3.0 CONCEPTUAL SITE MODEL AND EVALUATION METHODS

A conceptual site model (CSM) was developed to provide an initial understanding of potential site contamination and help formulate an approach to conducting the Remedial Investigation. This section summarizes the CSM and screening methods used in the remedial investigation.

3.1 CONCEPTUAL SITE MODEL

The CSM for the project was developed to convey (1) a summary of the sources of contamination, (2) mechanisms of contaminant release, (3) pathways of contaminant release and transport, and (4) ways in which humans and ecological resources in the basin are exposed to contaminants. The CSM was developed to provide a structure for assembling information about the basin and data from a variety of sources. To facilitate analysis of processes at work in the basin, portions of the basin with similar geomorphology, stream gradients and amounts and types of mining wastes were grouped into CSM units (see Part 1, Section 2 for a more complete discussion on CSM unit boundaries).

The following are the source types, release mechanisms and affected media that were identified as potentially important to the investigation of the site.

Primary source types:

- Mine workings—shafts and adits: Groundwater that enters 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.
- Artificial fill: Mining wastes intentionally placed as fill (e.g., for railroads, roadways and structures).

Secondary source types:

- Groundwater
- Surface water
- Suspended and bedload sediment
- Alluvium and floodplain deposits

Primary release mechanisms:

- Dissolution
- Water erosion
- Channel migration
- Wind erosion
- Mass wasting
- Chemical processes

Secondary release mechanisms:

- Chemical processes
- Water erosion
- Channel migration
- Wind erosion

Affected media:

- Groundwater
- Surface water
- Sediment
- Alluvium (soils and other materials that have been transported by water to their present location, and usually are not covered by water)
- Upland soils
- Air

Exposure routes are the pathways and processes by which humans and living natural resources (receptors) might be exposed to metals from mining waste. The selection and evaluation of risks to receptors is described in the Human Health Risk Assessment and the Ecological Risk Assessment (both published under separate cover). As discussed in the Human Health Risk Assessment, air was not found to be a significant pathway (Terragraphics 2000).

Sources, release mechanisms, affected media, exposure routes and potential receptors are illustrated in Part 1, Section 2 for the Coeur d'Alene River and tributaries, Coeur d'Alene Lake, and the Spokane River.

3.2 EVALUATION METHODS

The initial methods used to evaluate chemical and physical data compiled in the remedial investigation are presented in this section. Methods include (1) determination of pre-mining metal background concentration ranges, (2) identification of the chemicals of potential concern (COPCs), (3) selection of risk-based screening levels, and (4) calculation of mass loading.

3.2.1 Determination of Background Metals Concentrations

A primary purpose of the RI was to identify areas within the Coeur d'Alene basin that are contaminated by mining wastes. Contaminated areas can be determined by comparing concentrations of metals in environmental media (soil, sediment, and water) with concentrations that are likely to be naturally occurring. Those naturally occurring concentrations (not influenced by mining contamination) are called "background concentrations." Once established, background concentrations can also be used to assist in the selection of remedial goals or target clean-up levels when used in conjunction with risk-based values determined through human health and ecological risk assessments.

Sufficient data were available for soil, sediment, and surface water to develop background concentrations. Sufficient data were not available to develop background concentrations for groundwater. To determine which portions of the Coeur d'Alene basin should be considered contaminated and, therefore, evaluated in the feasibility study, concentrations of metals in environmental media were compared with background values and risk-based benchmarks.

Background concentrations derived for use in the remedial investigation for the ten chemicals of potential concern are discussed in Part 1, Section 5.2, and are summarized in Table 3.2-1. Background concentrations for soil and sediments represent the 90th percentile concentration. Background concentrations for surface water represent the 95th percentile concentration.

3.2.2 Chemicals of Potential Concern and Screening Levels

Based on preliminary results of the human health and ecological risk assessments, 10 COPCs were identified for inclusion and evaluation in the remedial investigation. The COPCs and

appropriate corresponding media (soil, sediment, groundwater, and surface water) are summarized in Part 1, Section 5.

For the evaluation of site soil, sediment, groundwater, and surface water chemical data, the lowest available risk-based screening level for each media was selected as the screening level. If the lowest risk-based screening level was lower than the available background concentration, the background concentration was selected as the screening level. Groundwater data were screened against surface water screening levels to evaluate the potential for impacts to surface water from groundwater discharge.

For site groundwater and surface water, total and dissolved metals data were evaluated separately. Risk-based screening levels for protection of human health (consumption of water) are based on total metals results. Therefore, total metals data for site groundwater and surface water were evaluated against screening levels selected from human health risk-based screening levels. Risk-based screening levels for protection of aquatic life are based on dissolved metals results. Therefore, dissolved metals data for site groundwater and surface water were evaluated against screening levels selected from aquatic life risk-based screening levels.

Selected screening levels are listed in Tables 3.2-2 through 3.2-4.

For evaluation of the nature and extent of the 10 chemicals of potential concern in site soil, sediment, groundwater, and surface water, data were compared to 1x, 10x, and 100x the screening levels.

Screening levels were used in the remedial investigation to help identify source areas and affected media that were carried forward for evaluation in the FS.

Table 3.2-1
Selected Background Concentrations for Metals in the Basin

Media[a,b]	Antimony	Arsenic	Cadmium	Copper	Iron	Lead	Manganese	Mercury	Silver	Zinc
Upper Coeur d'Alene River Basin										
Soils	5.8	22	2.7	53	65,000	171	3,597	0.3	1.1	280
Sediments	3.3	13.6	1.56	32.3	26,000	51.5	1,210	0.179	1.1[c]	200
Lower Coeur d'Alene River Basin and Coeur d'Alene Lake										
Sediments	1.63	12.6	0.678	25.2	27,600	47.3	325	0.179[d]	0.324	97.1
Spokane River Basin										
Sediments	1.63[e]	9.34	0.72	23.9	25,000	14.9	663	0.032	0.324[e]	66.4
Coeur d'Alene River and Spokane River										
Surface Water	2.92	0.91	0.38	1.48	46.8	1.09	20.4	0.66	0.14	24.2

[a]All soil and sediment concentrations in mg/kg (milligrams per kilogram); all surface water concentrations in µg/L (micrograms per liter).

[b]Data sources:

- Upper Basin Soils: 90th percentile from Gott and Cathrall (1980) data
- Upper Basin sediments: 90th percentile estimated from RI/FS data
- Lower Basin sediments: 90th percentile estimated from RI/FS data
- Spokane River Basin sediments: 90th percentile of Ecology soil background data (WDOE 1994)
- Surface water: 95th percentile estimated from RI/FS data

[c]A range of background concentrations for silver in Upper Basin sediments could not be estimated because most values were below reporting limits. Therefore, the value for silver in soil has been selected recognizing that this value is biased high.

[d]A range of background concentrations for mercury in Lower Basin sediments could not be estimated because most values were below reporting limits. Therefore, the value for mercury in Upper Basin sediments has been selected recognizing that this value is biased high.

[e]No Ecology data were available for antimony and silver in Spokane River Basin sediments. Therefore, the Lower Basin sediment values were selected recognizing that these values are biased high.

Table 3.2-2
Selected Screening Levels for Groundwater and Surface Water—Coeur d'Alene River Basin and Coeur d'Alene Lake

Chemical	Surface Water Total (µg/L)	Surface Water Dissolved (µg/L)	Groundwater Total (µg/L)	Groundwater Dissolved (µg/L)
Antimony	6[a]	2.92[b]	6[a]	2.92[b]
Arsenic	50[a]	150[c,d]	50[a]	150[c,d]
Cadmium	2[e,f]	0.38[b]	2[e,f]	0.38[b]
Copper	1[e,f]	3.2[c,d]	1[e,f]	3.2[c,d]
Iron	300[a]	1,000[c,d]	300[a]	1,000[c,d]
Lead	15[a]	1.09[b]	15[a]	1.09[b]
Manganese	50[a]	20.4[b]	50[a]	20.4[b]
Mercury	2[a]	0.77[c,d]	2[a]	0.77[c,d]
Silver	100[a]	0.43[c,d]	100[a]	0.43[c,d]
Zinc	30[e,f]	42[c,d]	30[e,f]	42[c,d]

[a]40 CFR 141 and 143. National Primary and Secondary Drinking Water Regulations. U.S. EPA Office of Water. Office of Groundwater and Drinking Water. http://www.epa.gov/OGWDW/wot/appa.html. October 18, 1999.
[b]Dissolved surface water 95th percentile background concentrations calculated from URS project database.
[c]Freshwater NAWQC for protection of aquatic life are expressed in terms of the dissolved metal in the water column.
[d]Freshwater NAWQC for cadmium, copper, lead, silver, and zinc are expressed as a function of hardness (mg/L of CaCO3) in the water column. Values above correspond to a hardness value of 30 mg/L.
[e]Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision. U.S. Department of Energy. Office of Environmental Management. ES/ER/TM-96/R2. Value based on total metals concentration.
[f]Value based on protection of aquatic plants.

Note:
µg/L - microgram per liter

Table 3.2-3
Selected Screening Levels for Surface Water—Spokane River Basin

Chemical	SpokaneRSeg01		SpokaneRSeg02		SpokaneRSeg03	
	Surface Water Total (µg/L)	Surface Water Dissolved (µg/L)	Surface Water Total (µg/L)	Surface Water Dissolved (µg/L)	Surface Water Total (µg/L)	Surface Water Dissolved (µg/L)
Antimony	6[a]	2.92[b]	6[a]	2.92[b]	6[a]	2.92[b]
Arsenic	50[a]	150[c]	50[a]	150[c]	50[a]	150[c]
Cadmium	2[e,f]	0.38[b]	2[e,f]	0.38[b]	2[e,f]	0.38[b]
Copper	1[e,f]	2.3[c,d]	1[e,f]	3.8[c,d]	1[e,f]	5.7[c,d]
Iron	300[a]	1,000[c]	300[a]	1,000[c]	300[a]	1,000[c]
Lead	15[a]	1.09[b]	15[a]	1.09[b]	15[a]	1.4[c,d]
Manganese	50[a]	20.4[b]	50[a]	20.4[b]	50[a]	20.4[b]
Mercury	2[a]	0.77[c]	2[a]	0.77[c]	2[a]	0.77[c]
Silver	100[a]	0.22[c,d]	100[a]	0.62[c,d]	100[a]	1.4[c,d]
Zinc	30[e,f]	30[c,d]	30[e,f]	50[c,d]	30[e,f]	75[c,d]

[a]40 CFR 141 and 143. National Primary and Secondary Drinking Water Regulations. U.S. EPA Office of Water. Office of Groundwater and Drinking Water. http://www.epa.gov/OGWDW/wot/appa.html. October 18, 1999.
[b]Dissolved surface water 95th percentile background concentrations calculated from URS project database. Technical Memorandum. Estimation of Background Concentration in Soils, Sediments, and Surface Waters. Coeur d'Alene Basin RI/FS. URS. May 2001.
[c]Freshwater NAWQC for protection of aquatic life are expressed in terms of the dissolved metal in the water column.
[d]Freshwater NAWQC for cadmium, copper, lead, silver, and zinc are expressed as a function of hardness (mg/L of $CaCO_3$) in the water column. Value for segments Spokane RSeg01, -02, and -03 calculated using hardness values of 20, 37, and 59 mg/L $CaCO_3$, respectively.
[e]Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision. U.S. Department of Energy. Office of Environmental Management. ES/ER/TM-96/R2. Value based on total metals concentration.
[f]Value based on protection of aquatic plants.

Note:
µg/L - microgram per liter

Table 3.2-4
Selected Screening Levels—Soil and Sediment

Chemical	Upper Coeur d'Alene River Basin		Lower Coeur d'Alene River Basin		Spokane River Basin	
	Soil (mg/kg)	Sediment (mg/kg)	Soil (mg/kg)	Sediment (mg/kg)	Soil (mg/kg)	Sediment (mg/kg)
Antimony	31.3[a]	3.30[b]	31.3[a]	3[c]	31.3[a]	3[c]
Arsenic	22[b]	13.6[b]	12.6[b]	12.6[b]	9.34[b]	9.34[b]
Cadmium	9.8[d]	1.56[b]	9.8[d]	0.678[b]	9.8[d]	0.72[b]
Copper	100[d]	32.3[b]	100[d]	28[c]	100[d]	28[c]
Iron	65,000[b]	40,000[c]	27,600[b]	40,000[c]	25,000[b]	40,000[c]
Lead	171[b]	51.5[b]	47.3[b]	47.3[b]	14.9[b]	14.9[b]
Manganese	3,597[b]	1,210[b]	1,760[a]	630[c]	1,760[a]	663[b]
Mercury	23.5[a]	0.179[b]	23.5[a]	0.179[b]	23.5[a]	0.174[c]
Silver	391[a]	4.5[c]	391[a]	4.5[c]	391[a]	4.5[c]
Zinc	280[b]	200[b]	97.1[b]	97.1[b]	66.4[b]	66.4[b]

[a]U.S. EPA Region IX Preliminary Remediation Goals for Residential or Industrial Soil http://www.epa.gov/region09/wasate/sfund/prg. February 3, 2000.
[b]Technical Memorandum. Estimation of Background Concentration in Soils, Sediments, and Surface Waters. Coeur d'Alene Basin RI/FS. URS. May 2001.
[c]Values as presented in National Oceanographic and Atmospheric Administration Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Seattle, WA. M. F. Buchman, 1999. Values generated from numerous reference documents.
[d]Final Ecological Risk Assessment. Coeur d'Alene Basin RI/FS. Prepared by CH2M HILL/URS for EPA Region 10. May 18, 2001. Values are the lowest of the NOAEL-based PRGs for terrestrial biota (Table ES-3).

Note:
mg/kg - milligram per kilogram