SMCSF 2.7
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# Feasibility Study

## St. Maries Creosote Site
## St. Maries, Idaho

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**17 JULY 2006**

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**REV Table 5-2 Cleanup Levels for Upland Soils**

| Chemical of Concern | Soil Cleanup Level (mg/kg) (1) | Universal Treatment Standards (mg/kg)(2) | Land Disposal Restrictions (mg/kg)(3) | Region IX PRGs Residential Soil (mg/kg) | Region IX PRGs Industrial Soil (mg/kg) | Region IX PRGs Soil Screening Levels – Migration to Groundwater DAF 20 (5) | Region IX PRGs Soil Screening Levels – Migration to Groundwater DAF 1 |
|---|---|---|---|---|---|---|---|
| Napthalene | 4 | 5.6 | 5.6 | - | - | - | - |
| Acenaphthylene | Not available | 3.4 | - | - | - | - | - |
| Acenaphthene | 29 | 3.4 | 3.4 | - | - | - | - |
| Fluorene | 28 | 3.4 | 3.4 | - | - | - | - |
| Phenanthrene | Not available | 5.6 | 5.6 | - | - | - | - |
| Anthracene | 590 | 3.4 | 3.4 | - | - | - | - |
| Fluoranthene | 210 | 3.4 | - | - | - | - | - |
| Pyrene | 210 | 8.2 | 8.2 | - | - | - | - |
| Benz(a)anthracene | 0.08 | 3.4 | 3.4 | - | - | - | - |
| Chrysene | 8 | 3.4 | 3.4 | - | - | - | - |
| Benzo(b)fluoranthene | 0.2 | 6.8 | - | - | - | - | - |
| Benzo(k)fluoranthene | 2 | 6.8 | 6.8 (sum) (4) | - | - | - | - |
| Benzo(a)pyrene | 0.4 | 3.4 | 3.4 | - | - | - | - |
| Indeno(l ,2,3,-c,d)pyrene | 0.7 | 3.4 | 3.4 | - | - | - | - |
| Dibenzo(a,h) anthracene | 0.08 | 8.2 | 8.2 | - | - | - | - |
| Benzo(g,h,i)perylene | Not available | 1.8 | - | - | - | - | - |
| 2-Methylnaphthalene | Not available | - | - | - | - | - | - |

**REV Table 5-2 Cleanup Levels for Upland Soils**

| Chemical of Concern | Soil Cleanup Level (mg/kg) (1) | Universal Treatment Standards (mg/kg)(2) | Land Disposal Restrictions (mg/kg)(3) | Region IX PRGs Residential Soil (mg/kg) | Region IX PRGs Industrial Soil (mg/kg) | Region IX PRGs Soil Screening Levels – Migration to Groundwater DAF 20 (5) | Region IX PRGs Soil Screening Levels – Migration to Groundwater DAF 1 |
|---|---|---|---|---|---|---|---|
| Benzene | 0.002 | 10 | - | 0.64 | 1.4 | 0.03 | 0.002 |
| Toluene | 0.6 | 10 | - | 520 | 520 | 12 | 0.6 |
| Ethylbenzene | 0.7 | 10 | - | 400 | 400 | 13 | 0.7 |
| Xylenes | 10 | 30 | - | 270 | 420 | 210 | 10 |
| Carbazole | 0.03 | - | - | 24 | 86 | 0.6 | 0.03 |
| Dibenzofuran | Not available | - | - | 150 | 1600 | - | - |
| 4-Methylphenol | Not available | - | - | 310 | 3100 | - | - |
| 2,4-Dimethylphenol | 0.4 | 14 | - | 1200 | 12000 | 9 | 0.4 |

(1) EPA Region 9 Preliminary Remediation Goal for the protection of groundwater using a dilution and attenuation factor (DAF) of 1.

(2) Universal Treatment Standards from 40 CFR 268.48

(3) Land Disposal Requirements 40 CFR 268

(4) Because benzo(b)fluoranthene and benzo(k)fluoranthene coelute on gas chromatography columns, this constituent is regulated as a sum of the compounds.

(5) Dilution Attenuation Factor

# 1 Introduction

Carney Products, Ltd. (Carney Products) and the City of St. Maries (the "City") entered into an Administrative Order on Consent (Comprehensive Environmental Response, Compensation and Liability Act (CERCLA-10-2001-0137)) with the United States Environmental Protection Agency (EPA), acting in consultation with the Coeur d'Alene Tribe (Tribe). The Administrative Order on Consent calls for Carney Products and the City to complete a remedial investigation (RI) and feasibility study (FS) for the St. Maries Creosote Site (Site) in St. Maries, Idaho. The final Remedial Investigation and Baseline Risk Assessment Report (RI/BLRA) (RETEC, 2004a) was submitted in February 2004.

The FS was prepared in conjunction with the EPA and Tribe through a series of three Technical Memoranda as outlined in the final Statement of Work (SOW) (Appendix A to the Administrative Order on Consent). The FS describes and evaluates remedial technologies and process options applicable to the Site. Remedial alternatives that incorporate applicable technologies are developed, evaluated and compared. **In February 2005 the FS for the St. Maries Creosote Site in St. Maries, Idaho was delivered to the EPA (RETEC, February 2004) Subsequent to the distribution of the FS, a Proposed Plan (Alternative 8) was developed by the EPA as lead agency and the Tribe (EPA, July, 2005). Alternative 8 proposed to contain, remove and treat source materials, reduce costs, and provide more permanent and protective measures for human health and the environment than the seven alternatives analyzed in the final FS. The Proposed Plan was issued as part of the EPA's public participation responsibilities under CERCLA, as amended, and Section 300.430(f)(2) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The Proposed Plan was made available to the public for a thirty-day public comment period that began on July 22, 2005 and concluded on August 22, 2005. The public comment period was extended to October 12, 2005.**

**The St. Maries Potential Responsible Parties (PRPs), including Carney Products, B.J. Carney & Company, and the City of St. Maries submitted comments on the Proposed Plan (Alternative 8) which included an additional alternative (Alternative 9). Alternative 9 will implement a series of actions to eliminate as much source contaminant mass as practicable. Alternative 9 will utilize excavation and thermal desorption to eliminate contaminant mass, and in situ stabilization to treat soils and sediments to eliminate the risk pathway. The PRPs requested EPA to evaluate Alternative 9 as a potential remedy for the Site as opposed to Alternative 8 that was outlined in the Proposed Plan, which had been selected as the preferred remedial alternative. In order to evaluate Alternative 9 as a potential preferred alternative, EPA required a document to be prepared which would be comparative to the existing RI/FS on November 23, 2005. The EPA issued a Supplemental Statement of Work (Supplemental SOW) to fully develop and evaluate Alternative 9 in a Supplemental FS.**

**In order to evaluate Alternative 9 to the other alternatives in the FS, the FS has been amended and restated to include supplemental work. The supplemental work is provided in bold, blue Arial font. This Supplemental RI/FS document includes site characterization and RI data, risk assessment documents and the Proposed Plan. Scoping, the initial planning process of the RI/FS, was initiated by EPA and the respondents under the 2001 SOW. During this initial process, Preliminary Remediation Goals (PRGs) were developed by EPA in consultation with the Tribe. Remedial Action Objectives (RAOs) were developed and presented for public comment during the public comment period as the Proposed Plan (Alternative 8). These RAOs remain in place and are supported by the activities described in Alternative 9. However, after the submittal of the FS and as a function of the development of Alternative 8 and subsequently Alternative 9, RAO 2 was determined not to be necessary by the EPA. As a result RAOs 3, 4 and 5 were re-numbered as RAOs 2, 3 and 4 respectively for Alternate 8 and 9 only. The evaluation for RAOs on Alternatives 1 through 7 remains the same as previously presented in the original FS..**

**The Supplemental work contains a detailed analysis of Alternatives 8 and 9, a list of applicable or relevant and appropriate requirements (ARARs) that apply to alternatives, a detailed cost estimate, and a comparative analysis of all the alternatives. Nine evaluation criteria have been developed by EPA to be used for comparative analysis; Alternative 9 is compared against Alternatives 1 through 8. Where appropriate, comparative analysis information from Alternative 8 (prepared by EPA) is incorporated into this document. While Alternative 9 incorporates some components from the other alternatives, including Alternative 8, it takes additional steps by using the presumptive remedies of thermal desorption and solidification to permanently and significantly reduce the toxicity, mobility, and volume of hazardous substances, pollutants, and contaminants; thereby, eliminating or reducing exposure to human and environmental receptors. In the FS, it was noted that thermal desorption is a presumptive remedy by the EPA for soils, sediments, and sludges at wood treatment sites, and thus, Alternative 9 would have been reasonably anticipated based on the information presented to the public in the FS and Proposed Plan, and available in the Administrative Record.**

## 1.1 Purpose

Consistent with RI/FS Guidance (EPA, 1988), the purpose of the St. Maries FS is to evaluate potential remedial options for this uncontrolled hazardous waste site. The RI and FS together are a "dynamic, flexible process than can and should be tailored to the specific circumstances of individual sites..." (EPA, 1988). "The objective of the RI/FS process is not the unobtainable goal of removing all uncertainty, but rather to gather information sufficient to support an informed risk management decision regarding which remedy appears to be most appropriate for a given site."

## 1.2 Feasibility Study Process

The basis for this FS is documented in several memoranda and correspondence. Consistent with the Administrative Order on Consent, the FS process consisted of three technical memoranda followed by this comprehensive document. The memoranda are as follows:

- Technical Memorandum on Revised Remedial Action Objectives and General Response Actions (March 5, 2003);
- Technical Memorandum on Remedial Technologies, Alternatives, and Screening (August 11, 2003); and
- Technical Memorandum on Detailed Analysis of Alternatives (April 27, 2004).

The content of these memoranda was based on the requirements of Tasks 9 and 10 in the SOW and included much of the content of the FS. The technical memoranda were classified as minor deliverables upon which EPA provided comment, but no formal acceptance was required. The memoranda and EPA comment on each was included in the Administrative Order on Consent to facilitate the FS process.

In addition to the three technical memoranda specified in the SOW, two additional interim memoranda were submitted for EPA's information. Meetings were held to discuss the memoranda and no formal comment was provided. The interim memoranda were:

- Interim Memorandum on Waste Designation (January 9, 2004); and
- Interim Memorandum on Remedial Action Objectives (January 23, 2004).

Finally, issues surrounding sediment cleanup levels and product mobility were addressed through correspondence with EPA and the Tribe in May through October 2004. This correspondence is included in Appendix A.

The FS was prepared based on the content of the three technical memoranda, EPA's comments on these memoranda, two interim memoranda, the various technical correspondence, and meetings with EPA, the Tribe, and the St. Maries PRP Group. The FS incorporates the information from these documents and is intended as a standalone document, which achieves the goal of the FS process; evaluating potential remedial options of the St. Maries Creosote Site.

# 2 Site Background

Background information on the Site was provided in the Summary of Data Gaps Report (RETEC, 2002a) and the RI/BLRA (RETEC, 2004a). This section summarizes this information as well as the conclusions of the RI/BLRA.

## 2.1 Site Description

The Site is located in an industrial portion of the town of St. Maries (population 2,800), in Benewah County, Idaho. The Site lies along the south bank of the St. Joe River (Figure 2-1), approximately 1 mile downstream from the confluence with the St. Maries River and 10 miles upstream of Lake Coeur d'Alene. The Site lies within the boundaries of the Coeur d'Alene Indian Reservation.

The Site lies on a portion of the property that until recently was used as a pole storage yard (no treating) by Carney Products. Carney Products closed its St. Maries office and pole storage yard in early 2003. The yard is partially Public Reserve land and partially owned by Carney Products. The former creosote wood treating plant was located on the Public Reserve Land. The Site, which includes portions of the Carney Products property, the Public Reserve Land, and the adjacent St. Joe River, is illustrated on Figure 2-2. The Figure also shows approximate property ownership boundaries.

The Site is located at Township 44 North, Range 8 West, Section 22, and is accessed through Carney Products' former pole yard. The address of the former pole yard is:

1369 Rail Road Avenue

St. Maries, Idaho 83861

## 2.2 Site History

### 2.2.1 Site Operations

The Site operated as a creosote wood treating plant beginning in the late 1930s. Partial dismantling of plant facilities began by May of 1960, with demolition and regrading of the treating plant area completed by 1965. The former creosote treating operation was relatively small, covering approximately 0.7 acre.

Creosote was brought to the Site via rail, and unpeeled poles were either trucked in or floated in on the St. Joe River. Poles were treated in the butt treating tanks and shipped off-site via rail or truck. During operations, three treating tanks, two aboveground storage tanks and a wood-fired boiler building were located in the main treating area; the former treating plant layout is shown on Figure 2-3. Creosote is the only known treating solution used at the Site.

Since approximately 1965, the Site and surrounding area have been used only for peeling, sorting, and storage of untreated poles. The only structures presently on the Site (near the treating area) are some remaining piles from log cribs, a non-operational water spigot, monitoring wells, concrete blocks, a buried stormwater culvert, and a sewer line.

### 2.2.2 Regulatory History

In December 1998, the City reported product sheen on the riverbank and in the water of the St. Joe River to the federal National Response Center. On January 26, 1999, EPA issued a Unilateral Administrative Order (UAO) to both the City, who has leased the property to various entities since the 1930s, and Carney Products, the current property lessee. The UAO required:

1) Mitigation of observed creosote seeps;

2) Removal of creosote-contaminated soil along the riverbank; and

3) Performance of a site investigation to characterize soil and groundwater contamination in and around the area of the former wood treating facility.

Since notification of the release, the City and Carney Products have maintained boom and sorbent pads at the Site in an effort to control any impacts to surface water.

In response to the UAO, the City and Carney Products performed several actions. In February 1999, the City and Carney Products conducted a removal action at the Site with EPA oversight. That action included excavation and removal of approximately 195 tons of debris and impacted soil along the St. Joe River bank in the area of the observed creosote and sheen. The area of excavation is shown on Figure 2-3 and was about 85 feet long, 10 feet wide, and up to 9 feet deep. The elevation of the base of the excavation was approximately 2125.5 feet (AVISTA datum). Since the removal, small areas of sheen have been noted intermittently on the river surface near the removal area. The boom and sorbent pads continue to be maintained.

Subsequent investigations have been completed by the City and Carney Products, and by the EPA both prior to and under the Administrative Order on Consent. Some additional investigation was completed by B.J. Carney et al.[1] in June of 2003 and September of 2004 for litigation purposes. The June 2003 data were summarized for RI purposes in the Remedial Investigation Addendum: June 2003 Data (RETEC, 2004g). Sampling in the uplands has included approximately 78 test holes, including test pits, hand augers, direct push test holes, and borings. Twenty-two of these borings were completed as wells or piezometers. Work in the St. Joe River has included 63 surface sediment samples, 11 sediment cores and 23 surface water samples. Sample locations are shown on Figure 2-4. The data generated from the investigations are pertinent to the RI/FS and have been set forth in the RI/BLRA. These investigations found that sediments, soil, and groundwater had been impacted

[1] See Appendix of RI Addendum (RETEC, 2004g).

by past creosote treating operations. These impacts are discussed further in Section 2.6. Results of these investigations are provided in more detail in the RI/BLRA (RETEC, 2004a) and the RI Addendum (RETEC, 2004g).

## 2.3 Demography

The City is the county seat of Benewah County, located in the panhandle of Idaho. The City has a population of about 2,800 people and Benewah County has a population of approximately 9,000 people. The City includes an area of 1.1 square miles. Beyond the City boundaries, the area is sparsely populated or forested. Benewah County land is roughly four-fifths forested and one-fifth farming and city. Timber is the main industry in the City and the county. Mining and farming also contribute to the area's economic base (St. Maries Chamber of Commerce [http://www.stmarieschamber.org], St. Maries Gazette Record [http://www.stmariesidaho.com/], Fed Stats, US Government [http://www.fedstats.gov/mapstats/more.data/16009.html]).

## 2.4 Land, Groundwater and Surface Water Use

The Site is located in the City and beneficial uses of the land and groundwater are subject to City code. Surface water use is affected by Tribal code as well.

### 2.4.1 Land Use

The Site and surrounding area are zoned for manufacturing and industrial use. Since Carney Products closed the office and pole storage yard in April 2003, there has been no activity at the Site. Property approximately 1,200 feet east and southeast of the Site is zoned and used as parks and recreation. Approximately 1,000 feet southwest of the Site, the land is zoned for multiple-residence dwellings. The residential area is uphill, upgradient, and isolated from the Site by a flood control levee, industrial road, storm drainage ditch, railroad tracks, and other industrial facilities. West of the Site, the land is zoned manufacturing and industrial.

Land use at the Site is significantly limited by its location between the St. Joe River and the flood-control levee. As discussed in Section 2.5.1, the Site is located in a floodway[2] and can be subject to relatively regular and periodic flooding. The Site area can be inundated by river water and experiences significant flooding. The Site and surrounding area experience minor intrusion by river water on an average frequency of every 1 to 2 years and experience more significant flooding every 3 to 4 years.

[2] A floodway, per the Federal Emergency Management Agency, is the area of the floodplain that should be kept free of obstructions (http://www.fema.gov/fhm/fg-fld01.shtm).

### 2.4.2 Groundwater Use

Under City code all houses, buildings, or properties used for human occupancy are required to utilize public (City) water. The City water supply includes surface water and groundwater sources located 2 to 8 miles upstream and upgradient of the Site. Groundwater is recovered from depths of 250 to 330 feet below ground surface (bgs). Consistent with the City code, no wells are present within a 0.5 mile of the former treating area. Eight wells are located approximately within a 0.5 to 1-mile radius. These water wells are located in areas hydraulically isolated from the Site, being located across the river, upstream, or upgradient to the south. Groundwater at the Site discharges to St. Joe River (see Section 2.5.1) and the beneficial use of Site groundwater is recharge to surface water.

### 2.4.3 Surface Water Use

Surface water uses for the St. Joe River are listed by the Tribe and State of Idaho as agricultural, recreational, cultural and aquatic life. Domestic water supply is not listed as a use by either entity (IDAPA 58.01.02, Coeur d'Alene Tribe, 2000). Prior to June 18, 2001, and the United States Supreme Court decision in Idaho v. United States, 121 S. Ct. 2135, 533 U.S. 262 (2001), the Idaho Department of Water Resources (IDWR) administered the surface water rights to the St. Joe River. Currently, the Tribe administers an encroachment program that includes water rights.

Surface water rights to the St. Joe River in the vicinity of the Site, as available on the IDWR database, are limited. Carney Products is listed as having an IDWR water right and pumped water from the river approximately 200 feet downstream of the former treating area. The water was used to keep poles that had not been debarked moist. Four other properties in the area are listed as having IDWR water rights on the St. Joe River. One is located on the north side of the river, approximately 1 mile upstream. The remaining three are located over 1 mile or more downstream of the former treating area, and on the same side of the river. The other four properties use the pumped water for watering lawns. Surface water testing adjacent to the Site has shown that surface water concentrations are below applicable screening levels.

## 2.5 Physical Characteristics

For discussion purposes, the Site can be subdivided into the uplands, riverbank, and river. The physical characteristics of each of these areas are interrelated. The uplands are generally flat and include the former treating plant and surrounding area. The riverbank is a steeply sloping portion of the Site between the uplands and the river. The St. Joe River and the river bed are included in the river portion of the Site.

## 2.5.1 The Uplands

### 2.5.1.1 General Characteristics

The uplands area is relatively flat with an approximate elevation of 2,135 feet (AVISTA datum). The surface consists of sandy to silty gravel with remnants of haul roads from prior Site operations. The former wood treating operations were located about 70 to 100 feet south of the St. Joe River (Figure 2-3). Concrete pads, building foundations and some tracks associated with former treating operations remain at, or immediately beneath the gravel surface.

Active underground utilities include adjacent City storm and sanitary sewers located approximately 50 feet east and upstream of the former treating plant (Figure 2-3) and a local storm drain. The two City sewers run parallel to one another in a general north-south direction. The storm sewer outfalls to the St. Joe River. This storm sewer collects runoff from an approximately 900-acre area including undeveloped land and commercial, residential and industrial properties. The sanitary sewer traverses beneath the river, transporting water to the City's water treatment area north of the river. A local storm drain collects water from the former Carney Products pole yard, generally southwest of the Site and drains the surface water to the St. Joe River through a series of ditches and a culvert. The outfall of local storm drain to the St. Joe River is approximately 150 feet downstream from the former treating area.

### 2.5.1.2 St. Joe River Influence

The upland portion of the Site lies on the floodplain between the St. Joe River and the flood-control levee (see Figure 2-2) and experiences periodic flooding. The Site is on land classified as a floodway by the Federal Emergency Management Agency (FEMA). The St. Joe River crests and water inundates the uplands portion of the Site with an approximate frequency of every one to two years. In approximately half of these events the height of water above the Site is one foot or less. During the other half of these events water commonly floods to a height of four feet above the Site and rarely reaches up to seven feet above the Site. While flooding occurs regularly, velocities over the uplands are relatively slow as the base elevation of the St. Joe River (Lake Coeur d'Alene) rises during flooding as well. Measurements of surface river velocities during the 2002 flood (combined St. Joe and St. Maries River discharges of approximately 30,000 cubic feet per second [cfs]) were between 0.59 and 2.87 feet per second.

### 2.5.1.3 Geology

Unconsolidated fluvial and deltaic sediments underlie the Site and St. Joe River valley as a whole. The St. Joe River flowed at a lower elevation until approximately 10,000 years ago, when the formation of Lake Coeur d'Alene by glacial flooding caused the river to fill its valley with the existing sequence of sands, silts, and clays. The upland slopes on both sides of the river valley are composed of Precambrian mudstones and sandstones, as well as Quaternary basalt.

The fluvial and deltaic floodplain deposits underlying the Site consist of interbedded unconsolidated sand, silt, and clay to a depth of at least 65 feet below grade. The geologic conditions are shown on cross-section (Figure 2-5). While there is some variation within the units (as expected in a fluvial setting), the general stratigraphic units described below are laterally continuous across the uplands portion of the Site.

#### 2.5.1.3.1 Fill

A veneer of fill material generally 2 to 5 feet thick overlies the native alluvial sediments in the uplands. This fill consists of crushed quartzitic gravel with a matrix of sand, silt, and woody debris. On roadway areas, including much of the former wood treating area, an asphaltic layer is present near the surface of the gravel. The asphaltic layer essentially cements the near surface gravel. The layer is thought to be the result of several historic applications of road oil as a dust control measure. In the vicinity of the wood treating operations, the fill is thicker (shown as the dashed line extending into the upper silt unit on Figure 2-5) and includes more debris such as wood, metal, brick, and pipe.

#### 2.5.1.3.2 Upper Silt Unit

This unit underlies the fill material. It consists of a dark gray to brown micaceous silt generally 15 to 20 feet thick. It locally contains root structures and thin, very fine-grained sand interbeds. Texturally the upper silt unit is loose to firm.

#### 2.5.1.3.3 Upper Interbedded Unit

The interbedded unit includes alternating layers of: (1) thinly laminated micaceous silts; (2) very-fine-grained, poorly graded sands, and (3) clay. The interbeds within the unit are generally less than 2 to 6 inches thick. Woody/reedy material is present in the unit. Overall thickness of the interbedded zone ranges from about 12 to 21 feet. In general, the interbedded unit fines downward with the upper portion of the unit having a higher proportion of sands beds and the lower portion of the unit having more silt and very fine grained sand interbeds.

#### 2.5.1.3.4 Sand Unit

The sand unit consists of a relatively homogenous, gray-colored, micaceous, very fine to medium grained, poorly graded sand to silty sand. Silt interbeds are locally present at the base of the sand. Overall thickness of this unit ranges from about 13 to 16 feet.

#### 2.5.1.3.5 Lower Interbedded Unit

In a portion of the uplands, interbedded sands and silts are present between the sand unit and the lower silt unit. This unit ranges from 0 to 10 feet thick and has been identified in the boring for MW-1D, and the CPT test holes CR-1, CR-2, CR-3 and CR-8 (see Figure 2-5). In the RI/BLRA, this unit was included in the top of the lower

silt unit. For clarity, these interbedded sands and silts have been called out as a separate unit in the FS.

#### 2.5.1.3.6 Lower Silt Unit

The lower silt to silty clay underlies the sand or lower interbedded unit and consists of interbedded gray micaceous silt texturally similar to the upper silt. The unit is also interbedded with gray-green inorganic clay of high plasticity. The overall thickness of this unit is not known, but is at least 10 feet thick.

### 2.5.1.4 Hydrogeology

Hydrogeologic units correspond to the geological units at the Site.

#### 2.5.1.4.1 Upper Silt Zone

The upper silt zone is the uppermost water bearing unit at the Site and is considered an unconfined aquifer. Depth to groundwater varies seasonally, ranging from about 2.5 to 7 feet bgs. Hydraulic conductivity of the upper silt ranged from $3.67 \times 10^{-5}$ to $1.32 \times 10^{-4}$ cm/s.

Figure 2-6 shows representative groundwater flow directions in the upper silt zone. During most of the year, groundwater flow is northward toward the river. However, groundwater flow in the upper silt fluctuates in response to river stage, with wells closer to the river showing a stronger response to changes in river stage. Temporary and local reversals in flow direction (southward from the river to the Site) occur as the river rises and floods (e.g., May 2002). Water level fluctuations in the upper silt zone are shown on Figure 2-7 (hydrograph) and the groundwater gradient during 2002 and 2003 in the upper silt is shown on Figure 2-8. Flow from the river to the Site is limited and the net groundwater flow at the Site is towards the river. In general, the groundwater gradient is relatively shallow in the upland area and steeper adjacent to the riverbank.

#### 2.5.1.4.2 Upper Interbedded Zone

The upper interbedded zone is fully saturated throughout the year. Figure 2-9 shows groundwater flow directions in the upper interbedded zone. Figure 2-10 is a hydrograph illustrating water level fluctuation and Figure 2-11 shows groundwater gradients in the upper interbedded zone. Similar to the silt zone, flow is generally toward the river and there are temporary flow reversals when the river level rises, locally recharging the upper interbedded unit. Groundwater level variations in the upper interbedded zone correlate well with the river level fluctuations, with the degree of correlation decreasing farther inland (i.e., at PZ-5I and PZ-6I).

#### 2.5.1.4.3 Sand Aquifer

The sand unit is a fully saturated semi-confined aquifer beneath the upper interbedded zone. The mean hydraulic conductivity of the sand unit is $3.03 \times 10^{-4}$ cm/s.

Figure 2-12 shows groundwater flow directions in the sand aquifer, Figure 2-13 shows water level fluctuations and Figure 2-14 shows the groundwater gradients.

Similar to the overlying units, groundwater flow is generally northward toward the river. However, during the spring runoff period, as the river reaches it banks, or tops its banks, the river temporarily recharges the aquifer. When the river rises, groundwater flow direction is southward, away from the river. These reverse flow events are temporary and water flow direction changes back northward when the river stage drops.

Groundwater in the sand aquifer responds rapidly to changes in river stage. The response is closer than the response observed in either the upper silt unit or the upper interbedded unit (intermediate wells). Water levels in deep wells adjacent to the river are essentially the same as river water levels during most measurements and the close correlation to river stage decreases inland at wells MW-4D and MW-5D. With a semi-confined aquifer, some of the change in head in response to river stage changes may be a pressure response and not be necessarily indicative of significant groundwater flow.

#### 2.5.1.4.4 Lower Interbedded Zone and Lower Silt Zone

The lower silt forms a confining layer beneath the sand unit. In some areas the contact between the sand and the lower silt is gradational and shows interbedding (the lower interbedded zone). At other locations the contact is more abrupt. Grain size data indicate the unit is clayey silt. Corresponding hydraulic conductivity literature estimates for this grain size are on the order of $10^{-6}$ cm/s (Freeze and Cherry, 1979).

#### 2.5.1.4.5 Vertical and Net Groundwater Flow

The vertical gradients between the upper silt unit and the sand aquifer, and the intermediate wells and the sand are provided on Figure 2-15, and Table 2-1, respectively. Calculated gradients correspond to river levels. Upward gradients occur when the river levels are high in the spring. Gradients are relatively flat and generally downward in the summer, and early fall when river levels are maintained at approximately 2,128 feet AVISTA. The magnitudes of downward gradients increases in the late fall when river elevations drop.

Overall, vertical gradients in the upper interbedded unit are low. In general, gradients are downward in the winter and spring and slightly upward in summer and fall. Between the upper silt and the upper interbedded unit, gradients ranged from 0.41 upward to 0.33 downward. Between the upper interbedded unit and the lower sand, vertical gradients ranged from 0.33 upward to 0.93 downward.

Figures 2-16 through 2-19 are flow nets showing the net groundwater flow in a two-dimensional cross section. Flow nets were constructed for May and November 2002, and January and April 2003 using the shallow, intermediate, and deep wells. The November 2002 and January 2003 flow nets show flow downward and toward the river. The April flow net also shows flow is downward and toward the river except in the immediate vicinity of the river where there is reverse flow (i.e., the river is recharging the aquifer). The flow net constructed for May 2002 represents high flow or flood conditions, using the shallow and deep wells, and shows the net flow direction is towards the former treating area, both from the river and the uplands.

The groundwater flow at the Site is largely controlled by river stage. During most of the year, groundwater flow is towards the river. During high river stages, flow reverses and begins to flow from the river southward to the Site. Depending on the extent of the flooding, the reversal can occur for a few days to a few weeks. All hydrostratigraphic units respond relatively rapidly to changes in river stage. The sand aquifer responds very quickly, likely as a pressure response. The response decreases inland at the well MW-4 pair. In some cases, flow may actually converge on the former treating area, which is 80 to 100 feet inland of the river.

The horizontal and laterally continuous upper interbedded zone from the uplands investigation was also encountered in sediment cores SD-34 and SD-21. In addition, the contact between the upper interbedded zone and the sand zone was encountered in SD-34. Therefore, the middle and lower sediment units from the sediment investigation conform to the upper interbedded unit and sand unit of the uplands investigation. The recent sediments (upper unit of the sediment investigation) comprised largely of organic clays and silts overlie the upper silt and upper interbedded units.

### 2.5.1.5 Ecology

The upland portion of the Site (the former creosote treating area) only comprises 0.7 acre on the 14-acre Carney Products previously used for pole storage, and this area is located on the most industrialized and least vegetated area of the property. The habitat survey indicated that all of the habitats on the Site are disturbed by industrial activity that has been ongoing since at least the late 1930s. The majority of the property (70 to 90 percent) is occupied by roads, bare ground, and dry upland disturbed habitat dominated by weedy forbs. Two small community types are present: a row of planted black hawthorn (1 percent), and a small patch of thin-leaved alder/red-osier dogwood community (1 percent). The black cottonwood/red-osier dogwood riparian habitat (8 to 28 percent of the Carney Products property, and not including the Site) is isolated from the river by steep banks, some portions of which are covered in riprap or crib walled.

## 2.5.2 The Riverbank

### 2.5.2.1 General Characteristics

The riverbank is relatively steep; it is less than 25 feet wide and has a relief of approximately 10 feet to the river in summer. The bank consists of rip rap in the vicinity of the 1999 removal action and heavily vegetated soil in surrounding areas. Wood pilings are present along much of the bank area, and the area has been used for log booms for decades. Currently, portions of the Site near the removal action (including the containment boom used to address sheening) are no longer used for log booms.

### 2.5.2.2 Geology and Hydrogeology

Away from the rip rap area the riverbank consists of silty soil with some debris including rock, brick, wire and woody debris. The silty soil is correlative to the silt unit in the uplands. Portions of the riverbank exposed during low water show some sediment accumulation. Depending on the stage of the river, the riverbank serves as an area of groundwater recharge and discharge.

### 2.5.2.3 Ecology

The riverbank in the vicinity of the Site has limited habitat. No wetlands are present along the shoreline at the Site. Avian use is concentrated in the cottonwood and red-osier dogwood habitat along the river shoreline. There is likely very little use of the Site by large mammals because access to the river is limited by the steep banks and crib walls and the band of riparian forest on the Site is very narrow (generally, less than 25 feet wide).

Wetland habitat is present in some areas in the general vicinity of the Site. Opposite the property (north bank side of the River) there is a small (less than 1 acre) emergent wetland and also on the north side of the river extending downriver there is a narrow strip of forested wetlands in several backwater sloughs between the river and the highway. During summer water levels, the forested wetland appeared to be separated from the river by the riverbank. There is a well-developed emergent, scrub-shrub, and forested wetland (greater than 10 acres) within Butler Bay, approximately 3.5 miles downstream of the Site. No federal or state listed plant species were found in the riparian and wetland habitats. No water potatoes were observed in the wetland areas.

Several avian species were seen along the river shoreline, the most numerous of which were swallows and cedar waxwings. A small number of mallard ducks, American robins, common ravens, and a single great blue heron were also observed. Approximately 0.5 and 0.75 miles downstream of the project Site there are two osprey nest platforms and ospreys were observed feeding near these platforms. No mammals were observed; however, deer tracks were seen in the sandy soils along the shore on the north bank near the Highway 3 Bridge. A variety of both small and large mammals likely use the riparian habitat and undisturbed upland areas. Although

coyote and raccoon may use the uplands and river shoreline, and mink may use the shoreline riparian habitats, most mammals are expected to use the north shoreline. Because the City lies to the south of the Site, the north bank of the river provides wider riparian corridors and more extensive and well-developed riparian habitats and less industrial activity. Most mammal use would be expected to occur along the north shoreline.

## 2.5.3 The St. Joe River

### 2.5.3.1 General Description

The St. Joe River channel is about 300 feet wide and 30 feet deep. The confluence of the St. Maries River and the St. Joe River is approximately 1 mile upstream of the Site and the river flows westward and into Lake Coeur d'Alene approximately 10 miles downstream of the Site. The mean annual flow for the St. Joe River ranges from 1,000 to 3,800 cfs, and the mean annual flow from the St. Maries River ranges from 160 to 900 cfs. The river elevation varies seasonally. The St. Joe River stage (as measured at the confluence with the St. Maries River approximately 1 mile upstream of the Site) varies in elevation from approximately 2,121 feet (winter level) to 2,128 feet (summer level) and rises to as high as 2,142 feet during spring runoff/flood stage.

The elevation of Lake Coeur d'Alene has a strong influence on river stage and flow in the St. Joe River at the Site. Flooding of Lake Coeur d'Alene raises the base level of the St. Joe River leading to water backing up upstream in the river, including the area around the Site. The town of St. Maries has experienced five major floods over the last century including a 100-year flood in 1996.

### 2.5.3.2 River Bed

The river bed bathymetry is shown on Figure 2-4. Soft sediment is present on the river bottom with thickness ranging from 0.4 to 5.4 feet. The river bottom generally consists of fine-grained sediments with scattered debris, trash, and submerged vegetation. The grain size of the surface sediments ranged from dominantly silt and clay near the bank to dominantly fine to medium sand in the middle of the channel.

Adjacent to the Site, the river channel drops off abruptly to a depth of approximately 15 feet, then gradually slopes to a depth of about 25 feet. The more gradually sloped zone corresponds to a horizontal distance of about 20 to 50 feet offshore representing a shallow bank of soft sediments. While uncertainties exist, radioisotope data suggest that this area is largely depositional. Average sedimentation rates in this area (cores SD-14 and SD-40) are estimated to be approximately 2 centimeters per year (RI/BLRA, Appendix K). The river cross section suggests that a zone of little or no deposition is more likely beyond 75 to 100 feet from shore in the flat deep area of the channel where faster moving currents would be located.

## 2.5.3.3 River Sediments

For the river portion of the Site, three lithologic units were identified in the upper 14 feet of the sediment column of the St. Joe River. Units below the surficial river sediment correlate well with uplands units.

### 2.5.3.3.1 River Sediment (Upper Unit)

In general, this unit is an olive-brown, soft, moderately compressible, "organic" sandy silt with some clay and high moisture content. The unit contains woody material including small, decomposed twigs, plants and other wood chips. This unconsolidated unit ranges from 0.9 to 4.7 feet in thickness throughout the study area. The sand content increases with distance from the shoreline. The water content is high near the surface (low percent solids) and decreases with depth. This unit generally represents the "soft sediment."

### 2.5.3.3.2 Upper Interbedded Unit (Middle Unit)

The unit below the recent soft sediment deposits is classified as an interbedded sand and silt unit. This unit ranges from 2.5 feet to 10.2 feet in thickness throughout the area. The silt beds are in general greenish gray, wet, medium stiff, sandy silt with trace wood and trace laminations. The sand units are in general medium gray, damp, medium stiff, silty fine sand with trace clay and trace rootlets. This unit correlates with the upper interbedded unit identified in the uplands. This unit also contains woody layers containing twigs, fibrous shreds, woodchips, and occasional gravels ranging in thickness from 0.5 to 4 inches.

### 2.5.3.3.3 Sand Unit (Lower Unit)

The unit is a fine to medium sand and was not fully penetrated by any sediment core. The recovered thickness of this unit ranges from 1.7 feet to 4.5 feet. In general, this unit is homogenous with an olive-gray color, wet, medium dense and fine to medium grained with trace silts. This unit correlates to the sand unit identified in the uplands. Most of the contacts are gradational.

## 2.5.3.4 Ecology

Few organisms were found in the sediment. No benthic organisms were found in field sieving and evidence of sediment invertebrates was only found at two stations (worms, chironomids, and insect larvae). These results could reflect seasonal changes in benthic population cycles (e.g., more growth and abundance during spring months); however, the results more likely indicate that this ecosystem may function as a pelagic (living in the water column) environment and not as a benthic system (lack of organisms living in the sediment). The river bottom could potentially function as a seasonal benthic habitat for activities such as spring hatching of invertebrate larvae. Stands of submerged aquatic vegetation were observed in the shallow nearshore areas in about 5 to 12 feet of water.

These findings are consistent with a 1987 benthic invertebrate study conducted by Falter and Hallock (1988) in which the St. Joe River ranked as very productive when compared to regional lakes data, although composition and diversity of organisms was relatively sparse (8 to 10 major taxa). The invertebrate composition was dominated by water-column biota, and many of the sediment samples often had no invertebrates present, especially in high sand content samples. This river study supports the assumption that the ecological food web is more pelagic based than benthic based.

## 2.6 Nature and Extent of Contamination

Creosote impacts above the Site screening levels were identified in soil, groundwater, and sediments at the Site. Chemicals of interest (COI) concentrations were below screening levels in surface water.

### 2.6.1 Contaminants of Interest

Contamination at the Site is related to the past use of creosote for wood preserving. Records indicate that creosote was the only chemical used in the treating process at the Site. PCP was not used at the Site and has been detected in only surface soil and one surface sediment sample and at low concentrations (below respective reporting limits). The creosote does contain some lighter end hydrocarbons including benzene from either incomplete refining of coal tar or additives to the creosote. A creosote sample collected from the St. Maries Site contains approximately 30 percent of the 16 priority pollutant polynuclear aromatic hydrocarbon (PAH), and 0.15 percent benzene, toluene, ethylbenzene, and xylenes (BTEX) (including 0.01 percent benzene). The sample also contained approximately 10 percent water and solids. Based on general creosote composition information (for coal tar creosote), the remaining 60 percent is expected to include other PAHs, phenols, heterocyclic oxygen, sulfur and nitrogen compounds (including dibenzofuran) (ATSDR, 2002).

COI were identified in the RI/FS Work Plan (RETEC, 2002b) based on historical Site operations, a comparison of the existing data to the screening levels, and an evaluation of background concentrations. For purposes of completing the RI field work, the COIs were identified as:

- Polycyclic aromatic hydrocarbons (PAHs);
- Other semivolatile organic compounds (SVOCs); and
- Benzene, toluene, ethylbenzene, and xylenes (BTEX).

These COIs applied to all media (soil, groundwater, surface water, and sediment). Samples were analyzed for PAHs and other SVOCs by EPA Methods 8270/8270-SIM and for BTEX by EPA Method 8260.

## 2.6.2 Sources

As discussed in Section 2.6.1, wood treatment was accomplished using butt tanks, and creosote was the only treating solution used at the treating plant. Based on the operational history, the potential primary source areas are as follows:

- Former wood treating area (butt tanks, above ground storage tanks and the surrounding area);
- Railroad tracks and roads adjacent to the treating area; and
- Disposal at the riverbank and the river.

Creosote was released from these primary source areas by spills, leaks, drips, and by historical disposal of wastes. Any remaining creosote and the affected soil, groundwater, and sediment are the secondary (or tertiary) sources.

Releases from the former treating area are evidenced by staining and oily residue in soil, odor and measured PAH concentrations in shallow unsaturated zone soil, and deeper soil from the saturated zone in the former treating area.

Several lines of evidence suggest that overbank disposal during plant operation and demolition in the 1960s contributed to impacts at the Site. Wastes have been found on and in the riverbank shoreline including a log, wood debris, wire, a barrel and chunks of solid creosote material. During the 1999 riverbank removal, one-quarter of the material disposed of was reported to be debris (EMCON, 1999). This indicates that the bank was either used for disposal or for operations and/or demolition that resulted in releases.

As indicated, chunks of solidified creosote were observed at the shoreline by the assistant rural fire chief in 1994[3] and during the 1998/1999 Site work on the riverbank shoreline (see photograph in Appendix B). This solidified creosote was not visible at most times of the year because it was below normal river elevations and was difficult to access during low river stages that occur in the late fall and winter. The solidified creosote-like material are indicative of historical disposal because the "chunks" noted during the removal were located in a dominantly subaqueous location, were solid chunks including tabular blocks and rounded balls (see photo in Appendix B), and the material was noted sitting on top of the sediment at the base of the steeper portion of the bank. Creosote that currently occurs in the shallow and deeper sediment and in the soil near the shoreline is a liquid, coating soil and sediment grains. Solidified chunks of creosote do not exist at the Site and therefore are not expected to form in the subsurface.

Tabular blocks and rounded balls of are not characteristic of product that has oozed to the surface and solidified. The product is not viscous enough to form large balls or

[3] Deposition of James Shubert on March 23, 2004, Carney Product Company Ltd., vs. B.J. Carney & Company, et al., CS00-377-FVS.

tabular blocks if it flowed out of the sediment. In addition, experience with similar material indicates that creosote would not harden unless the material was located in a hot, dry environment for many months of the year (thus, located above the water table and summer river level). Solidified material can also occur in process equipment. The material on the bank was only exposed above the river during low water in late fall/early winter and therefore a mechanism to cause the creosote to solidify where it was found is not apparent. Furthermore, based on the viscosity of the product found in soil and sediment, it could not have flowed out higher on the bank. The product viscosity is such that it would have flowed down the bank.

As indicated by contamination on-site and at other wood treating sites operating at the same time, the standard of care in the industry at that time generally included releases to the surface in the area around the treating plant. Creosote sludges and other wastes were generally disposed of at some location on the treating facility[4]. Based on the debris noted at the river bank at St. Maries, the disposal area could have included the river bank. Therefore, whether creosote on the bank was from operational releases or disposal it is likely that some material on the river bank is from sources other than migration from the upland.

In addition, PAH impacts are present on the riverbank and in the sediments upstream of where creosote has been observed in the subsurface of the uplands. River bank soil/sediment contain PAH concentrations above screening levels to a distance of approximately 150 feet upstream of the 1999 removal area. These detections are located in an area where groundwater concentrations are below screening criteria and no pathways for migration of creosote between the treating plant and the riverbank are evident. Finally, co-located radioisotope and PAH testing show highest concentrations occurring prior to or during the early 1960s (during treating and/or demolition) followed by a marked decrease in concentrations (Appendix B).

### 2.6.3 Distribution of Contamination

The understanding of the distribution of COI at the St. Maries Creosote Site was refined by RI sampling. The areas exceeding screening levels were based on a comparison of sample results and the screening levels (conservative concentrations identified in the RI/BLRA below which no adverse impact on human health or the environment is expected). For surface and subsurface sediment, the screening levels used in this section differ from those originally used in the RI/BLRA. The surface and subsurface sediment screening levels are the numeric preliminary remediation goals (PRGs) developed during the FS process as described in Section 3.1.3. Where creosote-related compounds were present above screening levels, it was not considered a clear risk to potential human or ecological receptors at the Site. Concentrations exceeding a screening level indicated that the area needed further evaluation. Further evaluation was completed in the RI/BLRA. The RI/BLRA followed EPA guidance to determine what compounds were actually COI for the Site,

[4] Deposition of James R. Batchelder on December 7, 2004, Carney Product Company Ltd., vs. B.J. Carney & Company, et al., CS00-377-FVS.

and whether or not the COI present at the Site presented a risk to the human and ecological receptors at the Site.

As discussed in the RI/BLRA, creosote-related chemicals exceeded conservative RI screening levels in surface soils, subsurface soils, groundwater in the shallow (fill, upper silt and upper interbedded units) and deep (deep sand) areas of the Site, and in surface (0-10 cm depth) and subsurface sediments (over 10 cm deep) at the Site as follows:

- Surface soil exceeded screening levels for leaching to groundwater and industrial direct contact screening levels for carcinogenic and total PAH in selected test pits (see Figure 2-20).

- Subsurface soil exceeded leaching and direct contact screening levels in the upper silt, upper interbedded and sand units. The lower silt unit did not exceed screening levels (see Figures 2-21 through 2-25).

- Riverbank soil exceeded screening levels to approximately 150 feet north of the 1999 removal area and at least 265 feet downstream of the 1999 removal area (see Figure 2-26).

- Shallow groundwater (5 to 20 feet bgs) exceeded screening levels near the treating plant and between the treating plant and the river (MW-1S and MW-7S). Groundwater in surrounding wells was below screening levels. Groundwater concentrations exceeding drinking water standards are limited to an area less than 200 by 200 feet (see Figure 2-27).

- Deep (35 to 55 feet bgs) groundwater exceeded screening levels near the treating plant (MW-1D2). Groundwater concentrations exceeding drinking water standards are limited to an area less than 200 by 200 feet (see Figure 2-28).

- Surface sediment exceeded the FS PRG approximately 100 feet downstream and 50 feet upstream of the 1999 removal area. Surface sediment exceeded the low screening levels approximately 1,650 feet downstream and 220 feet upstream of the 1999 removal area (see Figures 2-29 to 2-31).

- Subsurface sediment exceeded FS PRG for surface sediment through most of the core or for the entire core at locations near the 1999 removal area. Farther downstream (up to 725 feet downstream of the 1999 removal) concentrations exceeding surface sediment screening levels were generally at mid depth levels, approximately 4 to 6 feet below the mudline (see Figure 2-32).

Creosote was encountered in subsurface cores and sediment as defined by visual observations and ROST work. The occurrence of creosote, sheens, odor, and staining

as well as fluorescence noted in ROST borings are summarized in Figure 2-33. As discussed in Section 2.7, data indicate that the creosote is predominantly residual. Due to uncertainties, the creosote is considered to have some, limited potential to migrate.

### 2.6.4 Natural Attenuation in Groundwater

Natural attenuation data collected during the RI suggest that biodegradation is occurring and therefore, the modeling was conservative. Groundwater was tested for natural attenuation parameters in July 2002. The results of natural attenuation testing were presented in Table 3-10 of the RI/BLRA. The data were not interpreted in the RI/BLRA and a brief summary is presented here. The testing results indicate:

- The groundwater geochemical environment is generally anaerobic and highly reducing. Dissolved oxygen ranges from 0.11 to 0.82 mg/L and redox ranges from 84 to -403 mV. Only MW-3D, a generally up to cross gradient well, has a positive redox value.

- There is no evidence of biological nitrate or sulfate reduction. Concentrations of these electron acceptors are generally low and fairly consistent across the site.

- Iron and manganese in groundwater are mostly in the reduced form, which could signify biological iron and manganese reduction.

- Methane was detected in all of the monitoring wells, which is evidence of anaerobic biological activity. The highest methane concentrations occurred in the lower sand (generally >1000 µg/L). Concentrations were much lower (11-260 µg/L) in interbedded zone, except for MW-4S (1900 µg/L). With the exception of MW-4S, the shallow wells with the highest methane concentrations, MW-1S and MW-7S, are located in the source area and between the source area and the river. The methane concentrations were 260 and 180 µg/L, respectively.

These data suggest that biological degradation is occurring at the Site and that the dominant degradation mechanism is anaerobic degradation. Although anaerobic degradation is a relatively slow process, and limited for higher molecular weight PAH, testing results suggest that it may be occurring at the Site. A site-specific rate of degradation has not been quantified.

## 2.7 Migration Pathways

Migration pathways associated with the St. Maries Creosote Site have been discussed and evaluated in several of the scoping documents and were further assessed in the RI. Migration pathways were first discussed in the Data Gaps Report (RETEC, 2002). In the data gaps report, the air pathway associated with volatilization was

determined to be incomplete based on the types of COI. The RI/FS Work Plan identified remaining migration pathways that were potentially complete for further evaluation in the RI as follows:

- Migration of mobile DNAPL;
- Soil leaching to groundwater;
- Sediment leaching to surface water;
- Dissolved-phase migration with groundwater;
- Transport of impacted surficial soil during flooding;
- Wind erosion and atmospheric dispersion of surficial soil; and
- Transport of impacted sediment.

Information collected during the RI regarding physical conditions and the nature and extent of impacts at the Site were used to refine the understanding of the migration pathways. As part of the RI work, some of the potentially complete migration pathways were not found to be significant. Other pathways were evaluated and carried forward to be addressed as part of the RI/FS.

### 2.7.1 Potential Pathways Found Not Significant

Pathways considered in the RI but not carried forward and the associated rationale are discussed further in Section 6.2 of the RI/BLRA and summarized briefly in this subsection. Pathways not carried forward were:

- **Sediment leaching to surface water** – monitoring data collected during the RI indicated that surface water concentrations were below screening levels and therefore this pathway was not considered significant.

- **Transport of impacted surficial soil during flooding** – Data collected during the RI indicated that limited floods, such as the flood in 2002, did not have sufficient velocity to erode surface or near-surface soil. The potential for erosion of upland soils and the riverbank during larger floods was evaluated as part of the river modeling effort (Appendix O of the RI/FS). The results indicated that surficial soil at the site was sufficiently coarse that it would not be eroded in a 100-year flood event. Therefore, this pathway was not carried forward.

- **Wind erosion and atmospheric dispersion of surficial soil** – Wind erosion and atmospheric dispersion is not considered a significant migration pathway. The area of PAH in surficial soil above direct contact screening levels is very limited; heavily impacted soil is buried beneath fill placed

after treating operations ceased. Flood waters deposit a layer of silt and sand over the Site. The silt and sand is derived from upstream and, therefore, not impacted by former wood treating activities. This silt and sand is largely the particulates that are eroded and entrained during high wind.

## 2.7.2 Potential Pathways Considered Significant for Further Analysis

Migration pathways identified as potentially significant in the RI and considered in the Risk Assessment and FS are summarized in the following subsections.

### 2.7.2.1 Potential Migration of Dense Non-aqueous Phase Liquid

The evaluation of the potential for creosote to migrate at the Site has included three separate sets of data as follows:

- As described in the RI/BLRA, cores from the locations and depths judged most likely to contain mobile creosote based on higher intensity as measured using the Cone Penetrometer: Rapid Optical Screening Tool (CPT-ROST) were sampled for further testing. These samples were analyzed by the Dean-Stark method to measure the saturation of each core with creosote. These analyses showed that the highest saturation with creosote was approximately 10 percent of the pore volume. Literature values for residual saturation (saturation left after creosote has stopped migrating in an area), range from 5 to greater than 30 percent. Cohen & Mercer, (1993) reported residual saturation values in the range of 5 to 20 percent. Wilson et al. (1990) observed residual NAPL saturations ranging from 14 to 30 percent in unconsolidated sands and possibly higher in heterogeneous sand packs. Quantitative measurements of localized fluid saturations using dual gamma spectroscopy indicated macroscopic entrapment of NAPL at saturations well above 30 percent in heterogeneous sand packs (Illangasekare et al., 1995; Jackson et al., 2004).

- Four piezometers were installed at locations and depths which the CPT-ROST indicated were most likely to contain mobile creosote. In addition, two wells are screened in locations that could potentially contain mobile creosote between the former treating plant and the river. Less than one gallon of creosote accumulated in two of the piezometers installed across likely producing zones during the first nine months after installation. The initial creosote accumulation in the two piezometers is attributed to localized alteration of the subsurface conditions during well installation. Installation of a well alters capillary forces and can mobilize residual creosote in the immediate vicinity of the well. Mobilized creosote will move into the filter pack and the well to reach equilibrium. Once

equilibrium is reached, residual creosote will no longer move into the well. Due to the creosote fluid properties, the time to reach equilibrium may be many months. Recoverable volumes of creosote have not re-accumulated in the two wells, that had the initial accumulation, in the subsequent eighteen months of monitoring. Monitoring has been conducted from July 2002 to October 2004 on a monthly basis (at a minimum). In addition, creosote has not accumulated in the two other piezometers and the two wells installed between the plant and the river.

- Data regarding product mobility (intrinsic permeability, porosity, grain size, total organic carbon, drainage capillary pressure, and relative permeability) were collected in June 2003 (RETEC, 2004g). Analysis of these data indicates that the current calculated creosote seepage velocities are 0.8, 0.9 and 1.6 inches per year in the Upper Silt Unit, the sand layer within the Upper Silt Unit and Upper Interbedded Sand/Silt Unit, respectively. As migration continues, the seepage velocity decreases as the creosote continues to migrate reaching an essentially asymptotic condition. The analysis completed indicates that migration is in this asymptotic zone and thus, the creosote is considered to be essentially stable and may no longer be migrating. Information on this DNAPL mobility assessment is provided in the correspondence in Appendix A.

The investigation work indicates that there is limited potential for the creosote to be mobile at the Site. However, uncertainties associated with this work are sufficient such that EPA has requested that DNAPL migration should continue to be considered a potential migration pathway at the Site. Therefore, this FS considers the pathway of DNAPL migration towards the St. Joe River to be complete. Remedial alternatives are developed in Section 5 that will be protective for this pathway.

While uncertainties exist and this pathway is considered a risk, the magnitude of future migration is considered relatively limited. In contrast to many creosote sites (e.g., Pacific Sound Resources in Seattle Washington; Cascade Pole in Olympia, Washington; and former treating plants in Somers, Paradise and Libby, Montana), DNAPL does not regularly reaccumulate after removal from wells at the St. Maries Creosote Site. RI work has not identified a large pool of DNAPL which would drive substantial additional migration.

### 2.7.2.2 Dissolved-Phase Migration with Groundwater

Results from the RI/BLRA indicate that groundwater normally migrates from the source area and discharges to surface water. While there are some temporary reversals associated with increasing river stage, the net groundwater flow direction in towards the St. Joe River. Groundwater discharging to surface water will encounter sediments and surface water. Surface water sampling indicates that surface water is not impacted by dissolved-phase compounds. However, partitioning of contaminants from groundwater to sediment is a potential migration pathway.

An analysis of groundwater partitioning to sediments in the RI/BLRA (Section 6.2.4 and Appendix S of the RI/BLRA) indicates that long-term migration of groundwater in the upper silt unit and upper interbedded unit and partitioning to sediment may result in sediment concentrations exceeding screening levels used in the RI/BLRA in the nearshore area. For the deep sand unit, partitioning from groundwater is not expected to result in concentrations exceeding the RI/BLRA sediment screening concentrations. The modeling to assess impacts to sediments was completed without considering natural biodegradation of COI. As indicated in Section 2.6.4, site data indicate that anaerobic degradation is likely occurring at the Site. Nevertheless, no degradation was considered to provide a more conservative analysis. Based on the conservative analysis completed in the RI/BLRA, dissolved phase migration with groundwater is considered a complete pathway and is of particular concern for the upper silt and upper interbedded unit.

### 2.7.2.3 Soil Leaching to Groundwater

Creosote or COI sorbed to soil or trapped in pore spaces due to capillary pressures may leach to the surrounding groundwater. Leaching may occur both above and below the water table. This potential pathway is considered to be part of the dissolved-phase migration with groundwater pathway, as discussed above. The inclusion of this pathway with the groundwater pathway is consistent with EPA's Soil Screening Guidance (EPA, 1996).

### 2.7.2.4 Erosion of Impacted Sediments

The St. Joe River in the vicinity of the Site generally experiences relatively low velocity flows (RI-BLRA Appendix O). It is somewhat of a backwater location with respect to Lake Coeur d'Alene. However, during significant flooding events, velocities increase and the potential exists for some scouring of sediment. Significant flood events (e.g., 100-year floods) could potentially alter Site conditions by eroding the surface sediment and temporarily exposing or eroding underlying sediment. The potential for erosion of impacted sediments in the St. Joe River was evaluated through radioisotope dating, modeling, sediment core observations, and reviewing the physical conditions of the river and sediment chemistry (RI-BLRA Appendix P).

The radioisotope data were analyzed to determine the sedimentation rate over time and whether conditions are depositional in a given area of the river. The results of the radioisotope analyses indicate that in the nearshore area, the sediments may experience limited, episodic erosion, but are overall depositional. Modeling used to assess the potential for erosion corroborates the radioisotope data. The modeling indicates that erosion during a 100-year flood (the modeled case) is limited in the nearshore area, and that the magnitude of the erosion is greater in the deeper, mid-channel river sediments. Erosion could extend into subsurface sediment containing PAH concentrations above high screening levels used in the Risk Assessment for surface sediment. The modeled distribution of erosion indicates that subsurface sediment exceeding screening levels could be eroded in the nearshore and some offshore areas. Offshore areas have sediments that exceed screening levels at depth,

though the existing modeling indicates that these deeper sediments exceeding screening levels would only be eroded in some offshore areas. Deposition during waning stages of flooding will deposit a new layer of uncontaminated surface sediment derived from upstream. This redeposition is supported by the chemical data in sediments, which show that surface sediments with concentrations below screening levels have accumulated over more contaminated sediments in both the nearshore and offshore areas.

The modeling results that indicate scouring in the middle of the channel during a 100-year flood are somewhat contrary to observed Site conditions. A 100-year flood occurred in 1996. Currently, sediments with PAH concentrations exceeding PRGs remain at depths where the modeling predicted scour. Thus, the depths of erosion predicted in the basic modeling effort appear to be overestimated.

Erosion in the nearshore impacted area is a potential migration pathway. The potential for erosion of impacted subsurface sediment in the offshore zone is less certain and is retained as a potential pathway.

## 2.8 Summary of Risk Assessment

A baseline Risk Assessment was completed to assess potential risks to human and ecological receptors, both now and in the future from chemicals in impacted media both on and off-site.

### 2.8.1 Human Receptors

In developing the human receptors associated with the Site, the RI/BLRA considered the historic, current, and potential future land use of the upland area, the riverbank, and the river. The uplands portion of the site has historically been used for industrial purposes and is currently unoccupied. Future uses are limited by Site conditions. The upland portion of the site lies on the floodplain, located on the river side of a flood-control levee. The Site floods periodically with river water entering the uplands area every other year (on average). Residential, most commercial and industrial uses of the site are highly unlikely due to the flooding. In addition, FEMA classifies this area as a floodway that should be reserved to allow floodwaters to move downstream. This means it should generally be kept free from obstructions.

The riverbank area is not currently used for any purpose and is off-limits to the public. Trespassers using the area for recreation or fishing could potentially be exposed in the riverbank area. The St. Joe River is open to recreational fishing, and other resource extraction. Fishing activity on the river itself in the vicinity of the Site is currently minimal, both recreationally and by members of the Tribe. Log booms are commonly present in the area of the river adjacent to the riverbank (and away from the 1999 removal area).

Potential carcinogenic and non-carcinogenic human health effects were evaluated for the receptors currently present or potentially present at the Site. The receptors considered were:

- **On-site Commercial/Industrial Workers** – these workers are potentially exposed to surface soil. As discussed in the Risk Assessment, the upland area between the St. Joe River and the river levee is approximately 14 acres. The upland portion of the Site covers about one acre of this 14 acres. Therefore, it was assumed that the worker would spend approximately 10 percent of the workday on the Site.

- **On-site Construction Workers** – these workers are potentially exposed to surface and subsurface soil and groundwater during construction activities.

- **On-site Adult/Child Recreationalist/Trespasser** – these individuals are exposed to surface soil, surface sediment and surface water. This receptor scenario is considered protective of the indigenous population (subsistence user).

- **Hypothetical On-Site Resident** – Potable use of groundwater at the Site was evaluated as a hypothetical scenario.

Exposure routes evaluated included ingestion, dermal contact, absorption, and inhalation. A summary of the exposure routes evaluated is provided on Figure 2-34.

The RI/BLRA determined that all carcinogenic risks associated with soil and sediment for the above receptors and exposure routes were less than, or within, the acceptable risk range ($10^{-6}$ to $10^{-4}$). In all scenarios, carcinogenic total risk fell between $10^{-6}$ and $10^{-5}$. No carcinogenic total risk scenario exceeded a $10^{-5}$ risk level, a generally acceptable risk level for an industrial site where future use is not expected to change. Soil and sediment non-carcinogenic risk was below the acceptable chronic threshold level of HI = 1 in all scenarios. Carcinogenic risks from groundwater for the on-site construction worker are $7.7 \times 10^{-6}$. This is within the acceptable carcinogenic risk range ($10^{-6}$ to $10^{-4}$) and less risk than the $10^{-5}$ risk level commonly accepted for construction workers and industrial scenarios. Non-carcinogenic risk was below the acceptable chronic threshold level of HI = 1 in all scenarios.

As discussed in the RI/BLRA, Site groundwater is not currently used as drinking water and future use is highly unlikely due to the City's ordinances for drinking water and the location of the Site on the floodplain. At the request of EPA, this pathway was evaluated in the RI/BLRA, which determined that carcinogenic and non-carcinogenic risks associated with use of groundwater as potable water exceeded acceptable risk ranges ($10^{-6}$ to $10^{-4}$ for carcinogenic risk and a HI = 1 for noncarcinogenic risk) through the pathways of potential ingestion of, or dermal contact with, Site groundwater by on-site commercial/industrial workers or hypothetical on-site residents.

The RI/BLRA also determined that there are no risks from consumption of fish, water potatoes, and freshwater mussels in the St. Joe River. Water quality sampling demonstrated that there were no detectable COI in surface waters directly above impacted sediments. Surveys conducted within the area of the Site did not find any water potato or freshwater mussels, and thus were considered to be an incomplete pathway for those exposure routes.

### 2.8.2 Ecological Receptors

Potential ecological effects were determined for the following St. Joe River assessment endpoints selected as relevant for the Site:

- Aquatic Invertebrate Community (i.e., zooplankton);
- Benthic Invertebrate Community (i.e., sediment dwelling insect larvae, worms, and other organisms);
- Benthic and Pelagic Fish Communities, represented by the brown bullhead and the brown trout, respectively; and
- Piscivorous Riparian Wildlife, represented by the mink.

Potential risks to these ecological receptors were evaluated using a tiered analysis. The initial, conservative screening level Risk Assessment based on literature values (Tier 1A) indicated that ecological risk could not be excluded for the benthic invertebrate, benthic fish, and piscivorous wildlife communities due to exposure to PAHs in sediment. No significant risk was found for the pelagic fish and aquatic invertebrate communities primarily exposed to the water column.

An additional evaluation (Tier 1B and Tier 2) of ecological risk based on more realistic site-specific conditions indicated that the potential for ecological risk from constituents of potential concern (COPCs) at the Site is spatially limited to the nearshore sediments. As a result, under current conditions there may be ecological risk to benthic invertebrates and benthic fish in nearshore areas adjacent to and immediately downstream of the Site (the nearshore impacted area). Current bioassay data, however, remain insufficient to conclusively define the presence or magnitude of this risk. Potential ecological risk to the mink was not excluded based on a Tier 1B evaluation, although the magnitude is marginal.

## 2.9 Summary and Site Conceptual Model

### 2.9.1 Sources of Contamination

During plant operations/demolition, creosote was released through drips, leaks, spills, and over bank disposal, causing creosote contamination in soil, groundwater, and sediment. The treating plant and over bank disposal were primary sources. These primary sources caused creosote contamination of soils, groundwater, and sediment.

The creosote in the subsurface, soil, groundwater and sediment are secondary or tertiary sources. The risks associated with creosote are measured using specific components of creosote including PAH, selected semivolatile organic compounds (primarily carbazole and dibenzofuran) and selected volatile organic compounds (primarily BTEX).

## 2.9.2 Creosote Distribution

During and after plant operation, creosote migrated through the soil both above and below the water table following fractures, root traces and more permeable layers. Creosote migrated laterally from the source area through the upper silt unit following sand beds and through sandier beds in the upper interbedded unit. After the primary sources of release ceased, the creosote continued some migration through the soil. During migration, the head of the product decreased and residual creosote was left behind in the soil, decreasing the overall volume of mobile creosote. The remaining volume of mobile creosote in the soil is thought to be relatively limited. Creosote migration left a creosote source in soils to depths of approximately 40 feet bgs in the source area and extending outward from the source area, in the sand interbeds within the silt and upper interbedded unit. Creosote is also present in thin, shallow sand lenses in the uplands and near the shoreline at depths beginning about 10 feet below ground surface. With increasing depth, the distance from the shoreline to the mudline of the river increases. Data suggest that in the upper interbedded unit, creosote in sand beds does not reach the mudline. The deepest creosote observed in thin sand layers below the upland is located at a depth below the bottom of the river bed. The distribution of creosote is shown on Figure 2-33. While the mass of mobile creosote is limited, the remaining mobile creosote may have the potential to migrate.

Creosote constituents are present in the riverbank both upstream and downstream of the former treating plant. In the vicinity of the plant, the riverbank was removed in 1999 and consists of rip rap. Free creosote was not noted in the riverbank during the RI with one exception. Sediments exposed along the riverbank at low water (essentially the low water shoreline) adjacent to the former treating plant contain creosote.

As indicated, creosote is present in the sediments at the low water shoreline and in the nearshore area adjacent to the former treating plant to depths of approximately seven (7) feet below the low water shoreline or 14 feet below the summer shoreline (located an approximate horizontal distance of 40 feet riverward of the summer shoreline). Radioisotope dating shows concentrations of creosote constituents (PAH) in the nearshore area peaking in approximately the early 1960s, and the constituents decreasing one to two orders of magnitude after the middle 1960s. Periodically, sheens are noted on the surface water above the area where creosote is present in the nearshore sediment. These sheens are commonly associated with gas bubbles (assumed to be methane). According to observations made by RETEC during surface water sampling activities in 2002 and 2003, the sheens do not appear to emanate from the shoreline, but rather rise through the water column above the sediment-containing creosote (RETEC, 2004a). These sheens appear on the surface water some distance

from the shoreline. During low water periods, when the river level is sufficiently low that the creosote-bearing sediment is at the shoreline, sheens appear at the shoreline. In summary, gas (assumed methane) production and other disturbances in the nearshore area cause sheens to emanate from creosote in the nearshore surface sediment inside of the currently boomed area.

Downstream of this nearshore area creosote impacts are present in subsurface sediments with greatest concentrations generally in the four to six foot depth range. This creosote in the nearshore is a potential source to downstream sediment and a risk to ecological receptors. The creosote constituents in subsurface sediment farther offshore and downstream are not currently a risk to ecological receptors, but may be a potential source to downstream surface sediments should the buried sediments be eroded.

### 2.9.3 Existing Migration Pathways

Based on uncertainties associated with RI analyses, the potential for creosote to be mobile at the Site has not been ruled out. Migration of creosote would pose a risk where receptors in the river could be exposed. Creosote exists in the nearshore and may be the result of overbank disposal and/or creosote migration. The potential for additional creosote migration and impacts to the nearshore area will be further considered in the FS.

The remaining creosote in the subsurface (whether residual or potentially mobile) is a long term source to groundwater. Groundwater impacted with soluble creosote constituents occurs in an approximately 200 by 200 foot area beneath the uplands. The net groundwater flow is towards the river and groundwater carrying creosote constituents could potentially impact sediments or surface water. However, surface water testing shows acceptable concentrations, so potential impact to sediments is the primary concern.

The creosote releases and migration have caused concentrations of creosote constituents above RI screening levels in surface and subsurface soils, groundwater, surface and subsurface nearshore sediments, and subsurface offshore sediments. Migration pathways of concern for the Site include:

- Migration of any remaining mobile DNAPL;
- Constituents of concern (COC) in soil and/or creosote leaching to groundwater;
- Migration of impacted groundwater; and
- Erosion of impacted sediment.

Should driving forces be sufficient, any remaining mobile creosote could discharge to sediment and provide concentrated source material to sediment. Soil and creosote in

the subsurface will be a long term source to groundwater. The groundwater will migrate and have the potential to further impact sediments. The impacted sediments in the surface and subsurface in the nearshore, and sediment in the subsurface in the offshore area could potentially be eroded and further affect the river.

### 2.9.4 Potential Risks to Humans and Ecological Receptors

The Site is in a unique situation with regard to human use. It lies on a floodway between the St. Joe River and the flood control levee. On average, water inundates the Site area every other year. This frequent flooding restricts likely Site use. Representative potential receptors evaluated at the Site include:

- Commercial and industrial workers;
- Construction workers; and
- Recreationalists/trespassers/subsistence users.

Potable groundwater use by a hypothetical resident was also evaluated, although placement of a residence at the Site is not allowed due to City zoning. A rezoning would be necessary. In addition, groundwater use is prohibited by City code. Except in the case of human use of groundwater as potable water, the creosote constituents do not pose a risk to humans above the range considered acceptable to EPA (carcinogenic risk less than $10^{-5}$ and a hazard index less than 1).

From an ecological risk perspective, the St. Joe River assessment endpoints considered for the Site are:

- Aquatic Invertebrate Community (i.e., zooplankton);
- Benthic Invertebrate Community (i.e., sediment dwelling insect larvae, worms, and other organisms);
- Benthic and Pelagic Fish Communities, represented by the brown bullhead and the brown trout, respectively; and
- Piscivorous Riparian Wildlife, represented by the mink.

For the FS, the screening criteria used for surface and subsurface sediment are the numeric PRGs discussed in Section 3.1.3 and defined as Minimum Cleanup Levels (MCULs) in WAC 173-204-520. Some creosote constituent concentrations exceed these sediment numeric PRGs in surface and subsurface nearshore sediments and subsurface offshore sediments. Therefore, there may be unacceptable ecological risk to benthic invertebrates and benthic fish in nearshore areas adjacent to and immediately downstream of the Site (the nearshore impacted area). The conservatively-estimated Hazard Quotient of 57 suggests that mink may be at risk.

However, recalculation of the Hazard Quotient after a theoretical removal of risk to benthic receptors indicates that the risk to the mink would be acceptable, with a Hazard Quotient of 0.5. Remedial actions driven by protection of benthic invertebrates will be protective of other receptors at the Site.

### 2.9.5 Summary

The RI/BLRA showed that, should the groundwater use include potable use, risks would be unacceptable. In addition, risks may be unacceptable from an ecological perspective in the impacted nearshore area. Creosote migration, and soil and creosote leaching to groundwater may be a concern as sediments could be impacted. In addition, there is a potential for scour in the river during significant flood events that could erode sediment with COPC concentrations exceeding screening levels. Remedial Action Objectives and regulatory responses for these risks are described in subsequent sections of this FS.

# 3 Remedial Action Objectives and Regulatory Requirements

The purpose of this FS is to develop and evaluate remedial alternatives for the St. Maries Creosote Site. Sections 3 and 4 define several key cleanup concepts common to all FS and prepared in accordance with CERCLA rules and guidance (EPA, 1988) including:

- Remedial action objectives (RAOs);
- Applicable or relevant and appropriate requirements (ARARs) and information that is "to be considered" (TBC) in the development of remedial alternatives; and
- General response actions.

Collectively, these concepts set the stage for developing effective and protective remedial alternatives for conducting the cleanup at the St. Maries Site.

RAOs are general cleanup objectives designed to protect human health and the environment. RAOs address the threats site contaminants pose to human and ecological receptors. Risks to human and ecological receptors were characterized and estimated in the BLRA, and summarized in the previous section. These estimates of risk showed that based on the foreseeable Site use, there is a potential risk to humans from use of groundwater as potable water, and a potential risk to benthic and aquatic receptors from an area of surface sediments and an area of subsurface sediment.

ARARs and TBCs constitute the body of existing statutes, regulations, ordinances, guidance, and published reports pertaining to any and all aspects of a potential cleanup action at the Site, including within the waters of the St. Joe River. This information typically influences the development of remedial alternatives insofar as the establishment of numeric cleanup levels, permitting (or meeting the substantive requirements thereof), siting, disposal, operating parameters, health and safety, and monitoring.

The General Response Actions (GRAs) are broad categories of actions such as treatment, containment, removal, or combinations of the various categories designed to satisfy one or more of the RAOs. GRAs are included in Section 4.1. Remedial alternatives, which are more specific applications of GRAs to the Site, are developed in the subsequent sections.

## 3.1 Remedial Action Objectives

The first step in the FS process is establishment of the RAOs that will guide this development and evaluation of alternatives. The RI/FS Guidance (EPA, 1988) states that:

Remedial action objectives consist of medium-specific or operable unit-specific goals for protecting human health and the environment. The objectives should be as specific as possible but not so specific that the range of alternatives that can be developed is unduly limited…

Remedial action objectives aimed at protecting human health and the environment should specify:

- The contaminant(s) of concern
- Exposure route(s) and receptor(s)
- An acceptable contaminant level or range of levels for each exposure route.

Section 2.0 reviewed the results of the RI/BLRA, which are the basis for developing the RAOs. The media of concern investigated in the RI/BLRA were soil, groundwater, sediments, and surface water. Surface water concentrations were below risk-based screening levels and therefore an RAO was not developed for surface water. In general, the COC for the St. Maries Creosote Site are creosote-related constituents. Specific COC for each media are discussed in Section 3.1.2. Exposure routes and the associated receptors are as follows:

- Migration of any remaining mobile DNAPL may present an unacceptable risk to ecological receptors in the sediment and cause sheen on surface water;
- Migration of impacted groundwater may partition to sediment at concentrations presenting an unacceptable risk to ecological receptors;
- Erosion of impacted sediment may present an unacceptable risk to ecological receptors;
- An area of surface sediment presents an unacceptable risk to ecological receptors; and
- Potable use of groundwater presents an unacceptable risk.

The media, RAOs, COCs and PRGs are summarized on Table 3-1. The RAOs are discussed in section 3.1.1. COC for particular media are discussed in more detail in Section 3.1.2. Acceptable contaminant levels of the COC in each media or for each RAO are referred to as PRGs. The PRG for each RAO are discussed in Section 3.1.3.

## 3.1.1 RAOs and Basis of RAO Development

RAOs and associated rationale are summarized in Table 3-1.

### 3.1.1.1 Soil

Potential risks associated with soil include those from direct contact with soil, and transfer of COC from soil to another media. Risks related to direct contact with surface and subsurface soil are within the acceptable range for industrial use and therefore, an RAO was not developed. **As outlined in Table 3-1, RAOs were not developed for either surface or subsurface soils. Potential residential and commercial use, ingestion of or dermal contact with COCs or leaching of COCs to groundwater was addressed through development of groundwater RAOs (RAO 3 and RAO 5).**

Evaluation in the RI/BLRA determined that soil in the uplands portion of the Site would not be eroded by flooding and transferred to surface water. Thus, a RAO was not developed, as this is not a complete pathway.

COC are present at concentrations exceeding screening levels for leaching of soil to groundwater (Table 3-2). Consistent with EPA's Soil Screening Guidance (EPA, 1996), this pathway is included with the groundwater pathway.

### 3.1.1.2 Groundwater

Groundwater poses potentially unacceptable risk to human or ecological receptors through two exposure pathways. The first exposure pathway is potable groundwater use by humans. Potable groundwater use is highly unlikely at the Site due to industrial zoning and other municipal ordinances prohibiting such use, and the Site's location on a floodplain that floods frequently (floodway). However, potable use is being considered at EPA's request because any human use of the Site groundwater as potable water would pose carcinogenic and noncarcinogenic risks that are unacceptable. Restoration of the Site groundwater to concentrations suitable for use as drinking water is an applicable or relevant and appropriate requirement (ARAR), as discussed in Section 3.2. Risks associated with the pathway are addressed with the following RAO:

> **Prevent residential and commercial ingestion of, and dermal contact with, COCs in groundwater at concentrations greater than protective levels (RAO 5).**

For groundwater use as potable water, the PRG would be Maximum Contaminant Levels (MCLs) as discussed in Section 3.1.3. The MCLs are the applicable ARAR for concentrations of COC in potable water.

The second groundwater exposure pathway is migration of impacted groundwater from upland areas to the St. Joe River. As the groundwater migrates from impacted

areas and through sediment, COC will partition to sediment and can exceed concentrations protective of sediment-dwelling organisms. **Remedial Action Objective 3 specifies that sediment will be protected from unacceptable discharges of COCs in groundwater:**

> **Prevent migration of impacted groundwater or free-phase creosote to surface sediment in the St. Joe River that would result in COC concentrations greater than protective levels for aquatic and benthic organisms (RAO 3).**

**The groundwater concentrations protective of sediments should be consistent with the sediment concentrations that are protective of benthic infauna. The derivation and application of representative cleanup levels for groundwater that are protective of sediments are described in Section 3.1.3.2.**

### 3.1.1.3 DNAPL

Creosote, the DNAPL at the Site, may migrate. Migration of DNAPL from the Site could pose unacceptable risks associated with accumulation of DNAPL in sediment. With accumulation in sediment, sediment concentrations would exceed levels protective of ecologic receptors. A separate RAO is not developed for the DNAPL migration because this is addressed with the RAO for migration of groundwater listed above.

DNAPL is present at the low water shoreline and the immediately adjacent nearshore area. This DNAPL currently causes sheen to periodically appear in the St. Joe River within the boomed area. If the DNAPL migration pathway is not addressed during remedial action, sheen could potentially reoccur in the river. Surface water collected immediately above the DNAPL containing sediment meets surface water screening criteria, indicating that in the area of sheens, COC are not present in surface water in concentrations that may cause risk to human or ecological receptors. Nevertheless, removal of sheen is an ARAR, as discussed in Section 3.2 and is addressed by the following RAO:

**Prevent visible oil films or sheens in the St. Joe River (RAO 2)**

Sheens on surface water currently occur in a discrete portion of the nearshore impacted area, the area encompassed by the boom. DNAPL in this area should be addressed to prevent continued sheens.

### 3.1.1.4 Sediment

The Risk Assessment identified unacceptable risk for sediment-dwelling receptors in the surface sediment adjacent to the uplands portion of the Site (the nearshore impacted area). Risks associated with this pathway are addressed by the following RAO:

**Protect aquatic and benthic organisms by preventing direct contact of benthic organisms with COCs in surface sediment in the St. Joe River at concentrations greater than protective levels (RAO 1).**

PRG for surface sediment are the site specific MCUL discussed in Section 3.1.3.

**Ecological extent of apparent risk is limited to direct contact with sediments, as represented by benthic invertebrates. Although the risk assessment didn't completely rule out risks to mink, it did indicate that any such risks are 1) due to direct contact with sediment rather than food web exposures and 2) marginal because of the small spatial extent of contamination. Thus, there appears to be a marginal risk to an individual mink that might use the contaminated shoreline, but no apparent risk to the local mink population. Therefore, protection of mink was not included as an explicit RAO. Rather, mink are assumed to be adequately protected by actions taken to protect benthic biota.**

Surface and subsurface sediment in the nearshore impacted area, and downstream subsurface sediment (the offshore area)[5] exceed concentrations protective of sediment-dwelling receptors. Erosion of sediments in the River during major (100-year) flooding events may cause sediments that exceed MCUL to be transported downstream. The magnitude of risk to downstream receptors from this transport is not known. These potential risks are addressed by the following RAO:

**Prevent the downstream transport of COCs that result in COC concentrations in water or sediment that exceed levels protective of aquatic and benthic organisms (RAO 4).**

The PRG for this potential pathway is the MCUL for surface sediment as discussed in Section 3.1.3.

### 3.1.2 Constituents of Concern

COI for the Site were defined in the RI/FS Work Plan and concentrations of the compounds were assessed in the RI. The list of COI was reviewed in the Risk Assessment and a list of COPC was developed based on a comparison of COI concentrations measured as part of the RI and previous work to screening levels. After development of the COPC, Site risks were evaluated for COPC. This section identifies the COC for media of concern to be used in the FS. The COC list is a focused subset of the COPC that will be used to define remedial areas in the FS and will likely be used in performing and monitoring the remedial action.

[5] The downstream area where impacts are limited to subsurface sediments is referred to as the "offshore area." The reader should note that the "offshore area" includes downstream areas located both near the shore and offshore.

The COC list includes PAH, carbazole, and dibenzofuran for sediment, and the groundwater partitioning to sediment pathway, and PAH and selected volatile organic compounds for groundwater as potable water. The specific PAH and volatile organic compounds are listed on Table 3-3. Dibenzofuran and carbazole are SVOC that are commonly associated with creosote and are detected at the site. Dibenzofuran and carbazole are co-located with PAH. Benzene, toluene, ethylbenzene and xylenes (BTEX) are retained as a COC for groundwater as potable water. BTEX were screened out in the RI/BLRA as a COPC from other media because of both detection frequency and the fact that BTEX concentrations did not exceed screening levels (see RI/BLRA Table 7-36).

## 3.1.3 Preliminary Remediation Goals

PRGs are the acceptable contaminant level or range of levels for each exposure route. They are developed for COC and pathways defined in RAOs and are based on risk to receptors and chemical-specific ARARs and TBCs. ARARs and TBCs used in developing PRGs are discussed in more detail in Section 3.2. PRG are identified on Table 3-1 and presented on Tables 3-2through 3-6.

### 3.1.3.1 Sediment PRGs

Sediment PRGs are established to protect sediment-dwelling organisms from contaminants in sediment. These PRGs apply to RAOs 1 and 4 where the media of concern is sediment and the exposure pathway is benthic or benthic and aquatic organisms in contact with sediment. PRGs for sediments are based upon EPA's letter of August 3, 2004, a response and request for clarification submitted to EPA on behalf of the St. Maries PRP Group dated September 8, 2004, and a response to that letter from EPA dated October 13, 2004 (see Appendix A). Based on the October 13, 2004 letter, the FS will use the Washington State process as a TBC for establishing PRGs, and PRGs for sediments are established on the following premises:

- Sediment PRGs for the St. Maries CERCLA site in Idaho are based upon the process for setting cleanup levels in Washington State regulations.
- The overall "process included as part of the Sediment Management Standards (SMS) with some clarifications added below, will be used to establish the Preliminary Remediation Goals of the FS and the Remedial Action Objectives for the St. Maries site" (EPA letter dated 08/03/2004).
- The sediment PRGs are the Minimum Cleanup Levels (MCUL)[6] as defined in Washington Administrative Code (WAC) 173-204-570 (3).

[6] For the purposes of this FS, the MCUL will mean the numeric criteria in Table 3-4, while the CSL will mean the biological criteria in Table 3-5.

- The **generic** chemical numeric PRGs for St. Maries will be those individual and summed molecular weight PAHs listed in Table III of WAC 173-204-520, and listed in Table 3-4.

- The chemical numeric PRGs may be modified by results from freshwater bioassays pursuant to WAC 173-204-570(3)(b), by using the freshwater sediment biological Cleanup Screening Level (biological CSL) endpoints provided in Table 3-5.

- EPA may conduct additional chemical and/or biological testing to refine the boundary of sediment requiring remedial action after issuance of the Record of Decision.

Citing WAC 173-204-570(3) as a TBC implies all elements within the Washington State statute are applicable. Additional assumptions, confirmed by EPA in the October 13th letter, include:

- WAC 173-204-570(3)(a) cites WAC 173-204-560 as the procedure for evaluating cleanup alternatives. All cleanup alternatives will be evaluated in accordance with CERCLA and the NCP, rather than the Washington statute.

- The chemical PRGs for St. Maries will be determined by the process listed in WAC 173-204-520 and accompanying biological CSLs in the August 3 letter. Given that the **generic** MCUL will be the chemical numeric PRG for the FS, exceedance of the numeric PRG may provide a reason to initiate further biological testing.

- The biological PRG for St. Maries will be equivalent to that listed in WAC 173-204-570(3). WAC 173-204-570 (3)(b)(iii) states: "Sediments with biological effects that do not exceed the levels of WAC 173-204-520(3) shall be determined to meet the minimum cleanup level." Sediments in the St. Joe River, where biological effects do not exceed the CSL levels in Table 3-4, shall be determined to meet the minimum cleanup levels per section 570 (3)(b)(iii) and Table 3-5. By specific example, the two stations listed in the 8/03/04 Letter (ST03 and SD14) exceed the chemical criteria, but do not exceed the biological CSL levels in Table 3-4.

- **The biological PRG for sediment may further be used to derive a chemical site-specific cleanup level (SSCL). Alternatives 8 and 9 include stepwise processes to develop risk-based PAH cleanup concentrations protective of benthic organisms. The process used to develop the SSCL is consistent with the Washington State Sediment Management Standards (WAC 173-204) and is detailed in Section 5.3.13.2. The SSCLs will be used to identify sediment areas within the River Sediment Area**

**that require further action to protect aquatic and benthic organisms.**

The chemical and biological PRGs for sediments in this FS are given, then, in Tables 3-4 and 3-5.

### 3.1.3.2 Groundwater to Sediments PRGs

PRG for the groundwater partitioning to sediment pathway are established to protect sediment-dwelling organisms from contaminants that may migrate in groundwater and accumulate in sediment porewater at levels that could present a risk to those organisms. These PRG apply to RAO 3.

Potentially applicable ARAR are the Tribal Surface Water Quality Standards (as per discussion in Section 3.2.1, fourth bullet), the water quality standards of the Clean Water Act (CWA), and the Washington State SMS process, described above. However, no aquatic life standards have been published and/or promulgated for the Site COCs (i.e.: PAHs) by the Tribe, or the EPA in the CWA. Water quality criteria for the protection of humans consuming fish and wildlife exposed to COC are restricted to application in surface water, and would be applicable if groundwater leaching to surface water caused COC concentrations in surface water. Surface water quality measurements taken during the RI-BLRA were either non-detect or below the Tribal surface water quality standards.

In the absence of aquatic life criteria for the Site COCs, groundwater PRGs were developed using the sediment PRGs, and calculating the associated porewater concentrations using the assumptions of the Equilibrium Partitioning Theorem (EqP; DiToro et al, 1991). These porewater COC concentrations are applied to groundwater as a PRG, as groundwater discharges to sediment, and thus make up some or all of the sediment porewater.

Porewater concentration of COC in sediments can be estimated using the EqP to the measured concentrations of the COC and corresponding total organic carbon (TOC). The theory of EqP is that nonionic chemicals (which includes PAHs), in sediment, partition and are at equilibrium between the sediment organic carbon and porewater. If the concentration in one of the compartments is known, concentrations in the other compartments can be estimated, assuming equilibrium.

The rationale for the use of EqP methods is detailed in an EPA report *Technical Basis for the Derivation of Equilibrium Partitioning Sediment Guidelines (ESGs) for the Protection of Benthic Organisms: Nonionic Organics* (EPA, 2002a). An important component of EqP theory is the derivation of organic carbon partition coefficients ($K_{oc}$) for each chemical. These coefficients are constant, independent of sediment type assuming that the primary sorbent is organic carbon. Under EqP, the fraction of nonionic organic compounds can be predicted in each medium (sediment, water, or tissue) through a series of equations.

The primary equation used in EqP describes how organic carbon partition coefficients ($K_{oc}$ in units of liters per kilogram organic carbon [L/kg$_{oc}$]) for each chemical can be calculated by dividing the concentration of the chemical in the sediment ($C_{oc}$ in units of micrograms per kilogram organic carbon [$\mu$g/kg$_{oc}$]) by the concentration of the chemical in the porewater (Cd in units of micrograms per liter [$\mu$g/L]).

$$K_{oc}(L/kg_{oc}) = \frac{C_{oc}(\mu g/kg_{oc})}{Cd(\mu g/L)}$$

Where COC is the organic carbon-normalized sediment concentration and *Cd* is the estimated porewater concentration.

In the absence of site-specific data necessary for the derivation of $K_{oc}$ by the methods described, $K_{oc}$ for each chemical can be estimated from the $K_{ow}$ of the chemical by the following mathematical relationship (DiToro, 1985):

$$\log_{10} K_{oc} = 0.00028 + 0.983 \log_{10} K_{ow}$$

Using the **generic** MCUL as the **chemical numeric** sediment-PRG, groundwater/porewater PRGs are developed by estimating the porewater-equivalent concentration for the **generic** sediment MCUL. Table 3-3 shows the resultant generic groundwater PRGs. **The groundwater concentrations protective of sediments should be consistent with the sediment concentrations that are protective of benthic infauna. As noted in Section 3.1.3.1, a stepwise process may be used to develop risk-based sediment concentrations protective of the benthic invertebrate community (i.e., the SSCL). If an SSCL is developed during the remedial design phase, it will be used in place of the generic MCULs for the purpose of identifying sediments that require excavation or stabilization. Therefore, the SSCL also should be used in place of the generic MCULs for the purpose of identifying groundwater COC concentrations that are protective of sediments.**

**The groundwater values protective of sediment will be equal to the sediment porewater concentration associated with the SSCL. The sediment porewater concentrations of each of the 16 PAHs of interest will be derived based on equilibrium partitioning principles for non-ionic organic compounds. Site-specific organic carbon content and, if appropriate, black carbon content will be used to ensure that the estimated porewater concentrations are representative of the exposures experienced by the benthic invertebrates in the toxicity tests. For the purposes of implementability and consistency with the SSCLs, the individual PAH concentrations will be summed to derive an aqueous total PAH concentration protective of sediment.**

These sediment to groundwater PRGs do not apply throughout the groundwater at the Site, but apply in the surface sediment pore water prior to groundwater discharging to

surface water. Acceptable groundwater concentrations at a location farther inland (alternative concentration limits or ACLs) could be developed for assessment of compliance with PRGs in the surface sediment pore water.

The ACLs are acceptable concentrations for an alternate monitoring point at a specific location inland of the point of compliance for the PRG and are calculated based on achievement of the PRG at the point of compliance. The ACLs would be developed using a commercially-available groundwater fate and transport model. The exact model to be used, its capabilities, and the input parameters to be used would be determined in the remedial design, and would be subject to approval by EPA. This model development is likely to be necessary prior to implementation of remedial actions, as the establishment of the monitoring points and appropriate concentrations would be necessary to monitor for compliance after remedy implementation. The steps to developing the model would generally be:

- Identifying the appropriate model based on remedial design, monitoring needs, and the capabilities and limitations of the model;

- Identifying appropriate input parameters based on existing site-specific data and accepted literature values where site-specific data was not available;

- Running the model to determine concentrations of COC at an upland monitoring point that would correlate to PRG concentrations at the point where groundwater discharged to sediment porewater;

- Performing a sensitivity analysis to evaluate which parameters most influence model results and associated uncertainties;

- Evaluating potential variation in COC concentrations at the point of groundwater discharge to porewater based on variation in the sensitive model parameters; and

- Defining the acceptable concentrations of COC at the upland monitoring point (the ACL) accounting for potential variability in those parameters to which the model was sensitive.

These models typically consider groundwater flow patterns, groundwater chemistry, soil stratigraphy and properties, hydrologic forces, and chemical interaction between soil and groundwater. These models typically require input of some site-specific parameters, including soil hydraulic conductivity, groundwater flow rates, COC type, and COC concentration.

The ACLs determined through the modeling effort would apply at a specific upland location and be used to establish the monitoring program to ensure success of the remedy

#### 3.1.3.3 Potable Groundwater PRGs

Potable groundwater PRGs are established to protect humans consuming and using groundwater at the site. As indicated previously, this pathway is unlikely due to institutional controls and the Site being located on a floodway (on the river side of a flood control levee). These PRGs apply to RAO 5 where groundwater is the media of concern and the exposure pathway is potable groundwater use. The PRGs for potable groundwater use are the federal MCL established under the CWA. Where a MCL does not exist and an EPA Region IX PRG for drinking water exists, this PRG was used because these PRGs are based on protection of human health by pathways including drinking water. The PRGs for potable groundwater use at St. Maries are summarized in Table 3-3.

### 3.1.4 Areas to Which RAOs Apply

For each RAO, the area that exceeds PRGs and may cause risk to receptors needs to be addressed. These areas, based on data collected during the RI and previous investigations are shown on Figures 3-1 through 3-3. Tables 3-2, 3-6a, 3-6b, 3-7a, and 3-7b summarize data used to define these areas. Additional information regarding delineation of these areas can be found in Appendices C and D.

This section provides additional details to clarify these areas. Generally, these areas are:

- RAO 1: Protect aquatic and benthic organisms by preventing direct contact of benthic organisms with COC in surface sediment in the St. Joe River at concentrations greater than protective levels. RAO 1 is based on the potential risk to benthic and aquatic receptors from concentrations of site COC in surface sediment (upper 10 centimeters). Locations where more than one individual PAH or the total low- or high-molecular weight PAH exceed the MCUL and a passing bioassay test has not been completed are included in this area (Figure 3-1). This area is generally referred to as the nearshore impacted area in the FS. EPA may conduct additional chemical and/or biological testing to refine the boundary of sediment requiring remedial action after issuance of the Record of Decision.

- **RAO 2: Prevent visible oil films or sheens in the St. Joe River.** Currently, sheens appear episodically on the surface water above the nearshore sediment containing DNAPL. These sheens are commonly associated with gas bubbles (assumed to be methane). Most of the year during high water periods, on-site observations indicate that the sheens do not emanate from the shoreline, but appear to rise through the water column above the sediment containing DNAPL. These sheens appear on the surface water some distance from the shoreline. During low water periods, when the river level is sufficiently low that the creosote-bearing sediment is at the

shoreline, then sheens appear at the shoreline. The sheens are located within the boomed area currently maintained in the river. For FS purposes this area includes the low water shoreline and the immediately adjacent nearshore. The low water at the Site is determined by the level of Lake Coeur D'Alene, and is approximately 2121 feet elevation (AVISTA datum). The DNAPL in these areas, shown on Figure 3-1, need to be addressed to prevent sheens.

- RAO 3: Prevent migration of impacted groundwater or free-phase creosote to surface sediment in the St. Joe River that would result in COC concentrations greater than protective levels for aquatic and benthic organisms. Concentrations of COC in groundwater at the mudline (essentially sediment pore water) must be of sufficient quality that sediment concentrations do not exceed sediment PRG. Based on partitioning relationships, the associated groundwater quality at the mudline can be calculated. Groundwater concentrations beneath the uplands must be sufficiently protective such that, after migration to the sediments of the St. Joe River, concentrations would not exceed the PRG for RAO 3, which addresses the groundwater to sediment pathway. An analysis in the absence of biodegradation indicates that groundwater in the upper silt and interbedded zone may potentially cause sediments to exceed MCULs (see detailed analysis in Appendix C). Groundwater may exceed concentrations protective of the St. Joe River surface sediment in the area downgradient of creosote impacts in the upper silt and interbedded units. Groundwater outside of that area, shown on Figure 3-1 does not exceed the concentrations protective of sediment.

- RAO 4: Prevent downstream transport of COCs that result in COC concentrations in water or sediment that exceed levels protective of aquatic and benthic organisms. RAO 4 should apply to areas where erosion of surface or subsurface sediment would cause unacceptable risk downstream. In the nearshore impacted area, surface and subsurface sediment exceed MCUL and in the offshore area, subsurface sediment exceed MCUL. In the nearshore impacted area, river modeling suggested limited scouring. However, since surface sediments are impacted, any scouring may cause downstream transport of impacted sediment. In the offshore, modeling suggested scouring during major floods may extend through surface sediment and into the impacted subsurface sediment. This sediment could then be transported downstream and potentially cause unacceptable risk downstream. Potential risk to downstream receptors has not been evaluated quantitatively. First, there are uncertainties in the actual amount of scour due to simplifying assumptions made in the model, as well as conflict between empirical site data (presence of impacted subsurface sediment in area projected to scour) and the model results. Second, the risks downstream have not been evaluated. Site conditions

after scour, are similar to pre-flood conditions due to redeposition during waning stages of the flood.

- Establishing actual PRGs and the associated areas where RAO 4 applies is difficult with these uncertainties. In the absence of additional information, the conservative assumption is made that MCULs are the PRGs and that the RAO applies to locations where sediment exceeds MCULs and may be eroded (as indicated by scour modeling). This assumed area is shown on Figure 3-2.

- RAO 5: Prevent residential and commercial ingestion of and dermal contact with COCs in groundwater at concentrations greater than protective levels. RAO 5 is based on the protection of human health through potable use of groundwater. Potential concentrations of COC that would be protective of humans in these scenarios are federal MCLs or other more protective values used to determine protection of human health through use of groundwater as drinking water, such as EPA Region IX PRGs for groundwater. Both of these levels were considered in developing PRGs. The RAO applies to the area estimated where groundwater exceeds these concentrations as shown on Figures 3-1.

## 3.2 ARARs

Section 121(d) of CERCLA stipulates that remedial actions instituted under the Superfund program comply with ARARs. Consideration must also be given to relevant information that, while not legally binding, is collectively referred to as TBC information. ARARs are promulgated cleanup standards and other environmental protection requirements, criteria, or limitations contained within federal, tribal, state, and/or local laws and regulations. TBCs may or may not be promulgated standards and not legally enforceable. Nevertheless, TBCs may contribute to the development and implementation of effective and protective remedial alternatives.

**Each alternative that makes it to the comparative stage of analysis is expected to be protective of human health and the environment and compliant with ARARs (*unless a waiver is justified*). *ARARs include any Federal or State* standards, requirements, criteria, or limitations that are determined to be legally applicable or relevant and appropriate to a CERCLA site or action. ARARs are chemical specific, location specific, and action specific in nature.**

ARARs typically fall into three categories:

- **Chemical-specific Requirements.** These are typically health or concentration specific limits on a specific chemical, such as MCLs promulgated under the Safe Drinking Water Act.

- **Location-specific Requirements.** These are related to protection of a specific area or type of area, such as a wetland.

- **Action-specific Requirements.** These requirements typically regulate discrete actions or are triggered by performance of a specific action.

ARARs were originally discussed in the RI/FS Work Plan, consistent with the RI/FS Guidance. This section and others within this FS discuss potential ARARs for the Site. EPA will determine the final list of ARARs for the Site and remedial actions to be performed at the Site. Compliance with ARARs is evaluated for each Remedial Alternative in Section 6.

The Site is on the reservation and the river is administered by the Tribe. Federal and Tribal standards apply throughout the Site. The State standards may be relevant and appropriate throughout the site.

**Cleanup levels for soil will be based in whole or in part on EPA Region 9 PRGs for protection of groundwater as mentioned above. Baseline soil cleanup levels for the site's chemicals of concern were listed in Table 4 of EPA's Proposed Plan and are included as Table 5-4 and are considered applicable to Alternate 9 as well as Alternative 8.**

**Cleanup levels for groundwater for each chemical of concern will be selected as the lowest of either the federal drinking water standards, MCLs, (or the EPA Region 9 PRGs for tap water where MCLs have not been established), or a site-specific groundwater concentration calculated to be protective of sediment. Selection of the lowest of these values ensures that both of the above risk pathways will be protected.**

**The Tribe, the state of Idaho, and the EPA have not established freshwater sediment cleanup levels that would be applicable for the Site. Therefore, a stepwise approach for delineating the extent of contaminated sediment at the site and establishing boundaries for cleanup has been selected as a baseline for Alternative 9. This process is consistent with the Washington State Sediment Management Standards (WAC 173-204) and the process described in the Proposed Plan (i.e., Alternative 8). As noted in Section 3.1.3.1, this process will result in SSCLs to be used to identify sediment areas within the River Sediment Area that require further action to protect aquatic and benthic organisms. The stepwise process used to develop the SSCLs is described in detail in Section 5.3.13 and summarized below.**

**Step 1** **The first step will be to review the existing sediment data to identify locations that warrant further evaluation, some of which will be resampled for biological testing. Sediment PAH concentrations will be compared with the appropriate generic cleanup screening level in Table 5-2 to identify potential locations for re-sampling.**

Step 2 The second step will be to select a subset of locations to be resampled for biological testing. The objective is to select enough samples with a sufficiently high range of PAH concentrations to ensure that toxicity is observed in at least one, but not every, sample. Results of previous toxicity tests at the Site, in which the highest tested concentration (58 mg/kg total PAH) was not toxic, will be used to guide the sample selection process. More specifically, a minimum of six samples from the Site (plus a reference sample and laboratory control) will be toxicity tested, with samples selected to include exposure concentrations between approximately 50 mg/kg total PAH and 300 mg/kg total PAH. The goal of the sample selection process will be to minimize the difference in concentration between the NOEC and LOEC, to the extent practicable.

Step 3 The third step will be to re-sample and test the selected surface sediment locations for biological, chemical, and physical parameters. Site samples may be blended to produce intermediate exposure concentrations required for an informative exposure-response curve. Two acute and one chronic toxicity test will be selected from among those listed in Table 3-5. Statistical significance and magnitude of difference relative to the reference will be used to classify each tested sample as toxic or not toxic. Benthic invertebrate community metrics may also be used to determine which sample locations are associated with adverse impacts. Importantly, chemical and physical analyses will be performed on splits of samples on which biological tests are conducted.

Step 4 The next step of this process will be to identify the PAH concentrations that pose a risk to benthic invertebrates and select the SSCL. The weight of evidence provided by the biological, chemical, and physical tests will be used to determine which sample locations pose a risk to benthic invertebrates due to PAH toxicity. The SSCL will be the lowest observed effect concentration (LOEC) for the sum of the 16 PAHs listed in Table III of WAC 173-204-520 and Table 3-4. The use of Total PAHs is appropriate in this case, because the SSCL will be based on-site-specific biological effects data and because use of the LOEC as the SSCL means that cleanup will be based on the most toxic mixture of individual PAHs (see Section 5.3.13 for details).

The process for using the SSCLs to determine which sediment areas require further action is shown in Figures 3-4 and 3-5 and is described in detail in Section 5.3.13. In summary, the SSCLs for sediment will be used to identify the surface and subsurface sediments in the River Sediment Area that warrant remedial action to protect aquatic and benthic organisms. The point of compliance for RAO 1 is the top 10 centimeters of sediment (or "surface sediment") in the St. Joe River (Table 3-3). The point of compliance for RAO 4 is, on average, the top three feet of sediment in the St. Joe River (Table 3-3) (or "subsurface sediments"). Total PAH concentrations representative of each point of compliance will be used to identify the sediment areas

**that require remedial action. Surface and subsurface sediments throughout the River Sediment Area will be extensively sampled for PAH concentrations during the remedial design phase in order to provide adequate delineation of the spatial extent of contamination.**

**Step 5 The final step of this process is to identify what remedial action should be taken. ~~Two general types of sediment remedial actions are envisioned: 1) removal and treatment, or 2) stabilization (through physical isolation or chemical stabilization). The process for selecting the appropriate type of action for any given sediment location is shown in Figure 3-4 and 3-5 and also described in detail in Section 5.3.13.~~ The process for selecting the appropriate type of action for any given sediment location is shown on Figures 3-4 and 3-5 and also described in detail in Section 5.3.13.**

## 3.2.1 Chemical Specific ARARs and TBCs

Chemical-specific ARARs define concentration limits for environmental media. These requirements may be used to set cleanup levels for COCs in soil, groundwater, sediment and surface water. For example, the Federal Clean Water Act establishes concentration limits in surface water that are considered protective of human and aquatic life. The principal chemical-specific ARARs and TBCs for cleanup at the St. Maries Site are:

- **Federal Clean Water Act.** CWA may be both a chemical and action specific ARAR that establishes standards and/or processes for setting surface water quality criteria to be adapted by the States or Tribes. Ambient water quality criteria developed under the Clean Water Act are non-enforceable guidelines that identify protective concentrations of various chemical constituents for surface waters. As non-enforceable guidelines, the ambient water quality criteria are TBCs for the site. The numeric standards include:

    - *33 U.S.C.A. Sec. 1251–1387 Ambient Water Quality Criteria CWA Section 304 Quality Criteria for Water, (EPA, 1986).* Establishes non-enforceable guidelines for States to set water quality standards for surface water. Criteria are based on protection of aquatic life and human health.

    - *Water Quality Standards CWA Section 303 40 CFR 131.* Establishes how states and tribes develop water quality standards based on federal guidelines.

In addition to the ambient water quality criteria, the CWA includes a prohibition on oil films or sheens on surface water. 40 CFR 110.3B states that, for purposes of section 311(b)(4) of the CWA, discharges of oil in such quantities that may be harmful to the public health or welfare or the

environment and must be addressed, include discharges of oil that: (a) violate applicable water quality standards; or (b) cause a film or sheen upon or discoloration of the surface of the water or adjoining shorelines. While a violation of applicable water quality standards has not been identified, sheens have been observed on the surface of the water.

- **Federal Safe Drinking Water Act.** The SDWA establishes primary and secondary drinking water standards called federal MCLs. In addition, the SDWA includes Maximum Contaminant Level Goals (MCLGs), which are standards resulting in no known adverse health effects, regardless of technical feasibility. CERCLA specifies that MCLs and MCLGs be considered chemical-specific ARARs at sites where groundwater and surface water are potential sources of drinking water; however, it is EPA's policy to consider MCLGs as potential ARARs only where the MCLGs are established at a level above zero.

  The preamble to the NCP states that it is EPA's goal to return groundwaters to their beneficial use wherever practicable and that "in general, drinking water standards are relevant and appropriate cleanup levels for ground waters that are a current or future source of drinking water, but are not relevant and appropriate for groundwaters that are not expected to be a future source of drinking water (Federal Register, 1990, Preamble at 8732)" (EPA, 1993). Groundwater at the Site is not currently used as a source of drinking water, and the City's ordinances are currently in place to prevent future use of groundwater at the Site as drinking water. However, EPA has indicated through comment that groundwater at the Site must be considered a potential future source of drinking water. As such, MCLs are chemical-specific ARARs for groundwater at the Site. However, it may not be technically practicable to achieve these standards in the groundwater at the Site. The concept of technical impractibility is discussed further in the evaluation of alternatives (Section 6) and in Appendix E.

- **Idaho Rules for Public Drinking Water Systems (IDAPA 58.01.08).** The State of Idaho has adopted drinking water standards under the SDWA, which may be relevant and appropriate at the Site in light of the NCP statutory preference to return groundwaters to drinking water standards. These standards reference federal MCLs and MCLGs.

- **EPA Region 9 Preliminary Remediation Goals.** Groundwater screening levels for drinking water and soil screening levels have been identified as TBCs and will be considered in establishing action levels for soil with COC concentrations that may affect groundwater.

- **Water Quality Standards for Surface Waters of the Coeur d'Alene Tribe dated December 30, 2000.** Tribal water quality standards may be

both chemical and action specific ARARs. The Coeur d'Alene Tribal Council first approved tribal water quality standards in 1999. The standards have since been modified and re-approved by the tribal council. In 2001, the United States Supreme Court affirmed a lower court decision quieting title in the United States, for the benefit of the Tribe, to the submerged lands within the boundaries of the tribe's reservation. *Idaho v. United States*, 533 U.S. 262, (2001). This decision provided that the bed and banks (submerged lands) in the southern one-third of Lake Coeur d'Alene and that portion of the St. Joe River within current reservation boundaries belong to the United States of America, to be held in trust for the Tribe, as the beneficial owner. The Tribe has recently applied to the EPA for treatment as a state under the Clean Water Act ("CWA"). 33 U.S.C. § 1377(e), 40 C.F.R. 131.8. The EPA has not yet granted treatment as a state status to the Tribe under the CWA. The EPA has stated that in Superfund cleanup decision, and in particular at the St. Maries Creosote site, the Tribe's water quality standards are considered an ARAR as soon as the standards are promulgated under Tribal law by the Tribal government. The St. Maries PRP Group disagrees with the EPA's position. The St. Maries PRP Group has stated that Tribal standards cannot be considered an ARAR until the Tribe is granted "tribe as state" status due to the requirements set forth within 40 C.F.R. § 131.21 (c)(2) and §300.400(g)(4). If EPA grants that status, the Tribe would be responsible for maintaining water quality standards in the waters within the boundaries of its' reservation, including the St. Joe River.

- **Water Quality Standards for the State of Idaho.** The State of Idaho has adopted water quality standards for surface waters within the State of Idaho in IDAPA 58.01.02. While the Tribe has authority over the St. Joe River in the area of the Site, the State of Idaho standards may be relevant and appropriate or TBCs.

- **Ground Water Quality Rule (IDAPA 58.01.11).** The State of Idaho has adopted standards for protection of groundwater quality, which includes both numerical and narrative standards for groundwater quality. These standards may be relevant and appropriate to the groundwater at the Site.

- **Washington State Sediment Management Standards.** This process is established in Washington Administrative Code 173-204, as modified by EPA Region 10's letter dated August 3, 2004, clarification response by RETEC dated September 8, 2004, and EPA's response to that letter dated October 13, 2004. While the Washington standards are promulgated, the freshwater sediment numeric criteria provided in EPA's August 3 letter have not been promulgated, nor will be promulgated before completion of the Record of Decision for this site. Therefore, the Sediment Management Standard process is a TBC, and is used to develop PRGs for sediments and

for the protection of groundwater discharging to sediments in Section 3.3, below.

- **Ontario Provincial Sediment Quality Guidelines.** These guidelines were used as screening levels in the RI/FS Work Plan and the RI/BLRA. The Ontario Provincial Sediment Quality Guidelines establish action levels for sediment. These guidelines may be TBCs for the site.

### 3.2.2 Action Specific

**Federal Resource Conservation and Recovery Act (RCRA) –** RCRA applies to the identification, generation, transportation, and disposal of any hazardous wastes generated at the Site. As some F034 listed hazardous wastes may be generated at the Site, RCRA would apply to these wastes. Specific sections of RCRA which may apply are 40 CFR 260-**268: 40 CFR 260** (Hazardous Waste Management System – General), 40 CFR 261 (Identification and Listing of Hazardous Wastes), **40 CFR 261.4(g) "Dredged materials that is not a hazardous waste;"**40 CFR 262 (Standards Applicable to Generators of Hazardous Waste), 40 CFR 264 (Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities), and 40 CFR 268 (Land Disposal Restrictions) **(Contained in Policy). Remedial Action Plan (RAP) requirements (AOC, Staging Piles): The RCRA HWIR media rule regarding the RAP authorization process for the treatment, storage, or disposal of remediation wastes will be consulted and utilized as appropriate for staging piles, and the establishment and implementation of an Area of Contamination (AOC).**

- **Contained in Policy (40 CFR 268): The contained in policy is applicable to media, in this case soils, contaminated by a listed hazardous waste. A "contained in" determination will be developed for certain contaminants of concern based upon the establishment of a risk based standard in cooperation with EPA and the State. Compliance with the established LDR (40 CFR 268) requirements for the soils at the site will also be an applicable ARAR.**

- **Resource Conservation and Recovery Act Corrective Action Management Unit Policy and Guidance.**

- **Federal Clean Water Act, National Pollutant Discharge Elimination System (NPDES; 40 CFR Section 401) –** Requires compliance with permit limitations for discharge to navigable waters, including water quality effluent limits, water quality standards, national performance standards, and toxic and pretreatment effluent standards. EPA administers

the NPDES program throughout the State of Idaho, including the Reservation. Dewatering may be necessary during some remedial actions at the Site. Waters generated may be discharged under the substantive requirements of an NPDES permit, or a permit for uplands waters, or potentially either an NPDES permit or Clean Water Act Section 404 permit for waters from the St. Joe River, including waters from dewatering sediment.

- **Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S.—Testing Manual (EPA-823-B-98-004).**

- **State of Idaho Rules and Standards for Hazardous Waste (IDAPA 58.01.05)** – Specifies procedures for identifying, generating, transporting, treating, and disposing of hazardous wastes in Idaho. These standards incorporate by reference RCRA chemical-specific federal hazardous waste criteria. Within the Reservation, the State of Idaho standards may be considered relevant and appropriate requirements for a response action.

- **Solid Waste Disposal Act (40 CFR 257, 258).** These rules are applicable to disposal of any nonhazardous solid wastes generated during remedial actions.

- **State of Idaho Solid Waste Management Rules and Standards (IDAPA 58.01.06).** Specifies procedures for management and disposal of nonhazardous solid wastes in the State of Idaho. Within the Reservation, the State of Idaho standards may be considered relevant and appropriate requirements for a response action.

- **Idaho Land Remediation Rules (IDAPA 58.01.18).** Generally, these rules apply to cleanup actions performed under voluntary agreement with the State of Idaho. However, portions of these rules may be relevant and appropriate to cleanup of the Site.

- **U.S. EPA. 1996a. *Soil Screening Guidance: User's Guide,* Office of Emergency and Remedial Response, Washington, DC. EPA/540/R-96/018. NTIS PB96-963505. U.S. EPA. 1996b. *Soil Screening Guidance: Technical Background Document.* Office of Emergency and Remedial Response, Washington, DC. Soil Screening Guidance and Supplements for COC: This guidance will be used as a tool for determining the remediation standards for soil to be treated by both in situ and ex situ methods.**

- **State of Idaho Stream Channel Alteration Rules (IDAPA 37.03.07).** These rules are applicable to common construction within streams in the State of Idaho. The rule specifies that work performed under a CWA, Section 404 permit will meet the requirements of these rules. While the Tribe has authority over the St. Joe River in the area of the Site, some

sections of the rule regarding construction practices and standards may be relevant and appropriate to remedial actions at the Site.

- **CWA, Section 404** – For any activities within the St. Joe River that involve filling or dredging operations with fallback determined to be significant, the requirements of Section 404 of the Clean Water Act (33 U.S.C. Section 1344) may apply. These requirements would also apply to the discharge of waters from the activities to the St. Joe River. These requirements would apply to the placement of a cap in the St. Joe River or backfilling of dredged areas.

- **CWA Section 301(b)** – Requires all direct discharges to be treated with best control technology prior to discharge. This would be applicable if surface water is channeled directly to a surface water body via a ditch, culvert, storm sewer, or other means; or treated water is discharged.

- **Tribal Encroachment Laws** – Any work on the bed and banks of the St. Joe River could be considered an encroachment into the submerged lands of the Tribe, and may be governed under Tribal Code Chapter 44-14.01 (Fills, Dikes, Jetties, Piers, Private Booms and Buoys) and Tribal Code Chapter 44-20.01 (Dredging). Capping of the sediments may also be considered an encroachment, and governed under Tribal Code Chapter 44-14.01.

- **Section 10 of the Rivers and Harbors Act of 1899 (22 CFR 403)** – Permitting, or meeting the substantive requirements of the permit, is required for any construction that would impact the course, capacity, or condition of navigable waters of the United States. The Tribal Encroachment Laws may take precedence over this Act; however, at this time, the Tribe is indicating that it will require the substantive requirements of this permit and therefore, this act is included as a TBC.

- **Endangered Species Act (ESA)** – Depending on the remedial actions performed at the Site and the timing of these activities, some requirements of the ESA related to take of bull trout could apply. To avoid these requirements, work within rivers containing threatened or endangered specifies is typically only permitted during "fish windows" during which the risk to the species of concern is low. Work outside of these "fish windows" would necessitate meeting additional ESA requirements.

- **Idaho Rules for Air Pollution Control (IDAPA 58.01.01).** These rules may be relevant and appropriate to any sources of air pollution constructed as part of remedial actions.

- **The Archeological and Historic Preservation Act Section 106 and the Native American Grave Protection and Repatriation Act** – Depending

on remedial actions performed at the Site work may be subject to the Archaeological and Historic Preservation Act Section 106 and the Native American Grave Protection and Repatriation Act.

- **Well Construction Standards (IDAPA 37.03.09).** These rules may be relevant and appropriate to construction of groundwater monitoring wells for monitoring or active remediation.

  - **The Risk Assessment Guidance for Superfund (RAGS), Volume 1: Human Health.**

  - **Evaluation Manual (HHEM), Part A, Interim Final (U.S. EPA, 1989a) provides guidance on conducting baseline risk assessments for NPL sites.**

  - **RAGS HHEM, Part B, Development of Risk-Based Preliminary Remediation Goals. (U.S.EPA, 1991b).**

### 3.2.3 Location Specific

- **US Fish and Wildlife Coordination Act.** This Act prohibits water pollution with substances deleterious to fish, plant, or bird life. It will likely be addressed through the permitting process, or meeting the substantive requirements of permits.

- **Executive Order 11988, Floodplain Management.** As work will occur in the floodplain, portions of executive order 11988 may apply. These are considered TBCs.

- **Executive Order 1190, Protection of Wetlands.** The work is not anticipated to affect any of the wetlands known to be present in the vicinity of the Site, as these wetlands are located across the River from the Site, or downstream away from the Site. If applicable, these would be considered TBCs for the Site.

- **State of Idaho Stream Channel Alteration Rules (IDAPA 37.03.07).** These rules are applicable to common construction within streams in the State of Idaho. The rule specifies that work performed under a CWA, Section 404 permit will meet the requirements of these rules. While the Tribe has authority over the St. Joe River in the area of the Site, some sections of the rule regarding construction practices and standards may be relevant and appropriate to remedial actions at the Site.

- **RCRA Facility Locations (40 CFR 257, 264.18(b), 761.75).** These requirements apply to hazardous waste facilities, which must be designed, operated and maintained to avoid washout when sited in the 100-year

floodplain. Should remedial actions involve construction of a hazardous waste facility on the Site, these requirements would apply.

- **Hazardous Waste Facility Siting Act of 1985 (Section 39-5801 et seq., Idaho Code).** Governs locations and requirements for hazardous waste facilities in the State of Idaho. May be relevant and appropriate if a new hazardous waste management facility was constructed.

- **The Archeological and Historic Preservation Act Section 106 and the Native American Grave Protection and Repatriation Act.** Depending on remedial actions performed at the Site work may be subject to the Archaeological and Historic Preservation Act Section 106 and the Native American Grave Protection and Repatriation Act.

- **Institutional controls to restrict groundwater and land use: Institutional controls will be relied upon where needed to continue to restrict the use of groundwater as a drinking water source and/or to protect the integrity of any cap used as a part of a remedy. EPA institutional control policies and applicable regulatory requirements will be relied upon during the development of the necessary controls as a part of the remedial design.**

# 4 Identification and Screening of Technologies

## 4.1 General Response Actions

This section summarizes the GRAs that could be used at the Site to satisfy the RAOs. GRAs are developed as part of identifying appropriate technologies and developing remedial alternatives for the Site. GRAs for the Site were first included in the Summary of Data Gaps Report (RETEC, 2002a) as:

- No Action;
- Institutional Controls/Monitoring;
- Containment;
- Removal (with subsequent treatment, reuse, and/or disposal); and
- *In situ* Treatment.

The FS narrows the broad universe of GRAs to remedial technologies that are implementable and likely to be effective for remediation of the Site. For retained remedial technologies, representative process options are selected based on effectiveness, implementability, and cost.

## 4.2 Presumptive Remedies

Presumptive remedies are EPA's preferred technologies for certain types of sites and have been identified by EPA to speed the selection of cleanup actions. Presumptive remedies are to be used at all sites, except where site-specific criteria make other options preferable (**"Presumptive Remedies for Soils, Sediments, and Sludges at Wood Treater Sites", EPA, 1995**). The presumptive remedies identified for soil, sediment, and sludges found at organic wood treater sites with compounds such as those found at the Site are bioremediation, thermal desorption, and incineration.

In addition to presumptive remedies, EPA evaluated other technologies often considered for wood treating sites (EPA, 1997) based on frequency of evaluation and retention, and reasons for selection or screening out of technologies in feasibility studies. Based on this evaluation, EPA identified the following other technologies that may be applicable for remediation at wood treating sites, but concluded that the presumptive remedies were the most frequently retained as part of remedial alternatives for the site. Some of the technologies considered by EPA were:

- Restrictions/Monitoring;

- Capping;
- On-Site Containment;
- Thermal Treatment Technologies;
- **Soil Stabilization;**
- Soil Flushing;
- Soil Washing;
- Off-Site Disposal; and
- Off-Site Recycling.

Of these remedial technologies, some were not often part of the selected remedial alternative, but EPA did consider the other technologies as applicable for further evaluation of remedial technologies at wood treating sites. These potentially applicable treatment technologies were included in the evaluation of remedial technologies for the Site.

## 4.3 Identification and Screening of Remedial Technology Types and Process Options

As part of the FS process, remedial technologies and process options that are applicable to achieving RAOs at the Site are identified and screened prior to assembling alternatives. Preliminary remedial technologies applicable to the Site were identified in the Summary of Data Gaps Report. Sections 4.4, 4.5 and 4.6 expand on these technologies to include additional technologies that may be applicable at wood treating sites, to screen these remedial technologies, and to identify process options for these technologies. The process options are evaluated based on effectiveness, implementability, and cost, and one or more representative process options for each remedial technology are identified.

The identification of remedial technologies and process options is separated by media, with soils, sediments and groundwater discussed in Sections 4.4, 4.5 and 4.6, respectively. For each medium, the applicable RAOs are discussed, and the remedial technologies identified and screened. The screening evaluations draw from the Federal Remedial Technologies Roundtable, the presumptive remedies and alternate remedies discussed in Section 4.2, and site-specific factors that may affect the effectiveness, implementability, and cost. The remedial technologies, process options, and evaluation of process options are summarized on Table 4-1.

# 4.4 Soil

## 4.4.1 Remedial Goals for Soils

As discussed in the RI/BLRA, soil at the Site is within the acceptable risk range for human health and ecological receptors. However, soils and DNAPL within the soils at the Site provide an ongoing source of COC to groundwater and sediment, and may cause sheens on surface water. Risks associated with groundwater and sediment are addressed by RAOs as these media are present at the point of contact with receptors. Soils must be addressed by remedial actions at the Site as soils provide a source of COC that may be carried to these media. RAOs potentially addressed by a soil action include RAO 2, 3 and 5:

### RAO 2: Prevent visible oil films or sheens in the St. Joe River

Sheens are periodically released into the St. Joe River near the previous removal area of the riverbank. The sheens appear episodically and are sourced at the low water shoreline and in the nearshore sediments inside the boomed area. Sheens are released from sediment in conjunction with methane production or other disturbances. Any DNAPL migration that is occurring may also contribute to the sheens in the nearshore.

### RAO 3: Prevent migration of impacted groundwater to surface sediment in the St. Joe River that would result in COC concentrations greater than protective levels for aquatic and benthic organisms

Creosote-impacted subsurface soils at the Site, including those with residual DNAPL, serve as a source to groundwater by leaching from soil to groundwater. Conservative fate and transport modeling completed as part of the RI/BLRA and Appendix C of the FS indicated that there was a potential for groundwater in the upper silt and interbedded units to cause sediment in the St. Joe River to exceed MCUL.

### RAO 5: Prevent residential and commercial ingestion of and dermal contact with COC in groundwater at concentrations greater than protective levels

As discussed previously, groundwater at the Site poses a carcinogenic risk greater than $10^{-4}$ to human receptors, should humans use the groundwater for drinking water or in a dermal contact scenario, i.e. for showering. COC leach from soil to groundwater.

## 4.4.2 Soil General Response Actions, Remedial Technology Types and Process Options

The following paragraphs discuss remedial technologies and process options for soil, organized by GRA. Remedial technologies that may be applicable at the Site are

identified. Those technologies that are not likely to be implementable at the Site are screened out and not carried forward, consistent with the RI/FS Guidance (EPA, 1988). At least one representative process option is also identified for each retained remedial technology, based on the effectiveness, implementability, and cost of the process options. Consistent with the RI/FS Guidance (EPA, 1988), these representative process options will be used to simplify the assembly of remedial alternatives, though a different process option may actually be implemented as part of the remedy.

#### 4.4.2.1 No Action

The "no remedial action" response action does not address any potential pathway through which COC in Site soils could adversely affect receptors. Current conditions in soils at the Site are protective of human health and the environment, but by leaching to groundwater, COC contained in Site soils may cause sediments in the St. Joe River to exceed PRGs. In addition, residential use of the Site, though unlikely to occur, could pose a risk to these residential users, though the magnitude and acceptability of this risk has not been evaluated. The No Action GRA is retained consistent with the NCP. The No Action GRA is used primarily for comparison purposes.

#### 4.4.2.2 Institutional Controls/Monitoring

Institutional controls are typical components of many remedies and ensure that future activities at the Site account for residual impacts. Institutional controls often take the form of deed restrictions to preclude certain types of land use or to require proper controls should impacted soil be disturbed. Closely related to institutional controls are engineering controls, such as fencing or other means of limiting access to the Site. Indirectly, groundwater monitoring may be applicable to soils. Groundwater monitoring could be used to measure the degree to which soils provide a source of COC to groundwater and could subsequently affect sediment in the St. Joe River. Institutional controls and monitoring are retained as viable remedies for impacted soil at the Site.

Current zoning and City Codes restrict Site use. The Site is currently zoned for industrial use. City Code requires all houses, buildings, or properties used for human occupancy to utilize public (City) water. In addition, the St. Joe River is not classified as a potable water supply by either the Tribe or the State of Idaho. In addition, the Site is located in a floodway, which further limits potential Site use. As indicated in Section 5.2, a component of the five-year reviews ensures that zoning restrictions, City Codes and standards regarding surface water use remain in place. Should institutional controls change such that certain activities would pose a risk to site users, deed restrictions would be implemented.

### 4.4.2.3 Containment

Containment isolates contamination to prevent movement beyond a certain point, to prevent contamination from being transferred to another media, or to prevent receptor contact with COC. Several containment technologies are applicable to soil and are discussed with appropriate process options below.

#### 4.4.2.3.1 Capping

Capping involves isolating soils from receptors, or from forces that may cause transportation of COC or transfer to another media. Caps typically involve covering soils with a durable surface, such as gravel, asphalt, vegetated soils, or a multilayer system, and are designed to be compatible with future land use. Cap construction requires normal earthmoving equipment and commonly available materials. Capping is an implementable remedy at the Site.

Permeable caps are often constructed of gravel and are used to limit receptor direct contact with soils or erosion of soils. A permeable cap would have little effect in preventing any leaching from soils to groundwater.

Asphalt caps are made of asphalt, sometimes designed to meet a specific permeability. These caps are used to prevent receptor contact and can be used to limit infiltration while allowing the area to be used by on-road vehicles or for industrial facilities.

Clay caps are constructed of low permeability clay and are used to prevent infiltration and to limit contact with underlying soils.

Multilayer caps are combinations of plastic or clay liners, gravels, infiltration systems, methane collection systems, and other systems designed to meet several objectives, including preventing contact with underlying soils, limiting or controlling infiltration, and controlling any vapor migration through the cap.

RAO 3 requires that remedial actions for soil prevent the COC in the soil from dissolving into groundwater and being transported to the sediment of the St. Joe River in concentrations that could cause sediment in the river to exceed concentrations of COC protective of receptors. Capping with an impermeable surface could limit the amount of infiltration into shallow soils at the Site, thus preventing leaching of COC from unsaturated zone soils to infiltrating groundwater. A cap would not prevent leaching of COC from soils beneath the water table to groundwater, though it could decrease groundwater flow and associated COC transport by limiting infiltration.

Capping is implementable at the Site, though as a standalone remedy, capping would have little effectiveness, as it will not adequately address soils below the water table (RAO 3). However, it may be useful in combination with other technologies to prevent infiltration of surface water.

#### 4.4.2.3.2 Solidification/Stabilization

**Solidification and stabilization are a means of reducing the mobility of COC, which limits the chances of receptors encountering the COC. For these reasons and other historical practices EPA has included this use of technology as a presumptive remedy. Presumptive remedies produce the added benefit of promoting consistency in the remedy selection process and improving the predictability of the remedy selection process for communities and potentially responsible parties. These technologies involve physically limiting the contact of receptors through solidification, or the chemical availability of the COC through stabilization. Solidification and stabilization processes can be performed either in situ or ex situ (excavation, treatment and placement of the treated media). Solidification and stabilization are presumptive remedies for wood treatment sites with inorganic and in some cases organic contamination. Inorganic COC are not of concern at the Site, but solidification processes have proven effective with the organic COC present at wood treating sites. These processes are discussed below.**

Pressure Grouting

Pressure grouting is a type of solidification. This is a process by which a cement or chemical grout is injected into soils under pressure. It was originally developed for geotechnical soil improvements, but can also be used for solidifying soils and binding them into a solid matrix. Pressure grouting methods that would be applicable at the Site are permeation grouting, which involves injecting a thin grout mix at lower pressures through injection drill rods or injection pipes driven into the ground. The grout then travels out through the soils and fills the void spaces, then solidifies. The amount of grout penetration around the injection pipe is affected by the permeability of the soil into which the grout is injected, the viscosity of the grout injection, and the injection pressure. Jet grouting is another pressure grouting technique. Jet grouting involves injecting grout at high pressures through a specialized injection drill stem. The grout is directed so as to partially break up the soil surrounding it, allowing for better penetration of grout. This involves some replacement of soils, with the excess soil/grout mixture typically forced to the surface by the grout injection pressure.

Pressure grouting is a specialized process and involves the use of specialized equipment, but is used regularly for geotechnical improvements. It is effective at solidifying soils, but has a fairly low production rate and so it typically is not economical for large solidification projects when other methods are available. However, for small projects or projects with special requirements, such as grouting at a specific depth or at an angle, it can be more cost-effective for the work to be performed.

**Soil Mixing**

Soil mixing is an *in situ* method of injecting cement or other solidification agents and mixing these agents with the soil. It is accomplished using specialized large diameter augers to inject the solidification agent and achieve distribution of the agent in the soils. The mixed soil and solidification agent solidifies, encapsulating the COC in soils, preventing contact with and leaching of this material. This technique was originally developed to add geotechnical stability to soft soils and is effective at

depths up to 100 feet. This technology has been proven effective at addressing PAH impacts at other coal tar and creosote sites (e.g., Macon, Georgia; Cambridge, Massachusetts; Renton, Washington; Exeter, New Hampshire; Columbus, Ohio). Equipment is specialized, but commonly available, and site-specific factors that could limit implementability, such as utilities, nearby structures, or public proximity to the work area during construction are largely absent from the Site.

***In Situ* Vitrification**

Vitrification is a process that involves adding energy to soils as electric current, increasing the temperature of the soil to the point at which some of the minerals in the soil melt. When these cool, they form a solid, crystalline substance. Since the temperatures reached are several thousand degrees Fahrenheit, the majority of organic contaminants are destroyed by oxidation while inorganic contaminants are solidified within the cooled soils.

**Evaluation and Representative Process Option for Solidification/Stabilization**

As discussed above, *in situ* soil mixing has proven effective at coal tar and wood treating sites, and is implementable at the Site. In addition, this process is generally cost effective, as compared to vitrification or excavation and subsequent solidification or treatment. Pressure grouting is generally more costly than soil mixing, but is retained for potential use in situations involving smaller volumes of solidification where it may be more effective than soil mixing. *In situ* soil mixing and pressure grouting are identified as the representative process options for solidification of soils.

#### 4.4.2.3.3 On-Site Containment

EPA considers on-site containment as an alternative remedy to the presumptive remedies (EPA, 1997). On-site containment processes include closure in place (if soil is of acceptable quality), temporary on-site storage (pending further treatment or remedial action), or on-site containment cell construction.

Currently, the potential for soils to leach to groundwater indicate that closure in-place is not appropriate for the Site soils, as it would not achieve RAO 3 as a stand-alone approach. Temporary on-site storage is considered an intermediate step in the removal and treatment or disposal process.

Permanent on-site containment cells involve construction of engineered areas, which would contain soils to prevent receptors from contacting the soils or soils leaching to groundwater. Containment cells are typically built with bermed sides, an impermeable bottom constructed of clay or a polyethylene liner, and a durable cover to resist erosion and disturbance by humans, animals, vegetation, or surface water. The cover may also be impermeable. Some containment cells include a leachate collection and treatment system. After construction of the cell bottom, soils to be contained are loaded into the cell and a cover is constructed over the soils.

Permanent on-site containment cells are effective at containing contaminated soils after excavation. They are moderately implementable at the Site, requiring a detailed siting and engineering process due to the location of the Site in the floodway of the St. Joe River. Permanent on-site containment is identified as the representative process option for on-site containment of excavated soils. Temporary on-site storage may be used as an intermediate step for soil handling at the Site but is not a viable long-term remedial option.

### 4.4.2.4 Removal and *Ex Situ* Treatment or Disposal

As discussed in the section on GRAs, soils can be removed and **then treated, beneficially reused on-site, re-deposited, or disposed after the removal. This is true of sediments as well as soils.** Removal technologies typically involve excavation of impacted soils by traditional means with commonly available excavation equipment. Removal actions would be generally effective at achieving the RAOs as they remove the soils that could cause risk to receptors. The relative implementability and cost of removal actions is highly dependent on the subsequent treatment or disposal method. As such, this section discusses the subsequent *ex situ* treatment and disposal remedial technologies that could be employed after removal of the soils.

Implementation of the removal action itself is technically achievable, though detailed design of shoring and dewatering systems would be necessary for mass excavations due to the location adjacent to the St. Joe River and the shallow water table.

#### 4.4.2.4.1 *Ex Situ* Bioremediation

Bioremediation is based on the natural biochemical reactions mediated by microorganisms that result in degradation of organic COC. Bioremediation is the preferred presumptive remedy for soils, sediments, and sludges at wood treater sites. In practice, bioremediation can be implemented as an *in situ* or *ex situ* process. For the purposes of a removal action, it is considered an *ex situ* process.

Aerobic biodegradation converts organic matter and compounds to intermediate organic compounds and final decomposition products that include carbon dioxide, water, humic materials, and microbial cell matter. If practicable, anaerobic biodegradation converts the COC to carbon dioxide, methane, and microbial cell matter. Anaerobic metabolism has a more limited range of organic substrates than aerobic metabolism. Depending on COC characteristics, volume of material, and Site characteristics, bioremediation requires several years to complete. To accelerate the rate of bioremediation, addition of nutrients, oxygen, or other enhancements to the soils is required.

Bioremediation is proven for treatment of a wide variety of compounds. The success of bioremediation is site- and COC-specific. Extensive literature concerning biotreatment of polycyclic aromatic hydrocarbons (PAHs) is available. Studies have indicated that bioremediation of creosote contamination works well on 2-, 3-, and 4-ring compounds but is generally less effective on 5- and 6-ring compounds. On-site

*ex situ* bioremediation is generally cost effective for larger volumes of soil, as compared to off-site treatment and disposal of the soils, if they are listed hazardous wastes.

Several process options exist that use bioremediation for treatment of contaminated soils. These are outlined below.

**Land Farming**

Land farming involves construction of a treatment cell, which prevents spreading of contaminated soil or leachate to surrounding soils, groundwater, or surface water. Contaminated soil is then placed in the treatment cell. The soil is usually tilled to provide aeration for aerobic degradation. Nutrients, bulking agents, compounds to alter pH, and irrigation can be provided to maintain optimal conditions in the soil. As land farms are typically open to the atmosphere, containment and treatment of stormwater is required. Land farming is considered effective in treating semivolatile organic compounds (SVOCs), such as PAH.

**Biopiles**

Biopiles are similar to land farming, but include active aeration systems, which may also deliver nutrients, pH adjustment compounds, and other amendments. Biopiles are usually covered or lined, and require leachate collection and treatment. Biopiles typically have shorter-term remediation periods than land farms and require more complex equipment. Biopiles are considered moderately effective in treatment of SVOCs.

**Composting**

Composting involves mixing excavated soils with bulking agents, nutrients, and organic materials, then placing the soil in windrows or aerated treatment cells. The windrows or treatment cells are turned on a regular basis to provide maximum degradation. Temperature, moisture, and nutrient contents are typically monitored and controlled. Composting is considered moderately effective in treatment of SVOCs.

**Slurry-Phase Bioreactor**

In slurry-phase bioreactors, excavated soils are separated by size, mixed with water, and maintained in a slurry suspension in a bioreactor vessel. Additional microbial organisms, nutrients, pH adjusting agents, and oxygen may be added to control the bioremediation process. The wash water is often recycled for use in further batches. The process is affected by soil type, degree of contamination, and may require additional treatment of process waters and vapors. Fine soils, such as silts present at the Site, are likely to make this process difficult to implement, as separating the fine soil particles from the wash water is difficult.

**Evaluation and Representative Process Option for *Ex Situ* Bioremediation**

While bioremediation may be effective at treating creosote compounds on the Site, the location of the Site in the floodway is a hindrance in the implementability of bioremediation. Bioremediation of creosote is more effective in aerobic environments. As such, soils being bioremediated are typically left open to the air, unlike in a containment cell, where they are capped with solid materials. As bioremediation of soils typically takes place over a period of years, the soils would be exposed to the air for years. During this period, it is possible that the Site would flood to a level above containment berms constructed around the treatment area and soil being bioremediated could be eroded and transported downstream. Due to the potential risk from this scenario, on-site bioremediation of soils is not considered implementable at the Site and the technology is eliminated from further consideration.

### 4.4.2.4.2 *Ex situ* Thermal Treatment Technologies

A variety of *ex situ* treatment technologies exist that raise the temperature of the soil through the addition of energy. This volatilizes the COC, which are usually treated in the vapor phase after they have been volatilized. The means of adding energy, and the degree of heating, varies from one process option to another.

**Thermal Desorption**

Thermal desorption is the second-most preferable presumptive remedy for soils, sediments, and sludges at wood treating sites (EPA, 1995). Thermal desorption physically removes COC from the soil through application of direct or indirect heating. Excavated soils are moved through a heating chamber at a rate determined to most efficiently remove the required amount of COC. The separated COC are recovered and treated in the vapor stream.

Thermal desorption is affected by the operation temperature, feed soils, and vapor treatment requirements. Generally, dry, coarser-grained soils containing volatile non-hydrochlorinated compounds are most easily treated, while fine wet soils containing chlorinated compounds are the most difficult to treat.

Thermal desorption is performed as both an on-site and off-site process. Fixed-facilities exist in the United States, but few are licensed to accept hazardous waste. Mobile facilities have been used for cleanup at other CERCLA sites. The greatest difficulties in thermal desorption are hazardous waste status, physical site limitations, and quality and moisture content of feed soils. Thermal desorption of soils and/or sediments is implementable for the Site. On-site thermal desorption would require careful design, a pilot test for treatability, and management of soil residuals.

**Pyrolysis**

Pyrolysis involves subjecting dry soils to heat in the absence of oxygen. COC do not oxidize, but create vapor, liquids, and a solid coke material. The separate residual streams of vapor, liquid, and coke are treated or disposed as appropriate. Pyrolysis

treats PAH and other organic COC but is an emerging technology that has yet to be proven effective. Full-scale pyrolysis equipment does not exist at this time and the equipment required is complex, making the process difficult to implement. In addition, the pyrolysis process cannot accept sludge-type materials that could include wet soils excavated from below the water table.

***Ex Situ* Vitrification**

Vitrification is the process of heating soils to temperatures that melt the soils. Organic COC are typically destroyed with high efficiency in the process. Proper disposal of the residuals is required after heating. Vapors created during the heating must be controlled and treated, especially in the early stages of heating. Vitrification is currently a pilot-scale technology and has not been proven effective at full scale. The energy requirements for vitrification increase substantially with wet soil as energy is required to drive water off during the process. Low community acceptance and safety hazards associated with the high energy requirements of vitrification also limit its implementability. Overall, vitrification is not yet proven effective, is difficult to implement, and is relatively high in cost.

**Wet-Air Oxidation**

In wet-air oxidation, excavated soils are mixed with water and air, and heated. Organic COC are broken down by oxidation. Treatment of the vapor stream and any liquid wastes is typically required. Wet air oxidation is an emerging technology and does not have a record of proven effectiveness. In addition, field-scale equipment can be difficult to obtain. In general, effectiveness is unproven, implementation difficult, and costs high.

**Infrared Treatment**

Infrared treatment heats soils using infrared electromagnetic waves. The COC are separated from the soils by heating and COC are removed and treated in the vapor stream. Infrared technology is still emerging and is not proven effective. Due to the emerging status of this technology, equipment is difficult to obtain. Also, costs are relatively high due to the lack of equipment and experience with the process. Overall, infrared treatment is of unproven effectiveness, difficult implementability, and is high in cost.

**Advanced Electric Reactor**

This thermal treatment process heats contaminated soils with radiation to high temperatures, achieving destruction of COC. The process is still emerging and full-scale units are not yet available. This process is considered to be of unproven effectiveness and difficult to implement.

**Plasma Arc**

This process uses a plasma or electric arc to break down COC to their elemental components. Pilot-scale equipment is available for liquids, but equipment for soils is not currently available. This process is of unproven effectiveness and would be difficult to implement.

**Evaluation and Representative Process Option for *Ex Situ* Thermal Treatment**

The only thermal treatment technology which has been used full-scale and is readily available is thermal desorption. This process is effective in the treatment of soils. However, implementing the technology may be difficult, as community acceptance of on-site treatment can be low and few fixed facilities exist which are licensed to accept F034 wastes. However, due to its status as a presumptive remedy, thermal desorption is identified as a representative process option for thermal treatments.

#### 4.4.2.4.3 *Ex situ* Solidification/Stabilization

*Ex situ* solidification involves mixing solidifying agents with soils to create a matrix, similar to concrete, which encapsulates the soils and associated COC. After the matrix has solidified, the COC in soils cannot be contacted by receptors, nor can the COC leach to water.

*Ex situ* stabilization can be achieved by a number of methods, which typically involve mixing the soils into a cement or concrete matrix, asphalt, or polyethylene. Soils must first be excavated, then stabilized with the selected method. Several factors affect the implementation of *ex situ* stabilization processes at the Site. First, the Site is somewhat remote and no large-scale industrial processes that could use the soils as feedstock are nearby, therefore increasing transportation requirements. Second, if soils from the Site are designated as F034 listed hazardous waste, few, if any, of these processes are licensed to accept this waste. Due to the difficulty in implementability, *ex situ* stabilization processes are not retained for further consideration.

#### 4.4.2.4.4 *Ex Situ* Chemical Treatment

After excavation, a variety of chemical treatment methods can be used to treat COC in the soil. The most common is solvent extraction, which uses an organic solvent to remove COC from the soil. The COC are then stripped from the solvent, the solvent recycled into the process, and the COC treated or disposed, as appropriate. Solvent extraction is generally considered an inadequate technology due to implementation, cost, and availability issues (EPA, 1997).

#### 4.4.2.4.5 Incineration

Incineration is a presumptive remedy for organic COC at wood treatment sites, but is the least preferable of the presumptive remedies. Incineration treats organic contamination by subjecting it to high temperatures (greater than 1,000 degrees Fahrenheit [°F]), oxygen, and a flame. During the process, volatilization and

combustion convert the organic COC to carbon dioxide, water, hydrogen chloride, and sulfur oxides. Incineration generates several waste streams and off-gas treatment is required. Though incineration has an acceptable success rate, permitting requirements for on-site incineration are significant and public approval of the technology is difficult to obtain.

Off-site incineration is limited to a few fixed-location permitted facilities and is extremely expensive, typically on the order of $400 to $500 per ton of soil. It is anticipated that the Site location in the floodway and lack of public acceptance will eliminate the use of on-site incineration as a remedy for the Site. Additionally, the high cost associated with incineration will preclude its use as a viable remedial option for large soil volumes, though off-site incineration may be cost-effective for limited volumes of concentrated COC. Despite the high cost for off-site incineration, this technology is retained for further consideration due to its history of effectiveness and implementability.

#### 4.4.2.4.6 Soil Washing

Soil washing is a physical separation process that reduces the volume of contaminated soils by consolidating the fine-grained soils, which frequently contain the majority of the COC. The process separates soils by size and removes COC to the extent possible from the coarser fraction of the soil by using equipment common to the mineral and ore processing industries, such as screening, gravity separation, hydrocyclones, pug mills, and attrition scrubbing machines. Contamination is then consolidated into process water containing wet fine-grained soil, which needs further treatment by changing pH, and/or adding surfactants, leaching agents, or chelating agents.

Soil washing is a physical separation process and produces process residuals in the form of contaminated sludges, wastewaters, and vapors. These residuals require appropriate treatment or disposal. Soil washing has limited effectiveness with soils of fine grain size, such as fine silts and clays, as these soils are difficult to separate from the wash water. It can also be difficult to implement due to the process equipment required and significant volumes of wash water generated. Because of the difficulty in implementing soil washing with fine-grained soils at the Site, this technology is not retained for further evaluation.

#### 4.4.2.4.7 Subtitle C Landfill Disposal

Soils that contain F034 hazardous wastes at concentrations below 10 times the Universal Treatment Standards may be disposed in a RCRA Subtitle C landfill. Landfill disposal is not effective at reducing COC volumes, but is effective at limiting receptor access to impacted soils and ensuring that soil will not be disturbed in the future. Landfill disposal may be implemented for soils from the Site, though the transportation and disposal costs make this a fairly high cost option. This option is retained for further evaluation.

#### 4.4.2.4.8 Subtitle D Landfill Disposal

Soils which are not or do not contain hazardous wastes may be disposed in a RCRA Subtitle D landfill. Similar to Subtitle C disposal, Subtitle D disposal is not effective at treatment of COC but is effective at limiting receptor access to impacted soils and ensuring that soil will not be disturbed in the future. This option is retained for further evaluation.

#### 4.4.2.4.9 Off-Site Reuse

Off-site reuse of soils was considered as an alternative to presumptive remedies for wood treating sites (EPA, 1997). It is generally considered ineffective as a standalone remedial option as additional treatment would likely be required to attain concentrations acceptable for reuse. In order for soils to be reused off-site, they would need to be reused in accordance with their waste status, which is likely to be F034 listed hazardous waste. Due to the lack of facilities which may need soils in the St. Maries area, the availability of other soils, and the potential for Site soils to be F034 listed hazardous wastes, this option is likely to be difficult to implement and is not retained for further consideration.

### 4.4.2.5 *In Situ* Treatment

This GRA involves treating soils and COC *in situ*. Some process options are not treatment but provide physical or chemical consolidation of COC or extraction of the COC from the soil. These COC are then treated or disposed, as appropriate. Several technology types are considered for *in situ* treatment.

#### 4.4.2.5.1 Soil Vapor Extraction

Soil vapor extraction (SVE) applies a vacuum to soils using conventional air moving equipment and wells or piping inserted into the soil. The applied vacuum causes the vapor in the soil matrix to migrate to the extraction point from which the vacuum is applied. As the soil vapors are evacuated, more air moves in to replace the evacuated soil vapors. COC in the soil volatilize into the new air, which is then removed through vapor extraction. The extracted soil vapors are treated to remove COC. A common means of treating the extracted vapor and COC is thermal or catalytic oxidation. Soil vapor extraction is of limited effectiveness with SVOCs (FRTR), such as those found at the Site, and is more suited to volatile compounds that readily volatilize into the soil vapor. In addition, SVE does not treat soils below the water table and does not perform well in fine-grained soils. Impacted soils exist below the water table at the Site and significant units of silts exist at the Site. These factors limit the effectiveness of SVE. Soil vapor extraction is considered of limited effectiveness for the COC at the Site and would be difficult to implement due to the high water table. For these reasons, SVE is screened out as a viable remedial technology for the Site.

#### 4.4.2.5.2 Soil Flushing

Soil flushing physically separates COC from the soils using water, surfactant, solvents, or a mixture to recover COC from the soil. The process water or solvents

are extracted and treated to remove COC. The process water and solvents are typically recycled and re-injected into the ground to assist in the flushing process, though almost all pilot tests to date have disposed of recovered groundwater, surfactants, and solvents. This technology is still being developed and has seen limited use in pilot projects, mostly with chlorinated solvents. The technology is typically limited to coarse-grained soil to allow effective dispersion of the injected surfactants or solvents over the area to be treated. Effectiveness would be limited by the fine-grained soils at the Site. The technology is difficult to implement, requiring customized equipment and significant bench- and pilot-scale testing. In addition, the limited number of pilot studies, especially those demonstrating recycling of water, surfactant, and cosolvent and the lack of experience implementing on-site water treatment requirements make this technology difficult to implement. As the emerging nature of this technology makes implementation extremely difficult and the technology is likely to be of limited effectiveness, it is not retained for further evaluation.

#### 4.4.2.5.3 *In Situ* Thermal Treatment

There are many *in situ* thermal technologies in pilot scale development. These processes generally involve introducing heat to the soil to mobilize COC and allow them to be extracted through SVE, though some also allow removal of COC dissolved in water or as NAPLs. The technologies differ chiefly in the means by which they deliver the heat to the soil. With any *in situ* thermal treatment, there are some risks associated with mobilizing COC. Recovery of the mobilized COC and the consequences of mobilizing the COC should be carefully considered and designed. Thermal technologies have typically been applied to DNAPL sites to reduce the viscosity of DNAPLs and improve recovery. These technologies have not been applied to treatment of soil or residual DNAPL. This level of treatment requires the volatilization of COC at high temperature and collection of the vapors or condensed COC.

**Electrical Resistance Heating**

Electrical resistance heating uses an electrical current to heat less permeable soils such as clays and fine-grained sediments so that water and COC trapped in these relatively conductive regions are vaporized and ready for vacuum extraction. Electrodes are placed directly into the less permeable soil matrix and activated so that electrical current passes through the soil, creating a resistance that then heats the soil. The heat dries out the soil causing it to fracture. The fractures make the soil more permeable allowing the use of SVE to remove the COC. The heat created by electrical resistance heating also forces trapped liquids to vaporize and move to the steam zone for removal by SVE. The effectiveness of electrical resistance heating is largely unknown due to the limited numbers of full-scale applications. As the process uses SVE to recover COC, it may not be effective in the fine-grained soils at the Site. In addition, most soils at the Site are below the water table. Resistance heating may not be effective in drying out soils and allowing migration of COC since water provides a large energy sink for the supplied electricity. Implementation may also be

difficult as significant electrical supply is required and equipment may need to be custom-designed for the Site. Costs are likely to be high due to the customized equipment and large power demands.

**Radio-Frequency Heating**

Radio frequency heating (RFH) uses electromagnetic energy to heat soil and enhance SVE. RFH technique heats a discrete volume of soil using rows of vertical electrodes embedded in soil (or other media). Heated soil volumes are bounded by two rows of ground electrodes with energy applied to a third row midway between the ground rows. The three rows act as a buried triplate capacitor. When energy is applied to the electrode array, heating begins at the top center and proceeds vertically downward and laterally outward through the soil volume. The technique can heat soils to over 300 degrees centigrade (°C). The effectiveness of this process is largely unknown due to the limited use of the technology. In addition, the high water table at the Site may limit the effectiveness by providing an energy sink. The process may be difficult to implement, as it requires specialized equipment that is not readily available. There is little empirical data on the cost of the process but costs are likely to be high due to the specialized equipment and process.

**Hot Air Injection**

Hot air is injected into the soil, raising the temperature and volatilizing COC in the soil, which are then removed by soil vapor extraction. Little empirical data on effectiveness, implementability, or cost are available for hot air injection.

**Conductive Heating**

Conductive heating uses closely spaced heating probes inserted into the soil. These probes are heated with electric current, circulated fluid, or other means to volatilize and mobilize COC for recovery by SVE. Heating near the surface has been accomplished by covering the surface with heated blankets, which deliver the heat over a larger area. Conductive heating can reach high temperatures and significantly mobilize COC. The process also evaporates water but may have difficulties at significant depths below the water table. As the majority of soils at the Site are below the water table, conductive heating is not likely to be effective. Limited information on the effectiveness, implementation, or costs of conductive heating is available.

**Steam Injection**

Steam is injected into the soil matrix, stripping volatile COC, and mobilizing COC and LNAPL/DNAPL for recovery via SVE or via liquid-phase extraction, as appropriate. Condensation of the COC occurs at the front of the advancing steam, which creates a bank of COC. This technique is generally applicable to coarse-grained soils but it is sometimes combined with electrical heating, which mobilizes COC in fine-grained soils. Steam injection with enhancement by electrical heating is generally applicable to sites with DNAPL as it mobilizes the DNAPL, which can be difficult to recover. Effectiveness of steam injection has not yet been widely

demonstrated, though pilot projects have been initiated at wood treating sites. While no empirical cost data are available on this process, the costs are likely to be high due to the large amount of equipment and custom installation requirements.

**Discussion of Additional Treatment Processes**

Several other chemical treatment processes, including supercritical fluid extraction, ultraviolet (UV)/photolysis, alkaline hydrolysis, and supercritical oxidation were considered by the EPA (EPA, 1997). In general, the EPA found that these options were inadequate remediation methods for contaminated soils, sediment, and sludges at wood treater sites because of the lack of effectiveness with common wood treatment-related COC and problems with implementation.

Due to the determination that these are generally inadequate treatment processes, chemical treatments are not retained for further consideration.

**Evaluation and Representative Process Option for *In Situ* Thermal Treatment**

Some of the *in situ* thermal treatments are dependent on SVE to remove mobilized COC from soil, which is implementable above the water table but not effective with Site COC or soils below the water table. As SVE is difficult to implement at the Site due to the shallow water table and fine-grained soils and these processes are applicable to soils above the water table, *in situ* thermal treatment processes dependent on SVE are considered not implementable at the Site and are not retained for further consideration.

Some *in situ* thermal treatments, (e.g., steam injection), can recover COC from below the groundwater table. These processes have typically been applied to remove free-phase DNAPL, which exists in limited quantity at the Site. As these are emerging technologies, and their potential effectiveness is generally evaluated through pilot testing, which has not been performed at the Site, these technologies are not retained for further consideration.

#### 4.4.2.5.4 *In Situ* Bioremediation

Similar to *ex situ* bioremediation, *in situ* bioremediation uses naturally occurring microorganisms to break down COC in the soil. This degradation can occur under aerobic or anaerobic conditions. The timeframe for *in situ* bioremediation is generally longer than *ex situ* bioremediation but costs are lower. Bioremediation depends on several site-specific parameters including the concentrations of COC in the soil, the presence or absence of oxygen in the soil, and the number and type of microorganisms present in the soil. Treatability studies may be required to ascertain the effectiveness of *in situ* bioremediation at the Site. *In situ* bioremediation is relatively easy to implement at the Site and costs are low. *In situ* bioremediation is not likely to be effective in a reasonable timeframe for heavily impacted soil and it is not considered for further evaluation for treatment soil.

**Bioventing**

Bioventing involves introducing fresh air to soil to promote aerobic degradation of COC by naturally occurring microorganisms. The effectiveness of bioventing on creosote residuals has not been documented so the effectiveness of this technology is largely unknown. The technology applies to soils above the water table and is not effective for soils below the water table. In addition, forced distribution of air or oxygen in fine-grained soils may be difficult, limiting effectiveness. As the technology applies to soils above the water table and the majority of creosote-impacted soils at the Site are below the water table, the technology is not considered implementable for the majority of the creosote-impacted soils at the Site and is not retained for further consideration.

# 4.5 Sediment

## 4.5.1 Remedial Goals for Sediment

Remedial actions for sediment in the St. Joe River may be required to directly address several of the RAOs for the Site, as there is potential risk to receptors from sediment. Applicable RAOs are:

**RAO 1: Protect aquatic and benthic organisms by preventing direct contact of benthic organisms with COC in surface sediment in the St. Joe River at concentrations greater than protective levels**

Currently, an area of nearshore surface sediments in the St. Joe River is assumed to cause risk to ecological receptors in the river. Surface sediments exceed the MCUL, which is the surface sediment PRG for the Site.

**RAO 2: Prevent visible oil films or sheens in the St. Joe River**

Sheens are occasionally released into the St. Joe River from the shoreline soil/sediment and adjacent nearshore sediment near the removal area of the riverbank.

**RAO 4: Prevent the downstream transport of COC that result in COC concentrations in water or sediment that exceed levels protective of aquatic and benthic organisms**

As discussed in Section 2.7, modeling performed as part of the RI/BLRA indicated that subsurface sediments in the St. Joe River may erode during major flooding events such as a 100-year storm. Subsurface sediment exceeds the MCUL for surface sediment suggesting a potential risk if this subsurface sediment is eroded.

## 4.5.2 Description of GRAs

The following paragraphs discuss remedial technologies and process options for soil, organized by GRA. In addition to the five GRAs identified in the RI/FS Work Plan (RETEC, 2002b) consistent with the RI/FS Guidance (EPA, 1988), *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites* (EPA, 2002) was

considered to help identify GRAs for sediment. Specific categories of GRAs identified for the St. Joe River include:

- No Action;
- Institutional Controls;
- Monitored Natural Recovery;
- Containment;
- Removal (with subsequent treatment, reuse, and/or disposal);
- *In situ* Treatment; and
- Combined Remedies.

### 4.5.2.1 No Action

Consideration of a "No Action" response is required by the National Contingency Plan (NCP). No action serves as a baseline against which the performance of other remedial alternatives can be compared. This response assumes no active remedial measures are implemented.

RAOs would not be addressed if there were no remedial action for sediment. Current risks to ecological receptors in the St. Joe River from the nearshore sediments, and the potential future risk from erosion of subsurface sediment would not be addressed. It would not prevent sheens. The No Action GRA is meant to provide a baseline for evaluating other remedial actions.

### 4.5.2.2 Institutional Controls/Monitoring

Institutional controls are legal or administrative measures designed to restrict site access or limit site use. The measures reduce exposure to COCs by precluding activities that could lead to exposure. Dredging moratoriums and fish consumption advisories are relevant examples of institutional controls.

Institutional controls are administrative actions (e.g., fish consumption advisories, access restrictions, dredging moratoriums) designed to prevent exposure of humans and wildlife to contaminants. Institutional controls are generally effective at limiting human exposure, but are generally ineffective at affording protection to ecological receptors where impacts are ongoing. In general, institutional controls have no effect on ecological receptors. Nevertheless, institutional controls are important features of many sediment cleanup projects and are retained for further consideration in the development of remedial alternatives (EPA, 1999a).

Engineering controls to reduce or control sheens, including capping sediment, are potentially implementable at the site. Engineering controls to limit use are not likely

to be implementable due to the administrative difficulty in obtaining permission to implement the engineering controls and their potentially adverse effect on human use of the river or wildlife habitat.

Monitoring may be part of a remedial action in order to ensure the remedy is effective over the long term. Monitoring could involve sediment sampling, sampling of groundwater, and subsequent modeling of the potential for sediment to be affected, or monitoring of receptors that may encounter sediment.

### 4.5.2.3 Monitored Natural Recovery

Monitored natural recovery (MNR) takes advantage of naturally occurring processes to reduce concentrations of COC in surface sediment. These processes include biodegradation, diffusion, dilution, sorption, volatilization, chemical, and biochemical stabilization of COC, and burial by natural depositions of new, uncontaminated sediments. For the Site, the primary MNR process is likely burial, but other mechanisms for MNR include biodegradation, sediment resuspension and transport.

Methods for evaluating MNR as a remedial action for sediment are actively being developed by the EPA through the Remediation Technologies Development Forum (RTDF). The EPA created the RTDF in 1992 to foster collaboration between the public and private sectors in developing innovative solutions to mutual hazardous waste problems. One of the active areas of engagement of the Sediments Remediation Action Team has been to develop a "weight-of-evidence" approach for evaluating the use of MNR. Through a series of five working draft papers[7], the "weight-of-evidence" framework presents five interrelated elements—based on site-specific information—to assess the use and effectiveness of MNR:

- Characterize contamination sources and controls;
- Characterize fate and transport processes (both sediment and contaminant);
- Establish historical record for contaminants in sediments (including bed stability);
- Corroborate MNR based on biological endpoint(s) trends; and
- Develop acceptable and defensible predictive tools;

This weight-of-evidence approach is under development, and EPA is in the process of developing separate guidance on MNR for sediments (V. Magar, Environ International Corporation, personal communication, September 23, 2004).

[7] These papers may be found at the RTDF web site: http://www.rtdf.org/public/sediment/mnrpapers.htm

This section discusses the results of this weight-of-evidence approach to evaluate whether MNR should be carried forward for inclusion in remedial alternatives. This weight-of-evidence approach was, used in the RI-BLRA to serve as a process by which MNR has been evaluated for the St. Joe River.

Contamination sources were characterized in the RI-BLRA, and appropriate controls for continuing sources are described in this FS. Appendices K, L, O and P of the RI/BLRA evaluated sediment stability, along with transport, and burial mechanisms. The principal tools were the hydraulic river model, sediment core profiles, and geochronological radioisotope profiling. Bathymetry, soft sediment thickness, and chemical patterns were also used in the assessment.

Cesium-137 radioisotope dating presented in the RI/BLRA concluded that below the active mixing zone at the surface of the sediments (12 to 31 centimeters [cm] thick) the average net sedimentation rate was 1.14 to 2.37 cm per year. This indicates that in general, the river bed is stable, though moderate scour and re-deposition may be occurring.

Scour modeling of the St. Joe River indicated that from the Site to 600 feet downstream of the Site, scour in the event of a 100-year flood could range from 2.6 feet of scour to 0.1 feet of deposition, with an average scour of 1.7 ft. The cross-section distribution of the scour ranged from between 0.17 to 0.5 feet in the nearshore area to 1.34 to 2.89 feet in the center of the river. The predicted nearshore scour depths are within the range of the active mixing zone seen in the sediment cores (12 to 31 cm), which supports the cesium-137 data. The modeling indicates greater erosion in the center of the channel where flow velocities are higher. While there are uncertainties associated with the application of a fairly simple, stochastic model (the HEC-6 model used), the calculated results appear relatively consistent with the existence of chemical concentration patterns in the subsurface sediments, under the assumption that the bed elevation in 2002 has returned to the pre-1996 (100-year flood event) bed elevation. These data collectively suggest that the model is conservative (overestimates scour) and can be reasonably applied to the 100-year flood to assess bed scour and deposition with an assigned uncertainty of one foot vertically (RI-BLRA Appendix O).

When evaluated collectively using the RTDF weight-of-evidence approach, the collective information suggests that surface sediments may be eroded during scour events. While the hydraulic modeling suggests average scour up to 2.7 feet ± 1 foot, some of the radioisotope analyses of sediment cores indicate that this disturbance is limited to the top 0.4 to 1 foot in the nearshore area and limited to a maximum of approximately 3 feet in the offshore area. Reliable, predictive tools for assessing scour and the potential risks to downstream receptors, the last two bullets in the weight-of-evidence approach, have not been developed, but would be developed as part of a MNR program.

Monitored natural recovery is technically implementable at the Site. The analyses in the RI-BLRA indicate that it is likely that periodic scour and redeposition occurs in

the St. Joe River. However, the variability in the amount of potential scour indicated by the different analyses provides uncertainty in the actual risk caused by the scour. Because of this uncertainty, MNR is retained as a potential remedy only for those areas where sediment PRGs are not exceeded in the surface sediments, but are exceeded in the subsurface sediments. Contingencies would be built into the MNR program, such that active remedial actions would be implemented at those locations where MNR was not occurring. A MNR program with contingency includes:

- Development of an evaluation framework which includes using the RTDF weight-of-evidence approach, development of a reliable predictive tool for measuring scour, an evaluation method for assessing fate and transport, and potential risk to receptors.

- A contingent remedy of armored cap placement will be implemented if or where the stability evaluation and biological endpoint assessment indicate that scour and transport of COC in subsurface sediments may exceed water quality criteria and/or cause downstream sediment contamination above the PRGs.

- Ongoing monitoring to include measurements of COC concentration in sediment and surface water. The results of the monitoring would be used to evaluate potential scour and risk using the models.

- The contingent remedy option of armored cap placement remains in place in the event Site RAOs are not achieved within the monitored time frame.

#### 4.5.2.4 Containment/Capping

Containment involves the physical isolation and immobilization of contaminants in sediment. Containment remedies including capping, confined aquatic disposal facilities, and confined disposal facilities. The containment section discusses capping. Confined aquatic disposal and confined disposal facilities are discussed further in the discussion of removed sediment, as these containment technologies are used with *ex situ* sediment.

Capping contaminated sediments *in situ* contains impacted sediment. Capping is one of the remedies that the Sediment Remediation Guidelines stipulates be evaluated at all contaminated sediments sites. Capping isolates COC from the overlying water column and prevents direct contact with aquatic biota, which would achieve RAO 1. In addition, capping provides new unimpacted substrate for recolonization by benthic organisms. Cap designs should minimize the potential for sediment resuspension under normal and extreme (flood) conditions and caps can be placed specifically to armor sediments against erosion, which could be used to achieve RAO 4. Cap placement as a remedial alternative assumes source control and minimal potential for recontamination from upstream sources via sediment transport.

Capping remedies have been an important component of several CERCLA sites nationally and within EPA Region 10, including the Simpson/Tacoma Kraft site, Eagle

Harbor (East and West Operable Units), PSR West Seattle, the Thea Foss Waterway, and the Pine Street Canal Site in Vermont (Palermo et al 2002). A principle advantage of an in situ cap is that the potential for contaminant resuspension and the risks associated with dispersion of contaminated materials during construction is relatively low and comparable to environmental removal operations. Also, a major advantage is that no disposal site or *ex-situ* treatment for the dredged sediment is needed.

Capping may be implemented more quickly and may be less expensive than options involving removal and disposal or treatment, depending on the location of the cap, the type of construction, and the availability of materials. In addition, a cap may be readily repaired, if necessary. After capping of contaminated sediments, no sediment treatment occurs other than by natural processes under the cap surface. Assuming effective cap placement, the bioavailability and mobility of contaminants present in the sediments would be immediately limited (Palermo et al 1998).

Sediments in the St. Joe River could be contained to prevent receptor contact with the sediments, and migration of the sediments. *In situ* containment remedies generally take the form of natural or anthropogenic capping of sediments, though there have been some experiments with solidification or stabilization. This section outlines containment technologies and process options applicable to sediments at the Site.

**Conventional Capping**

Conventional caps involve the placement of sand or other suitable cover material (i.e., clay) over the top of contaminated sediments. Material selection and cap thickness are determined based on consideration of contaminant properties and local hydraulic conditions. Sandy soils and sediments are typically preferred as cap materials over fine-grained materials. The latter is more difficult to place evenly, will cause a great deal of turbidity during placement, and is more susceptible to erosion. A cap thickness of 30 to 50 cm is considered sufficient to chemically isolate highly sorptive COC (Palermo, 1994). Cap thickness may extend up to 100 cm depending on site-specific conditions such as extent of bioturbation, currents and sediment properties.

Capping operations can disturb and displace loose fine-grained bottom sediment, resulting in resuspension losses and mixing of contaminants into the clean capping layer. Physical characteristics such as solids content, plasticity, shear strength, consolidation, and grain size distribution affect the displacement of sediment. The sediment characteristics will often form the basis for determining the suitability of capping materials and placement options (Palermo, 1991).

A variety of methods are available for constructing conventional caps in riverine environments:

- Hydraulic pipeline delivery of a sand slurry through a floating spreader box or submerged diffuser;
- Physical dispersion of barged capping materials by dozing, clamming, or washing of material that settles through the water column;

- Distribution by controlled discharge from hopper barges;
- Mechanically-fed tremie to the river bottom; and
- High-pressure spraying of a hydraulic sediment water slurry across the water surface.

The method used to place the cap material must be capable of achieving uniform placement of material over the target area while limiting the resuspension and loss of contaminated sediment into the water column or the emerging cap layer. Uniform placement and limited resuspension of contaminated sediment are generally achieved when the capping materials are dispersed and allowed to settle through the water column. The dumping of large, dense masses of capping material (e.g., pushing sands off a barge) or methods that lead to density-driven hydraulic flow should be avoided.

**Armored Capping**

Armored caps are similar to conventional caps with the exception that the primary capping material (e.g., sand) is covered with stone or other suitable riprap (the armor) to add physical stability in erosive environments. Armored caps are commonly used in environments where high water velocities (i.e., flood flow, propeller wash) threaten the cap integrity. An armored cap has been placed in the Sheboygan River in Sheboygan Falls, Wisconsin and at Convair Lagoon in San Diego, California.

The conventional portion of the cap is placed using one of the previously described methods. Armoring materials (quarried rock or concrete riprap) are then barged to the Site and placed using conventional equipment (excavators, cranes). Methods for determining the appropriate armor stone grade and thickness can be found in the Assessment and Remediation of Contaminated Sediments (ARCS) Sediment Capping Study Final Report.

**Composite Capping**

A composite cap generally involves placement of a geotextile, flexible membrane liner, or fused HDPE directly over the contaminated sediments. Liner materials must be specified depending upon the migration potential of the COC and the potential for methane buildup under the liner in highly organic sediments. The liner is then armored with stone or riprap to ensure the physical integrity of the cap. Composite caps may also include a sand or activated carbon layer to capture any potential diffusive or advective migration of the underlying contaminants. Examples of recent composite capping include Mocks Pond in Indiana (geotextile plus graded sand), and the Thea Foss Waterway in Tacoma, Washington (HDPE).

**Miscellaneous Capping Techniques**

Additional capping approaches, besides those described above, have received attention in the capping literature including thin-layer capping, Aquiblock™, and Claymax™. Thin-layer capping involves the placement of a thin (1- to 3-inch) layer

of clean sediments that is subsequently mixed with the underlying contaminated sediments to achieve acceptable COC concentrations and/or enhance the natural attenuation process. Mixing occurs naturally as a result of benthic organism activity (bioturbation). This approach is best suited to situations involving contaminants that naturally attenuate over time. Thin-layer capping was successfully used in a mixed remedy with dredging and conventional capping at the West Eagle Harbor Superfund Site. Thin-layer caps have also been placed over dredged areas at several sites where residual surface sediment concentrations did not meet cleanup action levels. Aquiblock™ technology was used on the Ottawa River, Ohio as a pilot test and Claymax™ technology was used on floodplain soils for Hudson River sediments.

Enhanced capping involves the incorporation of materials such as activated carbon, iron filings, or other agents into the base capping material (e.g., sand) to enhance adsorption or *in situ* chemical reaction. This approach is intended for circumstances in which contaminants are mobile and are expected to migrate through the cap as dissolved constituents in the pore water.

Capping is effective to isolate COC provided that it is designed to prevent leaching to surface water or resuspension of sediments through the cap. The implementability of capping is dependent on the properties of the underlying sediment and may also be affected by permitting. Should capping be selected as a remedial alternative for the sediments of the St. Joe River, the effectiveness of the different types of caps will be further evaluated by modeling of cap consolidation and other parameters. Physical characteristics of the river (e.g., river flow dynamics, scour potential, bathymetry) and navigational constraints will also be evaluated. Capping is generally a cost effective approach, requiring some capital expenditure to place the cap and monitoring to ensure its continued effectiveness.

Issues affecting the implementability of sediment capping are the suitability of the sediment, river bottom, and river flow regime for cap placement and longevity, the availability of placement equipment, and community acceptance of a capping remedy. Caps can be placed on most types of sediment and slopes with proper engineering though a final evaluation of cap material, slope, and placement method would need to be made as part of the design process. Equipment for capping is available for full-scale applications. Community acceptance of a capping remedy is generally high as it is protective of receptors, does not cause the same short term environmental impacts as dredging, typically allows unrestricted reuse of the capped area, provided the cap is not disturbed, and is cost effective as compared to dredging and uplands disposal. Capping is implementable at the Site and is retained for further evaluation. Specific process options related to cap placement are not evaluated at this time, as these are more likely to be determined by the final cap design requirements. The representative process option used is a conventional cap constructed of sand and gravel.

### 4.5.2.5 Removal and *Ex Situ* Treatment or Disposal

Removal of creosote-impacted sediments that currently pose a risk to receptors or those sediments that could scour and expose deeper sediments would achieve RAO 1

and RAO 4. Sediments can be removed through several mechanisms including hydraulic or mechanical dredging or excavation. Sediments may then be treated or disposed in the same manner as soils, though additional handling and dewatering will be required. In addition to the treatment or disposal options available for soil, sediments may also be disposed in-water.

This section discusses the technologies that can be used to remove sediments and the treatment or disposal options for the removed sediment.

Resuspension of sediments in the water column is of concern during sediment removal. Resuspension would allow contaminated sediments to resettle potentially causing an increased risk to receptors. Also of concern is water quality as excessive mixing of contaminated sediments and water during dredging can cause COC in the sediments to dissolve in the water or suspended sediments to be transported away by the water. For these reasons, minimizing resuspension during dredging is desirable. Resuspension is often measured as suspended solids or turbidity in the water column compared to a baseline. Engineering controls, such as silt curtains or cofferdams, can be used to minimize transport of resuspended sediments during dredging operations.

#### 4.5.2.5.1 Dredging Technologies

**Hydraulic Dredging**

Hydraulic dredges remove and transport dredged materials as a pumped sediment-water slurry. The sediment is dislodged by mechanical agitation by, for example, cutterhead, augers, or by high-pressure water jets. In very soft sediment it may be possible to remove surface sediment by straight suction and/or by forcing the intake into the sediment without dislodgement. The loosened slurry is essentially then vacuumed into the intake pipe by the dredge pump and transported over long distances through the dredge discharge pipeline. One of the primary disadvantages of all hydraulic dredges is the need to manage significant quantities of soil-water slurry.

Types of hydraulic dredges include the conventional cutterhead, open suction, dustpan, and hopper dredges. In addition, there are specialty hydraulic dredges adapted mainly to limit resuspension losses at the dredge head and increase the solids content of the dredged slurry (auger, cleanup, and refresher type dredges).

**Open Suction**

Suction dredges are open-ended hydraulic pipes. Suction dredges generate low levels of turbidity but are limited to dredging soft, free-flowing and unconsolidated material. As suction dredges are not equipped with any kind of cutting devices, they produce very little resuspension of solids during dredging. However, the presence of trash, logs, or other debris in the dredged material will clog the suction and greatly reduce the effectiveness of the dredge (Averett et al., 1990).

**Cutterhead Dredges**

The hydraulic pipeline cutterhead suction dredge is the most commonly used dredging plant, with approximately 300 operating nationwide, and is generally the most efficient and versatile (Averett et al., 1990). It is similar to the open suction dredge but is equipped with a rotating cutter surrounding the intake of the suction pipe. By combining the mechanical cutting action with hydraulic suction the dredge has the capability to efficiently extract and remove materials.

Resuspension of sediments during cutterhead excavation is strongly dependent on operational parameters such as thickness of cut, rate of swing, and cutter rotation rate. Proper balance of operational parameters can result in suspended sediment concentrations as low as 10 milligrams per liter (mg/L) in the vicinity of the cutterhead. More commonly, cutterheads produce suspended solids in the 50 to 150 mg/L range.

The cutterhead dredge was evaluated for removing contaminated sediment during the New Bedford Harbor Superfund Pilot Study. Compared to two other suction types, the cutterhead was superior for minimizing sediment resuspension (82 mg/L in the dredge vicinity) (USACE, 1990).

**Horizontal Auger Dredge**

The horizontal auger dredge is a relatively small portable hydraulic dredge designed for projects where a small (50 to 120 cubic yards per hour [cy/hr]) discharge rate is desired. In contrast to a cutterhead, the auger dredge is equipped with horizontal cutter knives and a spiral auger that cuts the material and moves it laterally toward the center of the auger where it is picked up by the suction. There are more than 500 horizontal auger dredges in operation. A specialized horizontal auger dredge, the Mudcat™, was tested during the New Bedford Superfund Pilot Study. Suspended solids were found to be higher (1,610 mg/L) than those observed for the cutterhead dredge.

**Mechanical Dredging**

Mechanical dredges are analogous to upland excavation equipment such as backhoes. While there are a number of different design styles, the mechanical dredge is basically a suspended bucket that grabs discrete volumes of sediment and raises it to the surface. The dredged material is then deposited in a haul barge or other contained conveyance for transport and rehandling to final disposition. Under suitable digging conditions, mechanical dredges are capable of removing dredged material near *in situ* densities with almost no additional water entrainment in the dredged mass and little free water in the filled bucket. This low water content is highly important if dewatering is required for ultimate sediment disposal. Mechanical dredges provide one of the few effective methods for removing large debris.

Types of mechanical dredges include the conventional (open) and environmental (closed) clamshell buckets, dragline bucket, dipper dredge, and bucket ladder dredge.

The dragline, dipper, and bucket ladder are open-mouthed conveyances and are generally considered inapplicable to sediment remediation dredging due to the expected high amount of sediment resuspension and loss during dredging operations (EPA, 1994). Consequently, these latter methods are not considered further for this project.

The dredged sediments are typically placed on another barge, which transports the sediments to their disposal location for off-loading and additional treatment prior to final disposal. Some natural settling and dewatering of the sediment occurs on the barge and this water would be treated and discharged. Railcars may be used to transport sediment in some applications.

**Clamshell Bucket**

The clamshell bucket dredge, or grab-dredge, is widely used in the United States and throughout the world. It typically consists of a barge-mounted floating crane maneuvering a cable-suspended dredging bucket. The crane barge is held in place for stable and accurate digging by deployable vertical spuds imbedded into the sediment. The operator lowers the clamshell bucket to the bottom, allowing it to sink into the sediment on contact. The bucket is then lifted through the water column to the surface, swung to the side and emptied into a waiting haul barge moored alongside. When loaded, the haul barge is moved by tug to shore where a second clamshell off-loads the barge for rehandling and/or transport to treatment or disposal facilities. Clamshell dredges can work in depths over 100 feet and, using advanced positioning equipment (e.g., differential global positioning systems [DGPS]), dredging accuracy is in the order of 1 foot horizontally and 0.5 foot vertically.

A conventional clamshell bucket may not be appropriate for removal of contaminated sediments. Conventional buckets have a rounded cut that leaves a somewhat cratered sediment surface on the bottom. This irregular bottom surface results in the need for over dredging to achieve a minimum depth of cut and can also encourage dense resuspended sediment losses to settle at higher concentrations in the craters, possibly requiring at least some re-dredging. Furthermore, conventional open clamshell bucket is prone to sediment losses over the top during full bucket retrieval.

More recent innovations in bucket technologies have resulted in modified buckets with enclosed tops. Also, buckets can be fitted with tongue-in-groove rubber seals to limit sediment losses through the bottom and sides. These buckets, which limit material spills while lifting, are applicable for dredged removal of contaminated sediment.

A recent alternative bucket, demonstrated in several test and prototype sediment remediation projects, is the proprietary Cable Arm™ bucket. This bucket offers the advantages of a large footprint, level cut, capable of removing even layers of sediment. Under careful operating conditions, Cable Arm™ bucket reduces resuspension losses to the water column. The Cable Arm™ bucket has been successfully demonstrated for contaminated sediment removal at a number of sites in the Great Lakes (e.g., Toronto Harbour, Ontario; Hamilton Harbour, Ontario).

At the disposal end, a barge load of dredged sediment will yield some amount of free water that was captured as the clamshell bucket closed. The free water is extruded to the surface of the barge load by consolidation of the sediment load. If removal of free water is required for disposal, it can be decanted by pumping and treated to meet water quality requirements prior to discharge. Solids removed in water treatment can be recycled to disposal.

**Excavation**

Conventional excavating equipment can also be used for removing contaminated sediment and debris in shallow water. Although normally land-based, the excavator or backhoe can be positioned on a floating equipment spud-barge for dredging. Large construction excavators are available and can excavate to depths greater than 20 ft. Land-based dredging could dispose dredged material into waiting trucks equipped with sealed beds, while barge-mounted excavators would require a haul barge similar to clamshell dredging.

A conventional excavator bucket is open at the top and will result in sediment resuspension and loss during dredging, although careful operation can minimize losses. Various improved excavation buckets have been developed, which essentially enclose the dredged materials within the bucket prior to lifting through the water column. A special enclosed digging bucket was successfully used on the large excavator Bonacavor (C.F. Bean Corp.) for remediation of highly contaminated sediment in Slidell, Louisiana. Dredged material removed by backhoe would exhibit much the same characteristics as for clamshell dredging, including near *in situ* densities and limited free water.

In shallow waters, excavation can also be accomplished by damming off a section with a temporary dam, dewatering of the area inside the dam, and excavation of sediment inside the dam. Dams can be created using specific temporary damming equipment, concrete blocks and impermeable liners, or sheet piling. In deep waters, cofferdams can be constructed to allow dewatering and "dry" excavation of sediments. Cofferdams are generally not cost effective for dredging projects and are more commonly used for civil construction.

All of the dredging technologies could remove sediment from the St. Joe River. However, mechanical dredging and excavation are considered more effective due to the presence of wood waste and debris in the river. Also, hydraulic dredging creates a large volume of water that requires treatment and disposal and usually requires a large area for dewatering of the dredged sediment. This dewatering can take weeks to months, whereas the dewatering time for mechanically dredged or excavated sediments is much shorter, on the order of days to weeks. To avoid the potential of flooding the uplands dewatering cells during spring floods, long dewatering times are less desirable for remedial technologies.

Other factors also affect the implementability of the dredging technologies, such as the water depth from which dredging is required (excavation is depth limited), the availability of equipment, and the concentration of suspended solids and COC in the

water column during dredging. For the purposes of remedial alternative development, mechanical dredging and excavation are used as the representative dredging processes due to their better implementability in the St. Joe River. If dredging is selected as part of the remedial alternative, the final determination of the technology used at the Site is dependent on available equipment, cost, production rate, desired water quality during dredging, and other factors that would be determined during the design process.

#### 4.5.2.5.2 Management of Dredged Sediment

Similar to management of excavated soils, there is a range of treatment and disposal options in the uplands when managing dredged sediments. In addition, there is one (confined) aquatic disposal technology that is discussed below. The discussion of the upland treatment and disposal technologies was provided in the evaluation of soils technologies. These same technologies and representative process options, listed below, are retained for sediments. Sediment and soil treatment and/or disposal would likely occur together.

An additional step of dewatering would be performed for sediments prior to upland management. Typically, this dewatering involves holding the sediments in lined cells and letting them dewater under their own weight. The use of mechanical dredging reduces the dewatering timeframe and helps avoid concerns with freezing of dewatering sediments and flooding of the dewatering cell. Water generated during this process would be treated by whatever means necessary to meet discharge requirements. While such a treatment system would be dependent on the water quality of the dewatered water, the treatment system is likely to involve settling or filtration and treatment with activated carbon. The treated water would be discharged to the St. Joe River.

The uplands treatment and disposal technologies are:

- On-Site Containment;
- Thermal Desorption;
- Incineration;
- Subtitle C Disposal; and
- Subtitle D Disposal.

In addition to the upland treatment and disposal option, two other potentially applicable technologies for sediments are confined aquatic disposal (CAD), and a confined disposal facility (CDF).

A CAD is a subaqueous containment facility. A CAD includes lateral sidewall containment from an engineered berm, and/or as a result of excavating a depression at the disposal site (Averett et al., 1990; Washington Department of Ecology, 1990).

The deposit site is prepared either by excavating a depression and using the excavated material for construction of a perimeter berm, or by importing material to construct a perimeter berm on the existing sediment surface. The contaminated sediment is deposited at the specified location and topped with clean sediments. Further considerations in a CAD design are the impacts to hydraulic conditions within the river system, and that the CAD must be designed to withstand scour, erosion, and bioturbation. Due to the administrative difficulties expected to arise during implementation, a CAD is not retained for further consideration.

A confined disposal facility (CDF) is an engineered containment structure that provides for dewatering and permanent storage of dredged sediments. In essence, CDFs feature both solids separation and landfill capabilities (EPA, 1994a). Containment of contaminated sediments in CDFs is generally viewed as a cost effective remedial option at Superfund sites (EPA, 1996b). A CDF may be constructed as an upland or floodplain site, as a nearshore site (one or more sides exposed to water), or as an in-water island containment area. At the Site, floodplain and nearshore sites could be technically implemented.

Creation of a CDF requires an extensive design and permitting process (or substantive equivalent thereof) that takes into account detailed studies of river hydrology, uses, disposal facility construction, and public acceptance of the facility. These facilities are typically administratively difficult to implement. However, where administratively implementable, confined aquatic disposal can offer cost and administrative advantages over upland disposal. While the administrative implementability of this disposal has not been fully determined and is likely to be low, it is retained for further consideration.

### 4.5.2.6 *In Situ* Treatment

Bench- and pilot-scale studies have been performed to evaluate several technologies for *in situ* treatment of sediments. These technologies include chemical/enhanced biological treatment, and stabilization. Some of these technologies have been implemented at the pilot scale, but full-scale remediation via these methods has not yet been implemented.

#### 4.5.2.6.1 Nutrient Enrichment and Chemical Treatment

Several pilot studies have been performed which involved injecting oxidizers or nutrients into sediments to stimulate biological degradation of COC. These techniques have been used to remediate PAHs in Hamilton Harbour, Canada. Calcium nitrate and an organic amendment were injected into the sediments using a custom injection system. PAH were degraded in varying amounts, up to 48 percent, over an approximate 2-year period. Other pilot studies have been performed to assess the effects of chemical/biological enhancement on other COC including PCBs and sulfides. The effectiveness of these techniques has varied, and *in situ* treatment of sediments remains a largely experimental remediation technology. Implementation may be difficult as the equipment for nutrient and oxidizing agent injection is

specialized, the process requires extensive pilot testing, and permitting for injection of nutrients and organic material is likely to be time-consuming. Should it be successful, *in situ* chemical/enhanced biological treatments have the potential to be significantly lower in cost than dredging and treatment or disposal but their success have yet to be demonstrated. Due to the lack of successful pilot projects or full-scale implementations, *in situ* chemical or enhanced biological treatment is not considered implementable on the St. Joe River.

#### 4.5.2.6.2 *In Situ* Solidification

Similar to *in situ* solidification of soils, solidification of sediments involves adding agents, typically cement, which cause the sediments to solidify, reducing potential migration and availability to receptors. In addition, additives typically lower the pH to a point that makes COC, especially metals, less chemically available. Bench studies in Japan and by the United States Army Corps of Engineers (USACE) have not had conclusive results for solidification with cement or chemical fixation. The process is highly site-dependent. The notable pilot study on *in situ* solidification involved mixing sediments with cement inside a steel cylinder in the Manitowoc River in Wisconsin. The pilot test was largely unsuccessful, reportedly because the high water content of the sediments diluted the cement. In addition, significant implementation difficulties were encountered, which caused waters to spill over the top of the mixing cylinder and spill into the surrounding river, or sediments to blow out the bottom of the cylinder. Due to the absence of known successful projects, this technology is not considered implementable on the St. Joe River and is not retained for further evaluation.

# 4.6 Groundwater

## 4.6.1 Remedial Goals for Groundwater

Groundwater may cause risk through two pathways: 1) transport of COC to sediments of the St. Joe River in sufficient quantity to cause the sediments to exceed PRGs, and 2) use as potable water by humans. As such, groundwater remedial actions must prevent potential exceedances of sediment PRGs and human potable use of groundwater containing concentrations of COC that may cause risk to humans. Closely related to remedial actions for groundwater is soil and DNAPL, which provide an ongoing source of impacts to groundwater. As previously discussed, potential risks associated with the soil providing a source of COC to groundwater are addressed through RAOs for groundwater.

The RAOs for groundwater are RAO 3 and 5.

**RAO 3: Prevent migration of impacted groundwater to surface sediment in the St. Joe River that would result in COC concentrations greater than protective levels for aquatic and benthic organisms.**

Modeling performed in the RI/BLRA and in Appendix C indicate that partitioning of COC from groundwater to sediments in the St. Joe River could cause those sediments to exceed PRGs.

**RAO 5: Prevent residential and commercial ingestion of and dermal contact with COC in groundwater at concentrations greater than protective levels.**

While humans do not currently use groundwater at the Site for drinking water and are prevented from doing so in the future by City ordinance and zoning, any hypothetical potable groundwater use would cause unacceptable risk.

## 4.6.2 Groundwater General Response Actions, Remedial Technology Types and Process Options

### 4.6.2.1 No Action

Currently, groundwater does not pose a risk to receptors at the Site. However, groundwater does have the potential to cause sediment to exceed PRG or cause risk to humans, should groundwater be used as potable water. In addition, groundwater concentrations exceed MCLs for drinking water. While it would not decrease potential risks to these receptors, No Action is retained for comparison.

### 4.6.2.2 Institutional Controls/Monitoring

Monitoring is a universal component of groundwater remedies, providing data on the effectiveness of the remedy and ensuring protection of human health and ecological receptors. Monitoring of groundwater typically uses groundwater monitoring wells or piezometers that already exist at the Site.

Currently, there is no use of groundwater at the Site nor is there expected to be future use due to the availability of City water for drinking water, the current zoning of the Site, and the availability of permitted use of St. Joe River water for other purposes. However, should humans use the Site groundwater for potable water, it would cause unacceptable risks to these humans. The existing City codes on water use are one form of institutional controls. Additional institutional controls, such as deed restrictions, could be put in place to ensure that there is no future use of impacted groundwater or that groundwater was appropriately managed should it be encountered in excavations.

### 4.6.2.3 Containment

Groundwater containment can be completed through different technologies including groundwater extraction, barrier wall installation, or a combination of methods. This section outlines these technologies and process options associated with them.

#### 4.6.2.3.1 Hydraulic Containment

Hydraulic containment isolates COC by creating a localized water table low, causing groundwater to flow towards this low, preventing further downgradient migration of impacted groundwater. This is typically accomplished through groundwater pumps in wells or trenches. Or trench drains. Wells are installed using conventional drilling techniques. Trenches may be installed using traditional excavation, shoring, or a slurry-supported excavation.

The extracted groundwater is treated and discharged to a POTW, if available, or to a surface water body under an NPDES permit. Underground injection can also be used for disposal of treated groundwater. The most likely scenario at the Site would be discharge to the St. Joe River under an NPDES permit. Groundwater pumping systems are designed based on empirical data collected during investigation such as soil type, groundwater flow direction, hydraulic conductivity, and modeling of Site hydrology to identify appropriate extraction point placement and pumping rates. Pilot pumping tests may be useful in determining sustainable pumping rates, radius of influence, hydraulic conductivity, and extracted water quality. Consideration will have to be given to the potential for flooding of the Site. The system is likely to be overwhelmed during more substantial flooding events and its effectiveness will temporarily decrease.

Hydraulic containment is effective in preventing further migration of COC but the hydrology and soil types at the particular site influence its effectiveness. These factors need to be considered prior to selection of hydraulic containment as a remedial action. Hydraulic containment systems are not difficult to implement as systems and components are readily available. The degree of water treatment required and permitting for discharge of treated water may affect the implementation of a hydraulic containment system. Cost is influenced by the size and type of system required (trenches are more costly than wells), by the site limitations (pipe routing, etc), and by the degree of water treatment and discharge permitting required. The cost of hydraulic containment is generally high as compared to other remedial alternatives for groundwater, and is typically higher than physical containment of groundwater due to the long operation times and water treatment requirements of hydraulic containment. As such, hydraulic containment is not retained as a standalone remedy, but may be incorporated with physical containment, should design or performance monitoring of a physical containment system show that a hydraulic containment component would be beneficial.

#### 4.6.2.3.2 Physical Containment

Groundwater may be physically contained through construction of barriers to groundwater flow. Impermeable barrier walls, such as slurry walls or sheet piling, are installed along a vertical plane in the subsurface to provide a barrier to groundwater flow. The exact size and depth of the wall are determined through detailed groundwater flow modeling during the design of the wall. Hydraulic containment can

be combined with barrier walls. Several types of barrier walls, which are considered process options, are discussed in this section.

**Slurry Walls**

Slurry walls are subsurface walls formed of native soil and bentonite, or an introduced cement-bentonite mixture. The walls are installed by excavating a trench and backfilling the trench with a soil-bentonite or soil-cement-bentonite mixture, producing a barrier with a hydraulic conductivity of $10^{-6}$ to $10^{-9}$ centimeters per second (cm/s) although a more permeable barrier may be sufficient. During excavation and placement of the low permeability slurry, the trench is typically supported with a slurry mixture, which is displaced as the low-permeability backfill is placed. The desired permeability is dependent upon groundwater flow modeling completed during the design phase. Slurry walls can be constructed to depths of approximately 80 feet using specialized long-reach excavation equipment. Deeper depths are possible using clamshell buckets, but these are typically of much greater expense. Slurry walls can be constructed to be flexible to accommodate ground settlement and minor shifting without being compromised. Soil-bentonite slurry walls are generally less expensive than cement-bentonite slurry walls as they minimize spoils production. Soil-bentonite walls generally have lower hydraulic conductivities but have minimal geotechnical properties and may cause minor settlement of surface soils.

Slurry walls are highly effective at containing groundwater. Low hydraulic conductivities can be obtained and have been successfully used at other creosote wood treating sites (e.g. Puget Sound Resources). Installation of slurry walls requires specialized equipment and experience, but the equipment can be transported and contractors specializing in the installation of slurry walls are available. Factors affecting slurry wall placement can be utilities, nearby structures, and soil grain size (very coarse-grained soils cause excessive slurry loss during wall installation). In some cases, additional investigations can be performed during the design to determine these issues. Detailed groundwater flow modeling is an integral part of the design in order to determine the necessary length and depth of the wall, the area of capture of the wall, and any groundwater mounding that occurs behind the wall.

Overall, slurry wall installation is considered highly implementable at the Site. Generally, slurry walls are more cost effective than sheet piling walls but are not as suitable for structural use, such as along a bulkhead. A soil-bentonite slurry wall is considered the representative slurry wall process option.

**Sheet Piling**

Sheet pile barrier walls are installed by driving interlocking steel sheet piles into the subsurface. Permeability of sheet pile barriers is limited to leakage through the interlocking joints, which can be sealed (e.g., via grout injection) in some cases to minimize leakage. Standard sheet pile walls have hydraulic conductivities between $10^{-6}$ and $10^{-7}$ cm/s. Sheet piling forms an effective groundwater barrier wall and has been used successfully in many locations for containment of groundwater for

environmental or geotechnical purposes. Single sheet piles are usually limited to approximately 60 feet in length, through deeper barriers can be constructed by welding sections of sheet piling together. Larger rocks or debris can prevent the driving of sheet piles. Generally, soils that could limit the driving of sheet piling and major utilities that cannot be worked around are absent from the Site. As with a slurry wall, detailed groundwater flow modeling is an integral part of design in order to determine the necessary length, depth, capture area, and potential for mounding. Sheet piling is generally more expensive than slurry walls though still favorable compared to long-term hydraulic containment. Sheet piling is retained as a barrier wall process option.

### 4.6.2.4 Removal and *Ex Situ* Treatment or Disposal

Impacted groundwater can be removed through pumping. The recovered groundwater requires treatment and appropriate discharge. Groundwater recovery systems typically consist of downwell pumps, piping to a common collection point, concurrent treatment of the groundwater from all extraction points, and discharge of the treated groundwater. The treated groundwater is typically discharged to surface water under an NPDES permit, discharged to a POTW, or reinjected into the groundwater, sometimes to promote groundwater flow towards extraction points. This has been found to be a generally ineffective and expensive technology for restoration of groundwater as a standalone remedy, and so is not retained for further consideration as a standalone remediation technology at the Site. It may be of use to facilitate other remedial actions at the Site, such as soil removal.

While groundwater removal as a standalone remedy is not retained for further consideration, groundwater and other waters may be generated during remedial actions, such as from dewatering activities. These waters would likely require treatment prior to disposal, whether to a POTW or under the NPDES program. For this reason, *ex situ* groundwater treatment options are evaluated in this section. The optimal water treatment strategy will be determined during the remedial design, as it is highly dependent on the remedy and construction method. Use of carbon adsorption has been assumed throughout the FS for consistency, though remedial design may identify a better water treatment option.

#### 4.6.2.4.1 Ultraviolet Oxidation

Ultraviolet oxidation is a destruction process that oxidizes organic and explosive constituents in wastewater by the addition of strong oxidizers and irradiation with UV light. Oxidation of target COC is caused by direct reaction with the oxidizers, UV photolysis, and through the synergistic action of UV light, in combination with ozone and/or hydrogen peroxide. If complete mineralization is achieved, the final products of oxidation are carbon dioxide, water, and salts.

If used with the addition of oxidizing agents, such as ozone or hydrogen peroxide, UV oxidation is effective at treating the Site COC, although the presence of wood sugars at wood treating sites can foul the UV lamps, limiting effectiveness and

increasing maintenance costs. The process is implementable at the Site though care must be taken for vapor control and control of discharge concentrations from any added oxidizers; specialized equipment must be designed and installed, and surface water discharge permitting is required. The process is of moderate cost.

#### 4.6.2.4.2 Air Stripping

Air stripping passes air through extracted groundwater to volatilize compounds in the groundwater. The air and volatilized compounds are treated in the vapor stream, typically by thermal or catalytic oxidation. Typically, groundwater is sprayed into the top of a tower or set of stacked trays. Air is forced up the tower or trays causing the compounds in the groundwater to partition to air. The process is common for volatile compounds and commercial equipment is available in many sizes.

Air stripping is of limited effectiveness for the Site COC as the transfer from groundwater to process air is governed by the relative volatility of the compound. The process is relatively implementable at the Site. Costs are fairly low as compared to other treatment technologies for extracted groundwater.

#### 4.6.2.4.3 Carbon Adsorption

Carbon, available in a powder or granular form, readily adsorbs many organic compounds, including the Site COC. The carbon is typically held in vessels and the groundwater is pumped through the vessels. Depending on the concentrations in the influent water, appropriate residence times and carbon vessel sizes can be designed. Once the carbon has adsorbed its holding capacity of organic compounds, the carbon is typically sent to the manufacturer where it can be regenerated for reuse. The carbon can also be disposed in a landfill if not restricted by hazardous waste criteria. The effectiveness of the carbon adsorption is monitored in the effluent waste stream.

#### 4.6.2.4.4 Biological Treatment

Biological treatment uses microorganisms to break down and digest contaminants. The influent wastewater is adjusted for appropriate pH, oxygen content, and nutrient content in order to optimize the effectiveness of the biological treatment. Solids are removed from the water and the treated water is discharged, typically to a surface water body. This process is commonly used at large scale municipal wastewater treatment plants and can degrade the Site COC. Some adaptations on the process exist, which use high degradation rates in small biological reactors, as opposed to municipal wastewater treatment plants, which use large holding and treatment tanks.

Past use of groundwater pumping systems for remediation has shown that they are of limited effectiveness. Groundwater pumping could easily be implemented at the Site though certain factors would need to be considered, especially the proximity to the St. Joe River, effects on groundwater migration, and discharge. Discharge would likely require an NPDES permit. Costs for groundwater extraction and treatment systems are typically high as compared to natural attenuation, *in situ* treatment, or other treatment methods. Overall, groundwater removal for remediation is not retained as a

remedial technology because of its limited effectiveness in achieving remedial goals. However, carbon adsorption is retained as a process option for water treatment in the case of groundwater extraction for hydraulic containment or for water treatment associated with dredging, as it is an effective, implementable, and generally cost effective method of water treatment.

### 4.6.2.5 *In Situ* Treatment

The only presumptive remedy for *in situ* groundwater treatment at wood treating sites is bioremediation. This section discusses the potential for bioremediation at the Site and other *in situ* treatment options for groundwater that are not included as presumptive remedies. Bioremediation is an *in situ* technique that is being retained for consideration at the Site. Permeable reactive walls are retained as a part of containment walls. A permeable reactive wall would be considered if groundwater modeling as part of the remedial design determined that such a wall was desirable.

#### 4.6.2.5.1 Enhanced *In Situ* Biodegradation

Biodegradation is based on the natural biochemical reactions mediated by microorganisms that result in degradation of organic COC. Aerobic biodegradation converts organic matter and compounds to intermediate organic compounds and final decomposition products that include daughter compounds, carbon dioxide, water, humic materials, and microbial cell matter. Anaerobic biodegradation converts compounds to carbon dioxide, methane, and microbial cell matter. For SVOCs, such as exist at the Site, aerobic biodegradation tends to occur more quickly than anaerobic degradation. Higher molecular weight PAH tend to degrade under aerobic conditions, with limited degradation under anaerobic conditions. For this reason, oxygen enhancement in the groundwater is a commonly applied technique to promote increased biodegradation. This section discusses indicators of naturally occurring biodegradation at the Site and several process options that could be used to promote biodegradation at the Site.

Overall, conditions at the Site indicate that limited oxygen is available for biodegradation. While uncertainties exist, Site data suggest that anaerobic biodegradation may be occurring, as discussed in Section 2.6.4. The analysis in Appendix C, using low anaerobic biodegradation rates from literature, indicates that COC in groundwater at the Site could be metabolized by the biodegradation prior to the groundwater reaching sediment (see Appendix C). This analysis suggests that the groundwater would not cause risk to sediment and natural anaerobic biodegradation may be sufficient to achieve remedial objectives. Due to uncertainties, this process is monitored for performance. Provided DNAPL did not exist (or was removed) downgradient of well MW-7S and site-specific degradation rates were consistent with or greater than literature values, this remedy would be protective of RAO 1 and 3. Additional monitoring would be necessary to address these uncertainties. This remedy is not expected to achieve RAO 5 in an acceptable time frame. The technical impractibility of achieving RAO 5 is discussed in Appendix E.

In order to promote faster biodegradation, active systems can be put into place to increase dissolved oxygen, leading to aerobic biodegradation, which typically occurs at faster rates than anaerobic biodegradation. Several process options exist to deliver the increased oxygen.

#### 4.6.2.5.2 Air Sparging

Air sparging injects pressurized air below the water table. The air spreads outwards and rises towards the water surface, thus increasing the groundwater exposed to air and allowing dissolution of oxygen into the groundwater. Air sparging typically uses aboveground blowers and piping systems to pressurize and distribute the air. The air is injected into the groundwater either in wells or trenches. Air sparging also provides a degree of physical stripping, especially for volatile compounds. In these cases, the soil vapor and air quality may need to be monitored carefully or controlled with SVE to prevent release of potentially harmful concentrations of volatilized compounds. After recovery, the vapors are typically treated by thermal or catalytic oxidation.

Air sparging is effective at delivering oxygen in coarse-grained lithologies. Significant pressures are required to deliver oxygen in fine-grained lithologies and the penetration into fine-grained lithologies may result in short-circuiting and poor oxygen delivery. Use of trenches with coarse backfill will allow more uniform injection of oxygen into groundwater in fine-grained lithologies, but are dependent upon groundwater flow to circulate the oxygenated groundwater. The fine-grained lithologies at the Site may make air sparging less effective than other technologies for delivering oxygen to the groundwater. Air sparging is generally more effective on volatile compounds than semivolatile compounds. Air sparging is implementable at the Site. Design would be required to determine if collection and treatment of vapors would be required. Typically with Site COC, they are not required. Costs for air sparging are relatively low as compared to other means of delivering oxygen, though costs are increased considerably if vapor collection and treatment are required.

#### 4.6.2.5.3 Hydrogen Peroxide

In this process option, dilute hydrogen peroxide solutions are injected into the groundwater. These solutions release oxygen, which is then absorbed by the groundwater. Care must be taken to set up the peroxide injection and any groundwater circulation to prevent mobilizing COC.

Hydrogen peroxide is an effective means of increasing oxygen content in groundwater, though the effectiveness can be limited by high iron content (such as is found at the Site). The process is technically implementable at the Site though there are likely to be permitting requirements for extraction and injection of groundwater. Also, hydrologic studies would be required to design a system that prevents mobilizing COC and that is not significantly influenced by the St. Joe River. The cost of oxygen enhancement by hydrogen peroxide injection is up to an order of

magnitude higher than other means of injecting oxygen, therefore the cost is relatively high.

#### 4.6.2.5.4 Oxygen Release Compound™

This solid compound releases oxygen into groundwater over time. The compound can be directly injected into the groundwater as a slurry using a direct-push coring rig or drill rig. It can also be placed repeatedly in wells using contained "socks." The compound releases oxygen slowly and provides a moderate duration (up to several months) for an oxygen source.

This process is effective at delivering oxygen to the groundwater, but it is reliant on diffusion and groundwater advection and dispersion to distribute the oxygen over larger areas. In areas where the oxygen demand is high or groundwater migration is relatively slow, the oxygen distribution is slow limiting the effectiveness and rate of aerobic biodegradation. The process is highly implementable at the Site. Costs are dependent upon the frequency of injections, both spatially and temporally. In general, costs are fairly low as compared to other oxygen enhancement processes.

Overall, due to its proven effectiveness in delivering oxygen to groundwater, relative implementability at the Site, and low unit cost for oxygen delivery, air sparging is selected as the representative process option for enhanced biodegradation.

#### 4.6.2.5.5 Chemical Oxidation

Chemical oxidation is a technology that involves adding oxidizing compounds, such as oxygen, hydrogen peroxide, ozone, or permanganate, to the groundwater. These oxidants have been able to cause the rapid and complete chemical destruction of many toxic organic chemicals and have fast reaction times. Similar to oxygen delivery in enhanced biodegradation, the delivery and distribution of the oxidizing compounds is of critical importance to the success of the technology.

The effectiveness of chemical oxidation with SVOCs, including PAH, has been limited in the past. Difficulties with even delivery of oxidizers and risks associated with proximity to the St. Joe River may further limit effectiveness of the technology. The technology is highly implementable though controls and proper personnel training will be required prior to handling oxidizers. Provided the Site hydrogeology allows for good distribution of oxidizing material, costs associated with chemical oxidation are fairly low. Difficulties in distribution can increase costs considerably due to the relative high costs of the oxidizing compounds. This technology is not retained for further consideration, because this technology has not been widely used in full-scale applications.

#### 4.6.2.5.6 Reactive Treatment Walls

These subsurface walls create a passive matrix through which groundwater containing COC passes by normal groundwater flow. Reactive compounds, such as iron filings, built into the wall cause the COC to be degraded. Walls can be constructed in a

funnel-and-gate construction, which builds a wall of relative low permeability that leads groundwater to gates of high permeability, where groundwater is treated. All configurations use the natural groundwater gradient to drive the groundwater through the system and allow reactions to occur at or within the wall.

Treatment walls are effective at treating many compounds although most work has focused on the use of iron filings to treat chlorinated solvents. The groundwater gradient drives the flow through the reactive wall, which in turn correlates to the amount of treatment provided by the wall. Construction of a treatment wall is implementable at the Site and is subject to similar permitting and restrictions as a groundwater containment wall. Costs associated with treatment walls are high as compared to natural attenuation or other passive treatment technologies, but are typically lower than long-term groundwater extraction or hydraulic containment. However, reactive walls provide little treatment for Site COC. For this reason, reactive treatment walls will not be considered separately from barrier walls.

## 4.7 Summary of Representative Process Options

The representative process options were selected in the analysis presented in this section. These process options will be considered in developing the remedial alternatives to be evaluated in this FS and in selecting the preferred remedial alternative.

### Soil

- Institutional Controls/Monitoring;
- Soil Mixing **and Stabilization**;
- Pressure Grouting
- On-site Containment Cell;
- Thermal Desorption;
- Subtitle C Disposal; and
- Subtitle D Disposal.

### Sediment

- Institutional Controls/Monitoring;
- Monitored Natural Recovery;

- **Thermal Desorption;**
- Capping;
- Removal; and
- Confined Disposal.

## Groundwater

- Institutional Controls/Monitoring;
- Enhanced Biodegradation using air sparging;
- Water Treatment;
- Slurry Wall Containment; and
- Sheet Pile Wall Containment.

Of these technologies, thermal desorption and incineration were identified as presumptive remedies for organic contaminants in soils, sludges, and sediments at wood treatment sites (EPA, 1995). Solidification, which would include soil mixing and pressure grouting, was also identified as a presumptive remedy; though it was identified for inorganic compounds.

# 5 Remedial Alternatives

This section describes a range of treatment and containment options to address the RAOs for the Site, consistent with the RI/FS Guidance.

## 5.1 Development of Remedial Alternatives

Remedial alternatives are assembled from the representative process options retained for consideration to provide a range of remedial options for the Site. For each media, several representative process options have been identified. As such, there are a large number of possible combinations of process options. The assembled remedial alternatives meet the three screening criteria and take into account the representative process options. These screening criteria, discussed in Section 4.3.2 of the RI/FS guidance are effectiveness, implementability, and cost-effectiveness. Of the representative process options, only thermal desorption and upland or in-water confined fill (a CDF) of soil/sediment were not included in the remedial alternatives. For clarity and consistency in assessing remedial components within the main text of the FS, the evaluation assumed that all soils and sediments generated are disposed or treated off-site at an appropriate facility (incineration or Subtitle C landfill depending on concentration). The thermal desorption and confined fill process options should be retained for consideration in the proposed plan if it can be implemented and if it is cost-effective relative to disposal and incineration (e.g., if the removal volume of soil or sediment volume is sufficiently large). *Ex situ* management technologies are discussed in Appendix F.

Remedial alternatives are summarized on Table 5-1 and range from no action (Alternative 1) to removal of all accessible impacted soil and sediment (Alternative 7). As indicated in the previous paragraph, Table 5-1 and this analysis were completed assuming off-site soil management (incineration or Subtitle C landfill). Other management options are discussed in Appendix F.

**Table 5-2 shows a variety of relevant cleanup values that can be used to evaluate and develop potential cleanup levels for the Site. For excavation and removal of upland and river bank soils, residential soil cleanup values (Region 9 Residential Soil PRGs) will be used as the cleanup level for site soils (Table 5-3). This standard was selected because it is derived to protect a resident from direct contact hazards, and to provide the most stringent protection of any future land use scenario. This standard will be used to determine that the lateral extent of the soil excavation and the depth of stabilization of soils are sufficient to meet the final clean up goals.**

**Because Alternative 9 will achieve the groundwater MCL in wells at the point of compliance adjacent to the stabilized zone, the use of the prescriptive Region 9 PRG soil screening levels for migration to groundwater DAF 1 (Table 5-2) is not appropriate. This would create a redundant standard, where an empirical measurement is available and desirable. Monitoring wells installed around the upland cleanup area (on the river side of the excavation, up and downriver of the excavation and stabilization area) will be monitored to document the**

**performance of the remedy; i.e., groundwater MCLs are achieved for the relevant parameters (Table 5-3). This will provide the needed assurance that COCs at the site have been effectively removed to protect groundwater.**

**Derivation of an appropriate treatment standard for beneficial reuse of soils on site was achieved by combining the most stringent values of the Universal Treatment Standards, the Land Disposal Restrictions, the Region 9 Residential PRGs and selecting the most stringent value. The "Cleanup Levels for Upland Soils" in Table 5-3, will provide the basis for a "contained out" determination for treated soils thus assuring that hazardous constituents from listed wastes are either not present in the media or only present at concentrations that are at or below health based levels and therefore no longer considered to contain a hazardous waste. All soils and sediments at the site will be treated by thermal treatment so that this health based standard is achieved before the reuse of the media as backfill on site. Media that meets this health based standard will not present any direct contact exposure in view of the fact that the cleanup standards are at least as stringent as the Region 9 Residential PRGs. Meeting the residential standards will not require any special capping requirement.**

## 5.2 Components Common to Remedial Alternatives

Several activities would be completed as part of most remedial alternatives, except the No Action Alternative (Alternative 1). The components included in this Section are common to Alternatives 2 through 6 or Alternatives 2 through 7 as indicated for each component. The common components are:

- **Regulatory Status of Waste –** In Alternatives 2 through 7, it is assumed that soils, sediments, and groundwater containing COC related to creosote at the Site will be considered by EPA to contain F034 listed hazardous waste, except as otherwise discussed in this section. F034 listed hazardous waste is "wastewaters (except those that have not come into contact with process contaminants), process residuals, preservative drippage, and spent formulations from wood preserving processes generated at plants that use creosote formulations." (40 CFR 261.31(a)). Additional information is provided in the interim memorandum *Waste Designation Evaluation for Soils and Sediments* (RETEC, 2004c), which has been incorporated into Appendix F.

- **Establishment of an Area of Contamination –** In order to encourage remedial actions at contaminated sites, EPA has established the concept of an Area of Contamination (AOC). Within an AOC, media may be consolidated or treated *in situ* without triggering the requirements of the Resource Conservation and Recovery Act (RCRA). The AOC can be defined as the contiguous area of contamination at a site and adjacent areas that are needed for cleanup of the Site. When media are removed from the AOC, the requirements of RCRA will apply to that media. At the

Site, the AOC will be defined as the contiguous area of land within the uplands and the St. Joe River containing COC above screening levels used in the RI/BLRA and additional adjacent land necessary to complete remedial actions for the selected alternative. The final extent of the AOC will be refined at a later date based on the selected remedial alternative. Within the AOC, soils will be managed in such a manner so as to be protective of human health and the environment. Typical measures include use of appropriate construction techniques and trained personnel during remedial actions, and completion of residual risk assessments to ensure that remedial actions will not cause risk to human or ecological receptors in the future.

- **Contained Out Determination – It is expected that media will be generated that do not contain concentrations of COC above certain protective health based levels. These levels may exist naturally or be achieved through treatment These health based levels, below which the media can be determined by EPA to not "contain" hazardous wastes, are dependent on achieving the established health based standard and in some circumstances the final disposition of the media.** If certain areas or COC concentrations in media are determined to not "contain" hazardous waste prior to the media being generated as a waste, then that media would not be a hazardous waste upon generation as a waste. It is assumed that these health-based levels will be established and approved by EPA prior to remedial actions. As these determinations are specific to a media, potential generation event, and health-based concentrations, such determination is likely to be sought after selection of the remedial action, but before remedial actions occur at the Site. For the purposes of the FS, it is assumed that the following determinations will apply:

  - Soils and sediments below EPA Region IX Residential PRGs do not contain hazardous waste and are available for reuse in many scenarios, though not all reuses are appropriate, because the soils may still contain some COC. Proposed final disposition of the soil would be evaluated to ensure protection of human health and the environment at the location that soils and sediments would be placed.

  - Soils and sediments below EPA Region IX Industrial PRGs do not contain hazardous waste provided these materials are placed in an engineered facility that limits contact to the media in question (e.g., a Subtitle D landfill).

  - Soils and sediments below site-specific health-based levels do not contain hazardous waste provided these media remain on-site in a confined facility engineered to prevent exposures above those considered in determining the site-specific health-based levels.

- **Permitting Exemption –** Typically, CERCLA cleanup actions are exempt from federal, state, tribal and local permitting requirements. However, the substantive requirements of these permits must be met. It is assumed that the CERCLA permit exemption will apply to all remedial actions at the Site. However, it is likely that aspects of the permitting process will still need to be followed, including review by appropriate state, tribal and federal agencies. This applies especially to activities that may have requirements similar to the permitting requirements for work within streams and rivers in Idaho, which involves a Clean Water Act Section 404 permit and consultation with a number of state and federal agencies. Within the FS, the words "permit" or "permitting" are meant to include meeting the substantive requirements of a permit.

- **Land Use Control/Institutional Controls for Land Use –** A land use control/institutional control will be included as part of the remedy that states allowable future land uses. At the completion of any remedial alternative presented in this FS, surface soil will be protective for industrial site uses as discussed in the RI/BLRA. In addition, as part of the remedy, five-year reviews will be completed after the remedial action is implemented. The five-year reviews will include statements that COC concentrations exceed conservative residential risk-based screening levels and future residential use would be unacceptable without further evaluation. The ongoing existence of institutional controls will also be confirmed as part of the five-year review. This component would be applied to Alternatives 2 through 6. Removal activities completed as part of Alternative 7 should be sufficient to eliminate the need for controls on land use.

- **Technical Impracticability of achieving MCLs –** CERCLA includes a statutory preference that groundwater be returned to drinking water criteria as defined by non-zero MCLGs and MCLs (42 U.S.C. § 9621(d)(2)(A)). However, it is believed to be technically impracticable to return groundwaters to the MCLs due to the nature of creosote contamination and the ongoing source of COC from soil and DNAPL to groundwater, and the impracticability of removing all impacted soil and DNAPL. The criteria for a technical impracticability analysis are similar to those in an FS, with the technical impracticability evaluation being based on ARARs at the Site, the area over which the evaluation applies, the CSM, an evaluation of restoration potential at the Site, and a cost estimate (EPA, 1993). The components of the technical impracticability evaluation are included in this FS, and the information is summarized in Appendix E.

  This FS generally shows that restoring groundwater to MCLGs or MCLs is not technically practicable at the Site. The only feasible means to restore the groundwater to drinking water standards would be through complete removal of the contaminated soils. However, complete removal

of soils is not practical. Alternative 7 discusses removal of nearly all contaminated soil and sediment for a total cost of approximately 67 million dollars. However, some contaminants will remain at depths of 25 to 40 feet below site grade in sand layers extending beneath the St. Joe River channel as suggested by creosote in sand layers at this depth near the river bank (see Figure 2-33). This complete removal of all accessible soil without river diversion does not guarantee success. While limited in volume, this remaining contamination will continue as a source to groundwater.

Similar levels of protection of receptors can be achieved through less costly remedies. This FS indicates that EPA should determine that restoration of groundwater at the Site to drinking water standards is technically impracticable. Consistent with EPA guidance (EPA, 1993), EPA will make the final determination of whether or not it is technically impracticable to return the groundwater to drinking water standards in the Record of Decision. This component would clearly apply to Alternatives 2 through 6. In addition, it may apply to Alternative 7, as some impacted soil is inaccessible beneath the St. Joe River.

- **Groundwater Use Restriction –** For alternatives where restoration of the groundwater to drinking water standards is determined to be technically impracticable, a groundwater use control/institutional control will be included as part of the remedy that states allowable future groundwater uses. In addition, as part of the remedy, five-year reviews will be completed after the remedial action is implemented. The five-year reviews will include statements that COC concentrations exceed concentrations protective of drinking water and future drinking water use would be unacceptable. This component would be applied to Alternatives 2 through 6. In addition, it may apply to Alternative 7, as some impacted soil is inaccessible beneath the St. Joe River.

- **Off-site Disposal of Generated Soils and Sediments** – Generated soils and sediments could be managed on-site in an engineered upland or in-water containment cell or potentially using low temperature thermal desorption (although off-site disposal could be required). Soils and sediments can also be managed off-site at an incineration, treatment, or disposal facility, depending on their regulatory status and concentrations of COC. For consistency within this FS, the broad assumption is made that all soils and sediments generated are disposed or treated off-site in an appropriate facility, except as explicitly stated otherwise in the alternatives. Based on the assumed regulatory status of this material, volumes generated and the performance of low temperature thermal treatment, it may be cost-effective to thermally treat or contain these materials on-site in a long-term containment cell. An analysis of the potential costs of on-site containment and low temperature thermal treatment are included in Appendix F.

- **Contingent Actions** – All remedial actions use monitoring to assess the performance of the remedial actions, and to ensure that protection of human health and the environment will be achieved and maintained. For any remedial action, should monitoring show that human health or the environment are not protected, contingent actions would be implemented. The exact contingent action will depend on the media, and the information collected that demonstrates the need for a contingent action. Nevertheless, the likely contingent actions for the Site are those remedial options described in this FS that are one to two steps more aggressive. For some remedial actions, likely contingent actions are specified to provide information on the certainty that an alternative could be modified to address an RAO or media without "starting over."

## 5.3 Description of Site-Wide Remedial Alternatives

This section describes Site-wide combinations of the representative process options discussed in Section 5.1 as Site-wide remedial alternatives. A summary of the Site-wide remedial alternatives and the means by which each alternative addresses the RAOs is included in Table 5-1. The remedial alternatives were developed to include a range of actions for each media, such that the overall remedial alternatives represented a full suite of remedial actions. In addition, upland and in-water actions were combined in a number of ways such that the relative benefit of upland and in-water actions could be evaluated.

### 5.3.1 Alternative 1

The No Action Alternative is retained, consistent with the NCP and is the basis for comparison of the other alternatives. Alternative 1 would include the existing institutional controls on groundwater use on the Site due to City ordinances. Alternative 1 would not be effective in achieving the RAOs and would not meet CERCLA statutory requirements, including failing to protect human health and the environment.

### 5.3.2 Alternative 2

Alternative 2 achieves the RAOs by a combination of removal, *in situ* treatment, and natural recovery. The alternative involves:

- Removing shoreline soils and adjacent nearshore sediment to prevent sheens in the St. Joe River (RAO 2);

- Allowing natural processes to reduce COC concentrations in groundwater to levels protective of sediments prior to reaching the sediments (RAO 3);

- Enhanced monitored natural recovery of the nearshore sediment (RAOs 1 and 2);
- Monitoring offshore sediments in the St. Joe River to determine long-term protection of aquatic and benthic organisms (RAO 4), including implementation of scour-resistant capping as necessary; and
- Institutional controls on groundwater and land use (RAO 5).

The conceptual layout for Alternative 2 is shown on Figures 5-1 and 5-2.

### 5.3.2.1 Shoreline Soil/Sediment Removal

The removal of shoreline and immediately adjacent nearshore soil/sediment would accomplish the goal of RAO 2 of preventing visual sheens in the river. The RAO for the shoreline soil and immediately adjacent nearshore sediment would be accomplished by excavating material in the area where sheens are currently generated. A boom was placed, and is maintained, at the request of EPA to control sheens generated at the site and encompasses the area of sheen. Observations made during remedial design would confirm the area of sheens. The area of sheens (i.e., the boomed area) would be considered a maximum area of excavation. Within the boomed area, soil or sediment that did not cause sheens could remain. The ability of soil or sediment to cause sheens would be assessed through field testing during the excavation as determined during remedial design. In addition, during remedial design, numeric surface water criteria will be developed to address surface water quality during remediation. Currently, sheens appear episodically in the boomed area, typically in summer and during times of lower water in the winter months. These sheens are sourced in an area of nearshore sediments and are generated through releases of gas bubbles and disturbance of the sediments in times of low water. Based on existing knowledge of the Site, the excavation is anticipated to extend the width of the 1999 removal (see Figure 5-1) and into the bank approximately 20 feet (see Figure 5-2). This area would remove any DNAPL present between the monitoring points (e.g., MW-7 and the riverbank/sediment) and provide a buffer to allow for naturally occurring adsorption, dispersion, advection, diffusion and biodegradation processes in the absence of an additional source of COC from residual creosote in soil. This area would also provide an area for monitoring the performance of these processes and the ability to meet the PRGs in or immediately inland of the sediment pore water. The excavation would extend out into the nearshore to the current limit of sheening.

For the purposes of the FS, it is assumed that this sediment will be removed to a depth of two feet to allow for placement of backfill of sufficient thickness so as to prevent release of gases. A deeper removal would be used or a gas collection and venting system would be incorporated if the design showed that future releases of gases could continue to cause sheens. Gas generation is a process related to internal geotechnical stability of the sediments, which has only recently received attention as a cap design consideration (Palermo et al 2002). Methane generation in sediments appears to be

highly temperature-dependent (Matsumoto et al., 1992). Recent rigorous field and bench scale tests required for the design of a placed cap at the St. Louis River Interlake/Duluth Tar Site in Duluth, MN showed that gas is not generated until a temperature of 13 -16 degrees centigrade (°C) is reached (Service Engineering Group, 2002). At the Duluth site, bench scale testing and modeling showed that placement of a sand and gravel/stone cap would be expected to reduce gas generation by insulating the sediment to temperatures below the threshold of biogenic gas production. The final removal depth would be defined by a similar analysis using St. Joe River temperatures.

As previously discussed, the final extent of the removal would include soils and sediment within the boomed area and extending approximately 20 feet inland that yield sheen as determined by field testing. Based on driving forces, observations of lack of shallow DNAPL accumulation in MW-1S and MW-7, the excavation extending 20 feet inland should be sufficient to remove any mobile creosote with the potential to migrate to the nearshore at the elevations where sheen is generated in the nearshore.

In order to remove the shoreline soils and immediately adjacent sediment, a temporary dam would be placed in the St. Joe River around the area to allow excavation of the shoreline within a contained area to minimize impacts to the St. Joe River. The excavation would take place during the lowest water conditions possible. Based on design factors including the risk of the river rising above the dam system and the appropriate time for in-water work based on fish passage, the exact temporary dam system would be defined. River water within the contained area would be pumped directly to the St. Joe River or treated and then discharged to the St. Joe River, as appropriate, in consultation with all appropriate state, tribal, and federal agencies. Uncontaminated overburden soils and rocks along the bank would be removed and stockpiled on-site. The excavation would extend into and along the riverbank and the sides would be sloped to allow equipment access to the excavation and to meet Occupational Safety and Health Administration (OSHA) requirements for protection of workers.

A confining layer, such as a plastic liner or clay mat would be installed in the back of the excavation prior to backfilling. Both of these materials are compatible with creosote in at least one of their commercially-available formulations. This layer provides a means of sealing any remaining layers of residual creosote that could migrate through coarse lenses in place.

The removed soils would be stockpiled on-site within the AOC in one or more segregated stockpiles, sampled to determine appropriate disposal, and disposed at an appropriate off-site location. The final determination of disposal or containment options for the soil and sediment is dependent upon its waste characterization, which affects the implementability and cost of soil and sediment management. For the purposes of the FS, it is assumed that all of the soils and sediment removed from this area, with the exception of the backfill from the 1999 removal, would contain concentrations of COC exceeding 10 times the Universal Treatment Standards (UTS;

40 CFR 268.48). Based on these concentrations and assumption that these soils would be considered F034 wastes (see Section 5.2), the soils would be subject to the Land Disposal Restrictions (40 CFR 268). In this case, the soils could not be disposed outside of the AOC without incineration or treatment to less than 10 times the UTS, consistent with the Land Disposal Restrictions. Backfill used during the 1999 removal is assumed to be uncontaminated, though some small amount of it may have been contaminated by contact with any remaining impacted soils around the area of the 1999 removal. These assumptions represent rough estimates based on the distribution of soil and sediment concentrations determined from the RI investigation and previous investigations. Soils and sediment with concentrations of COC exceeding 10 times the UTS are calculated to be transported off-site and incinerated or disposed at a facility permitted to accept these soils.

After completion of excavation and the placement of a confining layer the area below the water table would be backfilled with granular soil/sediment to allow adequate compaction. The riverbank would be reconstructed using the overburden soils stockpiled on-site and imported soils. The riverbank would be restored using rocks, vegetation, or both.

The removal of shoreline soils and adjacent sediment that are associated with the visible sheens in the St. Joe River will achieve RAO 2 for the shoreline soils and sediment.

#### 5.3.2.2 Enhanced Natural Recovery of Nearshore Sediments

A thin layer of clean sand (e.g., 1 to 3 inch), gravel or sediment would be placed over the area of surface sediments exceeding PRGs (the nearshore impacted area) to immediately prevent receptor contact with these sediments. The placement of a layer of clean material would immediately interrupt the risk pathway for receptors in the short term. After placement of this material, the applicability of long-term management of the nearshore sediments through MNR would be determined.

The goal of monitored natural recovery (MNR) of nearshore sediments would be to monitor the natural reduction in concentrations of COC in surface sediment to concentrations protective of benthic and aquatic receptors, thus achieving RAO 1, and to allow for burial of deeper sediments that could cause sheens in the nearshore area, thus achieving RAO 2 in these sediments.

The layer of sand, gravel, or sediment would be designed to prevent receptor contact, resist some scouring forces, and provide little to no disruption on fluvial processes in areas around the nearshore sediments. The layer would be placed through careful distribution of the material and settling of the material onto the nearshore sediments, in order to disturb the nearshore sediments to the minimum extent possible. The exact placement method and rate would be determined through the design process.

Permitting, or the substantial equivalent thereof, would be required prior to placing the material into the St. Joe River. This process would include consideration of habitat and mitigation, effects on navigation and river use, potential for suspension of sediments during placement, and effects on water quality during placement.

As noted in Section 4, this remedy is contingent upon adequate demonstration during the remedial design that the river bottom is stable, and not eroding to a point where exposure, scour, and transport of subsurface contaminated sediments results in unacceptable risks to human health and the environment. The specific scope and methods that will be employed to demonstrate a stable environment using the RTDF weight-of-evidence approach is given in Appendix G.

The major focus of the additional work to demonstrate bed stability will be to collect sufficient data to construct an appropriate, predictive hydraulic model for the St. Joe River. Additional data such as bottom currents, grain size, flow rates, active mixing zone depths, total suspended solids loading and resuspension potentials are needed as input variables for the fate and transport model. Additional high-resolution sediment coring (radioisotopes), sediment traps, SEDFLUME studies, evaluation of sediment bed properties, estimation of watershed solid loads and PAH load estimates from the Site will be used to refine fate and transport model inputs regarding net deposition and gross sedimentation and to support the evaluation of potential MNR. These data will be used to construct critical shear stress isopleths, and for constructing a reliable, predictive hydraulic model using ECOM-sid-SEDZL and/or the Environmental Fluid Dynamics Code (EFDC). These frameworks have been applied to Superfund sites including the Lower Fox River, Wisconsin (SEDZL), the Housatonic River, MA (EFDC), and for the Lower Duwamish River, WA (EFDC).

Should the study show that transport of sediment downstream was unlikely, then a monitoring program would be implemented to ensure that this was the continued case. Description of the monitoring program is provided in Appendix G. If either the evaluation or subsequent monitoring show that there was likelihood of erosion of the layer of clean material or the underlying sediment, the contingent remedy of an erosion resistant cap would be placed over areas of potential erosion.

#### 5.3.2.3 Assessment and Monitoring or Capping of Offshore Sediments

Currently, offshore surface sediments do not pose a risk to receptors, as concentrations of COC in offshore surface sediments are below concentrations determined to be protective of ecological receptors through chemical and bioassay testing in the RI/BLRA. However, in some areas, concentrations of COC at depth exceed the sediment PRG. Conservative river scour modeling indicates that subsurface sediments with concentrations greater than the PRG could be exposed through river scour. Also, scouring could transport impacted sediments downstream, potentially causing downgradient surface water quality to exceed criteria or risk to receptors downstream.

Initially, additional assessment would be performed to create a predictive framework in which to evaluate potential risk from scour, based on potential amount of scouring and potential risks for receptors that could be exposed to sediments transported downstream. The specific scope and methods that will be employed to demonstrate a stable environment using the RTDF weight-of-evidence approach is given in Appendix G.

As with the nearshore evaluation, the major focus of the additional work to demonstrate bed stability will be to collect sufficient and appropriate data to construct an appropriate, predictive hydraulic model for the St. Joe River. Additional data such as bottom currents, grain size, flow rates, active mixing zone depths, and resuspension potentials are needed as input variables for the fate and transport model. Additional high-resolution sediment coring (radioisotopes), sediment traps, SEDFLUME studies, evaluation of sediment bed properties, estimation of watershed solid loads and PAH load estimates from the Site will be used to refine fate and transport model inputs regarding net deposition and gross sedimentation and to support the evaluation of potential MNR. These data will be used to construct critical shear stress isopleths, and for constructing a reliable, predictive hydraulic model using ECOM-sid-SEDZL and/or the Environmental Fluid Dynamics Code (EFDC). These frameworks have been applied to Superfund sites including the Lower Fox River, Wisconsin (SEDZL), the Housatonic River, MA (EFDC), and for the Lower Duwamish River, WA (EFDC).

The results of this assessment, a framework in which to evaluate potential risk to receptors from potential scour, would be applied to the Site. Should this show that there was potential risk to downstream receptors or potential exceedances of water quality, the areas which may scour and cause this risk would be identified and armored with scour resistant materials (see Alternative 3 for a description of how materials would be designed and placed). Those areas which did not cause risk to receptors would remain capped (naturally) in place. A description of a monitoring program is included in Appendix G. If at any point during the monitoring, the risk framework indicated potential risk, the areas causing risk would be armored to prevent erosion. The success of MNR will be determined based on sediment concentrations below the PQL and monitoring results consistent with conditions predicted by the updated model described in Appendix G.

### 5.3.2.4 Institutional Controls and Monitoring

This alternative will not restore groundwater to drinking water standards. As such, RAO 5 must be met through institutional controls. As indicated in Section 5.2, Alternative 2 will include use restrictions and institutional controls on land and groundwater use.

As discussed in Section 2.6.4, a preliminary evaluation of natural biodegradation at the Site showed that anaerobic degradation was likely occurring at the Site. Modeling in the RI/BLRA showed that even at low anaerobic biodegradation rates, there was no potential risk to the benthic or ecological receptors [model outputs show results with

no degradation and low anaerobic degradation rates (first order decay), Appendix S of the RI/BLRA (RETEC, 2004a)]. Shoreline groundwater monitoring would be completed as part of the remedy to ensure concentrations of COC in groundwater are below PRGs and remain consistent or decrease. Groundwater monitoring would be used to determine the concentrations of COC in groundwater over the long term and well gauging would be performed to check for potential DNAPL migration. Monitoring of groundwater parameters, including dissolved oxygen, oxidation-reduction potential, electrical conductance, pH, and alternate electron acceptors, would be performed to assess COC attenuation between the shoreline and the mudline. This monitoring would be performed consistent with a monitoring plan approved by EPA. The exact monitoring program would be designed during remedial design. Monitoring wells would be installed as necessary to meet the data needs of the monitoring program. If concentrations were to exceed ACLs based on the PRGs for protection of sediment, or show a statistical increase to concentrations near these ACLs, the naturally occurring degradation would no longer be considered sufficient. Contingent actions, such as enhanced bioremediation would be implemented should monitoring indicate that natural degradation was not sufficient to protect surface sediment from COC in groundwater.

Monitoring would also be used to verify that sheens were not reoccurring in the river and that offshore sediments were not creating an unacceptable risk to benthic organisms. Sheen monitoring would consist of regular observations of the river, especially during times when past sheens have been more frequent. The duration of the monitoring program will be determined during the remedial design and five-year reviews. Monitoring will continue until groundwater concentrations demonstrate statistical stability at concentrations protective of the ACLs or PRGs based on protection of sediment. Trends and stability of the groundwater data will be evaluated using the statistical program WQStat Plus (IDT, 1998) or other applicable statistical software available at the time of the review.

Institutional controls will also be required for the nearshore and offshore sediment areas to prevent disturbance of remaining sediment impacts. Future dredging of the St. Joe River is not anticipated since there is no federally designated and maintained navigation channel and all current and future navigation uses of the river would use shallow-draft watercraft.

### 5.3.3 Alternative 3a

Alternative 3a addresses the RAOs through:

- A combination of removal and solidification of potential sheen causing soils and sediments along the shoreline (RAO 2).
- Capping of surface sediments that exceed PRGs and potentially cause risk to benthic or aquatic receptors (RAO 1). The cap incorporates methane collection to prevent future sheens should some methane generation continue from remaining sediments (RAO 2).

- Natural biodegradation of COC in groundwater to concentrations below PRGs prior to groundwater contact with sediment (RAO 3).
- Capping surface sediments exceeding PRGs with an erosion-resistant cap.
- Assessing and monitoring the locations where subsurface sediments exceed PRGs, and capping as necessary (RAO 4).
- Institutional controls on groundwater use and land use (RAO 5).

The conceptual layout for Alternative 3a is shown on Figures 5-3 and 5-4.

### 5.3.3.1 Removal and Solidification of Shoreline Soils/Sediment Causing Sheens

As discussed in Section 2.9.2, sheens appear in an area of soils/sediments, inside the booms maintained at the Site. While the sheens are believed to be predominantly related to methane generation and other disturbances to the sediment, it is possible that sheens could be associated with increases in groundwater gradient and periodic DNAPL movement.

To prevent existing sheens, the top two feet of the sheen causing soils/sediments would be removed. Due to the possibility that groundwater or DNAPL migration could lead to future sheens, the remainder of the soil behind this removed soil would be solidified. The areas to be removed and solidified are shown on Figures 5-3 and 5-4. The area to be solidified is the area within and below the 1999 removal. The solidification would extend approximately 20 feet deep, to the bottom of the upper silt unit to address shallow thin sand layers with DNAPL. The area to be removed also includes the area of surface sediments inside the booms, which episodically produce sheens. In addition to these areas, more shoreline soils and sediments would be removed to allow placement of the sediment cap, as discussed later in this section. This shoreline removal eliminates the current source of sheens, and prevents sheens associated with potential migration. Additional measures to prevent future sheens from sediments are included in the sediment cap discussed later in this section.

The general plan for removal and solidification, construction activities would be to first solidify the upland soils using jet-grouting techniques. Jet grouting is likely to be used because of the ability to angle drill and break up silty soils. Grouting would be performed at low water times of the year. A barrier such as an impermeable curtain would be placed in the St. Joe River between the grouting area and St. Joe River to catch any excess grout and prevent its release to the St. Joe River. Grout holes would be advanced from the uplands into the area to be grouted in overlapping columns. During grouting, spoils generated would be forced to the ground surface by the grouting. These spoils would be contained by performing the grouting work in a pre-excavated trench to prevent the spreading of spoils. Excess spoils would be collected, and stockpiled temporarily. Spoils would be disposed with material removed from adjacent sediments in the sheen area.

After the upland grout columns solidified, the removal of soils at the shoreline and surface sediments would occur. This removal would address surface sediments inside the current area with sheens (boomed area). This removal would be incorporated with the area of nearshore surface sediment removal to maintain bathymetry during capping (see capping discussion).

### 5.3.3.2 Capping of Nearshore Sediments

An area of nearshore surface sediments adjacent to the uplands portion of the Site exceeds PRGs, and thus is assumed to cause risk to benthic and/or aquatic receptors in the St. Joe River. In order to prevent receptor contact with these sediments, thus preventing risk to these receptors and achieving RAO 1, an engineered cap would be placed over the area of nearshore surface sediments.

The FS assumes that remedial action will be required for those surface sediments exceeding the PRGs, as shown on Figure 5-3. This area will likely be refined during remedial design through chemical and biological analysis of additional sediment samples.

The exact type of cap would be determined by additional evaluation of the chemical and geotechnical properties of the sediments and hydrologic properties of the river during remedial design. At a minimum, the cap would prevent receptor contact with underlying sediments and prevent resuspension of underlying sediments. In addition, some higher and/or lower permeability layers may be included to collect any methane that may be generated from remaining sediment. The FS assumes that a two-foot thick conventional cap will be placed, based on existing knowledge of the Site. Remedial design may identify a different type of cap (benched cap, a thin-layer cap, enhanced cap) that may be more appropriate at the Site.

For the conventional cap assumed in this FS, the construction of the cap would occur from the shore and barges in the St. Joe River. Due to the rather steep slope of the riverbed, it is assumed that the cap will be constructed of a sand and gravel mixture capable of maintaining a 3:1 slope (horizontal:vertical). A methane collection system would be placed near the base of the cap to collect any methane released from below the cap. This methane collection system would route the methane such that it was not released to the St. Joe River, and so could not carry sheens to the surface of the river.

As discussed in Section 2.9.2, gas bubbles assumed to be methane have been observed at the Site. The amount of methane currently being generated has not been quantified. The amount of methane likely to be generated after capping will depend on the depth of removal and thickness of cap. Therefore, the need for, and design of any methane collection system will be determined during remedial design. For this FS, the methane collection system is assumed to consist of a high permeability gravel layer with an overlying geomembrane. Also included in the assumed methane collection system is piping to route the methane from the high permeability layer to the atmosphere. After removal of the upper sediments in the area currently producing

methane, and solidification of the adjacent shoreline, the methane production is assumed to be minimal.

The methane collection system would function such that as methane bubbles rose through the sediments and into the cap, they would be routed preferentially to the methane collection piping by the high permeability layer overlain by a low permeability geomembrane. Remedial design and/or bench studies would be used to determine the need for and exact construction of the methane collection system within the cap. Due to the small quantity of methane released from the remaining sediments, it is not anticipated that treatment of the methane vapors would be required.

Removal of some sediment (in addition to the sediment removal adjacent to the shoreline above) would be needed to construct the cap such that it was integrated with the existing shoreline. A removal at the shoreline may be necessary because placement of a cap in the shallow waters near the shore would raise the bed of the river above the normal water level, creating new land at the riverbank and limiting use of this area by benthic and aquatic organisms. The extent of the removal required would be determined by the hydraulic and habitat requirements identified during the permitting process (or substantive equivalent thereof).

For the FS, it is assumed that the sediment removal would be cut to a depth that would allow a cap to be placed that brought the riverbed back to its original grade. The nearshore sediment removal area would extend riverward from the shoreline removal to a location where the sediment surface is approximately six feet below the low water mark. The nearshore cap would be placed over the existing sediments without any removal, thus maintaining a minimum water depth of four feet above any cap. The cap would back fill removal areas and the native sediment riverward of the removal area as shown on Figure 5-4.

The likely construction sequence is that the capping would be completed after solidification of soils in the uplands, and removal of soil/sediment at and along the shoreline. Removal of additional nearshore sediment for capping would be completed in conjunction with removal of sediment adjacent to the shoreline. The shoreline soils and sediments would be removed from the shore using traditional excavation equipment, such as a backhoe or excavator. Disturbance of these sediments would resuspend some of these sediments in the River and likely cause sheens on the river during the removal. These effects would be mitigated to the extent possible using portable dam structures, silt curtains, and oil collection booms, though some impacts during removal are likely. Depending on the construction method, monitoring of downstream water quality may be necessary during the removal.

After completion of the removal, the cap would be placed over the area shown on Figures 5-3 and 5-4. This cap would extend up onto the shoreline in the area of removal, and extend into the river to the area of sediments in water 6 feet below the low water line. Some of the cap would be placed from the shoreline where possible, and some from barges. Typically, these sand and gravel caps are placed using

spreader boxes allowing slow diffusion through the water column. A geomembrane layer and methane collection piping may have to be placed by divers to ensure placement in the appropriate spot. The best placement method would be determined by the final cap construction. The cap construction quality would be monitored during construction through monitoring bathymetry and sampling of materials from the cap to ensure proper placement. During construction, monitoring of downstream water quality would also be likely. If necessary, silt curtains may be used to minimize losses of any sediment resuspended by the cap placement.

In addition to placement of the cap, the shoreline would need to be armored to prevent erosion of the cap by boat wakes or materials floating in the river, such as logs, ice, and debris. This armoring would likely need to be placed from near the low water point of the river to the top of the existing slope, similar to the existing riprap at the Site. This armoring layer would be placed from the uplands using conventional earthmoving equipment.

Prior to cap construction, the design phase would include bathymetric surveys, additional sampling of surface sediment (chemical and biological) and coring of subsurface sediment to confirm the locations. This design work would provide additional information on the area over which a cap would be required and the geotechnical and physical properties of the area to be capped. Hydrologic and capping models would be used to determine appropriate cap materials and thickness. Consideration would be given in the cap design for the potential of cap scouring by the river's erosive forces that may result both due to normal flow conditions, flood conditions, and the elevated grade of the cap on the river bottom. The design will also assess the possibility for cap settlement and disturbance of the sediments during cap placement. Design of the sediment removal would also be performed at this stage and would include the details on sediment management, integration of the removal area with the cap, and the effects of the construction on the St. Joe River during removal. After cap construction, monitoring to confirm long-term cap construction quality would be performed.

By preventing contact of benthic receptors with surface sediments that could cause risk to benthic and aquatic receptors, the cap would achieve RAO 1. By preventing direct contact of the St. Joe River with nearshore sediments and prevention of disturbance of these sediments by methane production, the potential for methane related sheens and low water sheens from this area would be eliminated, achieving RAO 2 for this area.

### 5.3.3.3 Assessment and Monitoring or Capping of Offshore Sediments

This alternative includes an assessment and monitoring program with contingent capping for offshore sediments as described in Alternative 2 (Section 5.3.2.3).

#### 5.3.3.4 Institutional Controls and Monitoring

This alternative will not restore groundwater to drinking water standards. As such RAO 5 must be met through institutional controls. As indicated in Section 5.2, Alternative 3 will include use restrictions and institutional controls and land and groundwater use.

As discussed in Section 5.3.2.4, groundwater monitoring would be performed to determine the biodegradation rate and the adequacy of this rate to protect sediment in the St. Joe River, to provide monitoring for potential changes to the COC distribution in soil or groundwater, to monitor for biodegradation rate, and to monitor for potential DNAPL migration as described in Alternative 2. Monitoring would be performed in accordance with a monitoring program designed during remedial design. Monitoring wells would be installed as necessary to meet the data needs of the monitoring program. Should monitoring demonstrate a significant exceedance of ACLs based on PRGs protective of sediment, contingent actions, such as enhanced bioremediation, will be implemented. Institutional controls will also be required for the nearshore and offshore sediment areas to prevent disturbance of remaining sediment impacts. Future dredging of the St. Joe River is not anticipated since there is no federally designated and maintained navigation channel and all current and future navigation uses of the river would use shallow-draft watercraft.

### 5.3.4 Alternative 3b

Alternative 3b addresses the RAOs through:

- A combination of removal and solidification of potential sheen causing soils and sediments along the shoreline (RAO 2).
- Capping of sediments that cause risk to benthic or aquatic receptors (RAO 1). The cap incorporates methane collection should some methane generation continue from the remaining sediments (RAO 2).
- Enhanced biodegradation of COC in groundwater to concentrations below PRGs prior to groundwater contact with sediment (RAO 3).
- Capping surface sediments exceeding PRGs with an erosion-resistant cap, and monitoring of locations where subsurface sediments exceed PRGs for potential mobility (RAO 4).
- Institutional controls on groundwater use and land use (RAO 5).

The conceptual layout for Alternative 3b is shown on Figures 5-5 and 5-6.

### 5.3.4.1 Removal and Solidification of Shoreline Soils/Sediment Causing Sheens

Soils and sediments would be solidified and removed as described in Alternative 3a. The removal and solidification would be integrated with the nearshore sediment cap, also as describe in Alternative 3a.

### 5.3.4.2 Capping of Nearshore Sediments

The nearshore sediments would be capped as described in Alternative 3a.

### 5.3.4.3 Enhanced Biodegradation of Groundwater

As discussed previously in Section 2.6.4, some biodegradation of COC may be occurring naturally at the Site. To be protective of the sediments in the St. Joe River, the biodegradation would have to occur at a great enough rate such that concentrations of COC were below PRGs at the point where groundwater reached the sediments. Typical aerobic and anaerobic degradation rates for Site COCs were obtained from Howard, et al, (1991). These values indicate that aerobic degradation rates are higher than anaerobic degradation rates. Fate and transport modeling (Appendix C) shows that anaerobic biodegradation rates based on literature values are likely to be sufficient to prevent groundwater at the Site from exceeding PRGs prior to discharge to sediment. Section 2.6.4 indicates that biodegradation at the Site is likely anaerobic. Thus, degradation at the higher aerobic rates would also achieve PRGs in groundwater prior to discharge to sediment. For example, the literature based anaerobic and aerobic degradation rates (half lives) for naphthalene are 0.71 years (258 days), .055 years (20 days), respectively (Howard et al., 1991).

An enhanced bioremediation system would be installed to supply oxygen to the groundwater, thus promoting faster aerobic biodegradation of Site COC to achieve RAO 3. First, the achievable aerobic degradation rate at the Site would be determined through groundwater monitoring, bench testing, pilot testing, or a combination of these activities. Based on this degradation rate, a system to enhance the biodegradation rate to the required level would be designed. For the purposes of the FS, it is assumed that oxygen will be added to groundwater by air sparging. Air sparging is capable of raising dissolved oxygen levels in groundwater to approximately oxygen saturation. This is the most oxygen that can be put into water and remain dissolved in the water. Air sparging is typically accomplished either by wells or a trench. For the FS, it is assumed that a trench will be used. The trench is assumed because trenches are generally more effective in lower permeability geologic units, such as the upper silts, while wells are usually effective in moderate or highly permeable units. The use of a trench in the interbedded unit allows the excess air to be collected rather than accumulated in the interbedded unit. A potential trench layout is shown on Figures 5-5 and 5-6.

The system would be operated by injecting air into the trench using an air compressor, which would be housed on the Site. The injected air would dissolve into

the groundwater, though excess air would bubble out of the groundwater into the soil. For semi-volatile compounds that dominate the COC at the Site, the air will typically not volatilize enough COC from the groundwater to cause risks to human health. This would be confirmed using calculations during the design phase of the project, and air monitoring would be performed during system startup for additional confirmation. In the event calculations or monitoring show volatilization was sufficient to cause unacceptable risk to human or ecological health, vapor controls would be installed. Vapor collection piping would be installed in the sparging trench, and an impermeable liner would be placed above the trench. Vapors would remain in the trench because of the higher permeability backfill used and the vacuum used to collect vapors from the trench. An air blower would be used to collect vapor from the vapor collection piping. The collected vapors would be treated as necessary, likely with granular carbon, and discharged under any air discharge permit or substantive equivalent thereof administered by the Idaho Department of Environmental Quality.

To determine system effectiveness, groundwater would be monitored for COC concentration and indicators of biodegradation. The monitoring program would monitor COC concentrations upgradient of the system, dissolved oxygen concentrations and COC concentrations in the groundwater being treated by the system, and COC concentrations and biodegradation rates downgradient of the system.

The monitored biodegradation rates and COC concentrations would be compared to the required rates determined in the design phase. If the actual biodegradation rates were above those designed and COC concentrations were at or below those designed, the system functions effectively and the COC would be degraded to below PRGs before reaching the sediments. Should monitoring demonstrate that the actual biodegradation rate was below that designed, and COC concentrations significantly exceeding ACLs, based on PRGs for protection of sediment, then contingent actions would be necessary. Contingent actions could include attempts to increase biodegradation rates through addition of nutrients or additional degrading organisms, or containment of groundwater, such as with a slurry wall. Monitoring will continue during system operation with the frequency of monitoring decreasing based on stability of groundwater concentrations at or below ACLs, based on PRGs protective of sediment.

As soil remaining on-site would be an ongoing source of COC to groundwater, operation of the air sparging system is anticipated to last for at least 30 years. Should concentrations of COC in groundwater drop below levels protective of sediment, air sparging could be discontinued. At the 30 year mark, the present value of additional operation and maintenance of the air sparging system beyond the 30 year period is not a significant cost, and so use of this assumption would also cover any future operation and maintenance.

#### 5.3.4.4 Assessment and Monitoring or Capping of Offshore Sediments

The offshore sediments would be evaluated and monitored or capped as described in Alternative 2 (Section 5.3.2.3).

#### 5.3.4.5 Institutional Controls and Monitoring

Institutional controls would be placed on groundwater and land use as described in Alternative 3a (Section 5.3.3.4). Groundwater monitoring would be used to determine the effectiveness of the enhanced biodegradation system as discussed previously in this section. Groundwater monitoring would also be used to ensure that groundwater migration and COC concentrations remained similar to those determined in the RI/BLRA and used for remedial action design at the Site. Monitoring could also be used to collect data to help determine appropriate contingent actions should monitoring of the remedial actions show that they were not effective. Monitoring would be performed in accordance with a monitoring program designed during remedial design. Monitoring wells would be installed as necessary to meet the data needs of the monitoring program

### 5.3.5 Alternative 3c

Alternative 3c addresses the RAOs through:

- A combination of removal and solidification of potential sheen causing soils and sediments along the shoreline (RAO 2).
- Capping of sediments that cause risk to benthic or aquatic receptors (RAO 1). The cap incorporates methane collection should some methane generation continue from the remaining sediments (RAO 2).
- Containment of groundwater containing COC at concentrations, which may exceed PRGs where groundwater discharges to sediment of the St. Joe River (RAO 3).
- Capping surface sediments exceeding PRGs with an erosion-resistant cap, and monitoring of locations where subsurface sediments exceed PRGs for potential mobility (RAO 4).
- Institutional controls on groundwater use and land use (RAO 5).

The conceptual layout for Alternative 3c is shown on Figures 5-7 and 5-8.

### 5.3.5.1 Removal and Solidification of Shoreline Soils Causing Sheens

The shoreline soils would be removed and solidified as described in Alternative 3a and as shown on Figures 5-7 and 5-8.

### 5.3.5.2 Soil-Bentonite Containment Wall

A containment wall would be constructed to contain groundwater in the fill and shallow silt units to prevent migration of groundwater exceeding PRGs for RAO 3 to the St. Joe River. The containment wall would also be designed to prevent any potential DNAPL migration towards the St. Joe River.

Based on the future use of the Site, site soils, and cost, the most appropriate containment wall at the Site is a soil-bentonite containment wall. The wall would be constructed to contain groundwater in the shallow silt and interbedded units. For the FS, it is assumed that this would mean that the area of groundwater and soil to which RAO 3 applied would be encompassed on three sides by the wall. The configuration of the wall to be implemented would be determined by detailed groundwater modeling to be included in the remedial design. Possible configurations could include a two-sided (v-shaped) wall, a three-sided wall, or a fully-encircling wall. The three-sided configuration of wall has been successful at another DNAPL site in the northwest (the PSR Superfund Site in Seattle, Washington). As groundwater mounded behind the wall, it would cause upgradient groundwater to be diverted around the area of creosote impacts, preventing this groundwater from being impacted. The wall would need to extend to at least the bottom of the interbedded unit. However, the wall would likely cause some groundwater mounding, which could lead to a downward vertical groundwater gradient that would cause groundwater, containing COC above acceptable levels into the sand unit. For the FS, the wall is assumed to extend into the lower silt unit (approximately 60 feet) to provide a "key" to minimize COC migration beneath the wall. Additional investigation of the soil hydrogeologic properties in the zones to be contained or the underlying low permeability units may be necessary as part of remedial design for accurate modeling.

The actual configuration, alignment and depth of the containment wall would be determined by detailed groundwater flow modeling performed as part of the design. The modeling would have the goal of determining the configuration, alignment and depth of wall required to prevent groundwater with concentrations of COC exceeding the RAO 3 PRGs from reaching the St. Joe River sediments. This flow modeling would include consideration of mounding of groundwater behind the wall, vertical gradients, interaction with the St. Joe River, and the extent of groundwater captured by the wall. Other factors that would be considered during design modeling would include the utility of a low-permeability cap to minimize infiltration, the effect of a fully encircling versus three-sided wall, and possible contingent actions such as hydraulic containment in addition to physical containment. Any additional site-

specific data necessary to support the modeling effort would also be collected as part of remedial design.

The appropriate bentonite mix for the wall during the design phase would be made either during design or at the start of construction. In order to help determine the appropriate mix, additional soil borings or test pits may be utilized, or bench tests may also be used.

A slurry wall would be installed using a specialized long-reach excavator capable of excavating to the desired wall depth. The maximum wall depth would be 60 feet. Wall widths vary with the equipment used, and are typically on the order of 2 to 4 feet wide. As specialized excavators exist to reach approximately 80 feet, no equipment limitations are expected. The excavator would be used to excavate the soils and the area would be backfilled using a mixture of bentonite and excavated soil or introduced soil. During excavation of the trench, the slurry mixture would be used to support the trench sides and prevent collapse. Other additives would be considered during the mix design based on Site soil conditions and proposed future land use (i.e., traffic loading). Spoils from the wall excavation would be segregated and managed as hazardous as would other soils from the Site. The wall construction would be performed in one continuous trenching operation and would create a continuous wall at the end of construction.

A limited amount of soil with DNAPL impacts will remain downgradient, in front of the wall. The impacted material will be located within thin sand layers of the interbedded unit, at depth below the river channel. Should mobile DNAPL exist in these layers, construction of the wall will remove the driving force for any DNAPL migration. DNPAL in these thin sand layers will become isolated from any remaining DNAPL head, and groundwater gradients in the area immediately in front of the wall will be significantly diminished, further limiting any potential for significant migration. The dissolution of this residual DNAPL may provide a long term source of COC to the groundwater in the immediate vicinity of a thin sand layer containing DNAPL. However, because of the relatively low solubility of PAH, the biodegradability of these compounds, and the lower gradients, these localized impacts are not expected to affect the surface sediments in the river.

To determine the effectiveness of the wall over the long-term, groundwater monitoring would be used. The groundwater monitoring would have the goal of demonstrating that the wall was preventing groundwater with concentrations of COC exceeding PRGs from reaching the St. Joe River. Monitoring would include monitoring of groundwater elevations to determine if groundwater flow was as designed. Concentrations of COC in groundwater could also be monitored downgradient and at the ends of the containment wall. The monitoring program would need to be designed to account for the presence of DNAPL in some thin sand layers downgradient of the wall.

Should monitoring show that the wall was not preventing groundwater, with concentrations of COC exceeding RAO 3 PRGs, from reaching the sediment in the

St. Joe River, contingent actions would be necessary. Contingent actions could include modification of the wall, solidification of upgradient soils to prevent leaching to groundwater, or hydraulic containment of groundwater.

#### 5.3.5.3 Capping of Nearshore Sediments

The nearshore sediments would be capped as discussed in Alternative 3a and as shown on Figure 5-7 and 5-8.

#### 5.3.5.4 Assessment and Monitoring or Capping of Offshore Sediments

The offshore sediments would be evaluated, monitored, and capped, as discussed in Alternative 2 (Section 5.3.2.3).

#### 5.3.5.5 Institutional Controls and Monitoring

Institutional controls would be placed on groundwater and land use as discussed in Alternative 3a (Section 5.3.3.4). Monitoring of groundwater flow direction and COC concentrations would be used to ensure that groundwater flow and COC concentrations were as the remedial action design anticipated, which would maintain the effectiveness of remedial actions. Monitoring could also be used to collect additional data that could be used in evaluation of contingent actions, should monitoring indicate that these were necessary. Monitoring would be performed in accordance with a monitoring program designed during remedial design. Monitoring wells would be installed as necessary to meet the data needs of the monitoring program.

### 5.3.6 Alternative 4a

Alternative 4a addresses the RAOs through:

- A combination of removal and solidification of potential sheen causing soils and sediments along the shoreline (RAO 2).
- Removal of surface sediments that exceed PRGs and could cause risk to benthic or aquatic receptors (RAO 1). The backfill incorporates methane collection should some methane generation continue from the remaining sediments (RAO 2).
- Natural biodegradation of COC in groundwater to concentrations below PRGs prior to groundwater contact with sediment (RAO 3).
- Using erosion-resistant backfill in sediment removal areas and monitoring of locations where subsurface sediments exceed PRGs for potential mobility (RAO 4).

- Institutional controls on groundwater use and land use (RAO 5).

The conceptual layout of Alternative 4a is shown on Figures 5-9 and 5-10.

### 5.3.6.1 Removal and Solidification of Shoreline Soils causing Sheens

The shoreline soils and sediments that could cause sheens would be removed and solidified similar to that described in Alternative 3a and as shown in Figure 5-9 and 5-10. Unlike Alternative 3a, where the removal and solidification actions were integrated with capping, the shoreline work would be integrated with the removal of surface sediments. The removal would be accomplished in a similar fashion to the surface sediment removal (Section 5.3.6.2). Backfilling would be similar to backfilling of the shoreline removal required to incorporate a cap in Alternative 3a with the existing river bathymetry.

### 5.3.6.2 Removal of Nearshore Surface Sediments

The removal would be completed to permanently reduce risk to receptors from COC in surface sediments to acceptable levels and achieve RAO 1. This removal would include the surface sediments exceeding PRGs and the underlying subsurface sediment to a depth of three feet. This depth was used to provide a conservative removal depth based on existing estimates of maximum scour possible during flooding events. The area removed would be backfilled to match the existing river bathymetry. A methane venting system could be incorporated into the backfill, similar to the system described in the cap in Alternative 3a. This removal and backfilling would also accomplish RAO 4 for this area by removing the subsurface sediment exceeding PRGs that could conservatively be eroded.

Prior to removal of the sediments, design and permitting (or substantive requirements thereof) would have to be completed. Design of the removal operation would decide the exact dimensions of the:

- Area of sediment removal (determined by bioassay and chemical analyses);
- The removal depth (determined by required depth to protect receptors and prevent future scour);
- The preferred removal method; and
- The backfill type, thickness, and placement method (modeling of potential scour and cap settlement).

For the FS, it is assumed that the area exceeding the PRGs for RAO 1 would be removed. Design could include additional sample collection and analysis (chemical

and bioassay), geotechnical analysis, or bioassay to refine the area of sediments to be removed and removal and backfilling methods.

The substantive permit requirements are anticipated to involve a study of the effects of dredging on water quality, evaluation of the potential for downstream transport of suspended sediments, and an evaluation of the potential effects of dredging on aquatic receptors. These evaluations would demonstrate the relative risk to aquatic receptors between removal of the sediment versus leaving sediment in place. Existing studies indicate that approximately 0.2 to 1% of dredged sediments can be expected to be resuspended in the water column using mechanical removal techniques (WEDA, 2001). Alternately, resuspension from mechanical dredging, even using a watertight ("environmental") bucket range from 0 to 300 mg/L (EPA, 1994). Based on these estimates, it is likely that dredging would lead to a greater mass of COC being suspended per unit of water in the River than scouring during storm events. While the mass of COC per unit of river water would be higher during dredging than during flooding, the total mass of suspended COC in the river would be lower than during flooding because the majority of the sediments would be removed by the dredging. This comparison of dredging and scouring indicates that impacts of the dredging could be significant and must be carefully balanced against leaving sediments in place.

For the purposes of the FS, it is assumed that approximately one-half of the surface sediments would be removed using a shore-based excavator or crane. A barge mounted crane or excavator would be required for the other one-half of the sediments due to the water depth and distance off shore. The removed sediments would be offloaded in the uplands portion of the Site in bermed areas designed to contain the wet sediments.

Removed sediments would be dewatered in the upland area of the Site in temporary dewatering cells within the AOC. Water collected from the cells would be treated and discharged under a similar process to a Nationwide 38 permit per Section 404 of the CWA or an NPDES permit (or substantive requirements thereof), as determined by the final permitting requirements. Dewatered sediments would be loaded and transported off-site for treatment and/or disposal.

Dredging would be performed until the design depth was reached. After this occurred, confirmation bathymetry or sampling could be used to ensure that the design depth was reached. To provide for long-term stability in the area of removal and to prevent receptor exposure to deeper sediments in the area of removal, the dredged area would be backfilled using a sand and gravel material designed to resist erosive forces in the river.

Monitoring of sediments would be required to ensure that a sufficient area of surface sediment was removed, to determine whether sediment resuspension and transport during dredging could be causing unacceptable downstream conditions, and to ensure construction quality of the backfill. Long-term monitoring of the backfill may be necessary to ensure that backfill remains in place over time. Monitoring of water

quality is a typical component of dredging operations to determine potential effects on downstream water and sediment quality due to the resuspension of sediments during dredging operations.

#### 5.3.6.3 Assessment and Monitoring or Capping of Offshore Sediments

Offshore sediments would be assessed and monitored or capped as described in Alternative 2 (Section 5.3.2.3).

#### 5.3.6.4 Institutional Controls and Monitoring

Institutional controls would be placed on groundwater and land use and groundwater would be monitored as described in Alternative 3a (Section 5.3.3.4).

### 5.3.7 Alternative 4b

Alternative 4b addresses the RAOs through:

- A combination of removal and solidification of potential sheen causing soils and sediments along the shoreline (RAO 2).
- Removal of surface sediments that exceed PRGs and could cause risk to benthic or aquatic receptors (RAO 1). The backfill incorporates methane collection should some methane generation continue from the remaining sediments (RAO 2).
- Enhanced biodegradation of COC in groundwater to concentrations below PRGs prior to groundwater contact with sediment (RAO 3).
- Using erosion-resistant backfill in sediment removal areas and monitoring of locations where subsurface sediments exceed PRGs for potential mobility (RAO 4).
- Institutional controls on groundwater use and land use (RAO 5).

The conceptual layout for Alternative 4b is shown on Figures 5-11 and 5-12.

#### 5.3.7.1 Removal and Solidification of Shoreline Soils Causing Sheens

Shoreline soils would be solidified and sediments would be removed as discussed in Alternative 4a and as shown on Figures 5-11 and 5-12.

#### 5.3.7.2 Enhanced Biodegradation of Groundwater

Enhanced biodegradation would be used to treat groundwater to acceptable levels, as described Alternative 3b and as shown on Figures 5-11 and 5-12.

#### 5.3.7.3 Removal of Nearshore Surface Sediments

The nearshore surface sediments would be removed as described in Alternative 4a and as shown on Figures 5-11 and 5-12.

#### 5.3.7.4 Assessment and Monitoring or Capping of Offshore Sediments

Offshore sediments would be assessed and monitored or capped as described in Alternative 2 (Section 5.3.2.3).

#### 5.3.7.5 Institutional Controls and Monitoring

Institutional controls and monitoring of groundwater would be performed as described in Alternative 3b (Section 5.3.5.5).

### 5.3.8 Alternative 4c

Alternative 4c addresses the RAOs through:

- A combination of removal and solidification of potential sheen causing soils and sediments along the shoreline (RAO 2).
- Removal of surface sediments that exceed PRGs and could cause risk to benthic or aquatic receptors (RAO 1). The backfill incorporates methane collection should some methane generation continue from the remaining sediments (RAO 2).
- Containment of groundwater containing COC at concentrations, which may exceed PRGs where groundwater discharges to sediment of the St. Joe River (RAO 3).
- Using erosion-resistant backfill in sediment removal areas and monitoring of locations where subsurface sediments exceed PRGs for potential mobility (RAO 4).
- Institutional controls on groundwater use and land use (RAO 5).

The conceptual layout for Alternative 4c is shown on Figures 5-13 and 5-14.

#### 5.3.8.1 Removal and Solidification of Shoreline Soils causing Sheens

Shoreline soils and sediments would be removed and solidified as described in Alternative 4a and as shown on Figures 5-13 and 5-14.

#### 5.3.8.2 Soil-Bentonite Containment Wall

Groundwater containing concentrations of COC exceeding levels protective of sediment would be contained as described in Alternative 3c and as shown on Figures 5-13 and 5-14.

#### 5.3.8.3 Removal of Nearshore Surface Sediments

Nearshore surface sediments would be removed as described in Alternative 4a and as shown on Figures 5-13 and 5-14.

#### 5.3.8.4 Assessment and Monitoring or Capping of Offshore Sediments

Offshore sediments would be assessed and monitored or capped as described in Alternative 2 (Section 5.2.3.2).

#### 5.3.8.5 Institutional Controls and Monitoring

Institutional controls would be placed on groundwater and land use and monitoring of groundwater would be implemented as described in Alternative 3c (Section 5.3.5.5).

### 5.3.9 Alternative 5

Alternative 5 addresses the RAOs through:

- Removal of sheen-causing soils and sediments along the shoreline (RAO 2).
- Removal of nearshore sediments that exceed PRGs and could cause risk to benthic or aquatic receptors (RAO 1) or cause sheens in the future (RAO 2).
- Containment of groundwater containing COC at concentrations, which may exceed PRGs where groundwater discharges to sediment of the St. Joe River (RAO 3).
- Removing nearshore sediments that exceed PRGs, and construction of a cap over the offshore area of potentially mobile sediments (RAO 4).
- Institutional controls on groundwater use and land use (RAO 5).

The conceptual layout for Alternative 5 is shown on Figures 5-15 and 5-16.

### 5.3.9.1 Integrated Removal of Shoreline Soils and Nearshore Sediments

As discussed in previous alternatives, shoreline soils and some nearshore sediments inside the currently boomed area are the source of sheens that appear in the St. Joe River. Nearshore surface sediments present a risk to benthic and aquatic receptors. This alternative proposes an integrated removal of these soils and sediments, thus achieving RAOs 1 and 2. By integrating the removal action with a sheetpile wall, a portion of a containment wall to minimize groundwater and DNAPL movement would also be constructed.

Prior to construction, detailed design and permitting (or substantive equivalent thereof) would be required due to the degree of work in the St. Joe River and the complexity of the project. The design process would include collection of additional sediment samples and chemical and bioassay testing to determine the exact dimensions of the removal area and the removal depth as well as the preferred removal method. Also included would be a bathymetric and bottom condition survey to determine the conditions along the wall alignment, additional soil borings and sediment cores to determine soil conditions along the proposed wall alignment. Modeling would be used during the design process to establish grain-size for the backfill and to estimate potential backfill settlement.

Permitting (or the substantive equivalent thereof) would be similar to that for sediment removal in Alternative 4. The substantive permit requirements are anticipated to involve a study of the effects of dredging on water quality, evaluation of the potential for downstream transport of suspended sediments, and an evaluation of the potential effects of dredging on aquatic receptors. These evaluations would demonstrate the relative risk to aquatic receptors between removal of the sediment versus leaving sediment in place.

To construct Alternative 5, a steel sheetpile wall would be driven around the area of both nearshore sediments and shoreline soils. One sidewall would be in the St. Joe River and another parallel wall would be at the top of the riverbank adjacent to the Site. The two walls would be connected by perpendicular walls to form a sheetpile cell enclosed on all four sides (see Figure 5-15). This area is roughly equivalent to the area that would be removed at the base of the shoreline excavation in Alternatives 2 through 4 and would encompass the area of surface sediments that exceed PRGs. One advantage of creating a sheetpile cell over traditional dredging and excavation is physical isolation of the area, minimizing the potential for releases to the St. Joe River during removal. However, disturbance of sediments and resuspension of sediment is expected during placement and removal of sheetpiling in the River, as this involves pushing the sheets into the sediments, vibratory impacts from driving the sheet piling into place, and disturbance of the sediment when removing the sheet piling. A second advantage is to prevent sloughing of surrounding sediments into the excavated area, which reduces the required volume that must be removed to reach

deeper sediments. Finally, the sheet piling forms a containment wall that would be used for groundwater containment as discussed later in this section. Disadvantages of use of a sheetpile wall include the limitation of additional excavation, if necessary, the relatively higher cost, and the potential for resuspension of contaminated sediments during placement and removal of the sheetpiles.

The sheetpile walls of the cell would likely be driven partially from a barge in the St. Joe River, as the outer wall of the cell would be greater than 50 feet offshore, and the remainder of the sheets would be driven from onshore. Interlocking sheets would be used so that the cell would be largely watertight. The cell would be partially dewatered after completion, but due to the water depths (up to approximately 25 feet water depth in the river) some water would likely need to be maintained in the cell to balance the force of surrounding river and soil. Excavation would be performed "in the wet." It is assumed that the average depth of removal will be approximately 8 feet. This assumption is based on sediment cores near the shoreline in which sediments exceed PRGs between 9 and 14 feet in depth, and sediment cores farther from the shore in which sediments exceed PRGs to a depth of approximately 0 to 2 feet. Excavated soils and sediments would be dewatered in temporary dewatering cells constructed in the uplands portion of the Site within the AOC. Water generated by dewatering would be treated and discharged to the St. Joe River.

After excavation, sediments in the water within the cell, which would contain significant amounts of suspended solids created during the removal, would be allowed to settle to minimize the release of solids during sheetpile removal. Some resuspension of sediments is expected during the sheetpile removal. The settled sediments/soils would be sampled to determine the quality of these sediments/soil. Some re-excavation of this area may be required, depending on the concentrations in the fallback after dredging.

The area within the sheetpile cell would be backfilled after excavation and establishment of acceptable sediment quality within the cell. After backfilling and establishment of acceptable water quality within the cell, the sheets in the St. Joe River forming the three walls from the shoreline into the river would be extracted. Some of these sheets would be driven again in the uplands to create a barrier wall, as described in Alternative 3c and as shown on Figure 5-15. The actual alignment of the barrier wall would be dependent upon detailed groundwater models used as part of design, as discussed in Section 5.3.5.2. The remainder would be salvaged for reuse or recycling. Similar to Alternatives 3c and 4c, this barrier wall would be designed such that it prevented flow of groundwater and DNAPL migration from the source area of impacted soils to the St. Joe River, thus achieving RAO 3.

Monitoring would be required during sheetpile placement and removal to determine impacts on the St. Joe River. Monitoring would also be required during construction to ensure that the proper depth was removed and to confirm sediment quality after fallback.

### 5.3.9.2 Sheetpile Wall Containment of Groundwater

After removal of the sediments and backfilling, sheets on the sides perpendicular to the riverbank and in the river would be removed. Some of these sheets would be re-driven in the uplands portion of the Site to form a barrier wall. The barrier wall would contain groundwater with concentrations of COC exceeding the PRGs for RAO 3 and DNAPL. The depth and lateral extent of the wall would be the same as that of a soil-bentonite slurry wall and the design would require the same detailed groundwater flow modeling, fate and transport modeling and potentially additional soil borings at the Site. The assumed extent of the wall is shown on Figures 5-15 and 5-16.

Corrosion of the wall would be prevented, if necessary, by use of cathodic protection. An evaluation of corrosion potential and rate, would be performed by a corrosion engineer during the design phase, to determine whether or not cathodic protection would be required. Such evaluations typically involve consideration of soil moisture, soil pH, soil electrical conductivity, and soil aeration.

As with a soil-bentonite slurry wall, monitoring of groundwater flow and COC concentration would be used to determine if the wall was functioning as designed and effectively preventing groundwater migration to the St. Joe River. Monitoring could also be used to collect information for evaluation of potential contingent actions, if necessary.

### 5.3.9.3 Capping of Offshore Sediments

In order to prevent potential erosion of sediments that could potentially cause risk to receptors downstream, an erosion resistant cap would be installed over those areas where sediments exceeding RAO 4 PRGs could be eroded.

As discussed regarding caps in the nearshore area, the final type of cap would be determined during remedial design. Design would include:

- Collection and analysis of additional sediment cores to refine the areas that would need to be capped, and to provide physical estimates of sediment properties for designing the cap and cap placement technique.
- Refinement of the PRGs area to be addressed through chemical and biological testing.
- Additional measurements of physical properties and radioisotope dating to provide additional information on the depth and distribution of river scour and depositional events. Bathymetric and river bottom condition surveys would be performed to provide information for the cap design and placement.

- Modeling to determine the proper grain-size and thickness for the cap, potential settlement of the cap, and potential for disturbance of the sediments during cap placement.

A combination of all of these factors would be used to determine the proper cap type and placement method.

The FS assumes that a two-foot thick cap would be used at the Site, constructed of scour resistant sands and gravels and placed as described in Alternative 3.

Monitoring would be required during and immediately after cap construction to ensure that water quality was maintained during the cap placement. This monitoring would involve measurements of river turbidity and water quality. Construction quality monitoring would also be used to ensure and that the cap was constructed according to the design. This monitoring would include bathymetry and sediment cores.

Long-term monitoring would be required to ensure continued effectiveness of the cap. This monitoring would include sediment cores to ensure that the cap was maintaining the desired thickness.

#### 5.3.9.4 Institutional Controls and Monitoring

Institutional controls would be placed on groundwater and land use and monitoring of groundwater would be implemented as described in Alternative 3c (Section 5.3.5.5).

### 5.3.10 Alternative 6

Alternative 6 addresses the RAOs through:

- Removal of sheen-causing soils and sediments along the shoreline (RAO 2).
- Removal of nearshore sediments that exceed PRGs and could cause risk to benthic or aquatic receptors (RAO 1) or cause sheens in the future (RAO 2)
- Solidification of soils that leach to groundwater and could cause groundwater exceeding PRGs to be discharged into sediment (RAO 3)
- Removing sediments that exceed PRGs (RAO 4).
- Institutional controls on groundwater use and land use (RAO 5).

The conceptual layout of Alternative 6 is shown on Figures 5-17 and 5-18.

### 5.3.10.1 Removal of Shoreline Soils and Sediment

Shoreline soils and adjacent nearshore sediment would be removed as discussed in Alternative 2. As Alternative 6 includes removal of all sediments exceeding concentrations protective of aquatic and benthic receptors, a deeper shoreline removal is planned for integration with the sediment removal. This deeper removal is shown on Figures 5-17 and 5-18.

### 5.3.10.2 Solidification of Upland Soils

Solidification could be used to prevent leaching from soil to groundwater, which would prevent groundwater with concentrations of COC exceeding PRGs from reaching the sediments in the St. Joe River. This solidification would be accomplished through in situ shallow soil mixing.

Design of the soil stabilization would include:

- Determining the mix design, which typically involves bench testing of solidification materials and site soil.
- Groundwater modeling to determine the effects of solidification on groundwater flow.
- Refinement of the area to be solidified, which could include additional soil borings.

To solidify these soils, soil-mixing equipment would be mobilized to the Site. Necessary equipment includes a large excavator or crane with mixing deck and auger, a mill for mixing the solidification agents (likely to be bentonite and cement), and equipment for management of the solidification agent, such as pumps, tanks, and piping. The augers are advanced in overlapping columns to the necessary depth and agents are added as slurry during the mixing. A test column would typically be completed at the beginning of construction to verify that the mix is effective at solidifying the soils.

For the purpose of the FS, the area of soil requiring stabilization is conservatively assumed to be the approximate area in which the groundwater currently exceeds the working PRGs for groundwater, which includes MCLs (PRGs for RAO 5) and those concentrations protective of sediment-dwelling organisms in the St. Joe River (PRGs for RAO 3). This area is shown on Figure 5-17. For the purposes of the FS, it is assumed that the stabilization will extend to the bottom of the upper interbedded unit.

The soil mixing process introduces material to the soil, thus it increases the soil volume in the mixing area and results in excess soil. This soil can be contained in place with a cap, if it is acceptable to change the grade at the Site and the containment of soil in place would not allow transport to another medium (groundwater, surface

water). The generated soil is frequently mixed with the introduced stabilization material and so has little leaching potential.

### 5.3.10.3 Removal of Nearshore and Offshore Sediments

Sediments that exceed the PRGs for sediment would be removed and treated (and/or contained in the uplands), accomplishing RAO 2 in the nearshore area and RAO 1 and RAO 4 in the nearshore and offshore sediments. These sediments would be removed by barge-mounted mechanical means.

Remedial design for the removal would include:

- A sediment investigation to refine the area of sediments that would have to be removed;
- A study of the resuspension to be expected during removal and the potential effects on water quality and downstream sediment quality;
- An analysis of the most efficient combination of methods (shore-based excavation versus barge-based dredging or excavation) to removed the sediments;
- An analysis of dewatering and water treatment requirements; and
- Evaluation of the backfill type to be used and the placement method to be used to minimize sediment resuspension during backfilling.

Sediments would be removed by the means identified in the design (e.g., dewatered in the uplands, and loaded and treated and/or disposed off-site). The removal would likely be performed with a mechanical dredge, as discussed in Alternative 4 (Section 5.3.6.2). The removal is assumed to average 6 feet deep, which is the average depth of sediment exceeding PRGs. The removed sediments would be placed in the uplands portion of the Site in bermed cells for management. Sediments would be dewatered in the uplands portion of the Site, and managed as determined.

### 5.3.10.4 Institutional Controls and Monitoring

After stabilization of the uplands soils, these soils will be highly impermeable. Monitoring of surrounding groundwater would be performed to determine the effectiveness of the remedial action. An appropriate monitoring program would be determined as part of remedial design, and could include use of existing or new wells, depending on the data needs of the monitoring program. New monitoring wells, if required, would be installed as part of implementation of the monitoring program. Depending on the results of this monitoring, it may be possible to discontinue institutional controls on groundwater use if all groundwater on the Site was within acceptable concentrations for use as drinking water. After completion of solidification, surface soil condition would be evaluated to determine if land use

controls were necessary as well. The solidification process and restoration of this area of surface soils may reduce the concentrations of COC in surface soil such that land use restrictions for residential use may not be necessary. Monitoring would likely be required to confirm continued performance of the stabilization measures. Institutional controls on the river will likely not be required due to removal of all impacted sediment.

### 5.3.11 Alternative 7

Alternative 7 addresses the RAOs by:

- Complete removal of all accessible soils and groundwater exceeding PRGs (RAOs 2, 3, and 5).
- Removal of sediments that exceed PRGs or could cause sheens (RAOs 1, 2 and 4).

The conceptual layout for Alternative 7 is shown on Figures 5-19 and 5-20.

This alternative includes the complete removal of accessible soil and sediment from the Site that exceed PRGs. All accessible soils in the uplands that are determined to leach to groundwater at concentrations that exceed groundwater RAOs (RAOs 3 and 5) would be excavated and taken off-site for treatment or disposal. For the purposes of the FS, soils which could leach to groundwater at unacceptable levels are those that exceed Region IX PRGs for leaching to groundwater. As part of a final remedy, site specific leaching concentrations could be determined. A limited amount of inaccessible impacted soil will remain in this alternative. This inaccessible impacted soil is the thin sand layers at depth that extend beneath the river channel. The volume of impacted material remaining beneath the river channel is limited, as is the potential for receptor exposure to these soils. Diversion of the river to remove these soils is not warranted based on the limited volume and risk.

To access the depths of the soil (approximately 60 feet), shoring would be required to allow excavation in these soils and to minimize infiltration of groundwater into the excavation. While the final means of excavation and support would depend on the final extent of excavation and selected contractor, for this FS, the excavation was assumed to have the following components:

- Sloped sides in the upper 40 feet, except along the St. Joe River, where a sheet pile-shoring system with tie-backs is assumed to minimize infiltration of water;
- Use of sheet piling with tie-backs below 40 feet in the excavation, to minimize groundwater infiltration in the deep sand unit and provide for stable excavations;
- Dewatering through dewatering points and pumping from the excavation;

- Containing upland soils and groundwater by construction of a sheetpile wall to create a containment cell; establishing a waste management area (WMA). The WMA would be capped and groundwater monitored for 30 years. These actions would achieve RAOs 2 and 4.

- Bank soils, shoreline sediments and nearshore sediments would be excavated and dredged to an average depth of 8 feet. Soil and sediment would be thermally treated off or on-site. Disposal may be required in a Subtitle C landfill. These actions would achieve RAOs 1 and 3.

- Additional chemical and biological testing, monitoring and capping of offshore sediments will be performed to confirm areas where sediment with COCs that exceed risk-based levels is located. These actions will achieve RAOs 1 and 3.

Alternative 8 is a combination of containment, removal, and capping that was developed by EPA. It is similar to Alternative 5 with modifications to provide a higher level of long-term effectiveness at lower cost. The conceptual approach to Alternative 8 is presented on Figures 5-21 and 5-22.

Upland soils and groundwater would be contained on-site with a four-sided sheetpile and slurry wall in a waste management area. The wall will be extended into the lower silt unit (approximate depth of 60 feet) to prevent migration of DNAPL and impacted groundwater to the river. The area will be capped to prevent precipitation and flood water infiltration and be resistant to scouring during flood events. Groundwater inside and outside this waste management area will be monitored to evaluate the effectiveness of the containment cell.

Bank soils, shoreline sediments, and nearshore sediment will be removed, treated on-site and disposed off-site. Removal of these most highly contaminated areas (to a depth of 8 feet) and backfilling with clean material to the original bathymetry will restore the aquatic and benthic environment and prevent further migration of contaminated sediments downstream. Engineering methods will be used during removal activities to control potential short-term, off-site impacts. The area will be monitored to evaluate performance and long-term stability.

Additional chemical and biological testing to determine the extent and depth of contaminated sediments will be conducted to determine the boundaries of the offshore area that would be capped (costs assume 100% of the area will be capped). The Tribe, the state of Idaho, and EPA have not established freshwater sediment cleanup levels that would be applicable for the Site; therefore, the following approach for delineating the extent of contaminated sediment at the site and establishing boundaries for cleanup will be used:

Step One. Screen sediment concentrations against the following values: the Washington State Sediment Quality Standards (SQS) and corresponding Lowest Apparent Effects Threshold (LAET), and the Minimum Cleanup Levels (MCUL) and corresponding second Lowest Apparent Effects Threshold (2LAET) equivalents for sediments in

Puget Sound. The LAET and 2LAET values are used in cases of either very low total organic carbon (<0.2%) or high organic carbon (>4%) sediment concentrations. Exceedance of the SQS will mark the reason to initiate biological testing (see step two below). The MCUL is the maximum allowed chemical concentration in sediment to be achieved after completion of cleanup actions.

Step Two. For those sediments that exceed the above SQS (or LAET) value, perform follow-up biological testing. Methods used by Washington State for at least two acute effects tests and one chronic effects test will be followed. Follow-up biological testing will be used to demonstrate site-specific effects to benthic organisms. The use of marine standards for invoking bioassay testing is justified because PAH compounds have a mode of action of narcosis (arrested activity) for aquatic animals. This mode of action is not significantly affected by ion strength of the medium, which is the main difference between freshwater and marine water.

The result of this stepwise approach will be to more firmly delineate sediment cleanup boundaries using results from site-specific biological testing during remedial design.

Physical conditions of the river would also be assessed to determine design parameters for a scour-resistant cap. The cap would be monitored to verify performance and long-term stability.

Institutional controls would be used to restrict groundwater and land use, and to protect the sediment cap.

### 5.3.13 Alternative 9

Alternative 9 Addresses the RAOs by:

- Removal of the upper 20 feet of Upland Soil area that leach creosote-related COCs to groundwater, thermal treatment of the removed soil to prevent groundwater contamination followed by on-site disposal of treated soils. Solidification of deeper upland soils (below 20 feet as necessary). The combination of removal and stabilization will leave materials on-site that will no longer leach PAHs to groundwater, thereby preventing further groundwater discharges to the St Joe River / sediments at levels exceeding cleanup standards (RAOs 2 and 4).

- Removal of soils and sediments along the Riverbank Soils Area, thermal treatment of these soils, and disposal on-site. Deeper soils may be stabilized in this zone in combination with the stabilization of soils in the Upland Soils Area (RAOs 1, 2, 3, and 4).

- Removal of St. Joe River sediments in River Sediment Area that exceed SSCLs and could cause risk to benthic or aquatic receptors or that

could in the future contaminate other sediments leading to future risk to benthic receptors (RAOs 1 and 3).

The conceptual approach to Alternative 9 is presented on Figures 5-23 and 5-24.

### 5.3.13.1 Soils Treatment Detail (Upland Soils Area and Riverbank Soils Area)

A complete delineation of the vertical and horizontal extent of creosote contamination will be performed during the remedial design. The remedial design will also consider the depth to which excavation can be successfully performed without risk of flooding and flowing sands from the sand layer. The delineation results and excavation dewatering and stability calculations will define the area that will be excavated and thermally treated, currently anticipated to be the top 20 feet of the upland sub-area. All of the deeper contaminated soils will be treated in situ with in situ stabilization. It is currently anticipated that the deeper soils will include the affected soils down to the sand layer, and in localized areas may include some of the sand layer, as determined by the results of the additional delineation. Areas of contamination will either be excavated and thermally treated or stabilized in situ.

The equipment that would be used for in situ soil stabilization would be tracked mounted drilling rigs. The anticipated depth of soils requiring stabilization is estimated to be relatively shallow at approximately 20 feet in depth. This stabilization would occur once the top 20 feet of soils were removed for treatment. Due to the relatively small area requiring stabilization, a smaller, more mobile hydraulic auger would be used on a larger tracked backhoe. The auger attachment would be approximately 48 inches in diameter. Based on soil conditions at the depth of the excavation, crane mats may be required to offer the stability needed to perform the stabilization activities.

Soil Removal (Upland Soils Area)

For the Upland Soil area, the soils down 20 feet will be excavated and treated on-site with thermal desorption equipment. Treatment will be performed to achieve cleanup standards for soil prior to replacement on-site. Deeper, impacted soils will be mixed in situ with Portland cement and potentially other materials to create a stabilized material. The depth of mixing in place is expected to average 25 to 30 feet below the water table. The goal of soil excavation and treatment or treatment (stabilization) in place for the Uplands Soil area is to treat as much of the source mass as can be reasonably accessible. While the exact dimensions of each cannot be ascertained until remedial design activities are accomplished, in the upland sub area, soils that are above the cleanup standard will be either excavated and thermally treated, or stabilized in place.

Excavation will be performed where the following criteria can be confidently achieved.

- Dewatering of the excavation to allow for access for the collection of soil sampling to demonstrate that removal of impacted soils has been achieved for the upper 20 feet of soils. The extent of excavation laterally will be defined by the soil cleanup criteria for COCs.

- Vertical excavation will continue with depth to remove as much mass as practical without getting too close to the sand layer as to cause uncontrolled flux of river water and running sands into the bottom of the excavation. This will be approximately the top 20 feet, based on our preliminary calculations. This represents approximately 75 percent of the creosote mass that is on-site.

Stabilization will be performed for deeper soils where excavation could trigger upward flooding. Stabilization will be performed wherever soils after excavation remain above the soil cleanup standard. After stabilization has been completed, backfilling will be performed with thermally treated soils, and the area will be reclaimed.

Air emission controls will be incorporated into the thermal treatment. A standard fabric filter bag house or a conventional wet scrubber will be utilized to meet emission limits. Metals and chlorine, if present in the soils, will have a very low concentration. Consequently no additional controls such as scrubbing alkalis or carbon bed absorbers will be needed to achieve emission limits. In a period of operation, when concentrations in the soil would exceed emission limits at full operating capacity, operations of the thermal treatment would be modified to either reduce the production rate or change the contaminate concentration levels of the feed materials.

Secondly, continuous monitoring for CO, $O_2$, and opacity will be required. In addition, several parameters, such as burn chamber temperature, control device pressure drop, and feed rate, will need to be continuously monitored as well. An initial source test for particulate, dioxins, chlorine, and metals will be required. The operating parameters monitored during the test will establish the operation protocol for things such as maximum pressure drop and minimum burner temperature for the operations plan. There will be a cost increase to the emissions controls that will be included as the cost of performing the work.

Excavated soils will be placed in a staging pile, where preparation and storage prior to treatment will occur. Staging piles will be used for physical operations intended to prepare wastes for subsequent thermal treatment and perhaps solidification (mixing, sizing, blending and other similar physical operations). These units will be located on-site ~~under the control of the owner/operator~~, and should not trigger land disposal restrictions. A two-year period (with a possible 180-day extension) applies to staging piles from the time the waste is first placed. ~~We understand that these piles are not self implementing, meaning that a facility undergoing remedial operations will obtain EPA's or the State's approval of the design and use of such a pile. A Consent Decree which includes a Statement of Work will be executed to trigger the activities.~~ Pad design would be completed to meet a performance standard. EPA has

previously allowed staging piles to be used as ARARs for the remediation of CERCLA sites.

If staging piles must be located on a clean parcel, it will be clean closed. If located in a contaminated area, the final cleanup on impacted soil can be coordinated with the over-all cleanup.

A contingency plan for flooding will be developed at the site and incorporated with the site work plans. Clean soils will be used to construct a dike around sensitive working areas such as excavations, soil staging areas and process equipment. As a function of the source material excavation and treatment, clean soils that surround the impacted soils will need to be excavated to achieve slope stability. These clean soils will be used on the site potentially for flood control berms. Upon completion of soil treatment and backfill, these clean soils will be used to bring the excavation to the original grade prior to remediation. Excess clean soils would then be transported off-site for other constructive uses. Flood plain boundary issues will be addressed as part of the remedial design. In conjunction with the soil dikes, additional controls may be used such as concrete barriers to increase the protection of sensitive areas.

Other controls that will be developed and incorporated in the project work plans will take in to consideration a maximum amount of soils that will be excavated and stored at any one time. This will be determined in the work plan stage of the project but would consider the size of the stockpile areas and the volume of soils that may need to be temporarily backfilled in the case of a flooding event.

With the exception of the 100-year storm event that occurred in the late 90's, the typical flooding event inundates the site with approximately six to twelve inches of low velocity waters. Scour in the upland area has not been a factor, even during the 100 year storm event. Excavation, treatment, and in situ stabilization are expected to be performed right up to the shoreline, stabilizing the upper edge of the riverbank. It is expected that no swelling from soil additives will result in the area being mixed, which will ultimately be covered with treated soils from the upland area, the riverbank area, and river sediment area and the clean topsoil stockpile removed prior to stabilization. This area will then be reclaimed by reseeding with grass.

Shallow groundwater entering the excavation area will be collected (excavation dewatered) and treated to discharge limits compliant with discharge to the St. Joe River. Impacted groundwater will be removed during excavation (both water entrained in the removed soils, and dewatering water removed during excavation dewatering). Additional impacted groundwater will be bound up in the soils during in situ stabilization. If groundwater monitoring wells show continued contamination after these two remedial actions have been accomplished, then natural attenuation and/or enhanced bioremediation could be an appropriate supplemental remediation step. These technologies are more appropriate for remediation of traces of PAHs once the primary source mass has been treated.

The need for the additional groundwater treatment will be ascertained once the groundwater ARAR has been settled, and after the in situ soil remedy (and associated groundwater remedy) has been installed. It is estimated that over 1 million gallons of (potentially) contaminated water will be pumped from the excavation and treated during dewatering operations—this step will flush the groundwater from around the existing contamination and will enhance the removal of residual groundwater contamination. This is equivalent to running a pump and treat system in the zone of excavation with over 40 pore volume flushes—this certainly will have an effect. The deeper groundwater will also be bound up in the stabilized materials, which will treat some additional zone of potentially contaminated groundwater. It is likely that these steps will be sufficient to recover the groundwater quality in the Upland sub-area. As previously stated above, a contingency plan will be developed in the event unanticipated flooding or inundation conditions are experienced from the St. Joe River during the excavation and treatment operations.

Wells currently located around the impacted upland soils area, and additional wells installed after upland soils removal and stabilization have been completed, will be sampled to document that the impacted groundwater has been removed or stabilized such that these wells are below groundwater quality standards. If this does not prove to be the case, enhanced bioremediation or monitored natural attenuation will be performed until groundwater quality standards have been achieved.

Soil Treatment: Excavated soils will be treated using thermal treatment to the RAO for upland soils (to cleanup values developed from Table 4 in the Proposed Plan, and revised as Table 5-3, in the FS). Once a representative characterization analysis indicates that the treated soils pass these cleanup standards, they will be replaced into the excavation area, regraded and either revegetated or amended to reduce infiltration. The decision for how these treated soils will be reclaimed once they have been treated will reflect their physical and chemical characteristics; credibility, location in the landscape and future land use, and permeability. It may be desirable to reduce infiltration by the addition of bentonite to the soils as they are replaced. It is anticipated that the Upland Soil area may be used as a industrial site; land use controls will prevent surface disturbance once final reclamation was complete.

Riverbank Soils

The removal of shoreline and immediately adjacent nearshore soil/sediment will be accomplished by excavating material in the area where sheens are currently generated. This area is approximately defined by the current location of the surface sheen boom. Soils would be removed to a vertical and horizontal extent such that all soil exceeding the cleanup standard is removed or stabilized. During remedial construction, groundwater would be dewatered and treated in the same system used to deal with groundwater removed during upland excavation. The excavation is anticipated to extend somewhat beyond the area of the 1999 removal and into the bank approximately 30-40 feet, which will be determined based on additional delineation information obtained prior to excavation. It is possible that the deeper soils will be stabilized concurrent and contiguous with the upland soils stabilization, which

will be determined when the configuration of the upland stabilization area is developed. The riverbank will be restored to its current the configuration.

Removal of the shoreline soils and thermal treatment of these materials will ensure that creosote materials are no longer present above site-specific cleanup levels, which will eliminate the pathway for groundwater contamination to occur. Monitoring in groundwater wells around the area of removal will demonstrate that the removal has adequately reduced concentrations of COCs such that the groundwater does not mobilize COCs and therefore is protective of the sediments in the St. Joe River. This remedial action satisfies RAO 2, RAO 3, and RAO 4.

Removal of the shoreline sediments and thermal treatment of these materials will ensure that creosote materials are not present at unacceptable concentrations. This action will eliminate the direct contact of benthic organisms with toxic concentrations of COCs. Monitoring of sediments after sediment removal, treatment and replacement would demonstrate that the removal has adequately reduced concentrations of COCs in the sediment resulting in the protection of the benthic organisms. This removal will also prevent contact with human activities on the shore of the St. Joe River. This remedial action satisfies RAO 1 and RAO 3.

## 5.3.13.2 Sediment Treatment Detail

River Sediments Area

The removal of nearshore sediments will be performed in a manner that protects the St. Joe River from increased suspended solids and mobilization of creosote-related COCs into the river. A silt barrier will be used prior to the removal activities to create a zone that can be partially dewatered. This silt barrier will be further defined in the remedial design and will need to be capable of limiting or eliminating the transport of impacted sediments off-site. These sediments will consist of what was previously defined as near shore and off shore sediment. In situ stabilization is not proposed for the sediments in the river.

Alternative 9 includes a stepwise process to develop risk-based cleanup concentrations protective of the benthic invertebrate community. This process, which is consistent with the Washington State Sediment Management Standards (WAC 173-204), and the process described in Alternative 8 will result in site-specific cleanup levels (SSCLs) for PAHs in sediment. The SSCLs will be used to identify sediment areas within River Sediment area that require further action to protect aquatic and benthic organisms. The process used to develop the SSCLs is shown in Figure 3-1 and described below.

Step 1 The first step will be to review the existing sediment data to identify locations that warrant further evaluation, some of which will be resampled for biological testing. Existing data for sediment intervals that include the top 10 centimeters (or "surface sediment") will be evaluated in this step of the process. The concentration of each PAH and molecular weight PAH class listed in Table III of WAC 173-204-520

and Table 3-3 will be compared with the appropriate generic cleanup screening level in Table 3-3 (i.e., the MCUL or, for sediments with very low or high total organic carbon, the 2LAET). Sample locations where at least one cleanup screening level is exceeded will be considered for re-sampling.

Step 2 The second step will be to select the subset of locations to be resampled for biological testing. The objective is to select enough samples with a sufficiently high range of PAH concentrations to ensure that toxicity is observed in at least one (but not every) sample. Results of previous toxicity tests at the Site, in which the highest tested concentration (58 mg/kg total PAH) was not toxic, will be used to guide the sample selection process. Concentrations of total PAHs in samples at the high end of the range should be at least several hundred mg/kg. At least two upstream reference locations also will be selected for biological testing consistent with prior background reference sites.

Step 3 The third step will be to re-sample and test the selected surface sediment locations. If necessary, site samples will be blended to produce one or more of the intermediate exposure concentrations required for an informative exposure-response curve. Two acute and one chronic toxicity test will be selected from among those listed in revised Table 3-5. Statistical significance and magnitude of difference relative to the reference, as well as the quality assurance and cleanup screening level criteria shown in revised Table 3-5 will be used to classify each tested sample as toxic or not toxic. Benthic invertebrate community metrics (e.g., taxonomic richness and density) may also be determined for co-located surface sediment samples. The community metrics for site samples will be compared with those for the reference samples. These results will be used to determine which sample locations are associated with impacts to the indigenous benthic invertebrate community. Chemical analyses also will be performed on splits of samples which biological tests are conducted. In addition to the 16 PAHs listed in FS Table 3-3, sediment characteristics (e.g., total organic carbon content and grain size distribution) and "natural" contaminants (e.g., ammonia) will be measured for each location.

Step 4 The next step of this process will be to identify the PAH concentrations that pose a risk to benthic invertebrates and select the SSCL. The weight of evidence provided by the chemical and biological tests will be used to determine which sample locations pose a risk to benthic invertebrates due to PAH toxicity. The SSCL will be the lowest observed effect concentration (LOEC). A single SSCL will be selected for purposes of identifying sediment areas requiring further action. Total PAH concentrations will be calculated as the sum of the 16 PAHs listed in Table III of WAC 173-204-520 and Table 3-3. These cleanup levels will be based on toxicity tests of sediments contaminated from the same basic source. Furthermore, setting the cleanup level to the lowest effect concentration (i.e., the LOEC) is a reasonably

conservative means of addressing the inherent variability of PAH mixtures in ambient media. That is, the site-specific PAH mixture used in bioassay testing will determine the cleanup level selected.

The use of Total PAHs for the purpose of identifying sediment areas requiring further action is appropriate in this case, because the SSCL will be based on site-specific biological effects data. That is, the SSCL will be based on the mixture of PAHs present at the Site. It is recognized that the relative concentrations of individual PAHs in the sediment may vary. However, this variation will be accounted for in the biological effects data, because a range of exposure concentrations will be tested. Selection of the lowest concentration associated with effects (i.e., the LOEC) as the SSCL will help ensure that cleanup is based on the most toxic mixture of individual PAHs.

The process for using the SSCLs to determine which sediment areas require further action is shown in Figure 3-2 and is described below. Specifically, the SSCLs for sediment will be used to identify the surface and subsurface sediments in River Sediment area that warrant remedial action to protect aquatic and benthic organisms, as defined by RAO 1 and RAO 4. For RAO 1, the pathway of concern is direct contact of surface sediment by benthic organisms. The pathway of concern for RAO 4 is erosion and downstream transport of subsurface sediment resulting in direct contact in the future of water or sediment by aquatic and benthic organisms. Surface and subsurface sediments throughout the River Sediment Area will be extensively sampled for PAH concentrations during the remedial design phase in order to provide adequate delineation of the spatial extent of contamination.

The approach that will be used in the remedial design will include the delineation of scour and depositional areas of the river bed. Those areas that are delineated as depositional areas will be subject to the stepwise process for development of the risk-based cleanup concentrations that is protective of benthic organisms. It is understood that subsurface sediment required further characterization, which will be performed during the remedial design process.

The point of compliance for RAO 1 is the top 10 centimeters of sediment (or "surface sediment") in the St. Joe River (Table 3-3). This is the portion of the sediment column that constitutes the primary zone of biological activity. The point of compliance for RAO 4 is, on average, the top three feet of sediment in the St. Joe River (Table 3-3) (or "subsurface sediments"). This is the portion of the sediment column that is potentially susceptible to erosion during a 100-year flood. Total PAH concentrations representative of each point of compliance will be used to identify the sediment areas that require remedial action. Additional delineation of the sediment areas of concern are planned prior to implementing the sediment remedy.

Step 5 The final step of this process is to identify what remedial action should be taken. Two general types of sediment remedial actions are envisioned: 1) removal and treatment, or 2) stabilization (through physical isolation or chemical stabilization). The process for selecting the appropriate type of action for any given sediment location is shown in Figure 3-2. If the TPAH concentration in surface sediment exceeds the SSCL, then the sediment in that area will be targeted for removal. The subsurface interval will be evaluated regardless of the decision made for the upper sediment interval. If the TPAH concentration in subsurface sediment exceeds the respective SSCL, then the sediment in that area will be evaluated to determine whether stabilization to prevent erosion and downstream dispersal is appropriate. If stability of subsurface sediment areas of concern cannot be adequately ensured, then the sediments exceeding the SSCL will be targeted for removal, or will be stabilized to remove the erosion pathway for exposure (RAO 4).

Sediments will be removed by a "dredging" operation, for example, vacuum removal, long stick excavator, hydraulic dredge, etc. Removed water will be treated to prevent suspended solids and creosote-related COCs from being released with the treated water released back to the river. The risk-based site-specific clean up level for PAHs in sediment will be used to evaluate treated sediments for their suitability to be returned to the river bed. The SSCL will be derived during the remedial design phased by performing toxicity tests with benthic invertebrates on untreated sediments from the St. Joe River. The residual PAHs in sediment following thermal treatment are not expected to be as bioavailable as the PAHs in the fresh sediment tested for toxicity. Therefore, the SSCL is a conservative criterion for treated sediments.

As for spatial and ecological extent of sediment contamination, Alternative 9 proposes to collect a representative number of sediment samples for PAH concentrations. Those samples will be compared with the SSCLs derived from the toxicity tests on a gradient of sediment PAH concentrations.

Ecological extent is limited to direct contact with sediments, as represented by benthic invertebrates. Protection of mink is occasionally raised as an outstanding issue. The risk assessment didn't completely rule out risks to mink, but it did indicate that any such risks are 1) due to direct contact with sediment rather than food web exposures and 2) marginal because of the small spatial extent of contamination. Basically, there is a marginal risk to the one mink that might use the contaminated shoreline, but no apparent risk to the local mink population. The Proposed Plan did not include sediment screening values for mink. Therefore, Alternative 9 did not include protection of mink as a distinct RAO.

Removed sediment will be dewatered on the upland area in a manner that keeps the material segregated from upland soils. As part of the sediment excavation work, a sheet pile wall will be installed at the perimeter of those sediments that are determined through the design process with require removal and treatment. This sheet pile wall will be continuous and interlocked to prevent the migration of sediments during the construction activities.

Removed sediment will be mechanically excavated or hydraulically dredged and deposited in the upland area within a detention pond for dewatering. The sediments will be placed in a manner in the upland area that keeps the sediments segregated from any stockpiled upland soils. Construction water collected as part of this dewatering activity will be re-circulated directly to the closed portion of the sheet pile wall where excavation is being performed. This will continue until the end of the sediment removals at which time the water quality of the retained water will be tested and treated if necessary. The removed dewatered sediment will be treated by thermal desorption and treated sediment will be replaced on the upland area, or in the river.

Prior to disposal on-site, treated soils will be tested to demonstrate that COCs will not continue to contaminate groundwater. Treated sediment could be used for backfill in the upland area. The ramifications of this approach would be to then dispose of clean soils excavated near the source material areas that had been used in flood control berms. These clean soils would be removed and used as fill materials off-site as to not raise the elevation and grades with in the floodway area up on completion of the project.

Alternative 9 does not propose to chemically stabilize within the river except potentially in the area around the riverbank sub-area, and if that were to occur, these materials would not be left as the surface sediment, but would only be a deeper layer that would be covered with more appropriate sediment materials such as sand and gravel. In every other case, stabilization in the river sediments refers to physical stabilization by capping. The materials and thicknesses of the cap will be determined during remedial design, with the process including an assessment of scour in this stretch of the river during flood stage, and materials will be used for stabilization that will resist this scour. The sediment transport model will be updated and expanded as part of the cap evaluation process. By placing a cap in the areas of excavation of sediments, protection would be given to those areas immediately downstream from the effects of scour. This cap could be treated as sediments or aggregate materials.

Removal of surface sediments in the St. Joe River containing COCs above SSCLs would protect benthic and aquatic receptors in this area by eliminating the potential for these receptors to come in contact with impacted surface sediment. This remedial action satisfies RAO 1 and RAO 4.

~~Removed sediment will be dewatered on the upland area in a manner that keeps the material segregated from upland soils. The removed dewatered sediment will be treated by thermal desorption and treated sediment will be replaced on the upland area, or in the river. Prior to disposal on site, treated soils will be tested to demonstrate that COCs will not continue to contaminated groundwater.~~

# 6 Detailed Analysis of Remedial Alternatives

A detailed analysis of alternatives involves the evaluation of each alternative against the nine criteria identified by EPA in the RI/FS Guidance. A summary of the analysis presented in this section is also provided in tables that are included with the Comparative Analysis in Section 7. The nine evaluation criteria are broken into threshold, balancing, and acceptance criteria.

The two threshold criteria that must be met due to statutory requirements are:

- **Overall protection of human health and the environment** – This evaluation criterion ensures that remedial actions achieve the overall remedial goal of protection of human health and the environment. This criterion will be evaluated and a determination of whether the alternative is protective of human health and the environment in the long-term term or short-term will be made.

- **Compliance with ARARs** – ARARs are statutory requirements with which remedial actions must comply. A determination will be made whether the remedial action would be in compliance with chemical-, action-, and location-specific ARARs, both in the long-term and the short-term.

The five balancing criteria form the majority of the analysis of the alternatives upon which remedial decisions are made. Each remedial alternative is evaluated according to its relative degree of meeting each of the balancing criteria. The balancing criteria are:

- **Long-Term Effectiveness and Permanence** – This criterion evaluates the risk that may remain after implementation of remedial actions and the longevity of that alternative, i.e. how the alternative will remain effective over time.

- **Reduction of Toxicity, Mobility, or Volume Through Treatment** – This criterion evaluates the methods, amounts, and permanence of treatment in alternatives.

- **Short-Term Effectiveness** – This criterion addresses effects of the alternative during the implementation phase. Of specific concern are negative impacts on human health and the environment during implementation of the alternative and the length of time required to implement the alternative.

- **Implementability** – This criterion considers the technical and administrative implementability of the remedial alternatives. Also, consideration is given

to the availability of expertise, equipment, and materials for implementing remedial actions.

- **Cost** – The cost of each alternative is estimated to allow a comparison of cost and cost-effectiveness of the remedial alternatives. Costs are included in Table 7-1 in this section, and detailed costs are included in Appendix H.

In addition to the threshold and balancing criteria, there are criteria for determining acceptance of remedial alternatives by the state and local community. These criteria are not specifically evaluated during the FS. These criteria are typically evaluated during development of the Record of Decision after comments on the FS and the proposed plan have been received. These acceptance criteria are:

- **State Acceptance** – This criterion allows for the comments of the state agencies and the tribes in which the remedial action will be implemented to be considered.

- **Community Acceptance** – This criterion addresses issues and concerns the community may have regarding remedial actions at a cleanup site.

## 6.1 Potential Remedial Actions by Area

For the purposes of the FS, alternatives are subdivided and evaluated by each physical area or media that the remedial actions address. The physical areas or media by which remedial actions will be analyzed are: 1) Upland Soils and Groundwater, 2) Nearshore Sediments, and 3) offshore Sediments. Alternative 9 slightly revises the area subdivisions into: 1) Uplands, 2) Riverbank Soils, and 3) River Sediments.

### 6.1.1 Upland Soil and Groundwater

The remedial alternative components for the upland soil and groundwater are focused on achieving the following RAOs:

- **RAO 2** – Prevent visible oil films or sheens on the St. Joe River.

- **RAO 3** – Prevent migration of impacted groundwater to surface sediment in the St. Joe River that would result in COC concentrations greater than protective levels for aquatic and benthic organisms.

- **RAO 5** – Prevent residential and commercial ingestion of and dermal contact with COCs in groundwater at concentrations greater than protective levels.

Each alternative addresses RAO 2 by removing and/or solidifying, or removing and treating the shoreline soils and immediately adjacent nearshore sediment that cause visible oil films or sheen in the St. Joe River.

To address RAO 3, the remedial alternatives, except Alternative 1, use one or a combination of the following methods:

- The existing natural biodegradation occurring at the Site;
- Enhanced biodegradation;
- Shoreline soil solidification;
- Barrier walls;
- Creation of a capped containment cell;
- Groundwater monitoring;
- Upland soil excavation and treatment;
- Soil treatment (stabilization in place or on-site treatment); and
- Removal.

While the FS evaluation indicates that all these methods may successfully address RAO 3, the current site data regarding natural biodegradation is somewhat limited and this adds uncertainty to this remedial component. Contingent measures have been included with this technology should natural biodegradation be insufficient to meet RAO 3.

Alternative 7 includes removal of all upland soils contributing to COCs in groundwater above protective levels. Alternatives 2 through 8 use institutional controls to prevent human ingestion or dermal contact with groundwater to ensure protection of human health in relation to RAO 5.

**Alternative 8 would construct a containment cell to surround the area of impacted soil and groundwater as delineated in the RI. Bank soils, shoreline sediments, and nearshore sediment would be removed, treated on-site, and disposed of off-site. Additional site characterization would determine the area to be capped.**

**Alternative 9 indicates that soils down 20 feet would be excavated and treated thermally on-site and that deeper impacted soils would be stabilized in place. Alternative 9 describes returning groundwater to groundwater quality standards in the Upland Soils Area. Wells currently located around the impacted Upland Soils Area, and additional wells installed after upland soils removal and stabilization have been completed, will be sampled to document that the impacted groundwater has been removed or stabilized, such that these wells are below groundwater quality standards. If this does not prove to be the case, enhanced bioremediation or monitored natural attenuation will be performed until groundwater quality standards have been achieved.**

### 6.1.2 Nearshore Sediments

Potential remedial actions in the nearshore sediments are focused on achieving the following remedial action objectives:

- RAO 1 – Protect aquatic and benthic organisms by preventing direct contact of benthic organisms with COCs in surface sediments in the St. Joe River at the concentrations greater than protective levels.
- RAO 2 – Prevent visible oil films or sheens in the St. Joe River.
- RAO4 – Prevent the downstream transport of COC that result in COC concentrations in water or sediment that exceed levels protective of aquatic and benthic organisms.

To achieve the remedial action objectives in the nearshore sediments, the alternatives involve removal of sediment adjacent to the shoreline where sheens occur and one of the following:

- Enhanced natural recovery of the remaining sediments;
- Capping of the remaining sediments with some associated removal to facility capping;
- Removal of the upper portion of the sediments that could impact receptors followed by capping;
- Removal of bank soils, shoreline sediments and nearshore sediments to an average depth of 8 feet off-site for disposal or on-site thermal treatment;
- Removal of shoreline and immediately adjacent nearshore soil/sediment (Alt. 9); and
- Complete removal of the impacted nearshore sediments.

While the FS evaluation indicates that all these methods may successfully address the nearshore RAOs, the current site data regarding natural recover is somewhat limited and this adds uncertainty to this remedial component.

**Alternative 8 proposes removal of impacted soil and sediment to an average depth of 8 feet. On-site thermal treatment and off-site disposal are components of Alternatives 2 through 8.**

**Alternative 9 proposes to address all soils exceeding the cleanup standard in such a way that all soil exceeding the cleanup standard would be removed or stabilized. The extent of removal, treatment, and stabilization would be determined based on additional delineation prior to excavation. The riverbank would be restored to its current configuration.**

### 6.1.3 Offshore Sediments

The offshore sediment area does not currently pose a risk to receptors as the concentrations of COCs in surface sediments are below PRGs. During flood events, there is potential for scouring into deeper sediments that contain higher concentrations of COCs. Should such scouring occur, some sediment with COC would be mobilized during flooding events. The remedial actions for this are focused on achieving the following RAOs:

- RAO 4 – Prevent the downstream transport of COC that results in COC concentration in water or sediment that exceeds levels protective of aquatic and benthic organisms.

To achieve the RAO in the offshore area, the remedial alternative components included in the FS are:

- Assessment and monitoring or capping;
- Capping;
- **Removal, treatment, and disposal on-site; and**
- Removal.

While the FS evaluation indicates that all these methods may successfully address the offshore RAOs, the current site data regarding natural recovery, the potential for scour during substantial flooding and the potential downstream impacts have not been established with certainty. **Additional modeling of river hydraulics proposed in Alternative 8 would further define the placement and configuration of a cap to be used on offshore sediments. Alternative 9 would remove and treat river sediments. The treated sediment would be replaced on the upland area or in the river.**

## 6.2 Alternative 1

The No Action Alternative is a basis for comparison of the other alternatives. It would not be effective in achieving all of the RAOs and would not meet CERCLA statutory requirements, including failing to protect human health and the environment.

### 6.2.1 Protection of Human Health and the Environment

RAOs were developed to address the COCs and pathways that were noted as providing unacceptable risk based on information from the RI/BLRA. Overall protection of human health and the environment is achieved by satisfying the RAOs.

#### 6.2.1.1 Upland Soil and Groundwater

The No Action alternative does not implement the institutional controls to fully ensure there is no future use of groundwater and, therefore, does not satisfy RAO 5. This alternative also does not take action to address sheens (RAO 2) or the groundwater to sediment pathway (RAO 3) that may cause risk to aquatic and benthic receptors. It is unlikely that this alternative would be protective in the long-term.

#### 6.2.1.2 Nearshore Sediments

This alternative is unlikely to be protective of the benthic and aquatic receptors potentially at risk in nearshore sediment since no remedial actions are taken to address RAO 1, RAO 2, and RAO 4.

#### 6.2.1.3 Offshore Sediments

Current Site conditions satisfy RAO 1. For RAO 4, uncertainties exist related to the potential for, and magnitude of scour. Therefore, RAO 4 is not considered effectively addressed under the No Action alternative.

### 6.2.2 Compliance with ARARs

Of the chemical-specific ARARs and TBCs, Alternative 1 would not comply with the federal Safe Drinking Water Act (MCLs), Washington State Sediment Management Standards, and EPA Region IX Preliminary Remediation Goals as indicated in Table 6-1.

No action-specific or location-specific ARARs or TBCs are expected to apply, as no remedial actions would be performed at the Site.

### 6.2.3 Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence is evaluated based on residual risk that may exist after implementation of remedial actions and the adequacy and reliability of controls that ensure continued protectiveness.

#### 6.2.3.1 Upland Soil and Groundwater

The No Action alternative is unlikely to provide long-term protection of upland soils and groundwater for several reasons. First, fate and transport modeling (Appendix C) shows that groundwater at the Site may cause risk to aquatic and benthic receptors due to sediment contamination and a No Action would not change the current situation. With regard to potable groundwater use, institutional controls (City ordinance) currently exist, which prohibit this use and require connection to City water. The Site will remain on the floodplain so future use is unlikely. While the permanence of a City enforced institutional control has some uncertainty, the five-year review that will be included as part of the remedy will ensure that the City

controls remain in place. In addition, some DNAPL mobility may remain that is not addressed under No Action. Finally, this alternative does not provide any monitoring to determine protection or lack of protection of human or ecological receptors.

#### 6.2.3.2 Nearshore Sediments

Current conditions in the nearshore are not protective for benthic receptors. Radioisotope dating suggests that net deposition may be occurring in the nearshore sediment area of the Site. As a result, the nearshore sediment area may naturally recover and this alternative may be protective in the long-term. However, significant uncertainty surrounds the natural recovery data and without further assessment, conditions can not be assumed to become protective in a reasonable time frame.

#### 6.2.3.3 Offshore Sediments

Current Site conditions satisfy RAO 1. For RAO 4, uncertainties exist related to the potential for, and magnitude of scour. Given these uncertainties, the potential exists that current conditions would not remain protective in the long term. In addition, , the alternative does not include any means to further determine or ensure this protectiveness.

### 6.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

This section discusses how the alternative reduces the toxicity to receptors, mobility, or volume of COC at the Site.

#### 6.2.4.1 Upland Soil and Groundwater

This alternative does not include treatment. There may be limited biodegradation of COC over a long time scale.

#### 6.2.4.2 Nearshore Sediments

This alternative does not include treatment.

#### 6.2.4.3 Offshore Sediments

This alternative does not include treatment, nor does it reduce the toxicity, mobility, or volume of Site COC.

### 6.2.5 Short-Term Effectiveness

Short-term effectiveness is based on the potential impacts to the community, workers, and environment during implementation of the alternative. In addition, the length of time for the alternative to achieve protectiveness is considered.

#### 6.2.5.1 Upland Soil and Groundwater

With regard to potential impacts, the No Action alternative is highly effective in the short term as no remedial actions would occur. However, with no action, the time for the alternative to achieve protectiveness would be lengthy.

#### 6.2.5.2 Nearshore Sediments

With regard to potential impacts, the No Action alternative is highly effective in the short term as no remedial actions would occur. However, with no action, the time for the alternative to achieve protectiveness would be lengthy.

#### 6.2.5.3 Offshore Sediments

With regard to potential impacts, the No Action alternative is highly effective in the short term as no remedial actions would occur. However, with no action, the time for the alternative to achieve protectiveness would be lengthy.

### 6.2.6 Implementability

Implementability includes the technical feasibility of construction of the alternative, administrative feasibility of implementing the alternative, the availability of the services and materials required to implement the alternative, and the ability of monitoring to ensure effectiveness of the remedy.

#### 6.2.6.1 Uplands Soil and Groundwater

The No Action alternative is easily implemented, but there is no monitoring to evaluate changes in risks to human or ecological receptors.

#### 6.2.6.2 Nearshore Sediments

The No Action alterative is easily implemented, both technically and administratively, but does not provide additional protection for receptors, nor does it monitor for any changes in risks to receptors.

#### 6.2.6.3 Offshore Sediments

This alternative can easily be implemented at the Site, but does not provide additional protection for receptors, nor does it monitor for any changes in risks to receptors.

### 6.2.7 Cost

There are no costs associated with the No Acton Alternative.

# 6.3 Alternative 2

Refer to Section 5.3.2 for the description of Alternative 2.

## 6.3.1 Protection of Human Health and the Environment

RAOs were developed to address the COCs and pathways that were noted as providing unacceptable risk based on information from the RI/BLRA. Overall protection of human health and the environment is achieved by satisfying the RAOs.

### 6.3.1.1 Upland Soil and Groundwater

Shoreline removal provides a buffer in the shallow unit that should allow natural attenuation to reduce COCs to protective levels prior to contacting surface sediment. Removing and replacing shoreline soil removes source material to allow natural attenuation to proceed from a more distal source, farther from the receptor such that natural attenuation produces protective concentrations at the receptor. Monitoring is used to determine if natural attenuation is adequately reducing concentrations of COC in both the shallow silt and interbedded units. Analysis of data collected in the RI/BLRA (see Section 2) indicated that this may be the case. However, uncertainties currently exist around the rate of site-specific biodegradation and this needs to be confirmed in order to demonstrate protection. Institutional controls would be implemented to prevent potable groundwater use. Contingent actions would be implemented if natural attenuation was not effective in reducing COC concentrations as necessary to protect sediment. Uncertainties exist around the volume of remaining mobile DNAPL at the Site. This alternative is protective if the volume remaining is limited and removal of thin shallow sand layers containing DNAPL prevents remaining migration to the river. However, the long term protection is uncertain.

Shoreline removal activities may result in a failure to satisfy RAO 4 but these effects would be mitigated to the extent possible by physically isolating the removal area from the rest of the river.

### 6.3.1.2 Nearshore Sediments

Removal of nearshore sediments that is a component of the combined soil/sediment removal action described in Section 5.3.2.1 will reduce the potential for sheens adjacent to the river bank. An additional component of the remedy for nearshore sediments is enhanced natural recovery as described in Section 5.3.2.2. Since the timeframe to establish protective conditions though natural recovery is on the order of years, a thin layer of clean material would be placed over the area of nearshore sediments to prevent receptor contact in the short term and allow a timeframe necessary for enhanced natural recovery to progress. Following placement of the clean material, an assessment would be completed to address uncertainties associated with natural nearshore recovery and associated protectiveness. This assessment

would evaluate the potential for erosion in the nearshore area and the associated risk. Where erosion may occur and cause risk, the area would be covered with an erosion-resistant material. Data collection and evaluation are required to determine the long-term protectiveness of this alternative. If the evaluation determines that natural recovery would not be effective, contingent actions (capping) would be implemented.

#### 6.3.1.3 Offshore Sediments

This alternative provides for assessment to ensure continued protection of human health and the environment and satisfaction of RAO 1 and RAO 4. This assessment would provide additional empirical information of the actual scour and potential risk to receptors. Should the monitoring determine that the situation is not protective of receptors, contingent actions (capping) to protect human health and the environment would be implemented.

### 6.3.2 Compliance with ARARs

Generally, all chemical-, location-, and action-specific ARARs can be met during construction and in the long-term through proper design of remedial actions and permitting as indicated in Table 6-1. The ARAR that would not be met by this remedy is the ARAR of returning groundwater to COC concentrations below MCLs. It is unlikely to be technically practicable to return groundwater to drinking water standards without complete removal of impacted soils and groundwater from the Site. The use of an alternate regulatory mechanism (TI waiver) may be required to ensure compliance with this requirement.

### 6.3.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence is evaluated based on residual risk that may exist after implementation of remedial actions and the adequacy and reliability of controls that ensure continued protectiveness.

#### 6.3.3.1 Upland Soil and Groundwater

Removal of the shoreline soils is an effective remedy to prevent sheens and provide a buffer zone for natural attenuation to occur in the shallow groundwater. While uncertainties exist, RI/BLRA data indicate that, natural biodegradation of COC in groundwater is likely ongoing at the Site. Monitoring is required to ensure that the shoreline removal along with natural attenuation of groundwater would be protective of aquatic and benthic receptors, and contingencies would need to be implemented if existing degradation was not sufficient. The certainty that this remedy will be protective in the long-term is low since DNAPL was to be considered mobile and able to migrate into the shoreline removal area. In addition, the current evaluation of natural attenuation is based on limited Site data and literature values. The effectiveness cannot be confirmed through monitoring until the remedy is implemented. Contingent actions, such as enhanced bioremediation would be implemented if this alternative was not effective in the long-term.

With regard to potable groundwater use, institutional controls (City ordinance and zoning) currently exist, which prohibit this use and require connection to City water. Zoning for the site is industrial use only. The Site will remain on the floodplain so future use is unlikely. While the permanence of a City enforced institutional control has some uncertainty, the five-year review that will be included as part of the remedy will ensure that the City controls remain in place.

#### 6.3.3.2 Nearshore Sediments

By immediately providing protection for aquatic and benthic receptors through placement of a layer of sand over the nearshore sediments and determining the degree of natural recovery occurring at the Site and providing the necessary enhancements to make the Site protective, this alternative can be effective in the long-term. Since the alternative is based on naturally occurring processes and does not require any active remedial measures after construction, it is likely to be permanent, if effective. Long-term monitoring to ensure continued protection would be required. Due to the current risk posed by surface sediment, and the uncertainty regarding the rate of natural recovery and the relationship between flood scour and depositional periods, this alternative rates low for long-term effectiveness.

#### 6.3.3.3 Offshore Sediments

Currently, surface sediments in the offshore are protective of receptors as sediments in the offshore do not exceed PRGs for RAO 1. The long-term effectiveness and permanence of this situation will be evaluated through detailed monitoring and assessment. If or where this assessment demonstrates risk, capping will be completed. While offshore capping is referred to as a contingent action, it is explicitly included in the alternative. During implementation of the remedy, risk would be addressed through natural recovery and placement of new erosion-resistant material as deemed appropriate due to an assessment indicating ability to erode and cause risk.

### 6.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

This section discusses how the alternative reduces the toxicity to receptors, mobility, or volume of COC at the Site.

#### 6.3.4.1 Upland Soil and Groundwater

Natural biodegradation of COC in groundwater provides biodegradation of COC dissolved in water, a form of treatment. This would reduce the volume of COC through metabolization of the COC into non-toxic components. It would also reduce risk to receptors in the St. Joe River by reducing the volume of contaminants approaching the River.

The soils removed from the shoreline are assumed to contain COC concentrations exceeding 10 times the Universal Treatment Standards. These soils cannot be land disposed in the United States and would either be incinerated, which would destroy the COC, or treated until COC concentrations were less than 10 times the Universal Treatment Standards. If these soils were treated, the treatment would be performed at a permitted off-site biological or thermal treatment facility. The COC treated at these off-site facilities would be destroyed or metabolized.

#### 6.3.4.2 Nearshore Sediments

The nearshore sediment removed from the area adjacent to the shoreline is assumed to contain COC concentrations exceeding 10 times the Universal Treatment Standards. These soils cannot be land disposed in the United States and would either be incinerated, which would destroy the COC, or treated until COC concentrations were less than 10 times the Universal Treatment Standards. If these soils were treated, the treatment would be performed at a permitted off-site biological or thermal treatment facility. The COC treated at these off-site facilities would be destroyed or metabolized.

Some degradation of COCs in nearshore sediments will occur naturally and long-term natural burial of these COCs may occur.

#### 6.3.4.3 Offshore Sediments

No active treatment is included in this alternative, though some degradation of COC will occur naturally.

### 6.3.5 Short-Term Effectiveness

Short-term effectiveness is based on the potential impacts to the community, workers, and environment during implementation of the alternative. In addition, the length of time for the alternative to achieve protectiveness is considered.

#### 6.3.5.1 Upland Soil and Groundwater

There would be some potential for additional risks to receptors in the St. Joe River due to the increased potential for releases of COC to the River during construction. The potential for releases to the St. Joe River during construction would be minimized to the extent possible by performing work during low water conditions and by using engineering controls such as a portable dam to isolate the removal area to the extent possible. Despite the use of such controls, not all risk of release of contaminated sediment or surface water impacted by the remedial activities can be eliminated. Potential health risks to workers would be minimized through the use of engineering controls and work practices to avoid contact with Site COC. Potential health risks to the community and terrestrial ecological receptors would be controlled through engineering controls such as fencing to restrict access and dust suppression to prevent off-site transport. Institutional controls and monitoring would not have

potential adverse effects, except for minor potential impacts to workers during construction. These potential risks could easily be controlled through engineering controls.

The on-site construction portion of this alternative could be completed in less than one year, but a longer period would be required to determine the effectiveness of monitored natural attenuation in maintaining long-term protection, and to implement a contingency if necessary.

#### 6.3.5.2 Nearshore Sediments

Some resuspension of sediments and potential impacts on water quality and benthic and aquatic habitat will occur during placement of enhanced recovery measures such as a thin layer cap. These would be mitigated to the extent possible through design of the natural recovery enhancements and their placement methods.

Placement of the initial layer of cover over surface sediments exceeding PRGs could be constructed fairly quickly, with an actual design and construction time of less than one year. Permitting (or the substantial equivalent thereof) would require a multi-stakeholder process that could require up to another year. The initial assessment could be completed within a year. Depending on the results of this assessment, an erosion resistant cover could be placed over the appropriate areas. The design, construction, and permitting (or substantive equivalent thereof) would require a similar timeframe to that of the initial cover over the nearshore sediments. Ongoing monitoring of the sediments would require longer timeframe to ensure protection in the long-term.

Assessment of the nearshore is unlikely to have significant short-term effect on human health or the environment. However, the initial placement of a cover over the nearshore sediments and any erosion resistant cover required, this construction would likely cause some suspension of sediment and potential impact to water quality and aquatic habitat due to this resuspension. Placement of the cap will also impact benthic habitat. These impacts would be mitigated to the extent possible through construction methods and controls.

#### 6.3.5.3 Offshore Sediments

Similar to the nearshore sediments, the initial assessment work (to be performed in conjunction with that for the nearshore sediments) would take less than a year and have little effect on human health or the environment. Permitting (or substantive equivalent thereof) and placement of any erosion resistant material necessary would take one or more years, and is likely to have some effect on the St. Joe River.

### 6.3.6 Implementability

Implementability includes the technical feasibility of construction of the alternative, administrative feasibility of implementing the alternative, the availability of the

services and materials required to implement the alternative, and the ability of monitoring to ensure effectiveness of the remedy.

#### 6.3.6.1 Upland Soil and Groundwater

This portion of the alternative is easily implemented. Administratively, this alternative may require satisfying the equivalent of the substantive requirements associated with Section 404 permitting and the ESA, such as performing in-water work during "fish windows."

#### 6.3.6.2 Nearshore Sediments

Removal of sediments adjacent to the shoreline can be implemented from the shoreline in conjunction with the shoreline removal. Again, the substantive requirements of a Section 404 permit may be required and would be met.

The initial placement of a layer of sand or clean sediment can be constructed at the Site. It may require mobilization of specific equipment such as barges, but these should be generally available within the Lake Coeur d'Alene basin. Some specialized construction knowledge and experience is also required to construct the enhancements; this experience is available within the western United States. Administratively, a multiple stakeholder process will be required to address the permitting requirements for placement of natural recovery enhancements.

Monitoring can adequately determine the effectiveness of the remedy. Should monitoring show that the natural recovery was not occurring at the designed rate, additional remedial actions may be necessary. These actions are likely to involve use of more intrusive engineered means to reduce risks to benthic and aquatic receptors, such as capping or removal.

#### 6.3.6.3 Offshore Sediments

This remedy could easily be implemented, requiring similar equipment to that used at the Site during the RI/BLRA investigation and no specific permitting requirements. Should placement of erosion protection be required, it would be necessary to complete the multi-stakeholder substantive permitting requirement process, as previously discussed.

### 6.3.7 Cost

Costs for each alternative have been estimated based on the evaluations and assumptions discussed in the FS. Some variation in the construction and cost of the alternative is likely to occur as the design process for the selected alternative proceeds. The estimated cost of this alternative is $4,180,000 if soil and sediment are incinerated and disposed off-site.

## 6.4 Alternative 3a

See Section 5.3.3 for the description of Alternative 3a.

### 6.4.1 Protection of Human Health and the Environment

RAOs were developed to address the COCs and pathways that were noted as providing unacceptable risk based on information from the RI/BLRA. Overall protection of human health and the environment is achieved by satisfying the RAOs.

#### 6.4.1.1 Upland Soil and Groundwater

Solidification of the shoreline and associated nearshore removal ensure that any DNAPL in the shallow zone is immobilized. DNAPL in sand stringers would remain at depth. Data suggests that there is limited mobility and these deeper thin sand layers may not reach the mudline. However, some uncertainty exists and monitoring and contingencies could be necessary if deeper DNAPL began to mobilize. Solidification of the shoreline is likely to cause groundwater to flow around and below the solidified area, which increases the flowpath of impacted groundwater from the shallow zone to sediment. Appropriate monitoring locations would be determined as part of remedial design. Modeling or additional monitoring of groundwater flow may be necessary to design the monitoring program. Initial monitoring would be required to determine the protectiveness based on a site-specific biodegradation rate. Continued monitoring would ensure that natural processes are adequately reducing concentrations of COC such that the groundwater is protective of the sediments in the St. Joe River. Institutional controls will prevent potable groundwater use. These remedial actions satisfy RAO 2, RAO 3, and RAO 5. Contingent actions would be implemented if natural attenuation was not successful in reducing COC concentrations in groundwater such that the groundwater would not exceed PRGs when it came into contact with sediment.

Shoreline solidification activities may result in releases to the river of cement slurry or COCs that would cause failure of RAO 4. These effects would be mitigated to the extent possible by physically isolating the solidification area from the river.

#### 6.4.1.2 Nearshore Sediments

Removal adjacent to the shoreline would protect benthic and aquatic receptors in this area by eliminating the potential for these receptors to contact impacted surface sediment in the nearshore area. This removal would eliminate the upper sediments in the area where sheens are generated.

Capping of the removal area and remainder of the nearshore area would also protect benthic and aquatic receptors by eliminating the potential for these receptors to contact the surface sediments. Capping requires the removal of some nearshore,

impacted sediment to facilitate capping. This sediment removal would help further prevent sheens from this area. In addition, a methane collection system located beneath the cap will prevent disturbance of the sediments by methane bubbles and production of sheens associated with these releases. These remedial actions would satisfy RAO 1, RAO 2, and RAO 4. Long-term monitoring of the cap would ensure continued effectiveness.

There would be some impacts on benthic and aquatic receptors in the short-term, as dredging and placement of the capping materials are likely to displace sediments and suspend them in the water column, which could then be transported in the St. Joe River. Selection of a qualified contractor will help minimize these releases although some releases are unavoidable.

#### 6.4.1.3 Offshore Sediments

This alternative provides for an assessment of scour and associated risk and subsequent monitoring, with implementation of erosion protection as necessary. This monitoring would provide additional empirical information of the actual scour and potential risk to receptors. Should the monitoring indicate that the situation is not protective of receptors, additional remedial actions to protect human health and the environment (capping) would be implemented. This program would ensure continued protection of human health and the environment and satisfaction of RAO 1 and RAO 4.

### 6.4.2 Compliance with ARARs

Generally, all chemical-, location-, and action-specific ARARs can be met during construction and in the long-term through proper design of remedial actions and permitting as indicated in Table 6-1. The ARAR that would not be met by this remedy is the ARAR of returning groundwater to COC concentrations below MCLs. It is unlikely to be technically practicable to return groundwater to drinking water standards without complete removal of impacted soils and groundwater from the Site. The use of an alternate regulatory mechanism (TI waiver) may be required to ensure compliance with this requirement.

### 6.4.3 Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence is evaluated based on residual risk that may exist after implementation of remedial actions and the adequacy and reliability of controls that ensure continued protectiveness.

#### 6.4.3.1 Upland Soil and Groundwater

Solidification and removal of some sediments and soils along the shoreline will prevent sheens from these soils/sediments. This removal and solidification will also prevent shallow DNAPL migration to the river, and will increase the shallow groundwater flowpath to surface sediment in the river, allowing additional time and

distance for natural processes to occur outside the area of heavy DNAPL impacts in soil. While uncertainties over the magnitude of biodegradation exist, sampling as part of the RI/BLRA indicate that natural biodegradation is likely occurring and may be effective in preventing groundwater from adversely impacting sediment. Monitoring would serve to determine the long-term effectiveness of this biodegradation. Due to uncertainties, contingent actions, such as enhanced bioremediation (see Alternative 3b), could be necessary if monitoring indicated that the remedy was not sufficiently protective.

With regard to potable groundwater use, institutional controls (City ordinance and zoning) currently exist, which prohibit this use and require connection to City water. Zoning for the site is industrial use only. The Site will remain on the floodplain so future use is unlikely. While the permanence of a City enforced institutional control has some uncertainty, the five-year review that will be included as part of the remedy will ensure that the City controls remain in place.

#### 6.4.3.2 Nearshore Sediments

Through placement of an engineered cap and associated dredging, this remedy would be effective in the long term. As the cap would be engineered to resist all anticipated disturbance events such as flooding and methane generation, it would be a permanent solution. Monitoring would be required to confirm long-term cap integrity.

#### 6.4.3.3 Offshore Sediments

Currently, surface sediments in the offshore are protective of receptors, as sediments in the offshore do not exceed PRGs for RAO 1. Currently, surface sediments in the offshore are protective of receptors, as sediments in the offshore do not exceed PRGs for RAO 1. The long-term effectiveness and permanence of this situation will be evaluated through detailed monitoring and assessment completed during the remedial design phase. This assessment would identify current and future risks from erosion. During implementation of the remedy, risk would be addressed through placement of new erosion-resistant material in those areas that the assessment indicates could erode and cause risk.

### 6.4.4 Reduction of Toxicity, Mobility, or Volume through Treatment

This section discusses how the alternative reduces the toxicity to receptors, mobility, or volume of COC at the Site.

#### 6.4.4.1 Upland Soil and Groundwater

Rates of natural biodegradation at the Site have not been quantified, but to the extent that biodegradation occurs, it is a form of treatment. This would reduce the volume of COC through metabolization of the COC into non-toxic components. There would

also be some reduction in risk to receptors in the St. Joe River by reducing the volume of contaminants approaching the River.

#### 6.4.4.2 Nearshore Sediments

Removal adjacent to the shoreline and additional removal to facilitate capping would reduce the volume of COCs in the nearshore sediment area. Capping would reduce potential toxicity to receptors through elimination of receptor contact with surface sediment containing unacceptable concentrations of COC. A cap would also reduce the potential mobility of nearshore surface sediments in disturbance events. The sediments removed from the shoreline to allow placement of a cap are assumed to contain COC concentrations exceeding 10 times the Universal Treatment Standards. These soils cannot be land disposed in the United States and would either be incinerated, which would destroy the COC, or treated until COC concentrations were less than 10 times the Universal Treatment Standards. If these soils were treated, the treatment would be performed at a permitted off-site biological or thermal treatment facility. The COC treated at these off-site facilities would be destroyed or metabolized.

#### 6.4.4.3 Offshore Sediments

No active treatment is included in this alternative, though some degradation and burial of COC may occur naturally.

### 6.4.5 Short-Term Effectiveness

Short-term effectiveness is based on the potential impacts to the community, workers, and the environment during implementation of the alternative. In addition, the length of time for the alternative to achieve protectiveness is considered.

#### 6.4.5.1 Upland Soil and Groundwater

There would be some potential for additional risks to receptors in the St. Joe River due to the increased potential for releases of COC to the River during construction. The potential for releases to the St. Joe River during construction would be minimized to the extent possible by performing work above the water line during low water conditions. Potential health risks to workers would be minimized through the use of engineering controls and work practices to avoid contact with Site COC. Potential health risks to the community and terrestrial ecological receptors would be controlled through engineering controls such as fencing to restrict access. Institutional controls and monitoring would not have potential adverse effects. Some potential effects to workers could be expected during construction, but these would easily be controlled through engineering controls. Provided natural biodegradation is sufficient, this alternative would achieve protectiveness in a short period of time.

#### 6.4.5.2 Nearshore Sediments

Some resuspension of sediments and potential impacts on water quality and aquatic and benthic habitat will occur during removal of the shoreline sediments and cap placement. These adverse impacts would be mitigated to the extent possible through design of the cap, timing of its placement and its placement methods.

Cap construction could be completed within one year, after permitting was complete.

#### 6.4.5.3 Offshore Sediments

This alternative would not cause adverse effects on the community or the environment. Risks to workers associated with assessment and monitoring activities could be mitigated through proper work practices. Should placement of erosion protection be required, the placement of this cover would cause resuspension of some sediment. These resuspended sediments could cause impacts to water quality and potentially risk to receptors in the St. Joe River. Cap placement may also disrupt benthic habitat that is not impacted by COC.

### 6.4.6 Implementability

Implementability includes the technical feasibility of construction of the alternative, administrative feasibility of implementing the alternative, the availability of the services and materials required to implement the alternative, and the ability of monitoring to ensure effectiveness of the remedy.

#### 6.4.6.1 Upland Soil and Groundwater

This remedy can be technically implemented at the Site, though mobilization of grouting equipment from a more distant area would be necessary, as pressure grouting is a specialized process.

#### 6.4.6.2 Nearshore Sediments

Removal of sediments adjacent to the shoreline is can be implemented from the shoreline in conjunction with the shoreline removal. Capping of the nearshore sediments can also be technically implemented, though detailed design and potentially design studies would be necessary to ensure construction quality, determine short-term effects on receptors during removal and cap placement, and to confirm the area to be capped. A multi-stakeholder process would be required to fulfill the substantive requirements of permitting for the removal and capping.

#### 6.4.6.3 Offshore Sediments

This remedy could easily be implemented, requiring similar equipment to that used at the Site during the RI/BLRA investigation and no specific permitting requirements.

Placement of erosion controls, if required, would necessitate a multi-stakeholder process similar to that required for placement of the nearshore cap.

### 6.4.7 Cost

Costs for each alternative have been estimated based on the evaluations and assumptions discussed in this FS. Some variation in the construction and cost of the alternative is likely to occur as the design process for the selected alternative proceeds. The cost of this alternative is approximately $5,100,000 if soil and sediment exceeding 10 times the UTS are incinerated and disposed off-site.

## 6.5 Alternative 3b

Refer to Section 5.3.4 for the description of Alternative 3b.

### 6.5.1 Protection of Human Health and the Environment

RAOs were developed to address the COCs and pathways that were noted as providing unacceptable risk based on information from the RI/BLRA. Overall protection of human health and the environment is achieved by satisfying the RAOs.

#### 6.5.1.1 Upland Soil and Groundwater

Solidification of the shoreline and associated nearshore removal ensure that any DNAPL in the shallow zone is immobilized. DNAPL in thin sand layers would remain at depth. Data suggest that there is limited mobility and these deeper thin sand layers may not reach the mudline. However, some uncertainty exists and monitoring and contingencies could be necessary if deeper DNAPL were to mobilize. Solidification of the shoreline also provides a physical barrier to any future DNAPL or groundwater migration through this area. This solidification also increases the flowpath of impacted groundwater from the shallow silt unit to sediment, which allows additional time and distance for natural processes to occur in an area not heavily impacted by DNAPL in soil. By enhancing biodegradation of COC in groundwater (i.e., producing aerobic conditions) in the shallow silt and underlying interbedded units, groundwater quality would improve prior to discharging to the St. Joe River, thus providing additional certainty of protecting aquatic and benthic receptors relative to Alternative 3a. These remedial actions satisfy RAO 2, RAO 3, and RAO 5. Monitoring would be required to initially determine the protectiveness, based on site-specific biodegradation. Monitoring would also be required in the long-term to confirm the long-term protectiveness.

Some minor short-term impacts on the environment may occur during solidification of shoreline soils, but these effects would be mitigated to the extent possible by physically isolating the solidification area from the rest of the river. Institutional

controls ensure protection of residential or commercial humans who may ingest or come into dermal contact with Site groundwater.

Institutional controls will prevent potable groundwater use.

#### 6.5.1.2 Nearshore Sediments

See Alternative 3a.

#### 6.5.1.3 Offshore Sediments

See Alternative 3a.

### 6.5.2 Compliance with ARARs

Generally, all chemical-, location-, and action-specific ARARs can be met during construction and in the long-term through proper design of remedial actions and permitting as indicated in Table 6-1. The ARAR that would not be met by this remedy is the ARAR of returning groundwater to COC concentrations below MCLs. It is unlikely to be technically practicable to return groundwater to drinking water standards without complete removal of impacted soils and groundwater from the Site. The use of an alternate regulatory mechanism (TI waiver) may be required to ensure compliance with this requirement.

### 6.5.3 Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence is evaluated based on residual risk that may exist after implementation of remedial actions and the adequacy and reliability of controls that ensure continued protectiveness.

#### 6.5.3.1 Upland Soil and Groundwater

Solidification along the shoreline will prevent sheens from this area and will prevent shallow DNAPL migration to the river. The solidification will also increase the shallow groundwater flow path to surface sediment in the river, allowing additional time and distance for biodegradation of COC. Enhanced biodegradation will add certainty that biodegradation will result in protective concentrations. Implementation of long-term monitoring would also be required to determine the long-term effectiveness of this site-specific biodegradation.

With regard to potable groundwater use, institutional controls (City ordinance and zoning) currently exist, which prohibit this use and require connection to City water. Zoning for the site is industrial use only. The Site will remain on the floodplain so future use is unlikely. While the permanence of a City enforced institutional control has some uncertainty, the five-year review that will be included, as part of the remedy will ensure that the City controls remain in place.

#### 6.5.3.2 Nearshore Sediments

See Alternative 3a.

#### 6.5.3.3 Offshore Sediments

See Alternative 3a.

### 6.5.4 Reduction of Toxicity, Mobility, or Volume through Treatment

This section discusses how the alternative reduces the toxicity to receptors, mobility, or volume of COC at the Site.

#### 6.5.4.1 Upland Soil and Groundwater

As the spoils from pressure grouting of the 1999 removal area and underlying soils are expected to be below 10 times the Universal Treatment Standards, they would likely be disposed in a landfill. No treatment of these soils is planned.

Enhanced bioremediation would promote biodegradation of Site COC by altering groundwater conditions from an anaerobic to aerobic system. This treatment would reduce the volume of COC and would reduce the potential toxicity to benthic and aquatic receptors by reducing the volume of COC to which these receptors could be exposed.

#### 6.5.4.2 Nearshore Sediments

See Alternative 3a.

#### 6.5.4.3 Offshore Sediments

See Alternative 3a.

### 6.5.5 Short-Term Effectiveness

Short-term effectiveness is based on the potential impacts to the community, workers, and environment during implementation of the alternative. In addition, the length of time for the alternative to achieve protectiveness is considered.

#### 6.5.5.1 Upland Soil and Groundwater

There would be some potential for additional risks to receptors in the St. Joe River due to the increased potential for releases of COC to the River during construction. The potential for releases to the St. Joe River during construction would be minimized to the extent possible by performing work above the water line during low water conditions. Potential health risks to workers would be minimized through the

use of engineering controls and work practices to avoid contact with Site COC. Potential health risks to the community and terrestrial ecological receptors would be controlled through engineering controls such as fencing to restrict access. Enhanced biodegradation adds some short-term impacts relative to groundwater monitoring. Some potential effects to workers could be expected during construction, but these would easily be controlled through engineering controls. Provided enhanced biodegradation is sufficient to decrease COC concentrations, this alternative would achieve protectiveness in a short period of time.

#### 6.5.5.2 Nearshore Sediments

See Alternative 3a.

#### 6.5.5.3 Offshore Sediments

See Alternative 3a.

### 6.5.6 Implementability

Implementability includes the technical feasibility of construction of the alternative, administrative feasibility of implementing the alternative, the availability of the services and materials required to implement the alternative, and the ability of monitoring to ensure effectiveness of the remedy.

#### 6.5.6.1 Upland Soil and Groundwater

This remedy can be technically implemented at the Site, though mobilization of grouting equipment from a multi-state area would be necessary as pressure grouting is a specialized process. The enhanced biodegradation system uses standard construction methods, but would require specialty contractors from within a multi-state area. Addition of the system makes this a slightly more difficult remedy to implement than one that could be implemented with locally available equipment. The remedy is administratively implementable.

#### 6.5.6.2 Nearshore Sediments

See Alternative 3a.

#### 6.5.6.3 Offshore Sediments

See Alternative 3a.

### 6.5.7 Cost

Costs for each alternative have been estimated based on the evaluations and assumptions discussed in this FS. Some variation from the exact construction and cost of the alternative is likely to occur, as the design process for the selected

alternative proceeds. The cost of this alternative is approximately $6,750,000 if those soils and sediments exceeding 10 times the UTS are incinerated and disposed off-site and those soils and sediments with COC concentrations below 10 times the UTS are disposed in a RCRA Subtitle C landfill.

# 6.6 Alternative 3c

Refer to Section 5.3.5 for the description of Alternative 3c.

## 6.6.1 Protection of Human Health and the Environment

RAOs were developed to address the COCs and pathways that were noted as providing unacceptable risk based on information from the RI/BLRA. Overall protection of human health and the environment is achieved by satisfying the RAOs.

### 6.6.1.1 Upland Soil and Groundwater

Solidification in the nearshore area ensures that any DNAPL in the shallow zone is immobilized. The containment wall extends through the shallow silt, interbedded, and deep sand units (to an estimated depth of 60 feet) and prevents DNAPL migration to the river. Some thin sand layers containing DNAPL would exist in front of the wall; however, the driving force for migration in these thin sand layers would be essentially eliminated. The wall prevents flow of impacted groundwater to sediment and limits upflow of any groundwater through impacted soil beneath the river, more effectively containing these impacts. By preventing migration of impacted groundwater to the St. Joe River, aquatic and benthic receptors would be protected. These remedial actions satisfy RAO 2, RAO 3, and RAO 5. Monitoring would ensure the continued protectiveness of the remedy. Institutional controls will ensure protection of residential or commercial humans who may ingest or come into dermal contact with Site groundwater. Contingencies are not expected to be necessary with this remedial component as uncertainties associated with the effectiveness of biodegradation noted in Alternatives 3a and 3b are not an issue and the wall prevents DNAPL migration.

Some minor short-term impacts on the environment may occur during solidification of shoreline soils, but these effects would be mitigated to the extent possible by physically isolating the solidification area from the rest of the river. Institutional controls ensure protection of residential or commercial humans who may ingest or come into dermal contact with Site groundwater.

### 6.6.1.2 Nearshore Sediments

See Alternative 3a.

#### 6.6.1.3 Offshore Sediments

See Alternative 3a.

### 6.6.2 Compliance with ARARs

Generally, all chemical-, location-, and action-specific ARARs can be met during construction and in the long-term through proper design of remedial actions and permitting as indicated in Table 6-1. The ARAR that would not be met by this remedy is the ARAR of returning groundwater to COC concentrations below MCLs. It is unlikely to be technically practicable to return groundwater to drinking water standards without complete removal of impacted soils and groundwater from the Site. The use of an alternate regulatory mechanism (TI waiver) may be required to ensure compliance with this requirement.

### 6.6.3 Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence is evaluated based on residual risk that may exist after implementation of remedial actions and the adequacy and reliability of controls that ensure continued protectiveness.

#### 6.6.3.1 Upland Soil and Groundwater

The containment wall would provide a physical barrier for groundwater and DNAPL migration towards the St. Joe River. This provides additional certainty that the remedy would prevent sheens and groundwater discharges from impacting shoreline sediments in the long-term. The containment wall would be more reliable than natural attenuation and enhanced biodegradation, which rely on site-specific degradation rates, as discussed in alternatives 3a and 3b.

With regard to potable groundwater use, institutional controls (City ordinance and zoning) currently exist, which prohibit this use and require connection to City water. Zoning for the site is industrial use only. The Site will remain on the floodplain so future use is unlikely. While the permanence of a City enforced institutional control has some uncertainty, the five-year review that will be included as part of the remedy will ensure that the City controls remain in place.

#### 6.6.3.2 Nearshore Sediments

See Alternative 3a.

#### 6.6.3.3 Offshore Sediments

See Alternative 3a.

## 6.6.4 Reduction of Toxicity, Mobility, or Volume through Treatment

This section discusses how the alternative reduces the toxicity to receptors, mobility, or volume of COC at the Site.

### 6.6.4.1 Upland Soil and Groundwater

As the spoils from pressure grouting of the 1999 removal area and underlying soils, and some of the spoils from barrier wall installation are expected to be below 10 times the Universal Treatment Standards, they would likely be disposed in a landfill. No treatment of these soils is planned. Some spoils from wall installation may contain COC concentrations exceeding 10 times the Universal Treatment Standards. These soils cannot be land disposed in the United States and would either be incinerated, which would destroy the COC, or treated until COC concentrations were less than 10 times the Universal Treatment Standards. Potential treatment and disposal options are discussed in Appendix F.

The barrier wall would interrupt the pathway for DNAPL migration and COC in groundwater and soils to migrate to the St. Joe River in concentrations that could adversely affect benthic and aquatic receptors in sediment. The barrier wall will therefore, reduce the potential toxicity to benthic and aquatic receptors by reducing the volumes of COC to which these receptors could be exposed. However, the barrier wall uses containment rather than treatment and, therefore, reduces volume less than natural attenuation and enhanced bioremediation as used in alternatives 3a and 3b. As the spoils from pressure grouting of the 1999 removal area and underlying soils are expected to be below 10 times the Universal Treatment Standards, they would likely be disposed in a landfill. No treatment of these soils is planned.

### 6.6.4.2 Nearshore Sediments

See Alternative 3a.

### 6.6.4.3 Offshore Sediments

See Alternative 3a.

## 6.6.5 Short-Term Effectiveness

Short-term effectiveness is based on the potential impacts to the community, workers, and environment during implementation of the alternative. In addition, the length of time for the alternative to achieve protectiveness is considered.

### 6.6.5.1 Upland Soil and Groundwater

There would be some potential for additional risks to receptors in the St. Joe River due to the increased potential for releases of COC to the River during construction

along the shoreline. The potential for releases to the St. Joe River during construction would be minimized to the extent possible by performing work above the water line during low water conditions. Potential health risks to workers would be minimized through the use of engineering controls and work practices to avoid contact with Site COC. Potential health risks to the community and terrestrial ecological receptors would be controlled through engineering controls such as fencing to restrict access. Construction of a barrier wall increases the potential short-term impacts relative to natural attenuation and enhanced bioremediation. Some potential effects to workers could be expected during construction, but these would easily be controlled through engineering controls. The time to achieve protectiveness is similar to Alternative 3b as the action immediately limits the amount of COC moving from the uplands to the river.

#### 6.6.5.2 Nearshore Sediments

See Alternative 3a.

#### 6.6.5.3 Offshore Sediments

See Alternative 3a.

### 6.6.6 Implementability

Implementability includes the technical feasibility of construction of the alternative, administrative feasibility of implementing the alternative, the availability of the services and materials required to implement the alternative, and the ability of monitoring to ensure effectiveness of the remedy.

#### 6.6.6.1 Upland Soil and Groundwater

This remedy can be technically implemented at the Site, though mobilization of the construction equipment and contractors for pressure grouting and the containment wall may involve a multi-state area. The remedy can be administratively implemented.

#### 6.6.6.2 Nearshore Sediments

See Alternative 3a.

#### 6.6.6.3 Offshore Sediments

See Alternative 3a.

### 6.6.7 Cost

Costs for each alternative have been estimated based on the evaluations and assumptions discussed in this FS. Some variation on the construction and cost of the

alternative is likely to occur as the design process for the selected alternative proceeds. The cost of this alternative is approximately $7,020,000 if soil and sediment are disposed off-site.

# 6.7 Alternative 4a

Refer to Section 5.3.6 for the description of Alternative 4a.

## 6.7.1 Protection of Human Health and the Environment

RAOs were developed to address the COCs and pathways that were noted as providing unacceptable risk based on information from the RI/BLRA. Overall protection of human health and the environment is achieved by satisfying the RAOs.

### 6.7.1.1 Upland Soil and Groundwater

Solidification in the nearshore area and associated nearshore removal ensure that any DNAPL in the shallow zone is immobilized and prevents migration of DNAPL or groundwater through this area. DNAPL in thin sand layers would remain at depth. Data suggests that there is limited mobility and these deeper thin sand layers may not reach the mudline. However, some uncertainty exists and monitoring and contingencies could be necessary if deeper DNAPL began to mobilize. Solidification of the shoreline also increases the flowpath of impacted groundwater from the shallow silt unit to sediment, allowing additional distance and time for biodegradation of COC in groundwater. Monitoring would be required to determine if natural processes are adequately reducing concentrations of COC such that the groundwater is protective of the sediments in the St. Joe River, as indicated by analysis of data collected in the RI/BLRA (see Section 2). Long-term monitoring of groundwater would be required to confirm continued protection. Institutional controls will prevent potable groundwater use. These remedial actions satisfy RAO 2, RAO 3, and RAO 5. Contingent actions would be implemented if natural attenuation was not successful.

Some minor short-term impacts on the environment may occur during solidification of shoreline soils, but these effects would be mitigated to the extent possible by physically isolating the solidification area from the rest of the river. Institutional controls ensure protection of residential or commercial humans who may ingest or come into dermal contact with Site groundwater.

### 6.7.1.2 Nearshore Sediments

Removal of the surface sediments that may be causing risk to the benthic and aquatic receptors would prevent long-term risk to these receptors and would be protective in the long-term. Erosion-resistant backfill would be placed to address remaining deeper sediment impacts. These remedial actions satisfy RAO 1, RAO 2, and RAO 4. The short-term protection of receptors during construction would be impacted, as

there is likely to be some resuspension of sediments and effects on water quality during removal. Selection of a qualified contractor will help minimize these releases although some releases are unavoidable. The appropriateness of vegetating the cap will be assessed during remedial design.

#### 6.7.1.3 Offshore Sediments

This alternative provides for assessment of scour and associated risk and subsequent monitoring with implementation of erosion protection as necessary. This monitoring would provide additional empirical information of the actual scour and potential risk to receptors. Should the monitoring determine that the situation is not, or would become not protective of receptors, additional remedial actions to protect human health and the environment would be necessary (capping). This program would ensure continued protection of human health and the environment and satisfaction of RAO 1 and RAO 4.

### 6.7.2 Compliance with ARARs

Generally, all chemical-, location-, and action-specific ARARs can be met during construction and in the long-term through proper design of remedial actions and permitting as indicated in Table 6-1. The ARAR that would not be met by this remedy is the ARAR of returning groundwater to COC concentrations below MCLs. It is unlikely to be technically practicable to return groundwater to drinking water standards without complete removal of impacted soils and groundwater from the Site. The use of an alternate regulatory mechanism (TI waiver) may be required to ensure compliance with this requirement.

### 6.7.3 Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence is evaluated based on residual risk that may exist after implementation of remedial actions and the adequacy and reliability of controls that ensure continued protectiveness.

#### 6.7.3.1 Upland Soil and Groundwater

Solidification and removal of some sediment along the shoreline will prevent sheens from this area, will prevent shallow DNAPL migration to the river, and will increase the shallow groundwater flow path to surface sediment in the river, allowing additional time and distance for natural processes to attenuate PAH concentrations outside the area of heavy DNAPL impacts. While uncertainties over the magnitude of biodegradation exist, sampling as part of the RI/BLRA indicate that natural biodegradation is occurring and may be effective in preventing groundwater from adversely impacting sediment. Initially, monitoring would determine if this protection was supported by empirical site data. Long-term groundwater monitoring would serve to determine ongoing effectiveness. Contingent actions, such as enhanced bioremediation (see Alternative 4b) or a containment wall (Alternative 4c)

would be implemented if monitoring indicated that the remedy was not sufficiently protective.

Institutional controls on groundwater use are effective at preventing human use of groundwater for drinking water or other uses that would result in direct contact. The institutional controls are permanently affixed to the deed for the property to inform any new owners of the prohibition on groundwater use. They are reliable in the long-term. In addition, the City's ordinances require connection to City water and industrial use of the property.

#### 6.7.3.2 Nearshore Sediments

Removal and capping of the surface sediments that may be posing risk to aquatic and benthic receptors would be effective in the long-term. This would also prevent sheens from sediments. Proper design of the backfill in the area of the removal would prevent mobilization of deeper sediments to the surface. As this backfill would be engineered to resist predictable erosional forces in the long-term, the solution would be permanent. Some monitoring to ensure long-term backfill integrity and institutional controls to prevent disturbance of deeper sediments may be necessary.

#### 6.7.3.3 Offshore Sediments

Currently, surface sediments in the offshore are protective of receptors as sediments in the offshore do not exceed PRGs for RAO 1. Currently, surface sediments in the offshore are protective of receptors, as sediments in the offshore do not exceed PRGs for RAO 1. The long-term effectiveness and permanence of this situation will be evaluated through detailed monitoring and assessment completed during the remedial design phase. This assessment would identify current or future risks from erosion. During implementation of the remedy, risk would be addressed through placement of new erosion-resistant material in those areas that the assessment indicates could erode and cause risk.

### 6.7.4 Reduction of Toxicity, Mobility, or Volume through Treatment

This section discusses how the alternative reduces the toxicity to receptors, mobility, or volume of COC at the Site.

#### 6.7.4.1 Upland Soil and Groundwater

Site-specific rates of natural biodegradation at the Site are not defined, but to the extent degradation occurs for any of the COC, it is a form of treatment. This would reduce the volume of COC through metabolization of the COC into non-toxic components. There would also be some reduction in risk to receptors in the St. Joe River by reducing the volume of contaminants approaching the River. Natural biodegradation of COC in groundwater provides biodegradation of COC dissolved in water, a form of treatment. This would reduce the volume of COC through

metabolization of the COC into non-toxic components. It would also reduce risk to receptors in the St. Joe River by reducing the volume of contaminants approaching the River.

#### 6.7.4.2 Nearshore Sediments

Dredging of the nearshore sediment area provides additional volume reduction of COC relative to Alternative 3. Some of the removed sediments would contain concentrations of COC exceeding 10 times the Universal Treatment Standards. These sediments would require ex-situ treatment through incineration or other treatments if they were removed from the Site.

#### 6.7.4.3 Offshore Sediments

No active treatment is included in this alternative, though some degradation of COC may occur naturally.

### 6.7.5 Short-Term Effectiveness

Short-term effectiveness is based on the potential impacts to the community, workers, and environment during implementation of the alternative. In addition, the length of time for the alternative to achieve protectiveness is considered.

#### 6.7.5.1 Upland Soil and Groundwater

There would be some potential for additional risks to receptors in the St. Joe River due to the increased potential for releases of COC to the River during construction. The potential for releases to the St. Joe River during construction would be minimized to the extent possible by performing work above the water line during low water conditions. Potential health risks to workers would be minimized through the use of engineering controls and work practices to avoid contact with Site COC. Potential health risks to the community and terrestrial ecological receptors would be controlled through engineering controls such as fencing to restrict access. Institutional controls and monitoring would not have potential adverse effects. Some potential effects to workers could be expected during construction, but these would easily be controlled through engineering controls. Provided natural biodegradation is sufficient, this alternative would achieve protectiveness in a relatively short period of time.

#### 6.7.5.2 Nearshore Sediments

Some resuspension of sediments and potential impacts on water quality and aquatic and benthic habitat would likely occur during sediment removal. This portion of the alternative would require approximately one year of permitting and another year to design and construct. These timeframes are provided to indicate how long the process may take and not each step of the process. For instance, the actual time to satisfy the substantive requirements of the permitting process after the preparation of

the appropriate materials may be less than a year. However, the complete time to prepare and submit these documents, have them reviewed by appropriate agencies to ensure substantive requirements are being met, and correct the document for any deficiencies could be on the order of a year.

#### 6.7.5.3 Offshore Sediments

This alternative would not cause adverse effects on the community or the environment. Risks to workers associated with assessment and monitoring activities could be mitigated through proper work practices. Should placement of erosion protection be required, the placement of this cover would cause resuspension of some sediment. These resuspended sediments could cause impacts to water quality and potentially risk to receptors in the St. Joe River. In the short term cap placement would also disrupt benthic habitat that is not impacted by COC.

### 6.7.6 Implementability

Implementability includes the technical feasibility of construction of the alternative, administrative feasibility of implementing the alternative, the availability of the services and materials required to implement the alternative, and the ability of monitoring to ensure effectiveness of the remedy.

#### 6.7.6.1 Upland Soil and Groundwater

This remedy can be technically implemented at the Site, though mobilization of grouting equipment from a more distant area would be necessary, as pressure grouting equipment is a specialized process.

#### 6.7.6.2 Nearshore Sediments

This alternative would generally be more difficult to construct due to the additional specialized equipment required, such as long-reach excavation equipment. In addition, the project would be more complex, requiring management of contaminated materials and additional design and likely engineering controls to minimize sediment resuspension and impacts on water quality. Due to the more invasive nature of removal actions, the process to meet the permitting requirements may be more difficult than that for capping and enhanced natural recovery. Monitoring of water quality, depth of sediment removal, and thickness of backfill placement during construction could adequately determine the success of the construction project in short-term and long-term effectiveness.

#### 6.7.6.3 Offshore Sediments

This remedy could easily be implemented, initially requiring similar equipment to that used at the Site during the RI/BLRA investigation and no specific permitting requirements. Placement of scour resistant material is fairly easily technically implemented, but would require a multi-stakeholder permitting process (or

substantive equivalent thereof), which could make the project administratively difficult to implement.

### 6.7.7 Cost

Costs for each alternative have been estimated based on the evaluations and assumptions discussed in this FS. Some variation in the construction and cost of the alternative is likely to occur, as the design process for the selected alternative proceeds. The cost of this alternative is approximately $8,730,000 if soil and sediment are disposed off-site.

## 6.8 Alternative 4b

Refer to Section 5.3.7 for the description of Alternative 4b.

### 6.8.1 Protection of Human Health and the Environment

RAOs were developed to address the COCs and pathways that were noted as providing unacceptable risk based on information from the RI/BLRA. Overall protection of human health and the environment is achieved by satisfying the RAOs.

#### 6.8.1.1 Upland Soil and Groundwater

Solidification of the shoreline and associated nearshore removal ensure that any DNAPL in the shallow zone is immobilized. DNAPL in thin sand layers would remain at depth. Data suggest that there is limited mobility and these deeper thin sand layers may not reach the mudline. However, some uncertainty exists and monitoring and contingencies could be necessary if deeper DNPAL began to mobilize. Solidification of the shoreline also provides a physical barrier to any future DNAPL or groundwater migration through this area. This solidification also increases the flowpath of impacted groundwater from the shallow silt unit to sediment, which allows additional time and distance for biodegradation to occur in an area not heavily impacted by DNAPL in soil. By enhancing biodegradation of COC in shallow and intermediate groundwater, groundwater quality would improve prior to discharging to the St. Joe River, thus providing additional certainty of protecting aquatic and benthic receptors relative to Alternative 4a. These remedial actions satisfy RAO 2, RAO 3, and RAO 5. Monitoring would confirm the performance of the action and the long-term protectiveness.

Some minor short-term impacts on the environment may occur during solidification of the shoreline soils, but these effects would be mitigated to the extent possible by physically isolating the solidification area from the rest of the river. Institutional controls ensure protection of residential or commercial humans who may ingest or come into dermal contact with Site groundwater.

Institutional controls will prevent potable groundwater use.

#### 6.8.1.2 Nearshore Sediments

See Alternative 4a.

#### 6.8.1.3 Offshore Sediments

See Alternative 4a.

### 6.8.2 Compliance with ARARs

Generally, all chemical-, location-, and action-specific ARARs can be met during construction and in the long-term through proper design of remedial actions and permitting as indicated in Table 6-1. The ARAR that would not be met by this remedy is the ARAR of returning groundwater to COC concentrations below MCLs. It is unlikely to be technically practicable to return groundwater to drinking water standards without complete removal of impacted soils and groundwater from the Site. The use of an alternate regulatory mechanism (TI waiver) may be required to ensure compliance with this requirement.

### 6.8.3 Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence is evaluated based on residual risk that may exist after implementation of remedial actions and the adequacy and reliability of controls that ensure continued protectiveness.

#### 6.8.3.1 Upland Soil and Groundwater

Solidification along the shoreline will prevent sheens from this area and will prevent shallow DNAPL migration to the river. The solidification will also increase the shallow groundwater flow path to surface sediment in the river, allowing additional time and distance for attenuation of COC. Enhanced biodegradation will add certainty that biodegradation will result in protective concentrations. Implementation of long-term monitoring would also be required to determine the long-term effectiveness of this site-specific biodegradation.

With regard to potable groundwater use, institutional controls (City ordinance and zoning) currently exist, which prohibit this use and require connection to City water. Zoning for the site is industrial use only. The Site will remain on the floodplain so future use is unlikely. While the permanence of a City enforced institutional control has some uncertainty, the five-year review that will be included as part of the remedy will ensure that the City controls remain in place.

#### 6.8.3.2 Nearshore Sediments

See Alternative 4a.

#### 6.8.3.3 Offshore Sediments

See Alternative 4a.

### 6.8.4 Reduction of Toxicity, Mobility, or Volume through Treatment

This section discusses how the alternative reduces the toxicity to receptors, mobility, or volume of COC at the Site.

#### 6.8.4.1 Upland Soil and Groundwater

As the spoils from pressure grouting of the 1999 removal area and underlying soils are expected to be below 10 times the Universal Treatment Standards, they would likely be disposed in a landfill. No treatment of these soils is planned.

Enhanced bioremediation would promote biodegradation of Site COC at a faster rate than natural biodegradation because it would oxygenate the groundwater. This treatment would stimulate aerobic metabolism, reduce the volume of COC, and would reduce the potential toxicity to benthic and aquatic receptors by reducing the volume of COC to which these receptors could be exposed.

#### 6.8.4.2 Nearshore Sediments

See Alternative 4a.

#### 6.8.4.3 Offshore Sediments

See Alternative 4a.

### 6.8.5 Short-Term Effectiveness

Short-term effectiveness is based on the potential impacts to the community, workers, and environment during implementation of the alternative. In addition, the length of time for the alternative to achieve protectiveness is considered.

#### 6.8.5.1 Upland Soil and Groundwater

There would be some potential for additional risks to receptors in the St. Joe River due to the increased potential for releases of COC to the River during construction. The potential for releases to the St. Joe River during construction would be minimized to the extent possible by performing work above the water line during low water conditions. Potential health risks to workers would be minimized through the use of engineering controls and work practices to avoid contact with Site COC. Potential health risks to the community and terrestrial ecological receptors would be controlled through engineering controls such as fencing to restrict access. Enhanced biodegradation adds some short-term impacts relative to groundwater monitoring.

Some potential effects to workers could be expected during construction, but these would easily be controlled through engineering controls. Long-term operation of the enhanced biodegradation system would be necessary.

Provided enhanced biodegradation is sufficient to decrease COC concentrations, this alternative would achieve protectiveness in a relatively short period of time.

#### 6.8.5.2 Nearshore Sediments

See Alternative 4a.

#### 6.8.5.3 Offshore Sediments

See Alternative 4a.

### 6.8.6 Implementability

Implementability includes the technical feasibility of construction of the alternative, administrative feasibility of implementing the alternative, the availability of the services and materials required to implement the alternative, and the ability of monitoring to ensure effectiveness of the remedy.

#### 6.8.6.1 Upland Soil and Groundwater

This remedy can be technically implemented at the Site, though mobilization of grouting equipment from a multi-state area would be necessary as pressure grouting is a specialized process. The enhanced biodegradation system uses standard construction methods, but would require specialty contractors from within a multi-state area. This makes this a more difficult remedy to implement than one that could be implemented with locally available equipment. The remedy is administratively implementable.

#### 6.8.6.2 Nearshore Sediments

See Alternative 4a.

#### 6.8.6.3 Offshore Sediments

See Alternative 4a.

### 6.8.7 Cost

Costs for each alternative have been estimated based on the evaluations and assumptions discussed in this FS. Some variation from the exact construction and cost of the alternative is likely to occur, as the design process for the selected alternative proceeds. The cost of this alternative is approximately $10,400,000 if soil and sediment are disposed off-site.

# 6.9 Alternative 4c

Refer to Section 5.3.8 for the description of Alternative 4c.

## 6.9.1 Protection of Human Health and the Environment

RAOs were developed to address the COCs and pathways that were noted as providing unacceptable risk based on information from the RI/BLRA. Overall protection of human health and the environment is achieved by satisfying the RAOs.

### 6.9.1.1 Upland Soil and Groundwater

Solidification in the nearshore area ensures that any DNAPL in the shallow zone is immobilized. The containment wall extends through the shallow silt, interbedded, and deep sand units (to an estimated depth of 60 feet) and prevents horizontal DNAPL migration to the river. Some thin sand layers containing DNAPL would exist in front of the wall; however, the driving force for migration in these thin sand layers would essentially be eliminated. The wall also prevents flow of impacted groundwater to sediment and limits upflow of any groundwater through impacted soil beneath the river, more effectively containing these impacts. By preventing migration of impacted groundwater to the St. Joe River, aquatic and benthic receptors would be protected. These remedial actions satisfy RAO 2, RAO 3, and RAO 5. Monitoring would ensure the continued protectiveness of the remedy. Institutional controls will ensure protection of residential or commercial humans who may ingest or come into dermal contact with Site groundwater. Contingencies are not expected to be necessary with this remedial component as uncertainties associated with the effectiveness of biodegradation noted in Alternatives 4a and 4b are not an issue and the wall prevents DNAPL migration.

Some minor short-term impacts on the environment may occur during solidification of shoreline soils, but these effects would be mitigated to the extent possible by physically isolating the solidification area from the rest of the river. Institutional controls ensure protection of residential or commercial humans who may ingest or come into dermal contact with Site groundwater.

### 6.9.1.2 Nearshore Sediments

See Alternative 4a.

### 6.9.1.3 Offshore Sediments

See Alternative 4a.

## 6.9.2 Compliance with ARARs

Generally, all chemical-, location-, and action-specific ARARs can be met during construction and in the long-term through proper design of remedial actions and permitting as indicated in Table 6-1. The ARAR that would not be met by this remedy is the ARAR of returning groundwater to COC concentrations below MCLs. It is unlikely to be technically practicable to return groundwater to drinking water standards without complete removal of impacted soils and groundwater from the Site. The use of an alternate regulatory mechanism (TI waiver) may be required to ensure compliance with this requirement.

## 6.9.3 Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence is evaluated based on residual risk that may exist after implementation of remedial actions and the adequacy and reliability of controls that ensure continued protectiveness.

### 6.9.3.1 Upland Soil and Groundwater

The containment wall would provide a physical barrier for groundwater and DNAPL migration towards the St. Joe River. This provides additional assurance that the remedy would prevent groundwater discharges from impacting sediments in the long-term. The containment wall would be more reliable than natural attenuation and enhanced biodegradation, which rely on site-specific degradation rates, as discussed in alternatives 4a and 4b.

With regard to potable groundwater use, institutional controls (City ordinance and zoning) currently exist, which prohibit this use and require connection to City water. Zoning for the site is industrial use only. The Site will remain on the floodplain so future use is unlikely. While the permanence of a City enforced institutional control has some uncertainty, the five-year review that will be included as part of the remedy will ensure that the City controls remain in place.

### 6.9.3.2 Nearshore Sediments

See Alternative 4a.

### 6.9.3.3 Offshore Sediments

See Alternative 4a.

## 6.9.4 Reduction of Toxicity, Mobility, or Volume through Treatment

This section discusses how the alternative reduces the toxicity to receptors, mobility, or volume of COC at the Site.

#### 6.9.4.1 Upland Soil and Groundwater

As the spoils from pressure grouting of the 1999 removal area and underlying soils, and some of the spoils from barrier wall installation are expected to be below 10 times the Universal Treatment Standards, they would likely be disposed in a landfill. No treatment of these soils is planned. Some spoils from wall installation may contain COC concentrations exceeding 10 times the Universal Treatment Standards. These soils cannot be land disposed in the United States and would either be incinerated, which would destroy the COC, or treated until COC concentrations were less than 10 times the Universal Treatment Standards. If these soils were treated, the treatment would be performed at a permitted off-site biological or thermal treatment facility. The COC treated at these off-site facilities would be destroyed or metabolized.

The barrier wall would interrupt the pathway for DNAPL migration and COC in groundwater and soils to migrate to the St. Joe River in concentrations that could adversely affect benthic and aquatic receptors in sediment. The barrier wall will therefore, reduce potential toxicity to benthic and aquatic receptors by reducing the volumes of COC to which these receptors could be exposed. However, the barrier wall uses containment rather than treatment and, therefore, reduces volume less than natural attenuation and enhanced bioremediation as used in alternatives 4a and 4b. As the spoils from pressure grouting of the 1999 removal area and underlying soils are expected to be below 10 times the Universal Treatment Standards, they would likely be disposed in a landfill. No treatment of these soils is planned.

#### 6.9.4.2 Nearshore Sediments

See Alternative 4a.

#### 6.9.4.3 Offshore Sediments

See Alternative 4a.

### 6.9.5 Short-Term Effectiveness

Short-term effectiveness is based on the potential impacts to the community, workers, and environment during implementation of the alternative. In addition, the length of time for the alternative to achieve protectiveness is considered.

#### 6.9.5.1 Upland Soil and Groundwater

There would be some potential for additional risks to receptors in the St. Joe River due to the increased potential for releases of COC to the River during construction. The potential for releases to the St. Joe River during construction would be minimized to the extent possible by performing work above the water line during low water conditions. Potential health risks to workers would be minimized through the use of engineering controls and work practices to avoid contact with Site COC.

Potential health risks to the community and terrestrial ecological receptors would be controlled through engineering controls such as fencing to restrict access. Construction of a barrier wall increases short-term impacts relative to natural attenuation and enhanced bioremediation. Some potential effects to workers could be expected during construction, but these would easily be controlled through engineering controls. Long-term monitoring would be necessary, but this remedy would be largely passive.

The time to achieve protectiveness is similar to Alternative 3B as the action immediately limits the amount of COC moving from the uplands to the river.

#### 6.9.5.2 Nearshore Sediments

See Alternative 4a.

#### 6.9.5.3 Offshore Sediments

See Alternative 4a.

### 6.9.6 Implementability

Implementability includes the technical feasibility of construction of the alternative, administrative feasibility of implementing the alternative, the availability of the services and materials required to implement the alternative, and the ability of monitoring to ensure effectiveness of the remedy.

#### 6.9.6.1 Upland Soil and Groundwater

This remedy can be technically implemented at the Site, though mobilization of the construction equipment and contractors for pressure grouting and the containment wall may involve a multi-state area. The remedy can be administratively implemented.

#### 6.9.6.2 Nearshore Sediments

See Alternative 4a.

#### 6.9.6.3 Offshore Sediments

See Alternative 4a.

### 6.9.7 Cost

Costs for each alternative have been estimated based on the evaluations and assumptions discussed in this FS. Some variation from the exact construction and cost of the alternative is likely to occur, as the design process for the selected

alternative proceeds. The cost of this alternative is approximately $10,680,000 if soil and sediment are disposed off-site.

# 6.10 Alternative 5

Refer to Section 5.3.9 for the description of Alternative 5.

## 6.10.1 Protection of Human Health and the Environment

RAOs were developed to address the COCs and pathways that were noted as providing unacceptable risk based on information from the RI/BLRA. Overall protection of human health and the environment is achieved by satisfying the RAOs.

### 6.10.1.1 Upland Soil and Groundwater

Removal of shoreline soil eliminates all COC in shallow soil near the river. Similar to Alternatives 3c and 4c, a containment wall prevents migration of DNAPL and groundwater to the St. Joe River to protect benthic and aquatic receptors from sediment reaccumulation of COC. Monitoring would ensure the continued protectiveness of the remedy. These remedial actions satisfy RAO 2, RAO 3, and RAO 5.

Some impacts on the environment may occur during the integrated removal, especially during the driving and removal of the sheetpiling adjacent to and in the St. Joe River. Institutional controls ensure protection of residential or commercial humans who may ingest or come into dermal contact with Site groundwater.

### 6.10.1.2 Nearshore Sediments

Removal of the sediments exceeding sediment PRGs would prevent long-term risk to these receptors and would be protective in the long-term. While it is expected that sediments exceeding PRGs would be removed, should it not be possible to remove them all, erosion-resistant backfill would be placed over the deep impacted sediment to ensure that RAO 1, RAO 2, and RAO 4 would be satisfied. Receptors would be impacted in the short term, as there is likely to be some resuspension of sediments and effects on water quality during sheetpile installation and removal. The sheetpiling minimizes water quality impacts during dredging activities.

### 6.10.1.3 Offshore Sediments

Placement of an engineered cap to prevent erosion over the area of sediments that could erode would prevent this erosion. The potential effects on risk to receptors cannot be evaluated because the presence and magnitude of this risk has not been determined. However, cap placement would be conservative in absence of risk

evaluation and would satisfy RAO 1 and RAO 4. Monitoring would be used to ensure long-term cap integrity.

## 6.10.2 Compliance with ARARs

Generally, all chemical-, location-, and action-specific ARARs can be met immediately during construction and in the long-term through proper design of remedial actions and permitting as indicated in Table 6-1. The ARAR that would not be met by this remedy is the ARAR of returning groundwater to COC concentrations below MCLs. It is unlikely to be technically practicable to return groundwater to drinking water standards without complete removal of impacted soils and groundwater from the Site. The use of an alternate regulatory mechanism (Alternate Concentration Limits) may be required to ensure compliance with this requirement.

## 6.10.3 Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence is evaluated based on residual risk that may exist after implementation of remedial actions and the adequacy and reliability of controls that ensure continued protectiveness.

### 6.10.3.1 Upland Soil and Groundwater

An integrated removal along the shoreline with a barrier wall would provide long-term effectiveness, as soils that could cause sheens would have been removed and any soils upgradient of these would be contained by the barrier wall. Monitoring to ensure long-term effectiveness of the barrier wall would be necessary. The barrier wall would be permanent, provided it was properly maintained and did not see excessive degradation over time. This degradation would be controlled to the extent possible through cathodic protection, if necessary.

The barrier wall would interrupt the pathway for DNAPL migration, COC in groundwater and soils to migrate to the St. Joe River in concentrations that could adversely affect benthic and aquatic receptors in sediment. The barrier wall will therefore reduce the potential toxicity to benthic and aquatic receptors by reducing the volumes of COC to which these receptors could be exposed. However, the barrier wall uses containment rather than treatment and therefore reduces volume less than natural attenuation and enhanced bioremediation as used in alternatives 3a and 3b.

With regard to potable groundwater use, institutional controls (City ordinance and zoning) currently exist, which prohibit this use and require connection to City water. Zoning for the site is industrial use only. The Site will remain on the floodplain so future use is unlikely. While the permanence of a City enforced institutional control has some uncertainty, the five-year review that will be included as part of the remedy will ensure that the City controls remain in place.

### 6.10.3.2 Nearshore Sediments

Removal of surface sediments that pose a risk to aquatic and benthic receptors would be effective in the long-term. Proper design of the backfill in the area of the removal would prevent mobilization of COC in deeper sediments to the surface. As this backfill would be engineered to resist predictable forces in the long-term, the alternative would be permanent. Some monitoring to ensure long-term backfill integrity and institutional controls to prevent disturbance of deeper sediments may be necessary.

### 6.10.3.3 Offshore Sediments

Capping would be effective in the long-term to minimize risk to benthic and aquatic receptors. Through proper design and construction of the cap, this alternative would be reliable in the long-term. Monitoring would be effective in confirming cap construction and long-term integrity.

## 6.10.4 Reduction of Toxicity, Mobility, or Volume through Treatment

This section discusses how the alternative reduces the toxicity to receptors, mobility, or volume of COC at the Site.

### 6.10.4.1 Upland Soil and Groundwater

Shoreline soil removed as part of an integrated removal would require treatment or incineration, as it is expected to exceed 10 times the UTS. This treatment or incineration would be effective in reducing the volume of COC. As compared to the preceding alternatives, additional soils may be removed at the shoreline, which would allow for off-site treatment of additional material. As with the soil-bentonite slurry wall and soil stabilization, a sheetpile barrier wall would reduce mobility and thus potential toxicity to receptors, but would not provide treatment.

The barrier wall would interrupt the pathway for DNAPL migration and COC in groundwater and soils to migrate to the St. Joe River in concentrations that could adversely affect benthic and aquatic receptors in sediment. The barrier wall will therefore, reduce the potential toxicity to benthic and aquatic receptors by reducing the volumes of COC to which these receptors could be exposed. However, the barrier wall uses containment rather than treatment and, therefore, reduces volume less than natural attenuation and enhanced bioremediation as used in alternatives 3a and 3b.

With regard to potable groundwater use, institutional controls (City ordinance and zoning) currently exist which prohibit this use and require connection to City water. Zoning for the site is for industrial use only. The Site will remain on the floodplain so future use is unlikely. While the permanence of a City enforced institutional control has some uncertainty, the five-year review that will included as part of the remedy will ensure that the City controls remain in place.

### 6.10.4.2 Nearshore Sediments

This alternative removes sediment to a greater depth than previous alternatives thus increasing the volume of COC removed. Some of the removed sediments would contain concentrations of COC exceeding 10 times the Universal Treatment Standards. These sediments would require ex situ incineration or treatment and disposal.

### 6.10.4.3 Offshore Sediments

No active treatment is included in this alternative. Capping the sediment will reduce the volume of sediments that may be eroded and be toxic to receptors.

## 6.10.5 Short-Term Effectiveness

Short-term effectiveness is based on the potential impacts to the community, workers, and environment during implementation of the alternative. In addition, the length of time for the alternative to achieve protectiveness is considered.

### 6.10.5.1 Upland Soil and Groundwater

Sheetpiling would have effects on the community due to the noise associated with pile driving operations. The actual removal of the soils would involve similar risks to the community, workers, and terrestrial receptors as other removals, all of which could be mitigated through the use of engineering controls.

The on-site construction portion of this alternative could be completed in less than one year. Long-term monitoring of this alternative would be required to demonstrate long-term effectiveness.

### 6.10.5.2 Nearshore Sediments

Some resuspension of sediments and potential impacts on water quality and aquatic and benthic habitat would likely occur during sediment removal. The use of sheetpiling minimizes the amount of resuspended sediment released to the river during removal. However, there is likely to be sediment resuspension and associated impacts to the river during sheetpile installation and removal.

### 6.10.5.3 Offshore Sediments

This alternative may cause some short-term effects on the environment through resuspension of sediments during cap placement. The placement of the cap also disrupts benthic habitat that is not impacted by COC. There is a possibility of longer-term effects due to long-term settlement of the cap, but these risks would be mitigated to the extent possible by the cap design. There is a slight possibility of short-term effects on workers during monitoring of cap construction and long-term stability, but these could be mitigated through proper work practices. It would take approximately

two to five years to implement this remedy. Of these, the first year or more would be spent in collecting design information to determine the area requiring capping, one year in design and permitting (or substantive equivalent thereof), and one year to construct.

## 6.10.6 Implementability

Implementability includes the technical feasibility of construction of the alternative, administrative feasibility of implementing the alternative, the availability of the services and materials required to implement the alternative, and the ability of monitoring to ensure effectiveness of the remedy.

### 6.10.6.1 Upland Soil and Groundwater

Considerably more design and construction planning effort will be required to implement this alternative than the preceding alternatives. In addition, a more involved process to meet the substantive requirements for work in the St. Joe River will be required due to the greater length of the project and the greater disturbance to the River through driving and removing sheetpiling. The equipment set for construction of this alternative is larger, likely requiring both barge-based and shore-based sheet piling equipment and specialized long-reach excavation equipment. All of the equipment is likely available within the western United States. The length of sheet piling required is somewhat specialized but is also likely to be available within the northwestern United States. Monitoring using groundwater wells and visual inspections of the St. Joe River can determine the effectiveness of the alternative.

### 6.10.6.2 Nearshore Sediments

These alternatives would generally be more difficult to construct due to the additional specialized equipment required, such as long-reach excavation equipment and sheetpiling equipment. In addition, the project would be more complex, requiring management of contaminated materials and additional design and likely engineering controls to minimize sediment resuspension and impacts on water quality. Due to the more invasive nature of removal actions, the process to meet the permitting requirements may be more difficult than that for capping and enhanced natural recovery. Monitoring of water quality, depth of sediment removal, and thickness of backfill placement during construction could adequately ensure the success of the construction project.

### 6.10.6.3 Offshore Sediments

This remedy could be implemented at the Site fairly easily from a technical standpoint. Equipment and materials are likely to be available on Lake Coeur d'Alene. Experience with placement of caps is available in the northwestern United States. This alternative is more administratively difficult to implement than Alternatives 1 through 4, as it requires significant permitting requirements and a multiple stakeholder process. The permitting process would likely include the

substantial equivalent of the requirements for a Clean Water Act Section 404 permit and working within the work window determined by bull trout migration timing.

### 6.10.7 Cost

Costs for each alternative have been estimated based on the evaluations and assumptions discussed in the FS. Some variation in the construction and cost of the alternative is likely to occur as the design process for the selected alternative proceeds. The cost for this alternative is approximately $28,290,000 if soil and sediment are incinerated or disposed off-site, as appropriate.

## 6.11 Alternative 6

Refer to Section 5.3.10 for the description of Alternative 6.

### 6.11.1 Protection of Human Health and the Environment

RAOs were developed to address the COCs and pathways that were noted as providing unacceptable risk based on information from the RI/BLRA. Overall protection of human health and the environment is achieved by satisfying the RAOs.

#### 6.11.1.1 Uplands Soil and Groundwater

Removal of shoreline soil eliminates all COC in shallow soil near the river. Stabilizing soils would prevent migration of DNAPL and leaching of COC to groundwater in concentrations that could cause risk to aquatic or benthic receptors. The COC would be physically contained by the stabilized soil mixture. These actions satisfy RAO 2, RAO 3, and RAO 5. Monitoring would ensure the continued protectiveness of the remedy including the impact of the stabilized soil mass on groundwater pH.

Some minor short-term impacts on the environment may occur during removal of the shoreline soils, but these effects would be mitigated to the extent possible by working above the water line. Institutional controls ensure protection of residential or commercial humans who may ingest or come into dermal contact with Site groundwater.

#### 6.11.1.2 Nearshore and Offshore Sediments

Removal of sediments with COC concentrations exceeding protective levels would protect benthic and aquatic receptors by eliminating the potential for these receptors to contact these sediments in the long-term, thus satisfying RAO 1, RAO 2, and RAO 4. Residual impacts would remain in deep sediment, with erosion-resistant backfill providing containment. There would be some impacts on benthic and aquatic receptors in the short-term, as the removal of the sediments is likely to displace some

of the underlying sediments and suspend them in the water column, which could then be transported in the St. Joe River.

## 6.11.2 Compliance with ARARs

Generally, all chemical-, location-, and action-specific ARARs can be met during construction and in the long-term through proper design of remedial actions and permitting as indicated in Table 6-1. The ARAR that would not be met by this remedy is the ARAR of returning groundwater to COC concentrations below MCLs. It is unlikely to be technically practicable to return groundwater to drinking water standards without complete removal of impacted soils and groundwater from the Site. The use of an alternate regulatory mechanism (Alternate Concentration Limits) may be required to ensure compliance with this requirement.

## 6.11.3 Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence is evaluated based on residual risk that may exist after implementation of remedial actions and the adequacy and reliability of controls that ensure continued protectiveness.

### 6.11.3.1 Uplands Soil and Groundwater

Removal of the shoreline soils is an effective remedy to prevent sheens to the upland soils and groundwater. Similar to the containment wall, stabilization of the soils would prevent migration of DNAPL or groundwater to the shoreline or sediments, further ensuring long-term effectiveness at the shoreline. This is also a passive remedy requiring only monitoring in the long-term. The soil stabilization provides additional permanence over a containment wall, as it stabilizes all impacted soil rather than just placing a barrier between the impacted soil and the river.

With regard to potable groundwater use, institutional controls (City ordinance and zoning) currently exist that prohibit this use and require connection to City water. Zoning for the site is industrial use only. The Site will remain in the floodplain so future use is unlikely. While the permanence of a City-enforced institutional control has some uncertainty, the five-year review that will be included as part of the remedy will ensure that the City controls remain in place.

### 6.11.3.2 Nearshore and Offshore Sediments

Removal of the nearshore and offshore sediments exceeding PRGs would be effective and permanent in the long-term in the St. Joe River. The boundaries of the cleanup area required to achieve this protection may be refined during the design stage using bioassay testing. Additional study may be used to define the area of erosion and potential risk associated with the erosion, as some offshore sediments contain COC above screening levels only at depth and only conservative modeling has been used to predict scour of these sediments. Removal of these sediments without this study

would be effective and permanent but may not be necessary to ensure protection of human health and the environment.

## 6.11.4 Reduction of Toxicity, Mobility, or Volume through Treatment

This section discusses how the alternative reduces the toxicity to receptors, mobility, or volume of COC at the Site.

### 6.11.4.1 Upland Soil and Groundwater

As with Alternative 2 and 5, the removal of the shoreline soils provides ex situ treatment of COC, reducing the volume of these COC. Solidification of the soils would reduce the mobility of COC and thus the potential toxicity to receptors.

### 6.11.4.2 Nearshore and Offshore Sediments

This alternative removes a similar volume of COC from the nearshore sediment area as Alternative 5, which is greater than the removal volume in Alternative 4. With the removal of offshore sediments, this alternative significantly increases the volume of COC removed from sediments although it provides little to no additional reduction in toxicity since the removed sediments were not exposed to receptors. A portion of the sediments would exceed 10 times the UTS, and treatment of the sediments would be required prior to off-site disposal. Incineration would also provide treatment of these sediments.

## 6.11.5 Short-Term Effectiveness

Short-term effectiveness is based on the potential impacts to the community, workers, and environment during implementation of the alternative. In addition, the length of time for the alternative to achieve protectiveness is considered.

### 6.11.5.1 Upland Soil and Groundwater

There is an increased potential for risks to aquatic and benthic receptors during the shoreline soil removal. Potential risks to the community, workers, and terrestrial receptors during construction of all portions of the alternative could easily be mitigated through engineering controls and proper work practices. Compared to Alternative 4, there may be some increased risk to workers due to the additional volume of spoils requiring handling. However, these potential risks can be mitigated through engineering controls and proper work practices.



The on-site construction portion of this alternative could be completed in less than one year.

### 6.11.5.2 Nearshore and Offshore Sediments

As discussed in Section 5.1, removal actions in sediments are likely to resuspend sediment in concentrations greater than those caused by normal erosional events. This would be a deleterious effect on the benthic and aquatic receptors at the Site. This alternative dredges deeper in the nearshore than Alternative 4 and adds offshore dredging such that short-term impacts would be much more significant that for Alternative 4. The short-term impacts from dredging may exceed any long-term impacts from leaving the sediments in place. In addition, dredging would remove areas of surface sediment in which COC are below screening levels that may provide habitat. Backfill would replace this habitat, but may not to be of as high of a quality as naturally deposited sediments.

## 6.11.6 Implementability

Implementability includes the technical feasibility of construction of the alternative, administrative feasibility of implementing the alternative, the availability of the services and materials required to implement the alternative, and the ability of monitoring to ensure effectiveness of the remedy.

### 6.11.6.1 Upland Soil and Groundwater

This alternative can be implemented at the Site, but additional design effort and specialized equipment will be necessary, making it more technically difficult to implement than the preceding alternatives. The administrative implementability is similar to the preceding alternatives. The mixing deck typically used for soil stabilization is specialized, and could require mobilization from greater distance. This equipment is likely to exist within the western United States. Other equipment is more readily available than the mixing equipment, though it may have to be mobilized from elsewhere in the northwestern United States. Required materials are likely to be available closer to the Site than the equipment. Monitoring using groundwater wells and visual inspections of the St. Joe River can determine the effectiveness of the remedy.

### 6.11.6.2 Nearshore and Offshore Sediments

This alternative can be technically implemented, though it is considerably more complex than preceding alternatives due to the amount of material to be removed and the need to minimize impacts on the St. Joe River during removal. Administratively, this alternative would require a multi-stakeholder process to evaluate the effects of dredging on water quality, habitat, and ecological receptors.

## 6.11.7 Cost

Costs for each alternative have been estimated based on the evaluations and assumptions discussed in the FS. Some variation in the construction and cost of the alternative is likely to occur as the design process for the selected alternative

proceeds. The cost of this alternative is approximately $44,040,000 if soil and sediment are incinerated or disposed off-site as appropriate.

## 6.12 Alternative 7

Refer to Section 5.3.11 for the description of Alternative 7.

### 6.12.1 Protection of Human Health and the Environment

RAOs were developed to address the COCs and pathways that were noted as providing unacceptable risk based on information from the RI/BLRA. Overall protection of human health and the environment is achieved by satisfying the RAOs.

#### 6.12.1.1 Upland Soil and Groundwater

By removing all soils with the potential to leach to groundwater and cause risk to aquatic or benthic receptors, or to cause groundwater to exceed MCLs, all human and ecological receptors would be protected in the long-term. In the short-term, there would likely be some impacts to the environment due to the size of the project and the shoreline soil removal.

#### 6.12.1.2 Nearshore and Offshore Sediments

Removal of sediments that contain concentrations of COC exceeding protective concentrations would ensure protection of receptors in the long-term. Impacts by COCs in deeper sediment may remain and a thick layer of clean sediment will be placed over this area. Long-term monitoring will be required in the nearshore sediment area to ensure this protection is maintained. The significant removal of sediments included in this alternative poses higher short-term risks to receptors during the construction period than other alternatives.

### 6.12.2 Compliance with ARARs

Generally, all chemical-, location-, and action-specific ARARs can be met during construction and in the long-term through proper design of remedial actions and permitting as indicated in Table 6-1. The CERCLA statutory preference for returning groundwater to drinking water standards is not necessarily an ARAR because it is part of the cleanup of the Site rather than an additional requirement. This is the only alternative that may satisfy this statutory requirement. Monitoring would be required to confirm compliance.

## 6.12.3 Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence is evaluated based on residual risk that may exist after implementation of remedial actions and the adequacy and reliability of controls that ensure continued protectiveness.

### 6.12.3.1 Upland Soil and Groundwater

Removal of all shoreline soils with the potential to cause oil films and sheens and all upland soils with the potential to cause groundwater to exceed MCLs would be permanent. Some short-term monitoring would be required to ensure effectiveness. Long-term monitoring and institutional controls would not be required.

### 6.12.3.2 Nearshore and Offshore Sediments

By removing most of the impacted sediments, a high degree of long-term effectiveness and permanence could be achieved. Little to no long-term monitoring would be required to ensure continued effectiveness, except for monitoring in the nearshore sediment area to ensure that surface sediment at the top of the backfill layer is not impacted by deeper COC impacts.

## 6.12.4 Reduction of Toxicity, Mobility, or Volume through Treatment

This section discusses how this alternative reduces the toxicity to receptors, mobility, or volume of COC at the Site.

### 6.12.4.1 Upland Soil and Groundwater

This alternative provides complete removal of COC in soil above cleanup levels for the Site. A portion of the soils removed from the Site would have to be treated prior to disposal, as they would exceed 10 times the Universal Treatment Standards. These soils would be incinerated, or treated off-site through biological or thermal treatment. Soils that do not exceed 10 times the Universal Treatment Standards would not be treated.

### 6.12.4.2 Nearshore Sediments

This alternative provides near complete removal of COC in sediment above cleanup levels for the Site. Some of the removed sediments would contain concentrations of COC exceeding 10 times the Universal Treatment Standards. These sediments would have to be incinerated or treated off-site prior to disposal.

## 6.12.5 Short-Term Effectiveness

Short-term effectiveness is based on the potential impacts to the community, workers, and environment during implementation of the alternative. In addition, the length of time for the alternative to achieve protectiveness is considered.

### 6.12.5.1 Upland Soil and Groundwater

Complete removal of shoreline soils and uplands soils would involve potential risks to receptors in the St. Joe River. The removal of uplands soils would provide for added risks to the community, workers, and terrestrial ecological receptors, since the magnitude of disturbance on the community (e.g., truck traffic and construction noise) is considerably greater than with the other alternatives.

The on-site construction portion of this alternative could be completed in one to two years. Long-term monitoring would not be required.

### 6.12.5.2 Nearshore and Offshore Sediments

Resuspension of sediments and impacts on water quality in the area of the Site are likely. These would be mitigated to the extent possible through construction methods such as the use of a sealing bucket and operational controls. However, the analysis in Section 5.1 showed that even using these techniques, sediment resuspension could easily exceed resuspension that occurs during a 100-year flooding event, which is a significant short-term impact on the St. Joe River. Typically, some resuspension of sediments and negative impacts on water quality occur in the area of the Site during and immediately following dredging operations.

This portion of this alternative would take approximately three years to implement, and would include additional sampling at the Site to support design, a design and permitting process, and construction.

## 6.12.6 Implementability

Implementability includes the technical feasibility of construction of the alternative, administrative feasibility of implementing the alternative, the availability of the services and materials required to implement the alternative, and the ability of monitoring to ensure effectiveness of the remedy.

### 6.12.6.1 Upland Soil and Groundwater

This alternative would be the most difficult to implement for soil and groundwater. The size of the excavation relative to the property on which it must be conducted, the depth of the excavation, sheetpiling requirements, and dewatering requirements combine to make it a construction project requiring careful planning and execution. The administrative implementability is likely similar to the other alternatives, though it may be more involved due to the scale of the project. Equipment required to

construct the alternative is available, though it may have to be mobilized from some distance. The long sheet piling required may have to be mobilized from some distance. Also, the volume of backfill required would require careful sourcing to provide sufficient speed of delivery at reasonable pricing so as to not inhibit the project progress. The alternative would require groundwater monitoring to determine the effectiveness of the alternative. Groundwater monitoring would last approximately five years, provided monitoring results were favorable.

### 6.12.6.2 Nearshore and Offshore Sediments

This is likely to be the most difficult of the alternatives to implement in the nearshore and offshore sediments, both technically and administratively. The volume and depth of removal will require careful design to minimize sloughing of surrounding sediments and mixing of contaminated sediments being removed with the surrounding sediments. Additional design effort and construction monitoring will also be required to ensure integration of the removal with work in offshore sediments and with the uplands. Engineering controls such as sealing buckets on removal equipment are likely to be required in order to minimize creation and transport of suspended sediments and the associated impacts on water quality. Due to the higher potential for resuspension and mobilization of sediments, additional care in study and design will need to be taken in meeting the requirements for the permitting process, which makes the project more administratively difficult. The equipment required, specifically sealing buckets on removal equipment, is specialized, but is likely available in the western United States. Monitoring of water quality and sediment removal depth and location during construction can adequately ensure construction quality and evaluate the effects on receptors.

The size of the project and the short "fish window" of about three months may require multiple years and separate mobilizations to complete the project.

## 6.12.7 Cost

Costs for each alternative have been estimated based on the evaluations and assumptions discussed in the FS. Some variation in the construction and cost of the alternative is likely to occur as the design process for the selected alternative proceeds. Groundwater treatment and discharge under an NPDES permit is estimated to cost $1,620,000. The total cost of this alternative (using off-site incineration, treatment, or disposal of soil and sediment) is approximately $67,190,000.

# 6.13 Alternative 8

**Refer to section 5.3.12 for the description of Alternative 8.**

## 6.13.1 Protection of Human Health and the Environment

RAOs were developed to address the COCs and pathways that were noted as providing unacceptable risk based on information from the RI/BLRA. Overall protection of human health and the environment is achieved by satisfying the RAOs. Alternative 8 prevents direct contact with soil or ingestion of contaminated groundwater using containment and institutional controls and is anticipated to adequately protect human health and the environment from the contaminants in soil and groundwater.

### 6.13.1.1 Upland Soil and Groundwater

Upland soils and groundwater would be contained on-site by the construction of a waste management area constructed within a sheetpile/slurry wall. The wall will be extended approximately 60 feet deep to prevent migration of DNAPL and impacted groundwater into the river. Groundwater inside and outside the containment area would be monitored to evaluate the effectiveness of the containment cell. Containing upland soils and groundwater would reduce the potential for leaching impacted groundwater to the river. In the short-term, there would likely be some impacts to the environment due to the size of the project. In the long-term, there may be the potential for continued leaching of impacted soil into groundwater outside of the containment cell.

### 6.13.1.2 Nearshore and Offshore Sediments

Removal and treatment of bank soils, shoreline sediments, and nearshore sediment to a depth of 8 feet will restore aquatic and benthic environments and reduce the volume of COCs exceeding protective concentrations. Impacts by COCs in bank soils and shoreline sediments impacted below 8 feet may remain. Additional characterization would be required to determine the extent and depth of contaminated offshore sediments. Some impact to the aquatic and benthic environments may result from the placement of a scour-resistant cap over the offshore area. Institutional controls would be required to restrict groundwater and land use.

## 6.13.2 Compliance with ARARs

The National Primary Drinking Water Standards under the Safe Drinking Water Act are relevant and appropriate to the groundwater contamination. The point of compliance for MCLs for remedies where waste materials will be managed in place are at and beyond the edge of the waste management area. Alternative 8 would comply with this ARAR in locations where the sheetpile/slurry wall containment area confined impacted soils and groundwater. Groundwater outside the waste management area would be monitored to evaluate the effectiveness of the containment cell.

## 6.13.3 Long Term Effectiveness and Permanence

### 6.13.3.1 Upland Soil and Groundwater

Alternative 8 includes a containment wall to provide long-term protection to sediment quality by preventing contact with contaminated groundwater. The containment cell proposed by Alternative 8 would provide long-term effectiveness by enclosing the contaminated area and includes a surface cap to exclude precipitation and surface water.

### 6.13.3.1 Nearshore and Offshore Sediments

Alternative 8 would provide for long-term effectiveness for bank soils, shoreline sediment, and offshore sediment unless there was recontamination of removal areas via migrating groundwater. Alternative 8 proposes to remove the most highly contaminated areas to a depth of 8 feet, treat on-site, and dispose of treated soil and sediments off-site. Scour-resistant sand and gravel backfill would be used to replace impacted materials. Residual contamination could remain in areas where COCs exceed cleanup levels at depths greater than 8 feet.

## 6.13.4 Reduction of Toxicity, Mobility, or Volume through Treatment

### 6.13.4.1 Upland Soil and Groundwater

Alternative 8 relies on natural attenuation and containment to reduce the volume of COCs leaching into the river via contaminated groundwater. No treatment within the containment cell is proposed.

### 6.13.4.2 Nearshore and Offshore Sediments

Alternative 8 proposes the removal, on-site treatment and off-site disposal of bank soils, shoreline sediments, and nearshore sediments to a depth of 8 feet. Clean material will be used to backfill the excavated areas to restore the aquatic and benthic environments. This alternative would be effective in reducing the toxicity, mobility, and volume of COCs within the 8 feet excavation zone. Additional characterization of offshore sediments would be required by Alternative 8; so no treatment with reduction of the toxicity, mobility, and volume of COCs would be achieved.

## 6.13.5 Short-Term Effectiveness

### 6.13.5.1 Upland Soil and Groundwater

The creation of the containment cell described in Alternative 8 would require a period of time to install and utilize heavy equipment. Short-term impacts due

to noise and dust would be monitored and minimized through engineering controls. Reductions in risks to the environment would be achieved soon after implementation.

### 6.13.5.2 Nearshore and Offshore Sediments

On-site treatment may include short-term impacts due to noise and dust. These conditions can be minimized during construction and would be monitored. There is a potential for short-term impacts to the aquatic environment during removal actions of bank soils, shoreline sediment, and nearshore sediment and capping of off-shore sediment. However, best management practices and engineering controls would be utilized to minimize these impacts. There is a potential for short-term impacts from noise and air emissions from the mobile treatment unit.

## 6.13.6 Implementability

### 6.13.6.1 Upland Soil and Groundwater

The construction of sheetpile/slurry walls for the containment cell represents well known technology. The timing and duration of this effort will need to reflect avoidance of any periodic flooding in the vicinity of the containment cell and the time required to obtain any additional permits to complete the work.

### 6.13.6.2 Nearshore and Offshore Sediments

Dredging sediments, and backfilling any subaqueous areas to their original bathymetry will be challenging to accomplish in such a manner as to prevent scour and further migration of contaminated sediments downstream. While each individual component of this alternative is relatively straightforward, the combination with environmental factors (flooding and timing constraints caused by fish habitat utilization windows) and political factors (permitting) may result in additional complexity.

## 6.13.7 Cost

The estimated total cost for Alternative 8 is $10,239,000. This is a combined cost of $9,479,000 capital cost and $760,000 O&M cost figured over a 30-year period.

# 6.14 Alternative 9

Refer to section 5.3.13 for the description of Alternative 9.

## 6.14.1 Protection of Human Health and the Environment

RAOs were developed to address the COCs and pathways that were noted as providing unacceptable risk based on information from the RI/BLRA. Overall protection of human health and the environment is achieved by satisfying the RAOs. Alternative 9 prevents direct contact with soil or ingestion of contaminated groundwater using containment and institutional controls and is anticipated to adequately protect human health and the environment from the contaminants in soil and groundwater.

### 6.14.1.1 Upland Soil and Groundwater

Removal and thermal treatment of the top 20 feet of upland soils and solidification of deeper soils under Alternative 9 will ensure that creosote source materials have been reduced to site-specific criteria, or are immobilized. Monitoring in groundwater wells around the area of removal, treatment and solidification would demonstrate that the removal, treatment and solidification processes have adequately reduced concentrations and mobility of COCs such that the groundwater does not mobilize COCs and therefore is protective of the sediments in the St. Joe River. Institutional controls will prevent potable groundwater use. These remedial actions satisfy RAO 2, RAO 3, and RAO 4.

Contingent actions would be implemented if, after excavation and treatment and stabilization, COC concentrations in groundwater exceed PRGs when it comes into contact at the groundwater/sediment interface.

### 6.14.1.2 Riverbank Soils Area

Removal of the shoreline soils and thermal treatment of these materials will ensure that creosote materials have been reduced to site-specific criteria, which will eliminate the pathway for groundwater contamination to occur. Monitoring in groundwater wells around the area of removal will demonstrate that the removal has adequately reduced concentrations of COCs such that the groundwater does not mobilize COCs and therefore is protective of the sediments in the St. Joe River. This remedial action satisfies RAO 2, RAO 3, and RAO 4.

Removal of the shoreline sediments and thermal treatment of these materials will ensure that any creosote materials are no longer present, which will eliminate the direct contact of COCs with benthic organisms. Monitoring of sediments after sediment removal, treatment and replacement would demonstrate that the removal has adequately reduced concentrations of COCs in the sediment resulting in the protection of the benthic organisms that are in the sediments in the St. Joe River. This removal will also prevent contact with human activities on the shore of the St. Joe River. This remedial action satisfies RAO 1 and RAO 3.

**St. Joe River Nearshore and Offshore Sediments (River Sediment Area): Removal of surface sediments in the St. Joe River containing COCs above SSCLs would protect benthic and aquatic receptors in this area by eliminating the potential for these receptors to come in contact with impacted surface sediment. This remedial action satisfies RAO 1 and RAO 3.**

**Removal and/or treatment, physical or chemical stabilization of deeper river sediment material would also protect benthic and aquatic receptors by eliminating the potential for these sediments to become contaminated surface sediments. Removal and treatment of sediments would eliminate the COC, and eliminate the potential that scour could mobilize deeper sediment into surface sediments. Physical stabilization would immobilize the COCs in such way that would prevent the deeper sediment from becoming surface sediments. Chemical stabilization would immobilize the contaminants in such a way as to render the COCs inert, and therefore not bioavailable to benthic and aquatic receptors. These remedial actions satisfy RAO 1 and RAO 3. There may be some impacts on benthic and aquatic receptors in the short term, as removal of sediment materials are likely to displace sediments and suspend them in the water column.**

**This alternative provides for an assessment of scour and associated risk and subsequent monitoring, with implementation of erosion protection (placement of additional material over the surface sediments) as necessary. Such monitoring would provide additional information of the actual scour and potential risk to receptors. Should the monitoring indicate that the situation is not protective of receptors, additional remedial actions to protect human health and the environment (capping) would be implemented. This evaluation will demonstrate that RAO 1 and RAO 3 are being achieved.**

## 6.14.2 Compliance with ARARs

**The National Primary Drinking Water Standards under the Safe Drinking Water Act are relevant and appropriate to the groundwater contamination. The point of compliance for MCLs for remedies where waste materials will be managed in place are at and beyond the edge of the waste management area. Under Alternative 9, all area components (Upland Soils, Riverbank Soils, and River Sediment areas) comply with ARARs.**

## 6.14.3 Long Term Effectiveness and Permanence

### 6.14.3.1 Upland Soil and Groundwater

**Alternative 9 would have long-term effectiveness and permanence by including both solidification and removal of the COCs.**

### 6.14.3.2 Nearshore and Offshore Sediments

**Alternative 9 includes the removal and treatment of upland and shoreline soil and groundwater to prevent recontamination of bank soils and sediments. This**

ensures long-term effectiveness of the remedy by eliminating contaminant mobility and toxicity.

### 6.14.3.3 St. Joe River Nearshore and Offshore Sediments

Alternative 9 includes removal of surface and subsurface sediments that are higher than SSCLs, and removal or stabilization of all deeper sediment that exceed SSCLs. The removal of sediment and replacement with clean materials and the stabilization of sediment by chemical means provide permanence because the COCs will have been eliminated from contact with the river. If physical stabilization (capping) of deeper sediments is performed, it would be performed as necessary based on further in field analysis, with a program to demonstrate that scour is not mobilizing cap material or underlying sediments, and that permanence has been achieved. The combination of any of these three alternatives provides cleanup and protections equivalent to any other alternatives with respect to effectiveness and permanence.

## 6.14.4 Reduction of Toxicity, Mobility, or Volume through Treatment

### 6.14.4.1 Upland Soil Area

Alternative 9 includes removal of the upland soils with on-site thermal treatment of soils to reduce the concentrations of COC to an acceptable level prior to replacement of the treated materials on-site. Thermal treatment produces a bulk soil that is biologically inert through the complete destruction of any organics. The treatment will be designed to produce a clean soil that meets or exceeds the site-specific soil cleanup standards. This approach aggressively addresses the removal of toxicity and mobility by destroying contaminant mass and in the process dramatically reduces the volume of contaminants. The reason this solution is more permanent and protective is by virtue that the source materials are treated to a clean-up criteria and reused on the Site. By performing a source removal or chemical stabilization, the potential for additional soils to become impacted is then decreased compared to implementation of just a containment solution.

This alternative also includes in situ stabilization of deeper soils to ensure that COCs in the deeper soils are immobilized. This part of the process completely reduces the mobility of the COCs. The reason that it is more permanent and protective is because the materials are treated and disposed on-site. Additionally, if soils with lower concentrations of COCs are found within the upper 20 feet the excavation area but outside the delineated area of source materials, they will be stabilized.

### 6.14.4.2 Riverbank Soils Area

The remedial actions include solidification or removal (with treatment). As with the actions for upland soils, removal of bank soils with on-site treatment does the most to reduce toxicity, mobility, and volume of contaminants.

### 6.14.4.3 River Sediment Area

The remedial actions include removal and thermal treatment or physical or chemical stabilization of impacted sediments wherever the SSCL is exceeded, which effectively reduces toxicity, mobility and volume of contaminants. This alternative does not differentiate between particular zones of sediment as does other alternatives, and, therefore, treats all contaminated materials equivalently.

## 6.14.5 Short-Term Effectiveness

### 6.14.5.1 Upland Soils Area

Short-term impacts from noise and air emissions may result from excavation, mixing and milling, in situ stabilization augers, and thermal desorption treatment of soils and sediments. These activities would be monitored and minimized using engineering controls. Elimination or reductions in risks to the environment would be achieved during and after implementation. Because soil solidification and removal are being performed, this alternative would require substantially more excavation and related construction activities and therefore would require more construction time and potentially pose more risk than installation of a slurry or sheetpile wall or other containment remedy. However, excavation and thermal treatment and solidification do achieve risk reduction equivalent to most other alternatives.

### 6.14.5.2 Riverbank Soils Area

The soil solidification and removal actions would pose approximately the same short-term risk to workers and the environment as the other alternatives. There is a potential for short-term impacts to the aquatic environment during removal actions; however, use of proper engineering controls, and in-river containment structures such as coffer dams, would be included during any removal operation to minimize these impacts. There is also a potential during on-site treatment activities for short-term impacts from equipment operations, including dust and noise. The length of time needed to implement the alternative, and the length of time until cleanup standards are met, is about the same for all alternatives.

### 6.14.5.3 River Sediments Area

The removal actions would pose approximately the same short-term risk to workers and the environment. Engineering controls such as a coffer dam would be used to minimize short-term impacts to the aquatic environment. There is also a potential during on-site treatment activities for short-term impacts from noise and air emissions of the mobile treatment unit. The length of time needed to implement the alternatives and the length of time until cleanup standards are met are about the same for all alternatives.

## 6.14.6 Implementability

### 6.14.6.1 Upland Soil Area

Excavation and thermal desorption treatment of soils is a presumptive remedy for wood treatment sites. Solidification has also been performed in situ within saturated groundwater, and is readily implementable with the proper equipment. The technical implementability of this alternative may be difficult because of its invasive process as compared to the other alternatives such as containment. The action would require an engineered construction design including the use of coffer dams, sheetpile walls, excavation, shoring, dewatering, water treatment, and on-site soil treatment and replacement.

### 6.14.6.2 Riverbank Soils Area

Excavation and thermal desorption treatment of soils and sediments is a presumptive remedy for wood treatment sites. Solidification has also been performed in situ within saturated groundwater, and is readily implementable with the proper equipment. The technical implementability of this alternative is complex because this remedial action will require a carefully engineered construction design including the use of coffer dams, sheetpile walls, excavation, shoring, dewatering, water treatment, and on-site soil treatment and replacement.

### 6.14.6.3 River Sediments Area

This alternative involves assessment, removal of some sediments, and potentially stabilizing sediment materials in place. The technical implementability of this alternative is complex because this remedial action will require a carefully engineered construction design including the use of coffer dams, sheetpile walls, excavation, shoring, dewatering, water treatment, and on-site sediment treatment and replacement.

## 6.14.7 Cost

Alternative 9 has a cost of $11,222,493. The combined cost of $10,790,703 capital cost and $431,790 O&M cost are figured over a period of five and a half years. This cost is in the same range as other alternatives that have similar complexity in proposed remedial actions and the quantity of material requiring treatment, such as Alternative 8. This estimate does not have a detailed engineering design, and is therefore approximate. The actual cost of the project would depend on the final scope of the remedial action which would be determined after further delineation and regulatory action.

# 7 Comparative Analysis

This section compares the alternatives against each other for each of the seven criteria. Consistent with the RI/RS guidance, the two acceptance criteria (State/Support Agency Acceptance and Community Acceptance) are not discussed in this section, as these will be analyzed for the Record of Decision. This analysis is performed for each of the criteria, separated by the area of the Site addressed. **The site divisions reflect the apportionment of the site under Alternative 9, which includes three operative areas: Upland Soils Area, Riverbank Soils Area, and River Sediments Area. Where appropriate, analysis completed for the Proposed Plan (compiled by the EPA) has been incorporated into this Supplemental FS.** For the threshold criteria, the criteria are evaluated against the standard of whether or not they meet the threshold. For the balancing criteria, the criteria are ranked by their relative order in best meeting the criteria. The certainty of the alternatives in relation to the criteria has been included in the discussion of ranking for each criterion. Table 7-1 uses a numerical ranking system and summarizes the information provided in this section.

## 7.1 Protection of Human Health and the Environment

Each alternative is compared with respect to how it meets protection of human health and the environment each alternative, with the exception of Alternative 7, will require monitoring to confirm protection of human health and the environment over time. For all alternatives, should monitoring show that an alternative is not protective, contingent actions would be evaluated and implemented.

### 7.1.1 Upland Soils Area

Alternative 7 is the most protective in the long term, as it involves removal of essentially all materials with the potential to cause risk to human health or the environment. This alternative eliminates the need for long-term performance monitoring to ensure remedy effectiveness. However, as Alternative 7 involves exposing and removing the greatest volume of soil, sediment and groundwater, it also carries the greatest risk of exposures to COCs of residents, workers, and the environment despite use of engineering controls and construction planning to mitigate these risks. Alternative 1 is the least protective remedy, as it does not involve any engineered, active, or monitored measures to increase protection of human health or the environment.

The other alternatives range between these two in terms of protectiveness. In general, engineered removal and treatment measures would provide the most protection, as these would remain provide for actual source control. These would include shoreline solidification and/or removal, barrier walls, and soil solidification. Active treatment measures such as air sparging and thermal desorption would generally be more protective than passive measures because treatment, even if operated only for the short term, would reduce the risk of discharge of groundwater containing chemicals of concern to the river and sediment.

**Alternative 8 would create a four-sided waste management area to contain the upland soils that contain COCs greater than soil levels protective of groundwater. These soils would be capped to prevent infiltration. Impacted groundwater would not be treated within the WMA. Long-term monitoring would be required to verify the effectiveness of the system to protect surface and groundwater resources.**

**Alternative 9 provides the next highest amount of protection to Alternative 7, as it would remove and treat the top 20 feet of upland soils and treat in place by solidification of deeper upland soils. Alternative 9 is superior to all other alternatives because it permanently removes the COCs from the environment rather than more passive measures. It also combines the efficiencies of in situ stabilization where depth makes excavation removal less cost-effective.**

### 7.1.2 Riverbank Soils Area

Alternative 7 is the most protective remedy in the long-term, removing all sediments with the potential to cause risk to human or ecological receptors. Alternative 1 is the least protective, as it does not address risks to benthic and aquatic receptors that currently exist at the site. Alternatives 3, 4, 5 and 6 are more certain to be immediately effective, while Alternative 2 would require a longer period to determine the certainty of long-term effectiveness.

**Alternatives involving removals in the St. Joe River, such as Alternatives 7, 8, and 9, have a potential to increase short-term exposure of workers, residents, and environmental receptors to COCs during and immediately following remedial actions. For removal of sediments, an analysis shows these actions may cause higher concentrations of Site sediment in the river during remedial actions than during flooding events. The amount of removal generally increases from Alternative 2 through 9.**

Monitoring will be performed during construction of each alternative with the exception of Alternative 1. Each alternative also includes a characterization investigation during remedial design to refine the impact area. **Long-term monitoring and contingencies are an integral portion of Alternative 2 and 8. Contingencies and monitoring would also be required as part of Alternatives 3, 4, 5, and 9. No long-term monitoring is anticipated for Alternative 9 based upon the use of presumptive remedies and selected cleanup standards.** Contingencies are necessary should assessment indicate that MNR was not going to be effective and capping is necessary. Monitoring would be completed to confirm that the sediment cap wasn't disturbed and to ensure that backfill from removal actions remained stable. Alternatives 6 and 7 would not require monitoring after construction, though there may be some short-term monitoring to monitor the recovery of the river after dredging. **Monitoring for the the presence of sediment after sediment removal, treatment, and replacement as part of Alternative 9 would demonstrate the removal had adequately reduced concentrations of COCs resulting in the protection of the benthic organisms. This removal would also prevent contact with human activities on the shore of the river. Alternate 9 offers the best approach to monitoring, in that it will substantially reduce the duration of long-term monitoring to potentially one 5 year**

**period. This removal would also prevent contact with human activities on the shore of the river.**

### 7.1.3 River Sediments Area

Alternatives 2 through **8** include additional assessment, monitoring, and potential capping of 20% to 100% of the offshore sediments. Alternatives 6, 7 and **9** include dredging of contaminated sediments. **Removal of surface sediments in the St. Joe River containing COCs above SSCLs in Alternative 9 would protect benthic and aquatic receptors in this area by eliminating the potential for these receptors to come in contact with impacted surface sediment. There may be some short-term monitoring required to monitor recovery of the river following dredging.**

## 7.2 Compliance with ARARs

**Compliance with ARARs will be finalized as part of the design and permitting process. In general, the only requirement that will not be met is the CERCLA statutory preference for returning groundwater to drinking water standards. This requirement would not be met by Alternatives 1, 2, 3, 4, 5, and 6, and may not be met for Alternative 7. Human receptors that may use the groundwater as drinking water will be protected by institutional controls or restrictions on groundwater use at the Site. These controls would require long-term monitoring at the site. Alternative 1 includes the existing land use control of the City's ordinance that requires use of City water for drinking water. Alternatives 2, 3, 4, 5, 6, and 8 include additional institutional controls or restrictions on groundwater use specifically in the area of the Site. Institutional controls may not be required for Alternative 7, though it is difficult to assure that this Alternative would not require some institutional controls. Alternative 9 may utilize a land use control if required by the outcome of remedial activities. However no long-term monitoring is anticipated for this alternative based upon the use of presumptive remedies and selected cleanup standards.**

**The National Primary Drinking Water Standards under the Safe Drinking Water Act are relevant and appropriate to the groundwater contamination. The points of compliance for MCLs for remedies where waste materials will be managed in place are at and beyond the edge of the designated waste management area. Alternative 9 would comply with this ARAR. Alternative 9 is superior, based on its use of treatment technology, to other alternatives such as 5 and 6 that leave contaminants in the groundwater and rely on physical isolation to prevent mobilization.**

## 7.3 Long-term Effectiveness and Permanence

The long-term effectiveness of the alternatives is considered based on the magnitude of residual risk to receptors, uncertainties associated with the performance of the alternative, and the adequacy and reliability of controls. No quantitative estimates of residual risk have been made for the FS, but the degree of certainty that the alternative would be permanent is considered. Generally, those alternatives using passive engineered solutions

are more permanent, while those using naturally occurring passive processes are less certain at this time, as they **would have to be** monitored for a period of time sufficient to determine their long-term effectiveness.

### 7.3.1 Upland Soils and Groundwater

**Alternatives 2, 3a, and 3b do not include treatment and the long-term effectiveness of natural attenuation for preventing soil leaching and migration of groundwater or DNAPL to the river is uncertain. Alternatives 3b and 4b may offer long-term effectiveness but it is unclear whether there is sufficient room between the zone of contaminated groundwater and the river for air sparging to be effective. Alternatives 3c, 4c, 5 and 8 include a wall to provide long-term protection to sediment quality by preventing contact with contaminated groundwater. Alternative 8 provides the highest level of protection of these four alternatives because the wall fully encloses the contaminated area and includes a surface cap to exclude precipitation or surface water. Alternatives 6, 7 and 9 would have the highest long-term effectiveness by including solidification, removal, and treatment, respectively. Alternative 9 would have the highest long-term effectiveness and permanence by including both solidification and removal of the COCs.**

### 7.3.2 Riverbank Soils Area

**All of the remedial actions include bank soil removal that would be effective in the long term unless there is recontamination via migrating groundwater. Alternatives 3c, 4c, 5, 6, 7, 8 and 9 include either the soil (and groundwater) containment, solidification, treatment, or the removal of upland soils to prevent recontamination of bank soils. Alternative 9 includes the removal and treatment of upland and shoreline soil and groundwater to prevent recontamination of bank soils and sediments. This ensures long-term effectiveness of the remedy by eliminating contaminant mobility and toxicity.**

**Alternative 2, which includes removal of two feet of contaminated sediment, placement of a thin cap, and monitored natural recovery has the lowest potential for permanence because of the potential for seepage through the cap or scouring. Alternatives 3a, 3b, and 3c, which include removal of two feet of sediment and replacement with a two-foot thick scour-resistant sand and gravel cap, would be more permanent because of the more substantial capping materials. Alternatives 4a, 4b, and 4c, which include removal of three feet of sediment and replacement with three feet thick of scour-resistant sand and gravel backfill, would be slightly more permanent because of the thicker layer of capping materials. Alternatives 5, 6, 7, 8 and 9 include removal and/or treatment of all sediment with the potential to cause risk to receptors and are considered to represent the most effective and permanent action.**

### 7.3.3 River Sediment Area

**The thin cap for Alternative 2 has a risk of being scoured away during a flood event and therefore is not considered effective in the long term. Alternatives 3 and**

4, which include removal and/or treatment of the top 2 to 3 feet of material and replacement with clean backfill, would leave in place residual contamination that could leach to surface sediments. Alternatives 5, 6, 7, 8 and 9 include removal of all sediment with the potential to cause risk to receptors and is considered the most effective and permanent action.

Alternatives 2, 3, 4, 5, and 8 include a cap for the offshore sediments, which is considered effective in the long-term if scour-resistant capping materials are used. Alternatives 6 and 7 include removal and treatment of the contaminated material, which is considered the most protective in the long-term.

Alternative 9 includes removal of surface and subsurface sediments that are higher than SSCLs, and removal or stabilization of all deeper sediment that exceed SSCLs. The removal of sediment and replacement with clean materials and the stabilization of sediment by chemical means provide permanence because the COCs will have been eliminated from contact with the river. If physical stabilization (capping) of deeper sediments is performed, it would be performed as necessary based on further in field analysis, with a program to demonstrate that scour is not mobilizing cap material or underlying sediments, and that permanence has been achieved. The combination of any of these three alternatives provides cleanup and protections equivalent to any other alternatives with respect to effectiveness and permanence.

## 7.4 Reduction of Toxicity, Mobility, or Volume through Treatment

### 7.4.1 Upland Soils Area

The remedial actions include monitoring, containment, soil solidification, or removal (with treatment). Alternatives 2, 3a, 3c, 4a, 4c, 5, and 8, which rely on monitored natural attenuation or containment do not include treatment and are ranked lowest under this criterion. Alternatives 3b and 4b include air sparging, which may reduce contaminant concentrations in groundwater before the point of discharge to the river but the effectiveness of this method is uncertain. Alternative 6 includes solidification to reduce the mobility of contaminants; however, the toxicity and volume of material remaining on-site would not be reduced. Alternative 7 includes removal with off-site thermal treatment of soils to reduce the concentrations of COCs (greater than 10x UTS) prior to disposal at an off-site landfill.

Alternative 9 includes removal of the upland soils with on-site thermal treatment of soils to reduce the concentrations of COC to an acceptable level prior to replacement of the treated materials on-site. Thermal treatment produces a bulk soil that is biologically inert through the complete destruction of any organics. The treatment will be designed to produce a clean soil that meets or exceeds the site-specific soil cleanup standards. This approach aggressively addresses the removal of toxicity and mobility by destroying contaminant mass and in the process dramatically reduces the volume of contaminants. ~~As a result, Alternate 9 exceeds the benefits of other options when considering ranking of alternatives by~~

~~the balancing criteria as shown on Table 7-1. The benefit for long-term effectiveness for the reduction of toxicity and mobility of COCs matched with factors such as cost and implementability demonstrate Alternate 9 as a preferred approach.~~

This alternative also includes in situ stabilization of deeper soils to ensure that COCs in the deeper soils are immobilized. This part of the process completely reduces the mobility of the COCs. These two treatment methods provide reduction in toxicity, mobility, and volume that achieve substantial risk reduction and are more permanent and protective as compared to the other preferred alternatives. The reason that it is more permanent and protective is because the materials are treated and disposed on-site, and an increase in volume of contaminated materials is avoided.

### 7.4.2 Riverbank Soils Area

The remedial actions include removal and treatment of impacted sediments up to 8 feet in depth. All of the removal activities would be effective in reducing toxicity, mobility and volume of contaminants. Alternatives 5, 6, 7, 8 and 9 would result in more reduction in toxicity, mobility and volume, than Alternatives 2, 3, and 4 because a greater quantity of material would be removed and treated. The remedial actions include solidification or removal (with treatment). Alternative 9 does not differentiate between particular zones of sediment as do other alternatives, and, therefore, treats all contaminated materials equivalently. In terms of constructability Alternative 9 will provide for more comprehensive removal and remedy.

### 7.4.3 River Sediments Area

The remedial actions include assessment, monitoring, capping or removal. The assessment, monitoring and capping actions (Alternatives 2, 3, 4, 5, and 8) do not include treatment and are therefore ranked lowest under this criterion. Alternatives 6 and 7 include removal and treatment of contaminated sediments. The remedial actions include removal and thermal treatment or physical or chemical stabilization of impacted sediments wherever the SSCL is exceeded, which effectively reduces toxicity, mobility and volume of contaminants. Alternative 9 does not differentiate between particular zones of sediment as do other alternatives, and, therefore, treats all contaminated materials equivalently.

## 7.5 Short-Term Effectiveness

### 7.5.1 Upland Soils Area

Alternatives 2, 3a, and 4a rely on monitoring, which poses little risk to workers. Risk of sediment recontamination is not reduced by these alternatives, and therefore it is uncertain when or if sediment cleanup levels will be attained. Alternatives 3b and 4b include air sparging, which could be implemented safely and have the potential for slightly reducing the potential for sediment

**recontamination. The rate at which reduction in contaminants would be achieved by this method is uncertain. Alternatives 3c, 4c, 5, 8 and 9 include containment, which would take longer to install (a few months) with more heavy equipment than previous alternatives. Short-term impacts due to noise and dust would be monitored and minimized. Reductions in risks to the environment would be achieved sooner after implementation. Soil solidification (Alternatives 6 and 9) and complete removal (Alternative 7) would require substantially more excavation and therefore would require more construction time and potentially pose more risk than installation of a slurry or sheetpile wall. These three alternatives would achieve risk reduction sooner than the other alternatives. On-site treatment (Alternatives 8 and 9) may also include short-term impacts from noise and air emissions that can be controlled during construction and monitored.**

**Short-term impacts from noise and air emissions may result from excavation, mixing and milling, in situ stabilization augers, and thermal desorption treatment of soils and sediments in Alternative 9. These activities would be monitored and minimized using engineering controls. Elimination or reductions in risks to the environment would be achieved during and after implementation. Because soil solidification and removal are being performed, this alternative would require substantially more excavation and related construction activities and therefore would require more construction time and potentially pose more risk than installation of a slurry or sheetpile wall or other containment remedy. However, excavation and thermal treatment and solidification do achieve risk reduction equivalent to most other alternatives.**

### 7.5.2 Riverbank Soils Area

**The monitored natural recovery component of Alternative 2 has the lowest short-term risk to workers but may not reduce the risk to the environment if a flood scours the nearshore areas. Alternatives 3 and 4, which include capping, have the next lowest short-term risk to the workers and the environment because there would be minimal disruption of contaminated sediment. Alternatives 5, 6, 7, 8, and 9 have the highest short-term risk to the environment because of the potential risk for incidental releases during dredging. Engineering controls would be used to minimize short-term impacts to the aquatic environment.**

The soil solidification and removal actions in Alternative 9 would pose approximately the same short-term risk to workers and the environment as the other alternatives. There is a potential for short-term impacts to the aquatic environment during removal actions; however, use of proper engineering controls, and in-river containment structures such as coffer dams, would be included during any removal operation to minimize these impacts. There is also a potential during on-site treatment activities for short-term impacts from equipment operations, including dust and noise. The length of time needed to implement the alternative, and the length of time until cleanup standards are met, is about the same for all alternatives.

### 7.5.3 River Sediments Area

Alternatives 2, 3, 4, 5, 8, and 9 include capping which should have minimal short-term risk to the environment. Cleanup standards would be met upon the installation of the cap. Alternatives 6, 7 and 9 have the highest short-term risk to the environment because of the potential for incidental releases during dredging. Engineering controls would be used to minimize short-term impacts to the aquatic environment. Cleanup standards would be met upon completion of the dredging. The length of time needed for implementation is the same of all alternatives.

The removal actions of Alternative 9 would pose approximately the same short-term risk to workers and the environment. Engineering controls such as a coffer dam would be used to minimize short-term impacts to the aquatic environment. There is also a potential during on-site treatment activities for short-term impacts from noise and air emissions of the mobile treatment unit. The length of time needed to implement the alternatives and the length of time until cleanup standards are met are about the same for all alternatives.

## 7.6 Implementability

While all of the actions can be implemented at the Site, some are more easily implemented than others. In general, the technical implementability decreases with increasing complexity of construction and use of specialized equipment. Administrative implementability decreases with the increase in substantive requirements that apply to permitting. Actions requiring construction and/or operations in the uplands may also be impacted by period flooding of the site that would need to be accounted for during design.

### 7.6.1 Upland Soils Area

Alternatives 2, 3a, and 4a rely on monitoring, which is easy to implement. Alternatives 3b and 4b include air sparging which would be easy to implement although it may be difficult to verify that the sparging zone includes all of the contaminated groundwater. Alternatives 3c, 4c, 5, 8, and 9 include sheetpile or slurry walls, which should be straightforward to implement because this is a well-known technology. Alternatives 6 and 9, which include solidification of contaminated soil, may be difficult to implement because the technology is relatively uncommon. Alternative 7, which includes removal of all upland soils would be the most technically complex to implement. This action would require a highly engineered construction design including the use of sheetpile walls, excavation, shoring, dewatering, water treatment, and off-site soil treatment and disposal.

Excavation and thermal desorption treatment of soils is a presumptive remedy for wood treatment sites. Solidification has also been performed in situ within saturated groundwater, and is readily implementable with the proper equipment. The technical implementability of Alternative 9 will include an invasive process as compared to the other alternatives such as containment. The action would require an engineered construction design including the use of coffer dams, sheetpile

walls, excavation, shoring, dewatering, water treatment, and on-site soil treatment and replacement.

### 7.6.2 Riverbank Soils Area

Alternative 2 includes monitored natural recovery, which would be the easiest to implement. Alternatives 3 and 4 include capping, which would be the next easiest to implement. Alternatives 5, 6, 7, 8, and 9 include dredging, which would be the most difficult to implement.

Excavation and thermal desorption treatment of soils and sediments is a presumptive remedy for wood treatment sites. Solidification has also been performed in situ within saturated groundwater, and is readily implementable with the proper equipment. The technical implementability of Alternative 9 will require a carefully engineered construction design including the use of coffer dams, sheetpile walls, excavation, shoring, dewatering, water treatment, and on-site soil treatment and replacement. All of the alternatives include removal so this does not affect the relative implementability between alternatives for shoreline soils.

### 7.6.3 River Sediments Area

Alternatives 2, 3, 4, 5, 8, and 9 include assessment, monitoring, and capping, which would not be difficult to implement because capping is a commonly used remedy. Alternatives 6, 7, and 9 include source removal by dredging, which would provide a more permanent solution than capping. Based on further analysis during remedial design, both capping and dredging/treatment may be employed for Alternative 9.

This alternative involves assessment, removal of some sediments, and potentially stabilizing sediment materials in place. The technical implementability of Alternative 9 will require a carefully engineered construction design including the use of coffer dams, sheetpile walls, excavation, shoring, dewatering, water treatment, and on-site sediment treatment and replacement.

## 7.7 Cost

Alternative 2 has the lowest estimated costs ($1,178,000). Costs increase with the increased complexity of the proposed remedial actions and the quantity of material requiring treatment. Alternatives were developed to give a broad range of options that would span from less aggressive, lower cost remedies to very aggressive, higher cost remedies. The most aggressive alternative, Alternative 7, includes complete removal and thermal treatment of soil and sediment containing contaminants, is the most costly with an estimated cost of $67,190,000.

Alternative 9 has an estimated cost of $11,220,000. This cost is in the same range as other alternatives that have similar complexity in proposed remedial actions and the quantity of material requiring treatment, such as Alternative 8. This estimate does not have a detailed engineering design, and is therefore

approximate. The actual cost of the project would depend on the final scope of the remedial action which would be determined after further delineation and regulatory action. Cost summary information is presented in Appendix H.

## 7.8 Summary of Comparative Analysis

The national goal of the remedy selection process is to select remedies that are protective of human health and the environment, that maintain protection over time, and that minimize untreated wastes. EPA's program expectation is to use treatment where ever feasible to address the principle threats posed by the site. EPA also has an expectation to return useable groundwater to beneficial uses where ever practicable. Furthermore, EPA typically relies upon land use controls such as water use and deed restrictions to supplement or eliminate the need for engineering controls as appropriate to limit, where possible, the need for long-term management of the site.

Alternate 9, through the use of presumptive remedies of thermal desorption, stabilization/solidification, and proposed cleanup standards that are protective of public health and the environment, meets these national program expectations at this site. The engineering capabilities of these treatment technologies are well understood, enabling the remedy selection process as well as ROD formulation to be streamlined. Soils and sediments and groundwater will meet a standard that will eliminate the need for long-term monitoring and 5-year reviews. MCLs will be met in the groundwater at the point of compliance and residential standards will be met in the soils. A risk based approach will be used to determine the level of cleanup and treatment necessary to protect the ecosystem of the river.

Alternative 9 achieves long-term effectiveness and permanence to a greater extent than other alternatives analyzed because of its focus on toxicity and mobility and source reduction through additional treatment. COCs from depths up to 20 feet will be removed by active thermal treatment. Deeper soils will be treated by solidification. Active treatment is a preferable alternative than more passive approaches such as encapsulation in place and monitoring. The removal of shoreline soils and sediments and thermal treatment of these materials will eliminate the direct contact of COCs with benthic organisms.

It is a superior approach because it does not rely on engineered systems to encapsulate waste on-site. It will achieve substantial risk reduction by removing and treating source materials. This combination reduces risks sooner, costs less than some of the other alternatives, and is more permanent and more protective of human health and the environment.

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# Appendix A

## Correspondence Pertinent to Sediment Cleanup Level and Post RI/BLRA DNAPL Mobility Analysis

# Sediment Cleanup Level Correspondence

# Product Mobility Correspondence

# Appendix B

## Information Regarding Overbank Disposal

**Photos of Shoreline Taken in October 1998**
**by Jim Comerford**

**(1) Creosote Chunks on Shoreline**

**(2) Barrel (in Foreground) and Other Debris**

# Co-Located Radioisotope and Total PAH Data (from Remedial Investigation Addendum June 2003, RETEC, April 2004)

# Appendix C

## COC Fate and Transport in Groundwater and Sediment PRGs

# Appendix D

## Data Tables Used to Define Remedial Areas

# Appendix E

## Summary Discussion of Technical Impracticability

# Appendix F

## *Ex-situ* Management Technologies and Costs

# Appendix G

## Scope of Work for MNR Assessment

# Appendix H

# Detailed Cost Estimates

"Off-shore Capping" Remedy
ALTERNATE 8
Elements of the remedy
1a) Sheet pile wall 210 feet long, 55 feet deep-tie into lower silt, along river front.
1b) Soil bentonite wall around other three sites (150' + 275' + 150') X 55' deep, tie into silt
1c) Place GCL and sand cap on surface to prevent infiltration.
2) Removal of shoreline soil and nearshore sediments
3) Treat Shoreline Soil and Nearshore Sediments by Low Temperature Thermal
4) Off-site disposal in a Subtitle C facility (with no further treatment)
5) Cap Offshore Sediment

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | Total Estimated Cost | | $ | 10,239,239 |
| | | | Quantities and Unit Costs Obtained from November 1, 2004 Draft Feasibility Study Unless otherwise noted | | | |
| | Description | Quantity | Unit | Unit Cost | per Unit | Subtotal | |
| | ***Integrated Removal of Nearshore Surface Sediments, Shoreline Soils, and Construction of Perimeter Barrier Wall*** | | | | | | |
| | *Capital Costs* | | | | | | |
| 1a | Site prep | 1 | ls | $25,000 | each | $25,000 | From FS Alt 5 |
| 1a | Mobilization/Demobilization - Shore-based Crane for piling | 1 | ls | $20,000 | each | $20,000 | From FS Alt 5 |
| 1a | Sheet Pile Install - Permanent in uplands | 11550 | sf | $30 | per sf | $346,500 | From FS Alt 5 |
| 1b | Mobilize slurry equipment | 1 | ls | $75,000 | each | $75,000 | From FS unit cost list |
| 1b | Soil Bentonite slurry wall | 31625 | sf | $8 | per sf | $253,000 | From FS unit cost list |
| 1c | GCL | 4000 | sy | $4 | | $16,000 | |
| 1c | Sand Cushion (6 inches thick) (Purchase and place) | 667 | cy | $26 | | $17,333 | |
| 1c | Gravel Cap (12 inches thick) (Purchase and place) | 1333 | cy | $16 | | $21,333 | |
| 2 | Portadam | 1 | ls | $35,000 | | $35,000 | From FS Alt 5 |
| 2 | Site Controls | 1 | ls | $10,000 | | $10,000 | From FS Alt 5 |
| 2 | Mobilization/Demobilization - Shore-based Excavation Equipment | 1 | ls | $15,000 | | $15,000 | |
| 2 | Mobilization/Demobilization - Barge-based removal equipment | 1 | ls | $15,000 | | $15,000 | |
| 2 | Shoreline - Create Platform | 222.22 | CY | $8 | per CY | $1,778 | |
| 2 | Remove Uncontaminated Overburden | 356 | CY | $8 | | $2,848 | |
| 2 | Excavate Contaminated Soil / Sediments | 12856 | CY | $15 | | $192,840 | Shoreline soil = 1023 CY, shoreline and sideslope sed = 273 CY |
| 2 | Tie back installations | 27 | tiebacks | $2,500 | each | $67,500 | |
| 2 | Construct Dewatering Cell | 1 | ls | $40,000 | | $40,000 | |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | dewatering = 85 gal/CY, volume to be dewatered = 12856-1296=11560 CY; |
| 2 | Water Treatment | 952,600 gal | $0.35 per gal | $343,910 | $0.12/gal in dredging all |
| 2 | Sample tailback within cell | 1 ls | $10,000 | $10,000 | |
| 2 | Additional Removal (20%) | 2571 CY | $15 | $38,565 | |
| 2 | Bank Reconstruction | 1 ls | $15,000 | $15,000 | From FS Alt 6 |
| 2 | Replace uncontaminated overburden | 356 CY | $8 per CY | $2,848 | |
| 2 | Site Restoration | 1 ls | $50,000 | $50,000 | |
| *Onsite Treatment* | | | | | |
| 3 | Mobilize LTTD Equipment | 1 ls | $40,000 each | $40,000 | conservative mob charge based on telephone quotes from ECC, RemTech and Midwest Soil |
| 3 | Oversize material separation | 18512 T | $2 per T | $37,024 | 1296 CY nearshore + 11560 sediment + 2571 addl excavation @ 1.2 T per CY |
| 3 | Dewater Sediment | 18512 T | $12 per T | $222,144 | Submerged Sediment Density 1 CY = 1.2 Ton |
| 3 | Treat Sediment onsite LTTD | 16957 T | $70 per T | $1,186,990 | conservative unit price based on telephone quotes from ECC, RemTech and Midwest Soil |
| 3 | Treat Soil onsite LTTD | 1,944 T | $70 per T | $136,080 | Soil 1 CY = 1.5 Ton |

| | | | | | |
|---|---|---|---|---|---|
| ***Off-site Disposal of Treated Soil/Sediment*** | | | | | |
| 4 | Load soil for offsite disposal | 15,427 CY | $2 per CY | $30,854 | From FS Alt 5 |
| 4 | Transportation and Disposal - direct burial in Subtitle C cell | 18,900 T | $110 per T | $2,079,000 | unit price based on telephone quotes from Chemical Waste Mgmt in Arlington, OR and US Ecology in Grandview, ID |
| ***Capping of Offshore Sediments*** | | | | | |
| *Capital Costs* | | | | | |
| 5 | Design Investigation | 1 ls | $200,000 | $200,000 | From FS Alt 5 |
| 5 | Mobilization of barges/equipment | 1 ls | $65,000 | $65,000 | From FS Alt 5 |
| 5 | Geomembrane Purchase | 10946 SY | $10 per SY | $109,460 | From FS Alt 5 |
| 5 | Shot Rock Purchase | 7297 CY | $32 per CY | $233,504 | From FS Alt 5 |
| 5 | Shot Rock Placement | 7297 CY | $20 per CY | $145,940 | From FS Alt 5 |
| 5 | Sand Purchase | 1824 CY | $32 per CY | $58,368 | From FS Alt 5 |
| 5 | Sand Place | 1824 CY | $20 per CY | $36,480 | From FS Alt 5 |
| 5 | Construction Confirmation | 1 ls | $150,000 | $150,000 | From FS Alt 5 |
| | *Subtotal Capital Costs* | | | ***$6,345,299*** | |
| | Remedial Design | 6% | | $380,718 | |
| | Project Management | 5% | | $317,265 | |
| | Construction Management | 6% | | $380,718 | |
| | Contingency | 30% | | $1,903,590 | |
| | **Total Capital Costs** | **Subtotal Capital Costs - Capping Off-shore Sed** | | **$9,327,590** | |
| ***Long-Term Monitoring - Sediment Cap*** | | | | | |
| | **Years 1-5, Year 1, 3, 5** | **3 event** | **$85,800 each** | **$225,166** | **PV** |
| | mob/demob | 1 ls | $20,000 each | $20,000 | |
| | bathymetry survey | 1 ls | $5,000 each | $5,000 | |
| | sediment core collection | 12 each | $900 per core | $10,800 | |
| | chemical analyses | 24 each | $750 per analysis | $18,000 | |
| | physical analyses | 24 each | $500 per analysis | $12,000 | |
| | evaluation | 1 ls | $20,000 each | $20,000 | |
| | **Years 6-20, Year 10, 15, 20** | **3 event** | **$85,800 each** | **$96,887** | **PV** |
| | mob/demob | 1 ls | $20,000 each | $20,000 | |
| | bathymetry survey | 1 ls | $5,000 each | $5,000 | |
| | sediment core collection | 12 each | $900 per core | $10,800 | |
| | chemical analyses | 24 each | $750 per analysis | $18,000 | |
| | physical analyses | 24 each | $500 per analysis | $12,000 | |
| | evaluation | 1 ls | $20,000 each | $20,000 | |
| | **Years 30, Year 30** | **1 event** | **$85,800 each** | **$11,271** | **PV** |
| | mob/demob | 1 ls | $20,000 each | $20,000 | |
| | bathymetry survey | 1 ls | $5,000 each | $5,000 | |

| | | | |
|---|---|---|---|
| sediment core collection | 12 each | $800 per core | $10,600 |
| chemical analyses | 24 each | $750 per analysis | $18,000 |
| physical analyses | 24 each | $500 per analysis | $12,000 |
| evaluation | 1 ls | $20,000 each | $20,000 |
| | | **Subtotal Sediment Cap Monitoring** | **$339,924** |
| ***O&M - Sediment Cap*** | | | |
| **2 events assume 10% repair per event** | | | |
| Mob/demob | 1 ls | $30,000 each | $30,000 |
| Shot Rock Purchase | 730 CY | $32 per CY | $23,360 |

| | | | | | |
|---|---|---|---|---|---|
| Shot Rock Placement | 730 CY | | $20 per CY | $14,600 | |
| Sand Purchase | 182 CY | | $32 per CY | $5,824 | |
| Sand Place | 182 CY | | $20 per CY | $3,640 | |
| Construction Confirmation | 1 ls | | $15,000 each | $15,000 | |
| | | | *Subtotal Sediment Cap O&M* | *$92,424* | |
| Remedial Design | 6% | | | $5,545 | |
| Project Management | 5% | | | $4,621 | |
| Construction Management | 6% | | | $5,545 | |
| Contingency | 30% | | | $27,727 | |
| | | | **Total Sediment Cap O&M Costs** | **$135,863** | **$459,187** |
| ***Institutional Controls and Long-term Monitoring - Groundwater*** | | | | | |
| *Assumptions* | | | | | |
| *Assumes well network will be designed specifically for long-term monitoring* | | | | | |
| *ten new wells required, ave 50 feet deep* | | | | | |
| *12 wells to be monitored* | | | | | |
| *Capital Costs* | | | | | |
| Placement of Institutional Controls | 1 ls | | $15,000 each | $15,000 | |
| Monitoring Plan | 1 ls | | $25,000 each | $25,000 | |
| Well installations for long-term monitoring | 10 ea | | $5,333 per well | $53,330 | Retec's assumptions say they are installing 10 new wells, but their spreadsheet says 6 |
| Add'l Items | 1 ls | | $10,000 each | $10,000 | |
| | | | *Subtotal Capital Costs* | $103,000 | |
| Remedial Design | 6% | | | $6,180 | |
| Project Management | 5% | | | $5,150 | |
| Construction Management | 6% | | | $6,180 | |
| Contingency | 30% | | | $30,900 | |
| | | | **Total Long-term GW Monitoring Capital Costs** | **$151,410** | |
| ***O&M Costs - Groundwater Monitoring*** | | | | | |
| Groundwater Monitoring - Years 1-3 | 3 years | | $42,840 per year | $112,428 | |
| Groundwater Monitoring - Years 4-15 | 12 years | | $21,960 per year | $142,380 | |
| Groundwater Monitoring - Years 16-30 | 15 years | | $10,980 per year | $36,246 | $291,052 |
| | | | **Total GW Monitoring Costs** | **$442,462** | $442,462 |

NOTES

No backfilling, except shoreline restoration, is included

*Prepared November 1, 2004 by Cohn Wagoner*

*Updated 12/2/04 by Sheila Fleming*