RECORD OF DECISION AMENDMENT

UPPER AQUIFER COMPONENT OF OPERABLE UNIT 2

Libby Groundwater Contamination Superfund Site
Libby, Montana

Part I - Declaration

Site Name and Location

Libby Groundwater Contamination Superfund Site (the Site), Libby, Montana 59923. U.S. Environmental Protection Agency (EPA) Identification (ID): MTD980502736. Operable Unit (OU) 2.

Statement of Basis and Purpose

This document amends the 1988 Record of Decision (ROD) (EPA 1988b) for the Site for OU2, as amended in 1993 and 1997, to address the cleanup of groundwater at the Site. The amended remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended, and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

This document is issued by EPA Region 8, the lead agency, with the concurrence of the Montana Department of Environmental Quality (DEQ), the supporting agency.

This ROD Amendment is based on the administrative record for this OU2 ROD Amendment and will become part of that administrative record in accordance with the NCP at 40 Code of Federal Regulations (CFR) Section 300.825(a)(2). The administrative record in electronic form and copies of key documents are available for public review at the Lincoln County Health Department located at 408 Mineral Avenue, Libby, Montana 59923. The administrative record is also maintained at the EPA-Montana Office Records Center, 10 West 15th Street, Suite 3200, in Helena, Montana, and can be viewed during normal business hours through advance arrangement with the records center staff. The administrative record can also be found on the Libby Groundwater Site's webpage (http://www.epa.gov/superfund/libby-groundwater).

Assessment of the Site

The Site is located in northwestern Montana, on the eastern and southeastern border of the city of Libby. Wood-treating activities conducted from 1946 through 1969 resulted in the contamination of soils and groundwater in this area. The primary contaminants of concern (COCs) are pentachlorophenol (PCP), polycyclic aromatic hydrocarbons (PAHs), benzene, and arsenic. The remedial action selected in this ROD Amendment is necessary to protect public health, welfare, and the environment from actual or threatened releases of hazardous substances at the Site.

Description of the ROD Amendment

This ROD Amendment changes only those provisions of the 1988 ROD that deal with the Upper Aquifer Component of OU2. Remedial decisions for the remainder of OU2 remain unchanged. The amended remedy differs from the remedy in the 1988 ROD and amendments in the following ways: (1) it replaces the current source area extraction and treatment system with in situ biosparging (ISB) in the nonaqueous phase liquid (NAPL) source area, (2) it adds ISB to the area downgradient of the NAPL source area, and (3) it continues monitored natural attenuation (MNA) for the dissolved plume area. All other components of the 1988 OU2 ROD remain unchanged[1].

These changes are needed because prior remediation efforts were not successful in meeting groundwater cleanup goals in certain portions of the upper aquifer, in particular those areas that contain NAPL. Thus, EPA and DEQ are proposing a revised cleanup strategy that addresses

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[1] As an example, OU 2's requirement regarding the closure of the land treatment unit is a required OU 2 remedial element yet to be completed. OU 1 addressed institutional controls as an interim protective measure. As noted in the most recent five-year review, institutional controls preventing domestic use of contaminated groundwater and/or the spread of the contaminated groundwater plume both within and outside of the city limits should be implemented in a more comprehensive manner. All institutional controls described in the OU1 ROD and the OU2 ROD must be reviewed and implemented where possible using best efforts..

NAPL-contaminated portions of the upper aquifer with the highest COC concentrations, the highest potential for releasing dissolved COCs to the groundwater, and the greatest potential risk to human health.

Statutory Determinations

The selected remedy meets the mandates of CERCLA Section 121 and the NCP. It is protective of human health and the environment, complies with all federal and state requirements that are applicable or relevant and appropriate to the remedial action, is cost effective, and uses permanent solutions and alternative treatment technologies to the maximum extent practicable.

Authorizing Signatures

This 2019 ROD Amendment documents the selected remedy for the Libby Groundwater Contamination Superfund Site, Upper Aquifer Component of OU2. This remedy was selected by EPA with concurrence by the State of Montana.

BETSY SMIDINGER Digitally signed by BETSY SMIDINGER Date: 2020.04.06 16:54:17 -06'00'
_______________________________________ Date:______________________________

Betsy Smidinger
Director, Superfund and Emergency Management Division
U.S. Environmental Protection Agency, Region 8

Record of Decision Amendment

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Acronyms and Abbreviations

µg/L	microgram(s) per liter
ARAR	applicable or relevant and appropriate requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
Champion	Champion International Corporation
COC	contaminant of concern
CUL	cleanup level
DEQ	Montana Department of Environmental Quality
EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Differences
FFS	focused feasibility study
GAC	granular activated carbon
HVAC	heating, ventilation, and air conditioning
ID	identification
IDW	investigation-derived waste
IP	International Paper Company
ISB	in situ biosparging
ISGS	in situ geochemical stabilization
MCL	maximum contaminant level
MNA	monitored natural attenuation
NAPL	nonaqueous phase liquid
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
O&M	operation and maintenance
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PCP	pentachlorophenol
RAO	remedial action objective
ROD	record of decision
SAETS	source area extraction and treatment system
SEE	steam-enhanced extraction
Site	Libby Groundwater Contamination Superfund Site
TBC	to be considered

Part II - Decision Summary

1.0 Introduction

Libby Groundwater Contamination Site
Upper Aquifer Component of Operable Unit 2

- EPA ID: MTD980502736
- Lead Agency: EPA
- Supporting Agency: Montana DEQ

Exhibit 1. Site Identification

This amendment to the 1988 Record of Decision (ROD; EPA 1988b) for the upper aquifer component of Operable Unit (OU) 2 at the Libby Groundwater Contamination Superfund Site (the Site) (*See* Exhibits 1, 2, and 3) changes the upper aquifer groundwater remedy in the following ways: (1) replaces the current source area extraction and treatment system with in situ biosparging (ISB) in the nonaqueous phase liquid (NAPL) source area, (2) adds ISB to the area downgradient of the NAPL source area, and (3) continues monitored natural attenuation (MNA) for the dissolved plume area. U.S. Environmental Protection Agency (EPA) and Montana Department of Environmental Quality (DEQ) have determined that these changes are necessary to protect human health and the environment, based on information obtained through implementation of the remedial action and other studies.

Treatment of groundwater at the Site has been ongoing since 1989. During that time, more than 40,000 gallons of NAPL have been removed from the subsurface. However, these actions have not been successful in meeting groundwater cleanup goals in certain portions of the upper aquifer, in particular those portions that still contain NAPL. Thus, the potentially responsible party, International Paper Company (IP), conducted additional studies and analyses to evaluate current groundwater treatment technologies. This work has led EPA and DEQ to conclude that an amendment to the 1988 ROD is required to describe and require a revised cleanup strategy that addresses NAPL-contaminated portions of the upper aquifer with the highest contaminant of concern (COC) concentrations, the highest potential for releasing dissolved COCs to the groundwater, and the greatest potential risk to human health. This ROD Amendment presents a brief overview of the Site and enforcement activities, the basis for amendment, evaluation of alternatives, description of the selected amended remedy, and statutory determinations.

EPA is the lead agency and DEQ is the support agency. EPA is issuing this ROD Amendment as part of its responsibilities under of Section 117 of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, and 40 Code of Federal Regulations (CFR) 300.435 (c)(2)(ii) of the National Oil and Hazardous Substance Pollution Contingency Plan (NCP). This ROD Amendment is based on the administrative record for this OU2 ROD Amendment and will become part of the administrative record in accordance with NCP at 40 CFR 300.825(a)(2). The administrative record in electronic form and copies of key documents are available for public review at the Lincoln County Health Department located at 408 Mineral Avenue, Libby, Montana 59923. The administrative record is also maintained at the EPA-Montana Office, 10 West 15th Street, Suite 3200, in Helena, Montana, and can be viewed during normal business hours through arrangement with the records center staff. The administrative record can also be found on the Site's webpage (http://www.epa.gov/superfund/libby-groundwater).

1.1 Site Description

The Site is a former lumber mill and wood-treating operation located on Highway 2 in and around the city of Libby (Exhibits 1, 2, and 3). The Site currently consists of the soil excavation areas (former tank farm area, former butt dip area, and former waste pit area); surface areas that are potentially contaminated with COCs in and around the excavated areas, including substrata material; former treatment areas; and the full extent of the contaminated groundwater plume emanating from the surface contamination (Exhibit 3). Historical releases of wood-treating fluids resulted in impacts on soil and the underlying groundwater. Soil and groundwater remediation has been ongoing at the Site since the late 1980s under the direction of EPA and DEQ. IP acquired the Site remediation responsibilities upon its merger with Champion International Corporation (Champion) on December 31, 2000.

Wood-treating fluids were used at the Site from 1946 to 1969. These fluids consisted of complex mixtures of different blends of chemical products used over time, product process residues, and spent mixtures. The primary wood treating products used at the Site were creosote and pentachlorophenol (PCP). Creosote consists predominantly of polycyclic aromatic hydrocarbons (PAHs). PCP crystals were dissolved in a medium aromatic solvent similar to diesel fuel, with 5 percent PCP and 95 percent carrier. In the mid-1960s, approximately 10 percent of the treatment was a salt process believed to use fluoride, chrome, arsenic, dinitrophenol, zinc chloride, boric acid, and ammonium salt. A 50/50 mixture of one-half creosote and one-half fuel oil (PS400) was occasionally used for some wood-treating orders. Production of treated-wood products peaked sometime during the late 1950s and gradually decreased until the facility was shut down in 1969 (Alsid and Carr 1985).

PCP and PAHs are the primary COCs at the Site, and they exist as both NAPL and dissolved-phase constituents in the groundwater. The Site NAPL is predominantly a dense NAPL (NAPL that is denser than water), but some light NAPL also exists.

Two aquifer units (the upper aquifer and lower aquifer) and a middle leaky aquitard (the Intermediate Zone) have been affected by NAPL and dissolved-phase COCs. The upper aquifer is the subject of this ROD Amendment.

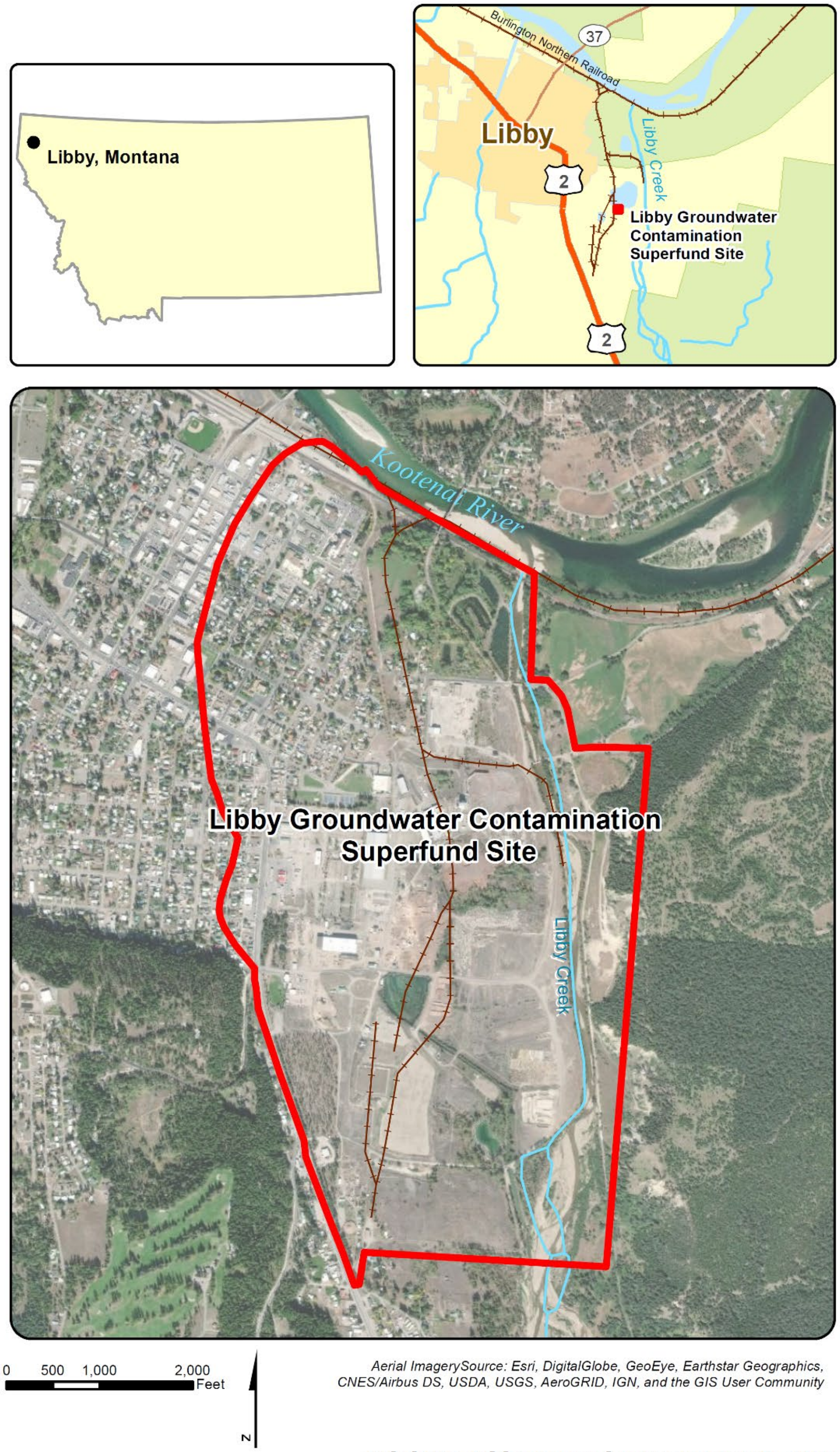
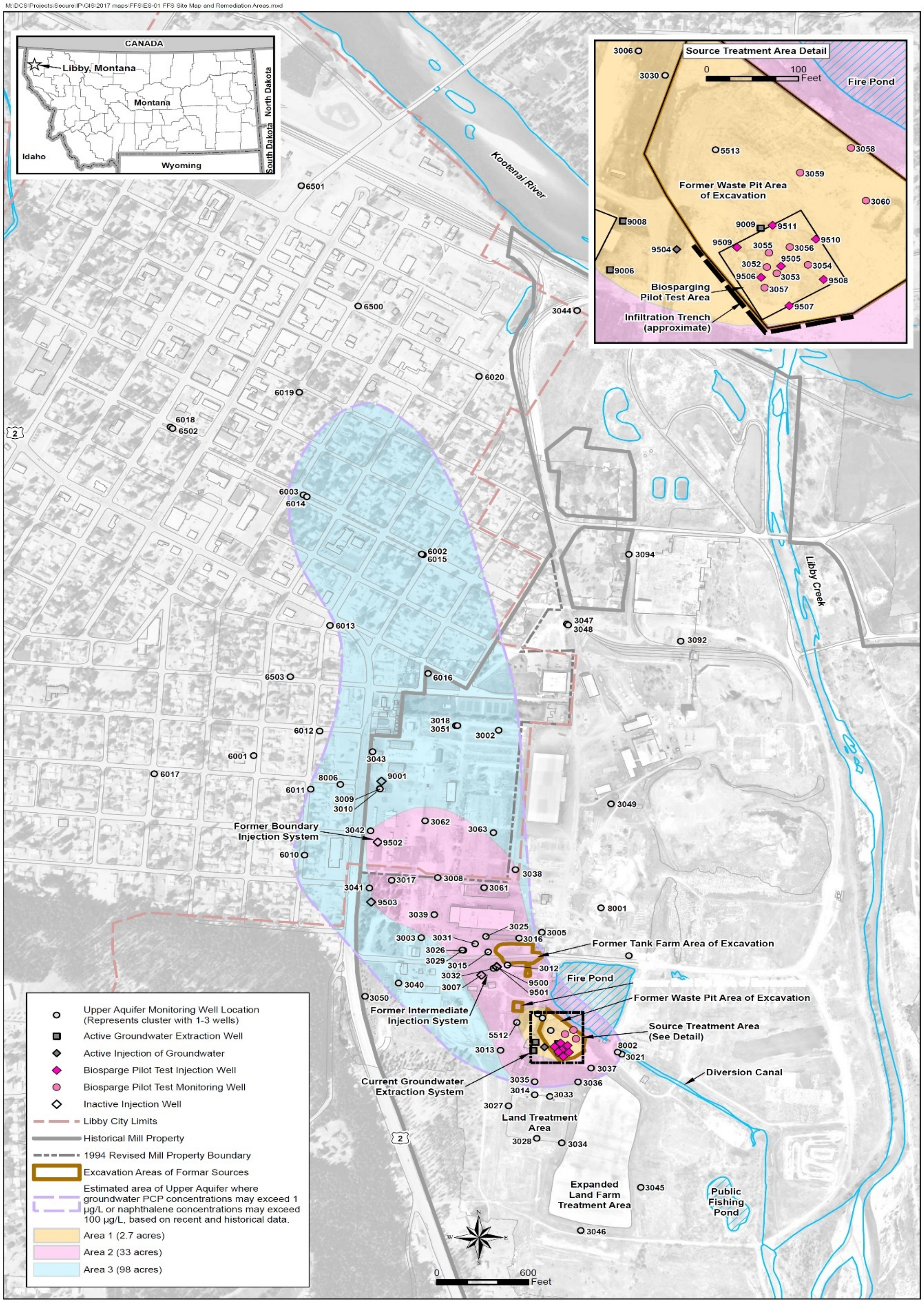


Exhibit 2. Libby Groundwater Contamination Superfund Site Location



Source: AECOM, 2018

Exhibit 3. Site Location Figure Including Contaminated Groundwater Plume and Remediation

1.2 Community Participation

The following community involvement activities were conducted as part of the ROD Amendment process:

- The proposed plan for the Site OU2 ROD Amendment was released on August 19, 2019.
- The EPA prepared and distributed a 2-page fact sheet that summarized the proposed plan for cleanup and the need for a ROD amendment. Fact sheets were available online, in the information repository, and at the public meeting.
- A public notice about the release of the Proposed Plan and information about the public meeting was published in *The Western News* on August 23, in the *Kootenai Valley Record* on August 27, and in the *Montanian* on August 28 and September 4. A follow-up ad detailing the extension of the public comment period was published in *The Western News* on October 4. The notices included the identification of the location of the administrative record supporting the ROD Amendment.
- The Libby groundwater upper aquifer cleanup public meeting was held on September 10, 2019, from 6:30 to 7:45 p.m. in the Ponderosa Room at Libby Town Hall, 952 E. Spruce Street in Libby. The EPA presented the details of the plan and distributed additional copies. A stenographer was present to capture oral comment from attendees. Five people attended the meeting, and one person provided oral comments. The transcript from the public meeting is part of the administrative record for the Site and can be obtained from EPA's Record Center.
- An article on the proposed plan and public comment period was published in the *Kootenai Valley Record* on September 17, 2019.
- A 30-day public comment period ran from August 19 through September 18, 2019. That comment period was extended for an additional 30 days following the receipt of a public comment requesting additional time until October 18, 2019.

2.0 Site History and Enforcement Activities

2.1 Site History

The Site is a former lumber mill and wood-treating operation located on Highway 2 in and around the city of Libby. Historical operating practices and the release of wood-treating fluids resulted in impacts on soil and the underlying groundwater. During early investigations, the Site was divided into two OUs to help accelerate the cleanup process. OU1 addressed immediate public exposure to contaminated groundwater and addressed the development of institutional controls to prevent domestic use of the contaminated groundwater. OU2 consists of soil and groundwater contaminated by wood-treating operations and releases and required remediation of the soils and groundwater. Soil and groundwater remediation has been ongoing at the Site since the late 1980s under the direction of the EPA and DEQ. Exhibit 4 shows the timeline of historical wood-treating activities at the Site.

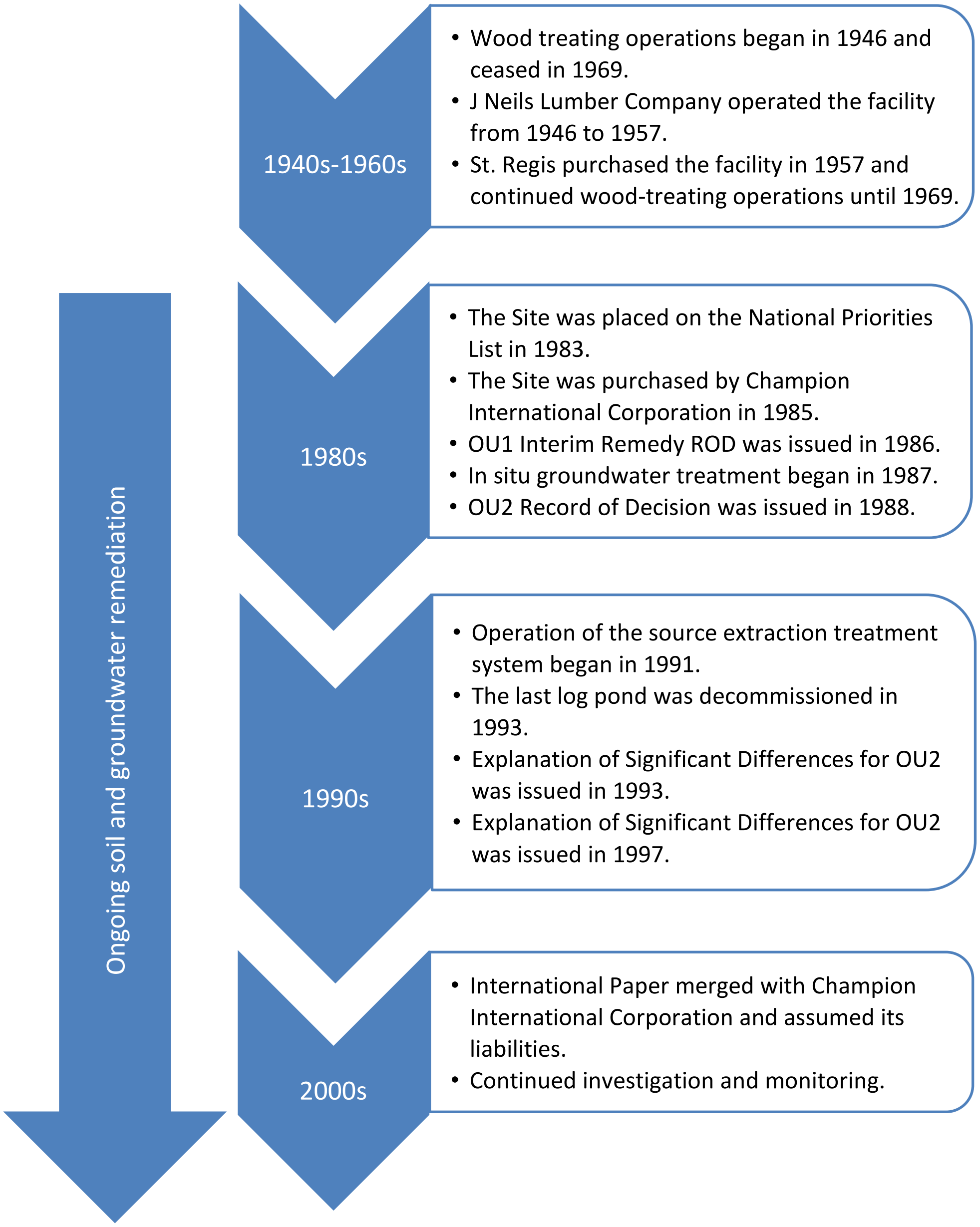


Exhibit 4. Timeline of Wood-treating Activities

The Site was added to the EPA's National Priorities List in 1983, pursuant to CERCLA authority. The St. Regis Paper Company was identified as the primary potentially responsible party, and an initial investigation began in 1983. Champion purchased and merged with the St. Regis Paper Company in 1985 and became the responsible party under the EPA's order. Champion continued remedial investigation and cleanup activities until IP merged with Champion in December 2000 and assumed Champion's liabilities, including its liabilities under a Consent Decree entered in federal district court. Since 1985, Champion, and now IP, has been actively involved in the investigation and cleanup of the Site, as follows:

1. **Interim Remedy for OU1 (1986 ROD).** The results of the 1986 OU1 interim remedy consisted of the following:
   - An ordinance by the City of Libby preventing the installation of new water wells that would provide water for human consumption or irrigation in the upper and lower aquifers within the limits of the City of Libby.
   - A Buy Water Plan, in which responsible parties offered to plug and abandon domestic wells within the aerial extent of groundwater contaminated by the Site, hook residents up to City Water (if not already) and offered financial compensation for the increased cost of using City water for irrigation purposes.
   - An agreement between the responsible party and the City of Libby, whereby Champion provided annual compensation to the City to ensure free irrigation water to residents.
2. **Remedy for OU2 (1988 ROD).** The 1988 OU2 ROD remedy consisted of the following:
   - Excavation and consolidation of contaminated soils from identified source areas (i.e., the waste pit area, the former butt dip area, and the former tank farm).
   - Soil treatment by a two-step biodegradation process: an initial treatment phase in the waste pit area and a second treatment phase in a lined and capped land treatment unit.
   - Degradation of organic contaminants in groundwater beneath the waste pit area using in situ bioremediation treatment processes.
   - NAPL recovery wells (historically referred to as oil recovery wells) to collect highly contaminated groundwater, followed by groundwater treatment prior to reinjection.
   - Monitoring activities to assess the performance of the remedy components during remedial activities at the Site.

   The 1988 ROD also addressed the need for institutional controls by discussing the OU1 institutional control results and the need for deed restrictions and notices, identifying the locations of hazardous substance disposal and treatment areas and land use restrictions for the Site.
3. **1993 Explanation of Significant Differences (ESD).** In September 1993, the EPA modified the OU2 remedy through an ESD (EPA 1993). The EPA, in consultation with DEQ, determined that active remediation in the lower aquifer was technically infeasible. The results of several studies formed the basis for this decision. These studies included a bench-scale study to evaluate bioremediation (WCC 1990); additional characterization to evaluate the nature and extent of contamination in the Lower Aquifer (WCC 1993a); a focused risk assessment (WCC 1993b); and an evaluation of technologies to remediate dense NAPL in the lower aquifer (WCC 1993c). As a result, the final remedy for the lower aquifer consisted of a waiver of groundwater applicable or relevant and appropriate requirements (ARARs; a technical impracticability waiver pursuant to CERCLA Section 121(d)(4)(C) and 40 CFR Section 430(f)(1)(ii)(C)(3)), the continuance of institutional controls prohibiting installation of new water supply wells for consumption or irrigation within the city of Libby, and long-term groundwater monitoring. In addition, the ESD removed the soil cleanup goals established in the 1988 ROD for pyrene, naphthalene, and phenanthrene.
4. **1997 ESD.** Following the first Five-year Review in 1995, the EPA, in consultation with DEQ, determined that the remediation levels presented in the 1988 ROD needed to be reviewed and updated to include criteria that had been developed since the OU2 ROD was issued (EPA 1995). The 1997 ESD modified cleanup levels for the upper aquifer to address updated federal and state maximum contaminant levels in groundwater (MCLs) and risk assessment calculations (EPA 1997).

2.2 Site Characterization

The COCs with associated cleanup levels identified in the 1988 ROD are PCP, PAHs, benzene, and arsenic; the 1988 ROD identified cleanup requirements for these COCs in the upper aquifer (EPA 1988b). The 1997 ESD updated several of these cleanup standards. Following agency denial of a technical impracticability waiver request for the upper aquifer, and recommendations in the 2010 Five-year Review, additional groundwater characterization work for the upper aquifer was undertaken that included an investigation to better delineate the extent of the dissolved-phase plume, a source area characterization to better understand the nature and extent of NAPL in the upper aquifer and an evaluation of remedial technologies (EPA 2010).

To gather information to support a focused feasibility study (FFS) aimed at developing a more effective remedial strategy, IP conducted the following additional work:

- Vapor intrusion investigation to assess vapor as a potential exposure pathway (see Section 4.1)
- Re-evaluation of groundwater cleanup levels
- Laboratory treatability studies to evaluate hot water/steam-enhanced extraction (SEE) and ISB technologies for removing NAPL and reducing dissolved-phase COCs in groundwater
- Field pilot study for ISB to determine specific parameters related to how well ISB might work at the Site
- Collection of additional NAPL and groundwater samples needed to support conceptual design and development of remedial alternatives for the FFS
- Definition (and refinement) of the NAPL source areas and consequent updating of the conceptual site model

This information was compiled into a comprehensive FFS by AECOM, completed in April 2018. In the FFS, AECOM considered supplemental data pertaining to source area investigation, groundwater monitoring, and technology evaluations at both the bench and field pilot scale. With a refined understanding of source distribution and the feasibility of subsurface treatment, AECOM identified a range of remedial alternatives capable of further addressing the nature and extent of contaminants encountered at the Site; the alternatives are presented in the FFS (AECOM 2018). The alternatives address possible remedial actions in three specific areas of the Site (Exhibit 5), as follows:

- Area 1 (2.7 acres) includes the former waste pit source area that contains predominantly residual (immobile) NAPL and the highest groundwater concentrations.
- Area 2 (33 acres) includes the former tank farm source area and residual NAPL that historically migrated away from the former sources.
- Area 3 (98 acres) includes the area containing only dissolved-phase COC contamination in the upper aquifer (beyond the extent of observed NAPL).

The FFS also evaluated residual NAPL as a principal or low-level threat waste. Principal threat waste at this Site is defined as source material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to groundwater, surface water, or air, or that acts as a source for direct exposure. Further, principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur.

According to the EPA (1991), determinations as to whether a source material is a principal or low-level threat should be based on the inherent toxicity as well as a consideration of the physical state of the material (e.g., liquid), the potential mobility of the wastes in the particular environmental setting, and the lability and degradation products of the material. NAPL source material in the upper aquifer is difficult to categorize as either principal or low-level threat waste. This is because of the complex distribution of NAPL in the aquifer and the variability in NAPL composition, NAPL saturation, and groundwater concentrations throughout the aquifer, both laterally and vertically. The highest COC concentrations (and highest toxicity) in groundwater exist in the former waste pit area, partly a result of many of the wells containing small amounts of NAPL (typically a sheen) that increases the concentration in the groundwater sample. Groundwater in this area ranges in concentration from near or below groundwater quality standards to four orders of magnitude above standards.

Because the Site NAPL is not highly mobile, and it is naturally contained reliably at residual saturation, it is not considered a principal threat waste. However, because of the high concentrations in groundwater at some locations where NAPL is present or near locations where NAPL is present, the Site NAPL is not considered to be a low-level threat waste either.

2.3 Implementation of the 1988 ROD

2.3.1 OU2 Groundwater Remedial Design/Remedial Action

The OU2 remedy for the upper aquifer originally consisted of two in situ bioremediation systems: the intermediate injection system and the boundary injection system. The intermediate injection system, located in the tank farm area, operated from 1987 to 1997. The boundary injection system, located approximately 1,000 feet downgradient of the intermediate system, operated from 1993 to 2003. Operation was discontinued because both systems were no more effective than natural attenuation in reducing dissolved-phase PCP and PAHs to cleanup levels because of the presence of trapped NAPL in the upper aquifer.

Since entering the long-term groundwater monitoring phase, the remedy has undergone numerous changes and adjustments. Initiation of a comprehensive groundwater monitoring program began in the fall of 1991 to evaluate the overall distribution of contamination in the upper aquifer. The dissolved-phase plume in the upper aquifer currently extends approximately 1,600 feet north and west of the former Champion property line. The outermost downgradient extent of the main plume is more than 0.5 mile upgradient of the Kootenai River. The recent discovery of a small area of PCP closer to the Kootenai River and in the deeper portion of the Upper Aquifer is either a result of upward migration from the lower aquifer plume or discrete migration through the deeper portion of the Upper Aquifer. Monitoring wells that have characterized the small area of PCP near the river will be incorporated into the groundwater monitoring network to better understand interactions between the Lower and Upper Aquifers and the behavior of PCP near the Kootenai River. PCP, the most widespread groundwater COC, defines the dissolved-phase plume.

NAPL is distributed throughout the upper aquifer in a complex manner and is most frequently observed near the base of the upper aquifer near the former waste pit where the source area extraction wells are screened. The estimated area of upper aquifer contaminated by NAPL is approximately 40 acres.

In the FFS, the groundwater contamination and possible modifications to the remedy to address remaining NAPL and accelerate the cleanup process were assessed. This feasibility study is "focused" in that it pertains to groundwater in the upper aquifer and to newer remedial technologies that have been developed, or further refined, since the submittal of the original feasibility study in 1988. The FFS addresses certain portions of the upper aquifer that contain NAPL, where prior remedial efforts were not successful.

A 2013 vapor intrusion assessment included soil gas sampling. Results indicated no evidence of vapor intrusion under current conditions. The vapor intrusion pathway may need to be revisited in the future if there are significant increases in the contamination levels of the groundwater underlying the buildings or if there are complaints about indoor air quality potentially related to petroleum hydrocarbons.

2.3.2 2015, Five-Year Review

The fifth Five-Year Review for the Site (EPA 2015) cited issues related to the ability of the current OU2 remedy to meet remedial action objectives (RAOs). The Five-Year Review indicated that the remedy for OU2 was not functioning as intended because of the inability to meet RAOs in the intended timeframe. The review referenced the ongoing focused remedial investigation and feasibility study evaluating additional remedial options to address source areas and groundwater contamination and identified additional institutional controls to prohibit groundwater use outside of the city limits.

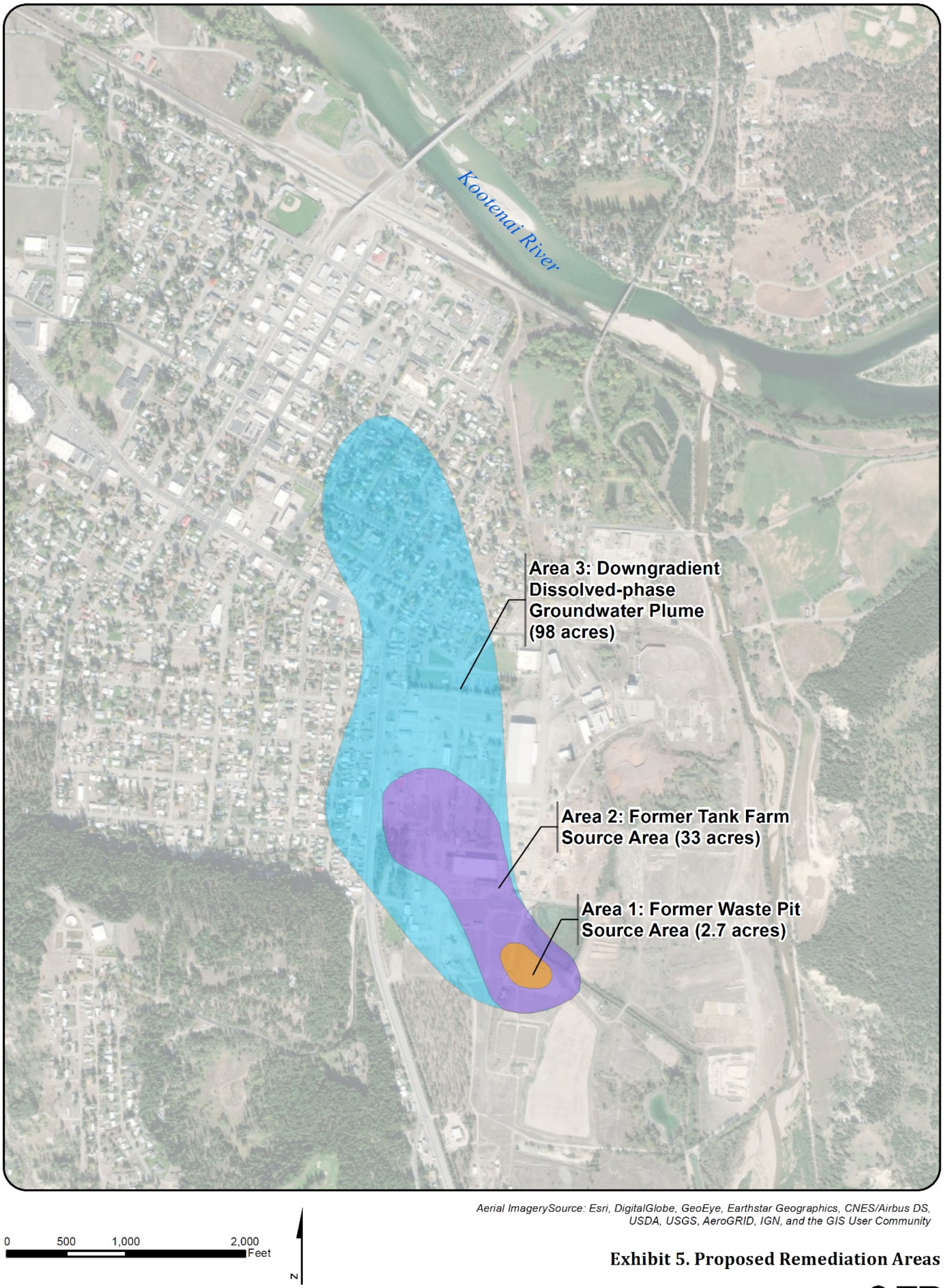


Exhibit 5. Proposed Remediation Areas

3.0 Basis for Amendment

Remediation of soil and upper aquifer groundwater has been ongoing at the Site since 1988. The primary source of groundwater contamination is wood-treating fluid and wastes that remain in the upper aquifer in the form of NAPL and chemicals in the NAPL that have dissolved in the groundwater.[2]

Early actions, including excavation of contaminated soil, extraction of NAPL, and treatment of contaminated groundwater, were taken to mitigate risks to human health until groundwater cleanup could be achieved.

The EPA's 1986 ROD discussed a city ordinance that prohibits well drilling for human consumption or irrigation (EPA 1986) and associated institutional control measures. Through an agreement with the City of Libby and Champion, that ordinance was enacted. The city ordinance is still in place today, and IP, who acquired the Site remediation responsibilities upon its merger with Champion in 2000, still subsidizes a portion of the city water cost for residents. Currently, there is no known use of contaminated groundwater for human consumption or irrigation outside of the city limits although institutional controls to ensure this situation remains is currently being pursued by EPA, DEQ and IP. In its 2015 Five-Year Review, the EPA concluded that the current Site remedy is protective of human health and the environment because no known completed exposure pathway exists (EPA 2015). Nevertheless, the contaminated groundwater plume must be remediated, such that cleanup levels are met, and changes to the existing remedy are needed, as explained in the following paragraph.

Although more than 40,000 gallons of NAPL have been removed from the subsurface, prior remedial efforts at the Site have not been successful in meeting groundwater cleanup goals in certain portions of the upper aquifer, in particular those areas that contain NAPL. Thus, the EPA and DEQ are implementing a revised cleanup strategy that addresses NAPL-contaminated portions of the upper aquifer with the highest COC concentrations, the highest potential for releasing dissolved COCs to the groundwater, and the greatest potential risk to human health. These measures should lead to achieving groundwater performance standards in the upper aquifer described in Exhibit 6. Concurrently, the EPA and DEQ are in the process of strengthening existing institutional controls to ensure that while groundwater is being remediated, that property owners inside and outside of city limits are not exposed to contaminated groundwater.

4.0 Development of Remedial Alternatives

4.1 Summary of Site Risks

A baseline human health assessment was prepared in 1986 that included an assessment of the current and future human health risks from groundwater contaminated primarily with PCP and PAHs in the upper aquifer.

No new upper aquifer groundwater risk assessment evaluation has been performed. Risks posed to human health and the environment by current conditions are expected to be comparable to those described in the 1986 baseline human health assessment and the 1988 OU2 ROD. At that time, the EPA determined that exposure to groundwater for residential domestic use would result in unacceptable risks (EPA 1988b, WCC 1986).

Samples collected from soil vapor, indoor air, and outdoor air between 2011 and 2013 were more recently used to determine that a risk assessment to evaluate human exposure to soil vapor is not required for this site.

4.2 Remediation Goals

The Site groundwater COCs were established in the 1988 ROD and the 1997 ESD. Groundwater cleanup levels revised by this ROD Amendment are federal MCLs promulgated under the Safe Drinking Water Act

[2] The lower aquifer was determined to be technically impracticable to clean up and a Technical Impracticality waiver for the lower aquifer was issued in the 1993 ESD. The deeper plume is monitored regularly to ensure the extent of contamination does not increase.

for the COCs that have MCLs; for COCs without MCLs, Montana's *Circular DEQ-7* numeric groundwater quality standards are used (Exhibit 6). The revised groundwater cleanup levels (also called Performance Standards) will become effective once the ROD Amendment is signed.

Exhibit 6. Revised Groundwater Cleanup Levels for the Upper Aquifer

Contaminant of Concern	Preliminary Revised Groundwater Cleanup Level—Upper Aquifer	Units
PAHs		
Acenaphthene	70	µg/L
Anthracene	2,100	µg/L
Fluoranthene	20	µg/L
Fluorene	50	µg/L
Naphthalene	100	µg/L
Pyrene	20	µg/L
Benz(a)anthracene	0.5	µg/L
Benzo(a)pyrene[a]	0.2	µg/L
Benzo(b)fluoranthene	0.5	µg/L
Benzo(k)fluoranthene	5	µg/L
Chrysene	50	µg/L
Dibenz(a,h)anthracene	0.05	µg/L
Indeno(1,2,3-c,d)pyrene	0.5	µg/L
Other Compounds		
Pentachlorophenol[a]	1	µg/L
Benzene[a]	5	µg/L
Arsenic	10	µg/L

Notes:

[a] Cleanup level is based on MCLs. All other cleanup levels are based on MDEQ-7 groundwater quality standards.

µg/L = microgram(s) per liter

4.3 Applicable or Relevant and Appropriate Requirements

Section 121(d) of CERCLA and the NCP require that onsite remedial actions must meet laws, standards, requirements, regulations, criteria, or limitations under federal or state environmental laws and regulations, and state citing laws and regulations, that are determined to be applicable or relevant and appropriate requirements (ARARs). Requirements determined to be applicable or relevant and appropriate under state law must be met if they are promulgated, consistently applied, and more stringent than federal requirements. If the state has primacy for a regulatory program and has adopted its own regulations that are at least as stringent as the federal regulations, then the state requirements are generally identified as ARARs, and the federal requirements are not listed. The 1990 NCP requires compliance with ARARs during, and at completion of, remedial actions. Under limited circumstances, ARARs for onsite remedial actions may be waived. Pursuant to the NCP, ARARs are frozen at the time a ROD is issued, unless changed ARARs are needed to ensure protectiveness.

ARARs are identified on a site-specific basis using a two-part analysis: 1) determination of whether a given requirement is applicable, and 2) determination of whether a requirement is relevant and appropriate if it is not applicable (EPA 1988a). Applicable requirements are cleanup standards, control standards, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance. Relevant and appropriate requirements are cleanup standards, control standards, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that may not be applicable to a specific hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance, but address problems or situations sufficiently similar to those encountered to render them well-suited for use at that particular site.

To determine whether a requirement is relevant and appropriate, characteristics of the remedial action, the hazardous substances present, and the physical characteristics of the Site must be compared to those addressed in the statutory or regulatory requirement. In some cases, a requirement may be relevant but not appropriate. In other cases, only part of a requirement will be considered relevant and appropriate. When it has been determined that a requirement is both relevant and appropriate, the requirement must be complied with to the same degree it would be if it were applicable (EPA 1988b).

Because the ARARs identified in the 1988 ROD have changed substantially since that time, and the risk-based science that forms the basis for the ARARs has been updated, this document identifies current ARARs for application to the remedial alternatives that were analyzed.

Remedial actions have to comply with the following requirements (EPA 1988b):

- *Chemical-specific ARARs:* Chemical-specific ARARs are health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values. These values establish an acceptable amount or concentration of a chemical that may remain in, or be discharged to, the ambient environment. Examples of chemical-specific ARARs include MCLs under the federal Safe Drinking Water Act and ambient water quality criteria enumerated under the Montana Water Quality Act.
- *Location-specific ARARs:* Location-specific ARARs are restrictions on hazardous substances or the conduct of the response activities solely based on their location in a special geographic area. Examples include restrictions on activities in wetlands, sensitive habitats, and historic places.
- *Action-specific ARARs:* Action-specific ARARs are technology- or activity-based requirements or limits on actions taken with respect to a particular hazardous substance. A particular remedial activity triggers these requirements, such as discharge of contaminated groundwater or in situ remediation.

To be considered (TBC) items are non-promulgated advisories, proposed rules, criteria, or guidance documents issued by the federal or a state government that are not legally binding and do not have the status of potential ARARs.

ARARs define cleanup goals when they set an acceptable level with respect to site-specific factors. However, cleanup goals for some substances may have to be based on non-promulgated criteria and advisories rather than on ARARs because ARARs do not exist for those substances or because an ARAR alone would not be sufficiently protective in the given circumstances. To meet the cleanup goals in these situations, the cleanup requirements will not be based on ARARs alone but also on TBCs.

In accordance with CERCLA, the NCP, and EPA policy and guidance, chemical-specific ARARs (and TBCs necessary for protection) must be attained for contaminants remaining onsite at the completion of the remedial action, unless a waiver is justified. The EPA also intends that the implementation of remedial actions should comply with location-specific and action-specific ARARs (and TBCs as appropriate).

The 1988 ROD specified that groundwater cleanup levels were MCLs for contaminants for which MCL standards exist. If there are no MCLs, the EPA determined that for this Site, risk-based cleanup levels representing risk to 1×10^{-5} were appropriate. The 1997 ESD altered some of the original ARAR or risk-based levels. As of January 23, 2006, the MCL for arsenic in groundwater decreased from 50 µg/L to

10 μg/L (40 CFR 141.62). In addition, the PAH-specific MCLs no longer exist for chrysene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-c,d)pyrene, or dibenzo(a,h)anthracene.

In the FFS (AECOM 2018), potential ARARs for each remedial alternative considered for the upper aquifer at the Site were evaluated. None of the potential alternatives would involve the following: 1) discharge to a publicly-owned treatment works, 2) release of any hazardous waste or hazardous constituents, 3) onsite disposal of any hazardous waste from groundwater (although there is onsite disposal of treated waste which must be addressed pursuant to current standards), or 4) storage for more than 90 days onsite of any hazardous waste (unless eligible for less stringent requirements available to waste generators for onsite accumulation of hazardous waste).

With the selection of the remedy described in this ROD Amendment, the larger list of preliminary ARARs in the FFS has been modified to a smaller list of the final ARARs for the selected remedy. These final ARARs are listed in Appendix A.

4.4 Remedial Action Objectives

This ROD Amendment addresses upper aquifer groundwater contamination at the Site. The following RAOs were updated for the upper aquifer based on recent site characterization information and recommendations in EPA's 2010 Five-Year Review (EPA 2010):

- Prevent ingestion of upper aquifer groundwater with site-related COCs at concentrations that exceed preliminary revised groundwater cleanup levels.
- Protect human health and the environment by reducing concentrations of site-related COCs in upper aquifer groundwater to revised groundwater cleanup levels.

4.5 Technology Screening

The FFS (AECOM 2018) identified and screened remedial action technologies. The report focused on a range of technologies applicable to wood-treating sites with an emphasis on treatment technologies that address NAPL and that are typically used for remediation of PCP and naphthalene in groundwater. Technology types and process options were identified as being applicable to the Site to address the COCs for each of the response actions. Multiple removal and in situ treatment technology types and process options were identified as being applicable to the Site, and these were further evaluated. These technologies and process options were evaluated with respect to effectiveness, implementability, and cost. The technology/process option screening results from the FFS are summarized in Appendix B. The retained technology process options are provided in Exhibit 7.

Exhibit 7. Technologies/Process Options Retained

General Response Action	Potential Remedial Technology	Technology/Process Option
No Action	No Action	No Further Action
Access Restrictions	Institutional Controls	Institutional Controls
Physical Containment	Hydraulic Containment	Groundwater Extraction
Removal	Enhanced Physical Removal	Steam Enhanced Extraction
In Situ Treatment	Physical/Chemical Treatment	In Situ Geochemical Stabilization
	Physical/Biological	Natural Attenuation Aerobic Oxidation (Biosparge)

4.6 Description of Alternatives

The current site remedy for the upper aquifer groundwater consists of the following major components:

- Soil removal (in 1989, approximately 45,000 cubic yards of soil and 31,000 cubic yards of rock [> 1 inch] were excavated, for a total of 76,000 cubic yards)
- Onsite soil treatment (land treatment units)
- In situ bioremediation systems (injection of clean oxygenated water into the upper aquifer, discontinued in 1997)
- Source area extraction and treatment systems (operating since 1989 in various configurations, offsite incineration of recovered NAPL, onsite treatment, and re-injection of inoculated groundwater)

In addition, the City ordinance and associated institutional control measures preventing the installation of new water wells that would produce water for human consumption or irrigation is still in place today, and IP still subsidizes a portion of the City water cost for residents.

In order to evaluate remediation alternatives in the FFS, upper aquifer remediation areas were developed on the basis of COC concentrations in groundwater and the interpreted presence of NAPL in the upper aquifer (Exhibit 7). The rationale for selecting remediation areas in this manner allowed for evaluation of applying more rigorous treatment technologies to those areas that pose the greatest risk to human health (i.e., areas of the aquifer with the highest COC concentrations) and those areas that serve as a continuous source of groundwater contamination (i.e., areas of the aquifer with the greatest NAPL impacts). The following three remediation areas were identified:

- Area 1 (2.7 acres) encompasses the former waste pit source area and contains the highest groundwater concentrations and the residual NAPL saturations.
- Area 2 (33 acres) encompasses the former tank farm source area and NAPL that historically migrated away from the former sources. The upper aquifer in Area 2 is intermittently affected by residual NAPL.
- Area 3 (98 acres) encompasses the area containing only dissolved-phase COC contamination in the upper aquifer (beyond the extent of observed NAPL).

Using the results of the technology/process option screening to address NAPL and COCs in the upper aquifer at the Site, five new alternatives (including no action) were evaluated in the 2018 FFS. The alternatives include application of remediation technologies by area, as follows:

Alternative 1- No Action with Institutional Controls
Alternative 2 - Hydraulic Containment (Area 1), ISB (Area 2), and MNA (Area 3)
Alternative 3 - ISB (Areas 1 and 2) and MNA (Area 3)
Alternative 4 - SEE/ISB (Area 1), ISB (Area 2), and MNA (Area 3)
Alternative 5 - In Situ Geochemical Stabilization (ISGS) (Area 1), ISB (Area 2), and MNA (Area 3)

Overall, the alternatives employ an active remedy to Area 1, which has a higher concentration of contamination, but a more passive remedy to Area 2 because of the discontinuous and irregular distribution of contamination intermixed with “cleaner” lenses throughout Area 2. With the exception of Alternative 1, each of the alternatives share the same approach for Area 2, which involves active treatment along a transect mid-way through the area, but natural and passive remediation throughout the remainder of the area. Each alternative employs MNA in Area 3. A summary of the major remediation technology components by area by alternative is provided in Exhibit 8.

Exhibit 8. Alternatives Summary

Area	Alternative	Major Remediation Technology Component
All Areas	Alternative 1	Institutional Controls
Area 1	Alternative 2	Hydraulic Containment
	Alternative 3	In Situ Biosparging
	Alternative 4	Steam-Enhanced Extraction and In Situ Biosparging
	Alternative 5	In Situ Geochemical Stabilization
Area 2	Alternative 2	In Situ Biosparging
	Alternative 3	
	Alternative 4	
	Alternative 5	
Area 3	Alternative 2	Monitored Natural Attenuation
	Alternative 3	
	Alternative 4	
	Alternative 5	

The five new alternatives and their associated cost estimates are summarized in Sections 4.6.1 through 4.6.5.

4.6.1 Alternative 1, No Action with Institutional Controls

Estimated Capital Costs: $400,000
Estimated Operation and Maintenance (O&M) Costs: $500,000
Total Estimated Present-value Costs: $900,000
Estimated Construction/Operation Duration: 0 year
Estimated Time to Achieve RAOs: 145 years

As required under CERCLA, a "no action" alternative is evaluated to compare cleanup alternatives with baseline Site conditions. Under Alternative 1, current remedial actions would be stopped for the upper aquifer. Current and additional institutional controls, including well drilling and deed restrictions, would be retained. Limited groundwater monitoring would be conducted.

4.6.2 Alternative 2, Hydraulic Containment (Area 1), In Situ Biosparging (Area 2), and Monitored Natural Attenuation (Area 3)

Estimated Capital Costs: $5,120,000
Estimated O&M Costs: $94,680,000
Total Estimated Present-value: $99,800,000
Estimated Construction/Operation Duration: 145 years
Estimated Time to Achieve RAOs in Area 1: 145 years

Alternative 2 includes the following components:

- Groundwater extraction from six wells, aboveground treatment, and reinjection of treated groundwater to hydraulically contain contaminated groundwater in the former waste pit area (Area 1) and limit the mass flux from Area 1 into Area 2

- ISB near the downgradient extent of NAPL in Area 2 (24 injection wells)
- MNA in Area 3

Institutional controls would also be a component of Alternative 2. Groundwater would be monitored to verify that the remedy is performing as intended (i.e., concentrations of COCs are decreasing over time).

4.6.3 Alternative 3, In Situ Biosparging (Areas 1 and 2) and Monitored Natural Attenuation (Area 3)

Estimated Capital Costs: $2,350,000
Estimated O&M Costs: $4,660,000
Total Estimated Present-value: $7,010,000
Estimated Construction/Operation Duration: 41 years
Estimated Time to Reach RAOs in Area 1: 6 years

Alternative 3 includes the following components:

- ISB in Area 1 by injecting compressed air through approximately 44 shallow and 11 deep injection wells
- ISB in Area 2 (same as Alternative 2)
- MNA in Area 3 (same as Alternative 2)

Institutional controls would also be a component of Alternative 3. Groundwater would be monitored to verify that the remedy is performing as intended.

4.6.4 Alternative 4, Steam-enhanced Extraction/In Situ Biosparging (Areas 1 and 2), and Monitored Natural Attenuation (Area 3)

Estimated Capital Costs: $33,490,000
Estimated O&M Costs: $4,480,000
Total Estimated Present-value: $37,970,000
Estimated Construction/Operation Duration: 41 years
Estimated Time to Achieve RAOs in Area 1: 5 years

Alternative 4 includes the following components:

- Application of SEE followed by ISB to address NAPL and contaminated groundwater in the waste pit area (Area 1). SEE will increase NAPL mobility and stripping of COCs using multi-phase extraction wells and soil vapor extraction wells.
- ISB in Area 2 (same as Alternative 2).
- MNA in Area 3 (same as Alternative 2).

Institutional controls would also be a component of Alternative 4. Groundwater would be monitored to verify that the remedy is performing as intended.

4.6.5 Alternative 5, In Situ Geochemical Stabilization (Area 1) and In Situ Biosparging (Area 2)

Estimated Capital Costs: $20,330,000
Estimated O&M Costs: $4,030,000
Total Estimated Present-value: $24,360,000
Estimated Construction/Operation Duration: 41 years
Estimated Time to Achieve RAOs in Area 1: 1 year

Alternative 5 includes the following components:

- Application of ISGS by injecting a proprietary modified-permanganate solution into Area 1 through approximately 600 injection points, which would encapsulate NAPL and oxidize organics.
- ISB in Area 2 (same as Alternative 2).
- MNA in Area 3 (same as Alternative 2).

Institutional controls would also be a component of Alternative 5. Groundwater would be monitored to verify that the remedy is performing as intended (i.e., concentrations of COCs are decreasing over time).

5.0 Comparative Analysis of the Remedial Alternatives

The NCP contains provisions that require each alternative to be evaluated against nine criteria listed in 40 CFR 300.430(e)(9). These criteria were published in the March 8, 1990, Federal Register (55 FR 8666) to provide a basis for comparing the relative performance of the alternatives and to identify their advantages and disadvantages. This evaluation is intended to provide sufficient information to adequately assess the alternatives and to select the most appropriate alternative for implementation as a remedial action at the Site. The nine evaluation criteria are the following:

Threshold Criteria:

(1) Overall protection of human health and the environment
(2) Compliance with ARARs

Balancing Criteria:

(3) Long-term effectiveness and permanence
(4) Reduction of toxicity, mobility, and volume through treatment
(5) Short-term effectiveness
(6) Implementability
(7) Cost

Modifying Criteria:

(8) State acceptance
(9) Community acceptance

The criteria are categorized into three groups: threshold criteria, balancing criteria, and modifying criteria. Unless a waiver can be obtained, a particular alternative must meet threshold criteria for it to be eligible for selection as a remedial action. A particular alternative must meet the threshold criteria or that alternative is considered unacceptable without a waiver. If ARARs cannot be met, a waiver may be obtained.

Unlike the threshold criteria, the five balancing criteria assess the advantages and disadvantages of alternatives. A low rating on one balancing criterion can be compensated by a high rating on another. The two modifying criteria are evaluated after the FFS undergoes public comment and are used to modify the recommended alternative, as appropriate. In addition, each of the alternatives was evaluated qualitatively with respect to sustainability metrics in the comparative analysis. A summary of the evaluation criteria is shown in Exhibit 9.

Exhibit 9. FFS Evaluation Criteria

Criterion	Description
Threshold	
Overall protection of human health and the environment	Alternative eliminates, reduces, or controls threats to health and environment through institutional controls, engineering controls, or treatment.
Compliance with ARARs	Alternative meets federal, state, and tribal ARARs or is waiver justified.

Exhibit 9. FFS Evaluation Criteria

Criterion	Description
Balancing	
Long-term effectiveness and permanence	Alternative maintains protection of human health and the environment over time?
Reduction of toxicity, mobility, or volume via treatment	Alternative uses treatment to reduce harmful effects, ability to move, and the amount of contamination left after cleanup?
Short-term effectiveness	How much time is needed to implement and what risk is posed in that time?
Implementability	What is feasibility of implementing alternative (e.g., availability of materials and services)?
Cost	What are estimated capital, annual O&M, and present-value costs?
Modifying	
State acceptance	State agrees with the EPA's analyses and recommendations.
Community acceptance	Community agrees with the EPA's analyses and preferred alternative.

In the comparative analysis, each of the alternatives was compared against one another with respect to each of the NCP criteria. Evaluation of the criteria generally identifies the significant differences and key issues between alternatives. Exhibit 10 presents a visual depiction of the comparative analysis results. A summary of the comparative analysis performed in the FFS is presented in Sections 5.1 through 5.3, by criterion.

Exhibit 10. Summary Evaluation of Alternatives

Alternative	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume through Treatment	Short-Term Effective-ness	Implement-ability	Cost Ranking	Sustain-ability
1. No Further Action	◐	◉	◐	○	◉	●	●	●
2. Area 1 Containment & Area 2 ISB	◉	◉	◉	◐	◐	◐	○	◐
3. Areas 1 & 2 ISB	●	●	●	●	◉	◉	◉	●
4. Area 1 SEE/ISB & Area 2 ISB	●	●	●	●	◐	○	○	○
5. Area 1 ISGS & Area 2 ISB	●	●	●	●	◉	◉	◐	◉

Ranking from lowest to highest performance: least desirable ○, next least desirable ◐, more desirable ◉, most desirable ●

5.1 Threshold Criteria

5.1.1 Overall Protection of Human Health and the Environment

Each alternative is adequately protective because institutional controls prevent the use of or receptor exposure to contaminated groundwater. Alternatives 3, 4, and 5 are the most protective because NAPL and groundwater contamination are removed or treated so that RAOs and cleanup levels for groundwater can be achieved over a shorter period of time relative to Alternatives 1 and 2. Alternatives 3 and 4 will reach cleanup goals more rapidly than the other alternatives. Alternative 2 is marginally more protective than Alternative 1 because it controls contaminant migration and provides minor treatment.

5.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

Each alternative complies with chemical-, location-, and action-specific ARARs; however, Alternative 1 will not comply with chemical-specific ARARs for a long period of time.

5.2 Balancing Criteria

5.2.1 Long-term Effectiveness and Permanence

Alternatives 3, 4, and 5 provide a permanent remedy through in situ treatment or removal of NAPL and contaminants in groundwater. Following active treatment, NAPL that remains would be immobilized and relatively insoluble. Alternatives 3 and 4 will degrade and immobilize NAPL. Under Alternative 5, NAPL will be encapsulated. Alternative 2 includes limited treatment but involves long-term management of an onsite facility. Alternative 1 is the least effective because no treatment will occur beyond natural attenuation over a long duration. Overall, Alternatives 3, 4, and 5 are anticipated to provide long-term effectiveness and permanence and are more effective than Alternative 2, which is slightly more effective than Alternative 1.

5.2.2 Reduction of Toxicity, Mobility, and Volume through Treatment

Alternatives 3, 4, and 5 provide the greatest reduction in toxicity, mobility, and volume, but differ in how they do so in Area 1. Alternatives 3 and 4 achieve the desired reduction in toxicity and mobility relatively quickly because ISB is anticipated to be complete at Year 6 for Alternative 3 and SEE is anticipated to be complete at Year 5 for Alternative 4. Alternative 4 also provides the greatest immediate reduction in volume and a considerable reduction in toxicity because it would remove 20 percent of the NAPL volume and reduce mass fractions in approximately 1 year. Alternative 5 achieves the most rapid reduction in toxicity and mobility, addressing 80 percent of the NAPL mass in the first year but then requires an additional 29 years of attenuation to adequately reduce toxicity and mobility. Alternative 2 takes considerably longer to reduce the toxicity, mobility, and volume of the NAPL and contaminated groundwater, and offers a marginal advantage over Alternative 1 (beyond natural attenuation) in that it reduces contamination via extraction in Area 1 and via ISB in Area 2.

5.2.3 Short-term Effectiveness

Alternative 1 has the fewest short-term impacts, followed by Alternative 3, Alternative 5, Alternative 2, and lastly by Alternative 4, which has the most short-term impacts. With the exception of Alternative 1, each alternative has equal remediation timeframes in Areas 2 and 3, which are the limiting time frames. In Area 1, Alternative 4 is estimated to meet cleanup levels in the shortest timeframe at Year 5, closely followed by Alternative 3 at Year 6, then Alternative 5 at Year 30, and Alternatives 1 and 2 at Year 145.

5.2.4 Implementability

Alternative 1 is the easiest to implement because no action is conducted, except for limited groundwater monitoring and continuation of institutional controls. Alternative 3 is the next easiest to implement, involving approximately 79 ISB injection wells and operation of a simple system for 6 and 41 years in Areas 1 and 2, respectively. There will be some efficiencies shared in operating ISB in both Areas 1 and 2 as part of Alternative 3. Alternative 5 is slightly more complex than Alternative 3 because it requires approximately 600 ISGS injection points. The complexity increases with Alternative 2, which involves an extraction and aboveground treatment system for 145 years in Area 1, in addition to 41 years of ISB in Area 2. Alternative 4 is the most complex, involving the most equipment and specialized services to implement, as well as multiple extraction systems and aboveground treatment components for vapor and liquids. Alternative 4 also involves implementing ISB upon completion of SEE, although the SEE injection points could be used for injecting air.

5.2.5 Cost

Alternative 1 has no costs associated with active remediation but includes costs for limited groundwater monitoring and EPA reviews. Alternative 3 is the lowest cost alternative to implement. Alternative 5 provides similar levels of protection with moderately longer remediation timeframes compared to Alternative 3, but Alternative 5's cost is estimated at more than three times the cost of Alternative 3. Alternative 4 provides protection similar to that of Alternative 3, but it is nearly five times more expensive. Alternative 2 is the costliest alternative and has the longest remediation timeframe.

5.3 Modifying Criteria

5.3.1 State Acceptance

DEQ has been involved throughout the remedy selection process and prefers Alternative 3 over the other alternatives based on the evaluation of the seven NCP criteria.

5.3.2 Community Acceptance

The EPA's assessment of community acceptance is based on conversations with community members and on comments received during the formal public comment period. No adverse comments regarding the proposed remedial approach were received from the public. The EPA received informal comments of support regarding the preferred alternative presented in the Proposed Plan (Alternative 3).

5.4 Sustainability Evaluation

The EPA recognizes that many factors are involved in evaluating remedial alternatives, including the environmental effects of remedy implementation. Greener or sustainable cleanup activities can be evaluated in the context of a complete balancing criteria analysis for evaluating alternatives after determining that the alternative meets the threshold criteria of protectiveness and compliance with ARARs. Sustainability metrics can be used to help determine relative benefits versus negative impacts of remedial actions.

A qualitative evaluation with respect to the sustainability metrics was performed as part of the FFS. The sustainability metrics considered included the following:

- Materials Used
- Waste Generated
- Water Usage
- Energy Usage
- Air Emission

These metrics are similar to EPA's metrics for conducting an environmental footprint analysis of site cleanup activities and are described in the EPA document, *Methodology for Understanding and Reducing a Project's Environmental Footprint* (EPA 2012).

Materials Metrics. The materials metrics consider the amount of materials used onsite. In general, manufactured or significantly processed materials used onsite and come from offsite sources include chemicals, nutrients, food grade amendments, metals, plastics, and cement.

Waste Metrics. The waste metrics consider the waste generated onsite and whether the waste is hazardous or nonhazardous or can be recycled or reused. Onsite hazardous waste includes waste generated onsite and disposed of at an offsite hazardous waste facility or a regulated onsite disposal unit. This includes excavated soil, treatment plant residuals, and recovered product. Onsite nonhazardous waste is generated onsite, disposed of offsite, and can include soil, concrete, metal, vegetation, and treatment plant residues.

Water Metrics. This metric considers the amount of water used onsite during remediation and the sources and fate of the used water. This includes water used for equipment decontamination, extraction and treatment, and chemical blending. Water sources include potable water supplies, extracted groundwater, surface water, and reclaimed water. The fate of water includes reuse, use in a process or for irrigation, discharge to groundwater, surface water or a publicly-owned treatment works or sewer system.

Energy Metrics. The energy metrics consider the amount of energy used by the remedy (onsite and offsite). This energy is for electricity generation, transportation, materials manufacturing, and other offsite activities that support the remedy.

Air Emissions Metrics. The air emission metrics consider emissions of greenhouse gases, nitrogen oxides, sulfur oxides, particulate matter, and hazardous air pollutants.

An analysis of alternatives with respect to the sustainability metrics was conducted to identify aspects of a remedy that cause the greatest impacts for each of the metrics presented in the FFS. Alternative 1, No Further Action, involves decommissioning the source area extraction and treatment system (SAETS), abandonment of wells, and demolition of the building. This activity would also be conducted under Alternatives 3, 4, and 5. For Alternative 2, existing equipment would be evaluated for reuse in the aboveground groundwater treatment system. Therefore, this activity was not included in the sustainability evaluation, and Alternative 1 was not evaluated because there would be no remediation activities associated with Alternative 1, except for limited groundwater monitoring once the SAETS, wells, and building are decommissioned and removed. The sustainability evaluation in the FFS focused on the alternatives employing active remediation. A summary of the qualitative evaluation of each alternative with respect to each metric and the relative impacts and impact drivers are provided in Exhibit 11. Based on the analysis, Alternative 3 is the most sustainable of the active remediation alternatives, having the lowest net environmental footprint. With respect to the five metrics considered under sustainability (materials used, waste generation, water usage, energy usage, and air emissions), Alternative 3 either had a smaller footprint than other alternatives or was similar to other alternatives in having the lowest impact.

Exhibit 11. Evaluation Based on Sustainability Metrics

Alternatives	Active Treatment Timeframe (Years)	Impact Assessment	Materials Used	Onsite Waste Generation	Water Usage	Energy Usage	Air Emissions
2. Hydraulic Containment and In Situ Biosparging		***Relative Impact***	***High***	***High***	***Low***	***High***	***Low***
	Area 1 160 Area 2 45	Impact Drivers	Well construction. Aboveground groundwater extraction, treatment, and reinjection system equipment. Aboveground air injection system.	Hazardous waste-NAPL. Spent GAC, biomass from treatment system operation. Hazardous and nonhazardous waste-soil IDW from well installation.	Decontamination of equipment. Well drilling.	Electrical power for aboveground groundwater extraction, treatment, and reinjection system equipment and building HVAC and lighting. Electrical power for one compressor for air injection. Fuel for drilling equipment.	Transportation of equipment to site. Drilling equipment used during well installation.
3. In Situ Biosparging		***Relative Impact***	***Low***	***Low***	***Low***	***Low***	***Low***
	Area 1 10 Area 2 45	Impact Drivers	Well construction. Aboveground air injection system.	Hazardous and nonhazardous waste-soil IDW from well installation.	Decontamination of equipment. Well drilling.	Electrical power for three compressors for air injection. Fuel for drilling equipment.	Transportation of equipment (compressors, piping) to site. Drilling equipment used during well installation.

Exhibit 11. Evaluation Based on Sustainability Metrics

Alternatives	Active Treatment Timeframe (Years)	Impact Assessment	Materials Used	Onsite Waste Generation	Water Usage	Energy Usage	Air Emissions
4. Steam Enhanced Extraction and In Situ Biosparging		***Relative Impact***	***High***	***High***	***High***	***High***	***High***
	Area 1 1+ Area 2 45	Impact Drivers	Well construction. Steam generating equipment. Aboveground liquid extraction and treatment system. Aboveground vapor extraction and treatment system. Shotcrete cover over 2.7 acres. Vinyl sheet pile and bentonite subsurface wall. Aboveground air injection system.	Hazardous waste-NAPL. Spent GAC from treatment system operation. Nonhazardous waste-liquid from water softening and steam generation system operation. Hazardous and nonhazardous waste-soil IDW from well installation. Hazardous and nonhazardous waste-soil IDW from wall installation.	Steam generation. Decontamination of equipment. Well drilling.	Electrical power for aboveground groundwater extraction, treatment, and reinjection system equipment. Electrical power for aboveground vapor extraction and thermal oxidizer treatment system equipment. Fuel for steam generation. Fuel for excavation equipment. Fuel for drilling equipment. Electrical power for one compressor for air injection.	Potential emissions from steam-generating equipment and thermal oxidizer. Transportation of equipment to site. Drilling equipment used during well installation. Excavation equipment during removal of soil and installation of sheet pile for wall.

Exhibit 11. Evaluation Based on Sustainability Metrics

Alternatives	Active Treatment Timeframe (Years)	Impact Assessment	Materials Used	Onsite Waste Generation	Water Usage	Energy Usage	Air Emissions
5. In Situ Geochemical Stabilization and In Situ Biosparging		***Relative Impact***	***Medium***	***Low***	***Medium***	***Low***	***Low***
	Area 1 1+ Area 2 45	Impact Drivers	Chemicals for ISGS solution. Self-contained aboveground mixing and injection system. Aboveground air injection system.	Hazardous and nonhazardous waste-soil IDW from drill holes.	Water for solution mixing. Decontamination of equipment. Area 1: ISGS borehole drilling. Area 2: ISB well installation.	Electrical power for generator for ISGS solution mixing. Fuel for compressor. Fuel for drilling equipment. Electrical power for one compressor for air injection.	Transportation of equipment to site. Equipment used during ISGS injection (generator, mixing).

Notes:

Green = low impact/usage

Yellow = medium impact/usage

Red = high impact/usage

GAC = granular activated carbon

HVAC = heating, ventilation, and air conditioning

IDW = investigation-derived waste

Source: AECOM 2018, Focused Feasibility Study, Table 5-2

6.0 Selected Remedy

The EPA has chosen **Alternative 3 (ISB in Areas 1 and 2 and MNA in Area 3)** as the selected amendment to the remedy. It replaces the historical groundwater remedy currently in operation at the Site, but Alternative 3 does not alter the soil component of the remedy. DEQ concurs in this selection. The selected amendment to the remedy includes the following components:

1. **ISB in the waste pit area (Area 1).** This will be accomplished by injecting air to deliver oxygen through a network of shallow and deep wells to address impacted groundwater and deplete COCs from NAPL.
2. **ISB near the downgradient extent of NAPL (Area 2).** The ISB will treat contaminated groundwater in Area 2 and will propagate a dissolved-oxygen-rich zone to further reduce COC concentrations and prevent dissolved COC migration downgradient of Area 2.
3. **MNA in the area containing only dissolved-phase COC contamination, beyond the extent of observed NAPL (Area 3).** MNA would occur in Area 3 as part of a sitewide monitoring program. The plume in Area 3 is expected to readily attenuate following implementation of ISB in Area 2.
4. **Institutional controls and monitoring,** including well drilling restrictions, water use restrictions and deed restrictions, would be retained from the current remedy and/or improved if feasible. Groundwater would be monitored to verify that the remedy is performing as intended (i.e., concentrations of COCs are decreasing over time).

Exhibit 12 shows the technologies proposed by area for the selected remedy, and the area where groundwater access and use will be controlled.

6.1 Evaluation of the Selected Remedy

The EPA acknowledges the challenge of treating NAPL source areas. As a result, the EPA will closely track the progress of the selected remedy in Area 1 in conjunction with DEQ. EPA Regional and Headquarters staff and management agreed to the following evaluation metrics to assess the effectiveness of ISB:

- **Hydrology:** Groundwater flow will be routinely evaluated to assess whether ISB affects flow patterns and aquifer parameters. The proposed frequency of collection would be at least quarterly.
- **Dissolved phase contaminant concentrations:** Collection of upgradient, source area, and downgradient groundwater samples to assess the effectiveness of ISB and pattern of influence. Contaminant and microbial population data would be collected at least quarterly and analyzed spatially and statistically.
- S**ource area degradation:** Collection of samples in the source area to assess whether ISB is effectively reducing the source term. Samples collected from the source area would be analyzed for the presence or absence of NAPL, site contaminants, and microbial populations. Sample frequency would be at least quarterly.

The overarching goals of the evaluation metrics are to provide information to determine whether ISB is performing as anticipated. Critically, is ISB reducing the source term and creating an environment that accelerates and reduces the extent of contaminants in the upper aquifer such that RAOs will be achieved in a time frame consistent with expectations?

Data will be reported to the agency at least annually. The EPA Region 8 will report back to EPA Headquarters at the 2-year mark after the revised remedy is fully implemented, which will allow for time to adjust the system, data collection, and provide enough data to allow for an adequate initial assessment. A second check in with EPA Headquarters will occur at the 4-year mark, and/or prior to next 5-year review. If EPA Region 8 receives data that warrants action or notification at a frequency other than at the 2- and 4-year marks, EPA Headquarters will be updated appropriately. Monitoring details may change as specifics are worked out in the drafting of the ISB monitoring plan.

If it appears that the selected remedy will not be able to achieve RAOs after a period of 6 years, a focused study will be conducted to identify other technologies that might more successfully remediate Area 1. Exhibit 13 presents a high-level decision tree for assessing the effectiveness of the selected remedy.

The EPA has determined that the selected remedy (Alternative 3) meets the threshold criteria and provides the best balance among the alternatives with respect to the balancing and modifying criteria. The EPA expects the selected remedy to satisfy the following statutory requirements of CERCLA Section 121:

- Protect human health and the environment
- Comply with ARARs
- Be cost effective
- Use permanent solutions to the maximum extent practicable

This decision amends the historical groundwater remedy currently in operation with ISB and MNA. This is considered a fundamental change to the 1988 ROD.

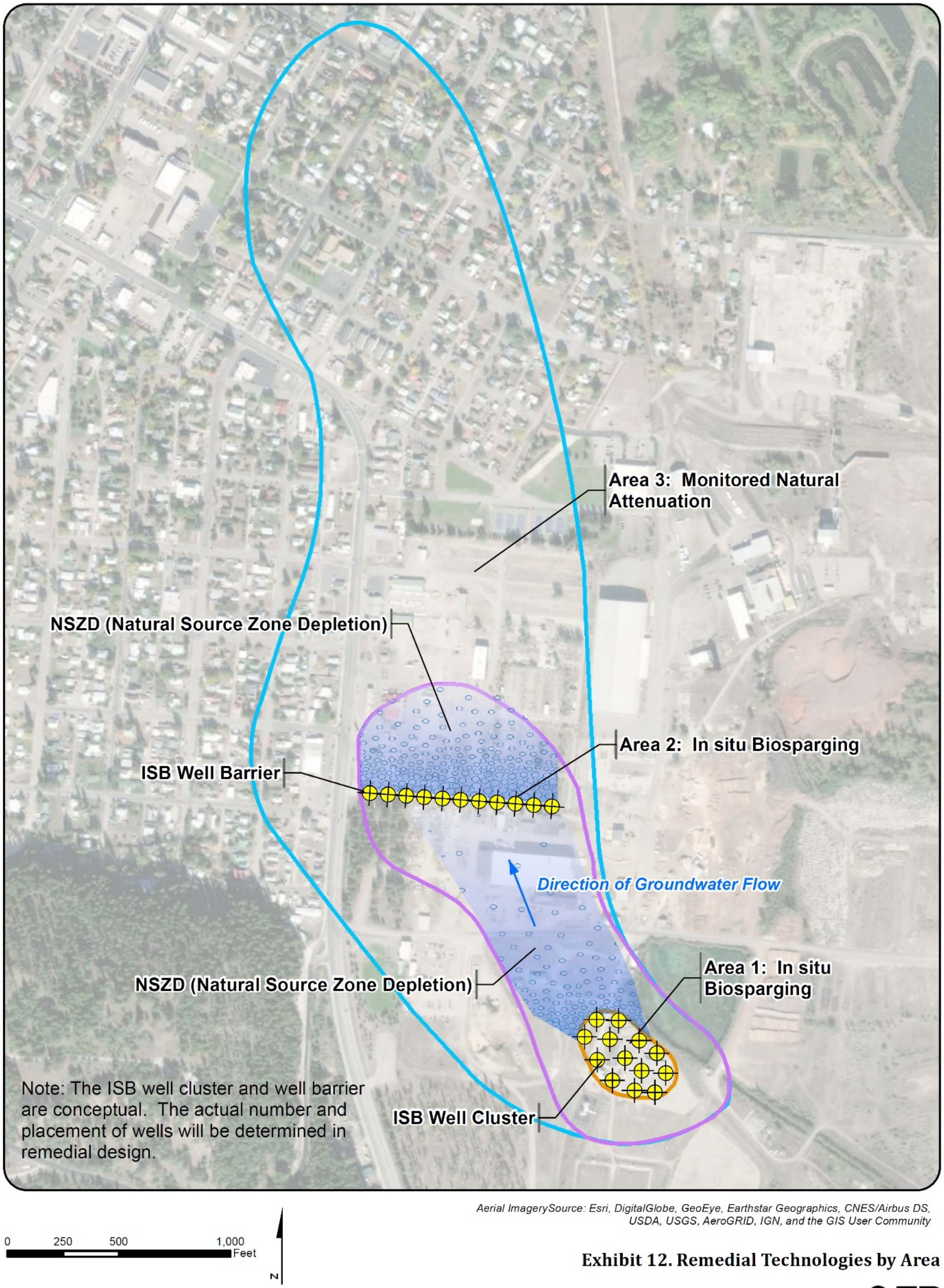


Exhibit 12. Remedial Technologies by Area

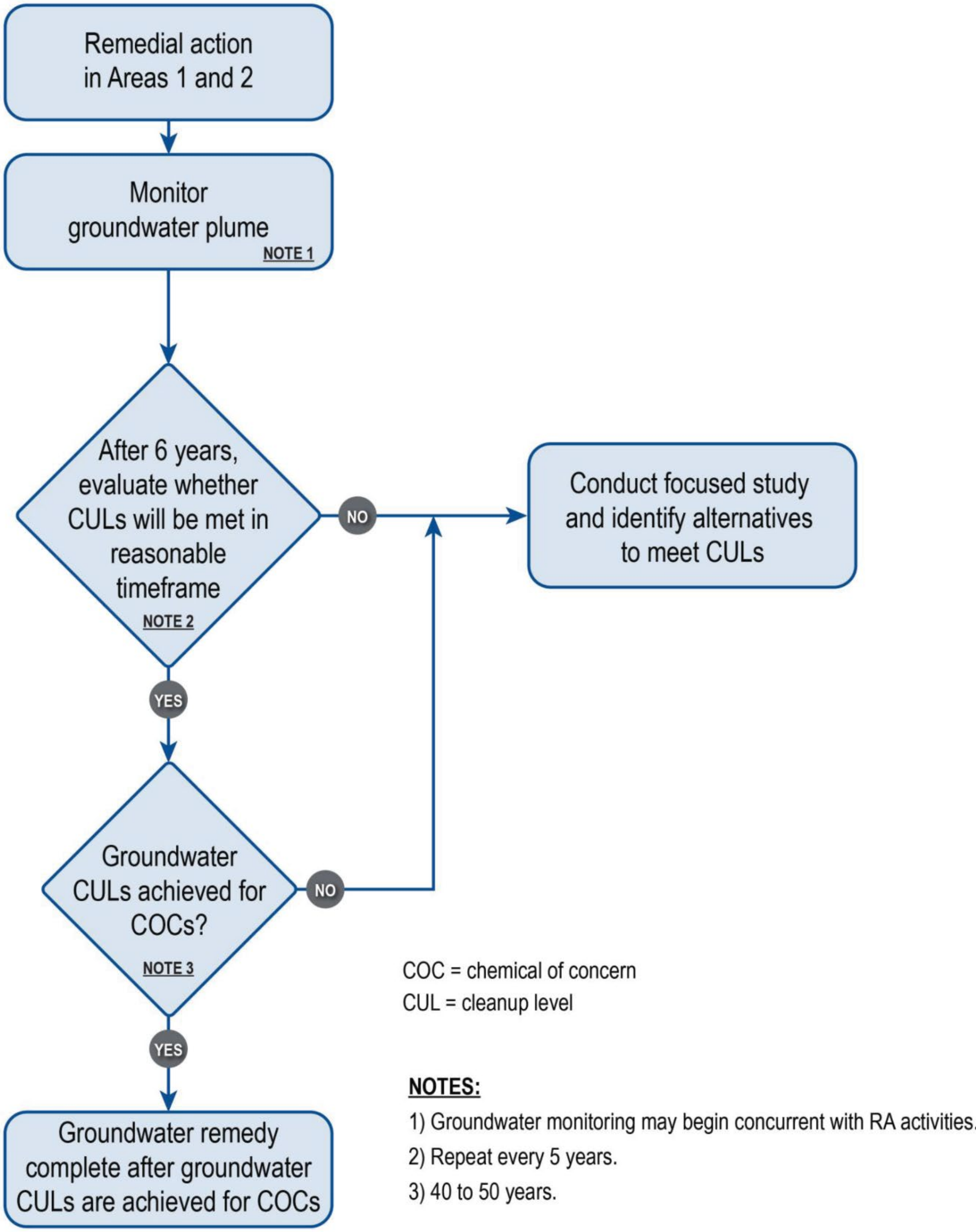


Exhibit 13. Decision Diagram

7.0 Statutory Determinations

The EPA has determined that the Site remedy, as it is amended herein, is protective of human health and the environment, complies with all federal and state requirements that are applicable or relevant and appropriate to this remedial action, meets the RAOs, is cost effective, uses permanent solutions and alternative technologies to the extent practicable, and satisfies the requirements in Section 121 of CERCLA.

There are no changes to the proposed remedy described in the Proposed Plan for a Record of Decision Amendment in this Selected Remedy Amendment.

8.0 References

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Woodward-Clyde Consultants (WCC). 1993c. *Technology Evaluation Report for the Lower Aquifer. Prepared for Champion International, Stamford, Connecticut.* August.

Part III - Responsiveness Summary

1.0 Comments from [name redacted]

- **Comment #1**: *My name is [name redacted]. I seem to be the only member of the public in attendance, and I think that kind of highlights the EPA's unwillingness to engage the public in this issue. Right off the bat I'd like to note that this is an improperly noticed meeting. The time was not advertised in a timely manner, and that's probably why you have no public here. But you also have no media here, and I would think that the EPA would have media present for something that's this big in this community.*

  EPA Response: The EPA has engaged the public on several occasions in 2019 for the Proposed Plan for a ROD Amendment. The Proposed Plan public meeting is one example of the EPA's effort to explain the proposed, revised approach to more rapidly clean up the upper aquifer beneath the Libby Groundwater Superfund site. A public notice for the meeting and the opportunity to provide public comment on the Proposed Plan was published in three local newspapers, *The Western News,* the *Kootenai Valley Record* and the *Montanian* several weeks in advance of the meeting at the beginning of the public comment period. The time for the public meeting was inadvertently left off the public notice published in *The Western News*. The *Kootenai Valley Record* was sent a correction, but the paper did not incorporate the change in the final posting. Public notice of the meeting was also provided on the Site's webpage, which provided the date and time of the public meeting. The EPA cannot direct the media to attend public meetings; however, *The Western News,* the *Kootenai Valley Record* and the *Montanian* were aware of the meeting and none chose to be present for the public meeting.

- **Comment #2**: *When you talk about the contaminant of concern, you talk about the PCPs, PAHs, benzene, arsenic, but you leave out a lot of chemicals that were in that stuff that I don't know that you have really well defined how those relate to human health and where they are in this groundwater plume.*

  EPA Response: The Libby Groundwater Site has been thoroughly investigated throughout the many years it has been on the National Priorities List for Superfund sites. During the initial investigation phases in the mid-1980s, it was determined that pentachlorophenol (PCP), polynuclear aromatic hydrocarbons (PAHs), benzene, and arsenic were the chemicals that were found in groundwater above levels that were safe for human consumption and that were related to historical wood-treating operations at the Site. It is important to note that PAHs are a family of chemical compounds, and the compounds that comprise the PAH family are sampled and monitored annually and then evaluated with respect to levels that are considered safe for human consumption. The distribution of PCP in groundwater has the largest vertical and horizontal extent, and thus is referred to more frequently. The goal of the new proposed (and old) remedy for the upper aquifer is to clean up all site contaminants in groundwater such that they are at concentrations that are safe for human consumption. The human health values that site contaminants are compared to are also routinely reviewed to ensure they are current and remain protective of human health.

- **Comment #3:** *You're kind of taking the position that the EPA took with the asbestos and saying that if you can't come in contact with it, then it isn't a human health hazard. I think you neglect to understand that this is Libby, Montana, and even when you guys are done, there are wells that will be being used. So you will not be restricting all access to the groundwater, there's no way you can do that, and you need to be aware of that.*

  EPA Response: As discussed above, the goal of the new remedy for the upper aquifer is to clean up site contaminants to a level such that human consumption is safe. While contaminants are being cleaned up, the Agencies must ensure that people are not being exposed to groundwater that is impacted by site contaminants. As a result, we must employ restrictions on groundwater use until the groundwater is safe for human consumption. The Agencies acknowledge that very few institutional controls are 100 percent effective; however, we believe that the City Ordinance and the proposed Controlled Groundwater Area are the most effective ways to limit human exposure to site contaminants.

- **Comment #4:** *I think because the meeting was improperly noticed, we should have more time, you should extend the comment time. The community has not been informed. I'd like to see the EPA launch some sort of media blitz and let people know what the changes are in the remedies.*

  EPA Response: The Agencies extended the public comment period for an additional 30 days based on this request. Public notices of the public comment extension were published in *The Western News* and on the Site's webpage. No additional comments were received during the extended comment period. The initial notification of the release of the Proposed Plan and the public meeting were also highlighted on the EPA's Facebook page and Twitter feed.

- **Comment #5**: *And specifically the one thing that I'd like to see is the ICs being better defined than what they are. We've been tricked that way before too.*

  EPA Response: Additional work to bolster the current institutional controls that minimize the opportunity for human exposure to site contaminants is currently under way. The new institutional control, a proposed Controlled Groundwater Area, which would be promulgated by the Montana Department of Natural Resources and Conservation, will provide another layer of protection within the city of Libby and will extend restrictions on the installation of wells and use of groundwater to adjacent areas within Lincoln County that are, or could be, affected by site contaminants.

  The Agencies have tried to be transparent about all existing and proposed institutional controls. The existing institutional controls are detailed in the *Libby Groundwater Site Operable Unit One Record of Decision*, which is publicly available at the information repositories and on our website. The proposed Controlled Groundwater Area, which would be a new institutional control, was introduced and explained to the public in a public meeting held in April 2019. Information that was presented at the public meeting in April is available on the Site's webpage.

- **Comment #6:** *I don't know if there's been any monitoring beyond the railroad. I tried to gather up some information before the meeting, and I was not able to gather the information that I needed to make good comments.*

  EPA Response: No wells were historically installed between the railroad and the river. However, we are currently in the process of characterizing groundwater flow and the presence of site-related contaminants in that area. New information from that area will be provided in the Annual Report and/or other site documents that can be made publicly available. The new data will be used to further our understanding of the Site and will be used to assess the adequacy of existing and proposed ICs.

- **Comment #7:** *The information office, Mike Cirian, down there said, That's someone else's -- that's Andrew's bailiwick, or something like that, and he had absolutely no information about this site. That's the EPA information office; you guys should have the information down there. And then the slide show, all the materials that were in the slide show should have been made available to the public. By not having those available to the public, it stymies comments and stymies the public's understanding of what you're doing.*

  EPA Response: All information related to the Site and the Proposed Plan was published in the administrative record. The administrative record was available online, at the City County Department of Health office, and at EPA's Helena Office. The location and availability of the administrative record was detailed in the public notices published in the newspapers and on the Site's webpage.

  The local information repository for the Libby Groundwater Site was selected prior to the establishment of the EPA Libby Information Center, which was created for the Libby Asbestos Site. Information regarding the Libby Groundwater Site is often available at the information center; however, because the EPA Information Center is not expected to exist in perpetuity, the

Agencies have continued to use the City County Department of Health as the Site's local information repository.

The presentation slides, the Proposed Plan, and a Fact Sheet summarizing the Proposed Plan that were provided at the public meeting are available on the Site's webpage and should also be available at the EPA information repositories. Additional hard copies of documents that were provided at the public meeting have been left at the EPA Information Center for visitors who may be interested in the Proposed Plan for the Libby Groundwater Site.

Appendix A
Applicable or Relevant and Appropriate Requirements and To Be Considered Items

Appendix A. Applicable or Relevant and Appropriate Requirements and To Be Considered Items

Citation	Type	Requirement Description	Comments
Chemical-Specific ARARs			
National Primary Drinking Water Regulations, 40 CFR 141 Subparts B, F, G, and I, as adopted by ARM 17.38.203 – 17.38.207	Relevant and Appropriate	Below is a summary of COCs and corresponding MCLs (if present) associated with the Site. Benzene: 0.005 mg/L Pentachlorophenol: 0.001 mg/L Arsenic: 0.010 mg/L Acenaphthene: no MCL Anthracene: no MCL Fluoranthene: no MCL Fluorene: no MCL Naphthalene: no MCL Pyrene: no MCL Benzo(a)anthracene: no MCL Benzo(a)pyrene: 0.0002 mg/L Benzo(b)fluoranthene: no MCL Benzo(k)fluoranthene: no MCL Chrysene: no MCL Dibenz(a,h)anthracene: no MCL Indeno(1,2,3-c,d)pyrene: no MCL 2,3,7,8-TCDD: $3x10^{-8}$ mg/L	The NCP sets forth the following at 40 CFR 300.430(e)(2)(i)(B) regarding the use of MCLs as cleanup levels for CERCLA sites: MCLGs, established under the Safe Drinking Water Act, that are set at levels above zero, shall be attained by remedial actions for ground or surface waters that are current or potential sources of drinking water, where the MCLGs are relevant and appropriate under the circumstances of the release based on the factors in Section 300.400(g)(2). If an MCLG is determined not to be relevant and appropriate, the MCL shall be attained where relevant and appropriate to the circumstances of the release. The NCP sets forth comparisons, which shall be made in determining relevance and appropriateness in 40 CFR 300.400(g)(2)(i) through (viii). 40 CFR 300.400(g)(2)(viii) requires that this comparison shall include consideration of use or potential use of affected resources at the CERCLA site. Because of the above, where an MCL exists for a COC, the MCL has been used as the cleanup level in this ROD. If no MCL exists for a specific COC, then the Montana Water Quality Standard for that COC has been used as the cleanup level (see below).
ARM 17.38.201 through 17.38.207, Montana MCLs	Relevant and Appropriate	These regulations were adopted to assure the safety of public water supplies with respect to bacteriological, chemical, and radiological quality and to promote efficient operation of public water supply systems.	These regulations adopt the federal MCLs listed above.
ARM 17.30.7, Nondegradation of Water Quality	Applicable	Existing uses of state waters and the level of water quality necessary to protect those uses must be maintained and protected.	The nondegradation rules apply to any activity of man resulting in a new or increased source that may cause degradation. If an activity will cause degradation, a person may request an authorization to degrade using the procedures given in ARM Section 17.30.707.

Appendix A. Applicable or Relevant and Appropriate Requirements and To Be Considered Items

Citation	Type	Requirement Description	Comments
			The criteria for determining if changes in water quality are nonsignificant are given in ARM 17.30.715. Very simplistically, these are as follows: - For carcinogenic substances – any change would be significant. - For toxic substances – any change that would be measurable or would result in an "instream" concentration that would exceed 15% of the lowest applicable standard would be significant. - For harmful substances – any change that would result in an in-stream concentration that would exceed 10% of the standard when ambient is less than 40% of the standard would be significant, while any change is generally considered significant if ambient is 40% or greater of the standard.
ARM 17.30.619, Water Quality Standards	Applicable	Adopts the requirements of "Department Circular DEQ-7, entitled 'Montana Numeric Water Quality Standards' (June 2019 edition)."	The water quality standards address potential problems and pertain to circumstances that are similar to the Libby site if point or nonpoint source pollutant discharges to the Kootenai River, Libby Creek, and/or Flower Creek occurred as a result of the proposed action. Point source or nonpoint source pollutant discharges as a result of the proposed action would degrade surface water quality and would not be protective of human health and the environment. Therefore, the criteria are relevant and appropriate for nonpoint source groundwater discharges into the Kootenai River, Libby Creek, and/or Flower Creek if the source is related to the Libby Groundwater Site or its remediation.
DEQ Circular DEQ-7, Montana Numeric Water Quality Standards, developed in compliance with MCA 75-5-301, Classification and Standards of State Waters and MCA 80-15-201, Groundwater Standards	Applicable	Numeric water quality standards for Montana's surface and groundwaters. Below is a summary of numeric water quality standards for COCs associated with the Site in groundwater. Benzene: 5 µg/L Pentachlorophenol: 0.3 µg/L surface water; 1 µg/L groundwater Arsenic: 10 µg/L Acenaphthene: 70 µg/L Anthracene: 3,000 µg/L in surface water; 2,100 µg/L groundwater Fluoranthene: 20 µg/L Fluorene: 50 µg/L Naphthalene: 100 µg/L Pyrene: 20 µg/L Benzo(a)anthracene: 0.012 µg/L surface water; 0.5 µg/L groundwater Benzo(a)pyrene: 0.0012 µg/L surface water; 0.05 µg/L groundwater	These standards were adopted to protect the designated beneficial uses of state waters, such as growth and propagation of fishes and associated wildlife, waterfowl and furbearers; use for drinking water, culinary and food processing purposes; recreation; agriculture; and industry and other commercial purposes.

Appendix A. Applicable or Relevant and Appropriate Requirements and To Be Considered Items

Citation	Type	Requirement Description	Comments
		Benzo(b)fluoranthene: 0.0012 µg/L surface water; 0.05 µg/L groundwater Benzo(k)fluoranthene: 0.12 µg/L surface water; 5 µg/L groundwater Chrysene: 1.2 µg/L surface water; 50 µg/L groundwater Dibenz(a,h)anthracene: 0.0012 µg/L surface water; 0.05 µg/L groundwater Indeno(1,2,3-c,d)pyrene: 0.012 µg/L surface water; 0.5 µg/L groundwater	
Action-Specific ARARs			
Endangered Species Act, 16 USC 1531 through 1536, 50 CFR 17.21	Applicable	Activities affecting species listed as endangered or threatened or their critical habitat are regulated. Prohibits the taking, harassment, harming, or killing of endangered or threatened species of flora and fauna. According to Appendix F of the FFS (AECOM 2018), the following threatened or endangered species may be present at the Site: - Canada lynx (*Lynx canadensis*) - Grizzly bear (*Ursus arctos horribilis*) - Wolverine (*Gulo gulo luscus*) - Yellow-billed cuckoo (*Coccyzus americanus*) - Bull trout (*Salvelinus confluentus*; downstream) - Spaulding's catchfly (*Silene spaldingii*)	The ESA requires that any action authorized, funded, or carried out by a federal agency not jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of critical habitat of such species. The FFS determined that there were no adverse effects from the Site remediation to the listed species for any of the alternatives evaluated.
Migratory Bird Treaty Act,	Applicable	Provides protection for migratory bird species (including geese, ducks,	Remedy may require mitigation measures to deter nesting by migratory birds on, around, or within remedial action areas and methods to protect occupied bird nests. Best management practices will be

Appendix A. Applicable or Relevant and Appropriate Requirements and To Be Considered Items

Citation	Type	Requirement Description	Comments
16 USC 703 and 50 CFR 10.12		raptors, many passerines). Prohibits killing or taking of bird or any part, nest, or egg of any such bird.	used to observe and avoid contact with migratory birds during construction of the remedy; this may include a survey of the Site to look for nests and eggs before construction starts.
Bald and Golden Eagle Protection Act, 16 USC 668, 50 CFR 22.11, General Requirements	Applicable	Protects bald and golden eagles from take, possession, or transportation without a permit.	If needed, remedial action work plans will include measures to minimize disturbances to bald eagles.
MCA 22-3 Part 8, Human Skeletal Remains and Burial Site Protection	Applicable	Protects human skeletal remains and burial sites.	Prohibits knowingly disturbing or destroying graves, burial grounds, or burial material without authorization and requires reporting discovery of such remains. Burial sites are not expected. However, if skeletal remains are found, work will stop, and the county coroner will immediately be notified.
MCA 87-5-106, Nongame and Endangered Species Unlawful Acts ARM 12.2.501, Nongame Wildlife in Need of Management	Applicable	Protects nongame species deemed to be in need of management. The non-game species listed in ARM 12.2.501 are: - Crayfish (*Pacifasticus spp.*; *Orconectes spp.)* - Freshwater mussels (all species of *Pelecypoda)* - Yellow perch (*Perca flavescens)* - Crappie (*Pomoxis)* - Black-tailed prairie dogs (*Cynomys ludovicianus)* - White-tailed prairie dogs (*Cynomys leucurus)* - Gray wolves (*Canis lupus)*	Except as provided in regulations issued by the department, it shall be unlawful for any person to take, possess, transport, export, sell, or offer for sale nongame wildlife deemed by the department to be in need of management. Subject to the same exception, it shall further be unlawful for any common or contract carrier knowingly to transport or receive for shipment nongame wildlife deemed by the department to be in need of management. The remedial activities will take precautions to not injure or take these nongame species.
ARM 12.5.201, Montana Endangered Species List	Applicable	Activities affecting species listed as endangered or threatened or their critical habitat are regulated. Prohibits the taking, harassment, harming, or killing of endangered or threatened species of flora and fauna. According to Appendix F of the FFS, the only endangered species listed in ARM 12.5.201 is:	Except as otherwise provided, it is unlawful for any person to take, possess, transport, export, sell or offer for sale, and for any common or contract carrier knowingly to transport or receive for shipment any species or subspecies of wildlife appearing on the list . The FFS determined that there were no adverse effects from the Site remediation to the listed species for any of the alternatives evaluated.

Appendix A. Applicable or Relevant and Appropriate Requirements and To Be Considered Items

Citation	Type	Requirement Description	Comments
		Northern Rocky Mountain wolf (*canis lupus irremotus*)	
Action-Specific ARARs			
ARM 4.5.201 through 4.5.210, Designation of Noxious Weeds MCA 7-22-2121, Weed Management Program	Applicable	Definition of noxious weeds and weed management criteria.	Any exotic plant species established or that may be introduced in the state that may render land unfit for agriculture, forestry, livestock, wildlife, or other beneficial uses or that may harm native plant communities. Designated noxious weeds are listed in ARM 4.5.201 through 4.5.210 and must be managed consistent with weed management criteria in the Lincoln County Noxious Weed Management Plan (2014). Any equipment brought into the area (e.g., on drill rigs) should be decontaminated prior to being brought onsite so that noxious weeds are not brought onsite.
MCA 7-22-2116	Applicable	Requires control of noxious weeds.	It is unlawful for any person to allow any noxious weed to propagate or go to seed on the person's land, except as authorized. Owners must notify purchasers of the presence of noxious weeks when property is offered for sale.
MCA 7-22-2152	Relevant and Appropriate	Notification to District Weed Board.	Any person proposing certain actions, including, but not limited to, a solid waste facility; a highway or road; a commercial, industrial, or government development; or any other development that needs state or local approval and that results in the potential for noxious weed infestation within a district must notify the District Weed Board at least 15 days prior to the activity and submit a written plan for approval, specifying methods to accomplish revegetation.
40 CFR 112, Oil Pollution Prevention	Applicable	Requirements for petroleum storage in aboveground tanks and containers. Requires preparation and implementation of a Spill Prevention, Control, and Countermeasure Plan.	40 CFR 112 applies to petroleum storage from which a release could reasonably be expected to discharge to a navigable water provided that the total aboveground oil storage is more than 1,320 gallons in containers or tanks 55 gallons or larger.
40 CFR 122, 123, and 124, and MCA 17.30.1105, Implemented by Construction Stormwater General Permit MTR100000	Applicable	Regulates pollutants in discharge of stormwater associated with construction activity (clearing, grading, or excavation) involving the disturbance of 1 acre or more. Requires the preparation of a stormwater pollution prevention plan, implementation of BMPs to minimize the effects of disturbed soil on stormwater and monitoring of stormwater to demonstrate compliance.	Although a permit is not required for CERCLA sites, the substantive permit requirements must be met unless otherwise waived.

Appendix A. Applicable or Relevant and Appropriate Requirements and To Be Considered Items

Citation	Type	Requirement Description	Comments
MCA 85-2-505	Applicable	Waste of groundwater and contamination of groundwater prohibited.	No groundwater may be wasted. The department shall require all wells producing waters that contaminate other waters to be plugged or capped. It shall also require all flowing wells to be so capped or equipped with valves that the flow of water can be stopped when the water is not being put to beneficial use. Likewise, both flowing and nonflowing wells must be so constructed and maintained as to prevent the waste, contamination, or pollution of groundwater through leaky casings, pipes, fittings, valves, or pumps either above or below the land surface.
ARM 36.21 Subchapter 4, Substantive Rules	Applicable	License requirements for well construction.	It is unlawful for any water well contractor, water well driller, or monitoring well constructor to construct, alter, or rehabilitate a water well or a monitoring well without first having obtained a valid license. The driller installing the wells will be appropriately licensed.
MCA 85-2-516, Well Logs	Applicable	Well Log Report.	Within 60 days after any well is completed, a well log report must be filed by the driller with the Montana Bureau of Mines and Geology (BMG). The driller installing the wells will file the well logs with BMG.
ARM 36.21 Subchapter 6, Construction Standards	Applicable	Construction standards for groundwater wells other than public drinking water and supply wells.	ARM 36.21.634-810 provide standards for construction of groundwater wells. ARM 36.21.669A to 672 provide requirements for well abandonment. The driller installing the wells will install them in accordance with ARM 36.61.
ARM 17.8.308, Particulate Matter, Airborne	Applicable	No person will manage any materials, use any road, or perform construction unless reasonable precautions are taken to control emissions of airborne particulates.	
ARM 17.8.309, Particulate Matter Limits for Fuel-burning Equipment	Applicable	No person shall cause particulate matter from fuel combustion to be discharged into the outdoor atmosphere in excess of rates specified in ARM 17.8.309: Maximum allowable emissions in pounds/MBtu for new units: 10 MBtu/hour and below: 0.60 MBtu/hour.	Engines may be used onsite as part of the biosparging.

Appendix A. Applicable or Relevant and Appropriate Requirements and To Be Considered Items

Citation	Type	Requirement Description	Comments
Lincoln County, Health and Environmental Regulations, Control of Air Pollution, Subchapter 3, Dust Control Regulations	Applicable	Actions must be taken to prevent vehicular carry-on and windborne entrainment of dust on unpaved/untreated roads, parking lots, or commercial lots.	The construction contract documents will include a provision for dust control.
ARM 17.53.501, Which Adopts 40 CFR 261, Identification and Listing of Hazardous Waste	Applicable	Defines hazardous waste characteristics and lists specific chemicals and waste streams that are hazardous waste when discarded.	Groundwater at the Site has historically been managed as a listed hazardous waste under Codes F032 (wastewaters from wood preserving that used chlorophenols) and F034 (wastewaters from wood preserving that used creosotes), and potentially also the characteristic hazardous waste Codes D004 (arsenic), D018 (benzene), and D037 (pentachlorophenol). Therefore, it is expected that regulated hazardous waste will be generated associated with the proposed action. 40 CFR 261 Subpart C identifies hazardous waste characteristics, including ignitability and toxicity characteristic wastes (e.g., benzene, pentachlorophenol, arsenic); and 40 CFR Part 261 Part D identifies hazardous waste listings, including F032 and F034. If remediation wastes are generated during construction and remediation, the wastes will be characterized to determine if they are hazardous waste.
ARM 17.53.601, Which Adopts 40 CFR 262, Hazardous Waste Generator Requirements	Applicable	Provides requirements for hazardous waste generators, including actions such as container labeling, storage requirements, disposal timeframes, inspections, training, contingency planning, accumulation area closure, air emissions control.	40 CFR Part 262 defines substantive requirements for the onsite storage of hazardous waste. F032 and F034 waste and characteristic hazardous wastes stored onsite would be subject to these management standards. If generated waste is hazardous waste, it will be managed in accordance with the substantive provisions of the large quantity generator hazardous waste regulations.
ARM 17.53.801, Which Adopts 40 CFR 264, Standards for Owners or Operators of Hazardous Waste Treatment Storage and Disposal Facilities	Relevant and Appropriate	Requirements for treatment, storage, and disposal facilities.	40 CFR 264 establishes management requirements for treatment, storage, and disposal of hazardous waste and special provisions for cleanup, which may be relevant depending on specific circumstances. If generated waste is hazardous waste, it will be managed in accordance with the substantive provisions of these regulations.

Appendix A. Applicable or Relevant and Appropriate Requirements and To Be Considered Items

Citation	Type	Requirement Description	Comments
ARM 17.53.1101, Which Adopts 40 CFR 268, Land Disposal Restrictions	Applicable	Requirements for treatment before land disposal of hazardous waste. Refers to 40 CFR 268.40, Treatment Standards for Hazardous Waste, and 49 CFR 268.48, Universal Treatment Standards, where referenced.	40 CFR 268 establishes treatment standards that must be met before hazardous waste can be disposed of in a landfill or other land-based unit. These requirements attach to the waste at the point of generation and affect offsite disposal. Off Site disposal is not anticipated for the remedial action.
MCA 75-10-422, Unlawful Disposal	Applicable	It is unlawful to dispose of used oil or hazardous waste without a permit or, if a permit is not required under this part or rules adopted under this part, by any other means not authorized by law.	
ARM 17.50.816 Privy Waste, Pit Toilet Waste, Portable Toilet Waste	Applicable	License required for cleaning septic tanks, portable toilets, etc.	A person may not engage in the business of cleaning cesspools, septic tanks, portable toilets, privies, grease traps, car wash sumps, or similar treatment works, or disposal of septage and other wastes from these devices, unless licensed by the department. The contractor who provides portable toilets for the remediation will be appropriately licensed.

Notes:

µg/L = microgram(s) per liter
ARM = Administrative Rules of Montana
BMP = best management practice
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
COC = contaminant of concern
DEQ = Montana Department of Environmental Quality
ESA = Endangered Species Act
FFS = Focused Feasibility Study
MBtu = million British thermal units
MCA = Montana Code Annotated
MCL = Maximum Contaminant Level
MCLG = Maximum Contaminant Level Goal
mg/L = milligram(s) per liter
NCP = National Oil and Hazardous Substances Pollution Contingency Plan
ROD = Record of Decision
Site = Libby Groundwater Contamination Superfund Site
TCDD = tetrachlorodibenzodioxin
USC = United States Code

References:

AECOM. 2018. *Focused Feasibility Study for the Upper Aquifer; Libby Groundwater Site*. Libby Montana. Revision 2. Final. April 25.

Lincoln County, Montana. 2014. Integrated Noxious Weed Management Plan. January. Accessed November 14, 2019. http://www.lincolncountymt.us/images/departments/weeds/pdf/County_Weed_plan_2004.pdf.

Appendix B
Focused Feasibility Study Technology/Process Option Screening Results

Appendix B. Technology/Process Option Screening Results from the Focused Feasibility Study

General Response Action	Potential Remedial Technology	Process Option	Description	Effectiveness	Implementability	Relative Cost	Retained (Yes/No) and Screening Comments
No Action	No Action	No further action	No further actions or responses will be implemented with the exception of groundwater monitoring. COCs will remain in place with no plans for future control, treatment, or removal.	**Low.** Will not further address concerns about protectiveness.	**High.** While technically implementable, no action does not address CERCLA threshold criteria.	**None.**	**Yes**, retained per the NCP.
Access Restrictions	Institutional Control (ICs)	Land Use Zoning, Deed Restrictions, Restrictive Covenant, Controlled Groundwater Area	Exposure pathway controlled with administrative measures.	**Moderate.** Relies on administrative measures to limit exposure to groundwater COCs. ICs effective in short term but must be maintained and enforced to provide long-term protection.	**Moderate to High.** Readily implemented using existing guidance; however, requires offsite land-owner concurrence and compliance. Some uncertainty on enforcement tools and responsibility over long term.	**Low.**	**Yes**, ICs are retained as a component for each alternative.
Physical Containment	Hydraulic Containment	Groundwater Extraction	Extract groundwater to capture and contain impacted groundwater from sources. Extracted liquids would require treatment and/or disposal.	**Moderate.** Groundwater extraction would be effective in preventing dissolved COCs from migrating downgradient, but effectiveness on decreasing NAPL mass via dissolution is limited.	**Moderate to High.** Readily implementable with extraction wells. May require modification of the existing treatment system or a new system to treat the mass of COCs.	**Moderate to High.** Installation and capital costs are relatively low compared to other active options; however, the life cycle costs are high due to the long operational period.	**Yes,** retained technology to control flow of groundwater COCs from source areas.
Removal	Physical Removal	Skimming	Recover LNAPL hydraulically, from the top of the groundwater column within a well.	**Moderate to High.** Can effectively decrease LNAPL mass in areas with readily recoverable LNAPL and limit occurrence of LNAPL in wells. Not effective when LNAPL transmissivity is at or below the ITRC guidance endpoint.	**Moderate to High.** Readily implemented in existing wells and may require installation of new extraction wells. Existing structures may limit accessibility.	**Low to Moderate.** Implementation costs are relatively low. Operation and disposal life-cycle costs may be moderate depending on the time to achieve the endpoint.	**No,** not retained as technology for LNAPL removal.
		Large diameter auger (LDA) excavation	NAPL impacted soil is excavated with large diameter (4 to 6 feet) augers with casing. Flowable fill is placed in the LDA boreholes and limits groundwater flux. Excavated soil direct loaded or stockpiled for offsite treatment and disposal. Soil is not typically reused.	**Moderate.** NAPL in soil is removed; thus, mitigating the mass flux of COCs to groundwater. The low permeability flowable fill limits horizontal groundwater flux through treated area. Uncertainty in effectiveness is caused by ability to locate and excavate NAPL impacted soil. Depth of NAPL impacted soil may be greater than practical limits of LDA excavation.	**Moderate.** A flowable fill production plant will likely be required onsite to meet demand. Surface access is required for subsurface impacted soil. A field-scale test would be required to determine ability to achieve required treatment depth with or without casing in cobble lithology. Requires treatment or disposal of excavated soil.	**High.** Cost increases with depth and amount of flowable fill required. Excavated soil treatment and\or disposal costs would be high.	**No,** Not retained because not likely to achieve required depth in site lithology.
	Enhanced Physical Removal	Steam Enhanced Extraction (SEE)	Inject steam to increase NAPL recoverability (lower interfacial tension and viscosity) by hydraulic recovery. Increases volatility and removal of semi- volatile constituents from the NAPL. Requires multiphase extraction to recover fluids. Requires multiple above ground treatment systems.	**Moderate to High.** Site-specific SEE bench-scale testing results showed: • NAPL saturation reduction of 1 to 3% of pore volume (10 to 30% reduction of NAPL content) • 59% reduction of PCP in aquifer soil • inconclusive reduction of PAHs in aquifer soil Less effective in low permeability soil. COCs may not be adequately removed from the NAPL to meet groundwater criteria.	**Moderate.** Requires installation of extensive injection and extraction well network and infrastructure to inject steam, recover fluids, and treat recovered fluids. Existing structures will limit accessibility. High groundwater flux through treatment area requires management to optimize energy consumption.	**High.** Capital costs are high for wells and equipment. Operational costs are high for energy and fluid treatment.	**Yes,** Retained as a technology to decrease the mass of NAPL in moderately permeable aquifer soils.

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General Response Action	Potential Remedial Technology	Process Option	Description	Effectiveness	Implementability	Relative Cost	Retained (Yes/No) and Screening Comments
Removal	Enhanced Physical Removal	Electrical Resistance Heating (ERH)	An electrical current and the electrical resistance of the formation creates heat, which vaporizes water, creating steam that volatilizes semi-volatile constituents from the NAPL. NAPL mobility and recoverability is also increased. Volatilized COCs and mobilized NAPL captured by a multi-phase extraction system and treated ex situ. Requires periodic water injections to maintain electrical conductivity of the formation. Requires multiple above ground treatment systems.	**Low to Moderate.** Can effectively reduce the mass fraction of COCs in the NAPL (composition change) and reduce the mass of NAPL (saturation change). COCs not likely to be adequately removed from the NAPL to meet groundwater criteria. Effective in low permeability soil.	**Low to Moderate.** Requires installation of extensive electrode network to heat the treatment area. Incurs a high energy demand and requires infrastructure to recover fluids and treat recovered fluids. Existing structures will limit accessibility. High groundwater flux through treatment area requires management to optimize energy consumption. Higher permeability and groundwater flux decreases efficiency (longer heating time).	**High.** High cost for electrodes, equipment, operation, ex-situ treatment facility and electrical energy.	**No,** Not retained due to low effectiveness in permeable aquifer soil.
		Thermal Conduction Heating (TCH)	Heat is supplied to the subsurface through specially designed heater wells. Achieves higher temperatures than ERH and SEE. Increases volatilization of semi-volatile COCs from the NAPL and increases NAPL mobility and recoverability. Multiphase extraction is required to recover fluids and vapor. Requires multiple above ground treatment systems.	Low to Moderate. Can effectively reduce the semi-volatile mass fraction of COCs in the NAPL (composition change) and reduce the mass of NAPL (saturation change). TCH can achieve higher temperatures than other thermal methods and may remove more COCs from the NAPL. Effective in low permeability soil.	**Low to Moderate.** Requires installation of extensive heating element network to heat the treatment area. Incurs a high energy demand and requires infrastructure to recover fluids and treat recovered fluids. Existing structures (fire pond) will limit accessibility. High groundwater flux through treatment area requires management to optimize energy consumption. Higher permeability and groundwater flux decreases efficiency (longer heating time).	**High.** High cost for wells, heating elements, equipment, operation, ex-situ treatment facility and electrical energy.	**No,** Not retained due to less effectiveness in permeable aquifer soil.
In Situ Treatment	Physical/Chemical Treatment	In Situ Geochemical Stabilization (ISGS)	A proprietary mix of permanganate and mineral salts are injected in the treatment area that oxidize dissolved organics and forms a stable mineral precipitate that reduces soil permeability, forms a mineral crust around the NAPL, and reduces mass flux from the treatment area.	**Moderate.** Although COC mass reduction occurs via chemical oxidation, mass flux reduction primarily occurs via geochemical stabilization. Applications have been successfully tested and completed at creosote and coal tar sites. Site specific testing and geochemical modeling is required to evaluate the long- term stability of the mineral crust.	**Moderate to High.** The proprietary solution is typically delivered to the subsurface by direct-push or injection wells. Injection wells likely required for the Site because of the cobble lithology. Site hydraulic conductivity is favorable for implementation. Fresh water recharge from the fire pond may support long-term stability of the mineral crust.	**Moderate to High.** Primary costs are injection wells, proprietary chemical mix, and injection time. Estimated costs for one event are relatively less than in situ soil stabilization (ISSS) and surfactant-enhanced in situ chemical oxidation (S-ISCO).	**Yes,** Retained because of effectiveness at other creosote sites.
	Physical/Biological Treatment	Monitored Natural Attenuation/Natural Source Zone Depletion	COCs attenuate over time through natural physical, chemical, and biological processes. Natural attenuation or natural source zone depletion (NSZD) is the reduction in NAPL mass from dissolution and volatilization followed by subsequent bio-attenuation of the COCs in soil gas and groundwater.	**Low.** The time required to achieve groundwater criteria through natural attenuation will be long without active remediation. Can slowly reduce the mass fraction of COCs in the NAPL (composition change) and reduce the aqueous solubility of COCs without significantly reducing the mass of NAPL.	**Moderate.** The rate of NSZD has not been evaluated and would require periodic geochemical monitoring of groundwater and measurement of carbon dioxide flux to the atmosphere.	**Low.** Long attenuation timeframe will require extended monitoring and reporting duration.	**Yes,** Natural attenuation is a component for each alternative.
		Anaerobic Bio-oxidation	Supply an alternative electron acceptor such as nitrate or sulfate to support anaerobic biodegradation of COCs, including the PAHs and PCP. Studies show that PAHs degrade under nitrate and sulfate reducing conditions.	**Low.** A bench-scale treatability study did not show PCP degradation or sulfate depletion with low levels of sulfate (7 milligrams per liter). Literature review did not identify anaerobic bio-oxidation of PCP with sulfate as an effective treatment.	**Moderate to High.** Injection of sulfate can be readily implemented with existing and new wells. High sulfate solubility and significant dispersion/diffusion increases the radius of influence for injection wells and persistence of electron acceptor between injection events.	**Low.** The cost of anaerobic bioremediation through the application of sulfate is relatively low.	**No,** Not retained because of limited effectiveness for PCP bio-oxidation.

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General Response Action	Potential Remedial Technology	Process Option	Description	Effectiveness	Implementability	Relative Cost	Retained (Yes/No) and Screening Comments
In Situ Treatment	Physical/Biological Treatment	Aerobic Bio-oxidation	Deliver oxygen via biosparging in treatment barriers or as arrays to promote aerobic biodegradation of dissolved NAPL constituents. In addition, biosparging can enhance removal of semi-volatile compounds from the NAPL.	**Moderate to High.** Site-specific bench and field-scale testing indicates biosparging can remove COCs from aquifer soil impacted by NAPL. Although ISB does not physically remove bulk NAPL, ISB enhances dissolution and biooxidation of COCs and hydrocarbons from the NAPL, thus decreasing NAPL mass. The insoluble compounds in the NAPL will not be removed.	**Moderate to High.** Field-scale testing indicates biosparging is readily implemented. The testing also highlighted the effects of aquifer heterogeneity on system design and operation.	**Low.** Costs are relatively low, although operational period is longer than other technologies which may increase life cycle costs.	**Yes,** Bench and field-scale testing indicate that biosparging is a feasible technology.

Notes:

COC = contaminant of concern

ISB = in situ biosparging

ITRC = Interstate Technology Regulatory Council

LNAPL = light non-aqueous phase liquid

NAPL = non-aqueous phase liquids

PAH = polynuclear aromatic hydrocarbons

PCP = pentachlorophenol

SVOC = semi-volatile organic compound

VOC = volatile organic compound