposal, and Treatment) is evaluated first in Section 7.3.4.1, followed by the OU 2 component (Alternative (a), Minimal Stream Lining) in Section 7.3.4.2. Section 7.3.4.3 then discusses each CERCLA criterion in terms of the combined alternative for OU 3 and OU 2 [Alternative 3+(a)].

[Please note: Beginning with the following subheads and continuing to the end of Section 7.0, labels have been added in brackets beneath level 4 and 5 headings to help the reader keep track of the alternative and OU being evaluated. As shown under the next heading, the first line of the label indicates which alternative is being evaluated; for example, [Alternative 3+(a)]. The second line indicates which OU is being evaluated; for example, [OU 3]. When both OUs are combined into a single alternative, the second line appears as [Combined].]

7.3.4.1 OU 3 Alternative 3+, More Extensive Removal, Disposal, and Treatment

[Alternative 3+(a)]
[OU 3]

7.3.4.1.1 Overall Protection of Human Health and the Environment

[Alternative 3+(a)]
[OU 3]

The actions included in OU 3 as part of Alternative 3+ would reduce the potential for direct exposures to contaminated media and reduce contaminant transport via erosion and leachate production. Removal of floodplain sources would include tailings-impacted alluvium both inside and outside the 100-year floodplain. Hydraulic isolation would be provided for all tailings impoundments built on contaminated sediments, and for limited portions of Canyon Creek and the SFCDR. The stream lining on the SFCDR included in Alternative 3+ could affect fish habitat due to an increase in water temperature as a result of removing cooler groundwater recharge. Additional actions would be taken for upland waste rock piles with significant leachate or mass wasting potential. Waste consolidation areas and repositories would be used to a greater extent to consolidate removals and provide higher-performance containment.[21] Alternative 3+ also includes stabilization and rehabilitation of riparian and riverine habitat structure to the extent practicable, which would also stabilize remaining floodplain sources. These actions would reduce the potential for direct human and ecological exposures to the most highly contaminated media, and reduce contaminant transport via erosion and leachate production. Alternative 3+ includes semi-passive and active treatment to address all significant adit discharges and to address groundwater in areas of hydraulic isolation.

Actions under Alternative 3+ are focused on consolidating and containing media with intermediate to high concentrations of metals and with the potential for significant loading to surface water and groundwater. Residual risks would primarily be associated with low- to intermediate-level contaminated media that are left in place, sources that are only partially contained, and the resultant residual loadings of contaminants to aquatic environments. The results of the Predictive Analysis (as described in Appendix B) indicate that Alternative 3+ may reduce the annual average dissolved zinc load in the SFCDR at Elizabeth Park (SF-268) by approximately 59 percent (Table 7-21). Over the long term, natural source depletion processes will result in further reductions in metals loads and associated residual risk. The estimated remedial action effectiveness at Pinehurst (SF-271) for this alternative is evaluated below for Alternative 3+(a) as a whole.

Source control measures (such as low-permeability caps) that are targeted at reducing loadings to surface water and groundwater would also be effective in reducing the potential for human and wildlife exposures to metals. Additional soil covers and access restrictions (signs and fencing) included in Alternative 3+ would be effective in further reducing potential human health risks at structures or remaining source sites. Alternative 3+ also includes decontamination of structures where practicable.

As with the other action-oriented alternatives, the engineering components of Alternative 3+ would require long-term management to remain effective. Monitoring, O&M, and institutional controls would be required. It is expected that these management requirements could be administered effectively.

The long-term effectiveness of stream and riparian cleanup actions may also be affected by land use issues (such as mining activities and forest management practices) that may

[21] USEPA will first seek opportunities to safely consolidate and cap waste onsite or in the immediate vicinity of mine and mill sites in side canyon areas.

disrupt watershed hydrology. The ability to effectively manage these non-CERCLA activities over the long term may be limited.

Alternative 3+ involves handling and transportation of significant quantities of waste material, potentially posing short-term risks to workers and the community. These risks would be minimized with standard health and safety controls, selective siting of waste consolidation areas and repositories, and traffic control plans. Construction-related short-term impacts on the environment would be minimized or mitigated through engineering controls and revegetation.

RAOs for soils, sediments, and source materials would be met as construction is completed, but only for the portion of soils and source materials addressed under this alternative. RAOs for surface water may be met in limited areas as construction is completed. The flux of contaminated groundwater to surface water would be significantly reduced. Groundwater quality may also be improved in some areas as a result of hydraulic isolation actions and extensive source material removals.

7.3.4.1.2 Compliance with ARARs

[Alternative 3+(a)]
[OU 3]

As described above, the results of the Predictive Analysis are used to compare the relative projections of compliance with AWQC, which are the potential primary chemical-specific ARARs for surface water. Although compliance with all AWQC is the ultimate goal, the dissolved zinc AWQC is used as an indicator for compliance in the Upper Basin. Compliance with potential surface water ARARs equates to achieving an AWQC ratio equal to 1.0.

The results of the Predictive Analysis indicate that Alternative 3+ would reduce the AWQC ratio for dissolved zinc in the SFCDR at Elizabeth Park from approximately 5.5 to approximately 1.9 at the completion of remedy implementation. Natural source depletion processes are also expected to decrease metals concentrations in surface water over the long term.

Drinking water standards (maximum contaminant levels [MCLs]) are also a potential ARAR for surface water. As previously discussed, AWQC are generally more stringent than MCLs (for the key contaminants of concern) and, therefore, when AWQC are achieved, MCLs will also likely be achieved.

While there are no RAOs for remediation of groundwater, some of the groundwater actions to reduce contaminant concentrations in surface water (i.e., those that include source removal or hydraulic isolation) would also result in reductions of contaminants in groundwater. However, given the pervasive nature of the subsurface contamination, the actions may not achieve the drinking water standards for groundwater at all locations. USEPA would evaluate future monitoring data to determine whether additional actions would be needed or would be effective in meeting drinking water standards. If further actions would not be effective, a Technical Impracticability (TI) waiver may be warranted at specific locations where groundwater does not achieve drinking water standards.[22]

Preliminary remediation goals (PRGs) for soil and sediment would be met upon completion of remedial actions in areas where actions are taken.

The actions included in Alternative 3+ could potentially be implemented in compliance with potential location-specific and action-specific ARARs. Alternative 3+ would be implemented to meet requirements for federal agencies under Section 7 of the Endangered Species Act (ESA). The ESA requires that the actions be protective of critical habitat for several species in the Coeur d'Alene Basin. A summary of other potential location-specific and action-specific ARARs is included in Section 4.0.

7.3.4.1.3 Long-Term Effectiveness and Permanence

[Alternative 3+(a)]
[OU 3]

Long-term effectiveness and permanence of Alternative 3+ is discussed below in the context of the (1) expected magnitude of residual risk and (2) adequacy and reliability of engineering and institutional controls.

Magnitude of Residual Risk. Actions under Alternative 3+ are directed at consolidating and containing media with high to intermediate concentrations of metals and the potential for significant loading to surface water and groundwater. These actions would reduce the mobility of metals in the environment and reduce the potential for exposure of human and environmental receptors to metals. Residual risks would primarily be associated with low- to intermediate-level contaminated media that are left in place and sources that are only partially contained.

Residual risks following implementation would primarily be associated with contaminated media not addressed by the alternative, which would continue to act as a source of dissolved metals loading to aquatic environments. Significant amounts of contaminated sediments are present in floodplains and below developed areas throughout the Upper Basin, resulting in groundwater and subsequent surface water contamination. Residual loading is a function of the types and quantities of contaminated media that would remain in the environment following cleanup (i.e., unremediated materials), with consideration of the effectiveness of the cleanup actions for the materials that are remediated. As discussed in Section 7.3.2, different waste types have different loading potentials. Based on current source quantity estimates, the types and quantities of media that would receive no action or monitoring only under Alternative 3+ include (in approximate decreasing order of residual loading potential):

- Approximately 13 percent of accessible contaminated floodplain sediments (primarily sediments with no gross tailings enrichment or located outside of the 100-year floodplain);

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[22] Specific ARARs can be waived if appropriately justified [CFR 300.430(f)(1)(ii)(C)].

- 100 percent of inaccessible contaminated floodplain sediments (although associated contaminated groundwater would be treated in many areas);
- Approximately 32 percent of tailings located in active impoundments;
- Approximately 38 percent of unimpounded tailings;
- Approximately 10 percent of waste rock located in floodplains; and
- Approximately 86 percent of waste rock located in upland areas with little potential for significant loading.

Other potentially significant sources of loading that may remain under Alternative 3+ include:

- Contaminated groundwater discharging to surface water as a result of contaminated floodplain sediments remaining in some areas. Although Alternative 3+ includes actions to control the discharge of contaminated groundwater to surface water, these actions are not designed to eliminate 100 percent of the discharge, and, therefore, contaminated groundwater would continue to discharge to surface water in some areas, albeit attenuating over time; and
- Approximately 10 percent of waste rock with loading potential would be either stabilized using stream and riparian cleanup actions, or regraded, covered with soil, and revegetated. These actions would reduce transport of contaminants through erosion and runoff, but percolation of precipitation would still generate leachate at approximately 50 percent[23] of current quantities.

Contaminated media remaining within the 100-year floodplains would be a source of ongoing loadings into aquatic environments. Under Alternative 3+, these media would primarily be limited to (1) alluvium with low-to-intermediate concentrations of metals, and (2) impounded tailings. These would contribute ongoing loadings of dissolved metals as well as particulate transport during flooding events. Periodic dredging of sediment traps included under Alternative 3+ would help reduce bedload transport.

Contaminated overbank alluvium on the SFCDR (located outside the 100-year floodplain but within the historic floodplain) may also pose a residual risk. Alternative 3+ includes extensive stream and riparian cleanup actions to stabilize stream channels as well as removals of tailings-enriched overbank deposits, so the potential for significant erosive transport of this material is greatly reduced. However, there is still a potential for stream channel migration into remaining contaminated floodplain deposits, particularly during flooding events. This material would continue to act as a source of dissolved metals loading to groundwater. Under Alternative 3+, this loading would largely be controlled through hydraulic isolation and treatment of groundwater.

The overall effectiveness of the alternatives can be quantified in terms of the predicted improvement in surface water quality. For Alternative 3+, the reduction in the AWQC ratio

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[23] This value is based on the estimated RF for regrading and revegetating used in the Predictive Analysis (Appendix B).

in surface water upstream from Elizabeth Park was estimated by the Predictive Analysis to be approximately 1.9 at remedy completion, versus 5.5 with no action. The dissolved zinc load reduction was predicted to be approximately 59 percent. Natural source depletion processes would result in further reductions in AWQC ratios, dissolved metals load, and residual risk over the long term.

Because this alternative would result in metals remaining onsite at concentrations above levels that allow for unlimited use and unrestricted exposure, a review would be conducted at least every 5 years, in accordance with the NCP [300.430(f)(4)(ii)].

Adequacy and Reliability of Controls. Under Alternative 3+, the expected long-term performance issues, monitoring requirements, and maintenance requirements are as follows:

- **Soil Covers.** Covers may be susceptible to erosion, particularly on steep slopes or in areas where revegetation is unsuccessful. The adequacy and reliability of manufactured growth media for sustaining revegetation, should its use be required due to native topsoil availability limitations, would be more uncertain than that of native topsoil. Periodic inspections of the soil covers could effectively identify areas where the soil cover has failed, and additional cover material would be imported and placed to repair the damaged area. Additional revegetation efforts may also be necessary periodically.
- **Stream Liners.** Stream liners should effectively eliminate the flow of surface water to groundwater in lined areas and would generally require little maintenance. However, stream liners may be damaged by flooding, and periodic replacement of a portion of the liner would likely be required. A replacement rate of 5 percent per 10 years was assumed for cost estimating purposes.
- **French Drains**– Groundwater would be collected using French drains that would require routine O&M to maintain functionality. O&M components include physical maintenance of drains and pipelines, including periodic and routine removal of precipitates. Groundwater monitoring would be performed in the vicinity of the French drain to evaluate groundwater elevations and quality.
- **Low-permeability Caps and Repositories.** Low-permeability caps and repositories may also be subject to erosion or other damage to capping materials, particularly for facilities located within floodplains. Periodic inspections and groundwater monitoring could effectively identify the need for repairs. Failure to repair damage could result in greatly reduced cap performance and increased production of leachate.
- **Stream and Riparian Cleanup Actions.** Stream and riparian cleanup actions may be damaged by environmental stresses such as flooding and droughts, and periodic replacement of a percentage of the components would likely be required. Phytotoxicity may hinder re-establishment of vegetation in some areas. In early years, maintenance requirements are expected to be greater, and adaptive management would be required. For example, specific current deflector structures may prove to be inappropriate at specific locations, and re-design and re-installation would be required. As stream channel stability improves over time (as a result of successional recovery of physical habitat structure), maintenance requirements are expected to decrease. Periodic inspections could effectively identify areas where corrective actions are needed. The

long-term effectiveness of stream and riparian cleanup actions may also be affected by land use issues in the basin (such as continuing mining activities and forest management practices) that may disrupt watershed hydrology. For example, extensive clear-cutting could increase runoff from rain or snow events, which may reduce the longevity of stream channel and bank stabilization measures. The ability to effectively manage these non-CERCLA activities over the long term may be limited.

- **Sediment Traps.** Sediment traps would require periodic dredging and disposal of the accumulated sediments. Visual inspections would be used to determine dredging frequencies. Dredging requirements are expected to be greatest during and immediately following completion of the remedy construction. Dredging requirements may decrease in later years as both total sediment quantities and contaminant concentrations in sediments decrease. However, because Alternative 3+ would leave some contaminated sediments, waste rock, and tailings in place, periodic dredging is assumed to be required over the long term. Chemical analysis of the collected sediments would be used to determine whether dredging could be discontinued.

- **Semi-Passive Treatment Systems.**[24] Semi-passive treatment systems may not be able to achieve AWQC in the treated effluent throughout the year. Systems based on TCD WT03 (sulfate-reducing bioreactors [SRBs]) would require periodic removal, disposal, and replacement of the substrate material and would also require periodic dredging of precipitates from the aerobic polishing pond. Chemical analysis of treated effluent would be used to indicate the need for substrate change-out. Systems based on TCD WT02 (lime addition and settling pond[s]) would also require periodic dredging of precipitates from the aerobic polishing pond. O&M components would include physical maintenance of pipelines and flow structures, inspection and operating labor, reagent consumption (lime for TCD WT02), and chemical analysis and reporting.

- **Active Treatment.** Treatment of the collected drainage from adits, seeps, and groundwater would require O&M of the treatment plant and pipelines. O&M components would include physical maintenance of pipelines and equipment, operating labor, utilities, reagent consumption, and chemical analysis and reporting.

- **Decontamination.** Decontamination of abandoned structures would have greater long-term effectiveness in controlling human exposures and require less long-term maintenance, compared to access restrictions. However, practicability constraints may limit the number of sites where decontamination is feasible.

- **Land Use Restrictions and Requirements.** Land use restrictions and requirements are needed to maintain the protectiveness of this alternative over the long term. These would address maintenance of the physical components of this alternative and would control activities that could interfere with or compromise the function of the various alternative components. The long-term effectiveness of these institutional controls would be dependent on continued enforcement by the administering entity. The existing

[24] A limestone permeable reactive barrier (PRB) was evaluated as a potential option in place of a portion of the French drain in these alternatives (as discussed in Section 6.3.2.3 and Appendix F). However, based on the results of this evaluation, the PRB option has not been retained for direct inclusion in the alternatives. Additional study would be needed to further evaluate the potential effectiveness and cost of the PRB option.

ICP for the Basin may need to be modified to include institutional controls necessary for implementation of the Selected Remedy.

7.3.4.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

[Alternative 3+(a)]
[OU 3]

Alternative 3+ includes the following treatment components:

- Active treatment of an average flow of 11,500 gpm (290 lb/day) of collected adit drainage (21 adits), seeps, and groundwater;
- Semi-passive treatment of an average flow of 800 gpm (47 lb/day) of collected drainage from 36 additional adits and one seep; and
- Active treatment of leachate from repositories (during the dewatering period).

Active treatment would require construction of pipeline systems to convey the drainage from the targeted locations to the CTP. Semi-passive treatment would be accomplished at or near the sources of adit drainage, using either TCD WT02 (lime addition and settling pond[s]) or TCD WT03 (SRB system).

Under Alternative 3+, a total of 47 adit drainages and one seep would be treated, along with a large volume of groundwater in areas of hydraulic isolation and a relatively small amount of groundwater at the tailings impoundment closures. Other metals including cadmium and lead would also be treated, with commensurate reductions in loading.

Because the metals are inorganics, they cannot be destroyed. Active treatment at the CTP relies on precipitation of heavy metals by the formation of hydroxides with low solubility under high pH conditions. The semi-passive treatment involves a combination of adsorption and precipitation of metals.

Active and semi-passive treatment processes reduce the mobility of inorganics through precipitation or combined adsorption and precipitation. Active treatment would reduce effluent metals concentrations by at least 99 percent. Achievable effluent concentrations for semi-passive treatment are specific to the treatment technology used and the chemical characteristics of the adit drainage, but are estimated to be 80 percent or greater. Lower effectiveness is expected for the semi-passive processes due to less operational oversight and less direct control. The total load removed under Alternative 3+ through treatment is therefore (290 x 0.99)+ (47 x 0.8) = 325 lb/day.

Treatment is considered irreversible for the treated water stream. Treatment residuals (sludge and spent media) would require isolation from low-pH water to remain insoluble. It is assumed that these materials would not be characterized as hazardous wastes and would be disposed of onsite.

The residual waste associated with the active treatment process is the sludge containing the precipitated metal hydroxides. The volume and weight of the sludge produced would depend on the total mass loading of all precipitated species, specific process operating conditions, and the degree to which the sludge is dewatered prior to disposal. The estimated volume of dewatered sludge requiring disposal for Alternative 3+ is 8,900 cy/yr, as represented in Table 7-14 by Alternatives 3+(a) and (b), which include no treatment in OU 2.

The residual wastes associated with the semi-passive treatment processes are spent substrate (in the case of the SRB) and precipitated metals from the aerobic/settling ponds for both the SRB and lime addition processes. The spent substrate would require periodic removal, disposal, and replacement. It is assumed that the spent substrate could be disposed of at the repository. The estimated volume of treatment residuals from the semi-passive processes is 190 cy/yr on an annual average basis. Generation of treatment residuals from semi-passive processes would be a periodic operation. Design assumptions for this FFS provide for one media replacement within 30 years for the SRB systems (TCD WT03) and two cleanouts of the lime settling ponds (TCD WT02) within 30 years. Actual change-out frequencies for the spent substrate would be a function of the medium formulation, mass loading, designed bed volume, and hydraulic efficiency at a given site.

7.3.4.1.5 Short-Term Effectiveness

[Alternative 3+(a)]
[OU 3]

The short-term effectiveness of Alternative 3+ is discussed below in the context of (1) protection of the community, (2) protection of workers, (3) environmental impacts, and (4) time required to implement the alternative and eventually achieve response objectives.

Protection of Community During Remedial Actions. The primary risks to the community associated with Alternative 3+ are traffic-related hazards from transportation of large quantities of contaminated media and imported construction materials. These traffic risks would be minimized with standard health and safety controls and traffic control plans. Because Alternative 3+ includes both locally sited waste consolidation areas and regionally sited repositories, a portion of this truck traffic would be on highly traveled corridors. Waste consolidation areas and repositories would be sited to minimize traffic hazards to the community, to the extent practicable. For example, waste consolidation areas may be sited in Canyon Creek and Ninemile Creek to reduce traffic through Wallace. Additional truck trips would be required to import construction materials, such as clean soil and rock.

An additional potential hazard to the community would be particulate emissions during construction. These emissions could be largely controlled through the use of dust control measures such as water sprays and air monitoring.

Protection of Workers During Remedial Actions. Short-term risks to workers would consist of physical construction hazards and traffic-related hazards from materials handling and transportation. These risks would be controlled with standard health and safety controls and traffic control plans. Alternative 3+ includes a variety of construction activities to address more than 21 million cy of contaminated material. Approximately 4.6 million cy of this material would require excavation and rehandling. In addition, particular sites that are characterized by steep topography or difficult access may pose greater construction hazards to workers. In such cases, construction hazards may be reduced or avoided in the design or construction phase by modifying the degree or type of action taken at a particular site.

Workers would also be subject to exposure from contaminated soil and dust. This risk can be largely controlled by the use of personal protective equipment (PPE) and dust control measures such as water sprays and air monitoring.

Environmental Impacts. Short-term impacts on the environment, including re-suspension of sediment and temporary destruction of habitat, would primarily be associated with construction within floodplains and riparian areas. Approximately 240,000 linear feet of stream would be affected by construction of bioengineered revetments and vegetative bank stabilization. An estimated 2.2 million cy of material in floodplains would require excavation and hauling. Alternative 3+ also includes in-stream sediment removal, which could have short-term impacts on water quality. Engineering controls such as sediment fencing, sediment traps, temporary cofferdams, and revegetation and installation of stream and riparian cleanup actions would be used to minimize and mitigate short-term environmental impacts. Any short-term environmental impacts that do occur during construction should be considered in the context of current water quality in the SFCDR and its tributaries (impacted with metals) and long-term objectives of the remedial action (significantly improved water quality and ecosystem function). During long-term maintenance of the alternative, periodic short-term environmental impacts from dredging of sediment traps would also occur.

Additional potential ecological impacts under Alternative 3+ are associated with hydraulic isolation and attendant reduced stream flows in some river segments. Estimation of these potential effects would require further study.

Alternative 3+ would require mining suitable borrow materials (granular materials, growth media, and common fill) for repository construction, capping actions, and floodplain backfill. Short-term environmental impacts would be associated with mining and transporting borrow materials. These impacts at the borrow sites include increased uncontaminated sediment loads from runoff and erosion, destruction of existing vegetation and habitat, and potentially long-term degradation of topsoil quality. Standard engineering controls such as sediment fencing and revegetation would reduce these impacts.

Additional long-term environmental impacts are expected under Alternative 3+ as a result of land being converted for use as permanent repositories and waste consolidation areas and construction of temporary haul roads. The extent of environmental impacts, in terms of lost habitat, would depend on the specific sites selected for repositories. Temporary haul roads would be constructed and operated during implementation, with corresponding impacts on terrestrial habitat and sediment loads from runoff.

Time Until Response Objectives Are Achieved. For the purpose of the FFS, it is assumed that Alternative 3+ would take an estimated 50 to 90 years to implement completely.[25] However, construction at specific source sites could begin immediately, and the time to complete construction at specific source sites would range from several weeks to several years. As construction is completed at individual sites, RAOs for those soils, sediments, and source

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[25] This assumes a rough estimated range of $15 million/yr to $25 million/yr of available annual funding to cover $1.3 billion of capital and O&M costs (See Section 7.3.4.1.7). If funding were not the driving factor, it is estimated that it would require at least 20 years to implement Alternative 3+.

materials addressed by this alternative could be achieved within a relatively short time. Post-remediation studies in OU 2 (CH2M HILL, 2006a) have shown that, following remedial actions in that area, concentrations in surface water stabilized after approximately 2 to 3 years. Because this alternative would not address all contaminated media (including contaminated floodplain sediments that are left in place), these media would continue to act as sources of loading to surface water and groundwater. The RAOs of preventing releases of contaminants to groundwater would not be met for these media.

In summary, the time to achieve the RAOs for soils, sediments, and source materials upstream from Elizabeth Park would be on the order of 50 to 90 years, but only for the portion of soils and source materials addressed under this alternative. The time to achieve these RAOs at a given site would primarily depend on the construction scheduling. Acceleration of the cleanup time frames discussed above is possible, but would result in greater traffic impacts, more intense sediment loads, and potentially higher costs.

Groundwater quality may improve in some areas after construction is completed. However, in other areas contaminated groundwater would remain. Data are not currently available with which to estimate the rate of natural source depletion of metals in groundwater; therefore, it is not known when potential ARARs would be met in groundwater as a result of remedial actions.

RAOs for surface water may be met in certain upgradient project reaches as construction in those reaches is completed. Achieving surface water RAOs in downgradient areas of the SFCDR would generally require completion of construction in most upgradient areas (50 to 90 years), several years for re-establishment of riparian habitat, and additional time for natural source depletion following completion of construction.

The time required to achieve potential ARARs in tributaries to the SFCDR upstream from Elizabeth Park could be shorter or longer than the time frames discussed for the SFCDR at Elizabeth Park.

7.3.4.1.6 Implementability

[Alternative 3+(a)]
[OU 3]

The implementability of Alternative 3+ is discussed below in the context of (1) technical feasibility, (2) administrative feasibility, and (3) the availability of services and materials.

Technical Feasibility. Alternative 3+ is considered to be technically feasible, although construction of the SFCDR stream liners between Wallace and Elizabeth Park may pose significant logistical issues considering the size of the SFCDR and the location near Interstate 90 (I-90). In some areas, there would be limited access to the SFCDR for large equipment and limited space for onsite screening of materials. The limited space would pose logistical considerations for the SFCDR diversion, which is required for stream liner installation. Diversion of the SFCDR and subsequent liner construction would be performed during lower SFCDR flows in the spring and early summer. Site-specific stream liner design would have to include consideration of the impact of liners on stream hydraulics and existing flood control structures. A design objective of the remedial actions would be to have no negative impact on existing flood control systems. If it is determined that in some areas stream lining cannot be implemented without creating negative impacts on existing flood control structures, alternative process options would be used (such as slurry walls) to provide the desired degree of hydraulic isolation.

The primary construction uncertainties associated with Alternative 3+ relate to uncertainties in waste volume and area estimates. Difficulties that may be encountered during implementation may include inability to remove all planned wastes due to subsurface obstacles, construction limitations presented by steep slopes at specific sites, recontamination of remediated areas, and availability of borrow material and vegetative planting stock. These issues would be addressed to the extent practical in the remedial design phase, as more site-specific information (such as detailed surveys, subsurface investigations, or additional sampling) becomes available. Transportation logistics and costs would increase if borrow material were obtained from more distant sources or if suitable growth medium had to be manufactured onsite.

As with Alternative 4+, excavation of sediments from below the water table would pose additional logistical considerations and potentially increased costs. Alternative 3+ involves excavation of approximately 2.2 million cy of floodplain sediments, a portion of which would require dewatering. Deeper excavations, if required, would increase the dewatering difficulties. The water collected during dewatering would be evaluated on a case-by-case basis and, if possible, re-infiltrated.

Design of the semi-passive treatment systems would require treatability testing. This is due to the challenges associated with the semi-passive treatment systems such as performance of the treatment ponds, management of pH fluctuation, extreme weather conditions, and the unknown effectiveness of the system over time. The treatability testing may consist of an onsite pilot-study at one or more representative sites, to be operated for a period not less than one year so that the effect of seasonal climatic changes on the system could be evaluated. The pilot study could consist of implementation of each of the systems at one or more of the smaller adit sources.

Monitoring could effectively measure the success of Alternative 3+ in achieving the RAOs, and the results of the monitoring and periodic inspections would give notice if maintenance or additional action were needed. No component of Alternative 3+ would preclude additional remedial action, if it were needed in the future.

Administrative Feasibility. Alternative 3+ is anticipated to be generally implementable from an administrative standpoint. The primary administrative feasibility concern relates to the ability to acquire land and easements, fulfill substantive permit requirements, and obtain local agency concurrence for siting and construction of waste consolidation areas and repositories (with a cumulative capacity of 4.6 million cy) and active water treatment pipelines. Implementation may require a biological assessment to demonstrate compliance with ESA requirements and consultation with natural resource agencies to obtain concurrence (or determine the need for mitigation or avoidance). Coordination with natural resource agencies may also be required under the Fish and Wildlife Coordination Act. Coordination with USACE may be required under the Rivers and Harbors Act.

Offsite actions, if needed, may require permits. In particular, surface mining permits from state and local agencies may be required to excavate borrow materials (e.g., gravel or common fill used for backfilling deeper floodplain excavations) and drainage layer and growth media for repository construction and capping actions. Potential difficulties in obtaining permits may delay implementation or increase costs.

If institutional controls are necessary to ensure that the implemented remedy is protective, the Region will evaluate whether the existing ICP administered by the Panhandle Health District is adequate or additional measures are needed.

Availability of Services and Materials. Availability of suitable clean borrow materials, particularly growth media, is limited within a reasonable haul distance of the site. Transportation logistics and costs would increase if borrow materials were obtained from more distant sources or if growth media had to be manufactured onsite. Treatability testing of potential growth medium formulations may be required. Surface mining permits (or fulfillment of substantive requirements) may be required to excavate borrow material.

For the purpose of developing cost estimates, it was assumed that all wastes could be disposed of onsite. Hydroxide precipitation sludge generated at the CTP would be disposed of in the existing sludge pond on top of the CIA in accordance with current practices until this sludge pond reaches its capacity, at which time a new lined sludge pond would be constructed on the CIA. Hydroxide precipitation sludge from semi-passive lime addition systems (TCD WT02) and spent substrate from the SRB systems (TCD WT03) would be disposed of at one of the repositories. Necessary services and equipment are readily available, and no special technologies are required for implementation.

7.3.4.1.7 Cost of Implementation

[Alternative 3+(a)]
[OU 3]

Cost estimates for Alternative 3+ were developed assuming 30 years of O&M and a discount rate of 7 percent. Detailed cost estimates are provided in Appendix D (Cost Analysis Documentation). The estimated total costs for implementing Alternative 3+ are summarized as follows (all costs are rounded to three significant figures):

- Total Capital Cost: $1.17 billion
- O&M Cost: $93.6 million (30-year NPV); $7.5 million (Annual Average)
- Total Cost (30-year NPV): $1.27 billion

The factors identified as the most significant sources of cost uncertainty for this alternative are (1) total volumes of contaminated sediments requiring excavation, (2) sediment excavation dewatering requirements and associated unit costs, (3) growth media unit costs, and (4) hydraulic isolation (and associated treatment) requirements. The greatest contributor to the uncertainty is the potentially large escalation in the total volumes of contaminated sediments requiring excavation.

7.3.4.2 OU 2 Alternative (a): Minimal Stream Lining

[Alternative 3+(a)]
[OU 2]

In this section, OU 2 Alternative (a), Minimal Stream Lining, is evaluated based on the seven CERCLA criteria. Following this section, the complete alternative combining both OU 3 and OU 2 components is evaluated.

7.3.4.2.1 Overall Protection of Human Health and the Environment

[Alternative 3+(a)]
[OU 2]

OU 2 Alternative (a) includes a water management option to reduce the mobilization and transport of dissolved metals in the groundwater and surface water system.

As shown in Table 7-22, the estimated load reduction in the SFCDR at Pinehurst as estimated by the groundwater model (Appendix A) for this alternative is 108 lb/day, which represents approximately 5 percent of the annual average dissolved zinc load in the SFCDR at Pinehurst. This relatively small reduction in dissolved metals loading in the SFCDR would provide minimal reduction of risks to both human health and ecological receptors currently associated with direct contact with contaminated surface water. The stream lining on the SFCDR included in OU 2 Alternative (a) could also affect fish habitats due to an increase in water temperature as a result of removing cooler groundwater recharge.

There would be a significant disturbance (e.g., increased traffic, handling and transportation of contaminated material) to the community during the implementation of Alternative (a) because much of the liner installation would occur in the reach of the SFCDR within the developed portion of the City of Kellogg. Mitigation measures would be implemented to minimize this disturbance. These mitigation measures could include, but are not limited to, health and safety controls, traffic control plans, and the use of water sprays for dust control during construction activities.

7.3.4.2.2 Compliance with ARARs

[Alternative 3+(a)]
[OU 2]

Due to the limited reduction in the metals load estimate (5 percent), implementation of this alternative alone would have little impact on the AWQC ratio at Pinehurst. However, when coupled with upstream actions in OU 3, estimates of post-remediation water quality would be significantly improved. Refer to the discussion of the combined Alternative 3+(a) for evaluation of this criterion. There are no RAOs for remediation of groundwater, although improvements in groundwater quality would be realized through implementation of this alternative. A TI waiver may be warranted at specific locations where groundwater does not achieve drinking water standards if it is determined that additional actions would not be effective.

The stream liners are intended to reduce contaminant concentrations in surface water by decreasing recharge to the groundwater system.

As with all OU 2 alternatives, OU 2 Alternative (a) does not include actions to address any remaining soil and sediment present at concentrations above PRGs because the majority of contaminated materials accessible for remediation were addressed during Phase I actions.

The actions included in OU 2 Alternative (a) could potentially be implemented in compliance with potential location-specific and action-specific ARARs. Alternative (a) would be implemented to meet requirements for federal agencies under Section 7 of the ESA. The ESA requires that the actions be protective of critical habitat for several species in the Coeur d'Alene Basin. A summary of other potential location-specific and action-specific ARARs is included in Section 4.0.

7.3.4.2.3 Long-Term Effectiveness and Permanence

[Alternative 3+(a)]
[OU 2]

Long-term effectiveness and permanence of OU 2 Alternative (a) is discussed below in the context of (1) the expected magnitude of residual risk and (2) the adequacy and reliability of engineering and institutional controls.

Magnitude of Residual Risk. The water management actions under OU 2 Alternative (a) would reduce the mobility of metals in the environment and reduce the potential for exposure of environmental receptors to metals. OU 2 Alternative (a) incorporates surface-water-based actions in the SFCDR and tributaries in OU 2 and is not intended to address the site-wide groundwater contamination. If properly maintained, the Alternative (a) actions should continue to provide the same degree of load removal over the long term, and therefore would have a relatively high degree of long-term effectiveness and permanence.

Residual risks following implementation would primarily be associated with contaminated media not addressed by the alternative, which would continue to act as a source of dissolved metals loading to aquatic environments. Significant amounts of contaminated sediments are present in floodplains and beneath the populated areas and infrastructure within OU 2, resulting in groundwater and subsequent surface water contamination. Contaminated groundwater would continue to discharge into the SFCDR and its tributaries in areas where stream liners are not installed. Similarly, surface water would continue to discharge to groundwater and come into contact with contaminated materials, eventually transporting a portion of soluble metals encountered back into surface water downstream.

Because this alternative would result in metals remaining onsite at concentrations above levels that allow for unlimited use and unrestricted exposure, a review would be conducted at least every 5 years, in accordance with the NCP [300.430(f)(4)(ii)].

Adequacy and Reliability of Controls. Long-term performance issues, monitoring requirements, and O&M requirements related to OU 2 Alternative (a) are primarily related to stream liners. Stream liners should effectively eliminate the flow of surface water to groundwater in lined areas of losing reaches and would generally require little maintenance. However, stream liners may be damaged by flooding, and periodic replacement of a portion of the liner would likely be required. A replacement rate of 5 percent per 10 years was assumed for cost estimating purposes.

Institutional controls (i.e., land use restrictions) would also be required. These management requirements are expected to be administered effectively.

7.3.4.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

[Alternative 3+(a)]
[OU 2]

OU 2 Alternative (a) provides no treatment to reduce the toxicity, mobility, or volume of contaminated material. Principal threat wastes would not be treated; therefore, OU 2 Alternative (a) would not satisfy the statutory preference under CERCLA that USEPA use treatment to address the principal threats posed by a site wherever practicable.

7.3.4.2.5 Short-Term Effectiveness

[Alternative 3+(a)]
[OU 2]

The short-term effectiveness of OU 2 Alternative (a) is discussed below in the context of (1) protection of the community, (2) protection of workers, (3) environmental impacts, and (4) time required to achieve response objectives.

Protection of Community During Remedial Actions. The primary risks to the community associated with OU 2 Alternative (a) are traffic-related hazards from transportation of contaminated media and imported construction materials. To the extent possible, these risks would be minimized with standard health and safety controls and traffic control plans. The majority of this truck traffic would be on highly traveled corridors. Truck trips would be required to import construction materials such as the stream liners and to travel to repositories to dispose of contaminated materials encountered during construction of the liners.

An additional potential hazard to the community would be particulate emissions during construction. These emissions could be largely controlled through the use of dust control measures such as water sprays and air monitoring.

Protection of Workers During Remedial Actions. Short-term risks to workers would consist of physical construction hazards and traffic-related hazards from materials handling and transportation. These risks would be controlled with standard health and safety controls and traffic control plans. Construction hazards may be reduced or avoided in the design or construction phase by modifying the degree or type of action taken at a particular site. Workers would also be subject to exposure from contaminated soil and dust. This risk can be largely controlled using PPE and dust control measures such as water sprays and air monitoring.

Environmental Impacts. During the implementation of OU 2Alternative (a), significant short-term impacts, including re-suspension of sediment and temporary destruction of habitat, would be imposed on the environment. These would primarily be associated with construction within floodplains and riparian areas. Approximately 10,000 linear feet of the SFCDR and 11,500 linear feet of tributaries would be affected by construction of a stream liner, which would require excavation and hauling of potentially contaminated sediments. The in-stream construction may influence short-term water quality; however, engineering controls such as sediment fencing, temporary sediment traps, and temporary cofferdams would be used to minimize and mitigate short-term environmental impacts. River and riparian habitat would be affected during implementation of Alternative (a); suitable habitat would be created as part of the construction process. Any short-term environmental impacts that do occur during construction should be considered in the context of current water quality in the SFCDR and its tributaries (impacted with metals) and long-term objectives of the remedial action (significantly improved water quality and ecosystem function).

OU 2 Alternative (a) would require importing borrow materials (granular materials and riprap) for construction of the stream liners. The total quantity of borrow material is uncertain because some excavated materials would be re-used as part of the remedial action. Short-term environmental impacts would be associated with mining and transporting borrow materials. These impacts at the borrow sites include increased uncontaminated sediment loads from runoff and erosion, destruction of existing vegetation and habitat, and potentially long-term degradation of topsoil quality. Standard engineering controls such as sediment fencing and revegetation would reduce these impacts.

Time Until Response Objectives are Achieved. Contaminated soils, sediments, and source materials remaining in OU 2 are not addressed by this alternative; therefore, these media would continue to act as sources of loading to surface water and groundwater. The RAOs of preventing releases of contaminants to surface water and groundwater would not be met for these media.

Contaminated groundwater is not directly addressed by this alternative, and the time required for natural source depletion processes to decrease groundwater concentrations to levels at or below potential ARARs is not known.

RAOs for surface water may be met in the lined tributaries included in this alternative as construction is completed. Achievement of RAOs in the SFCDR would require implementation of actions in OU 3 in addition to those in OU 2. Estimated times to achieve potential ARARs in the SFCDR are presented and discussed below as part of the evaluation of the combined Alternative 3+(a).

7.3.4.2.6 Implementability

[Alternative 3+(a)]
[OU 2]

The implementability of OU 2 Alternative (a) is discussed below in the context of (1) technical feasibility, (2) administrative feasibility, and (3) the availability of services and materials.

Technical Feasibility. OU 2 Alternative (a) is considered to be technically feasible, although construction of the SFCDR stream liner may pose significant logistical issues considering the size of the SFCDR and location in the developed area of the City of Kellogg. There is limited access to the SFCDR for large equipment and limited space for onsite screening of excavated materials. The limited space would pose logistical considerations for the SFCDR diversion, which is required for stream liner installation. Diversion of the SFCDR and subsequent liner construction would be performed during lower SFCDR flows and would not be feasible during higher flows in the spring and early summer. Site-specific stream liner design would have to include consideration of the impact of liners on stream hydraulics and existing flood control structures. A design objective of the remedial actions would be to have no negative impact on existing flood control systems. This SFCDR reach is bound by levees, which would likely be affected by the stream liner installation. Maintaining levee integrity would be required during stream liner construction. If it is determined that in some areas stream lining cannot be implemented without creating negative impacts on existing flood control structures, then alternative process options would be used (such as slurry walls) to provide the desired degree of hydraulic isolation.

In addition, the lining of Bunker Creek would result in increased flow in the creek, exacerbating the current problem of the undersized culvert conveying Bunker Creek flow under I-90. This alternative does not include provisions for constructing a larger culvert under I-90 because this is already in need of improvement and is part of a complex, system-wide problem that would require substantial involvement and investment on the part of a range of local, state, and federal entities. USEPA is committed to participating in efforts to more fully understand ways in which various entities can contribute to the management of flooding problems in the Upper Basin. These efforts are being pursued separately from the FFS.

Excavated sediments generated during construction of OU 2 Alternative (a) would be screened onsite, and disposition of the materials would be done on a site-specific basis.

Administrative Feasibility. Administrative issues would need to be worked out prior to construction of OU 2 Alternative (a) remedial actions. These issues include permitting and compliance with the CWA and negotiating access agreements and rights-of-way with private landowners.

Availability of Services and Materials. The services and materials needed to implement the alternative should be available regionally. Any machinery required for OU 2 Alternative (a) construction and not available within northern Idaho should be available for mobilization from either Washington or Oregon. Implementation may require consultation with other federal or state agencies for permitting and/or regulatory requirements.

Additional difficulties encountered during implementation may include availability of borrow material. This issue could be handled in the remedial design phase as more site-specific information (such as detailed surveys or additional sampling) becomes available. Transportation logistics and costs would increase if borrow material were obtained from more distant sources.

7.3.4.2.7 Cost of Implementation

[Alternative 3+(a)]
[OU 2]

Cost estimates for OU 2 Alternative (a) were developed assuming 30 years of O&M and a discount rate of 7 percent consistent with USEPA guidance (USEPA, 2000c). Table 7-22 includes the cost estimates for the OU 2 alternatives. Detailed cost estimates are provided in Appendix D of this FFS Report. The estimated total costs for implementing OU 2 Alternative (a) are summarized as follows:

- Total Capital Cost: $60.2 million
- O&M Cost: $1.19 million (30-year NPV); $95,900 (Annual Average)
- Total Cost (30-year NPV): $61.4 million

7.3.4.3 Combined Alternative 3+(a)

[Alternative 3+(a)]
[Combined]

7.3.4.3.1 Overall Protection of Human Health and the Environment

[Alternative 3+(a)]
[Combined]

The estimated reduction in dissolved metals loadings at Elizabeth Park and Pinehurst, based on the results of the Predictive Analysis (Appendix B) for Alternative 3+(a), is as follows:

	Pre-Remediation AWQC Ratio	Post-Remediation AWQC Ratio
Elizabeth Park (SF-268)	5.5	1.9
Pinehurst (SF-271)	5.2	2.9

Based on the post-remediation AWQC estimates presented above, Alternative 3+(a) would meet the threshold criterion of overall protection of human health and the environment for surface water. This determination is made with the recognition that attainment of site cleanup objectives for surface water would require a period of natural source depletion.

In addition to the expected reduction in AWQC ratios, Alternative 3+(a) would also significantly improve the quality of the riparian and riverine habitat structure, which would also stabilize remaining floodplain sources, reducing the potential for direct human and ecological exposures to the most highly contaminated media and reducing contaminant transport via erosion and leachate production.

7.3.4.3.2 Compliance with ARARs

[Alternative 3+(a)]
[Combined]

The results of the Predictive Analysis indicate that Alternative 3+(a) would meet the threshold criterion of compliance with ARARs for surface water, but only after a natural source depletion period, which is common to all of the alternatives. Discussions of compliance with other potential ARARs are provided under Alternative 3+ and OU 2 Alternative (a), above.

7.3.4.3.3 Long-Term Effectiveness and Permanence

[Alternative 3+(a)]
[Combined]

The long-term effectiveness and permanence of Alternative 3+(a) is discussed below in the context of (1) magnitude of risk and (2) adequacy and reliability of controls.

Magnitude of Residual Risk. This alternative was estimated by the Predictive Analysis to result in a moderate reduction in post-remediation mass loadings (an estimated 41 percent reduction in the SFCDR at Pinehurst). Some smaller loading sources would receive no action or limited containment. There would be a low potential for erosive transport of contaminated alluvium left in place.

Residual risks following implementation would primarily be associated with contaminated media not addressed by the alternative, which would continue to act as a source of dissolved metals loading to aquatic environments. Natural source depletion processes would further reduce residual risks.

There would be a low residual risk to humans. Decontamination of structures and access restrictions would be effective.

Because this alternative would result in metals remaining onsite at concentrations above levels that allow for unlimited use and unrestricted exposure, a review would be conducted at least every 5 years, in accordance with the NCP [300.430(f)(4)(ii)].

Adequacy and Reliability of Controls. This alternative could effectively be maintained through monitoring, maintenance, and institutional controls. There would be moderate maintenance requirements for caps, stream and riparian cleanup actions, sediment traps, French drains, and stream liners, and there would be relatively high maintenance requirements for semi-passive and active treatment.

7.3.4.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

[Alternative 3+(a)]
[Combined]

This alternative includes active treatment of adit drainages, impoundment closures, and hydraulic isolation areas in OU 3 using hydroxide precipitation as part of the HDS process at the CTP. As shown in Table 7-13, the estimated average flow rate from all sources included in this alternative to the CTP is approximately 11,500 gpm (290 lb/day). All of this water would come from OU 3. No additional water from OU 2 would be treated under this alternative. In addition, the average flow rate from all sources included in this alternative to semi-passive treatment processes is 800 gpm (47 lb/day).

Semi-passive treatment would be implemented at 36 additional adits and one seep in OU 3 using either sulfate reducing bioreactors (SRBs) or lime addition and precipitation. Repository drainage would also be treated at the CTP (during the dewatering period).

This alternative reduces mobility of metals by hydroxide precipitation as part of the HDS process at the CTP and adsorption/precipitation onto media in semi-passive systems. Treatment effectiveness is expected to be between 80 and greater than 99 percent, depending on the treatment technology. Treatment is considered irreversible for the treated water stream. Treatment residuals (sludge and spent media) would require isolation from low-pH water to remain insoluble. It is assumed that these materials would not be characterized as hazardous wastes and would be disposed of onsite. The total annual volume of treatment residuals associated with Alternative 3+(a) is 9,100 cy/yr. This alternative satisfies the statutory preference for treatment under CERLCA. The total load removed under Alternative 3+(a) through treatment is (290 x 0.99) + (47 x 0.8) = 325 lb/day.

7.3.4.3.5 Short-Term Effectiveness

[Alternative 3+(a)]
[Combined]

This alternative would involve potentially significant short-term risks to the community and workers from construction traffic. Risks could be minimized through traffic control plans and selective repository siting. There would be limited chemical risks to workers from remediation actions. Risk would be minimized with standard health and safety measures.

This alternative would involve significant short-term environmental impacts from construction, including re-suspension of sediment and temporary destruction of habitat. These impacts could be minimized and mitigated through engineering controls and revegetation. Impacts would be associated with stream and riparian cleanup actions, extensive excavation, haul road construction and maintenance, construction within floodplains, repository requirements, and potential stream flow reduction through hydraulic isolation actions. Any short-term environmental impacts that do occur during construction should be considered in the context of current water quality in the SFCDR and its tributaries (impacted with metals) and long-term objectives of the remedial action (significantly improved water quality and ecosystem function).

It is estimated that it would take approximately 50 to 90 years[26] to implement the alternative and to achieve RAOs for most source materials.

7.3.4.3.6 Implementability

[Alternative 3+(a)]
[Combined]

The most significant technical feasibility concerns with this alternative are related to construction of the stream liners on the SFCDR (discussed as part of the evaluation of Alternative 3+ and OU 2 Alternative (a), above). Significant uncertainties in construction volumes could be handled in the design or construction phase. There are cost and logistical considerations for obtaining borrow materials and excavating in floodplains that would need to be addressed.

The services, equipment, and technologies used are all available at least on a regional level.

7.3.4.3.7 Cost of Implementation

[Alternative 3+(a)]
[Combined]

Cost estimates for Alternative 3+(a) are summarized as follows:

- Total Capital Cost: $1.24 billion
- O&M Cost: $95 million (30-year NPV); $7.67 million (Annual Average)
- Total Cost (30-year NPV): $1.34 billion

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[26] This assumes a rough estimated range of $15 million/yr to $25 million/yr of available annual funding to cover $1.3 billion of capital and O&M costs (see Section 7.3.4.3.7). If funding were not the driving factor, it is estimated that it would require at least 20 years to implement Alternative 3+(a).

7.3.5 Alternative 3+(b)

Alternative 3+(b) is discussed below with respect to the seven CERCLA threshold and balancing criteria. The only difference between Alternative 3+(b) and Alternative 3+(a) described in Section 7.3.4 is the set of remedial actions included for OU 2. Therefore, the following discussion is focused on the OU 2 components and the analysis of the combined (OU 3 plus OU 2 components) alternative.

7.3.5.1 OU 3 Alternative 3+, More Extensive Removal, Disposal, and Treatment

[Alternative 3+(b)]
[OU 3]

Refer to Section 7.3.4 for a discussion of the CERCLA threshold criteria and primary balancing criteria related to Alternative 3+ for OU 3.

7.3.5.2 OU 2 Alternative (b): Extensive Stream Lining

[Alternative 3+(b)]
[OU 2]

In this section, OU 2 Alternative (b) is evaluated based on the seven CERCLA criteria. Following this section, the combined alternative containing both OU 3 and OU 2 components [Alternative 3+(b)] is evaluated.

7.3.5.2.1 Overall Protection of Human Health and the Environment

[Alternative 3+(b)]
[OU 2]

OU 2 Alternative (b) combines water collection and management options to reduce the mobilization and transport of dissolved metals in the groundwater and surface water system.

As shown in Table 7-22, the estimated load reduction in the SFCDR at Pinehurst as estimated by the groundwater model (Appendix A) for this alternative is 100 lb/day, which represents approximately 4 percent of the annual average dissolved zinc load in the SFCDR at Pinehurst. This relatively small reduction in dissolved metals loading in the SFCDR would provide minimal reduction of risks to both human health and ecological receptors currently associated with direct contact with contaminated surface water. There would be a moderate disturbance (e.g., increased traffic, handling and transportation of contaminated material) to the community during the implementation of Alternative (b) because some actions would be installed in populated areas of OU 2. Mitigation measures would be implemented to minimize this disturbance. These mitigation measures could include, but are not limited to, health and safety controls, traffic control plans, and the use of water sprays for dust control during construction activities.

7.3.5.2.2 Compliance with ARARs

[Alternative 3+(b)]
[OU 2]

Due to the limited reduction in metals load estimated (4 percent), implementation of this alternative alone would have little impact on the AWQC ratio at Pinehurst. However, when coupled with upstream actions in OU 3, estimates of post-remediation water quality would be significantly improved. Please refer to the discussion of the combined Alternative 3+(b) for evaluation of this criterion. Remediation of groundwater is not an objective of OU 2 Alternative (b). The stream liners are intended to reduce recharge to the groundwater system, thus reducing mobilization and transport of contaminants to the surface water system.

As with all OU 2 alternatives, OU 2 Alternative (b) does not include actions to address any remaining soil and sediment present at concentrations above PRGs because the majority of contaminated materials accessible for remediation were addressed during Phase I actions.

The actions included in OU 2 Alternative (b) could potentially be implemented in compliance with potential location-specific and action-specific ARARs. OU 2 Alternative (b) would be implemented to meet requirements for federal agencies under Section 7 of the ESA. The ESA requires that the actions be protective of critical habitat for several species in the Coeur d'Alene Basin. A summary of other potential location-specific and action-specific ARARs is included in Section 4.0.

7.3.5.2.3 Long-Term Effectiveness and Permanence

[Alternative 3+(b)]
[OU 2]

The long-term effectiveness and permanence of OU 2 Alternative (b) is discussed below in the context of (1) the expected magnitude of residual risk and (2) the adequacy and reliability of engineering and institutional controls.

Magnitude of Residual Risk. The water management actions under OU 2 Alternative (b) would reduce the mobility of metals in the environment and reduce the potential for exposure of environmental receptors to metals. Alternative (b) incorporates surface-water-based actions at select tributaries within OU 2 and is not intended to address the site-wide groundwater contamination. If properly maintained, the OU 2 Alternative (b) actions should continue to provide the same degree of load removal over the long term, and therefore would have a relatively high degree of long-term effectiveness and permanence.

Residual risks following implementation would primarily be associated with contaminated media not addressed by the alternative, which would continue to act as a source of dissolved metals loading to aquatic environments. Significant amounts of contaminated sediments are present in floodplains and beneath the populated areas and infrastructure within OU 2, resulting in groundwater and subsequent surface water contamination. Contaminated groundwater would continue to discharge into the SFCDR and its tributaries in areas where stream liners are not installed. Similarly, surface water would continue to discharge to groundwater and come into contact with contaminated materials, eventually transporting a portion of soluble metals encountered back into surface water downstream.

Because this alternative would result in metals remaining onsite at concentrations above levels that allow for unlimited use and unrestricted exposure, a review would be conducted at least every 5 years, in accordance with the NCP [300.430(f)(4)(ii)].

Adequacy and Reliability of Controls. Long-term performance issues, monitoring requirements, and O&M requirements related to OU 2 Alternative (b) are summarized as follows:

- **Groundwater Collection** – Groundwater would be collected using extraction wells installed at the upgradient end of the stream liners (except Bunker Creek). Collected groundwater would be discharged into the stream liners. The extraction wells, pumps, and associated controls would all require routine O&M to maintain full functionality. O&M components include physical maintenance of drains, pipelines, and pumps, including periodic and routine removal of mineral scaling. Electronic control of pumping systems would also require ongoing O&M to maintain desired flow rates and groundwater elevations.
- **Slurry Walls –** Slurry walls should require little maintenance; however, their performance would be limited to reducing, not eliminating, the flow of groundwater. In this case, the objective of the slurry wall in OU 2 Alternative (b) is to reduce the flow of clean groundwater through contaminated materials in Deadwood Gulch, Government Gulch, and Magnet Gulch, thereby improving water quality in these tributaries. Groundwater elevation and groundwater quality monitoring would be performed to evaluate slurry wall effectiveness. Because extraction wells would be used in conjunction with the slurry walls in Deadwood Gulch, Government Gulch, and Magnet Gulch, groundwater monitoring costs are included in extraction well O&M.
- **Stream Liners –** Stream liners should effectively eliminate the flow of surface water to groundwater in lined areas and would generally require little maintenance. However, stream liners may be damaged by flooding, and periodic replacement of a portion of the liner would likely be required. A replacement rate of 5 percent per 10 years was assumed for cost estimating purposes.

Institutional controls (i.e., land use restrictions) would also be required. These management requirements are expected to be administered effectively.

7.3.5.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

[Alternative 3+(b)]
[OU 2]

OU 2 Alternative (b) provides no treatment to reduce the toxicity, mobility, or volume of contaminated material. Principal threat wastes would not be treated; therefore, OU 2 Alternative (b) would not satisfy the statutory preference under CERCLA that USEPA use treatment to address the principal threats posed by a site wherever practicable.

7.3.5.2.5 Short-Term Effectiveness

[Alternative 3+(b)]
[OU 2]

The short-term effectiveness of OU 2 Alternative (b) is discussed below in the context of (1) protection of the community, (2) protection of workers, (3) environmental impacts, and (4) time required to achieve response objectives.

Protection of Community During Remedial Actions. The primary risks to the community associated with OU 2 Alternative (b) are traffic-related hazards from transportation of contaminated media and imported construction materials because the actions are located in the unpopulated areas of OU 2. To the extent possible, these risks would be minimized with standard health and safety controls and traffic control plans. The majority of this truck traffic would be on highly traveled corridors. Truck trips would be required to import construction materials such as liners and pipe and to travel to the repository to dispose of contaminated materials encountered during construction.

Protection of Workers During Remedial Actions. Short-term risks to workers would consist of physical construction hazards and traffic-related hazards from materials handling and transportation. These risks would be controlled with standard health and safety controls and traffic control plans. Significant construction hazards may be avoided in the design or construction phase by modifying the degree or type of action taken at a particular site. Workers would also be subject to exposure from contaminated soil and dust. This risk can be largely controlled using PPE and dust control measures such as water sprays and air monitoring.

Environmental Impacts. During the implementation of OU 2 Alternative (b), significant short-term impacts, including re-suspension of sediment and temporary destruction of habitat, would be imposed on the environment. These would primarily be associated with construction within floodplains and riparian areas. Approximately 35,000 linear feet of tributaries would be affected by construction of a stream liner, which would require excavation and hauling of potentially contaminated sediments. The in-stream construction may influence short-term water quality; however, engineering controls such as sediment fencing, temporary sediment traps, and temporary cofferdams would be used to minimize and mitigate short-term environmental impacts. River and riparian habitat would be affected during implementation of OU 2 Alternative (b); suitable habitat would be created as part of the construction process. Any short-term environmental impacts that do occur during construction should be considered in the context of current water quality in the SFCDR and its tributaries (impacted with metals) and long-term objectives of the remedial action (significantly improved water quality and ecosystem function).

OU 2 Alternative (b) would require importing borrow materials (granular materials and riprap) for construction of the stream liners. The total quantity of borrow material is uncertain because some excavated materials would be re-used as part of the remedial action. Short-term environmental impacts would be associated with mining and transporting borrow materials. These impacts at the borrow sites include increased uncontaminated sediment loads from runoff and erosion, destruction of existing vegetation and habitat, and potentially long-term degradation of topsoil quality. Standard engineering controls such as sediment fencing and revegetation would reduce these impacts.

Time Until Response Objectives are Achieved. Contaminated soils, sediments, and source materials remaining in OU 2 are not addressed by this alternative; therefore, these media would continue to act as sources of loading to surface water and groundwater. The RAOs of preventing releases of contaminants to surface water and groundwater would not be met for these media.

Contaminated groundwater is not directly addressed by this alternative, and the time required for natural attenuation processes to decrease groundwater concentrations to levels at or below potential ARARs is not known.

RAOs for surface water may be met in the lined tributaries included in this alternative as construction is completed. Achievement of RAOs in the SFCDR would require implementation of actions in OU 3 in addition to those in OU 2.

7.3.5.2.6 Implementability

[Alternative 3+(b)]
[OU 2]

The implementability of OU 2 Alternative (b) is discussed below in the context of (1) technical feasibility, (2) administrative feasibility, and (3) the availability of services and materials.

Technical Feasibility. OU 2 Alternative (b) is considered to be technically feasible, but the lining of Bunker Creek would result in increased flow in the creek, exacerbating the current problem of the undersized culvert conveying Bunker Creek flow under I-90 [as discussed above for OU 2 Alternative (a)].

Excavated sediments generated during construction of OU 2 Alternative (b) would be screened onsite, and disposition of the materials would be done on a site-specific basis.

Administrative Feasibility. Administrative issues would need to be worked out prior to construction of OU 2 Alternative (b) remedial actions. These issues include permitting and compliance with the CWA and negotiating access agreements and rights-of-way with private landowners.

Availability of Services and Materials. The services and materials needed to implement the alternative should be available regionally. Any machinery needed for OU 2 Alternative (b) construction not available within northern Idaho should be available for mobilization from either Washington or Oregon. Implementation may require consultation with other federal or state agencies for permitting and/or regulatory requirements.

Additional difficulties encountered during implementation may include availability of borrow material. This issue could be handled in the remedial design phase as more site-specific information (such as detailed surveys or additional sampling) becomes available. Transportation logistics and costs would increase if borrow material were obtained from more distant sources.

7.3.5.2.7 Cost of Implementation

[Alternative 3+(b)]
[OU 2]

Cost estimates for OU 2 Alternative (b) were developed assuming 30 years of O&M and a discount rate of 7 percent consistent with USEPA guidance (USEPA, 2000c). Detailed cost estimates are provided in Appendix D. The estimated total costs for implementing OU 2 Alternative (b) are summarized as follows:

- Total Capital Cost: $24.8 million
- O&M Cost: $1.02 million (30-year NPV); $82,200 (Annual Average)
- Total Cost (30-year NPV): $25.9 million

7.3.5.3 Combined Alternative 3+(b)

[Alternative 3+(b)]
[Combined]

7.3.5.3.1 Overall Protection of Human Health and the Environment

[Alternative 3+(b)]
[Combined]

The estimated reduction in the AWQC ratios at Elizabeth Park and Pinehurst based on the results of the Predictive Analysis (Appendix B) is as follows:

	Pre-Remediation AWQC Ratio	Post-Remediation AWQC Ratio
Elizabeth Park (SF-268)	5.5	1.9
Pinehurst (SF-271)	5.2	3.0

Based on the post-remediation AWQC estimates presented above, Alternative 3+(b) would meet the threshold criterion of overall protection of human health and the environment for surface water. This determination is made with the caveat that attainment of site cleanup objectives for surface water would require a period of natural source depletion.

In addition to the expected reduction in AWQC ratios, Alternative 3+(b) would also significantly improve the quality of the riparian and riverine habitat structure, which would also stabilize remaining floodplain sources, thus reducing the potential for direct human and ecological exposures to the most highly contaminated media and reducing contaminant transport via erosion and leachate production.

7.3.5.3.2 Compliance with ARARs

[Alternative 3+(b)]
[Combined]

The results of the Predictive Analysis indicate that Alternative 3+(b) would meet the threshold criterion of compliance with ARARs for surface water, but only after a period of natural source depletion, which is common to all of the alternatives. Discussions of compliance with other potential ARARs are provided under Alternative 3+ and OU 2 Alternative (b), above.

7.3.5.3.3 Long-Term Effectiveness and Permanence

[Alternative 3+(b)]
[Combined]

The long-term effectiveness and permanence of Alternative 3+(b) is discussed below in the context of (1) magnitude of risk and (2) adequacy and reliability of controls.

Magnitude of Residual Risk. This alternative would result in a moderate reduction in post-remediation mass loadings (estimated 41 percent reduction). Some smaller loading sources would receive no action or limited containment. There would be a low potential for erosive transport of contaminated alluvium left in place.

Residual risks following implementation would primarily be associated with contaminated media not addressed by the alternative, which would continue to act as a source of dissolved metals loading to aquatic environments. Natural source depletion processes would further reduce residual risks.

There would be a low residual risk to humans. Decontamination of structures and access restrictions would be effective.

Because this alternative would result in metals remaining onsite at concentrations above levels that allow for unlimited use and unrestricted exposure, a review would be conducted at least every 5 years, in accordance with the NCP [300.430(f)(4)(ii)].

Adequacy and Reliability of Controls. This alternative could effectively be maintained through monitoring, maintenance, and institutional controls. There would be moderate maintenance requirements for caps, stream and riparian cleanup actions, sediment traps, French drains, and stream liners, and there would be relatively high maintenance requirements for semi-passive and active treatment.

7.3.5.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

[Alternative 3+(b)]
[Combined]

This alternative includes active treatment of adit drainages, impoundment closures, and hydraulic isolation areas using hydroxide precipitation as part of the HDS process at the CTP. As shown in Table 7-13, the estimated average flow rate from all sources included in this alternative to the CTP is approximately 11,500 gpm (290 lb/day). All of this flow would be from OU 3. Semi-passive treatment would be implemented at 36 additional adits and one seep in OU 3 using either SRBs or lime addition and precipitation. The average flow rate from all sources included in this alternative to semi-passive treatment processes is 800 gpm (47 lb/day). Repository drainage would also be treated at the CTP (during the dewatering period).

This alternative reduces mobility of metals by hydroxide precipitation and adsorption/ precipitation onto media. Treatment effectiveness is expected to be between 80 and greater than 99 percent, depending on the treatment technology. Treatment is considered irreversible for the treated water stream. Treatment residuals (sludge and spent media) would require isolation from low-pH water to remain insoluble. The total annual volume of treatment residuals associated with Alternative 3+(b) is 9,100 cy/yr. It is assumed that these materials would not be characterized as hazardous wastes and would be disposed of onsite.

This alternative satisfies the statutory preference for treatment under CERLCA. The total load removed under Alternative 3+(b) through treatment is (290 x 0.99) + (47 x 0.8) = 325 lb/day.

7.3.5.3.5 Short-Term Effectiveness

[Alternative 3+(b)]
[Combined]

Alternative 3+(b) would involve potentially significant short-term risks to the community and workers from construction traffic. Risks could be minimized through traffic control plans and selective repository siting. There would be limited chemical risks to workers from remediation actions. Risk would be minimized with standard health and safety measures.

This alternative would involve significant short-term environmental impacts from construction, including re-suspension of sediment and temporary destruction of habitat. These impacts could be minimized and mitigated through engineering controls and revegetation. Impacts would be associated with stream and riparian cleanup actions, extensive excavation, haul road construction and maintenance, construction within floodplains, repository requirements, and potential stream flow reduction through hydraulic isolation actions. Any short-term environmental impacts that do occur during construction should be considered in the context of current water quality in the SFCDR and its tributaries (impacted with metals) and long-term objectives of the remedial action (significantly improved water quality and ecosystem function).

It is estimated that it would take approximately 50 to 90 years[27] to implement the alternative and to achieve RAOs for most source materials.

7.3.5.3.6 Implementability

[Alternative 3+(b)]
[Combined]

This alternative is considered to be technically feasible, although construction of the SFCDR stream liners between Wallace and Elizabeth Park may pose significant logistical issues considering the size of the SFCDR and the location near I-90. In some areas, there would be limited access to the SFCDR for large equipment and limited space for onsite screening of materials. The limited space would pose logistical considerations for the SFCDR diversion, which is required for stream liner installation. Diversion of the SFCDR and subsequent liner construction would be performed during lower SFCDR flows in the spring and early summer. Site-specific stream liner design would have to include consideration of the impact of liners on stream hydraulics and existing flood control structures. A design objective of the remedial actions would be to have no negative impact on existing flood control systems. If it is determined that in some areas stream lining cannot be implemented without creating negative impacts on existing flood control structures, then alternative process options would be used (such as slurry walls) to provide the desired degree of hydraulic isolation.

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[27] This assumes a rough estimated range of $15 million/yr to $25 million/yr of available annual funding to cover $1.3 billion of capital and O&M costs (see Section 7.3.5.3.7). If funding were not the driving factor, it is estimated that it would require at least 20 years to implement Alternative 3+(b).

Significant uncertainties in construction volumes could be handled in the design or construction phase. There are cost and logistical considerations for obtaining borrow materials and excavating in floodplains that would need to be addressed.

The services, equipment, and technologies used are all available at least on a regional level.

7.3.5.3.7 Cost of Implementation

[Alternative 3+(b)]
[Combined]

Cost estimates for Alternative 3+(b) are summarized as follows:

- Total Capital Cost: $1.2 billion
- O&M Cost: $94.9 million (30-year NPV); $7.64 million (Annual Average)
- Total Cost (30-year NPV): $1.29 billion

7.3.6 Alternative 3+(c)

Alternative 3+(c) is discussed below with respect to the seven CERCLA threshold and balancing criteria. The only difference between Alternative 3+(c) and Alternative 3+(a) described in Section 7.3.4 is the set of remedial actions included for OU 2. Therefore, the following discussion is focused on the OU 2 components and the analysis of the combined (OU 3 plus OU 2 components) alternative.

7.3.6.1 OU 3 Alternative 3+, More Extensive Removal, Disposal, and Treatment

[Alternative 3+(c)]
[OU 3]

Refer to Section 7.3.4 for a discussion of the CERCLA threshold criteria and primary balancing criteria related to Alternative 3+ for OU 3.

7.3.6.2 OU 2 Alternative (c): French Drains

[Alternative 3+(c)]
[OU 2]

In this section, OU 2 Alternative (c) is evaluated based on the seven CERCLA criteria. Following this section, the combined alternative containing both OU 3 and OU 2 components [Alternative 3+(c)] is evaluated.

7.3.6.2.1 Overall Protection of Human Health and the Environment

[Alternative 3+(c)]
[OU 2]

OU 2 Alternative (c) combines water collection, management, and treatment options to reduce the mobilization and transport of dissolved metals in the groundwater and surface water system.

As shown in Table 7-22, the estimated load reduction in the SFCDR at Pinehurst as estimated by the groundwater model (Appendix A) for this alternative is 510 lb/day, which represents approximately 22 percent of the annual average dissolved zinc load in the

SFCDR at Pinehurst. This substantial reduction in dissolved metals loading in the SFCDR would reduce the risks to both human health and ecological receptors currently associated with direct contact with contaminated surface water.

Alternative (c) includes direct piping of the CTP effluent to the SFCDR for discharge. Direct piping of the discharge to the SFCDR rather than the current practice of discharging to Bunker Creek would eliminate the infiltration and recontamination of this treated water, thus keeping clean water clean.

There would be a light to moderate disturbance (e.g., increased traffic, handling and transportation of contaminated material) to the community during the implementation of OU 2 Alternative (c) because the actions would primarily be installed in the unpopulated areas of OU 2. Mitigation measures would be implemented to minimize this disturbance. These mitigation measures could include, but are not limited to, health and safety controls, traffic control plans, and the use of water sprays for dust control during construction activities.

7.3.6.2.2 Compliance with ARARs

[Alternative 3+(c)]
[OU 2]

The significant reduction in metals load estimated for this alternative (22 percent) would result in a correspondingly reduced AWQC ratio at Pinehurst following implementation. However, when coupled with upstream actions in OU 3, estimates of post-remediation water quality are significantly improved. Please refer to the discussion of the combined Alternative 3+(c) below for evaluation of this criterion.

Although groundwater would be collected and treated as part of OU 2 Alternative (c), there are no RAOs for remediation of groundwater. Groundwater would be collected only as a means of reducing contaminant concentrations in surface water, although improvements in groundwater quality would be realized through implementation of this alternative. A TI waiver may be warranted at specific locations where groundwater does not achieve drinking water standards if it is determined that additional actions would not be effective.

As with all OU 2 alternatives, OU 2 Alternative (c) does not include actions to address any remaining soil and sediment present at concentrations above PRGs because the majority of contaminated materials accessible for remediation were addressed during Phase I actions

The actions included in OU 2 Alternative (c) could potentially be implemented in compliance with potential location-specific and action-specific ARARs. However, there may be difficulties in meeting potential location-specific and action-specific ARARs associated with repository siting and obtaining borrow material. OU 2 Alternative (c) would be implemented to meet requirements for federal agencies under Section 7 of the ESA. The ESA requires that the actions be protective of critical habitat for several species in the Coeur d'Alene Basin. A summary of other potential location-specific and action-specific ARARs is included in Section 4.0.

7.3.6.2.3 Long-Term Effectiveness and Permanence

[Alternative 3+(c)]
[OU 2]

The long-term effectiveness and permanence of OU 2 Alternative (c) is discussed below in the context of (1) the expected magnitude of residual risk and (2) the adequacy and reliability of engineering and institutional controls.

Magnitude of Residual Risk. The water collection and treatment actions under OU 2 Alternative (c) would reduce the mobility of metals in the environment and reduce the potential for exposure of environmental receptors to metals. Alternative (c) incorporates groundwater-based actions in the area of OU 2 with the highest metals load gains to the SFCDR and is not intended to address the site-wide groundwater contamination. If properly maintained, the Alternative (c) actions should continue to provide the same degree of load removal over the long term, and therefore would have a relatively high degree of long-term effectiveness and permanence.

Residual risks following implementation would primarily be associated with contaminated media not addressed by the alternative, which would continue to act as a source of dissolved metals loading to aquatic environments. Significant amounts of contaminated sediments are present in floodplains and beneath the populated areas and infrastructure within OU 2, resulting in groundwater and subsequent surface water contamination. Contaminated groundwater would continue to discharge into the SFCDR in the western portion of OU 2 and in tributaries of the SFCDR.

Because this alternative would result in metals remaining onsite at concentrations above levels that allow for unlimited use and unrestricted exposure, a review would be conducted at least every 5 years, in accordance with the NCP [300.430(f)(4)(ii)].

Adequacy and Reliability of Controls. Long-term performance issues, monitoring requirements, and O&M requirements related to Alternative (c) are summarized as follows:

- **Groundwater Collection and Conveyance** – Groundwater would be collected using French drains and conveyed, via a pump station, to the CTP. The French drains, pumps, and associated controls would all require routine O&M to maintain functionality. O&M components include physical maintenance of drains, pipelines, and pumps, including periodic and routine removal of precipitates. Electronic control of pumping systems would also require ongoing O&M to maintain desired flow rates and groundwater elevations. Groundwater monitoring would be performed in the vicinity of the French drain to evaluate groundwater elevations and quality.
- **Active Treatment –** Collected groundwater would be collected, conveyed, and actively treated at the CTP. O&M of the CTP is described in Section 7.2.4.
- **CTP Effluent Piping –** The CTP effluent would be piped directly to the SFCDR for discharge. Physical maintenance of the pipeline would be required, including periodic and routine removal of precipitates.

Institutional controls (i.e., land use restrictions) would also be required. These management requirements are expected to be administered effectively.

7.3.6.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

[Alternative 3+(c)]
[OU 2]

OU 2 Alternative (c) includes active treatment (at the CTP) of groundwater collected near the gaining reach of the SFCDR in the eastern portion of OU 2. As shown in Table 7-13, the CTP would require expansion to treat the additional 4,200 gpm (peak flow) of OU 2 waters. A discussion of CTP expansion to accommodate the OU 2 Alternative (c) flows, along with flows from Alternative 3+ in OU 3, is provided in Section 7.2.4.

Active treatment as part of the OU 2 Alternative (c) actions is estimated to reduce the dissolved zinc load in the SFCDR at Station SF-271 by about 510 lb/day. The groundwater model was used to estimate both the net reduction in dissolved zinc load to the SFCDR and the dissolved zinc load that would be entering the drains for treatment. The estimated annual average dissolved zinc load that would be sent to the CTP for treatment under this alternative is 1,160 lb/day (see Table 7-13).

The active water treatment component of OU 2 Alternative (c) would reduce the mobility of contaminants through precipitation or combined adsorption and precipitation. The residual waste associated with the active treatment process is the sludge containing the precipitated metal hydroxides. The mass and volume of dissolved metals would be reduced in the groundwater and surface water systems, but the residual waste would require management and disposal. Active treatment can be considered irreversible for the treated water stream. The hydroxide sludge from the HDS process at the CTP would require isolation from low-pH water to remain insoluble. It is assumed that the sludge would not be characterized as a hazardous waste and would be disposed of onsite. The volume of treatment residuals associated with OU 2 Alternative (c) is discussed below as part of the combined Alternative 3+(c).

7.3.6.2.5 Short-Term Effectiveness

[Alternative 3+(c)]
[OU 2]

The short-term effectiveness of OU 2 Alternative (c) is discussed below in the context of (1) protection of the community, (2) protection of workers, (3) environmental impacts, and (4) time required to achieve response objectives.

Protection of Community During Remedial Actions. The primary risks to the community associated with OU 2 Alternative (c) are traffic-related hazards from transportation of contaminated media and imported construction materials because the actions are located in the unpopulated areas of OU 2. To the extent possible, these risks would be minimized with standard health and safety controls and traffic control plans. The majority of truck traffic would be on highly traveled corridors. Truck trips would be required to import construction materials such as pipe and to travel to the repository to dispose of contaminated materials encountered during construction.

Protection of Workers During Remedial Actions. Short-term risks to workers would consist of physical construction hazards and traffic-related hazards from materials handling and transportation. These risks would be controlled with standard health and safety controls and traffic control plans. Significant construction hazards may be avoided in the design or construction phase by modifying the degree or type of action taken at a particular site. Workers would also be subject to exposure from contaminated soil and dust. This risk can be largely controlled using PPE and dust control measures such as water sprays and air monitoring.

Environmental Impacts. During the implementation of OU 2 Alternative (c), light to moderate short-term impacts would be imposed on the environment, including re-suspension of sediment and temporary destruction of habitat. These would primarily be associated with the installation of the French drain system, which require excavation and hauling of potentially contaminated sediments. Potential sediment loading from runoff during these excavations would be mitigated using standard engineering controls such as sediment fencing would be used to minimize and mitigate short-term environmental impacts. Any short-term environmental impacts that do occur during construction should be considered in the context of current water quality in the SFCDR and its tributaries (impacted with metals) and long-term objectives of the remedial action (significantly improved water quality and ecosystem function).

OU 2 Alternative (c) would require importing borrow materials for construction of the French drain system. The total quantity of borrow material is uncertain because some excavated materials may be re-used as part of the remedial action. Short-term environmental impacts would be associated with mining and transporting borrow materials. These impacts at the borrow sites include increased uncontaminated sediment loads from runoff and erosion, destruction of existing vegetation and habitat, and potentially long-term degradation of topsoil quality. Standard engineering controls such as sediment fencing and revegetation would reduce these impacts.

The pump station excavation would require dewatering; however, this water would be evaluated on a case-by-case basis and, if possible, re-infiltrated or transported to the lined pond for active treatment at the CTP.

Additional potential ecological impacts under OU 2 Alternative (c) are associated with the removal of the CTP effluent from Bunker Creek, which currently contributes to the majority of Bunker Creek discharge near its headwaters and during periods of low tributary inflow.

Time Until Response Objectives are Achieved. Contaminated soils, sediments, and source materials remaining in OU 2 are not addressed by this alternative; therefore, these media would continue to act as sources of loading to surface water and groundwater. The RAOs of preventing releases of contaminants to surface water and groundwater would not be met for these media.

Under this alternative, groundwater would be collected passively in French drains and conveyed to the CTP for treatment. This contaminated groundwater would no longer discharge to the SFCDR in areas where the drains are present, although concentrations of metals in groundwater are expected to remain elevated. The time required for natural attenuation processes to decrease groundwater concentrations to levels at or below potential ARARs is unknown.

RAOs would eventually be achieved in surface water following completion of both OU 2 and OU 3 remedial actions. Estimated times to achieve potential ARARs in the SFCDR are presented and discussed below as part of the evaluation of the combined Alternative 3+(c).

7.3.6.2.6 Implementability

[Alternative 3+(c)]
[OU 2]

The implementability of OU 2 Alternative (c) is discussed below in the context of (1) technical feasibility, (2) administrative feasibility, and (3) the availability of services and materials.

Technical Feasibility. OU 2 Alternative (c) is considered to be technically feasible. Excavated sediments generated during construction of OU 2 Alternative (c) would be disposed of at the repository. However, during excavation of the French drain trench, material would be screened onsite and disposition of the materials would be done on a site-specific basis.

Under OU 2 Alternative (c), excavation of sediments from below the water table for pump station installation would pose significant logistical considerations and result in higher costs. These implementability concerns are great under OU 2 Alternative (c) because the pump station depth may reach 40 feet below ground surface (bgs). Deeper excavations, if required, would increase the dewatering difficulties. Any groundwater removed as part of pump station installation would be evaluated on a case-by-case basis and, if possible, re-infiltrated or transported to the CTP for treatment.

Administrative Feasibility. Administrative issues such as access agreements and right-of-way negotiations with private owners would need to be worked out prior to construction of the OU 2 Alternative (c) remedial actions. The substantive permit NPDES requirements for the CTP would need to be modified to reflect the proposed change in discharge location from Bunker Creek to the SFCDR.

Availability of Services and Materials. The services and materials needed to implement the alternative should be available regionally. The machinery needed to install the French drain system is probably not available within northern Idaho, but should be available for mobilization from either Washington or Oregon. Implementation may require consultation with other federal or state agencies for permitting and/or regulatory requirements.

Additional difficulties encountered during implementation may include availability of borrow material. This issue could be handled in the remedial design phase as more site-specific information (such as detailed surveys or additional sampling) becomes available. Transportation logistics and costs would increase if borrow material were obtained from more distant sources.

7.3.6.2.7 Cost of Implementation

[Alternative 3+(c)]
[OU 2]

Cost estimates for OU 2 Alternative (c) were developed assuming 30 years of O&M and a discount rate of 7 percent consistent with USEPA guidance (USEPA, 2000c). Detailed cost estimates are provided in Appendix D. The estimated total costs for implementing OU 2 Alternative (c) are summarized as follows:

- Total Capital Cost: $21.8 million
- O&M Cost: $5.79 million (30-year NPV); $467,000 (Annual Average)

- Total Cost (30-year NPV): $27.6 million

7.3.6.3 Combined Alternative 3+(c)

[Alternative 3+(c)]
[Combined]

7.3.6.3.1 Overall Protection of Human Health and the Environment

[Alternative 3+(c)]
[Combined]

The estimated reduction in AWQC ratios at Elizabeth Park and Pinehurst based on the results of the Predictive Analysis (Appendix B) is as follows:

	Pre-Remediation AWQC Ratio	Post-Remediation AWQC Ratio
Elizabeth Park (SF-268)	5.5	1.9
Pinehurst (SF-271)	5.2	1.8

Based on the post-remediation AWQC estimates presented above, Alternative 3+(c) would meet the threshold criterion of overall protection of human health and the environment for surface water. This determination is made with the caveat that attainment of site cleanup objectives for surface water would require a period of natural source depletion.

In addition to the expected reduction in AWQC ratios, Alternative 3+(c) would also significantly improve the quality of the riparian and riverine habitat structure, which would also stabilize remaining floodplain sources, thus reducing the potential for direct human and ecological exposures to the most highly contaminated media and reducing contaminant transport via erosion and leachate production.

Further, Alternative 3+(c) includes direct piping of the CTP effluent to the SFCDR for discharge. Direct piping of the discharge to the SFCDR rather than the current practice of discharging to Bunker Creek would eliminate the infiltration and recontamination of this treated water, thus keeping clean water clean.

7.3.6.3.2 Compliance with ARARs

[Alternative 3+(c)]
[Combined]

The results of the Predictive Analysis indicate that Alternative 3+(c) would meet the threshold criterion of compliance with ARARs for surface water, but only after a period of natural source depletion, which is common to all of the alternatives. Discussions of compliance with other potential ARARs are provided under Alternative 3+ and OU Alternative (c), above.

7.3.6.3.3 Long-Term Effectiveness and Permanence

[Alternative 3+(c)]
[Combined]

The long-term effectiveness and permanence of Alternative 3+(c) is discussed below in the context of (1) magnitude of risk and (2) adequacy and reliability of controls.

Magnitude of Residual Risk. This alternative would result in a high reduction in post-remediation mass loadings (estimated 59 percent reduction). Some smaller loading sources would receive no action or limited containment. There would be a low potential for erosive transport of contaminated alluvium left in place.

Residual risks following implementation would primarily be associated with contaminated media not addressed by the alternative, which would continue to act as a source of dissolved metals loading to aquatic environments. Natural source depletion processes would further reduce residual risks.

There would be a low residual risk to humans. Decontamination of structures and access restrictions would be effective.

Adequacy and Reliability of Controls. This alternative could effectively be maintained through monitoring, maintenance, and institutional controls. There would be moderate maintenance requirements for caps, stream and riparian cleanup actions, sediment traps, French drains, and stream liners, and there would be relatively high maintenance requirements for semi-passive and active treatment.

Because this alternative would result in metals remaining onsite at concentrations above levels that allow for unlimited use and unrestricted exposure, a review would be conducted at least every 5 years, in accordance with the NCP [300.430(f)(4)(ii)].

7.3.6.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

[Alternative 3+(c)]
[Combined]

This alternative includes active treatment of adit drainages, impoundment closures, and hydraulic isolation areas using hydroxide precipitation as part of the HDS process at the CTP. As shown in Table 7-13, the average flow rate from all sources included in this alternative to CTP would be approximately 15,400 gpm (1,450 lb/day). The majority of this flow would be from OU 3, with the exception of approximately 3,900 gpm (1,160 lb/day) from the French drain in OU 2 included in this alternative. Although the majority of the flow to be treated comes from OU 3, the majority of the metals load to be treated comes from OU 2. Semi-passive treatment would be implemented at 36 additional adits and one seep in OU 3 using either SRBs or lime addition and precipitation. The average flow rate from all sources included in this alternative to semi-passive treatment processes is 800 gpm (47 lb/day). Repository drainage would also be treated at the CTP (during the dewatering period).

This alternative reduces mobility of metals by hydroxide precipitation and adsorption/ precipitation onto media. Treatment effectiveness is expected to be between 80 and greater than 99 percent, depending on the treatment technology. Treatment is considered irreversible for the treated water stream. Treatment residuals (sludge and spent media) would require isolation from low-pH water to remain insoluble. It is assumed that these materials would not be characterized as hazardous wastes and would be disposed of onsite. The total annual volume of treatment residuals associated with Alternative 3+(c) is 14,100 cy/yr.

This alternative satisfies the statutory preference for treatment under CERLCA. The total load removed under Alternative 3+(c) through treatment is (1,450 x 0.99) + (47 x 0.8) = 1,470 lb/day.

7.3.6.3.5 Short-Term Effectiveness

[Alternative 3+(c)]
[Combined]

Alternative 3+(c) would involve short-term risks to the community and workers from construction traffic. Risks could be minimized through traffic control plans and selective repository siting. There would be limited chemical risks to workers from remediation actions. Risk would be minimized with standard health and safety measures.

This alternative would involve short-term environmental impacts from construction, including re-suspension of sediment and temporary destruction of habitat. These impacts could be minimized and mitigated through engineering controls and revegetation. Impacts would be associated with stream and riparian cleanup actions, extensive excavation, haul road construction and maintenance, construction within floodplains, repository requirements, and potential stream flow reduction through hydraulic isolation actions. Any short-term environmental impacts that do occur during construction should be considered in the context of current water quality in the SFCDR and its tributaries (impacted with metals) and long-term objectives of the remedial action (significantly improved water quality and ecosystem function).

It is estimated that, depending on available funding, it would take approximately 50 to 90 years[28] to implement the alternative and to achieve RAOs for most source materials.

7.3.6.3.6 Implementability

[Alternative 3+(c)]
[Combined]

This alternative is considered technically feasible, although construction of the SFCDR stream liners between Wallace and Elizabeth Park may pose significant logistical issues considering the size of the SFCDR and the location near I-90. In some areas, there would be limited access to the SFCDR for large equipment and limited space for onsite screening of materials. The limited space would pose logistical considerations for the SFCDR diversion, which is required for stream liner installation. Diversion of the SFCDR and subsequent liner construction would be performed during lower SFCDR flows in the spring and early

[28] This assumes a rough estimated range of $15 million/yr to $25 million/yr of available annual funding to cover $1.3 billion of capital and O&M costs (see Section 7.3.6.3.7). If funding were not the driving factor, it is estimated that it would require at least 20 years to implement Alternative 3+(c).

summer. Site-specific stream liner design would have to include consideration of the impact of liners on stream hydraulics and existing flood control structures. A design objective of the remedial actions would be to have no negative impact on existing flood control systems. If it is determined that in some areas stream lining cannot be implemented without creating negative impacts on existing flood control structures, then alternative process options would be used (such as slurry walls) to provide the desired degree of hydraulic isolation. Significant uncertainties in construction volumes could be handled in the design or construction phase. There are cost and logistical considerations for obtaining borrow materials and excavating in floodplains that would need to be addressed.

The services, equipment, and technologies used are all available at least on a regional level.

7.3.6.3.7 Cost of Implementation

[Alternative 3+(c)]
[Combined]

Cost estimates for Alternative 3+(c) are summarized as follows:

- Total Capital Cost: $1.2 billion
- O&M Cost: $99.8 million (30-year NPV); $8.04 million (Annual Average)
- Total Cost (30-year NPV): $1.30 billion

7.3.7 Alternative 3+(d)

Alternative 3+(d) is discussed below with respect to the seven CERCLA threshold and balancing criteria. The only difference between Alternative 3+(d) and Alternative 3+(a) described in Section 7.3.4 is the set of remedial actions included for OU 2. Therefore, the following discussion is focused on the OU 2 components and the analysis of the combined (OU 3 plus OU 2 components) alternative.

7.3.7.1 OU 3 Alternative 3+, More Extensive Removal, Disposal, and Treatment

[Alternative 3+(d)]
[OU 3]

Please refer to Section 7.3.4 for a discussion of the CERCLA threshold criteria and primary balancing criteria related to Alternative 3+ for OU 3.

7.3.7.2 OU 2 Alternative (d): Stream Liner/French Drain Combination

[Alternative 3+(d)]
[OU 2]

In this section, OU 2 Alternative (d) is evaluated based on the seven CERCLA criteria. Following this section, the combined alternative containing both OU 3 and OU 2 components [Alternative 3+(d)] is evaluated.

7.3.7.2.1 Overall Protection of Human Health and the Environment

[Alternative 3+(d)]
[OU 2]

OU 2 Alternative (d) combines water collection, management, and treatment options to reduce the mobilization and transport of dissolved metals in the groundwater and surface water system.

As shown in Table 7-22, the estimated load reduction in the SFCDR at Pinehurst as estimated by the groundwater model (Appendix A) for this alternative is 550 lb/day, which represents approximately 24 percent of the annual average dissolved zinc load in the SFCDR at Pinehurst. This significant reduction in dissolved metals loading in the SFCDR would reduce the risks to both human health and ecological receptors currently associated with direct contact with contaminated surface water.

In addition, actions taken in Government Creek would likely result in achievement of the AWQC for Government Creek within a relatively short time frame.

Alternative (d) includes direct piping of the CTP effluent to the SFCDR for discharge. Direct piping of the discharge to the SFCDR rather than the current practice of discharging to Bunker Creek would eliminate the infiltration and recontamination of this treated water, thus keeping clean water clean.

There would be a light to moderate disturbance (e.g., increased traffic, handling, and transportation of contaminated material) to the community during the implementation of OU 2 Alternative (d) because the actions would primarily be installed in the unpopulated areas of OU 2. Mitigation measures would be implemented to minimize this disturbance. These mitigation measures could include, but are not limited to, health and safety controls, traffic control plans, and the use of water sprays for dust control during construction activities.

7.3.7.2.2 Compliance with ARARs

[Alternative 3+(d)]
[OU 2]

The significant reduction in metals load estimated for this alternative (24 percent) would result in a correspondingly reduced AWQC ratio at Pinehurst following implementation. However, when coupled with upstream actions in OU 3, estimates of post-remediation water quality are significantly improved. Please refer to the discussion of the combined Alternative 3+(d) below for evaluation of this criterion.

Although groundwater would be collected and treated as part of OU 2 Alternative (d), remediation of groundwater is not an objective of this alternative. Groundwater would be collected only as a means of reducing contaminant concentrations in surface water. A TI waiver may be warranted at specific locations where groundwater does not achieve drinking water standards if it is determined that additional actions would not be effective.

As with all the OU 2 alternatives, OU 2 Alternative (d) does not include actions to address any remaining soil and sediment present at concentrations above PRGs because the majority of contaminated materials accessible for remediation were addressed during Phase I actions

The actions included in OU 2 Alternative (d) could potentially be implemented in compliance with potential location-specific and action-specific ARARs. OU 2 Alternative (d) would be implemented to meet requirements for federal agencies under Section 7 of the

ESA. The ESA requires that the actions be protective of critical habitat for several species in the Coeur d'Alene Basin. A summary of other potential location-specific and action-specific ARARs is included in Section 4.0.

7.3.7.2.3 Long-Term Effectiveness and Permanence

[Alternative 3+(d)]
[OU 2]

Long-term effectiveness and permanence of OU 2 Alternative (d) is discussed below in the context of (1) the expected magnitude of residual risk and (2) the adequacy and reliability of engineering and institutional controls.

Magnitude of Residual Risk. The water collection, management, and treatment actions under OU 2 Alternative (d) would reduce the mobility of metals in the environment and reduce the potential for exposure of environmental receptors to metals. OU 2 Alternative (d) incorporates groundwater-based actions in the area of OU 2 with the highest metals load gains to the SFCDR and is not intended to address the site-wide groundwater contamination. If properly maintained, the Alternative (d) actions should continue to provide the same degree of load removal over the long term, and therefore would have a relatively high degree of long-term effectiveness and permanence.

Residual risks following implementation would primarily be associated with contaminated media not addressed by the alternative, which would continue to act as a source of dissolved metals loading to aquatic environments. Significant amounts of contaminated sediments are present in floodplains and beneath the populated areas and infrastructure within OU 2, resulting in groundwater and subsequent surface water contamination. Contaminated groundwater would continue to discharge into the SFCDR in the western portion of OU 2 and the SFCDR tributaries with the exception of Government Creek.

Because this alternative would result in metals remaining onsite at concentrations above levels that allow for unlimited use and unrestricted exposure, a review would be conducted at least every 5 years, in accordance with the NCP [300.430(f)(4)(ii)].

Adequacy and Reliability of Controls. Long-term performance issues, monitoring requirements, and O&M requirements related to Alternative (d) are summarized as follows:

- **Groundwater Collection and Conveyance** – Groundwater would be collected using French drains and extraction wells. Collected groundwater would be conveyed, via a pump station, to the CTP, with the exception of groundwater collected in front of the slurry wall at the top of Government Gulch, which would be discharged to the stream liner in Government Creek. The French drains, extraction wells, pumps, and associated controls would all require routine O&M to maintain full functionality. O&M components include physical maintenance of drains, pipelines, and pumps, including periodic and routine removal of precipitates. Electronic control of pumping systems would also require ongoing O&M to maintain desired flow rates and groundwater elevations. Groundwater monitoring would be performed in the vicinity of the French drain to evaluate groundwater elevations and groundwater quality.

- **Slurry Walls –** Slurry walls performance would be limited to reducing, not eliminating, the flow of groundwater. In this case, the objective of the slurry wall in Alternative (d) is to reduce the flow of clean groundwater through contaminated materials in Government Gulch, thereby improving Government Creek water quality and reducing the treatment burden at the CTP and the overall cost of the alternative. Therefore, in this case, a reduction in groundwater flow, rather than an elimination of flow, is acceptable. Groundwater that bypasses the slurry wall and passes through Government Gulch would eventually be collected either by the extraction wells or the French drain near the mouth of the Gulch. Groundwater elevation and groundwater quality monitoring would be performed to evaluate slurry wall effectiveness. Because extraction wells are used in conjunction with the slurry wall in Government Gulch, groundwater-monitoring costs are included in the extraction well O&M.

- **Stream Liners –** Stream liners should effectively eliminate the flow of surface water to groundwater in lined areas and would generally require little maintenance. However, stream liners may be damaged by flooding, and periodic replacement of a portion of the liner would likely be required. A replacement rate of 5 percent per 10 years was assumed for cost estimating purposes.

- **Active Treatment –** Collected groundwater would be collected, conveyed, and actively treated at the CTP. O&M of the CTP is described in Section 7.2.4.

- **CTP Effluent Piping –** The CTP effluent would be piped directly to the SFCDR for discharge. Physical maintenance of the pipeline would be required, including periodic and routine removal of precipitates.

Institutional controls (i.e., land use restrictions) would also be required. These management requirements are expected to be administered effectively.

7.3.7.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

[Alternative 3+(d)]
[OU 2]

OU 2 Alternative (d) includes active treatment (at the CTP) of groundwater collected near the gaining reach of the SFCDR in the eastern portion of OU 2. The CTP would require expansion to treat the additional 4,400 gpm of OU 2 waters (design flow rate). A discussion of CTP expansion to accommodate the Alternative (d) flows, along with flows from Alternative 3+ in OU 3, is provided in Section 7.2.4.

Active treatment as part of the OU 2 Alternative (d) actions would reduce the dissolved zinc load in the SFCDR at SF-271 by about 550 lb/day. The groundwater model was used to estimate both the net reduction in dissolved zinc load to the SFCDR and the dissolved zinc load that would be entering the drains for treatment. The estimated annual average dissolved zinc load that would be sent to the CTP for treatment under this alternative is 1,150 lb/day (see Table 7-13).

The active water treatment component of Alternative (d) would reduce the mobility of contaminants through precipitation or combined adsorption and precipitation. The residual waste associated with the active treatment process is the sludge containing the precipitated metal hydroxides. The mass and volume of dissolved metals would be reduced in the groundwater and surface water systems, but the residual waste would require management and disposal. Treatment is considered irreversible for the treated water stream. Treatment residuals (hydroxide sludge) would require isolation from low-pH water to remain insoluble; it is assumed that these materials would not be characterized as hazardous wastes and would be disposed of onsite. The volume of treatment residuals associated with OU 2 Alternative (d) is discussed below as part of the combined Alternative 3+(d).

7.3.7.2.5 Short-Term Effectiveness

[Alternative 3+(d)]
[OU 2]

The short-term effectiveness of OU 2 Alternative (d) is discussed below in the context of (1) protection of the community, (2) protection of workers, (3) environmental impacts, and (4) time required to achieve response objectives.

Protection of Community During Remedial Actions. The primary risks to the community associated with OU 2 Alternative (d) are traffic-related hazards from transportation of contaminated media and imported construction materials because the actions are located in the unpopulated areas of OU 2. To the extent possible, these risks would be minimized with standard health and safety controls and traffic control plans. The majority of truck traffic would be on highly traveled corridors. Truck trips would be required to import construction materials such as liners and pipe and to travel to the repository to dispose of contaminated materials encountered during construction.

Protection of Workers During Remedial Actions. Short-term risks to workers would consist of physical construction hazards and traffic-related hazards from materials handling and transportation. These risks would be controlled with standard health and safety controls and traffic control plans. Significant construction hazards may be avoided in the design or construction phase by modifying the degree or type of action taken at a particular site. Workers would also be subject to chemical exposure from contaminated soil and dust. This risk can be largely controlled using PPE and dust control measures such as water sprays and air monitoring.

Environmental Impacts. During the implementation of OU 2 Alternative (d), significant short-term impacts would be imposed on the environment, including re-suspension of sediment and temporary destruction of habitat. These would primarily be associated with the installation of the Government Creek stream liner. Approximately 11,000 linear feet of Government Creek would be affected by construction of a stream liner, which would require excavation and hauling of potentially contaminated sediments. The in-stream construction may influence short-term water quality; however, engineering controls such as sediment fencing, temporary sediment traps, and temporary cofferdams would be used to minimize and mitigate short-term environmental impacts. Excavation of contaminated sediments would occur during French drain, pump station, and conveyance pipeline installation. Potential sediment runoff during these excavations would be mitigated using standard engineering controls. Any short-term environmental impacts that do occur during construction should be considered in the context of current water quality in the SFCDR and its tributaries (impacted with metals) and long-term objectives of the remedial action (significantly improved water quality and ecosystem function).

OU 2 Alternative (d) would require importing borrow materials for construction of French drains and stream liners. The total quantity of borrow material is uncertain because some excavated materials would be re-used as part of the remedial action. Short-term environmental impacts would be associated with mining and transporting borrow materials. These impacts at the borrow sites include increased uncontaminated sediment loads from runoff and erosion, destruction of existing vegetation and habitat, and potentially long-term degradation of topsoil quality. Standard engineering controls such as sediment fencing and revegetation would reduce these impacts.

The pump station excavation would require dewatering; however, this water would be evaluated on a case-by-case basis and, if possible, re-infiltrated or transported to the lined pond for active treatment at the CTP.

Additional potential ecological impacts under OU 2 Alternative (d) are associated with the removal of the CTP effluent from Bunker Creek, which currently contributes to the majority of Bunker Creek discharge. Estimating these impacts would require further study.

Time Until Response Objectives are Achieved. Contaminated soils, sediments, and source materials remaining in OU 2 are not addressed by this alternative; therefore, these media would continue to act as sources of loading to surface water and groundwater. The RAOs of preventing releases of contaminants to surface water and groundwater would not be met for these media.

Under this alternative, groundwater would be collected passively in French drains and conveyed to the CTP for treatment. This contaminated groundwater would no longer discharge to the SFCDR in areas where the drains are present, although concentrations of metals in groundwater are expected to remain elevated. The time required for natural attenuation processes to decrease groundwater concentrations to levels at or below potential ARARs is unknown. RAOs for surface water may be met in Government Gulch as construction is completed. Estimated times to achieve potential ARARs in the SFCDR are presented and discussed below as part of the evaluation of the combined Alternative 3+(d).

7.3.7.2.6 Implementability

[Alternative 3+(d)]
[OU 2]

The implementability of OU 2 Alternative (d) is discussed below in the context of (1) technical feasibility, (2) administrative feasibility, and (3) the availability of services and materials.

Technical Feasibility. OU 2 Alternative (d) is considered to be technically feasible. Excavated sediments generated during construction of OU 2 Alternative (d) would be disposed of at the repository. However, during excavation of the French drain trench, material would be screened onsite, and disposition of the materials would be done on a site-specific basis.

Under OU 2 Alternative (d), excavation of sediments from below the water table during pump station installation would pose significant logistical considerations and result in higher costs. These implementability concerns are great under OU 2 Alternative (d) because the pump station depth may reach 40 feet bgs. Deeper excavations, if required, would increase the dewatering difficulties. Any groundwater removed as part of pump station installation would be would be evaluated on a case-by-case basis and, if possible, re-infiltrated or transported to the CTP for treatment.

Administrative Feasibility. Administrative issues such as access agreements and right-of-way negotiations with private owners would need to be worked out prior to construction of the OU 2 Alternative (d) remedial actions. The substantive permit NPDES requirements for the CTP would need to be modified to reflect the proposed change in discharge location from Bunker Creek to the SFCDR.

Availability of Services and Materials. The services and materials needed to implement the alternative should be available regionally. The machinery needed to install the French drains is probably not available within northern Idaho, but should be available for mobilization from either Washington or Oregon. Implementation may require consultation with other federal or state agencies for permitting and/or regulatory requirements.

Additional difficulties encountered during implementation may include availability of borrow material. This issue could be handled in the remedial design phase as more site-specific information (such as detailed surveys or additional sampling) becomes available. Transportation logistics and costs would increase if borrow material were obtained from more distant sources.

7.3.7.2.7 Cost of Implementation

[Alternative 3+(d)]
[OU 2]

Cost estimates for OU 2 Alternative (d) were developed assuming 30 years of O&M and a discount rate of 7 percent consistent with USEPA guidance (USEPA, 2000c). Detailed cost estimates are provided in Appendix D. The estimated total costs for implementing OU 2 Alternative (d) are summarized as follows:

- Total Capital Cost: $32.9 million
- O&M Cost: $6.46 million (30-year NPV); $521,000 (Annual Average)
- Total Cost (30-year NPV): $39.4 million

7.3.7.3 Combined Alternative 3+(d)

[Alternative 3+(d)]
[Combined]

7.3.7.3.1 Overall Protection of Human Health and the Environment

[Alternative 3+(d)]
[Combined]

The estimated reduction in AWQC ratios at Elizabeth Park and Pinehurst based on the results of the Predictive Analysis (Appendix B) is as follows:

	Pre-Remediation AWQC Ratio	Post-Remediation AWQC Ratio
Elizabeth Park (SF-268)	5.5	1.9
Pinehurst (SF-271)	5.2	1.7

Based on the post-remediation AWQC estimates presented above, Alternative 3+(d) would meet the threshold criterion of overall protection of human health and the environment for surface water. This determination is made with the caveat that attainment of site cleanup objectives for surface water would require a period of natural source depletion. In addition to water quality improvements in the SFCDR, implementation of Alternative 3+(d) would also result in achievement of AWQC for Government Creek within a relatively short time frame.

In addition to the expected reduction in AWQC ratios, Alternative 3+(d) would also significantly improve the quality of the riparian and riverine habitat structure, which would also stabilize remaining floodplain sources, thus reducing the potential for direct human and ecological exposures to the most highly contaminated media and reducing contaminant transport via erosion and leachate production.

Further, Alternative 3+(d) includes direct piping of the CTP effluent to the SFCDR for discharge. Direct piping of the discharge to the SFCDR rather than the current practice of discharging to Bunker Creek would eliminate the infiltration and recontamination of this treated water, thus keeping clean water clean.

7.3.7.3.2 Compliance with ARARs

[Alternative 3+(d)]
[Combined]

The results of the Predictive Analysis indicate that Alternative 3+(d) would meet the threshold criterion of compliance with ARARs for surface water, but only after a period of natural source depletion, which is common to all of the alternatives. Discussions of compliance with other potential ARARs are provided under Alternative 3+ and OU Alternative (d) above.

7.3.7.3.3 Long-Term Effectiveness and Permanence

[Alternative 3+(d)]
[Combined]

The long-term effectiveness and permanence of Alternative 3+(d) is discussed below in the context of (1) magnitude of risk and (2) adequacy and reliability of controls.

Magnitude of Residual Risk. This alternative would result in a high reduction in post-remediation mass loadings (estimated 60 percent reduction). Some smaller loading sources would receive no action or limited containment. There would be a low potential for erosive transport of contaminated alluvium left in place.

Residual risks following implementation would primarily be associated with contaminated media not addressed by the alternative, which would continue to act as a source of dissolved metals loading to aquatic environments. Natural source depletion processes would further reduce residual risks.

There would be a low residual risk to humans. Decontamination of structures and access restrictions would be effective.

Adequacy and Reliability of Controls. This alternative could effectively be maintained through monitoring, maintenance, and institutional controls. There would be moderate maintenance requirements for caps, stream and riparian cleanup actions, sediment traps, French drains, and stream liners, and there would be relatively high maintenance requirements for semi-passive and active treatment.

Because this alternative would result in metals remaining onsite at concentrations above levels that allow for unlimited use and unrestricted exposure, a review would be conducted at least every 5 years, in accordance with the NCP [300.430(f)(4)(ii)].

7.3.7.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

[Alternative 3+(d)]
[Combined]

This alternative includes active treatment of adit drainages, impoundment closures, and hydraulic isolation areas using hydroxide precipitation as part of the HDS process at the CTP. The estimated average flow rate from all sources to CTP would be approximately 15,400 gpm (1,430 lb/day). The majority of this flow would be from OU 3, with the exception of approximately 3,900 gpm (1,150 lb/day) from the French drains and extraction wells in OU 2 included in this alternative. Although the majority of the flow comes from OU 3, the majority of the metals load to be treated comes from OU 2. Semi-passive treatment would be implemented at 36 additional adits and one seep in OU 3 using either SRBs or lime addition and precipitation. The average flow rate from all sources included in this alternative to semi-passive treatment processes is 800 gpm (47 lb/day). Repository drainage would also be treated at the CTP (during the dewatering period).

This alternative reduces mobility of metals by hydroxide precipitation and adsorption/precipitation onto media. Treatment effectiveness is expected to be between 80 and greater than 99 percent, depending on the treatment technology. Treatment is considered irreversible for the treated water stream. Treatment residuals (sludge and spent media) would require isolation from low-pH water to remain insoluble. It is assumed that these materials would not be characterized as hazardous wastes and would be disposed of onsite. The total annual volume of treatment residuals associated with Alternative 3+(d) is 14,000 cy/yr.

This alternative satisfies the statutory preference for treatment under CERLCA. The total load removed under Alternative 3+(d) through treatment is therefore
$(1{,}430 \times 0.99) + (47 \times 0.8) = 1{,}450$ lb/day.

7.3.7.3.5 Short-Term Effectiveness

[Alternative 3+(d)]
[Combined]

Alternative 3+(d) would involve increased construction traffic. Risks could be minimized through traffic control plans and selective repository siting. There would be limited chemical risks to workers from remediation actions. Risk would be minimized with standard health and safety measures.

This alternative would involve short-term environmental impacts from construction, including re-suspension of sediment and temporary destruction of habitat. These impacts could be minimized and mitigated through engineering controls and revegetation. Impacts would be associated with stream and riparian cleanup actions, extensive excavation, haul road construction and maintenance, construction within floodplains, repository requirements, and potential stream flow reduction through hydraulic isolation actions. Any short-term environmental impacts that do occur during construction should be considered in the context of current water quality in the SFCDR and its tributaries (impacted with metals) and long-term objectives of the remedial action (significantly improved water quality and ecosystem function).

It is estimated that it would take approximately 50 to 90 years[29] to implement the alternative and to achieve RAOs for most source materials.

7.3.7.3.6 Implementability

[Alternative 3+(d)]
[Combined]

This alternative is considered to be technically feasible, although construction of the SFCDR stream liners between Wallace and Elizabeth Park may pose significant logistical issues considering the size of the SFCDR and the location near I-90. In some areas, there would be limited access to the SFCDR for large equipment and limited space for onsite screening of materials. The limited space would pose logistical considerations for the SFCDR diversion, which is required for stream liner installation. Diversion of the SFCDR and subsequent liner construction would be performed during lower SFCDR flows in the spring and early summer. Site-specific stream liner design would have to include consideration of the impact of liners on stream hydraulics and existing flood control structures. A design objective of the remedial actions would be to have no negative impact on existing flood control systems. If it is determined that in some areas stream lining cannot be implemented without creating negative impacts on existing flood control structures, then alternative process options would be used (such as slurry walls) to provide the desired degree of hydraulic isolation.

[29] This assumes a rough estimated range of $15 million/yr to $25 million/yr of available annual funding to cover $1.3 billion of capital and O&M costs (see Section 7.3.7.3.7). If funding were not the driving factor, it is estimated that it would require at least 20 years to implement Alternative 3+(d).

Significant uncertainties in construction volumes could be handled in the design or construction phase. There are cost and logistical considerations for obtaining borrow materials and excavating in floodplains that would need to be addressed.

The services, equipment, and technologies used are all available at least on a regional level.

7.3.7.3.7 Cost of Implementation

[Alternative 3+(d)]
[Combined]

Cost estimates for Alternative 3+(d) are summarized as follows:

- Total Capital Cost: $1.21 billion
- O&M Cost: $101 million (30-year NPV); $8.09 million (Annual Average)
- Total Cost (30-year NPV): $1.31 billion

7.3.8 Alternative 3+(e)

Alternative 3+(e) is discussed below with respect to the seven CERCLA threshold and balancing criteria. The only difference between Alternative 3+(e) and Alternative 3+(a) described in Section 7.3.4 is the set of remedial actions included for OU 2. Therefore, the following discussion is focused on the OU 2 components and the analysis of the combined (OU 3 plus OU 2 components) alternative.

7.3.8.1 OU 3 Alternative 3+, More Extensive Removal, Disposal, and Treatment

[Alternative 3+(e)]
[OU 3]

Please refer to Section 7.3.4 for a discussion of the CERCLA threshold criteria and primary balancing criteria related to Alternative 3+ for OU 3.

7.3.8.2 OU 2 Alternative (e): Extensive Stream Lining/French Drain Combination

[Alternative 3+(e)]
[OU 2]

In this section, OU 2 Alternative (e) is evaluated based on the seven CERCLA criteria. Following this section, the combined alternative containing both OU 3 and OU 2 components [Alternative 3+(e)] is evaluated.

7.3.8.2.1 Overall Protection of Human Health and the Environment

[Alternative 3+(e)]
[OU 2]

OU 2 Alternative (e) combines water collection, management, and treatment options to reduce the mobilization and transport of dissolved metals in the groundwater and surface water system.

As shown in Table 7-22, the estimated load reduction in the SFCDR at Pinehurst as estimated by the groundwater model (Appendix A) for this alternative is 620 lb/day, which represents approximately 27 percent of the annual average dissolved zinc load in the

SFCDR at Pinehurst. This significant reduction in dissolved metals loading in the SFCDR would reduce the risks to both human health and ecological receptors currently associated with direct contact with contaminated surface water.

The stream lining on the SFCDR included in OU 2 Alternative (e) could affect fish habitats due to an increase in water temperature as a result of removing cooler groundwater recharge.

There would be a significant disturbance (e.g., increased traffic, handling and transportation of contaminated material) to the community during the implementation of OU 2 Alternative (e) because the actions would be completed throughout OU 2. Mitigation measures would be implemented to minimize this disturbance. These mitigation measures could include, but are not limited to, health and safety controls, traffic control plans, and the use of water sprays for dust control during construction activities.

7.3.8.2.2 Compliance with ARARs

[Alternative 3+(e)]
[OU 2]

The significant reduction in metals load estimated for this alternative (27 percent) would result in a correspondingly reduced AWQC ratio at Pinehurst following implementation. However, when coupled with upstream actions in OU 3, estimates of post-remediation water quality are significantly improved. Please refer to the discussion of the combined Alternative 3+(e) below for evaluation of this criterion. Although groundwater would be collected and treated as part of OU 2 Alternative (e), there are no RAOs for remediation of groundwater. Groundwater would be collected only as a means of reducing contaminant concentrations in surface water. A TI waiver may be warranted at specific locations where groundwater does not achieve drinking water standards if it is determined that additional actions would not be effective.

As with all OU 2 alternatives, OU 2 Alternative (e) does not include actions to address any remaining soil and sediment present at concentrations above PRGs because the majority of contaminated materials accessible for remediation were addressed during Phase I actions

The actions included in OU 2 Alternative (e) could potentially be implemented in compliance with potential location-specific and action-specific ARARs. OU 2 Alternative (e) would be implemented to meet requirements for federal agencies under Section 7 of the ESA. The ESA requires that the actions be protective of critical habitat for several species in the Coeur d'Alene Basin. A summary of other potential location-specific and action-specific ARARs is included in Section 4.0.

7.3.8.2.3 Long-Term Effectiveness and Permanence

[Alternative 3+(e)]
[OU 2]

The long-term effectiveness and permanence of OU 2 Alternative (e) is discussed below in the context of (1) the expected magnitude of residual risk and (2) the adequacy and reliability of engineering and institutional controls.

Magnitude of Residual Risk. The water collection, management, and treatment actions under OU 2 Alternative (e) would reduce the mobility of metals in the environment and reduce the potential for exposure of environmental receptors to metals. OU 2 Alternative (e) incorporates groundwater- and surface-water-based actions to the maximum extent practicable throughout OU 2. OU 2 Alternative (e) incorporates the most actions in OU 2, but is not intended to address the site-wide groundwater contamination. If properly maintained, the OU 2 Alternative (e) actions should continue to provide the same degree of load removal over the long term and therefore would have a relatively high degree of long-term effectiveness and permanence.

Residual risks following implementation would primarily be associated with contaminated media not addressed by the alternative, which would continue to act as a source of metals loading to aquatic environments. Significant amounts of contaminated sediments are present in floodplains and beneath the populated areas and infrastructure within OU 2, resulting in groundwater and subsequent surface water contamination.

Because this alternative would result in metals remaining onsite at concentrations above levels that allow for unlimited use and unrestricted exposure, a review would be conducted at least every 5 years, in accordance with the NCP [300.430(f)(4)(ii)].

Adequacy and Reliability of Controls. Long-term performance issues, monitoring requirements, and O&M requirements related to Alternative (e) are summarized as follows:

- **Groundwater Collection and Conveyance** – Groundwater would be collected using French drains and extraction wells. Collected groundwater using French drains would be conveyed, via a pump station, to the CTP. Collected groundwater using extraction wells would be discharged into the respective lined stream. The French drains, extraction wells, pumps, and associated controls would all require routine O&M to maintain full functionality. O&M components include physical maintenance of drains, pipelines, and pumps, including periodic and routine removal of precipitates. Electronic control of pumping systems would also require ongoing O&M to maintain desired flow rates and groundwater elevations. Groundwater monitoring would be performed in the vicinity of the French drain to evaluate groundwater elevations and groundwater quality.

- **Slurry Walls –** Slurry wall performance would be limited to reducing, not eliminating, the flow of groundwater. In this case, the objective of the slurry wall in OU 2 Alternative (e) is to reduce the flow of clean groundwater through contaminated materials, thereby improving water quality and reducing the treatment burden at the CTP and the overall cost of the alternative. Therefore, in this case, a reduction in groundwater flow, rather than an elimination of flow, is acceptable. Groundwater that bypasses any of the slurry walls would eventually be collected in one of the two the French drains placed near the gaining reaches of the SFCDR. Groundwater elevation and groundwater quality monitoring would be performed to evaluate slurry wall effectiveness. Since extraction wells are used in conjunction with the slurry walls, groundwater-monitoring costs are included in extraction well O&M.

- **Stream Liners –** Stream liners should effectively eliminate the flow of surface water to groundwater in lined areas and would generally require little maintenance. However, stream liners may be damaged by flooding, and periodic replacement of a portion of the liner would likely be required. A replacement rate of 5 percent per 10 years was assumed for cost estimating purposes.

- **Active Treatment –** Collected groundwater would be collected, conveyed, and actively treated at the CTP. O&M of the CTP is described in Section 7.2.4.

Institutional controls (i.e., land use restrictions) would also be required. These management requirements are expected to be administered effectively.

7.3.8.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

[Alternative 3+(e)]
[OU 2]

OU 2 Alternative (e) includes active treatment (at the CTP) of groundwater collected near the two gaining reaches of the SFCDR. The CTP would require expansion to treat the additional 4,800 gpm (peak flow) of OU 2 waters. A discussion of CTP expansion to accommodate the OU 2 Alternative (e) flows, along with flows from Alternative 3+ in OU 3, is provided in Section 7.2.4.

Active treatment as part of the OU 2 Alternative (e) actions would reduce the dissolved zinc load in the SFCDR at SF-271 by about 620 lb/day. The groundwater model was used to estimate both the net reduction in dissolved zinc load to the SFCDR and the dissolved zinc load that would be entering the drains for treatment. The estimated annual average dissolved zinc load that would be sent to the CTP for treatment under this alternative is 530 lb/day (see Table 7-13).

The active water treatment component of OU 2 Alternative (e) would reduce the mobility of contaminants through precipitation or combined adsorption and precipitation. The residual waste associated with the active treatment process is the sludge containing the precipitated metal hydroxides. The mass and volume of dissolved metals would be reduced in the groundwater and surface water systems, but the residual waste would require management and disposal. Treatment is considered irreversible for the treated water stream. Treatment residuals (hydroxide sludge) would require isolation from low-pH water to remain insoluble. It is assumed that these materials would not be characterized as hazardous wastes and would be disposed of onsite. The volume of treatment residuals associated with OU 2 Alternative (e) is discussed below as part of the combined Alternative 3+(e).

7.3.8.2.5 Short-Term Effectiveness

[Alternative 3+(e)]
[OU 2]

The short-term effectiveness of OU 2 Alternative (e) is discussed below in the context of (1) protection of the community, (2) protection of workers, (3) environmental impacts, and (4) time required to achieve response objectives.

Protection of Community During Remedial Actions. The primary risks to the community associated with OU 2 Alternative (e) are traffic-related hazards from transportation of large quantities of contaminated media and imported construction materials. These traffic risks are greater under OU 2 Alternative (e) due to the extensive remedial actions requiring excavation and hauling. To the extent possible, these risks would be minimized with standard health and safety controls and traffic control plans. The majority of truck traffic would be on highly traveled corridors. Truck trips would be required to import construction materials such as liners and pipe and to travel to the repository to dispose of contaminated materials encountered during construction.

Protection of Workers during Remedial Actions. Short-term risks to workers would consist of physical construction hazards and traffic-related hazards from materials handling and transportation. These risks would be controlled with standard health and safety controls and traffic control plans. Significant construction hazards may be avoided in the design or construction phase by modifying the degree or type of action taken at a particular site. Workers would also be subject to exposure from contaminated soil and dust. This risk can be largely controlled using PPE and dust control measures such as water sprays and air monitoring.

Environmental Impacts. During the implementation of OU 2 Alternative (e), short-term impacts would be imposed on the environment, including re-suspension of sediment and temporary destruction of habitat. These would primarily be associated with construction within floodplains and riparian areas. Approximately 34,000 linear feet of SFCDR and 44,000 linear feet of tributaries would be affected by construction of a stream liner, which would require excavation and hauling of potentially contaminated sediments. The in-stream construction may influence short-term water quality; however, engineering controls such as sediment fencing, temporary sediment traps, and temporary cofferdams would be used to minimize and mitigate short-term environmental impacts. Excavation of contaminated sediments would occur during French drain, pump station, and conveyance pipeline installation. Potential sediment runoff during these excavations would be mitigated using standard engineering controls. Any short-term environmental impacts that do occur during construction should be considered in the context of current water quality in the SFCDR and its tributaries (impacted with metals) and long-term objectives of the remedial action (significantly improved water quality and ecosystem function).

OU 2 Alternative (e) would require importing borrow materials for construction of French drains and stream liners. The total quantity of borrow material is uncertain because some excavated materials would be re-used as part of the remedial action. Short-term environmental impacts would be associated with mining and transporting borrow materials. These impacts at the borrow sites include increased uncontaminated sediment loads from runoff and erosion, destruction of existing vegetation and habitat, and potentially long-term degradation of topsoil quality. Standard engineering controls such as sediment fencing and revegetation would reduce these impacts.

The pump station excavation would require dewatering; however, this water would be evaluated on a case-by-case basis and, if possible, re-infiltrated or transported to the lined pond for active treatment at the CTP.

Additional potential ecological impacts under OU 2 Alternative (e) are associated with the dewatering of the groundwater system and potential dewatering of the aquatic habitat in Smelterville Flats. Estimating these impacts would require further study.

Time Until Response Objectives are Achieved. Contaminated soils, sediments, and source materials remaining in OU 2 are not addressed by this alternative; therefore, these media would continue to act as sources of loading to surface water and groundwater. The RAOs of preventing releases of contaminants to surface water and groundwater would not be met for these media.

Under this alternative, contaminated groundwater would be collected passively in French drains and actively using extraction wells. This contaminated groundwater would no longer discharge to the SFCDR in areas where the drains are present, although concentrations of metals in groundwater are expected to remain elevated. The time required for natural attenuation processes to decrease groundwater concentrations to levels at or below potential ARARs is unknown. RAOs for surface water may be met in some SFCDR tributaries as construction is completed. Estimated times to achieve potential ARARs in the SFCDR are presented and discussed below as part of the evaluation of the combined Alternative 3+(e).

7.3.8.2.6 Implementability

[Alternative 3+(e)]
[OU 2]

The implementability of OU 2 Alternative (e) is discussed below in the context of (1) technical feasibility, (2) administrative feasibility, and (3) the availability of services and materials.

Technical Feasibility. OU 2 Alternative (e) is considered to be technically feasible; however, it poses the most significant logistical issues of all the OU 2 alternatives.

Excavated sediments generated during construction of OU 2 Alternative (e) would be disposed of at the repository. However, during excavation of the French drain trenches, material would be screened onsite and disposition of the materials would be done on a site-specific basis.

Construction of the SFCDR stream liner may pose significant logistical issues considering the length of the SFCDR to be lined and the section of liner located in the developed area of the City of Kellogg. The SFCDR requires diversion during construction, which would need to occur in phases because diverting the SFCDR from Elizabeth Park to Pinehurst Narrows is not feasible. Phases of construction would also depend on the seasonal SFCDR flows, because diversion of the SFCDR would not be feasible during higher flows in the spring and early summer. There is limited access to the SFCDR within the developed area of the City of Kellogg for large equipment and limited space for onsite screening of excavated materials. Site-specific stream liner design would have to include consideration of the impact of liners on stream hydraulics and existing flood control structures. A design objective of the remedial actions would be to have no negative impact on existing flood control systems. This SFCDR reach is also bound by levees, which would be affected by the stream liner installation. Maintaining levee integrity would be required during stream liner construction. If it is determined that in some areas stream lining cannot be implemented without creating negative impacts on existing flood control structures, then alternative process options would be used (such as slurry walls) to provide the desired degree of hydraulic isolation.

Installation of the slurry walls in the SFCDR valley floor at Elizabeth Park and in the Pinehurst Narrows may also pose significant logistical issues. Construction of the slurry walls at both locations would require transecting I-90 and the SFCDR. The narrow valley floor at these locations, in combination with the I-90 and the SFCDR, allows limited workspace for large equipment.

The lining of Bunker Creek would result in increased flow in the creek, exacerbating the current problem of the undersized culvert conveying Bunker Creek flow under I-90 (as discussed above for OU 2 Alternative (a). Under OU 2 Alternative (e), excavation of sediments from below the water table during pump station installation would pose significant logistical considerations and result in higher costs. These implementability concerns are great under Alternative (e) because the pump station depth may reach 40 feet bgs. Deeper excavations, if required, would increase the dewatering difficulties. Any groundwater removed as part of pump station installation would be evaluated on a case-by-case basis and, if possible, re-infiltrated or transported to the CTP for treatment.

Administrative Feasibility. Administrative issues would need to be worked out prior to construction of OU 2 Alternative (e) remedial actions. These issues include permitting and compliance with the CWA and negotiating access agreements and rights-of-way with private landowners. Due to the magnitude of the components included in this alternative, administrative feasibility considerations would be substantial.

Availability of Services and Materials. The services and materials needed to implement OU 2 Alternative (e) should be available regionally. The machinery needed to install the French drains and slurry walls is probably not available within northern Idaho, but should be available for mobilization from either Washington or Oregon. Implementation may require consultation with other federal or state agencies for permitting and/or regulatory requirements.

Additional difficulties encountered during implementation may include availability of borrow material. This issue could be handled in the remedial design phase as more site-specific information (such as detailed surveys or additional sampling) becomes available. Transportation logistics and costs would increase if borrow material were obtained from more distant sources.

7.3.8.2.7 Cost of Implementation

[Alternative 3+(e)]
[OU 2]

Cost estimates for OU 2 Alternative (e) were developed assuming 30 years of O&M and a discount rate of 7 percent consistent with USEPA guidance (USEPA, 2000c). Detailed cost estimates are provided in Appendix D. The estimated total costs for implementing OU 2 Alternative (e) are summarized as follows:

- Total Capital Cost: $250 million
- O&M Cost: $10 million (30-year NPV); $806,000 (Annual Average)]
- Total Cost (30-year NPV): $260 million

7.3.8.3 Combined Alternative 3+(e)

[Alternative 3+(e)]
[Combined]

7.3.8.3.1 Overall Protection of Human Health and the Environment

[Alternative 3+(e)]
[Combined]

The estimated reduction in AWQC ratios at Elizabeth Park and Pinehurst based on the results of the Predictive Analysis (Appendix B) is as follows:

	Pre-Remediation AWQC Ratio	Post-Remediation AWQC Ratio
Elizabeth Park (SF-268)	5.5	1.9
Pinehurst (SF-271)	5.2	1.5

Based on post-remediation AWQC estimates presented above, Alternative 3+(e) would meet the threshold criterion of overall protection of human health and the environment for surface water. This determination is made with the caveat that attainment of site cleanup objectives for surface water would require a period of natural source depletion.

In addition to the expected reduction in AWQC ratios, Alternative 3+(e) would also significantly improve the quality of the riparian and riverine habitat structure, which would also stabilize remaining floodplain sources, thus reducing the potential for direct human and ecological exposures to the most highly contaminated media and reducing contaminant transport via erosion and leachate production.

The stream lining on the SFCDR included in OU 2 Alternative (e) could affect fish habitats due to an increase in water temperature as a result of removing cooler groundwater recharge.

7.3.8.3.2 Compliance with ARARs

[Alternative 3+(e)]
[Combined]

The results of the Predictive Analysis indicate that Alternative 3+(e) would meet the threshold criterion of compliance with ARARs for surface water, but only after a period of natural source depletion, which is common to all of the alternatives. Discussions of compliance with other potential ARARs are provided under Alternative 3+ and OU Alternative (e) above.

7.3.8.3.3 Long-Term Effectiveness and Permanence

[Alternative 3+(e)]
[Combined]

The long-term effectiveness and permanence of Alternative 3+(e) is discussed below in the context of (1) magnitude of risk and (2) adequacy and reliability of controls.

Magnitude of Residual Risk. This alternative would result in a high reduction in post-remediation mass loadings (estimated 63 percent reduction). Some smaller loading sources would receive no action or limited containment. There would be a low potential for erosive transport of contaminated alluvium left in place.

Residual risks following implementation would primarily be associated with contaminated media not addressed by the alternative, which would continue to act as a source of metals loading to aquatic environments. Natural source depletion processes would further reduce residual risks.

There would be a low residual risk to humans. Decontamination of structures and access restrictions would be effective.

Adequacy and Reliability of Controls. This alternative could effectively be maintained through monitoring, maintenance, and institutional controls. There would be moderate maintenance requirements for caps, stream and riparian cleanup actions, sediment traps, French drains, and stream liners, and there would be relatively high maintenance requirements for semi-passive and active treatment.

Because this alternative would result in metals remaining onsite at concentrations above levels that allow for unlimited use and unrestricted exposure, a review would be conducted at least every 5 years, in accordance with the NCP [300.430(f)(4)(ii)].

7.3.8.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

[Alternative 3+(e)]
[Combined]

This alternative includes active treatment of adit drainages, impoundment closures, and hydraulic isolation areas using hydroxide precipitation as part of the HDS process at the CTP. The estimated average flow rate from all sources in this alternative to CTP would be approximately 13,900 gpm (820 lb/day). The majority of this flow would be from OU 3, with the exception of approximately 2,400 gpm (530 lb/day) from the French drains and extraction wells in OU 2 included in this alternative. Although the majority of the flow comes from OU 3, the majority of the metals load to be treated comes from OU 2. Semi-passive treatment would be implemented at 36 additional adits and one seep in OU 3 using either SRBs or lime addition and precipitation. The average flow rate from all sources included in this alternative to semi-passive treatment processes is 800 gpm (47 lb/day). Repository drainage would also be treated at the CTP (during the dewatering period).

This alternative reduces mobility of metals by hydroxide precipitation and adsorption/precipitation onto media. Treatment effectiveness is expected to be between 80 and greater than 99 percent, depending on the treatment technology. Treatment is considered irreversible for the treated water stream. Treatment residuals (sludge and spent media) would require isolation from low-pH water to remain insoluble. It is assumed that these materials would not be characterized as hazardous wastes and would be disposed of onsite. The total annual volume of treatment residuals associated with Alternative 3+(e) is 12,100 cy/yr.

This alternative satisfies the statutory preference for treatment under CERLCA. The total load removed under Alternative 3+(e) through treatment is (820 × 0.99) + (47 × 0.8) = 850 lb/day.

7.3.8.3.5 Short-Term Effectiveness

[Alternative 3+(e)]
[Combined]

Alternative 3+(e) would involve potentially significant short-term risks to community and workers from construction traffic. Risks could be minimized through traffic control plans and selective repository siting. There would be limited chemical risks to workers from remediation actions. Risk would be minimized with standard health and safety measures.

This alternative would involve short-term environmental impacts from construction, including re-suspension of sediment and temporary destruction of habitat. These impacts could be minimized and mitigated through engineering controls and revegetation. Impacts would be associated with stream and riparian cleanup actions, extensive excavation, haul road construction and maintenance, construction within floodplains, repository requirements, and potential stream flow reduction through hydraulic isolation actions. Any short-term environmental impacts that do occur during construction should be considered in the context of current water quality in the SFCDR and its tributaries (impacted with metals) and long-term objectives of the remedial action (significantly improved water quality and ecosystem function).

It is estimated that it would take approximately 60 to 100 years[30] to implement the alternative and to achieve RAOs for most source materials.

7.3.8.3.6 Implementability

[Alternative 3+(e)]
[Combined]

Alternative 3+(e) is considered to be implementable, although there are considerable logistical concerns that would need to be evaluated. There are challenges associated with the OU 3 components of this alternative, such as hydraulic isolation actions throughout the Upper Basin, including along the SFCDR between Elizabeth Park and Wallace, and in Woodland Park. However, the actions that pose the greatest challenges are in OU 2 [described above as part of the evaluation of OU 2 Alternative (e)]. Remedial components in OU 2 with significant implementability concerns include the SFCDR stream liner, slurry walls in the SFCDR valley floor above Elizabeth Park and in Pinehurst Narrows, and the lining of Bunker Creek (which would exacerbate existing issues with the undersized culvert under I-90). Specifically, the areas of the SFCDR and tributaries to be lined in the Box would be located within the developed areas of the City of Kellogg. Access for large equipment along with space for SFCDR and tributary diversion would pose significant logistical considerations. Site-specific stream liner design would have to include consideration of the impact of liners on stream hydraulics and existing flood control structures. A design objective of the remedial actions would be to have no negative impact on existing flood control systems. If it is determined that in some areas stream lining cannot be implemented without creating negative impacts on existing flood control structures, then alternative

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[30] This assumes a rough estimated range of \$15 million/yr to \$25 million/yr of available annual funding to cover \$1.5 billion of capital and O&M costs (see Section 7.3.8.3.7). If funding were not the driving factor, it is estimated that it would require at least 20 years to implement Alternative 3+(e).

process options would be used (such as slurry walls) to provide the desired degree of hydraulic isolation.

Significant uncertainties in construction volumes could be handled in the design or construction phase. There are cost and logistical considerations for obtaining borrow materials and excavating in floodplains that would need to be addressed.

The services, equipment, and technologies used are all available at least on a regional level.

7.3.8.3.7 Cost of Implementation

[Alternative 3+(e)]
[Combined]

Cost estimates for Alternative 3+(e) are summarized as follows:

- Total Capital Cost: $1.43 billion
- O&M Cost: $104 million (30-year NPV); $8.37 million (Annual Average)
- Total Cost (30-year NPV): $1.53 billion

7.3.9 Alternative 4+(a)

Alternative 4+(a) is discussed below with respect to the seven CERCLA threshold and balancing criteria. The only difference between Alternative 4+(a) and Alternative 3+(a) described in Section 7.3.4 is the set of remedial actions included for OU 3. Therefore, the following discussion is focused on the OU 3 component and the analysis of the combined (OU 3 plus OU 2 components) alternative.

7.3.9.1 OU 3 Alternative 4+, Maximum Removal, Disposal, and Treatment

[Alternative 4+(a)]
[OU 3]

7.3.9.1.1 Overall Protection of Human Health and the Environment

[Alternative 4+(a)]
[OU 3]

Alternative 4+ involves the most extensive removal and containment actions, to address all known and accessible waste rock, tailings, and sediment sources that exceed PRGs. Alternative 4+ also includes treatment to address all significant adit discharges. These additional actions would provide the maximum reduction in direct human and ecological exposures to contaminated media and reduce contaminant transport via erosion, leachate production, and groundwater flow. Removals of floodplain sources would be expanded to include all known and accessible sediments above PRGs, as well as excavating impounded tailings (at inactive facilities) and placing them in repositories. Hydraulic isolation would be provided for remaining active tailings impoundments and inaccessible contaminated sediments. The stream lining on the SFCDR included in Alternative 4+ could affect fish habitats due to an increase in water temperature as a result of removing cooler groundwater recharge. Additional actions would be taken for upland waste rock piles exceeding PRGs. To consolidate removals and provide higher-performance containment, repositories would be used to the maximum extent. Stream and riparian cleanup actions would be similar in scope to those included in Alternative 3+, but with more extensive placement of off-channel hydrologic units. Alternative 4+ includes semi-passive and active treatment to address all significant adit discharges, along with expanded active treatment of groundwater associated with additional areas of hydraulic isolation.

Actions under Alternative 4+ include maximum containment of media with metal concentrations above PRGs. Residual risks would primarily be associated with sources that are only partially contained, primarily inaccessible sediments and active tailings impoundments. The results of the Predictive Analysis (as described in Appendix B) indicate that Alternative 4+ may reduce the annual average dissolved zinc load in the SFCDR at Elizabeth Park by approximately 66 percent (Table 7-21). Over the long term, natural source depletion processes would result in further reductions in metals loads and associated residual risk.

The removal and containment measures that are targeted at reducing loadings to surface water and groundwater would also be effective in reducing the potential for human and ecological exposures to metals or remaining source sites. Alternative 4+ also includes demolition of structures and removal of underlying contamination to further reduce any potential unacceptable human health risks.

As with the other action-oriented alternatives, the engineering components of Alternative 4+ would require long-term management to remain effective over the long term. Monitoring, O&M, and institutional controls would be required. It is expected that these management requirements could be administered effectively.

The long-term effectiveness of stream and riparian cleanup actions is expected to be greatest under Alternative 4+; however, the ability to ultimately achieve habitat goals may be affected by land use issues (such as mining activities and forest management practices) that may disrupt watershed hydrology. The ability to effectively manage these non-CERCLA activities over the long term may be limited.

Because Alternative 4+ involves handling and transportation of the greatest quantities of material, the short-term risks to workers and the community would be greatest under Alternative 4+. To the extent practicable, these risks would be minimized with standard health and safety controls, selective siting of repositories, and traffic control plans. Construction-related short-term impacts on the environment would be minimized or mitigated through engineering controls and revegetation.

Alternative 4+ is estimated to take approximately 80 to 130 years to implement completely.[31] RAOs for soils, sediments, and source materials would be met as construction is completed, but only for the portion of soils and source materials addressed under this alternative.

[31] This assumes a rough estimated range of $15 million/yr to $25 million/yr of available annual funding to cover $1.9 billion of capital costs (see Section 7.3.9.1.7). If funding were not the driving factor, it is estimated that it would require at least 30 years to implement Alternative 4+.

RAOs for surface water may be met in limited areas as construction is completed. RAOs for groundwater may be met in some areas as a result of hydraulic isolation actions and extensive source material removals.

7.3.9.1.2 Compliance with ARARs

[Alternative 4+(a)]
[OU 3]

The results of the Predictive Analysis indicate that Alternative 4+ would reduce the AWQC ratio for dissolved zinc in the SFCDR at Elizabeth Park from approximately 5.5 to approximately 1.6 at the completion of remedy implementation. Drinking water standards (MCLs) are also a potential ARAR for surface water. As previously discussed, AWQC are generally more stringent than MCLs (for the key contaminants of concern), and, therefore, when AWQC are achieved, MCLs will also likely be achieved.

Potential chemical-specific PRGs for soil and sediment would be met upon completion of remedial actions in areas where actions are taken.

Although there is no RAO for remediation of groundwater, some of the groundwater actions to reduce contaminant concentrations in surface water would also result in reductions of contaminants in groundwater. A TI waiver may be warranted at specific locations where groundwater does not achieve drinking water standards if it were determined that additional actions would not be effective.

The actions included in Alternative 4+ could potentially be implemented in compliance with potential location-specific and action-specific ARARs. Alternative 4+ would be implemented to meet requirements for federal agencies under Section 7 of the ESA. The ESA requires that the actions be protective of critical habitat for several species in the Coeur d'Alene Basin. A summary of other potential location-specific and action-specific ARARs is included in Section 4.0.

7.3.9.1.3 Long-Term Effectiveness and Permanence

[Alternative 4+(a)]
[OU 3]

Long-term effectiveness and permanence of Alternative 4+ is discussed below in the context of (1) the expected magnitude of residual risk and (2) the adequacy and reliability of engineering and institutional controls.

Magnitude of Residual Risk. Actions under Alternative 4+ are directed at containing all known media with concentrations of metals above PRGs, along with treatment of all adit discharges and remaining known areas of contaminated groundwater. These actions would reduce the mobility of metals in the environment and reduce the potential for exposure of human and environmental receptors to metals. Actions in OU 3 as part of this alternative would leave behind significant residual environmental risk.

Residual risks following implementation would primarily be associated with contaminated media not addressed by the alternative, which would continue to act as a source of metals loading to aquatic environments. Residual loading is a function of the types and quantities of contaminated media that would remain in the environment following cleanup (i.e., unremediated materials), with consideration of the effectiveness of the cleanup actions for the materials that are remediated. As discussed in Section 7.3.2, different waste types have different loading potentials. The types and quantities of media that would receive no action or monitoring only under Alternative 4+ include (in approximate decreasing order of residual loading potential):

- Approximately 20 percent of tailings located in active impoundments
- Approximately 18 percent of waste rock located in upland areas (waste rock with little potential for significant loading)
- Approximately 9 percent of waste rock located in floodplains
- Approximately 36 percent of unimpounded tailings

Other potentially significant sources of loading that may remain under Alternative 4+ include contaminated groundwater discharging to surface water. Although Alternative 4+ includes hydraulic isolation actions (and treatment) for groundwater along the SFCDR, the hydraulic isolation actions would not contain 100 percent of contaminated groundwater discharging to surface water.

The overall effectiveness of the alternatives can be quantified in terms of the predicted improvement in surface water quality. For Alternative 4+, the reduction in the AWQC ratio in surface water upstream of Elizabeth Park was predicted by the Predictive Analysis to be approximately 1.6 at remedy completion, versus 5.5 with no action. The dissolved zinc load reduction is predicted to be approximately 66 percent. Natural source depletion processes would result in further reductions in AWQC ratios, dissolved metals load, and residual risk over the long term.

Because this alternative would result in metals remaining onsite at concentrations above levels that allow for unlimited use and unrestricted exposure, a review would be conducted at least every 5 years, in accordance with the NCP [300.430(f)(4)(ii)].

Adequacy and Reliability of Controls. Under Alternative 4+, the expected long-term performance issues, monitoring requirements, and maintenance requirements would be similar to those described for Alternative 3+, with the following exceptions.

- **Stream and Riparian Cleanup Actions.** Stream and riparian cleanup components are expected to have a high likelihood of long-term success, with lower short-term and long-term maintenance requirements compared to Alternative 3+. The greater degree of contaminated sediment removals and increased use of current deflectors and off-channel hydrologic units would be expected to result in more rapid and permanent improvements in stream channel stability and successional recovery of physical habitat structure. The resulting system may also be more resilient in recovering from extreme disruptions such as drought or flooding.
- **Sediment Traps.** Sediment traps would not be included, and thus periodic dredging would not be required.

- **Demolition and Cleanup of Abandoned Structures.** Demolition and cleanup of abandoned structures would permanently eliminate human exposures at these sites and eliminate the need for long-term maintenance.

7.3.9.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

[Alternative 4+(a)]
[OU 3]

Alternative 4+ includes the following treatment components:

- Active treatment of an average flow of 14,000 gpm (180 lb/day) of collected adit drainage (32 adits), seeps, and groundwater;
- Semi-passive treatment of an average of 1,410 gpm (49 lb/day) of collected drainage from 51 additional adits and one seep; and
- Active treatment of leachate from repositories (during the dewatering period).

This treatment would be implemented as generally described under Alternative 3+. Under Alternative 4+, a total of 84 adit drainage sources would be treated, along with large volumes of groundwater in areas of hydraulic isolation. Other metals including cadmium and lead would also be treated, with commensurate reductions in loading.

Active and semi-passive treatment processes reduce the mobility of inorganics through precipitation or combined adsorption and precipitation. Active treatment would reduce effluent metals concentrations by 99 percent or greater. As described under Alternative 3+, achievable effluent concentrations for semi-passive treatment are specific to the treatment technology and the chemical characteristics of the adit drainage. Treatment effectiveness for semi-passive systems is expected to be 80 percent or greater.

Both active and semi-passive treatment can be considered irreversible for the treated water stream. Treatment residuals (sludge and spent media) would require isolation from low-pH water to remain insoluble. It is assumed that these materials would not be characterized as hazardous wastes and would be disposed of onsite.

The residual waste associated with the active treatment process is the sludge containing the precipitated metal hydroxides. The volume and weight of the sludge produced would depend on the total mass loading of all precipitated species, specific process operating conditions, and the degree to which the sludge is dewatered prior to disposal. The estimated volume of dewatered sludge requiring disposal for Alternative 4+ is 9,900 cy/yr, as represented by the estimates for Alternatives 4+(a) and (b) in Table 7-14, which include no water treatment in OU 2.

The residual wastes associated with the semi-passive treatment processes are spent substrate (in the case of the SRB) and precipitated metals from the aerobic/settling ponds for both the SRB and lime addition processes. The spent substrate would require periodic removal, disposal, and replacement. It is assumed that the spent substrate could be disposed of at the repository. The estimated volume of treatment residuals from the semi-passive processes is 330 cy/yr on an annual average basis. Generation of treatment residuals from semi-passive processes would be a periodic operation. Design assumptions for this FFS provide for one media replacement within 30 years for the SRB systems (TCD WT03) and two cleanouts of the lime settling ponds (TCD WT02) within 30 years. Change-out frequencies for the spent substrate are a function of the medium formulation, mass loading, designed bed volume, and hydraulic efficiency at a given site.

7.3.9.1.5 Short-Term Effectiveness

[Alternative 4+(a)]
[OU 3]

The short-term effectiveness of Alternative 4+ is discussed below in the context of (1) protection of the community, (2) protection of workers, (3) environmental impacts, and (4) time required to implement the alternative and to eventually achieve response objectives.

Protection of Community During Remedial Actions. The primary risks to the community associated with Alternative 4+ are traffic-related hazards from transportation of large quantities of contaminated media and imported construction materials. These traffic risks are of particular concern under Alternative 4+ due to the very large amounts of material requiring excavation and hauling. To the extent possible, these risks would be minimized with standard health and safety controls and traffic control plans. Because Alternative 4+ would place most waste in repositories, the majority of this truck traffic would be on highly traveled corridors. Additional truck trips would be required to import construction materials, such as soil, rock, and liners.

As with Alternative 3+, potential hazards to the community associated with particulate emissions during construction could be largely controlled through the use of dust control measures such as water sprays and air monitoring.

Protection of Workers During Remedial Actions. Short-term risks to workers would consist of physical construction hazards and traffic-related hazards from materials handling and transportation. These risks would be controlled with standard health and safety controls and traffic control plans. Alternative 4+ includes a variety of construction activities to address roughly 26 million cy of contaminated material. Approximately 14 million cy of this material would require excavation and rehandling. Also, certain sites that are characterized by steep topography or difficult access may pose greater construction hazards to workers. In such cases, significant construction hazards may be avoided in the design or construction phase by modifying the degree or type of action taken at a particular site.

Workers would also be subject to exposure from contaminated soil and dust. This risk can be largely controlled using PPE, dust control measures such as water sprays, and air monitoring.

Environmental Impacts. During the implementation time frame of approximately 80 to 130 years, Alternative 4+ would pose short-term impacts on the environment, including re-suspension of sediment and temporary destruction of habitat. These would primarily be associated with construction within floodplains and riparian areas. Approximately 300,000 linear feet of stream would be affected by construction of bioengineered revetments and vegetative bank stabilization. A minimum of 14 million cy of sediments, tailings, and waste rock in floodplains would require excavation and hauling. Alternative 4+ also includes in-stream sediment removal, which would have greater short-term impacts on water quality. As with Alternative 3+, engineering controls such as sediment fencing, temporary sediment traps, temporary cofferdams, and revegetation and installation of stream and riparian cleanup actions would be used to minimize and mitigate short-term environmental impacts. Any short-term environmental impacts that do occur during construction should be considered in the context of current water quality in the SFCDR and its tributaries (impacted with metals) and long-term objectives of the remedial action (significantly improved water quality and ecosystem function).

Alternative 4+ would require mining suitable borrow materials (granular materials, growth media, and common fill) for repository construction, capping actions, and floodplain backfill. Additional fill may be required to backfill deeper floodplain sediment excavations. Short-term environmental impacts would be associated with mining and transporting borrow materials. These impacts at the borrow sites include increased uncontaminated sediment loads from runoff and erosion, destruction of existing vegetation and habitat, and potentially long-term degradation of topsoil quality. Standard engineering controls such as sediment fencing and revegetation would reduce these impacts.

Additional potential ecological impacts under Alternative 4+ are associated with hydraulic isolation and attendant reduced stream flows in some river segments. Estimating these potential effects would require further study.

Additional long-term environmental impacts are expected under Alternative 4+ as a result of land being converted for use as permanent repositories and construction of temporary haul roads. The extent of environmental impacts, in terms of lost habitat, would depend on the specific sites selected for repositories. Haul roads would be constructed and operated during implementation, with corresponding impacts on terrestrial habitat and sediment loads from runoff.

Time Until Response Objectives Are Achieved. Alternative 4+ would take an estimated 80 to 130 years to implement completely. However, construction at specific source sites could begin immediately, and the time to combined construction at specific source sites would range from several weeks to several years. As construction is completed at individual sites, RAOs for those soils, sediments, and source materials addressed by this alternative could be achieved within a relatively short time frame. Post-remediation studies in OU 2 (CH2M HILL, 2007d) have shown that, following remedial actions in that area, concentrations in surface water stabilized after approximately 2 to 3 years.

Because this alternative would not remove all contaminated media (primarily inaccessible contaminated floodplain sediments that are left in place), these media would continue to act as sources of loading groundwater. The RAO of preventing releases of contaminants to groundwater would not be met for these media.

In summary, the time to achieve the RAOs for soils, sediments, and source materials would be on the order of 80 to 130 years, but only for the portion of soils and source materials addressed under this alternative. The time to achieve these RAOs at a given site would primarily depend on the construction scheduling. Acceleration of the cleanup time frames discussed above is possible, but would result in greater traffic impacts, more intense sediment loads, and potentially higher costs.

Groundwater quality may improve in some areas after source removal actions are completed. However, in other areas, contaminated groundwater would remain. Data are not currently available with which to estimate the rate of natural attenuation of metals in groundwater; therefore, it is not known when potential ARARs would be met in groundwater as a result of remedial actions.

RAOs for surface water may be met in certain areas as construction is completed. Achieving surface water RAOs in downgradient areas of the SFCDR would generally require completion of construction in most upgradient areas (80 to 130 years), several years for re-establishment of riparian habitat, and additional time for natural source depletion

7.3.9.1.6 Implementability

[Alternative 4+(a)]
[OU 3]

The implementability of Alternative 4+ is discussed below in the context of (1) technical feasibility, (2) administrative feasibility, and (3) the availability of services and materials.

Technical Feasibility. Alternative 4+ is considered to be technically feasible, although there are significant logistical issues to be considered. The primary construction uncertainties associated with Alternative 4+ relate to uncertainties in waste volume and area estimates. Unique to Alternative 4+ is the goal of excavating all known and accessible floodplain sediments exceeding PRGs. The estimated quantity of sediments targeted for excavation (3.6 million cy) is considered highly uncertain, and the quantity of sediments requiring excavation could increase dramatically (potentially up to 10 million cy or more). This uncertainty in the volume of contaminated sediments is primarily associated with limited information in many areas on the depths of the sediment deposits exceeding PRGs.

The primary construction difficulties with Alternative 4+ arise from logistical constraints on transportation; these may extend the implementation time frame or increase costs. Some existing haul routes have limited capacity, and the ability to construct dedicated haul routes would be limited by topography, land ownership, and environmental concerns.

As with Alternative 3+, additional difficulties that may be encountered during implementation may include construction limitations presented by steep slopes at specific sites, recontamination of remediated areas, and availability of borrow material and vegetative planting stock. These issues could be handled in the remedial design phase as more site-specific information (such as detailed surveys or additional sampling) becomes available. Transportation logistics and costs would increase if borrow material were obtained from more distant sources, or if suitable growth medium had to be manufactured onsite.

Under Alternative 4+, excavation of sediments from below the water table would pose significant logistical considerations and result in higher costs. These implementability concerns are greatest under Alternative 4+ because of the extensive scope and depth of sediment removals, ranging from 3.6 million cy to 10 million cy or more. Deeper excavations, if required, would increase the dewatering difficulties.

As with Alternative 3+, treatability testing would be required to design the semi-passive treatment systems.

Construction of the SFCDR stream liners between Mullan and Elizabeth Park may pose significant logistical issues considering the size of the SFCDR and the location near I-90. In some areas, there would be limited access to the SFCDR for large equipment and limited space for onsite screening of materials. The limited space would pose logistical considerations for the SFCDR diversion, which is required for stream liner installation. Diversion of the SFCDR and subsequent liner construction would be performed during lower SFCDR flows in the spring and early summer. Site-specific stream liner design would have to include consideration of the impact of liners on stream hydraulics and existing flood control structures. A design objective of the remedial actions would be to have no negative impact on existing flood control systems. If it is determined that in some areas stream lining cannot be implemented without creating negative impacts on existing flood control structures, then alternative process options would be used (such as slurry walls) to provide the desired degree of hydraulic isolation.

Monitoring can effectively measure the success of Alternative 4+ in achieving the RAOs, and the results of the monitoring and periodic inspections would give notice if maintenance or additional action were needed. No component of Alternative 4+ would preclude additional remedial action if it were needed in the future.

Administrative Feasibility. There may be significant administrative difficulties in implementing Alternative 4+. As with Alternative 3+, the primary administrative feasibility concern relates to the ability to acquire land and easements, fulfill substantive permit requirements, and obtain local agency concurrence for siting and construction of waste consolidation areas, repositories, and active water treatment pipelines. However, the magnitude of the removal actions is greater with Alternative 4+, and the administrative feasibility difficulties are anticipated to be correspondingly greater. The ability to coordinate truck traffic and haul routes with local authorities over a period of up to 130 years is also a concern. The potential for increased excavation and backfill quantities could further reduce the administrative feasibility of this alternative.

Implementation may require a biological assessment to demonstrate compliance with ESA requirements, and consultation with natural resource agencies to obtain concurrence (or determine the need for mitigation or avoidance). Coordination with natural resource agencies may also be required under the Fish and Wildlife Coordination Act. Coordination with USACE may be required under the Rivers and Harbors Act.

Offsite actions, if needed, may require permits. In particular, surface mining permits from state and local agencies may be required to excavate borrow materials, such as gravels or common fill used for backfilling deeper floodplain excavations, and drainage layer and growth media for repository construction and capping actions. Potential difficulties in obtaining permits may delay implementation or increase costs.

Availability of Services and Materials. Availability of suitable clean borrow materials, particularly growth media, within a reasonable haul distance of the site is limited. Transportation logistics and costs would increase if borrow materials were obtained from more distant sources or if growth media had to be manufactured onsite. Treatability testing of potential growth medium formulations may be required. Surface mining permits (or fulfillment of substantive requirements) may be required to excavate borrow material.

For the purpose of developing cost estimates, it is assumed that all wastes could be disposed of onsite. Hydroxide precipitation sludge generated at the CTP would be disposed of in the lined sludge pond on top of the CIA in accordance with current practices until this sludge pond reaches its capacity, at which time a new sludge pond would be constructed onsite. Hydroxide precipitation sludge from semi-passive lime addition systems (TCD WT02) and spent substrate from the SRB systems (TCD WT03) would be disposed of at one of the repositories.

Due to the massive, long-term scope of the construction activities under Alternative 4+, availability of construction equipment, trucks, and operators may be limited in early years of implementation. It is anticipated that the construction economy would expand over the years to fill any voids in the availability of equipment and operators.

7.3.9.1.7 Cost of Implementation

[Alternative 4+(a)]
[OU 3]

Cost estimates for Alternative 4+ were developed assuming 30 years of O&M and a discount rate of 7 percent. Detailed cost estimates are provided in Appendix D. The estimated total costs for implementing Alternative 4+ are summarized as follows:

- Total Capital Cost: $1.77 billion
- O&M Cost: $144 million (30-year NPV); $11.6 million (Annual Average)
- Total Cost (30-year NPV): $1.91 billion

The factors identified as the most significant sources of cost uncertainty for this alternative are (1) total volumes of contaminated sediments requiring excavation, (2) sediment excavation dewatering requirements and associated unit costs, and (3) growth media unit costs. The greatest contributor to the uncertainty is the potentially large escalation in the total volumes of contaminated sediments requiring excavation.

7.3.9.2 OU 2 Alternative (a)

[Alternative 4+(a)]
[OU 2]

Please refer to Section 7.3.4.2 for a discussion of the CERCLA threshold criteria and primary balancing criteria related to OU 2 Alternative (a).

7.3.9.3 Combined Alternative 4+(a)

[Alternative 4+(a)]
[Combined]

7.3.9.3.1 Overall Protection of Human Health and the Environment

[Alternative 4+(a)]
[Combined]

The estimated reduction in AWQC ratios at Elizabeth Park and Pinehurst based on the results of the Predictive Analysis (Appendix B) is as follows:

	Pre-Remediation AWQC Ratio	Post-Remediation AWQC Ratio
Elizabeth Park (SF-268)	5.5	1.6
Pinehurst (SF-271)	5.2	2.8

Based on the post-remediation AWQC estimates presented above, Alternative 4+(a) would meet the threshold criterion of overall protection of human health and the environment for surface water. This determination is made with the caveat that attainment of site cleanup objectives for surface water would require a period of natural source depletion.

In addition to the expected reduction in AWQC ratios, Alternative 4+(a) would also significantly improve the quality of the riparian and riverine habitat structure, which would also stabilize remaining floodplain sources, thus reducing the potential for direct human and ecological exposures to the most highly contaminated media and reducing contaminant transport via erosion and leachate production.

7.3.9.3.2 Compliance with ARARs

[Alternative 4+(a)]
[Combined]

The results of the Predictive Analysis indicate that Alternative 4+(a) would meet the threshold criterion of compliance with ARARs for surface water, but only after a period of natural source depletion, which is common to all of the alternatives. Discussions of compliance with other potential ARARs are provided under Alternative 4+ and OU Alternative (a) above.

7.3.9.3.3 Long-Term Effectiveness and Permanence

[Alternative 4+(a)]
[Combined]

The long-term effectiveness and permanence of Alternative 4+(a) is discussed below in the context of (1) magnitude of risk and (2) adequacy and reliability of controls.

Magnitude of Residual Risk. This alternative was estimated by the Predictive Analysis to result in a moderate reduction in post-remediation mass loadings (estimated 45 percent reduction). The majority of environmental risk in OU 3 would be addressed by this alternative. Actions in OU 2 as part of this alternative would leave behind significant residual environmental risk.

Residual risks following implementation would primarily be associated with contaminated media not addressed by the alternative, which would continue to act as a source of metals loading to aquatic environments. Natural source depletion processes would further reduce residual risks.

There would be a low residual risk to humans. Decontamination of structures and access restrictions would be effective.

Because this alternative would result in metals remaining onsite at concentrations above levels that allow for unlimited use and unrestricted exposure, a review would be conducted at least every 5 years, in accordance with the NCP [300.430(f)(4)(ii)].

Adequacy and Reliability of Controls. This alternative could effectively be maintained through monitoring, maintenance, and institutional controls. There would be moderate maintenance requirements for caps, stream and riparian cleanup actions, sediment traps, French drains, and stream liners, and there would be relatively high maintenance requirements for semi-passive and active treatment.

7.3.9.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

[Alternative 4+(a)]
[Combined]

This alternative includes active treatment of adit drainages, impoundment closures, and hydraulic isolation areas in OU 3 using hydroxide precipitation as part of the HDS process at the CTP. The estimated average flow rate from all sources in this alternative to the CTP is approximately 14,000 gpm (180 lb/day). All of this water would come from OU 3. No additional water from OU 2 would be treated under this alternative. Semi-passive treatment would be implemented at 51 additional adits and one seep in OU 3 using either SRBs or lime addition and precipitation. The average flow rate from all sources included in this alternative to semi-passive treatment processes is 1,410gpm (49 lb/day). Repository drainage would also be treated at the CTP.

This alternative reduces mobility of metals by hydroxide precipitation as part of the HDS process at the CTP and adsorption/precipitation onto media in semi-passive systems. Treatment effectiveness is expected to be between 80 and greater than 99 percent, depending on the treatment technology. Treatment is considered irreversible for the treated water stream. Treatment residuals (sludge and spent media) would require isolation from low-pH water to remain insoluble. It is assumed that these materials would not be characterized as hazardous wastes and would be disposed of onsite. The total annual volume of treatment residuals associated with Alternative 4+(a) is 10,200 cy/yr.

This alternative satisfies the statutory preference for treatment under CERLCA. The total load removed under Alternative 4+(a) through treatment is (180 × 0.99) +(49 × 0.8) = 217 lb/day.

7.3.9.3.5 Short-Term Effectiveness

[Alternative 4+(a)]
[Combined]

This alternative would involve potentially significant short-term risks to the community and workers from construction traffic. Risks could be minimized through traffic control plans and selective repository siting. There would be limited chemical risks to workers from remediation actions. Risk would be minimized with standard health and safety measures.

This alternative would involve short-term environmental impacts from construction, including re-suspension of sediment and temporary destruction of habitat. These impacts could be minimized and mitigated through engineering controls and revegetation. Impacts would be associated with stream and riparian cleanup actions, extensive excavation, haul road construction and maintenance, construction within floodplains, repository requirements, and potential stream flow reduction through hydraulic isolation actions. Any short-term environmental impacts that do occur during construction should be considered in the context of current water quality in the SFCDR and its tributaries (impacted with metals) and long-term objectives of the remedial action (significantly improved water quality and ecosystem function).

It is estimated that it would take approximately 80 to 130 years[32] to implement the alternative and to achieve RAOs for most source materials.

7.3.9.3.6 Implementability

[Alternative 4+(a)]
[Combined]

The most significant technical feasibility concerns with this alternative are related to the construction of the stream liner on the SFCDR (discussed as part of the evaluation of OU 2 Alternative (a) and Alternative 4+, above). Access for large equipment along with space for SFCDR diversion would pose significant logistical considerations.

Significant uncertainties in construction volumes could be handled in the design or construction phase. There are cost and logistical considerations for obtaining borrow materials and excavating in floodplains that would need to be addressed.

Major difficulties could be encountered in acquiring land and obtaining approvals for repositories and active treatment pipelines, obtaining borrow material, and coordinating truck traffic. Coordination with other agencies could be required, potentially including completion of a biological assessment.

The services, equipment, and technologies used are all available at least on a regional level.

7.3.9.3.7 Cost of Implementation

[Alternative 4+(a)]
[Combined]

Cost estimates for Alternative 4+(a) are summarized as follows:

- Total Capital Cost: $1.84 billion
- O&M Cost: $145 million (30-year NPV); $11.7 million (Annual Average)
- Total Cost (30-year NPV): $1.99 billion

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[32] This assumes a rough estimated range of $15 million/yr to $25 million/yr of available annual funding to cover $2.0 billion of capital costs (see Section 7.3.9.3.7). If funding were not the driving factor, it is estimated that it would require at least 30 years to implement Alternative 4+(a).

7.3.10 Alternative 4+(b)

The individual OU 2- and OU 3-specific components of Alternative 4+(b) have been addressed in Sections 7.3.5.2 and 7.3.9.1, respectively. These two OU-specific components are not addressed further here. However, the combined Alternative 4+(b) has not been previously addressed with regard to the seven CERCLA threshold and balancing criteria. That evaluation of the combined Alternative 4+(b) is provided below.

7.3.10.1 Overall Protection of Human Health and the Environment

[Alternative 4+(b)]
[Combined]

The estimated reduction in AWQC ratios loadings at Elizabeth Park and Pinehurst based on the results of the Predictive Analysis (Appendix B) is as follows:

	Pre-Remediation AWQC Ratio	Post-Remediation AWQC Ratio
Elizabeth Park (SF-268)	5.5	1.6
Pinehurst (SF-271)	5.2	2.8

Based on the post-remediation AWQC estimates presented above, Alternative 4+(b) would meet the threshold criterion of overall protection of human health and the environment for surface water. This determination is made with the caveat that attainment of site cleanup objectives for surface water would require a period of natural source depletion.

In addition to the expected reduction in AWQC ratios, Alternative 4+(b) would also significantly improve the quality of the riparian and riverine habitat structure, which would also stabilize remaining floodplain sources, thus reducing the potential for direct human and ecological exposures to the most highly contaminated media and reducing contaminant transport via erosion and leachate production.

7.3.10.2 Compliance with ARARs

[Alternative 4+(b)]
[Combined]

The results of the Predictive Analysis indicate that Alternative 4+(b) would meet the threshold criterion of compliance with ARARs for surface water, but only after a period of natural source depletion, which is common to all of the alternatives. Discussions of compliance with other potential ARARs are provided under Alternative 4+ and OU Alternative (b) above.

7.3.10.3 Long-Term Effectiveness and Permanence

[Alternative 4+(b)]
[Combined]

The long-term effectiveness and permanence of Alternative 4+(b) is discussed below in the context of (1) magnitude of risk and (2) adequacy and reliability of controls.

7.3.10.3.1 Magnitude of Residual Risk

[Alternative 4+(b)]
[Combined]

This alternative was estimated by the Predictive Analysis to result in a moderate reduction in post-remediation mass loadings (estimated 45 percent reduction). The majority of environmental risk in OU 3 would be addressed by this alternative. There would be a low potential for erosive transport of contaminated alluvium left in place.

Residual risks following implementation would primarily be associated with contaminated media not addressed by the alternative, which would continue to act as a source of metals loading to aquatic environments. Natural source depletion processes would further reduce residual risks.

There would be a low residual risk to humans. Decontamination of structures and access restrictions would be effective.

7.3.10.3.2 Adequacy and Reliability of Controls

[Alternative 4+(b)]
[Combined]

This alternative could effectively be maintained through monitoring, maintenance, and institutional controls. There would be moderate maintenance requirements for caps, stream and riparian cleanup actions, sediment traps, French drains, and stream liners, and there would be relatively high maintenance requirements for semi-passive and active treatment.

Because this alternative would result in metals remaining onsite at concentrations above levels that allow for unlimited use and unrestricted exposure, a review would be conducted at least every 5 years, in accordance with the NCP [300.430(f)(4)(ii)].

7.3.10.4 Reduction of Toxicity, Mobility, or Volume through Treatment

[Alternative 4+(b)]
[Combined]

This alternative includes active treatment of adit drainages, impoundment closures, and hydraulic isolation areas using hydroxide precipitation as part of the HDS process at the CTP. The estimated average flow rate from all sources in this alternative to the CTP is approximately 14,000 gpm (180 lb/day). All of this flow would be from OU 3. Semi-passive treatment would be implemented at 51 additional adits and one seep in OU 3 using either SRBs or lime addition and precipitation. The average flow rate from all sources included in this alternative to semi-passive treatment processes is 1,410 gpm (49 lb/day). Repository drainage would also be treated at the CTP.

This alternative reduces mobility of metals by hydroxide precipitation and adsorption/ precipitation onto media. Treatment effectiveness is expected to be between 80 and greater than 99 percent, depending on the treatment technology. Treatment is considered irreversible for the treated water stream. Treatment residuals (sludge and spent media) would require isolation from low-pH water to remain insoluble. It is assumed that these materials would not be characterized as hazardous wastes and would be disposed of onsite.

This alternative satisfies the statutory preference for treatment under CERLCA. The total load removed under Alternative 4+(b) through treatment is (180 × 0.99) + (49 × 0.8) = 217 lb/day.

7.3.10.5 Short-Term Effectiveness

[Alternative 4+(b)]
[Combined]

Alternative 4+(b) would involve potentially significant short-term risks to the community and workers from construction traffic. Risks could be minimized through traffic control plans and selective repository siting. There would be limited chemical risks to workers from remediation actions. Risk would be minimized with standard health and safety measures.

This alternative would involve short-term environmental impacts from construction, including re-suspension of sediment and temporary destruction of habitat. These impacts could be minimized and mitigated through engineering controls and revegetation. Impacts would be associated with stream and riparian cleanup actions, extensive excavation, haul road construction and maintenance, construction within floodplains, repository requirements, and potential stream flow reduction through hydraulic isolation actions. Any short-term environmental impacts that do occur during construction should be considered in the context of current water quality in the SFCDR and its tributaries (impacted with metals) and long-term objectives of the remedial action (significantly improved water quality and ecosystem function).

It is estimated that it would take approximately 80 to 130 years[33] to implement the alternative and to achieve RAOs for most source materials.

7.3.10.6 Implementability

[Alternative 4+(b)]
[Combined]

This alternative is considered technically feasible, although construction of the SFCDR stream liners between Mullan and Elizabeth Park may pose significant logistical issues considering the size of the SFCDR and the location near I-90. In some areas, there would be limited access to the SFCDR for large equipment and limited space for onsite screening of materials. The limited space would pose logistical considerations for the SFCDR diversion, which is required for stream liner installation. Diversion of the SFCDR and subsequent liner construction would be performed during lower SFCDR flows in the spring and early summer. Site-specific stream liner design will have to include consideration of the impact of liners on stream hydraulics and existing flood control structures. A design objective of the remedial actions would be to have no negative impact on existing flood control systems. If it is determined that in some areas stream lining cannot be implemented without creating

[33] This assumes a rough estimated range of $15 million/yr to $25 million/yr of available annual funding to cover $2.0 billion of capital costs (see Section 7.3.10.7). If funding were not the driving factor, it is estimated that it would require at least 30 years to implement Alternative 4+(b).

negative impacts on existing flood control structures, then alternative process options would be used (such as slurry walls) to provide the desired degree of hydraulic isolation.

There are no significant technical feasibility concerns with this alternative aside from potential construction challenges related to the hydraulic isolation actions.

Major difficulties could be encountered in acquiring land and obtaining approvals for repositories and active treatment pipelines, obtaining borrow material, and coordinating truck traffic. Coordination with other agencies could be required, potentially including completion of a biological assessment.

Significant uncertainties in construction volumes could be handled in the design or construction phase. There are cost and logistical considerations for obtaining borrow materials and excavating in floodplains that would need to be addressed.

The services, equipment, and technologies used are all available at least on a regional level.

7.3.10.7 Cost of Implementation

[Alternative 4+(b)]
[Combined]

Cost estimates for Alternative 4+(b) are summarized as follows:

- Total Capital Cost: $ 1.8 billion
- O&M Cost: $145 million (30-year NPV); $11.7 million (Annual Average)
- Total Cost (30-year NPV): $1.95 billion

7.3.11 Alternative 4+(c)

The individual OU 2 and OU 3 components of Alternative 4+(c) have been addressed in Sections 7.3.6.2 and 7.3.9.1, respectively. These two OU-specific components are not addressed further here. However, the combined Alternative 4+(c) has not been previously addressed with regard to the seven CERCLA threshold and balancing criteria. That evaluation of the combined Alternative 4+(c) is provided below.

7.3.11.1 Overall Protection of Human Health and the Environment

[Alternative 4+(c)]
[Combined]

The estimated reduction in AWQC ratios at Elizabeth Park and Pinehurst based on the results of the Predictive Analysis (Appendix B) is as follows:

	Pre-Remediation AWQC Ratio	Post-Remediation AWQC Ratio
Elizabeth Park (SF-268)	5.5	1.6
Pinehurst (SF-271)	5.2	1.6

Based on the post-remediation AWQC estimates presented above, Alternative 4+(c) would meet the threshold criterion of overall protection of human health and the environment for surface water. This determination is made with the caveat that attainment of site cleanup objectives for surface water would require a period of natural source depletion.

In addition to the expected reduction in AWQC ratios, Alternative 4+(c) would also significantly improve the quality of the riparian and riverine habitat structure, which would also stabilize remaining floodplain sources, thus reducing the potential for direct human and ecological exposures to the most highly contaminated media and reducing contaminant transport via erosion and leachate production.

Further, Alternative 4+(c) includes direct piping of the CTP effluent to the SFCDR for discharge. Direct piping of the discharge to the SFCDR rather than the current practice of discharging to Bunker Creek would eliminate the infiltration and recontamination of this treated water, thus keeping clean water clean.

7.3.11.2 Compliance with ARARs

[Alternative 4+(b)]
[Combined]

The results of the Predictive Analysis indicate that Alternative 4+(c) would meet the threshold criterion of compliance with ARARs for surface water, but only after a period of natural source depletion, which is common to all of the alternatives. Discussions of compliance with other potential ARARs are provided under Alternative 4+ and OU Alternative (c) above.

7.3.11.3 Long-Term Effectiveness and Permanence

[Alternative 4+(c)]
[Combined]

The long-term effectiveness and permanence of Alternative 4+(c) is discussed below in the context of (1) magnitude of risk and (2) adequacy and reliability of controls.

7.3.11.3.1 Magnitude of Residual Risk

[Alternative 4+(c)]
[Combined]

This alternative would result in a high reduction in post-remediation mass loadings (estimated 63 percent reduction). There would be a low potential for erosive transport of contaminated alluvium left in place.

Residual risks following implementation would primarily be associated with contaminated media not addressed by the alternative, which would continue to act as a source of metals loading to aquatic environments. Natural source depletion processes would further reduce residual risks.

There would be a low residual risk to humans. Decontamination of structures and access restrictions would be effective.

7.3.11.3.2 Adequacy and Reliability of Controls

[Alternative 4+(c)]
[Combined]

This alternative could effectively be maintained through monitoring, maintenance, and institutional controls. There would be moderate maintenance requirements for caps, stream and riparian cleanup actions, sediment traps, French drains, and stream liners, and there would be relatively high maintenance requirements for semi-passive and active treatment.

Because this alternative would result in metals remaining onsite at concentrations above levels that allow for unlimited use and unrestricted exposure, a review would be conducted at least every 5 years, in accordance with the NCP [300.430(f)(4)(ii)].

7.3.11.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

[Alternative 4+(c)]
[Combined]

This alternative includes active treatment of adit drainages, impoundment closures, and hydraulic isolation areas using hydroxide precipitation as part of the HDS process at the CTP. As shown in Table 7-13, the estimated average flow rate from all sources included in this alternative to CTP would be approximately 17,900 gpm (1,350 lb/day). The majority of this flow would be from OU 3, with the exception of approximately 3,900 gpm (1,160 lb/day) from the French drain in OU 2 included in this alternative. Although the majority of the flow comes from OU 3, the majority of the metals load to be treated comes from OU 2. Semi-passive treatment would be implemented at 51 additional adits and one seep in OU 3 using either SRBs or lime addition and precipitation. The average flow rate from all sources included in this alternative to semi-passive treatment processes is 1,410gpm (49 lb/day). Repository drainage would also be treated at the CTP.

This alternative reduces mobility of metals by hydroxide precipitation and adsorption/ precipitation onto media. Treatment effectiveness is expected to be between 80 and greater than 99 percent, depending on the treatment technology. Treatment is considered irreversible for the treated water stream. Treatment residuals (sludge and spent media) would require isolation from low-pH water to remain insoluble. It is assumed that these materials would not be characterized as hazardous wastes and would be disposed of onsite. The total annual volume of treatment residuals associated with Alternative 4+(c) is 15,200 cy/yr.

This alternative satisfies the statutory preference for treatment under CERLCA. The total load removed under Alternative 4+(c) through treatment is (1,350 × 0.99) + (49 × 0.8) = 1,380 lb/day.

7.3.11.5 Short-Term Effectiveness

[Alternative 4+(c)]
[Combined]

Alternative 4+(c) would involve potentially significant short-term risks to the community and workers from construction traffic. Risks could be minimized through traffic control plans and selective repository siting. There would be limited chemical risks to workers from remediation actions. Risk would be minimized with standard health and safety measures.

This alternative would involve short-term environmental impacts from construction, including re-suspension of sediment and temporary destruction of habitat. These impacts could be minimized and mitigated through engineering controls and revegetation. Impacts would be associated with stream and riparian cleanup actions, extensive excavation, haul road construction and maintenance, construction within floodplains, repository requirements, and potential stream flow reduction through hydraulic isolation actions. Any short-term environmental impacts that do occur during construction should be considered in the context of current water quality in the SFCDR and its tributaries (impacted with metals) and long-term objectives of the remedial action (significantly improved water quality and ecosystem function).

It is estimated that it would take approximately 80 to 130 years[34] to implement the alternative and to achieve RAOs for most source materials.

7.3.11.6 Implementability

[Alternative 4+(c)]
[Combined]

This alternative is considered technically feasible, although construction of the SFCDR stream liners between Mullan and Elizabeth Park may pose significant logistical issues considering the size of the SFCDR and the location near I-90. In some areas, there would be limited access to the SFCDR for large equipment and limited space for onsite screening of materials. The limited space would pose logistical considerations for the SFCDR diversion, which is required for stream liner installation. Diversion of the SFCDR and subsequent liner construction would be performed during lower SFCDR flows in the spring and early summer. Site-specific stream liner design would have to include consideration of the impact of liners on stream hydraulics and existing flood control structures. A design objective of the remedial actions would be to have no negative impact on existing flood control systems. If it is determined that in some areas stream lining cannot be implemented without creating negative impacts on existing flood control structures, then alternative process options would be used (such as slurry walls) to provide the desired degree of hydraulic isolation.

There are no significant technical feasibility concerns with this alternative aside from potential construction challenges related to the hydraulic isolation actions. Significant uncertainties in construction volumes could be handled in the design or construction phase. There are cost and logistical considerations for obtaining borrow materials and excavating in floodplains that would need to be addressed.

Major difficulties could be encountered in acquiring land and obtaining approvals for repositories and active treatment pipelines, obtaining borrow material, and coordinating truck traffic. Coordination with other agencies could be required, potentially including completion of a biological assessment.

The services, equipment, and technologies used are all available at least on a regional level.

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[34] This assumes a rough estimated range of \$15 million/yr to \$25 million/yr of available annual funding to cover \$2.0 billion of capital costs (see Section 7.3.11.7). If funding were not the driving factor, it is estimated that it would require at least 30 years to implement Alternative 4+(c).

7.3.11.7 Cost of Implementation

[Alternative 4+(c)]
[Combined]

Cost estimates for Alternative 4+(c) are summarized as follows:

- Total Capital Cost: $1.8 billion
- O&M Cost: $150 million (30-year NPV); $12.1 million (Annual Average)
- Total Cost (30-year NPV): $1.95 billion

7.3.12 Alternative 4+(d)

The individual OU 2 and OU 3 components of Alternative 4+(d) have been addressed in Sections 7.3.7.2 and 7.3.9.1, respectively. These two OU-specific components are not addressed further here. However, the combined Alternative 4+(d) has not been previously addressed with regard to the seven CERCLA threshold and balancing criteria. That evaluation of the combined Alternative 4+(d) is provided below.

7.3.12.1 Overall Protection of Human Health and the Environment

[Alternative 4+(d)]
[Combined]

The estimated reduction in AWQC ratios at Elizabeth Park and Pinehurst based on the results of the Predictive Analysis (Appendix B) is as follows:

	Pre-Remediation AWQC Ratio	Post-Remediation AWQC Ratio
Elizabeth Park (SF-268)	5.5	1.6
Pinehurst (SF-271)	5.2	1.5

Based on the post-remediation AWQC estimates presented above, Alternative 4+(d) would meet the threshold criterion of overall protection of human health and the environment for surface water. This determination is made with the caveat that attainment of site cleanup objectives for surface water would require a period of natural source depletion. In addition to water quality improvements in the SFCDR, implementation of Alternative 3+(d) would also result in achievement of AWQC for Government Creek within a relatively short time frame.

In addition to the expected reduction in AWQC ratios, Alternative 4+(d) would also significantly improve the quality of the riparian and riverine habitat structure, which would also stabilize remaining floodplain sources, reducing the potential for direct human and ecological exposures to the most highly contaminated media, and reducing contaminant transport via erosion and leachate production.

Further, Alternative 4+(d) includes direct piping of the CTP effluent to the SFCDR for discharge. Direct piping of the discharge to the SFCDR rather than the current practice of discharging to Bunker Creek would eliminate the infiltration and recontamination of this treated water, thus keeping clean water clean.

7.3.12.2 Compliance with ARARs

[Alternative 4+(d)]
[Combined]

The results of the Predictive Analysis indicate that Alternative 4+(d) would meet the threshold criterion of compliance with ARARs for surface water, but only after a period of natural source depletion, which is common to all of the alternatives. Discussions of compliance with other potential ARARs are provided under Alternative 3+ and OU Alternative (c) above.

7.3.12.3 Long-Term Effectiveness and Permanence

[Alternative 4+(d)]
[Combined]

The long-term effectiveness and permanence of Alternative 4+(d) is discussed below in the context of (1) magnitude of risk and (2) adequacy and reliability of controls.

7.3.12.3.1 Magnitude of Residual Risk

[Alternative 4+(d)]
[Combined]

This alternative would result in a high reduction in post-remediation mass loadings (estimated 65 percent reduction). Some smaller loading sources would receive no action or limited containment. There would be a low potential for erosive transport of contaminated alluvium left in place.

Residual risks following implementation would primarily be associated with contaminated media not addressed by the alternative, which would continue to act as a source of metals loading to aquatic environments. Natural source depletion processes would further reduce residual risks.

There would be a low residual risk to humans. Decontamination of structures and access restrictions would be effective.

7.3.12.3.2 Adequacy and Reliability of Controls

[Alternative 4+(d)]
[Combined]

This alternative could effectively be maintained through monitoring, maintenance, and institutional controls. There would be moderate maintenance requirements for caps, stream and riparian cleanup actions, sediment traps, French drains, and stream liners, and there would be relatively high maintenance requirements for semi-passive and active treatment.

Because this alternative would result in metals remaining onsite at concentrations above levels that allow for unlimited use and unrestricted exposure, a review would be conducted at least every 5 years, in accordance with the NCP [300.430(f)(4)(ii)].

7.3.12.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

[Alternative 4+(d)]
[Combined]

This alternative includes active treatment of adit drainages, impoundment closures, and hydraulic isolation areas using hydroxide precipitation as part of the HDS process at the CTP. As shown in Table 7-14, the estimated average flow rate from all sources to CTP would be approximately 17,900 gpm (1,330 lb/day). The majority of this flow would be from OU 3, with the exception of approximately 3,900 gpm (1,150 lb/day) from the French drains and extraction wells in OU 2 included in this alternative. Although the majority of the flow comes from OU 3, the majority of the metals load to be treated comes from OU 2. Semi-passive treatment would be implemented at 51 additional adits and one seep in OU 3 using either SRBs or lime addition and precipitation. The average flow rate from all sources included in this alternative to semi-passive treatment processes is 1,410 gpm (49 lb/day). Repository drainage would also be treated at the CTP.

This alternative reduces mobility of metals by hydroxide precipitation and adsorption/ precipitation onto media. Treatment effectiveness is expected to be between 80 and greater than 99 percent, depending on the treatment technology. Treatment is considered irreversible for the treated water stream. Treatment residuals (sludge and spent media) would require isolation from low-pH water to remain insoluble. It is assumed that these materials would not be characterized as hazardous wastes and would be disposed of onsite. The total annual volume of treatment residuals associated with Alternative 4+(d) is 15,200 cy/yr.

This alternative satisfies the statutory preference for treatment under CERLCA. The total load removed under Alternative 4+(d) through treatment is $(1,330 \times 0.99) + (49 \times 0.8) = 1,360$ lb/day.

7.3.12.5 Short-Term Effectiveness

[Alternative 4+(d)]
[Combined]

Alternative 4+(d) would involve potentially significant short-term risks to the community and workers from construction traffic. Risks could be minimized through traffic control plans and selective repository siting. There would be limited chemical risks to workers from remediation actions. Risk would be minimized with standard health and safety measures.

This alternative would involve short-term environmental impacts from construction, including re-suspension of sediment and temporary destruction of habitat. These impacts could be minimized and mitigated through engineering controls and revegetation. Impacts would be associated with stream and riparian cleanup actions, extensive excavation, haul road construction and maintenance, construction within floodplains, repository requirements, and potential stream flow reduction through hydraulic isolation actions. Any short-term environmental impacts that do occur during construction should be considered in the context of current water quality in the SFCDR and its tributaries (impacted with metals) and long-term objectives of the remedial action (significantly improved water quality and ecosystem function).

It is estimated that it would take approximately 80 to 130 years[35] to implement the alternative and to achieve RAOs for most source materials.

7.3.12.6 Implementability

[Alternative 4+(d)]
[Combined]

This alternative is considered technically feasible, although construction of the SFCDR stream liners between Mullan and Elizabeth Park may pose significant logistical issues considering the size of the SFCDR and the location near I-90. In some areas, there would be limited access to the SFCDR for large equipment and limited space for onsite screening of materials. The limited space would pose logistical considerations for the SFCDR diversion, which is required for stream liner installation. Diversion of the SFCDR and subsequent liner construction would be performed during lower SFCDR flows in the spring and early summer. Site-specific stream liner design would have to include consideration of the impact of liners on stream hydraulics and existing flood control structures. A design objective of the remedial actions would be to have no negative impact on existing flood control systems. If it is determined that in some areas stream lining cannot be implemented without creating negative impacts on existing flood control structures, then alternative process options would be used (such as slurry walls) to provide the desired degree of hydraulic isolation.

There are no significant technical feasibility concerns with this alternative aside from potential construction challenges related to the hydraulic isolation actions. Specifically, the stream liners and French drains included in the Box would be located within the developed areas of the City of Kellogg. Access for large equipment along with space for stream and river diversion would pose significant logistical considerations.

Significant uncertainties in construction volumes could be handled in the design or construction phase. There are cost and logistical considerations for obtaining borrow materials and excavating in floodplains that would need to be addressed.

The services, equipment, and technologies used are all available at least on a regional level.

7.3.12.7 Cost of Implementation

[Alternative 4+(d)]
[Combined]

Cost estimates for Alternative 4+(d) are summarized as follows:

- Total Capital Cost: $1.81 billion
- O&M Cost: $151 million (30-year NPV); $12.2 million (Annual Average)
- Total Cost (30-year NPV): $1.96 billion

[35] This assumes a rough estimated range of $15 million/yr to $25 million/yr of available annual funding to cover $2.0 billion of capital costs (see Section 7.3.12.7). If funding were not the driving factor, it is estimated that it would require at least 30 years to implement Alternative 4+(d).

7.3.13 Alternative 4+(e)

The individual OU 2 and OU 3 components of Alternative 4+(e) have been addressed in Sections 7.3.8.2 and 7.3.9.1, respectively. These two OU-specific components are not addressed further here. However, the combined Alternative 4+(e) has not been previously addressed with regard to the seven CERCLA threshold and balancing criteria. That evaluation of the combined Alternative 4+(e) is provided below.

7.3.13.1 Overall Protection of Human Health and the Environment

[Alternative 4+(e)]
[Combined]

The estimated reduction in AWQC ratios at Elizabeth Park and Pinehurst based on the results of the Predictive Analysis (Appendix B) is as follows:

	Pre-Remediation AWQC Ratio	Post-Remediation AWQC Ratio
Elizabeth Park (SF-268)	5.5	1.6
Pinehurst (SF-271)	5.2	1.3

Based on the post-remediation AWQC estimates presented above, Alternative 4+(e) would meet the threshold criterion of overall protection of human health and the environment for surface water. This determination is made with the caveat that attainment of site cleanup objectives for surface water would require a period of natural source depletion.

In addition to the expected reduction in AWQC ratios, Alternative 4+(e) would also significantly improve the quality of the riparian and riverine habitat structure, which would also stabilize remaining floodplain sources, thus reducing the potential for direct human and ecological exposures to the most highly contaminated media and reducing contaminant transport via erosion and leachate production.

7.3.13.2 Compliance with ARARs

[Alternative 4+(e)]
[Combined]

The results of the Predictive Analysis indicate that Alternative 4+(e) would meet the threshold criterion of compliance with ARARs for surface water, but only after a period of natural source depletion, which is common to all of the alternatives. Discussions of compliance with other potential ARARs are provided under Alternative 4+ and OU Alternative (e) above.

7.3.13.3 Long-Term Effectiveness and Permanence

[Alternative 4+(e)]
[Combined]

The long-term effectiveness and permanence of Alternative 4+(e) is discussed below in the context of (1) magnitude of risk and (2) adequacy and reliability of controls.

7.3.13.3.1 Magnitude of Residual Risk

[Alternative 4+(e)]
[Combined]

This alternative would result in a high reduction in post-remediation mass loadings (estimated 68 percent reduction). Most sources in OU 3 and OU 2 would be addressed by the alternative components.

Residual risks following implementation would primarily be associated with contaminated media not addressed by the alternative, which would continue to act as a source of metals loading to aquatic environments. Natural source depletion processes would further reduce residual risks.

There would be a low residual risk to humans. Decontamination of structures and access restrictions would be effective.

7.3.13.3.2 Adequacy and Reliability of Controls

[Alternative 4+(e)]
[Combined]

This alternative could effectively be maintained through monitoring, maintenance, and institutional controls. There would be moderate maintenance requirements for caps, stream and riparian cleanup actions, sediment traps, French drains, and stream liners, and there would be relatively high maintenance requirements for semi-passive and active treatment.

Because this alternative would result in metals remaining onsite at concentrations above levels that allow for unlimited use and unrestricted exposure, a review would be conducted at least every 5 years, in accordance with the NCP [300.430(f)(4)(ii)].

7.3.13.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

[Alternative 4+(e)]
[Combined]

This alternative includes active treatment of adit drainages, impoundment closures, and hydraulic isolation areas using hydroxide precipitation as part of the HDS process at the CTP. As shown in Table 7-14, the estimated average flow rate from all sources included in this alternative to CTP would be approximately 16,400 gpm (720 lb/day). The majority of this flow would be from OU 3 with the exception of approximately 2,400 gpm (530 lb/day) from the French drains and extraction wells in OU 2 included in this alternative. Semi-passive treatment would be implemented at 51 additional adits and one seep in OU 3 using either SRBs or lime addition and precipitation. The average flow rate from all sources included in this alternative to semi-passive treatment processes is 1,410 gpm (49 lb/day). Repository drainage would also be treated at the CTP.

This alternative reduces mobility of metals by hydroxide precipitation and adsorption/ precipitation onto media. Treatment effectiveness is expected to be between 80 and greater than 99 percent, depending on the treatment technology. Treatment is considered irreversible for the treated water stream. Treatment residuals (sludge and spent media) would require isolation from low-pH water to remain insoluble. It is assumed that these materials would not be characterized as hazardous wastes and would be disposed of onsite. The total annual volume of treatment residuals associated with Alternative 4+(e) is 13,200 cy/yr.

This alternative satisfies the statutory preference for treatment under CERLCA. The total load removed under Alternative 4+(e) through treatment is (720 × 0.99) + (49 × 0.8) = 752 lb/day.

7.3.13.5 Short-Term Effectiveness

[Alternative 4+(e)]
[Combined]

Alternative 4+(e) would involve potentially significant short-term risks to the community and workers from construction traffic. Risks could be minimized through traffic control plans and selective repository siting. There would be limited chemical risks to workers from remediation actions. Risk would be minimized with standard health and safety measures.

This alternative would involve short-term environmental impacts from construction, including re-suspension of sediment and temporary destruction of habitat. These impacts could be minimized and mitigated through engineering controls and revegetation. Impacts would be associated with stream and riparian cleanup actions, extensive excavation, haul road construction and maintenance, construction within floodplains, repository requirements, and potential stream flow reduction through hydraulic isolation actions. Any short-term environmental impacts that do occur during construction should be considered in the context of current water quality in the SFCDR and its tributaries (impacted with metals) and long-term objectives of the remedial action (significantly improved water quality and ecosystem function).

It is estimated that it would take approximately 90 to 150 years[36] to implement the alternative and to achieve RAOs for most source materials.

7.3.13.6 Implementability

[Alternative 4+(e)]
[Combined]

Alternative 4+(e) is considered to be implementable, although there are considerable logistical concerns that would need to be evaluated. There are challenges associated with the OU 3 components of this alternative, such as hydraulic isolation actions throughout the Upper Basin, including along the SFCDR between Elizabeth Park and Mullan. However, the actions that pose the greatest challenges are in OU 2 [described above as part of the evaluation of OU 2 Alternative (e)]. Remedial components in OU 2 with significant implementability concerns include the SFCDR stream liner, slurry walls in the SFCDR valley floor above Elizabeth Park and in Pinehurst Narrows, and the lining of Bunker Creek (which would exacerbate existing issues with the undersized culvert under I-90). Specifically, the stream liners and French drains included in the Box would be located

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[36] This assumes a rough estimated range of $15 million/yr to $25 million/yr of available annual funding to cover $2.2 billion of capital costs (see Section 7.3.13.7). If funding were not the driving factor, it is estimated that it would require at least 30 years to implement Alternative 4+(e).

within the developed areas of the City of Kellogg. Access for large equipment along with space for stream and river diversion would pose significant logistical considerations. In addition, implementation of this alternative would require diversion of traffic on I-90.

Significant uncertainties in construction volumes could be handled in the design or construction phase. There are cost and logistical considerations for obtaining borrow materials and excavating in floodplains that would need to be addressed.

The services, equipment, and technologies used are all available at least on a regional level.

7.3.13.7 Cost of Implementation

[Alternative 4+(e)]
[Combined]

Cost estimates for Alternative 4+(e) are summarized as follows:

- Total Capital Cost: $2.03 billion
- O&M Cost: $154 million (30-year NPV); $12.4 million (Annual Average)
- Total Cost (30-Year NPV): $2.18 billion

SECTION 8.0

Comparative Analysis of Remedial Alternatives

In this section, the remedial alternatives are compared with one another in terms of the two threshold and five primary balancing evaluation criteria required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The other two CERCLA criteria, state and community acceptance, will be addressed in the Record of Decision (ROD) Amendment for the Upper Coeur d'Alene Basin that will follow public comment on the Proposed Plan.

The purpose of this comparative analysis is to identify the relative advantages and disadvantages of the remedial alternatives in terms of the threshold and primary balancing criteria. This is in contrast to the preceding evaluation, in Section 7.0, in which each alternative is analyzed independently without considering the other alternatives. The comparative analysis is intended to identify the key tradeoffs that decisionmakers must balance in the remedy selection process. It is not the purpose of this analysis to identify a preferred alternative.

The comparative analysis for the No Action Alternative and Alternatives 3+(a) through 3+(e) is provided in Table 8-1a, and the comparative analysis for Alternatives 4+(a) through 4+(e) is provided in Table 8-1b. The following sections summarize the comparative analysis results by criterion.

8.1 Overall Protection of Human Health and the Environment

Protection of human health and the environment is one of two threshold requirements that each alternative must meet in order to be eligible for selection as a remedy (the other being compliance with applicable or relevant and appropriate requirements [ARARs]). All of the alternatives, except the No Action Alternative, would achieve the criterion of overall protection of human health and the environment.

Although this criterion is evaluated as either "meets" or "does not meet", it can be helpful to also look at the different approaches to protectiveness, in that some alternatives may be more favorable than others. For example, all of the alternatives based on Operable Unit 3 (OU 3) Alternative 3+ provide different benefits than those based on OU 3 Alternative 4+, regardless of which OU 2 alternative it is coupled with. Alternative 4+ would involve more risks to workers, the community, and the environment than Alternative 3+, due to the massive extent of long-term construction and hauling involved during the implementation timeframe for Alternative 4+ of 70 to 120 years, that are considered to outweigh the long-term benefits of the proposed actions. Alternative 4+ would also have the greatest short-term environmental effects at off-site locations where borrow materials are obtained. Implementation timeframes are shorter for Alternative 3+ (50 to 80 years) and remedial actions are less extensive and carry fewer risks to workers, the community, and the environment.

A summary of the projected relative effectiveness of all the alternatives, developed using the Predictive Analysis (described in Section 7.3.3), is provided in Table 7-21. The Predictive Analysis was used to estimate the relative effects on surface water quality that may be expected as a result of implementing each alternative. The No Action Alternative is also included in Table 7-21 for comparison purposes. As shown in Table 7-21, Alternative 4+ is estimated to be slightly more effective than Alternative 3+, resulting in a post-remediation ambient water quality criteria (AWQC) ratio of 1.6 in the South Fork of the Coeur d'Alene River (SFCDR) at Elizabeth Park, in comparison with 1.9 for Alternative 3+.

The differences among the OU 2 alternatives under this criterion do not outweigh the differences between Alternatives 3+ and 4+ overall. However, in balancing the overall effectiveness with short-term risks, there are details worth noting, as presented below for each OU 2 alternative.

- **OU 2 Alternative (a).** This alternative includes stream liners in Bunker, Magnet and Deadwood Creeks and on the SFCDR. Installing lining on the SFCDR carries with it risks to the community, workers, and the environment because of the magnitude of the effort (the width of the stream channel, flows requiring diversion, the potential for resuspension of contaminated sediments). SFCDR water would require diversion during implementation. In addition, the SFCDR liner could affect fish habitats because of an increase in water temperature as a result of removing cooler groundwater recharge. OU 2 Alternative (a) has the same predicted effectiveness as OU 2 Alternative (b), with overall dissolved zinc load reductions at Pinehurst of 41 and 45 percent when coupled with OU 3 Alternatives 3+ and 4+, respectively.
- **OU 2 Alternative (b).** This alternative is very similar to OU 2 Alternative (a) except that there is no liner on the SFCDR; the stream liners on Magnet and Deadwood Creeks are longer and include slurry walls and extraction wells at the upstream ends; and there would be a stream liner on Government Creek. Although the lining is extensive, there is no liner on the SFCDR and, as a result, the net short-term risk is expected to be relatively low. The effectiveness of this alternative is estimated to be the same as that of OU 2 Alternative (a) and lower than projected for OU 2 Alternatives (c) and (d), discussed below. OU 2 Alternative (b) is projected to have estimated overall dissolved zinc load reductions of 41 and 45 percent in the SFCDR at Pinehurst when coupled with OU 3 Alternatives 3+ and 4+, respectively. Although the effectiveness of this alternative as estimated for the SFCDR is essentially the same as that for OU 2 Alternative (a), this alternative includes the additional benefit of providing significant improvements in water quality to SFCDR tributaries (Government, Magnet, and Deadwood Creeks).
- **OU 2 Alternative (c)**. This alternative is projected to have the lowest short-term risk because the actions are less extensive than other OU 2 alternatives. The piping of effluent water from the Central Treatment Plant (CTP) to the SFCDR poses very little risk. The French drain along the SFCDR poses some short-term ecological risk, although the length of this drain is less than floodplain construction elements included in other OU 2 alternatives. Further, given that the SFCDR is currently impacted by metals contamination, the short-term risks associated with this alternative are anticipated to be negligible relative to the improvements in water quality that would be achieved. This alternative also has relatively high effectiveness in terms of dissolved zinc load

reduction, with estimated overall reductions in the SFCDR at Pinehurst of 59 and 63 percent when coupled with OU 3 Alternatives 3+ and 4+, respectively.

- **OU 2 Alternative (d)**. OU 2 Alternative (d) is very similar to OU 2 Alternative (c), with the addition of a stream liner, slurry wall, and extraction wells in Government Gulch. Like OU 2 Alternative (c), this alternative also has relatively high effectiveness, with estimated overall dissolved zinc load reductions in the SFCDR at Pinehurst of 60 and 65 percent when coupled with OU 3 Alternatives 3+ and 4+, respectively. Projected effectiveness in the SFCDR is only slightly higher for OU 2 Alternative (d) relative to OU 2 Alternative (c), although the additional improvements in water quality in Government Creek that would be achieved would be significant. In addition, the actions in Government Creek are expected to be more effective under high flow conditions than the groundwater actions in the SFCDR valley would be.
- **OU 2 Alternative (e).** This is the most extensive OU 2 alternative, with stream lining of nearly all surface water bodies through the Box. Construction of this alternative would be conducted within populated areas of Kellogg. Much of the work would be conducted within stream beds, potentially resulting in substantial risks to the environment during implementation. However, these risks to the environment must be considered in the context of current water quality in the SFCDR, which is estimated to be, on an average annual basis, 5.2 times the AWQC at Pinehurst. As with OU 2 Alternative (a), the stream liner on the SFCDR could affect fish habitats due to an increase in water temperature as a result of removing cooler groundwater recharge. Effectiveness is high for this alternative—the estimated overall dissolved zinc load reductions in the SFCDR at Pinehurst are 63 and 68 percent when coupled with OU 3 Alternatives 3+ and 4+, respectively. However, it is not significantly higher than that for OU 2 Alternatives (c) and (d). Compared to other OU 2 Alternatives, OU 2 Alternative (e) carries with it significantly higher short-term risks and technical and administrative challenges associated with implementation, which are discussed below in Section 8.6.

8.2 Compliance with ARARs

Compliance with ARARs is the second threshold requirement that each alternative must meet in order to be eligible for selection as a remedy. All of the alternatives would achieve the criterion of compliance with ARARs.

Federal and state AWQC, and federal drinking water maximum contaminant levels (MCLs) and state drinking water standards are the primary chemical-specific potential ARARs for protection of surface water. The AWQC are used as an indication of compliance with surface water ARARs because, in general, the AWQC are lower than the MCLs and state drinking water standards for site contaminants of concern. The Predictive Analysis was used to estimate the effects on surface water quality that may be expected as a result of implementing each alternative based on the estimated post-remediation AWQC ratio (the ratio of dissolved zinc concentration to the sample-specific AWQC). Compliance with ARARs is considered to be met when the AWQC ratio is 1 or less. The results of the Predictive Analysis indicate that all of the action alternatives would meet the threshold criterion of compliance with ARARs for surface water, but only after a natural source depletion period, which is common to all of the alternatives. The relative period of time required between alternatives is expected to be related to the water quality improvement achieved.

The results of the Predictive Analysis are provided in Table 7-21 for the SFCDR at both Elizabeth Park and Pinehurst. The results below are summarized for Pinehurst, which is considered representative of the Upper Basin as a whole, as it is located at the downstream end of the Bunker Hill Box (which coincides closely with the downstream end of the Upper Basin).

Alternative	Estimated Post-Remediation AWQC Ratio for Dissolved Zinc at Pinehurst
Alternative 4+(e)	1.3
Alternative 3+(e)	1.5
Alternative 4+(d)	1.5
Alternative 4+(c)	1.6
Alternative 3+(d)	1.7
Alternative 3+(c)	1.8
Alternative 4+(b)	2.8
Alternative 4+(a)	2.8
Alternative 3+(a)	2.9
Alternative 3+(b)	3.0
No Action Alternative	5.2

It should be noted that post-remediation AWQC ratios could be lower or higher at some locations upstream of Pinehurst, and it is expected that dramatic localized improvements would be seen in some areas resulting from remedial actions in specific tributaries and watersheds in the SFCDR.

As with the overall protectiveness criterion, although this criterion is evaluated as either "meets" or "does not meet", it can be helpful to also look at the differences between the initial effectiveness of each alternative in the progress towards meeting surface water quality standards (i.e., an AWQC of 1 or less). Based on the Predictive Analysis, it appears that post-remedial AWQC ratios in the SFCDR at Pinehurst are more affected by the differences in the components of OU 2 Alternatives (a) through (e), than by the differences between OU 3 Alternatives 3+ and 4+. The alternatives with the more aggressive groundwater actions in OU 2 would be expected to achieve surface water ARARs sooner than the remaining alternatives.

Preliminary remediation goals (PRGs) for soil, sediment, and source materials would be met following implementation of the remedy in locations where remedial actions are taken under all of the alternatives. Alternatives including OU 3 Alternative 4+ would remediate a greater volume of soil, sediment, and source materials than alternatives including OU 3 Alternative 3+.

The flux of contaminated groundwater to surface water would be significantly reduced under all alternatives, although more so under OU 2 Alternatives (c), (d), and (e), than it would under OU 2 Alternatives (a) and (b). However, given the pervasive nature of the subsurface contamination, achieving drinking water standards in groundwater may not be achieved in all locations.

Each of the action-oriented alternatives could be implemented in compliance with location-specific and action-specific ARARs. However, fulfilling substantive permit requirements of action- and location-specific ARARs for siting and construction of repositories and obtaining borrow materials may be difficult, particularly for OU 3 Alternative 4+ actions. Each of the alternatives would be implemented to meet requirements for federal agencies under Section 7 of the Endangered Species Act (ESA). The ESA requires that the actions be protective of critical habitat for several species in the Coeur d'Alene Basin.

Because the No Action Alternative does not meet the threshold criteria of overall protection of human health and the environment or compliance with ARARs, it is eliminated from further consideration and is not included for comparison in the following sections that discuss the remaining evaluation criteria.

8.3 Long-Term Effectiveness and Permanence

All of the alternatives based on OU 3 Alternative 4+ rank slightly higher under this criterion than those based on OU 3 Alternative 3+, regardless of which OU 2 alternative it is coupled with. Alternative 4+ affords the highest degree of long-term effectiveness and permanence and would result in the lowest residual risks to ecological receptors. Potentially unacceptable human health risks would effectively be addressed by cleanup actions. Residual mass loadings would be associated with contaminated media left in place (primarily inaccessible floodplain sediments and active tailings impoundments) and the resulting ongoing contamination of groundwater. Hydraulic isolation and treatment of groundwater would greatly reduce this residual risk. High-performance repositories included in Alternative 4+ would be very effective in reducing leachate generation but would require maintenance to remain effective. Stream and riparian cleanup actions included in Alternative 4+ are expected to have the highest likelihood of long-term success.

Alternative 4+ includes the greatest amount of contaminated sediment removals (known and accessible sediments with concentrations above PRGs) and extensive use of bioengineered/vegetated bank stabilization (addressing 300,000 feet of shoreline), current deflectors, and off-channel hydrologic units (210 acres). These actions are expected to result in more rapid and permanent improvements in stream channel stability and subsequent recovery of physical habitat structure, compared to the other alternatives. The resulting ecosystem under Alternative 4+ would be more resilient in recovering from extreme disruptions such as drought or flooding. Stream channel migration over time (and resulting mobilization of contaminated sediments through erosion) would pose the smallest risk under Alternative 4+ because all accessible contaminated alluvium would be removed. As a result of the extensive removals included in Alternative 4+, particulate transport of contaminants would be substantially reduced and periodic dredging of sediment traps would not be required.

Alternative 4+ has the highest overall operation and maintenance (O&M) requirements, primarily because it requires the most extensive O&M of repositories and active and semi-passive water treatment systems. The stream and riparian cleanup actions under Alternative 4+ are expected to have lower long-term maintenance requirements compared to Alternative 3+. However, until the vegetation becomes established, the short-term O&M requirements of the stream and riparian cleanup actions would be somewhat greater than under Alternative 3+.

Alternative 4+ has a higher degree of permanence than Alternative 3+ as a result of the much higher volumes of contaminated materials that would be removed as sources of loading from the system and managed in repositories.

The differences in ranking among the OU 2 alternatives under this criterion do not outweigh the differences between OU 3 Alternatives 3+ and 4+. The ranking of OU 2 alternatives under this criterion is (e), (d), (c) (a), and (b). This ranking is based on the relative differences in post-remedial dissolved zinc load in the SFCDR at Pinehurst. Each OU 2 alternative is discussed below in terms of this criterion.

- **OU 2 Alternative (e).** This is the most extensive OU 2 alternative, with stream lining of nearly all surface water bodies through the Box. Effectiveness is very high for this alternative: the overall dissolved zinc load reductions for this alternative in the SFCDR at Pinehurst are 63 and 68 percent when coupled with Alternatives 3+ and 4+, respectively, and residual risk is low.
- **OU 2 Alternative (d)**. This alternative has relatively high effectiveness, with overall dissolved zinc load reductions in the SFCDR at Pinehurst of 60 and 65 percent when coupled with Alternatives 3+ and 4+, respectively. Residual risks associated with this alternative would be relatively low.
- **OU 2 Alternative (c)**. This alternative also has relatively high effectiveness in terms of dissolved zinc load reduction, with overall reductions in the SFCDR at Pinehurst of 59 and 63 percent when coupled with Alternatives 3+ and 4+, respectively. Residual risks associated with this alternative would be relatively low.
- **OU 2 Alternatives (a) and (b).** These alternatives have relatively low effectiveness, with overall dissolved zinc load reductions in the SFCDR at Pinehurst of 41 and 45 percent when coupled with Alternatives 3+ and 4+, respectively. Residual risks associated with this alternative would be relatively high.

In summary, the ranking of alternatives under the criterion of long-term effectiveness and permanence is as follows:

1. Alternative 4+(e)
2. Alternative 4+(d)
3. Alternative 4+(c)
4. Alternative 4+(a) and 4+(b)
5. Alternative 3+(e)

6. Alternative 3+(d)
7. Alternative 3+(c)
8. Alternatives 3+(a) and 3+(b)

8.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Under this criterion, the alternatives are analyzed and ranked on the basis of the degree of reduction of toxicity, mobility, or volume of hazardous substances through treatment. The only type of treatment included in any of the alternatives is water treatment. Both semi-passive and active treatment processes are used as part of each of the 10 action-oriented remedial alternatives; therefore, all 10 action alternatives are considered to satisfy the statutory preference for treatment. Both semi-passive and active processes have a high expected effectiveness: approximately 80 percent for semi-passive systems, and an estimated greater than 99 percent for active treatment at the CTP. All the water treatment technologies included in the alternatives are considered irreversible for the water stream. Water treatment residuals would have the potential to leach metals back into the environment if not properly disposed of and isolated from water sources. It is assumed that all treatment residuals will be disposed of properly onsite. Semi-passive treatment technologies included in the alternatives are sulfate-reducing bioreactors (SRBs) and lime addition with settling. Additional semi-passive treatment technologies (such as a limestone permeable reactive barrier [PRB] in OU 2) may also be employed during the design and implementation phases if further consideration proves favorable.

Treatment residuals would include spent media from the SRBs and hydroxide sludge from active treatment at the CTP, the post-SRB aeration ponds, and the settling ponds associated with the lime addition systems. The quantity and composition of these treatment residuals will depend on treated water flow rates, influent metals loads and concentrations, general water chemistry parameters, and the lime demand and solids formed for each process. The estimated volumes of treatment residuals for OU 3 Alternatives 3+ and 4+ based on average flows are similar; 9,100 cubic yards per year (cy/y) for Alternative 3+ (8,900 cy/y from active treatment at the CTP and 190 cy/y from semi-passive treatment) compared with 10,200 cy/y for Alternative 4+ (9,900 cy/y for active treatment at the CTP and 330 cy/y for semi-passive treatment). Depending which OU 2 alternative the OU 3 alternatives are coupled with, these estimates increase or decrease by no more than 5,000 cy/y (from additional flow treated at the CTP, see Table 7-14).

Flows and loads for active and semi-passive water treatment are presented in Tables 7-3 and 7-5 for Alternatives 3+ and 4+, respectively. Estimated average and maximum flow rates and dissolved zinc loads treated at the CTP under each of the 10 action alternatives are presented in Table 7-13. Although Alternative 4+ includes a significantly higher number of water sources for active treatment at the CTP than Alternative 3+, the total flow treated is only slightly higher (average annual flow of 14,000 gallons per minute [gpm] for Alternative 4+ compared with 11,500 gpm for Alternative 3+) because many of the adits treated under Alternative 4+ only are relatively low-flow. Despite this increase in flow under Alternative 4+, the total load removed through treatment on an annual average basis is lower for Alternative 4+ (180 pounds per day for active treatment and 49 pounds per day for semi-passive treatment) than it is for Alternative 3+ (290 pounds per day for active treatment and 47 pounds per day for semi-passive treatment). Therefore, Alternative 3+ provides more efficient mass removal through treatment than Alternative 4+ does, by treating a lower volume, yet removing more contaminant mass.

The difference in water treatment flows and loads between the two alternatives is due to a combination of the decrease in the need to capture groundwater and the collection of a higher number of lower concentration sources under Alternative 4+. Less groundwater is projected for collection under Alternative 4+ because this alternative seeks to excavate and dispose of all accessible contaminated floodplain sediments, which would significantly reduce metals loading to groundwater in alluvial areas, thereby reducing or eliminating the need to collect and treat groundwater, other than in the Box. Alternative 4+ also includes a significantly higher number of water sources for semi-passive treatment than Alternative 3+, as reflected in a total average flow for semi-passive treatment for Alternative 4+ (1,410 gpm) being almost twice that of Alternative 3+ (800 gpm). However, the total dissolved zinc loads do not follow this trend and are very similar (47 pounds per day [lb/day] in Alternative 3+ and 49 lb/day in Alternative 4+). This is because many low concentration sources are included in Alternative 4+ that are not included in Alternative 3+.

All the remedial alternatives are considered to satisfy the statutory preference for treatment. The ranking of alternatives for this criterion is based on the dissolved zinc load removed from the system through water treatment, based on an estimated 80 percent effectiveness for semi-passive treatment and greater than 99 percent effectiveness for active treatment. Because the total dissolved zinc loads removed are so similar for semi-passive treatment in Alternative 3+ and 4+ the ranking is ultimately based on the total load actively treated at the CTP for each of the combined alternatives (Table 7-13). The ranking of alternatives under the criterion of reduction of toxicity, mobility, or volume through treatment is presented below. Note that none of the volumes include ongoing treatment of Bunker Hill mine water at the CTP, and that each of the total flows presented represent a combination of flows from adit drainages, seeps, and groundwater.

1. **Alternative 3+(c).** Under Alternative 3+(c), on average, approximately 1,450 lb/day of dissolved zinc would be treated at the CTP.
2. **Alternative 3+(d).** Under Alternative 3+(d), on average, approximately 1,430 lb/day of dissolved zinc would be treated at the CTP.
3. **Alternative 4+(c).** Under Alternative 4+(c), on average, approximately 1,350 lb/day of dissolved zinc would be treated at the CTP.
4. **Alternative 4+(d).** Under Alternative 4+(d), on average, approximately 1,330 lb/day of dissolved zinc would be treated at the CTP.
5. **Alternative 3+(e).** Under Alternative 3+(e), on average, approximately 820 lb/day of dissolved zinc would be treated at the CTP.
6. **Alternative 4+(e).** Under Alternative 4+(e), on average, approximately 720 lb/day of dissolved zinc would be treated at the CTP.
7. **Alternative 3+(b).** Under Alternative 3+(b), on average, approximately 287 lb/day of dissolved zinc would be treated at the CTP.

8. **Alternative 3+(a).** Under Alternative 3+(a), on average, approximately 287 lb/day of dissolved zinc would be treated at the CTP.
9. **Alternative 4+(b).** Under Alternative 4+(b) on average, approximately 184 lb/day of dissolved zinc would be treated at the CTP.
10. **Alternative 4+(a).** Under Alternative 4+(a), on average, approximately 184 lb/day of dissolved zinc would be treated at the CTP.

8.5 Short-Term Effectiveness

This criterion addresses the potential short-term negative impacts (to the community, workers, and the environment) associated with remedial construction, including the time required to complete the remedial actions, and the time required to achieve remedial action objectives (RAOs). Often, an alternative involving more extensive construction will pose more short-term risks but may achieve RAOs faster, compared to an alternative comprising less action. For this reason, the contribution of this criterion to the overall ranking of the alternatives is complex.

All of the alternatives based on OU 3 Alternative 3+ rank slightly higher under this criterion than those based on OU 3 Alternative 4+ because Alternative 4+ would pose greater short-term negative impacts during construction than Alternative 3+, regardless of which OU 2 alternative it is coupled with. This is primarily due to the extensive nature of the remedial actions that will be conducted under Alternative 4+, which would require a much longer time period to complete. Alternative 3+ does include sediment traps as part of the stream and riparian cleanup actions, while Alternative 4+ does not. Periodic dredging of these sediment traps could result in short-term environmental impacts. However, these impacts are not estimated to be significant enough as to outweigh the impacts from Alternative 4+ overall. The ranking of the OU 2 alternatives from highest to lowest short term effectiveness is as follows: (d), (c), (b), (a), and (e). This ranking is based on a balance of implementation time, effectiveness, and short-term risks. Each OU 2 alternative is described with respect to this criterion as follows:

- **OU 2 Alternative (d)**. This alternative is projected to have the highest short-term effectiveness. OU 2 Alternative (d) is very similar to OU 2 Alternative (c), with the addition of stream lining, a slurry wall, and extraction wells in Government Gulch. The additional action in Government Gulch would likely result in Government Creek achieving ARARs immediately following completion of the remedial action. Although there is some additional short-term risk to workers, the community, and, to a lesser extent, the environment with this alternative compared with OU 2 Alternative (c), achieving ARARs for Government Creek outweighs the additional risk of the action.
- **OU 2 Alternative (c)**. This alternative is similar to OU 2 Alternative (d) as estimated by the post-remediation AWQC ratio for the SFCDR, but would not have the added benefit of improving water quality in Government Creek as OU 2 Alternative (d) would. The piping of CTP effluent to the SFCDR poses very little risk. The French drain along the SFCDR would pose some risk to workers and the community from construction traffic, although the length of this drain is less than floodplain construction elements included in other OU 2 alternatives.

- **OU 2 Alternative (b).** This alternative includes stream lining of tributaries on the south side of the SFCDR. Although the lining is extensive, there is no lining on the SFCDR and the net short-term risk is expected to be relatively low compared with alternatives that include SFCDR lining [OU 2 Alternatives (a) and (e)]. However, the effectiveness of this alternative is relatively low. The estimated post-remediation AWQC ratio for OU 2 Alternative (b) is approximately two times higher than that estimated for OU 2 Alternatives (d) and (c).
- **OU 2 Alternative (a).** This alternative is very similar to OU 2 Alternative (b), except there are no actions for Government Gulch and the liners on Magnet and Deadwood Creeks are much shorter. In addition, OU 2 Alternative (a) includes a stream liner on the SFCDR. Installing a liner on the SFCDR carries with it much greater risks to the community, workers, and the environment than installing a liner on a tributary would. SFCDR water and traffic along Interstate 90 would require diversion during implementation. The estimated effectiveness of this alternative is relatively low and essential equal to that for OU 2 Alternative (b).
- **OU 2 Alternative (e).** This is the most extensive OU 2 alternative, with stream lining of nearly all surface water bodies through the Box. Construction of this alternative would be conducted within populated areas of Kellogg. Much of the work would be conducted within stream beds, with the exception of the French drains, which would be off-set from the stream beds, potentially resulting in substantial risks to the environment during implementation.

In summary, the ranking of the alternatives under the criterion of short-term effectiveness is as follows: [1]

1. **Alternative 3+(d).** It is estimated that it would take approximately 50 to 90 years to implement the alternative and to achieve RAOs for most source materials. Following implementation of remedial actions, the AWQC ratio is estimated at 1.7 in the SFCDR at Pinehurst.
2. **Alternative 3+(c).** It is estimated that it would take approximately 50 to 90 years to implement the alternative and to achieve RAOs for most source materials. Following implementation of remedial actions, the AWQC ratio is estimated at 1.8 in the SFCDR at Pinehurst.
3. **Alternative 3+(b).** It is estimated that it would take approximately 50 to 90 years to implement the alternative and to achieve RAOs for most source materials. Following implementation of remedial actions, the AWQC ratio is estimated at 3.0 in the SFCDR at Pinehurst.
4. **Alternative 3+(a).** It is estimated that it would take approximately 50 to 90 years to implement the alternative and to achieve RAOs for most source materials. Following implementation of remedial actions, the AWQC ratio is estimated at 2.9 in the SFCDR at Pinehurst.

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[1] Implementation times assumes a rough estimated range of $15M/yr to $25M/yr of available annual funding to cover the capital and O&M costs of the alternatives.

5. **Alternative 3+(e).** It is estimated that it would take approximately 60 to 100 years to implement the alternative and to achieve RAOs for most source materials. Following implementation of remedial actions, the AWQC ratio is estimated at 1.5 in the SFCDR at Pinehurst.
6. **Alternative 4+(d).** It is estimated that it would take approximately 80 to 130 years to implement the alternative and to achieve RAOs for most source materials. Following implementation of remedial actions, the AWQC ratio is estimated at 1.5 in the SFCDR at Pinehurst.
7. **Alternative 4+(c).** It is estimated that it would take approximately 80 to 130 years to implement the alternative and to achieve RAOs for most source materials. Following implementation of remedial actions, the AWQC ratio is estimated at 1.6 in the SFCDR at Pinehurst.
8. **Alternative 4+(b).** It is estimated that it would take approximately 80 to 130 years to implement the alternative and to achieve RAOs for most source materials. Following implementation of remedial actions, the AWQC ratio is estimated at 2.8 in the SFCDR at Pinehurst.
9. **Alternative 4+(a).** It is estimated that it would take approximately 80 to 130 years to implement the alternative and to achieve RAOs for most source materials. Following implementation of remedial actions, the AWQC ratio is estimated at 2.8 in the SFCDR at Pinehurst.
10. **Alternative 4+(e).** It is estimated that it would take approximately 90 to 150 years to implement the alternative and to achieve RAOs for most source materials. Following implementation of remedial actions, the AWQC ratio is estimated at 1.3 in the SFCDR at Pinehurst.

8.6 Implementability

All of the alternatives based on OU 3 Alternative 3+ rank higher under this criterion than those based on OU 3 Alternative 4+, because Alternative 4+ would have substantially increased technical and administrative feasibility considerations compared to Alternative 3+.

Alternative 4+ has generally the same types of implementability considerations as Alternative 3+, but with much larger quantities. Alternative 4+ has significant technical feasibility considerations with respect to the capacity of existing roads to accommodate the volumes of waste and construction material that would be transported. In addition, excavation of large quantities of saturated sediment from below the water table would be required. Dewatering would be associated with excavation below the water table, and disposal and/or treatment of water would be an implementability consideration. These implementability concerns are greater under Alternative 4+ than under Alternative 3+ because of the extensive scope and depth of sediment removals. Deeper excavations, if required, would increase the dewatering difficulties. Further, Alternative 4+ relies on semi-passive treatment to a greater degree than does Alternative 3+. The ability of semi-passive treatment options to consistently meet discharge standards throughout the full range of seasonal conditions is uncertain and will require further study.

Alternative 4+ would also pose greater administrative difficulties than Alternative 3+. The ability to acquire land, fulfill substantive permit requirements, and obtain local agency concurrence and community acceptance for siting repositories under Alternative 4+ would be more difficult than under Alternative 3+ because of the greater volume of materials to be disposed of (approximately 13 million cy) compared to Alternative 3+ (2.5 million cy). Similarly, difficulties with obtaining access to areas targeted for remediation would be greater under Alternative 4+. Siting and permitting of a minimum of about 200 acres would be required for the repositories. Siting and construction of dedicated haul roads may be required in canyons and in sediment removal areas. Siting requirements for active water treatment pipelines would be similar to those under Alternative 3+. The availability of borrow materials would present substantial technical and administrative implementability concerns under Alternative 4+, which requires a minimum of 3.4 million cy of borrow materials, and potentially up to 13 million cy. The logistics of obtaining backfill, capping materials, and growth media would therefore be higher under Alternative 4+.

Both Alternatives 3+ and 4+ rely on the use of stream liners on the SFCDR and other tributaries. The implementation of these actions could pose significant technical and administrative implementability issues. Impacts to fisheries (through changes in water temperature and habitat) and existing flood control systems would need to be carefully studied such that the actions could be implemented without adverse environmental impacts. Other hydraulic isolation process options (such as slurry walls) may be used in some cases in place of the stream liners if needed to avoid these implementation challenges.

For all the remedial alternatives, excavation of sediments within the floodplain may require dewatering of the excavation site to improve workability. Excavation below the water table would require dewatering (probably using common construction techniques of pit and ditch sumps with pumping). The extracted groundwater may have to be infiltrated back into the ground and/or treated to comply with discharge requirements. Commensurate with the degree to which the alternatives include excavation within the floodplain, this would increase the construction difficulty and logistical considerations.

The ranking of the OU 2 alternatives from most to least desirable on the basis of implementability is as follows: (c), (d), (b), (a), and (e). Implementability concerns associated with each OU 2 alternative are outlined below.

- **OU 2 Alternative (c)**. This alternative is projected to have the fewest implementability concerns because the actions are less extensive than under the other OU 2 alternatives. The piping of CTP effluent to the SFCDR is implementable. The French drain along the SFCDR does pose some technical and administrative feasibility challenges: dewatering and associated water treatment would be required during construction, and siting and access would need to be negotiated with property owners.

- **OU 2 Alternative (d)**. This alternative is very similar to OU 2 Alternative (c), with the addition of stream lining, a slurry wall, and extraction wells in Government Gulch, which would pose some additional technical and administrative feasibility considerations relative to OU 2 Alternative (c).

- **OU 2 Alternative (b).** This alternative includes stream lining of tributaries to the SFCDR but no lining of the SFCDR. Although the proposed stream lining is extensive under this alternative, there would be no liner on the SFCDR, which improves the technical feasibility considerably.
- **OU 2 Alternative (a).** This alternative is very similar to OU 2 Alternative (b), except there are no actions for Government Gulch) while there is liner on the SFCDR. Installing a liner on the SFCDR carries with it much greater implementability concerns. SFCDR water and traffic along Interstate 90 would require diversion during implementation.
- **OU 2 Alternative (e).** This is the most extensive OU 2 alternative, with stream lining of nearly all surface water bodies through the Box. Administrative and technical feasibility concerns with this alternative are relatively high. All of the work would be conducted within stream beds, requiring extensive dewatering and associated water treatment. Installation of the slurry wall across the SFCDR would require drilling through Interstate 90, during which time traffic on the interstate would need to be re-routed.

In summary, the ranking of alternatives under the criterion of implementability is as follows:

1. Alternative 3+(c)
2. Alternative 3+(d)
3. Alternative 3+(b)
4. Alternative 3+(a)
5. Alternative 3+(e)
6. Alternative 4+(c)
7. Alternative 4+(d)
8. Alternative 4+(b)
9. Alternative 4+(a)
10. Alternative 4+(e)

8.7 Cost

Table 8-2 summarizes the total capital, O&M (30-year net present value [NPV] and annual average), and total (30-year NPV) costs for each of the alternatives. Costs are presented for the OU 3 components, the OU 2 components, and the complete alternative. NPV costs are based on a 30-year planning period and a discount rate of 7 percent. The costs listed in Table 8-2 are in 2009 dollars, do not include future escalation, and assume that all construction occurs in year 1. These feasibility-level (-30/+50%) cost estimates have been prepared for guidance in project evaluation from the information available at the time of preparation. The final costs of the project will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, the final project scope, the final project schedule and other variable factors. As a result, the final project costs will vary from those presented above. Additional information about costs, including the basis for the unit costs used to develop alternative costs, is provided in Section 5.0 and Appendix D.

Estimated costs for alternatives based on Alternative 4+ are consistently higher than those based on Alternative 3+, regardless of which OU 2 alternative it is coupled with. The OU 2 costs are relatively small, ranging from 1 to 20 percent of the total alternative cost. For each alternative, Figure 8-1 depicts the relationship between the total cost (30-year NPV) and the predicted post-remediation AWQC ratio in the SFCDR at Pinehurst.

The ranking of alternatives on the basis of total cost (30-year NPV) as presented in Table 8-2, from lowest to highest, is as follows:

1. Alternative 3+(b)
2. Alternative 3+(c)
3. Alternative 3+(d)
4. Alternative 3+(a)
5. Alternative 3+(e)
6. Alternative 4+(b)
7. Alternative 4+(c)
8. Alternative 4+(d)
9. Alternative 4+(a)
10. Alternative 4+(e)

SECTION 9.0

Development and Evaluation of Remedy Protection Alternatives

This section documents the development and evaluation of remedy protection alternatives for the Upper Basin of the Coeur d'Alene River portion of the Bunker Hill Mining and Metallurgical Complex Superfund Site (referred to hereafter as the Bunker Hill Superfund Site). The remedy protection alternatives for Operable Units (OUs) 1, 2, and 3 focus on the soil portion of the Selected Human Health Remedies (the "Selected Remedies") (U.S. Environmental Protection Agency [USEPA], 1991a, 1992, 2002b).

9.1 Introduction

The final Selected Human Health Remedies for OUs 1, 2, and 3 that have been implemented to date have functioned as designed and are protective of human health, as documented in the Five-Year Review Reports prepared for the Bunker Hill Superfund Site (USEPA, 2000a, 2000d, 2005b). USEPA is aware of certain circumstances, however, that have the potential to, and in limited circumstances have already (e.g., Milo Creek area in 1997), adversely impacted the successful long-term effectiveness and permanence of the barriers (clean caps made of materials such as gravel, soil, pavement, etc.), which were installed as part of the residential soils portion of the Selected Remedies. These circumstances include inadequate infrastructure to effectively convey floodwater and surface water through communities without damaging the Selected Remedies. Protective barriers have been installed as part of the Selected Remedies to prevent direct contact exposure to mining-related contaminants. Long-term maintenance of these barriers is a key component to the success of the Selected Remedies (USEPA, 1991a, 1992, 2002b).

Protection of human health continues to be a vital part of USEPA's work at the Bunker Hill Superfund Site. This section evaluates the potential for recontamination of in-place barriers within communities located in the Upper Basin of the Coeur d'Alene River (Upper Basin) area of the Bunker Hill Superfund Site and the potential risk to the long-term permanence of the Selected Human Health Remedies for OUs 1, 2, and 3. For the purposes of this evaluation, the Upper Coeur d'Alene Basin (or the Upper Basin) includes the South Fork Coeur d'Alene River (SFCDR), its tributaries, and the area of Kingston that extends approximately 1 mile downstream from the confluence of the SFCDR with the Coeur d'Alene River (see Figure 1-2 in Section 1.0). Other components of the Selected Human Health Remedies, such as interior cleaning or recreational area cleanup, are not included in this evaluation. Evaluating portions of the Selected Remedies is consistent with USEPA's adaptive management approach to the Bunker Hill Superfund Site, which involves identifying and evaluating remedy modifications and making adjustments to the cleanup approach through design, implementation, or decision documents as appropriate when needed based on new information.

9.1.1 Purpose and Scope

In accordance with USEPA guidance for feasibility studies (USEPA, 1988b), this section documents the development and evaluation of the remedy protection alternatives, whose purpose is to maintain or increase the long-term effectiveness and permanence of the soil portion of the Selected Human Health Remedies in OUs 1, 2, and 3 of the Bunker Hill Superfund Site. The remedy protection alternatives evaluated in this section focus on localized flooding and high precipitation events that may impact human health and the environment by eroding clean barriers or contaminating clean areas, thereby making contaminated soil and gravel potentially available for direct contact by and increased risk to people.

Section 1.0 of this Focused Feasibility Study (FFS) Report lists issues that are not addressed in this report, including the following:

- Potential flood damage to implemented remedial actions that may be caused by future flooding of the SFCDR or Pine Creek
- Potential future exposure to contaminated materials that are beneath existing paved roadways
- Actions to upgrade sanitary sewer lines to prevent infiltration of contaminated groundwater into local sanitary sewer treatment systems
- Actions to address contamination in the Lower Coeur d'Alene River Basin.

This FFS Report includes alternatives for remedial actions at specific locations and remedy protection actions identified for specific locations that are intended to enhance the long-term protectiveness of the cleanup. As used in this FFS Report, "remedy protection" is focused on keeping clean areas clean by addressing uncontrolled overland water flow from tributary flooding, rain storms, and rapid snowmelt runoff that can erode clean barriers or leave behind contaminated sediments. This approach is consistent with one of the primary goals of the human health cleanup, which is to create barriers that are durable and protective of human health.

The remedy protection measures addressed in this FFS Report are in direct response to the types of barrier damage observed in communities from frequent high precipitation events, as well as certain recommendations included in National Academy of Sciences (NAS) (2005). These remedy protection measures will enhance the long-term protectiveness of the implemented human health remedy. USEPA and the Idaho Department of Environmental Quality (IDEQ) have incorporated local drainage control into past remedial activities on a site-by-site basis to ensure that the remedy remains viable, but potential damage to a large portion of the remedy from major flooding has not been addressed.

During its Five-Year Reviews of the completed portions of the Selected Remedies, USEPA evaluated the risks of flooding and related threats to the remedies and recommended follow-up actions, which resulted in the evaluation of the remedy protection alternatives in this FFS Report. USEPA will continue to evaluate such risks to the Selected Remedies in future Five-Year Reviews.

9.1.2 Current Status of the Soil Portion of the Selected Human Health Remedies

This section includes a general description of the Selected Remedies that have been implemented at the Bunker Hill Superfund Site and a summary of the documented effectiveness and permanence of the existing Selected Remedies.

9.1.2.1 Description of the Soil Portion of the Selected Human Health Remedies

Implementation of the Selected Remedies began following the Record of Decision (ROD) for OU 1 (USEPA, 1991a), and progressed into OU 2 and OU 3 after issuance of the RODs for OU 2 and OU 3 in 1992 and 2002, respectively (USEPA, 1992, 2002b). As described in Section 2.0 of this FFS Report, the soil portion of the Selected Remedies includes the installation of protective barriers in public use and recreational areas, residential yards, driveways, and road shoulders. Typically, these barriers consist of the excavation of contaminated material up to 12 inches deep, the placement of a visual barrier (geotextile fabric), and placement of clean material (gravel, sod, pavement, etc.) to meet existing grade. The Selected Remedies also include development and implementation of a local Institutional Controls Program (ICP) to ensure that protective barriers are maintained over time and that safe waste disposal is available for local development projects.

The RODs for OUs 1 and 2 (USEPA, 1991a, 1992) relied on each community to maintain and/or improve infrastructure. These RODs did not address issues associated with flood or precipitation events resulting from inadequate or deteriorating conveyance systems or surface water controls. The ROD for OU 3 included some provisions, based on the implementation of the Selected Remedies in OU 1 and OU 2, for addressing issues of recontamination or degradation of the protective barrier (Part 2, USEPA, 2002b).

The majority of the Selected Remedies for human health have been implemented throughout OU 1 and OU 2. The human health remedies for OU 3 have been implemented in many Upper Basin communities; however, cleanup has not yet been completed at all property parcels. Table 9-1 summarizes the number of parcels that have been remediated in each community through 2008. Appendix G provides graphic representations of the communities and watersheds throughout the Upper Basin, showing the property parcels that have been remediated as of 2008 (see Attachment G-2 in Appendix G).

9.1.2.2 Human Health Barrier Effectiveness and Permanence

The purpose of a Five-Year Review Report is to evaluate the implementation and performance of a remedy to determine whether it is and will remain protective of human health and the environment (USEPA, 2001a). A Five-Year Review Report also provides a means for identifying issues or problems with the remedy and recommendations to ensure the long-term effectiveness and permanence of the remedy.

In 2000, Five-Year Review Reports were completed for both the populated (OU 1) and the non-populated (OU 2) operable units (USEPA, 2000a, 2000d). In 2005, the Second Five-Year Review Report was completed that included OU 1, OU 2, and OU 3 (USEPA, 2005b). Their key findings related to the soil portion of the Selected Remedies, as listed below.

2000 Five-Year Review Report: OU 1 Populated Areas Operable Unit (USEPA, 2000a):

- The remedy being implemented in the populated areas OU is protective of human health and the environment.
- The lack of drainage maintenance by local entities and the need for infrastructure improvements have resulted in recurrent flooding in many areas.
- The lack of road maintenance and the need to replace failing road infrastructure has exposed underlying contaminated material in several areas.
- Contaminated materials resulting from hillside erosion have been deposited into residential areas.

2000 Five-Year Review Report: OU 2 Non-Populated Area Operable Unit (USEPA, 2000d):

- The remedy being implemented in the non-populated area OU is expected to be protective of human health and the environment upon completion.
- There is a need to assess additional access control to hillsides and gulches.
- Inspection of catchment wall areas is needed in Smelterville and Wardner to determine whether additional action is necessary to prevent recontamination of remediated yards.

2005 Second Five-Year Review for Operable Units 1, 2, and 3 (USEPA, 2005b):

- The Selected Remedies being implemented in OU 1 and OU 2 are expected to be protective of human health and the environment upon completion. Although remedy implementation had been ongoing for approximately 3 years at the time of the Second Five-Year Review Report in 2005, the report stated that the human health remedy in residential and community areas of OU 3 was expected to be protective of human health and the environment upon completion.
- Contamination of eroding hillsides adjacent to residential areas in OU 1 was identified as a potential source of recontamination.
- Infrastructure maintenance and improvements were identified as a potential source of recontamination in OU 1.
- Barrier maintenance and identification of funding and other resources for infrastructure maintenance and improvements to protect the Selected Remedies (such as stormwater controls) in OU 2 were identified as issues.
- Hillside access control in OU 2 was identified as an issue.
- Milo Gulch, specifically Reed Landing, was identified as a potential problem. Potential slope instability and/or erosion due to adit drainage flows would pose a recontamination risk to remediated properties in Wardner and Kellogg.
- For OU 3 the following statement was made about the issue of infrastructure: "Infrastructure upgrades and maintenance are critical to long-term remedy success" (USEPA, 2005b).

The issue of failing infrastructure and the need for improvements and routine maintenance have been identified in each of the Five-Year Review Reports to date for OU 1, OU 2, and OU 3. The Second Five-Year Review Report states that the local government is the party responsible for repair and maintenance of existing community infrastructure. This FFS Report does not evaluate community infrastructure in general, but instead only a subset of this infrastructure, as described later in this subsection. As discussed in Section 9.1.1, this evaluation of the remedy protection alternatives excludes the SFCDR and Pine Creek flooding, roads as barriers, and sanitary sewers.

USEPA is currently assessing a subset of the infrastructure issues identified in the Upper Basin, specifically those related to uncontrolled water flow from tributary flooding and precipitation events that could erode clean barriers or deposit contaminated sediments. The potential for damage to the Selected Remedies due to these types of overland surface water flows exists to varying degrees throughout the Upper Basin, resulting in two common issues. First, inadequate structures to convey creek floodwaters and associated sediments can lead to (1) erosion of the protective barrier and (2) deposition of the contaminated material on remediated areas. The deposition of contaminated material can be from erosion of the protective barrier and mobilization of the contaminated material beneath barriers, or from upstream contaminated sediments transported by flows within a creek and deposited downstream on the protective barriers. These storm events are relatively infrequent, but the consequences can be significant.

Secondly, overland surface water flow from heavy precipitation can also cause protective barrier degradation and, in some cases, deposition of contaminated material on remediated sites. In general, erosion and deposition due to surface water flow would be a localized threat to the Selected Remedies and of a smaller scale than the threat posed by larger creek flows and major floods. These precipitation events are relatively frequent, but the consequences are relatively minor compared to the less frequent, larger events (a 5-year storm event or larger).

The Milo Creek flood event in 1997 is a documented example of the risk posed to the Selected Remedies by the creeks and gulches flowing through the communities. In January 1997, Milo Creek flooded. Due to lack of maintenance on the creek channel and failure of the deteriorating below-grade piping, the creek deposited contaminated sediments in portions of the communities of Wardner and Kellogg, which resulted in localized elevated blood lead concentrations in children.

The Panhandle Health District is implementing the ICP that regulates excavation activities and contaminant migration away from properties for purposes of long-term maintenance of the Selected Remedies. The property owner is responsible for compliance with the ICP and managing property activities in a manner that limits degradation of the protective barriers. Maintenance includes remediation and placement of protective barriers after excavation and development activities. During the implementation phase of the Selected Remedies in OU 3, if the barrier became recontaminated, IDEQ would often complete the barrier repairs, in coordination with the subcontractors, as necessary to maintain protectiveness of human health and the environment. These types of barrier repairs were completed in OU 1 and OU 2 by USEPA. With the exception of the Milo Creek flood of 1997, large-scale repairs and replacement of the protective barriers have not been necessary.

Inadequate drainage and surface water management is a threat to the long-term effectiveness and permanence of the human health remedy. With this FFS Report and subsequent ROD Amendment, USEPA will mitigate the risk posed to the Selected Remedies by developing a process and framework to evaluate remedy protection alternatives that increase the long-term effectiveness and permanence of the remedy and maintain the protectiveness of human health and the environment.

9.1.3 Investigation Area

The investigation area for developing and evaluating the remedy protection alternatives includes those Upper Coeur d'Alene Basin areas of OUs 1, 2, and 3 where the Selected Remedies currently exist or are planned to be implemented. For the purposes of this remedy protection alternatives evaluation, the Upper Basin was categorized based on the eight primary communities with the highest density of existing Selected Remedies. These communities, which are shown in Figure 9-1, are Pinehurst, Smelterville, Kellogg, Wardner, Osburn, Silverton, Wallace, and Mullan. Section 9.2.1 describes the criteria used for categorizing the areas included in this evaluation.

The Selected Remedies have also been implemented at side gulches located throughout the Upper Basin. A complete list of the side gulches screened during this remedy protection alternatives evaluation is included in Table 9-2. In general, these communities are more rural with a lower density of residential properties than the eight identified communities. USEPA acknowledges that risks are posed to the existing Selected Remedies in the small communities and side gulches. They were not included in the detailed analyses conducted, however, because of their lower densities of the Selected Remedies than the eight identified communities and because less information is known about the side gulch drainage areas.

The following sections briefly describe the eight identified communities and the side gulches. See Figure 9-1 for the locations of the side gulches and Upper Basin community investigation areas. Detailed topographic maps of the watersheds discussed below are included in Attachment G-2 in Appendix G.

9.1.3.1 Pinehurst

Pinehurst is located in OU 2 along the SFCDR east of Kingston. According to the 2000 census, Pinehurst has a population of 1,661 people living in 720 housing units (U.S. Census Bureau, 2000). The city of Pinehurst is bordered by the SFCDR and Interstate 90 to the north, Pine Creek and Little Pine Creek Watersheds to the south, French Gulch to the west, and Humboldt Gulch and Page Ponds to the east. Pine Creek and Little Pine Creek flow through the city of Pinehurst. Little Pine Creek is included in this evaluation because it is a small tributary to the SFCDR that has the potential to cause damage to the Selected Remedies during storm events. Pine Creek is a large tributary to the SFCDR that could damage the Selected Remedies during a large flood; however, as discussed in Section 9.1.1, flooding in Pine Creek is highly influenced by the SFCDR system. Because of this, Pine Creek is not included in this analysis.

9.1.3.2 Smelterville

Smelterville is located in OU 2 along the SFCDR east of Pinehurst and west of Kellogg. According to the 2000 census, Smelterville has a population of 651 people living in

308 housing units (U.S. Census Bureau, 2000). The city of Smelterville is bordered by Smelterville Flats to the north, Government Gulch to the east, the Grouse Creek drainage area to the south, and Page Ponds to the west. The topography in Smelterville is generally flat, with steep hillsides bordering the city to the south. Grouse Creek is the only drainage area of concern to the remedy protection alternatives in Smelterville. Government Gulch to the east has a minimal to negligible impact on the existing Selected Remedies within the city of Smelterville.

9.1.3.3 Kellogg

Kellogg is located in OU 2 between Smelterville and Osburn along the SFCDR. Kellogg has a population of 2,395 people living in 1,023 housing units, according to the 2000 census (U.S. Census Bureau, 2000). The city of Kellogg is bordered by the Italian Gulch and Jackass Creek Watersheds to the north, the Milo Creek Watershed and the city of Wardner to the south, the Montgomery Creek and Elk Creek Watersheds to the east, and Bunker Creek to the west. The topography of Kellogg is generally flat. Jackass Creek, Italian Gulch, and localized drainage areas were evaluated as part of the remedy protection alternatives for Kellogg. Other drainages on the south side of Kellogg, including Bunker Creek and Slaughterhouse Gulch, do not pose a risk to large areas of the Selected Remedies in Kellogg; therefore, these drainages were classified as side gulches. Although the lower portion of Milo Creek flows through Kellogg, Milo Creek was addressed as part of Wardner for this evaluation.

9.1.3.4 Wardner

Wardner is located within OU 2 and to the south of Kellogg along Milo Creek. According to the 2000 census, the city of Wardner has a population of 246 people living in 88 housing units (U.S. Census Bureau, 2000). The city of Wardner is bordered by the city of Kellogg to the north, the Silver Mountain ski area to the south, Bunker Creek Watershed to the west, and Slaughterhouse Gulch Watershed to the east. Milo Creek is the only drainage area identified with remedy protection alternatives issues in Wardner, but the sloughing of hillsides also poses a threat to the Selected Remedies.

9.1.3.5 Osburn

Osburn is located in OU 3 on the SFCDR approximately 6 miles east of Kellogg. The city of Osburn has a population of 1,579 people living in 699 households, according to the 2000 census (U.S. Census Bureau, 2000). Osburn is bordered by the SFCDR to the north; McFarren Gulch, Meyer Creek, and Shields Gulch watersheds to the south; Rosebud Gulch Watershed to the west; and the SFCDR and Revenue Gulch Watershed to the east. Rosebud Gulch, McFarren Gulch, Meyer Creek, and Shields Gulch all flow through Osburn and were included in the remedy protection alternatives evaluation.

9.1.3.6 Silverton

Silverton is located in OU 3 east of Osburn and west of Wallace along the SFCDR. Silverton is an unincorporated community of Shoshone County, and U.S. census population estimates are not available. Silverton is bordered by Nuchols Gulch and Revenue Gulch watersheds to the north, the SFCDR to the south, Revenue Gulch Watershed to the east, and the SFCDR and the city of Osburn to the west. Revenue Gulch and an unnamed creek in west Silverton were both included in the remedy protection alternatives evaluation for Silverton.

9.1.3.7 Wallace

Wallace is located in OU 3 southeast of Silverton and west of Mullan at the confluence of Ninemile and Canyon Creeks with the SFCDR. Wallace has a population of 1,010 people living in 427 housing units, according to the 2000 census (U.S. Census Bureau, 2000). The city of Wallace is bordered by the SFCDR and Ninemile Creek and Canyon Creek watersheds to the north, Placer Creek Watershed to the south, the SFCDR to the west, and various steep watersheds to the east. Placer Creek and Printers Creek flow through Wallace and are the drainage areas of concern that were included in the remedy protection alternatives evaluation.

9.1.3.8 Mullan

Mullan is located in OU 3 along the SFCDR approximately 7 miles east of Wallace near the Idaho-Montana border. According to the 2000 census, the city of Mullan has a population of 821 people living in 367 households (U.S. Census Bureau, 2000). Mullan is bordered by the Mill Creek Watershed to the north, the Boulder Creek Watershed to the south, various steep watersheds to the west, and Gold Hunter Gulch to the east. Mill Creek, the major drainage area of concern in Mullan, was evaluated in the remedy protection alternatives evaluation. Additional localized drainage issues were also identified and evaluated in Mullan.

9.1.3.9 Side Gulches

Table 9-2 lists the side gulches and general characteristics of each drainage. The general characteristics were developed based on limited field reconnaissance and analysis using geographic information system (GIS) maps for the Upper Coeur d'Alene Basin.

Many of the side gulches share common characteristics, including relatively steep slopes, deteriorating infrastructure primarily consisting of culverts or bridges that are not regularly maintained, and relatively close proximity to protective barriers and residential properties. These characteristics pose risks to the side gulches and are similar to the risks documented in the eight Upper Basin communities and their associated drainages (Appendix G).

9.2 Assessment of the Potential Risk to the Selected Human Health Remedies from Storm Events

Before developing alternatives to increase the protectiveness of the Selected Remedies in the Upper Basin, the potential risk posed to the Selected Remedies by localized storm events was assessed. The assessment focused on the eight primary communities identified in Section 9.1.3 and discussed in Section 9.2.1. The erosion (or scour) of clean barriers to expose contamination and the deposition of contaminated sediments on previously clean areas are the major threats posed to the existing Selected Remedies. The scour of clean barriers could occur in unpaved areas where the velocity of stormwater exceeds 5 feet per second, as discussed in Appendix G. Contamination below the protective barriers would be exposed over time, which would pose a potential risk to the community and its residents. The deposition of contaminated sediments left behind by floodwaters would leave contaminated material exposed on top of the previously clean areas. The risk of sediment deposition exists in the following scenarios: (1) deposition of contaminated creek sediments on previously clean areas if a creek overtops its banks during a flood, (2) scour of contaminated material below a protective barrier and deposition of this material on a previously clean area, and (3) scour of contaminated material from a nearby hillside or other source and deposition on previously clean areas.

9.2.1 Initial Screening to Determine Investigation Areas

The first step in developing the remedy protection alternatives was to determine the investigation areas. The initial screening focused on three criteria: (1) the presence of the existing Selected Remedies, (2) the potential for barrier scour and contaminated material deposition to damage the existing Selected Remedies, and (3) upstream sources of contamination within the creeks and gulches. The initial screening eliminated various watersheds where the Selected Remedies have not been and will not be implemented. Nearly all of the remaining watersheds have differing degrees of potential for barrier scour and contaminated material deposition and/or upstream contamination sources.

Following the initial screening, the drainage areas (or watersheds) were classified as being within communities where there is a high density of the Selected Remedies and within communities where the density is lower. The communities identified as having the highest density of the Selected Remedies are listed in Section 9.1.3; the remaining drainage areas were categorized as side gulches (see Table 9-2). The eight identified Upper Basin communities were analyzed in detail as described in the subsequent sections.

9.2.2 Hydrologic and Hydraulic Modeling to Assess Potential Risk to Selected Remedies

As documented in Appendix G, peak flow rates corresponding to the 5-, 25-, and 50-year design storm events for most watersheds were obtained using the Idaho U.S. Geologic Survey Regional Regression equations. For the Grouse Creek and Meyer Creek Watersheds, however, peak flow rates were estimated using existing Hydrologic Engineering Centers (HEC) models created by TerraGraphics Environmental Engineering, Inc. for previous studies. From the peak flow rates for each of these watersheds, hydraulic models were developed using the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Centers-River Analysis System (HEC-RAS) program. Stormwater runoff flow rates for urbanized areas within the communities were then calculated using the methods prescribed by the Bunker Hill Superfund Site, Stormwater Management Plan, Criteria and Engineering Standards (Welch et al., 1994). Specifically, the Rational Method was used to calculate these peak stormwater runoff rates in all urban areas for the various design storms. The hydraulic and hydrologic modeling assumed proper maintenance of the existing infrastructure. Further descriptions of the methods, model inputs, and model assumptions are provided in Appendix G.

The outputs from these models predicted areas within communities that would be impacted by either scour or contaminated sediment deposition during 5-, 25-, and 50-year storm events. A storm event is defined as the design storm for a given event that would cause subsequent tributary flooding and/or surface water flow that could damage the existing Selected Remedies. The total area at potential risk includes remediated properties and clean properties that could be at risk of contamination during storm events. As discussed in Appendix G, these storm events were selected to provide insight regarding the range of risk as a function of large (50-year event), medium (25-year event) and small (5-year event) scenarios. The 50-year event was used as the largest storm event to remain consistent with, and in some cases more protective than, design engineering standards developed for the Bunker Hill Superfund Site (Welch et al., 1994), the State of Idaho Transportation Department (ITD, 2009), and the Washington State Department of Transportation (WSDOT, 2008).

Appendix G presents detailed documentation of the methodology and results of the assessment of risks posed to the existing Selected Remedies. Impact maps showing areas of scour and deposition are also included in Appendix G (see Attachment G-1 in Appendix G). Table 9-3 presents the percentage of the Selected Remedies that are currently at risk during 5-, 25-, and 50-year storm events. Based on the model results, it is estimated that 7 percent, 16 percent, and 25 percent of the existing Selected Remedies are at risk for contamination within the investigation area during 5-, 25-, and 50-year storm events, respectively.

9.3 Identification of Remedy Protection Technologies and Process Options

In response to the risk posed to the Selected Human Health Remedies, as discussed in Section 9.2, a list of technologies and process options was identified to mitigate this risk. The technologies and process options can be used to increase the long-term effectiveness and permanence of the Selected Remedies by helping to mitigate the damage caused by storm events. Table 9-4 summarizes the technologies and process options identified for the remedy protection alternatives. This list, which was compiled based on existing conditions throughout the Upper Basin, is meant to be inclusive of technologies and process options applicable for remedy protection alternatives projects both currently and into the future. As discussed in Appendix G, technologies and process options were developed based on information gathered during field observations, anecdotal information provided by local residents and representatives, and other process options commonly used for conveying surface water. These technologies could be used individually or multiple options could be used together. The list of technologies and process options are standard engineering practices that are commonly implemented for water conveyance projects.

9.4 Development of Remedy Protection Alternatives

The objective of the remedy protection alternatives is to increase the long-term effectiveness and permanence of portions of the Selected Remedies specifically in localized areas where analyses indicate that the current level of protectiveness is expected to be compromised by storm events. The approach for developing these alternatives is based on a combination of the Five-Year Review Reports, community concerns, and the hydrologic and hydraulic analyses documented in Appendix G. The following sections describe the process for developing the remedy protection alternatives for the Upper Basin.

The development of the remedy protection alternatives included the following steps: (1) the risk posed by storm events to the existing Selected Remedies was assessed, (2) applicable technologies and process options were identified for each investigation area, and (3) unit costs were developed for the process options.

The assessment of the risk posed to the Selected Remedies was performed, as previously discussed in Section 9.2. Model outputs provided the total expected impact area of barrier scouring and deposition of potentially contaminated sediment for 5-, 25-, and 50-year storm events. The results of the hydrologic and hydraulic analyses were used to assess whether remedy protection projects were needed to improve the long-term effectiveness and permanence of the in-place barriers within each community. To evaluate this, two remedy protection alternatives were considered: RP-1, No Further Action (Post-Event Response), and RP-2, Modifications to Selected Remedies to Enhance Protectiveness (Remedy Protection Projects). The remedy protection projects would be expected to vary from community to community based on site-specific conditions. For this evaluation, the projects were developed using the list of technologies and process options summarized in Table 9-4 and Section 9.3. Sections 9.5 through 9.7 describe and evaluate the two remedy protection alternatives.

In many cases, more than two alternatives are evaluated for a typical Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) feasibility study report. The remedy protection issues addressed in this FFS Report are narrowly focused on maintaining the existing Selected Human Health Remedies. Based on the hydrologic and hydraulic analyses conducted for this evaluation, the relatively straightforward list of technologies and process options (presented in Section 9.3) would be expected to provide adequate protectiveness.

9.5 Description of Remedy Protection Alternatives

This section summarizes the two remedy protection alternatives: Alternative RP-1, No Further Action (Post-Event Response), and Alternative RP-2, Modifications to Selected Remedies Remedy to Enhance Protectiveness (Remedy Protection Projects).

9.5.1 Alternative RP-1: No Further Action (Post-Event Response)

Alternative RP-1 would not modify any of the existing infrastructure in the Upper Coeur d'Alene Basin to increase the current level of long-term permanence of the existing Selected Remedies. Alternative RP-1 assumes that property owners would continue to comply with the ICP. The ICP is implemented by the Panhandle Health District and regulates excavation activities and contaminant migration away from properties for purposes of long-term maintenance of the Selected Remedies. If the existing Selected Remedies were damaged during storm events and this damage posed risks to human health and/or the environment that warranted response actions to reduce the risks, USEPA and state agencies would determine the best tools for addressing such contamination. In the event of catastrophic flooding, USEPA, other federal agencies, and state agencies would evaluate response needs as appropriate. As discussed in Section 9.2 and Appendix G, the hydrologic and hydraulic analyses indicate that the existing stormwater management infrastructure within the communities is generally inadequate to protect the Selected Remedies and that varying degrees of damage would be expected by storm events if they were to occur.

As discussed in Section 9.1.3.9, the side gulches and associated Selected Remedies generally have similar physical and topographical characteristics to the drainages that were analyzed in detail in the eight primary Upper Basin communities. Although detailed analyses were not conducted for the side gulches in Appendix G, it would be expected that relatively similar hydrologic and hydraulic modeling trends that applied to the Upper Basin communities in Alternative RP-1 would be applicable to the side gulches.

9.5.2 Alternative RP-2: Modifications to Selected Remedies to Enhance Protectiveness (Remedy Protection Projects)

Alternative RP-2 is composed of combinations of various technology and process options (Table 9-4) to protect the existing Selected Remedies against flood and high precipitation events up to the 50-year storm event (Section 9.2.2). Each community has different infrastructure issues and this evaluation focuses only on the subset of water conveyance issues that pose a risk to the Selected Remedies, as discussed in Section 9.1.2.2. These water conveyance issues are dependent on the geography and changing environmental conditions common to mountainous drainage areas. The process options identified in Alternative RP-2 were determined based on current existing conditions in each community area and the hydrologic and hydraulic analyses. Furthermore, not all of the process options included in Section 9.3 were incorporated into the Alternative RP-2 actions. Process options could be removed, added, or changed for Alternative RP-2 as a result of new data, stakeholder input, or other emergent considerations.

For the purposes of this evaluation, the Alternative RP-2 remedy protection projects were preliminarily defined for each community. Preliminary cost opinions were then developed for the projects in each community. In some cases, more than one process option would provide the same level of protectiveness for similar costs. In these cases, one process option was chosen for purposes of this evaluation, which could be modified during the design phase based on stakeholder input or an improved understanding of existing conditions.

Operations and maintenance (O&M) costs were developed for each of the eight primary Upper Basin communities. The O&M cost includes the process option for visual observation and documentation of drainages where the existing infrastructure has adequate capacity and Alternative RP-2 projects were not identified.

Ongoing maintenance of the constructed Alternative RP-2 remedy protection projects will be essential to ensure that the remedy protection drainage improvements continue to function as designed. Easements and O&M agreements may be a necessary component of Alternative RP-2 to ensure long-term access to and functionality of the remedy protection projects. If necessary to ensure long term maintenance of the remedy protection projects, USEPA, IDEQ, and the Trustees will also rely on local governments to ensure continued operation and maintenance as property use changes.

A summary of the Alternative RP-2 process options for each community is included in Appendix G (see Attachment G-3 in Appendix G). The following sections summarize the risks posed and process options to mitigate these risks defined for each community for Alternative RP-2.

9.5.2.1 Pinehurst

Little Pine Creek and Pine Creek flow through the city of Pinehurst (see Figure 3-1 in Attachment G-3 in Appendix G). Pine Creek is not included in the scope of this evaluation as discussed in Section 9.1.1. For Little Pine Creek, the estimated area of remedy at risk of contamination during 5-year to 50-year storm events ranges from approximately 0.69 to 2.15 million square feet. During a 5-year storm event, 22 percent of the existing Selected Remedies would be expected to be damaged. Because Pinehurst is relatively flat, the primary source of contamination would be the deposition of sediments due to flooding of Little Pine Creek (see Figure 1-4 in Attachment G-1 in Appendix G). Alternative RP-2 would include process options for channel improvements, box (bridge) culvert replacement, and pipe culvert replacement for Little Pine Creek to reduce the risk posed by the flooding (see Figures 3-2 and 3-3 in Attachment G-3 in Appendix G).

9.5.2.2 Smelterville

Grouse Creek flows through the city of Smelterville (see Figure 3-10 in Attachment G-3 in Appendix G). The hydrologic and hydraulic analyses indicate that approximately 0.16 million, 0.64 million, and 1.25 million square feet of the Selected Remedies would be at risk during the 5-, 25-, and 50-year storm events, respectively. Flooding of Grouse Creek is the primary risk to the existing Selected Remedies because of lack of capacity to effectively convey the creek to the Page Ponds area west of Smelterville (see Figures 1-7 and 1-8 in Attachment G-1 in Appendix G). Because of the flat topography of Smelterville, deposition of contaminated sediments from Grouse Creek would be the primary source of contamination. Process options to protect the Selected Remedies adjacent to Grouse Creek include channel hydraulic capacity improvements and culvert replacement (see Figure 3-11 in Attachment G-3 in Appendix G). Due to the areal constraints where Grouse Creek flows through Smelterville, channel improvements would likely include the construction of a concrete wall on one side of the creek.

9.5.2.3 Kellogg

The hydrologic and hydraulic analyses indicate that there are two areas of primary concern to the existing Selected Remedies in Kellogg: (1) Jackass Gulch and (2) the west Portland Road localized drainage area (see Figure 3-14 in Attachment G-3 in Appendix G). Additional localized watersheds flow through the city of Kellogg, but the analyses did not indicate that they currently pose a risk to the Selected Remedies. The analyses indicate that approximately 92,000; 144,000; and 168,000 square feet would be at risk during the 5-, 25-, and 50-year storm events, respectively. For Jackass Gulch, the analyses indicate isolated issues with channel capacity immediately downstream from Kellogg High School (see Figures 1-11 and 1-12 in Attachment G-1 in Appendix G). To mitigate these impacts, Alternative RP-2 includes channel hydraulic capacity improvements and channel stabilization with riprap to protect the existing Selected Remedies along Jackass Gulch near the high school (see Figure 3-15 in Attachment G-3 in Appendix G). Process options, including rock-lined ditches and culvert replacement, are also included in Alternative RP-2 for the localized drainage area at Portland Road in Kellogg (see Figure 3-17 in Attachment G-3 in Appendix G). The analyses indicate that minimal damage to the Selected Remedies would occur during storm events for Italian Gulch and the other localized drainage areas in Kellogg. These analyses are based on the assumption that the existing conveyance systems are operating as designed, but changing environmental conditions could damage existing infrastructure. In the case that the existing infrastructure is damaged or compromised in the future, it could pose a risk to the Selected Remedies. Therefore, Alternative RP-2 also includes visual observations and documentation of Italian Gulch, Alhambra, Chestnut, Miner's Hat, and other localized drainage areas to ensure that they continue to effectively convey stormwater.

9.5.2.4 Wardner

The major watershed in Wardner is Milo Creek (see Figure 3-19 in Attachment G-3 in Appendix G). The Milo Creek drainage and diversion structures were reconstructed following the 1997 Milo Creek flood event. Alternative RP-2 does not include any additional work on those structures. The hydrologic and hydraulic analyses did indicate that approximately 135,000 square feet of the Selected Remedies in Wardner would be at risk during 5-year to 50-year storm events. The same area is at risk for all three storm events because the primary issue in Wardner is the scour of contaminated material on hillsides and deposition of this material on the existing Selected Remedies (see Figure 1-15 in Attachment G-1 in Appendix G). This scour and deposition would be expected to occur relatively frequently during precipitation events. Because the potential scour and deposition of contaminated hillsides can be addressed through the existing RODs for OU 1, OU 2, and OU 3, these remedial actions are not included in Alternative RP-2. To mitigate additional scour potential near Sierra Nevada Road in Wardner, Alternative RP-2 includes high-capacity stormwater inlets and associated below-grade piping in Wardner (see Figure 3-20 in Attachment G-3 in Appendix G).

9.5.2.5 Osburn

There are four drainage areas near the existing Selected Remedies in Osburn: Rosebud Gulch, McFarren Gulch, Meyer Creek, and Shields Gulch (see Figure 3-21 in Attachment G-3 in Appendix G). The hydrologic and hydraulic analyses indicate the potential for flooding of these drainage areas during storm events and deposition of contaminated material on the existing Selected Remedies (see Figures 1-19 and 1-20 in Attachment G-1 in Appendix G). Approximately 256,000; 701,000; and 859,000 square feet of the Selected Remedies would be expected to be contaminated during the 5-, 25-, and 50-year storm events, respectively. The primary risk posed by the creeks in Osburn is the deposition of contaminated sediments during storm events.

Rosebud Gulch is located on the west side of Osburn. For Alternative RP-2, channel hydraulic capacity improvements, culvert replacements, and a small bridge (or box culvert) could be implemented in Rosebud Gulch to protect the Selected Remedies (see Figure 3-22 in Attachment G-3 in Appendix G). Based on the model results included in Appendix G, McFarren Gulch has sufficient capacity to convey water through Osburn without impacting the Selected Remedies, but visual observation and documentation of the condition of this drainage area would be included in Alternative RP-2 to ensure that the existing infrastructure continues to be protective. Meyer Creek would be routed through an underground bypass drainage network through the city of Osburn (see Figure 3-25 in Attachment G-3 in Appendix G) along rights-of-way as described in the *Meyer Creek Final Report* (TerraGraphics, 2005). Multiple options were evaluated for routing the underground drainage network through Osburn in the *Meyer Creek Final Report*; however, for the purposes of this evaluation, the right-of-way routing option was chosen. The final determination would be dependent on field considerations and right-of-way access. Remedy protection process options for Alternative RP-2 in Shields Gulch would include channel hydraulic capacity improvements, culvert replacement, and a new channel routed away from the middle school in Osburn (see Figure 3-27 in Attachment G-3 in Appendix G).

9.5.2.6 Silverton

Revenue Gulch is the primary watershed in Silverton, although a smaller, unnamed watershed is also located in west Silverton (see Figure 3-29 in Attachment G-3 in Appendix G). The hydrologic and hydraulic analyses indicate that approximately 185,000; 311,000; and 617,000 square feet of the Selected Remedies could be at risk during 5-, 25-, and 50-year storm events, respectively. During storm events, analyses indicate that Revenue Gulch lacks the capacity to convey water to the SFCDR (see Figures 1-23 and 1-24 in Attachment G-1 in Appendix G). Additionally, there are steep areas in Silverton within the Revenue Gulch Watershed that have the potential for scour of the existing Selected Remedies and deposition of contaminated sediments due to uncontrolled surface water flow (see Figures 1-23 and 1-24 in Attachment G-1 in Appendix G).

There are two approaches (combinations of process options) for implementing improvements to Revenue Gulch to effectively convey water to the SFCDR. One option is to implement channel improvements and construct new pipe and box culverts, while the other option is to construct a high-flow bypass drainage network in Revenue Gulch to safely route this water through town to protect the Selected Remedies. Both of these approaches have similar costs and could be effective in protecting the existing Selected Remedies. For the purposes of this evaluation, the high-flow bypass drainage network was included for Alternative RP-2 (see Figure 3-30 in Attachment 3-1 in Appendix G), although further analysis would determine the preferred process options.

Alternative RP-2 also includes the installation of a limited stormwater drainage network to effectively convey surface water in the steep areas of Silverton to Revenue Gulch and then the SFCDR (see Figures 3-31 through 3-33 in Attachment G-3 in Appendix G), and channel improvements and culvert replacement for the unnamed creek in Silverton to protect the existing Selected Remedies (see Figure 3-34 in Attachment G-3 in Appendix G).

9.5.2.7 Wallace

Printer's Creek and Placer Creek flow through Wallace (see Figure 3-36 in Attachment G-3 in Appendix G). The hydrologic and hydraulic analyses indicate that approximately 17,000; 48,000; and 103,000 square feet of the existing Selected Remedies could be at risk during 5-, 25-, and 50-year storm events, respectively. The sources of risk in Wallace would include both deposition of contaminated sediments and scouring of existing protective barriers (see Figures 1-27 and 1-28 in Attachment G-1 in Appendix G).

Placer Creek is routed through a concrete channel built by the U.S. Army Corp of Engineers that is effective in conveying water to the SFCDR. Visual observation and documentation would be conducted for Alternative RP-2 to ensure this existing infrastructure continues to perform as designed.

Printer's Creek is a localized drainage area in south Wallace. For Alternative RP-2, a new inlet structure could be constructed for Printer's Creek and improvements could be made to the existing culvert to allow for maintenance and cleaning of the culvert (see Figure 3-37 in Attachment G-3 in Appendix G).

9.5.2.8 Mullan

Mill Creek and Tiger Creek are the primary creeks that flow through the city of Mullan (see Figure 3-40 in Attachment G-3 in Appendix G). The hydrologic and hydraulic analyses indicate that approximately 164,000; 399,000; and 559,000 square feet of the Selected Remedies could be at risk during 5-, 25-, and 50-year storm events, respectively. The analyses indicate that, along with risks from the flooding of Mill Creek, there are risks associated with uncontrolled surface water flow and the potential for localized scour and deposition during storm events due to the steep topography in Mullan (see Figures 1-31 and 1-32 in Attachment G-1 in Appendix G). Process options to mitigate these localized risks, referred to as neighborhood surface water flow issues, are included in Alternative RP-2. These neighborhoods include Copper Street, Dewey Street, Mill Street, Third Street, and the south end of Second Street. Process options that could mitigate damage to the Selected Remedies for the neighborhood surface water flow issues include asphalt-lined ditches, pipe culverts, and stormwater catch basins (see Figures 3-47, 3-50, 3-51, 3-52, and 3-55 in Attachment G-3 in Appendix G).

Technology and process options included in Alternative RP-2 for Mill Creek include a rolling dip to prevent the scour of a gravel road and deposition in residential properties. Mill Creek also would include channel hydraulic capacity improvements, a concrete-lined channel, pipe culvert replacement, and box (bridge) culvert replacement (see Figures 3-41 through 3-43 in Attachment G-3 in Appendix G). For Tiger Creek, Alternative RP-2 includes a diversion structure, channel stabilization, pipe culvert installation, and asphalt-lined ditch process options (see Figure 3-44 in Attachment G-3 in Appendix G).

9.5.2.9 Side Gulches

As discussed in Section 9.1.3.9, the side gulches and associated Selected Remedies generally have similar physical and topographical characteristics to the drainages that were analyzed in detail in the eight primary Upper Basin communities. Although the side gulches were not included in the detailed analyses described in Appendix G, it would be expected that similar technologies and process options would be applicable to the side gulches. The most common technologies and process options included as part of Alternative RP-2 for the investigation areas include creek channel modifications (channel hydraulic capacity improvements, channel stabilization, and creek culvert [pipe or box] replacement) and drainage improvements (paved roadside ditches, high-flow bypass network, stormwater drainage network, high-capacity stormwater inlet, and rolling dips). Additional technologies and process options such as inlet and diversion structures were included in Alternative RP-2, but to a lesser extent.

The process for applying technologies and process options to the side gulches in the future should include (1) completing hydrologic and hydraulic analyses to determine the areas of remedy at risk, and (2) if warranted, to mitigate risk to the Selected Remedies using the results of the hydrologic and hydraulic analyses, the specific physical constraints of the site, and engineering judgment to select appropriate process options that would mitigate the risk posed to the Selected Remedies. The process for developing these remedy protection projects should follow the framework used to develop Alternative RP-2 for the eight Upper Basin communities.

9.6 Site-Specific Considerations and Assumptions for Evaluation of Remedy Protection Alternatives

This section discusses community and site-specific considerations and assumptions considered as part of the evaluation of the remedy protection alternatives (subsequently described in Sections 9.7 and 9.8 below).

9.6.1 Assumptions for Cost Analysis

The cost of each remedy protection alternative was developed in accordance with the *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (USEPA, 1988b). This section describes the assumptions used to develop costs for each of the alternatives.

Cost estimates developed for this alternative evaluation reflect a 30-year project life cycle as recommended by CERCLA guidance. In reality, the existing protective barriers installed to protect human health need to be maintained into perpetuity to meet the CERCLA threshold criteria. Furthermore, the design life of the remedy protection projects implemented under Alternative RP-2 would be expected to be greater than 30 years. Cost estimates for Alternatives RP-1 and RP-2 are based on 30-year net present value (NPV) life-cycle costs.

9.6.1.1 Alternative RP-1: No Further Action (Post-Event Response)

Alternative RP-1 does not include actions to reduce the potential risk of damage to the existing Selected Human Health Remedies, but instead relies on cleanup and re-remediation of damage to the existing Selected Remedies after the damage occurs. The expected cost to repair existing protective barriers and remediate previously clean areas, based on the modeling results, is the cost associated with Alternative RP-1. The costs that would be associated with the general cleanup of impervious barriers (such as roadways and structures) and repair of failed infrastructure in a post-event response scenario are assumed to be the responsibility of others (property owners, communities, etc.), and are not included in the Alternative RP-1 cost analysis.

A methodology for evaluating the long-term damage to the existing Selected Remedies that would be expected from storm events in the Upper Basin was developed to complete the NPV cost analysis for Alternative RP-1 (CH2M HILL, 2009k). The methodology uses risk analysis principles used by the USACE to evaluate flood control projects (USACE, 1989, 1996). Basic probability theory suggests that the “expected” annual damage from extreme weather events can be stated as the sum of all such events, with each of the expected damages multiplied by its probability of occurrence.

The risk posed to the existing Selected Remedies under Alternative RP-1 is a product of the probability of damage occurring and the consequence, or magnitude, of the damage. The probability of damage is higher for more frequent, smaller storm events. However, the consequence of damage is higher for less frequent, larger storm events. The probability of damage and consequence, or magnitude, of damage together make up the risk to the existing Selected Remedies. The magnitude of damage that would occur for each storm event is discussed here, and quantified in Appendix G. As previously discussed, this evaluation includes an analysis of 5-, 25-, and 50-year storm events. The model results from each of these storm events provided a total area that would require re-remediation and/or cleanup following the given storm event. Unit costs (per square foot) were developed for re-remediation following storm events. These unit costs were based on previous work conducted in the Upper Basin during installation of the existing Selected Remedies, the Milo Creek flood repairs, and engineering cost estimates. Appendix G provides detailed documentation of the assumptions applied to calculate the expected impacts of the 5-, 25-, and 50-year storm events on the existing Selected Remedies.

The probability of damage occurring is based on the probability of occurrence of all different storm events. In any given year, the Selected Remedies are at risk for damage from storm events of all sizes and frequencies. In a single year, there is a 2 percent probability of experiencing damage from a 50-year storm event. There is also a 20 percent probability of experiencing damage from a 5-year event, added onto the probability of the occurrence of the 50-year event. It is this cumulative probability and consequence that is the annual expected damage to the remedy.

Using the methodology described above, the annual expected cost of damage to the Selected Remedies was calculated based on the potential area of damage estimated by the hydrologic and hydraulic model outputs of the 5-, 25-, and 50-year storm events, and the probability of these floods occurring. The 30-year NPV life-cycle cost was then calculated as the present value of the expected annual damage over the 30-year time horizon. Table 9-5 provides an example calculation of the Alternative RP-1 cost estimation methodology.

Cost estimates for both Alternative RP-1 and Alternative RP-2 consider costs for protection or post-event response up to the 50-year storm event. Protection from floods larger than the 50-year event was not included in the cost estimates for either alternative. The rationale for this is that events larger than the 50-year event would have a similar effect on the existing Selected Remedies and similar cost to maintain protectiveness regardless of the alternative implemented. Therefore, inclusion of those events is not necessary for this evaluation.

The threat from storm events smaller and more frequent than the 5-year event is minimal compared to the threat from larger events. There are no data available for storm events smaller than the 5-year event, but anecdotal information from local residents suggests that there are varying impacts on the Selected Remedies during small storm events. In general, this damage is minimal to negligible, and is not included in the estimated cost for Alternative RP-1.

Assumptions were applied to develop approximate costs for Alternative RP-1 actions in the side gulches. Although detailed analyses were not conducted for the side gulches (i.e., drainages located outside the eight primary Upper Basin communities), the expected damage due to storm events was estimated based on the trends found in the hydrologic and hydraulic analyses of the Upper Basin communities. Appendix D (Table D-19) documents the assumptions applied to develop Alternative RP-1 side gulch costs.

9.6.1.2 Alternative RP-2: Modifications to Selected Remedies to Enhance Protectiveness (Remedy Protection Projects)

Alternative RP-2 includes the implementation of remedy protection projects that are selected from the technology and process options for each community presented in Section 9.3. Although similar types of process options could be used to protect the existing

Selected Remedies in the communities, the geographic variations cause each remedy protection project to be slightly different. In some cases, multiple process options of similar protectiveness and cost could be applied to protect the existing Selected Remedies. Assumptions were made, based on the data available, to choose process options that would effectively protect the existing Selected Remedies, and were applied as a basis for this evaluation.

The design life of the remedy protection projects is expected to be greater than the 30-year project life used for this cost analysis. The additional value of the remedy protection projects is not accounted for in this cost analysis.

O&M costs were also included for the remedy protection projects. Costs for O&M, including inspections and repairs, were developed on a community basis. Assumptions were made that 2 percent of the capital costs would be spent annually on repairs and maintenance to the remedy protection projects beginning the year the project is implemented. One of the process options for the remedy protection projects is visual observation and documentation; this cost is included in the Alternative RP-2 O&M cost estimate. This process option does not include the cost for maintenance of the existing infrastructure if a problem is identified during the visual observation and documentation. It is assumed that these maintenance items would be the responsibility of others (property owners, communities, etc.). The detailed assumptions for the cost analysis of Alternative RP-2 are included in Appendix D of this FFS Report, and documentation of the modeling completed to develop the remedy protection projects is included in Appendix G.

As discussed in Section 9.5.2.9, the side gulches were not evaluated to the same level of detail as the eight Upper Basin communities. Although detailed analyses were not conducted for the side gulches, approximate costs were developed based on the trends found in the analysis of the eight Upper Basin communities. These costs are a rough estimate of the resources it would take to implement expected remedy protection projects in the side gulches.

Relatively broad assumptions were applied to develop the approximate cost for Alternative RP-2 actions in the side gulches. As discussed in Section 9.5.2.9, the primary assumption is that the types of risk posed to the Selected Remedies in the side gulches would be similar to the types of risks found in the eight Upper Basin communities. Characterization of a typical side gulch was developed and its cost was estimated, as documented in Table D-36 in Appendix D. This cost was based on an average side gulch size (see Table 9 in Appendix G), for which it was assumed that creek channel modifications (including channel hydraulic capacity improvements and culvert replacements) and drainage and road shoulder improvements would be needed to mitigate the expected risk. The total estimated cost for a typical side gulch included average costs for the technologies and process options that were used most often for the eight primary Upper Basin communities. Finally, the total estimated cost for the side gulches was calculated by applying the typical side gulch costs to the side gulches identified (Section 9.2.1) as having potential risks to the Selected Remedies.

9.6.2 Mine and Mill Site Considerations and Assumptions

During the development of the remedy protection alternatives, several mine and mill sites[1] were identified as potential sources for contaminated materials that could be transported downstream into the communities during storm events. Mine and mill sites of potential concern for remedy protection may include sites located close to communities, as well as mine sites (or mine dumps) with some degree of potential instability located along creeks upstream from the communities. Detailed field reconnaissance and analysis were not conducted to determine the expected impacts of mine and mill sites on the existing Selected Remedies. Many factors (including source type, metals concentrations in source material, and topography) would influence the likelihood of the particular mine and mill site being a source of recontamination. Therefore, the extent of potential damage to the existing Selected Remedies from nearby mine and mill sites, if any, is unknown at this time.

Some mine and mill sites of potential concern for remedy protection in OU 3 are included in the evaluation of remedial alternatives in Sections 7.0 and 8.0 of this FFS Report. It would be expected that remedial actions included as part of remedial alternatives, such as consolidation, native soil capping, or excavation, would also address issues associated with protecting the existing Selected Human Health Remedies. Where mine and mill sites are found to be of concern for remedy protection and no remedial actions are specified, the remedial alternatives would include contingency actions to address sites with potential for unacceptable human exposures (see Section 7.2.1.1 of this FFS Report). During the implementation phase of the selected remedial alternative and associated remedial actions, USEPA would ensure these actions protect both ecological and human health receptors.

The remedy protection alternatives do not include actions for mine and mill sites within the Bunker Hill Box. Such mine and mill sites were addressed by the ROD for OU 2, which selected remediation of mine waste based on metals concentrations, ease of erosion, and accessibility by children. The ROD for OU 2 continues to provide the basis for remedial actions to address mine wastes based on such considerations. Therefore, USEPA has not included mine and mill sites in this evaluation of the remedy protection alternatives. As previously stated, the extent of potential damage to the existing Selected Remedies from mine and mill sites, if any, is unknown. Further analysis would need to be conducted to determine the actual risk posed to the existing Selected Remedies. If, upon further analysis, actions are determined to be warranted, they could be implemented through the existing ROD for OU 2 and the upcoming Upper Basin ROD Amendment to mitigate this risk and increase the long-term effectiveness and permanence of the existing Selected Remedies.

9.7 Detailed Evaluation of Remedy Protection Alternatives

This section presents an analysis of the two remedy protection alternatives (RP-1 and RP-2) using the evaluation criteria specified in the CERCLA guidance (USEPA, 1988b). This analysis considers the eight Upper Basin communities presented in Section 9.1.3. This analysis does not address the mine and mill sites that have potential to impact the Selected Human Health Remedies.

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[1] Mine and mill sites refer to a subset of the source sites included in the development and evaluation of remedial alternatives (Sections 6.0 through 8.0 of this FFS Report).

These alternatives were evaluated using nine CERCLA criteria, although the remedy protection alternatives do not modify the existing Selected Remedies and the Selected Remedies already meet the threshold criteria. The evaluation in this FFS Report shows that Alternative RP-1 and Alternative RP-2 are primarily differentiated by the balancing criteria, particularly long-term effectiveness and cost. The original evaluation of threshold criteria for the Selected Remedies was presented in the previous Feasibility Study Reports and RODs for OUs 1, 2, and 3.

The threshold criteria relate to the statutory requirements that each alternative must satisfy in order to be eligible for selection; they consist of overall protection of human health and the environment, and compliance with ARARs. The five primary balancing criteria represent the primary technical, cost, institutional, and risk factors that form the basis of the evaluation. They consist of long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost. The individual criteria are described in detail in Section 7.3.1 of this FFS Report. The following text describes how the criteria apply to this specific evaluation.

1. **Overall Protection of Human Health and the Environment.** The remedy protection alternatives were evaluated for this criterion although the alternatives only maintain the existing Selected Remedies, which already meet the threshold criteria. This criterion evaluates the degree of protectiveness of human health and the environment offered by each remedy protection alternative.

2. **Compliance with ARARs.** This criterion was only evaluated for potential location-specific and action-specific ARARs. Potential chemical-specific ARARs were not evaluated because the remedy protection alternatives do not propose to change or modify the existing Selected Remedies. The potential location- and action-specific ARARs are described in Section 4.0 of this FFS Report. Location- and action-specific ARARs pertaining to the remedy protection alternatives may include Section 404 of the Clean Water Act, which applies to the dredging or filling of navigable waters, substantive requirements of Idaho's Stream Channel Alteration Rules and/or Executive Order 11988, Protection of Floodplains. Location- and action-specific ARARs generally set performance, design, or other similar controls on specific activities. Many of the location- and action-specific ARARs would be identified during the remedial design process.

3. **Long-Term Effectiveness and Permanence.** This criterion addresses the long-term effectiveness and permanence of the protection of human health and the environment that would be provided by the remedy protection alternatives. The primary components evaluated include the magnitude of residual risks remaining at a site, and the adequacy and reliability of actions or controls that might be required to maintain the effectiveness of the alternative over time.

4. **Reduction of Toxicity, Mobility, or Volume through Treatment.** This criterion addresses the anticipated performance of the remedy protection alternatives' actions in permanently and significantly reducing the toxicity, mobility, and/or volume through treatment in the Upper Basin.

5. **Short-Term Effectiveness**. The short-term effectiveness criterion addresses adverse effects that may be posed to human health and/or the environment by the remedy protection alternatives during the short term.

6. **Implementability.** This criterion is used to evaluate the remedy protection alternatives based on technical and administrative feasibility and logistical challenges during implementation of the alternative.

7. **Cost.** This criterion evaluates the cost of implementing the remedy protection alternatives. The estimated cost of the remedy protection alternatives encompass all engineering, construction, and O&M costs incurred over the 30-year life cycle. In accordance with CERCLA guidance, cost estimates for the remedy protection alternatives were developed with an expected accuracy range of –30 percent to +50 percent. Estimated costs are presented in terms of total capital cost, annual average O&M cost, 30-year NPV O&M cost where applicable, and total costs (30-year NPV) for each alternative. Appendix D in this FFS Report includes documentation of the cost estimates for the remedy protection alternatives. It should be noted that the cost estimates provided in this section have been prepared to assist the evaluation of the remedy protection alternatives using the information available at the time of preparation. The final cost of the remedy protection alternatives will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, the final remedy protection scope and schedule, and other variable factors. As a result, the final remedy protection costs will vary from the costs presented in this section.

9.7.1 Alternative RP-1: No Further Action (Post-Event Response)

Alternative RP-1 would not address current limitations of the existing community infrastructure as a means to provide additional measures of long-term protectiveness to the existing Selected Remedies. This alternative would instead rely on post-event cleanup response to storm events to maintain the protectiveness of the existing remedy.

9.7.1.1 Overall Protection of Human Health and the Environment

Alternative RP-1 would not include remedy protection actions, but would be protective of human health and the environment by maintaining the existing Selected Human Health Remedies through post-event response. The existing Selected Remedies are protective as documented in the Second Five-Year Review Report (USEPA, 2005b). The risk of exposure for Alternative RP-1 could temporarily increase following a storm event, from the time that the remedy was damaged or recontaminated until completion of the post-event response.

9.7.1.2 Compliance with ARARs

Alternative RP-1 could potentially be implemented in compliance with location- and action-specific ARARs. Location- and action-specific ARARs for Alternative RP-1 would be identified and complied with during the post-event response actions included in Alternative RP-1.

9.7.1.3 Long-Term Effectiveness and Permanence

In general, Alternative RP-1 would be an effective long-term alternative because, in most cases, the existing protective barriers provide long-term protection from contamination. Due to the geographic and environmental nature of the Selected Remedies and the deteriorating condition of portions of the existing infrastructure for water drainage systems in the Upper Basin, the protectiveness of the Selected Remedies is not expected to last into perpetuity. Based on the hydrologic and hydraulic models presented in Appendix G, there are areas where the existing Selected Remedies are at risk of recontamination due to flooding and uncontrolled surface water flow. The models predict recontamination of the protective barriers based on the probabilities associated with 5-, 25-, and 50-year storm events. While in general Alternative RP-1 would be effective in the long term, based on these data, portions of the existing Selected Remedies are not expected to have long-term effectiveness and permanence. Alternative RP-1 would not address this issue of permanence of the existing Selected Remedies, but instead assumes that the protective barriers would be repaired after recontamination.

9.7.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative RP-1 would not include treatment and, therefore, would not reduce the toxicity, mobility, or volume of metals contamination through treatment.

9.7.1.5 Short-Term Effectiveness

In general, Alternative RP-1 would be effective in the short term because the existing protective barriers associated with the Selected Human Health Remedies have proven effective in reducing exposure through decreases in residents' blood lead levels (USEPA, 2005b). Since Alternative RP-1 does not include actions to address the existing infrastructure, the risk to portions of the Selected Remedies remain. Much of the existing infrastructure throughout the Upper Basin communities is undersized and/or deteriorating. Alternative RP-1 would allow a relatively higher risk of contaminant mobility within residential areas during storm events. Additionally the risk of exposure could temporarily increase following a storm event from the time that the remedy was damaged or recontaminated until completion of the post-event response.

9.7.1.6 Implementability

Alternative RP-1 would not have any technical feasibility issues. This alternative only includes the maintenance and repair of existing protective barriers and this technology has been proven during implementation of the existing Selected Remedies.

Administrative implementability issues would exist in regards to repair and maintenance of the existing Selected Human Health Remedies. Based on the hydrologic and hydraulic models, storm events (5-year storm event or greater) are expected to impact the existing protective barriers in some communities. Since storm events cannot be predicted, there could be administrative issues in the availability of funds to maintain the barriers' protectiveness. Additionally, in some cases, the repair of the protective barriers could be time-sensitive in order to maintain protectiveness and limit a resident's risk of exposure.

9.7.1.7 Cost

The cost for Alternative RP-1 is based on the methodology and assumptions discussed in Section 9.6.1.1. The cost for Alternative RP-1 includes the expected cost to repair and re-remediate the existing Selected Remedies following storm events. This expected cost is based on the hydrologic and hydraulic modeling included in Appendix G, and assumes the existing infrastructure is functioning as designed. The cost for Alternative RP-1 does not include costs that would be associated with the general cleanup of non-soil barriers (such as roadways and structures) or repair of failed infrastructure in a post-event response scenario. Alternative RP-1 does not include any capital costs, and the expected post-event response cleanup costs are categorized as O&M costs. Appendix D of this FFS Report provides detailed cost estimates for each community included in this evaluation. Table 9-6 summarizes the Alternative RP-1 costs for each community.

The estimated total cost (30-year NPV) for Alternative RP-1 in the eight primary Upper Basin communities would be $33.8 million.

The approximate total cost (30-year NPV) for Alternative RP-1 in the side gulches is approximately $16.3 million. Because very little information (and no hydrologic or hydraulic modeling data) is currently available for the side gulches, this cost estimate was developed based on assumptions developed from the hydrologic and hydraulic modeling trends found in the eight primary Upper Basin communities, as previously discussed in Section 9.6.1.1. Appendix D (Table D-19) includes documentation of the assumptions made to develop the approximate cost for Alternative RP-1 for the side gulches.

The total cost (30-year NPV) for Alternative RP-1, including the eight primary communities and the side gulches in the Upper Basin, is estimated to be $50.1 million.

9.7.2 Alternative RP-2: Modifications to Selected Remedies to Enhance Protectiveness (Remedy Protection Projects)

Alternative RP-2 includes water conveyance improvements to increase the long-term permanence and effectiveness of the existing Selected Human Health Remedies from damage due to floods and uncontrolled surface water flow. The water conveyance improvements are composed of process options included in the technology list and are defined on a community-by-community basis. The hydrologic and hydraulic modeling results included in Appendix G present the basis for the process options chosen to protect the Selected Remedies. The water conveyance improvements would be designed to protect the remedy up to a 50-year storm event.

9.7.2.1 Overall Protection of Human Health and the Environment

Alternative RP-2 would be protective of human health and the environment because it would modify the existing Selected Remedies to enhance their long-term effectiveness and permanence. This alternative would reduce the risk of floods and uncontrolled surface water flow damaging the existing Selected Remedies. Although the existing Selected Remedies are considered protective of human health and the environment in accordance with the 2005 Five-Year Review Report (USEPA, 2005b), the report did find some issues associated with the permanence of the existing Selected Remedies. Alternative RP-2 would address the issues associated with tributary flooding and overland flow from precipitation and snow melt and would enhance the permanence of the existing Selected Human Health Remedies. By enhancing the existing Selected Remedies, Alternative RP-2 would reduce the risk of exposure to contaminated material in the residential areas.

9.7.2.2 Compliance with ARARs

Alternative RP-2 could be implemented in compliance with location- and action-specific ARARs. The location-specific stream and creek channel ARARs (see Sections 4.2.2 and 4.2.3) would apply to Alternative RP-2 for creek channel modification technologies. Additional location- and action-specific ARARs for Alternative RP-2 would be identified and complied with during the design and implementation of remedy protection projects.

9.7.2.3 Long-Term Effectiveness and Permanence

Alternative RP-2 would enhance the long-term effectiveness and permanence of the existing human health barriers portion of the existing Selected Remedies. The risk of damage to the Selected Remedies in the communities from storm events would decrease. Alternative RP-2 would have limitations because the remedy protection projects would be designed to convey flows up to a 50-year storm event. Therefore, the flooding risk would remain, but to a lesser extent.

9.7.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative RP-2 would not include treatment and, therefore, would not reduce the toxicity, mobility, or volume of metals contamination through treatment.

9.7.2.5 Short-Term Effectiveness

Alternative RP-2 would be effective in the short term because the existing protective barriers associated with the Selected Human Health Remedies have been shown to be protective of human health and the environment (USEPA, 2005b). Alternative RP-2 would also decrease the risk that a flood less than a 50-year storm event would damage the existing Selected Remedies in the short-term time frame and expose residents to contaminated material.

The objective of Alternative RP-2 would be to effectively convey potentially contaminated floodwaters and sediments through the communities where the Selected Remedies have the highest risk of exposure and recontamination. Currently, based on model results, the contaminated floodwaters and sediments would be expected to spread through the communities during relatively minor events (5-year storm event). Alternative RP-2 would reduce the mobility of contaminants and increase short-term effectiveness of the Selected Remedies within the communities because the contaminants would be effectively conveyed through the communities for floods up to the 50-year storm event.

9.7.2.6 Implementability

Alternative RP-2 would not have any technical implementability issues. The water conveyance improvements included in the technology list (Table 9-4) are common technologies used in stormwater and creek conveyance systems. It would be important to implement the Alternative RP-2 remedy protection projects during the low-flow (dry) season to minimize construction costs associated with dewatering and diversion of water.

Administrative implementability issues would exist concerning O&M for Alternative RP-2. For Alternative RP-2 to effectively increase the long-term effectiveness and permanence of the existing Selected Remedies, it would be necessary to complete routine O&M tasks. Prior to construction, agreements would have to be completed regarding which state or local entity will perform the O&M tasks associated with Alternative RP-2 and which entity will ensure that sufficient resources are available, or a determination will be made that a local regulatory scheme ensures performance of O&M. Furthermore, there would be logistical challenges to implementing Alternative RP-2 on private properties, where access and easement agreements would be needed prior to construction.

9.7.2.7 Cost

The cost for Alternative RP-2 is based on the assumptions provided in Section 9.6.1.2 and the modeling results included in Appendix G. The detailed cost estimates for Alternative RP-2 are included in Appendix D. Table 9-7 summarizes the total capital costs, annual average O&M, 30-year NPV O&M, and total cost (30-year NPV).

The total capital costs are separated by drainage area and by community. The estimated total capital cost for Alternative RP-2 in the eight primary Upper Basin communities is $13.7 million. The estimated annual average O&M cost for Alternative RP-2 is $401,000, and the 30-year NPV O&M cost is $4.98 million. Assumptions were made that 2 percent of the capital costs would be spent annually on repairs and maintenance to the remedy protection projects beginning the year the project is implemented. O&M costs pertain to remedy protection projects identified in Alternative RP-2 and visual inspection and documentation process options identified for various drainages located within the eight Upper Basin communities. The total cost (30-year NPV) for Alternative RP-2 in the eight Upper Basin communities would be $18.8 million.

The total cost (30-year NPV) for Alternative RP-2 for the side gulches would be approximately $15.1 million. Because very little information (and no hydrologic or hydraulic modeling data) is currently available for the side gulches, this cost estimate was developed based on assumptions developed from the remedy protection actions identified in the eight Upper Basin communities, as previously discussed in Section 9.6.1.2. Appendix D (Table D-36) includes documentation of the assumptions made to develop the approximate cost for Alternative RP-2 for the side gulches.

The total cost (30-year NPV) for Alternative RP-2, including the eight primary communities and the side gulches in the Upper Basin, is estimated to be $33.9 million.

9.8 Comparative Evaluation of the Remedy Protection Alternatives

Based on the detailed evaluation in Section 9.7, this section compares the remedy protection alternatives. The purpose of the comparative analysis is to identify the relative advantages and disadvantages of each alternative to assist in the selection of a remedy protection alternative. The following sections describe the results of the comparative analysis in terms of the seven CERCLA criteria, and Table 9-8 summarizes the findings.

9.8.1 Overall Protection of Human Health and the Environment

Both Alternative RP-1 and Alternative RP-2 would be protective of human health and the environment because the existing Selected Human Health Remedies have been shown to be protective (USEPA, 2005b). Alternative RP-2 would be more protective of human health and the environment because it increases the long-term effectiveness and permanence of the existing Selected Remedies by decreasing the risk of recontamination due to floods and uncontrolled surface water flow. Alternative RP-1 does not reduce the risk that floods and uncontrolled surface water pose to the existing Selected Remedies, but instead would repair and/or re-remediate when the Selected Remedies are damaged. Alternative RP-1 could expose people in the affected area to contaminants until such time as the remedy could be repaired and/or re-remediated. Based on modeling results, flooding and surface water flow would be expected to damage portions of the existing Selected Remedies due to the existing, inadequate community infrastructure during storm events.

9.8.2 Compliance with ARARs

Both Alternative RP-1 and Alternative RP-2 could potentially be implemented in compliance with location- and action-specific ARARs. As discussed in Section 9.7, chemical-specific ARARs were not included as part of this evaluation because the remedy protection alternatives only maintain the Selected Remedies.

9.8.3 Long-Term Effectiveness and Permanence

Alternative RP-2 would increase the long-term effectiveness and permanence of the existing Selected Human Health Remedies, while Alternative RP-1 would only maintain and repair the existing Selected Remedies when they are damaged or recontaminated. Alternative RP-2 would implement water conveyance improvements to convey floodwater and stormwater without damaging the existing Selected Remedies up to a 50-year storm event. This would decrease the risk of damage to the existing Selected Remedies and increase their permanence. Alternative RP-1 does not address the issues associated with the permanence of the existing Selected Remedies and instead would address permanence by repairing and replacing the Selected Remedies into perpetuity.

9.8.4 Reduction of Toxicity, Mobility, and Volume through Treatment

Neither Alternative RP-1 nor Alternative RP-2 would include treatment and, therefore, would not reduce the toxicity, mobility, or volume of metals contamination through treatment.

9.8.5 Short-Term Effectiveness

Both alternatives would be effective in the short term because the existing Selected Remedies have proved effective in protection of human health and the environment. Alternative RP-2 would reduce the mobility of potentially contaminated sediments transported by floodwaters and surface water flows within the communities by effectively conveying floodwaters up to a 50-year storm event. Alternative RP-1 would not reduce the current mobility of contaminated sediments transported by floodwaters within the communities.

9.8.6 Implementability

Both Alternative RP-1 and Alternative RP-2 are implementable, but each would have typical implementation issues that would need to be addressed.

Alternative RP-1 addresses the cleanup of the soil portions of the Selected Remedy. Contaminated sediments may be deposited on other areas within the communities such as streets, buildings, and parking lots. Effective implementation of Alternative RP-1 would require a coordinated overall response within the communities. Administrative implementability issues would exist for Alternative RP-1 with respect to the repair and replacement of the Selected Remedies following storm events. These storm events cannot be predicted and the availability of funds to repair the Selected Remedies and maintain their protectiveness in the future is unknown. In some cases, the repair of the protective barriers could be time-sensitive in order to maintain protectiveness and limit community residents' risk of exposure.

Alternative RP-2's only technical implementation issue is that it would be beneficial to implement the remedy protection projects during the low-flow season to minimize cost. Alternative RP-2 would have administrative implementability issues associated with O&M of the water conveyance improvement projects. Prior to construction, agreements would have to be completed regarding which state or local entity will perform O&M tasks associated with Alternative RP-2 and which entity will ensure that sufficient resources are available, or a determination will be made that a local regulatory scheme ensures performance of O&M. Additionally, there would be logistical feasibility issues associated with the construction of remedy protection projects on private property. Access and easement agreements would be needed prior to implementation of Alternative RP-2.

9.8.7 Cost

Alternative RP-2 would cost less than Alternative RP-1. Table 9-9 presents a side-by-side comparison of the total costs (30-year NPV) for Alternatives RP-1 and RP-2 in each community and the side gulches. The total cost (30-year NPV) for Alternative RP-1 includes the expected cost to repair and re-remediate the existing Selected Remedies based on model outputs and flood event probabilities. For Alternative RP-2, the total cost (30-year NPV) includes direct and indirect capital costs and O&M costs (30-year NPV) for the construction of the remedy protection projects.

In total, Alternative RP-1 would cost $50.1 million in 30-year NPV terms, while Alternative RP-2 would cost a total of $33.9 million in 30-year NPV terms.

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