Fifth Five-Year Review Report
for
Libby Groundwater Contamination Superfund Site
EPA ID: MTD980502736

Libby
Lincoln County, Montana

August 2015

Prepared by:
U.S. Environmental Protection Agency
Region 8
Denver, Colorado

Approved by:

Martin Hestmark
Assistant Regional Administrator
Office of Ecosystems Protection
and Remediation

9/25/15
Date

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LIST OF ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirement
bgs	Below Ground Surface
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CGWA	Controlled Groundwater Area
COC	Contaminant of Concern
Dioxin TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
ELF	Expanded Landfarm
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Difference
FYR	Five-Year Review
HI	Hazard Index
IC	Institutional Control
LTU	Land Treatment Unit
MCL	Maximum Contaminant Level
µg/L	Micrograms per Liter
mg/kg	Milligrams per Kilogram
MTDEQ	Montana Department of Environmental Quality
NAPL	Non-Aqueous Phase Liquid
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
O&M	Operation and Maintenance
OU	Operable Unit
PAHs	Polycyclic Aromatic Hydrocarbons
PCP	Pentachlorophenol
PRP	Potentially Responsible Party
RAO	Remedial Action Objective
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RSLs	Regional Screening Levels
SAETS	Source Area Extraction and Treatment System
TBC	To-Be-Considered
TEF	Toxicity Equivalence Factors
TI	Technical Impracticability

EXECUTIVE SUMMARY

The Libby Groundwater Contamination Superfund Site (the Site) is located on a former lumber mill and wood treatment facility in Libby, Montana. The facility treated timbers and poles with creosote and pentachlorophenol (PCP) from 1946 through 1969. These operations also contaminated soils and groundwater with polycyclic aromatic hydrocarbons (PAHs), PCP, dioxins, furans and arsenic. The resulting groundwater plume of contamination is also part of the Site.

The first discovery of well water contaminated with PCP occurred in 1979, when water drawn from a new residential well near the Site smelled of creosote. The U.S. Environmental Protection Agency (EPA) added the Site to its National Priorities List in September 1983. EPA designated two operable units (OUs) at the Site: OU1, the alternative drinking water supply initiative; OU2, the affected environmental media to include contaminated soils and groundwater in the upper and lower aquifers. The triggering action for this five-year review (FYR) was the signing of the previous FYR report on March 29, 2010.

The EPA signed the Record of Decision (ROD) for OU1 on September 26, 1986 and selected an interim remedy that required:

- Monetary compensation to Libby residents for using the municipal water supply instead of contaminated private water wells; and
- Adoption of an ordinance to prevent the installation of new water wells for human consumption or irrigation in the upper and lower aquifer within the corporate limits for the City of Libby.

The EPA signed the ROD for OU2 on December 30, 1988 and selected a remedy to address contaminated soils and groundwater. The remedy included:

- Excavation and biological treatment of contaminated soil above the water table in the former source areas,
- Extraction of contaminated groundwater and oil in the former waste pit source area, with oil/water separation followed by biological treatment of dissolved contaminants, and
- In-situ bioremediation of contaminated groundwater downgradient to the former contaminant sources areas.

Remedial efforts at the Site have not been successful in meeting cleanup goals in portions of the upper aquifer that contain a non-aqueous phase layer (NAPL). EPA is conducting an ongoing focused feasibility study to assess groundwater contamination in the upper aquifer and to assess remedial technologies newly developed or further refined since the implementation of the original remedy. A decision document will outline any modifications to the remedy.

The interim remedy at OU1 currently protects human health and the environment because the city is implementing and enforcing its ordinance that prohibits use of contaminated groundwater within the city limits and there are no known users of contaminated groundwater outside of the city limits. However, for the remedy to be protective in the long term, it must include additional institutional controls to prohibit groundwater use outside of the city limits.

The remedy at OU2 currently protects human health and the environment because no known completed exposure pathways exist. As with OU1, a city ordinance prohibits groundwater use within the city limits and there is no known groundwater use in contaminated areas of Lincoln County. Areas with remaining soil contamination are fenced and some land use restrictions are in place. However, for the remedy to be protective in the long term, it must include the following additional actions:

- Implement additional institutional controls to restrict land use and activities which may interfere with remedial activities in all areas with remaining waste;
- Modify groundwater ARARs in a decision document;
- Assess risk-based cleanup levels and residual soil contamination; and
- Appropriately modify the remedy to ensure RAO achievement.

Because the remedial actions at all OUs currently protect human health and the environment, the Site currently protects human health and the environment.

FIVE-YEAR REVIEW FORM

Site Identification		
Site Name: Libby Groundwater Contamination		
EPA ID: MTD980502736		
Region: 8	**State:** MT	**City/County:** Libby/Lincoln

NPL Status: Final	
Multiple OUs? Yes	**Has the Site achieved construction completion?** Yes

Lead agency: EPA
Author name: Kathy Hernandez and Ryan Burdge
Author affiliation: EPA Region 8 and Skeo Solutions
Review period: 3/11/2014 – 3/29/2015
Date of site inspection: 8/05/2014
Type of review: Statutory
Review number: 5
Triggering action date: 3/29/2010
Due date *(five years after triggering action date)*: 3/29/2015

OU(s) without Issues/Recommendations Identified in the Five-Year Review: None

Issues and Recommendations Identified in the Five-Year Review:

OU(s): 1	**Issue Category:** Institutional Controls			
	Issue: The city ordinance does not include all properties overlying the contaminant plume.			
	Recommendation: Implement additional institutional controls to restrict use of contaminated groundwater in all affected areas.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	3/29/2016
OU(s): 2	**Issue Category:** Remedy Performance			
	Issue: The current OU2 remedy may not attain RAOs.			
	Recommendation: Complete ongoing focused feasibility study and record modified remedy in a decision document.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	3/29/2016
OU(s): 2	**Issue Category:** Institutional Controls			
	Issue: Land use controls do not appropriately limit future land uses or protect all areas with waste.			
	Recommendation: Implement additional institutional controls to restrict residential land use and protect areas with waste in place. Also, see recommendation for OU1 regarding additional groundwater institutional controls.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	3/29/2016
OU(s): 2	**Issue Category:** Remedy Performance			
	Issue: Groundwater cleanup levels may no longer be valid.			
	Recommendation: A decision document is necessary to incorporate Circular DEQ-7 Montana Numeric Water Quality Standards			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	3/29/2016

FIVE-YEAR REVIEW FORM (cont'd)

OU(s): 2	**Issue Category:** Remedy Performance			
	Issue: Soil cleanup levels may no longer be valid.			
	Recommendation: Assess risk from residual contamination and determine if soil remedy can meet appropriate cleanup levels.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	3/29/2016

Protectiveness Statement(s)

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
OU1	Short-term Protective	Click here to enter date.

Protectiveness Statement:

The interim remedy at OU1 currently protects human health and the environment because the city is implementing and enforcing its ordinance that prohibits use of contaminated groundwater within the city limits and there are no known users of contaminated groundwater outside of the city limits. However, for the remedy to be protective in the long term, it must include additional institutional controls to prohibit groundwater use outside of the city limits.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
OU2	Short-term Protective	Click here to enter date.

Protectiveness Statement:

The remedy at OU2 currently protects human health and the environment because no known completed exposure pathways exist. As with OU1, a city ordinance prohibits groundwater use within the city limits and there is no known groundwater use in contaminated areas of Lincoln County. Areas with remaining soil contamination are fenced and some land use restrictions are in place. However, for the remedy to be protective in the long term, it must include the following additional actions: implement additional institutional controls to restrict land use and activities that may interfere with remedial activities in all areas with remaining waste; modify groundwater ARARs in a decision document; assess risk-based cleanup levels and residual soil contamination; and appropriately modify the remedy to ensure RAO achievement.

Sitewide Protectiveness Statement

Protectiveness Determination:	*Addendum Due Date (if applicable):*
Short-term Protective	Click here to enter date.

Protectiveness Statement:

Because the remedial actions at all OUs currently protect human health and the environment, the Site currently protects human health and the environment.

1.0 INTRODUCTION

The purpose of a five-year review is to evaluate the implementation and performance of a remedy in order to determine if the remedy is protective of human health and the environment. The FYR report documents methods, findings and conclusions drawn. In addition, the report identifies any issues found during the review and proposes recommendations to address them.

The U.S. Environmental Protection Agency (EPA) prepares FYRs pursuant to the Comprehensive Environmental Response, Compensation and Liability Act as amended (CERCLA) Section 121 and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). CERCLA Section 121 states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the Site, the President shall review such remedial action no less often than each 5 years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such Site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

EPA interpreted this requirement further in the NCP, 40 Code of Federal Regulations (CFR) Section 300.430(f)(4)(ii), which states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the Site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after initiation of the selected remedial action.*

Region 8 EPA contracted Skeo Solutions to conduct the FYR and prepared this report regarding the remedy implemented at the Libby Groundwater Contamination Superfund Site in Libby, Lincoln County, Montana for EPA. EPA conducted this FYR from March 2014 to March 2015. EPA is the lead agency for developing and implementing the remedy for the potentially responsible party (PRP)-financed cleanup at the Site. The Montana Department of Environmental Quality (MTDEQ), as the support agency representing the State of Montana, has reviewed all supporting documentation and provided input to EPA during the FYR process.

This is the fifth FYR for the Site. The triggering action for this statutory review the date on which EPA signed the previous FYR. The FYR is required because hazardous substances, pollutants or contaminants remain at the Site above levels that allow for unlimited use and unrestricted exposure. The Site consists of two OUs.

2.0 SITE CHRONOLOGY

Table 1 lists the dates of important events for the Site.

Table 1: Chronology of Site Events

	Date
J. Neils Lumber Company began lumber yard and wood treating operations at the Site	1946
Then owner St. Regis Company (St. Regis) discontinued wood treating operations at the Site	1969
EPA discovered contamination in nearby residential drinking water well	July 1, 1979
EPA conducted a preliminary assessment of the Site	Jan. 1, 1980
EPA conducted a site inspection	Aug. 1, 1981
EPA listed the Site on the National Priorities List	Sept. 8, 1983
St. Regis entered into an Administrative Order on Consent	Oct. 1983
The PRP started the remedial investigation/feasibility study for OU1and OU2	March 9, 1985
The PRP completed the RI/FS for OU1. EPA signed the OU1 ROD	Sept. 26, 1986
The PRP completed the remedial design for OU1	Oct. 1, 1986
The PRP completed the remedial action for OU1	Nov. 1, 1986
The PRP (now Champion International Corp. (Champion), the successor to St. Regis) completed the RI/FS for OU2. EPA signed the OU2 ROD	Dec. 30, 1988
The PRP began remedial design activities for OU2	March 27, 1989
The Court approved a Consent Decree for the Site. The PRP began remedial action for OU2	Oct. 18, 1989
The PRP completed the remedial design for OU2	Sept. 26, 1991
EPA issued an Explanation of Significant Differences (ESD) for OU2 to modify cleanup levels and implement a technical impracticality waiver for the lower aquifer contamination	Sept. 14, 1993
EPA prepared a preliminary close-out report for OU2 EPA filed a Construction Complete notice for the Site	Sept. 20, 1993
Champion (PRP) sells mill property to Stimson Lumber Co. Restrictions added to property deed	Nov. 2, 1993
EPA signs the Site's first FYR	Jan. 24, 1995
EPA issues an ESD for OU2	Jan. 22, 1997
EPA expanded the Land Treatment Unit	1998
EPA shut down the Intermediate Injection System based on information from the then-current site review	1999
Champion submitted a Technical Impracticability Evaluation Report for upper aquifer to EPA	Jan. 11, 1999
EPA signs the Site's second FYR	March 30, 2000
International Paper merges with Champion and assumes responsibility for site liability, including operations and maintenance of remedial systems	June 20, 2000
Stimson Lumber Company sells mill property to Lincoln County Port Authority	2003
EPA signs the Site's third FYR	March 31, 2005
EPA denied a TI waiver of ARAR groundwater standards for the upper aquifer	May 2009
PRPs completed a plume stability analysis	Oct. 1, 2009
EPA began a focused remedial investigation/feasibility study for OU2 to address compliance with RAOs, pursuant to an amendment to the existing Consent Decree	Jan. 27, 2010
EPA signs the Site's fourth FYR	March 29, 2010
PRPs completed investigation of upper aquifer dissolved plume	Feb. 17, 2011
PRPs completed investigation of source area characterization	May 14, 2012
PRPs initiated the preparation of a focused feasibility study to evaluate alternatives to remediate contaminants in the upper aquifer	March 13, 2013
PRPs completed bench-scale test of steam enhanced groundwater extraction	Aug. 29, 2013
PRPs completed vapor intrusion assessment	Oct. 14, 2013
PRPs submitted updated conceptual site model	Jan. 13, 2014
PRPs submitted technical memorandum of remedial alternatives for the upper aquifer	Jan. 21, 2014
PRPs completed bench-scale test of in-situ biosparging	March 14, 2014

3.0 BACKGROUND

3.1 Physical Characteristics

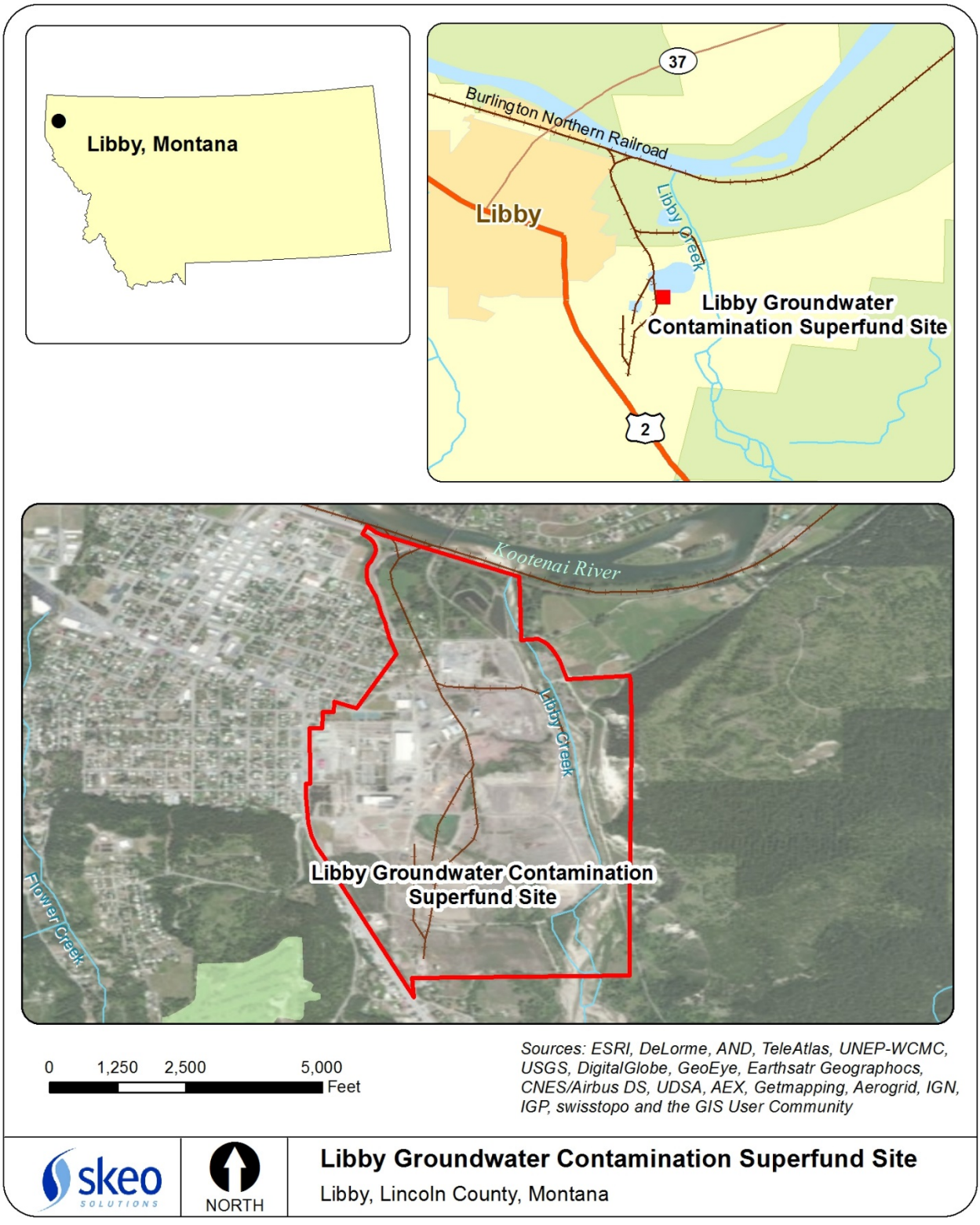
The Site is located at a former lumber mill and wood treatment operation located in northwestern Montana on the eastern edge of the City of Libby, Montana (Figure 1). Historical releases of wood treating fluids at the Site resulted in impacts to the underlying soil and groundwater. Figure 2 shows the Site surface boundaries as defined by the former Champion International property line, i.e., eastern boundary, Libby Creek; southern boundary, private property; western boundary, U.S. Highway 2; and northern boundary, Kootenai River. The Site also includes a groundwater plume in the upper aquifer that extends laterally from a former waste pit area to the north-northwest. Figure 3 provides detail of the contaminated soil areas (historically referred to as "source areas") and remedial features.

The topographic relief at the Site is relatively flat and dips gently toward the north-northeast. The Site lies within a valley with deposits of both alluvial and glacial sediments. The glacial till deposits consist of low permeability silt and clay containing varying amounts of sand and gravel. These geologic materials have resulted in a complex stratigraphic system below the Site.

Upper aquifer: The upper 70 feet of the alluvial deposits, the upper aquifer, contain the highest hydraulic conductivity of the water bearing units. The upper aquifer is unconfined and extends from the water table surface (5 to 30 feet below ground surface) to approximately 60 to 70 feet below ground surface (bgs). The aquifer materials are primarily silty gravel and sand with occasional layers of interbedded clayey, silty deposits. The general groundwater flow direction in the upper aquifer is north-northwest, toward the Kootenai River.

Lower aquifer: Alluvial deposits exist from about 110 to 190 feet bgs and exhibit somewhat lower hydraulic conductivity than the upper aquifer. The lower aquifer consists of silty gravel and sand interbedded with sandy, gravelly silt and clay layers. The lower aquifer generally contains a higher silt and clay content than the upper aquifer, with more silt and clay lenses than the upper aquifer. The general groundwater flow direction in the lower aquifer is north-northwest, toward the Kootenai River.

Figure 1: Site Location Map



Disclaimer: This map and any boundary lines within the map are approximate and subject to change. The map is not a survey. The map is for informational purposes only regarding EPA's response actions at the Site.

Figure 2: Detailed Site Map

Disclaimer: This map and any boundary lines within the map are approximate and subject to change. The map is not a survey. The map is for informational purposes only regarding EPA's response actions at the Site.

Figure 3: Detailed Remedial Features

Disclaimer: This map and any boundary lines within the map are approximate and subject to change. The map is not a survey. The map is for informational purposes only regarding EPA's response actions at the Site.

3.2 Land and Resource Use

The former Champion International property line defines the surface boundary of the Site. Though most of this land is sparsely developed, businesses are located along US Highway 2. Residential neighborhoods surround the Site to the northwest and west. The Kootenai River lies north of the Site, and undeveloped forested land adjoins the Site to the east and south.

The northern portion of the Site is light industrial or commercial use. The Lincoln County Port Authority now owns the northwest portion of the Site, including property overlying the contaminant plume, with the proposed future use as industrial and commercial. The deed to the former Champion International property includes restrictions on disturbing the subsurface in areas of remaining soil contamination (see section 6.4).

A portion of the dissolved phase contaminant plume in the upper aquifer underlies residential areas within the City of Libby. Local residents historically used the upper aquifer groundwater for drinking and irrigation, but a city ordinance is in place that prohibits drilling of water wells for the purpose of human consumption or irrigation within the city of Libby. City residents use City of Libby public water for human consumption and irrigation, and International Paper Corporation subsidizes a portion of the city water supply cost. The city ordinance does not include a portion of the plume located outside the city limits, in Lincoln County. To prevent the installation of wells within that area and prevent exposure of residents to the contaminants a controlled groundwater area (CGWA), a type of institutional control available under State law, as well as other institutional controls, are under consideration.

Surface water features include the on-site fire pond, Libby Creek to the east, Flower Creek to the west and the Kootenai River to the north. The Kootenai River, which flows to the northwest, is a major river system of regional groundwater discharge used by the public for fishing, kayaking and white water rafting.

3.3 History of Contamination

Between 1946 and 1969, wood treatment operations contaminated soil and groundwater at several locations on the Site. Operations included periodic hauling of sludge from the wood-treating fluid tanks to waste pits. Montana Department of Health and Environmental Sciences Water Quality Bureau first detected wood-treating compounds in groundwater in April 1979, when water from a newly installed residential drinking water well smelled of creosote.

EPA conducted the initial investigation of the Site in 1980. This initial study reported the presence of creosote, polycyclic aromatic hydrocarbons (PAHs) and pentachlorophenol (PCP) in three of 11 residential wells sampled. EPA identified the wood-treating operations at the former Champion International property as the source of the groundwater contamination and non-aqueous phase liquid (NAPL), notably a tank farm, butt dip area, and waste-disposal pits (see Figure 2).

3.4 Initial Response

Due to the release or threatened release of hazardous substances and the potential risk to human health and the environment posed by groundwater contamination, EPA placed the Site on the

National Priorities List (NPL) in September 1983. St. Regis Company (the original responsible party) entered into an Administrative Order on Consent with EPA in October 1983, to begin remedial investigations, feasibility studies and remedial action programs. The objectives of the investigations were to define the extent of site contamination, and to develop and evaluate available alternatives to remove or reduce potential threats to human health and the environment.

Beginning in 1983, EPA performed four phases of site investigative work. The results of the Phase III investigations concluded that wood treating compounds in the upper aquifer were migrating off site. Based on 1984 sampling data, Champion International Corporation (Champion), successor to St. Regis Company, offered to buy water agreements to the owners of contaminated wells in 1985. EPA conducted field investigations in May 1985 and January 1986 under the Phase IV remedial investigation program. Approval to implement an alternate water supply followed shortly thereafter.

3.5 Basis for Taking Action

A baseline human health endangerment assessment was prepared in 1986 as part of the feasibility study. It included assessment of the current and future human health risks from contaminated groundwater in the upper aquifer. A second baseline endangerment assessment in 1988 expanded upon the first, to include a human health and environmental impact evaluation for all potential exposure pathways to contaminated soils and the lower aquifer. The assessments identified unacceptable risks to residential, industrial and construction workers.

EPA determined that exposure to groundwater for domestic use would result in unacceptable risks under a residential scenario. The primary contaminants of concern (COCs) for groundwater at the Site are PCP and PAHs. Benzene, dioxins/furans and arsenic are also groundwater COCs, based on their potential association with historical wood treating practices, but concentrations of these constituents are not as widespread.

EPA determined that direct exposure to soils in the waste pit area, the former butt dip and area and the former tank farm (Figure 2) would result in unacceptable risk under a residential or industrial land use scenario. Primary COCs for soils include PCP, PAHs and dioxins/furans.

4.0 REMEDIAL ACTIONS

In accordance with CERCLA and the NCP, remedial actions are required to protect human health and the environment and to comply with applicable or relevant and appropriate requirements (ARARs). A number of remedial alternatives were considered for the Site in the feasibility study, and final selection was made based on an evaluation of each alternative against nine evaluation criteria that are specified in Section 300.430(e)(9)(iii) of the NCP.

The NCP criteria are:

1. Overall Protection of Human Health and the Environment
2. Compliance with ARARs
3. Long-Term Effectiveness and Permanence
4. Reduction of Toxicity, Mobility or Volume through Treatment
5. Short-Term Effectiveness
6. Implementability
7. Cost
8. State Acceptance
9. Community Acceptance

4.1 Remedy Selection

EPA signed the OU1 Record of Decision (ROD) on September 26, 1986. The remedial action objective (RAO) for OU1 was to significantly reduce or eliminate human exposure to contaminated groundwater as an interim remedy. The selected interim remedy consisted of:

- Champion's Buy Water Plan, in which Libby residents paid to use municipal water for irrigation and drinking water instead of contaminated private water wells.
- An ordinance preventing the installation of new water wells for human consumption or irrigation in the upper and lower aquifers within the corporate limits for the City of Libby.

EPA signed the OU2 ROD on December 30, 1988. The RAOs for OU2 were to reduce human exposure to both the soil and groundwater COCs. Two subsequent Explanations of Significant Differences (ESDs) modified the remedy selected in the 1988 ROD. Anticipations are that further modifications will be necessary following completion of a focused remedial investigation and feasibility study (RI/FS).

The original OU2 remedy consisted of:

- 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 biodegration process: an initial treatment phase in the waste pit area and a second treatment phase in a lined and capped land treatment unit (LTU).
- Insertion of language into property deeds identifying the locations of hazardous substance disposal and treatment areas, and land use restriction of these areas.

- Degradation of organic contaminants in the saturated zone of the waste pit area using in-situ bioremediation treatment processes.
- Oil recovery wells to collect highly contaminated groundwater, followed by treatment in a fixed-film bioreactor prior to reinjection.
- Creating an ordinance to prohibit drilling new water supply wells within the corporate limits of the City of Libby, within both the upper and lower aquifers. (This was also part of the ROD for OU1.)
- Monitoring activities to assess the performance of the remedy components during remedial activities at the Site.
- Review of site conditions every five years to ensure that the remedy is protecting human health and the environment.

The OU2 remedy also included an interim remedy for the lower aquifer that required the PRP to conduct a pilot test to determine whether enhanced biorestoration of the aquifer, both alone and in conjunction with oil recovery and oil dispersion techniques, was an effective method of remediation.

In September 1993, EPA modified the OU2 remedy through an ESD. EPA, in consultation with MDEQ, determined that the final remedy for the lower aquifer is to consist of the continuance of both institutional controls prohibiting installation of new water supply wells for consumption or irrigation within the City of Libby and the long-term groundwater monitoring program initiated by Champion. In addition, the ESD removed the soil cleanup goals established in the 1988 ROD for pyrene, naphthalene and phenanthrene.

In 1997, EPA issued a second ESD that further modified the OU2 remedy, based upon recommendations in the first FYR. The following points describe significant differences between the remedy described in the 1988 ROD, the 1993 ESD and the 1997 ESD:

- The Maximum Contaminant Limit (MCL) for PCP in groundwater, promulgated as a federal standard in 1992, replaced the risk-based PCP remediation level set in the 1988 ROD for the upper aquifer. The MCL is 1.0 micrograms per liter (µg/L).
- The MCL for dioxin (2,3,7,8-tetrachlorodibenzo-p-dioxin TCDD)) in groundwater, also promulgated since the 1988 ROD was issued and calculated using toxicity equivalence factors (TEF), added to the remediation parameters in the ROD for the upper aquifer. The MCL for dioxin TCDD is 3.0×10^{-5} µg/L.
- The MCL for each of the carcinogenic PAHs in groundwater replaced the Total Carcinogenic PAH remediation level in the 1988 ROD for the upper aquifer.
- The soil remediation level for Total Carcinogenic PAHs was revised to 59 milligrams per kilogram (mg/kg) calculated as benzo(a)pyrene equivalents using the EPA 1993 relative potency factors.
- Additional soil remediation levels for Total Noncarcinogenic PAHs were included in the list of remediation parameters, based on a Hazard Index (HI) value of 1.0.
- Revised soil remediation levels for dioxins/furans to reflect the most recent TEF methodologies for risk-based value calculation were added.

MCLs determine groundwater cleanup levels for the Site, where those promulgated standards exist for a given contaminant. Where MCLs do not exist, calculated risk-based concentrations for adult residential exposure determine groundwater cleanup levels, at a risk level of 1×10^{-5} in this case. Risk-based concentrations for construction worker exposure determine soil cleanup levels, also at a risk level of 1.0×10^{-5} in this case. Appendix E documents the contaminants identified in the 1988 OU2 ROD and the cleanup levels set in the 1997.

4.2 Remedy Implementation

4.2.1 OU1

The OU1 interim remedy of an alternative water supply and institutional controls began October 1, 1986, and was completed November 1, 1986. The interim remedy for OU1 includes the following elements:

- An offer of an alternate water supply to Libby residents whose domestic wells were either contaminated or potentially contaminated by off-site contaminant migration in the upper aquifer. Residents who agreed to participate in Champion's Buy Water Plan would obtain their water from Libby's public water system. Champion capped and locked those wells in return for monetary compensation for costs incurred from using metered public water. The first FYR reported that 35 residential well owners were part of the Buy Water Plan.
- Champion augmented the Buy Water Plan in 1997 by offering to reimburse $2,000 to affected well owners. In return, the well owners allowed Champion to permanently seal and disable the wells according to State of Montana well abandonment regulations. The second FYR reported 44 residential wells abandoned by Champion. International Paper recently reported one additional abandoned well.
- Champion also made 12 payments of $30,000 per year to the City of Libby for a fixed amount of irrigation water per household. Payments began in 1986.
- Adoption of a city ordinance prohibiting the installation of new water supply wells (within City of Libby corporate limits) in the upper and lower aquifers for the purpose of consumption or irrigation. The ordinance, passed in 1986, is still in effect.
- The current PRP, International Paper Company, has continued to work with the city of Libby in funding and updating the program to provide continued incentives for homeowners to observe the city ordinance prohibiting the installation of new water supply wells.

4.2.2 OU2

The OU2 remedial design began March 27, 1989, and remedial action began October 18, 1989. A focused feasibility study of additional OU2 remedial technologies began January 27, 2010.

<u>Soils and Source Area</u>
The remedial design estimated excavation of approximately 45,000 cubic yards of soils from the three source areas: the waste pit area, the former butt dip area and the former tank farm, and consolidated the excavated soil in the waste pit area for initial landfarming treatment. The

excavation limits were defined as the depth to groundwater or until remaining soils did not exceed the 88 mg/kg PAHs action level. Excavated areas were backfilled with clean fill.

The soils and source area remedy includes separate remedial measures designed to address the contaminated soils and the NAPLs present in the waste pit area. The contaminated soils are treated biologically in the land treatment unit (LTU), and the NAPLs are extracted and separated in the waste pit area via the source area extraction and treatment system (referred to as the SAETS; discussed below). Soils were transferred to the LTU for additional landfarming once soil contaminant concentrations had been reduced 50 to 80 percent in the consolidated soils.

The LTU consists of two 1-acre lined impoundments. To accelerate the completion of the soil remedy, the PRPs constructed an additional 10-acre LTU, the Expanded Landfarm (ELF), in 1998. All of the remaining consolidated soil in the waste pit, except 3,000 cubic yards of highly contaminated soil, was placed on the ELF. The waste pit was then backfilled with clean soil and rock and the 3,000 cubic yards not sent to the ELF were placed on top of the backfilled area for intensive treatment.

Treatment in the ELF consists of periodic cultivation with the spring-tooth cultivator along with irrigation. Upon attainment of cleanup goals, soils return to the original LTU for final disposition. In recent years, no movement of ELF soils to the LTU could occur due to the concentration of dioxins in the soils. Soil will remain in the ELF until cleanup goals are attained or modified.

The source area extraction and treatment system (referred to as the SAETS), constructed in 1991, recovers NAPL and contaminated groundwater from the upper aquifer in the waste pit area. The SAETS currently consists of the bioreactor system and the coalescing separator system, located in the bioreactor building (see Figure 2). Three components make up the two sub-systems: 1) three extraction wells, 2) two oil/water separators and 3) bioreactor tanks and ancillary equipment. The fixed-film bioreactors have degraded more than 33,000 pounds of total PAHs and 6,600 pounds of PCP since 1991. Ongoing pilot-scale treatability studies may result in the alteration of the SAETS operation.

Groundwater

The 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 discontinued because both systems were no more effective than natural attenuation in reducing dissolved-phase PCP and PAHs to cleanup levels, due to the presence of trapped NAPL in the upper aquifer.

Since entering the long-term groundwater monitoring phase, the remedy has undergone numerous changes and adjustment. 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 surface boundary of the Site (as defined by the former Champion

property line). The outermost downgradient extent of the plume is more than one-half mile upgradient of 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 impacted by NAPL is approximately 40 acres.

An ongoing focused feasibility study is assessing the groundwater contamination and possible modifications to the remedy to address remaining NAPL and accelerate the cleanup process. 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. The focused FS addresses certain portions of the upper aquifer that contain NAPL, for which prior remedial efforts have not been successful. EPA expects the focused feasibility study to be completed in 2016.

A 2013 vapor intrusion assessment included soil-gas sampling. Results indicated no evidence of any 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 there are complaints about indoor air quality that are potentially related to petroleum hydrocarbons.

4.3 Operation and Maintenance

The Annual Landfarm Operations Reports describe operations and maintenance (O&M) and long-term monitoring activities performed at the landfarm. Operations include periodic cultivation and irrigation of the soils in the ELF. Once the soils in the ELF meet cleanup levels, soil transfer to the LTU occurs. Leachate collected in the LTU sumps undergoes quarterly sampling. All water collected from the sumps directly discharges into the on-site infiltration galleries. Three basic monitoring activities occur at the landfarm: 1) soil sampling in the treatment zone to evaluate contaminant degradation, soil moisture and compliance with cleanup levels, 2) sampling of leachate from the collection sumps and 3) berm integrity inspections.

The SAETS Annual Operations Reports for each operational year describe O&M and long-term monitoring activities associated with the SAETS and performed at the Site. O&M activities at the Site have evolved as conditions have changed, but current O&M of the SAETS is adequate to ensure consistent system operation. The SAETS operation inspections occur nearly five days a week.

Long-term groundwater monitoring at the Site includes collection of groundwater samples for chemical analysis and water levels from the monitoring well network. The Site's monitoring program receives annual examination to determine if the program can eliminate any wells and/or analyses.

O&M costs in the past five years remain consistent with prior years.

5.0 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

The protectiveness statement from the 2010 FYR for the Site stated the following:

The remedy for OU1 is not protective. The existing institutional control, a City ordinance, does not include a portion of the upper aquifer PCP plume that is located beneath the Stimson lumber mill property (east of the City boundary). In addition, during a recent drought, anecdotal information indicated that some residents were installing new wells and/or using wells that had not been closed as part of the Buy Water Plan. Institutional controls preventing contaminated groundwater use were meant to be temporary, but given the long-term timeframe for groundwater cleanup, are important.

The remedy for OU2 is not protective. ARARs are not being met. It is uncertain whether the soil remedy can meet the revised risk-based cleanup levels. Risk-based cleanup levels for groundwater have changed due to changes in toxicity factors and exposure assumptions. The concentrations of arsenic in groundwater warrant further evaluation since the MCL has decreased from 50 to 10 µg/L. MDEQ numeric standards for water quality are, in many cases, more stringent than the risk-based cleanup levels for groundwater. The availability of new technologies for source zone characterization and remediation warrant further evaluation for the Site since it appears that the SAETS may not be adequately remediating the source zone and PCP plume. The problem is compounded by the current lack of comprehensive institutional controls. The vapor intrusion pathway and potential presence of 1,4-dioxane in groundwater have been identified as issues, and warrant additional data collection and evaluation.

The remedial actions at OU1 and OU2 are not protective therefore the Site is not protective of human health and the environment. The action items identified above and below are necessary to ensure protectiveness.

The 2010 FYR included 10 issues and recommendations. Table 2 summarizes each recommendation and its current status below.

Table 2: Progress on Recommendations from the 2010 FYR

Recommendations	Party Responsible	Milestone Date	Action Taken and Outcome	Date of Action
Public awareness efforts should be made to prevent residents from using existing wells for irrigation or installing new wells.	PRP	9/15/2015	Complete. Upon completion of the FYR, the PRPs met with local officials to investigate anecdotal claims of groundwater use and found no evidence of use.	06/23/2014
The City ordinance should be expanded to include the Stimson mill property and potentially limited to the CGWA.	PRP	9/15/2015	Ongoing. EPA is in discussions with the state, PRPs and local governments to implement appropriate additional restrictions. Groundwater modeling is in progress to support the evaluation of areas to restrict groundwater use. The PRPs submitted draft reports to EPA in 2010 and 2014.	Ongoing (2015/2016)

Table 2: Progress on Recommendations from the 2010 FYR

Recommendations	Party Responsible	Milestone Date	Action Taken and Outcome	Date of Action
Soil cleanup levels should be re-evaluated in light of changes to toxicity factors and exposure assumptions used to calculate risk-based cleanup levels. New cleanup levels should be issued in an ESD to the ROD for OU2.	EPA	6/1/2011	Ongoing. The PRPs submitted updated soil cleanup level calculations to EPA for review on January 15, 2015. EPA has reviewed these calculations and will work to modify the OU2 ROD accordingly.	Ongoing (2015/2016)
Groundwater cleanup levels should be re-evaluated in light of changes to toxicity factors and exposure assumptions used to calculate risk-based cleanup levels. New cleanup levels should be issued in an ESD to the ROD for OU2.	EPA	6/1/2011	Ongoing. The PRPs submitted an evaluation of groundwater cleanup levels to EPA in a technical memorandum on March 13, 2013. Cleanup levels will be finalized in the focused feasibility study and subsequent decision document.	Ongoing (2015/2016)
Additional arsenic data should be collected in monitoring wells to determine if the groundwater remedy is protective.	PRP	6/1/2011	Complete. The PRPs increased arsenic monitoring to ensure no exceedances of the MCL.	08/31/2011
MDEQ's Numeric Water Quality Standards should be evaluated relative to calculated risk-based levels. If the more stringent values are not warranted, an ARAR waiver should be issued through an ESD for OU2.	EPA	6/1/2011	Ongoing. Will be addressed in the focused feasibility study and subsequent decision document.	Ongoing (2015/2016)
Additional source characterization should be performed and remedial technologies should be evaluated for the upper aquifer.	PRP	12/31/2013	Ongoing. Pilot studies are underway to address the source area. Will be addressed in the feasibility study and subsequent decision document.	Ongoing (2015/2016)
Additional wells should be installed to better delineate the NAPL source area and extent of the dissolved contaminant plume.	PRP	12/31/2011	Complete. PRPs added additional wells to delineate the contaminant plumes.	02/17 2011
Additional sampling should be performed in the source area, and a risk evaluation should be performed.	PRP	6/1/2011	Complete. Vapor intrusion was assessed and determined to not be of concern under current conditions.	10/ 14/2013
The analysis for 1,4-dioxane should be included in future groundwater sampling events, particularly for samples collected in well located in the NAPL source area.	PRP	6/1/2011	Complete. EPA determined sampling for 1,4-dioxane was not needed.	07/28/2010

6.0 FIVE-YEAR REVIEW PROCESS

6.1 Administrative Components

EPA Region 8 initiated the FYR in March 2014 and scheduled its completion for April 2015. The EPA remedial project manager Kathy Hernandez led the EPA site review team with contractor support provided to EPA by Skeo Solutions. MDEQ also participated in the review process. In March 2014, EPA held a scoping call with the review team to discuss the Site and items of interest as they related to the protectiveness of the remedy currently in place. The review schedule established consisted of the following activities:

- Community notification.
- Document review.
- Data collection and review.
- Site inspection.
- Local interviews.
- FYR Report development and review.

6.2 Community Involvement

EPA will make the final FYR Report available to the public. EPA will place copies of the document in the designated site repository: Lincoln County Health Department, 408 Mineral Ave, Libby, MT 59923; and in the EPA Records Center in Helena, Montana. Upon completion of the FYR, EPA will place a public notice in the local newspaper to announce the availability of the final FYR Report in the Site's document repository or records center.

6.3 Document Review

6.3.1 ARARs Review

CERCLA Section 121(d)(1) requires that Superfund remedial actions attain "a degree of cleanup of hazardous substance, pollutants, and contaminants released into the environment and of control of further release at a minimum which assures protection of human health and the environment." Additionally, the remedial action must achieve a level of cleanup that at least attains those requirements and standards that are legally applicable or relevant and appropriate (ARARs), unless a waiver is appropriate. Pursuant to the NCP, ARARs are frozen at the time a ROD is issued, unless changed ARARs are needed to ensure protectiveness.

- Applicable requirements are those cleanup standards, standards of control and other substantive requirements, criteria or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, remedial action, location or other circumstance found at a CERCLA site.

- Relevant and appropriate requirements are those standards that, while not "applicable," address problems or situations sufficiently similar to those encountered at the CERCLA

site that their use is well suited to the particular site. Only those state standards that are more stringent than federal requirements may be applicable or relevant and appropriate.

- To-Be-Considered criteria are non-promulgated advisories and guidance. Although not legally binding, these criteria warrant consideration in determining the necessary remedial action. For example, To-Be-Considered criteria may be particularly useful in determining health-based levels where no ARARs exist or in developing the appropriate method for conducting a remedial action.

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 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 federal Clean Water Act.

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, e.g., discharge of contaminated groundwater or in-situ remediation.

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.

Remedial actions are required to comply with the all ARARs, including the chemical-specific ARARs identified in the ROD. In performing the FYR for compliance with ARARs, review is limited to only those ARARs that address the protectiveness of the remedy.

6.3.2 Groundwater ARARs

The 1988 ROD specified that groundwater cleanup levels were MCLs for contaminants for which MCL standards exist. If there are no MCLs, EPA determined that for this Site, risk-based cleanup levels representing risk to 1 x 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. 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.

Table 3: Previous and Current ARARs for Groundwater COCs

COCs	MCL[a] (µg/L) 1997 ESD	MCL[b] (µg/L) Current (2014)	ARAR Changes[d]
PCP	1	1	None
Benzene	5	5	None
Arsenic	50	10	More Stringent
Dioxin TCDD	3.0 x 10^{-5}	3.0 x 10^{-5}	None
Chrysene	0.2	NA	No Longer Promulgated
Benzo(a)anthracene	0.1	NA	No Longer Promulgated
Benzo(b)fluoranthene	0.2	NA	No Longer Promulgated

Table 3: Previous and Current ARARs for Groundwater COCs

COCs	MCL[a] (µg/L) 1997 ESD	MCL[b] (µg/L) Current (2014)	ARAR Changes[d]
Benzo(k)fluoranthene	0.2	NA	No Longer Promulgated
Benzo(a)pyrene	0.2	0.2[c]	None
Indeno(1,2,3-c,d)pyrene	0.4	NA	No Longer Promulgated
Dibenzo(a,h)anthracene	0.3	NA	No Longer Promulgated

NA = Not Applicable
a. The decision documents identified federal MCLs as groundwater ARARs.
b. National Primary and Secondary Drinking Water MCLs are located at http://water.epa.gov/drink/contaminants/index.cfm (accessed on 9/2/2014).
c. The MCL for benzo(a)pyrene is considered the cumulative standard for PAHs.
d. Montana has adopted Circular DEQ-7 Montana Numeric Water Quality Standards for many of the contaminants that do not have MCLs. These standards will need to be evaluated and potentially incorporated as part of a post-ROD change decision document.

6.3.3 Soil ARARs

The decision documents did not identify chemical-specific soil ARARs, as no promulgated standard exists for soil action levels.

6.4 Institutional Control Review

Table 4 lists deed information pertaining to the Site.

Table 4: Deed Documents from Lincoln County Public Records Office

Date	Type of Document	Description	Book #	Page #
11/02/1993	Grant Deed	Transfer of mill property from Champion to Stimson Lumber. Includes restrictions for waste areas.	193	233-276

Table 5 and Figure 4 indication the ICs associated with areas of interest at the Site. Field verification of the IC's implementation was completed by the field team.

Table 5: OU2 Institutional Control Summary Table

Media	ICs Needed	Called for in the Decision Documents	IC Objective	Instrument in Place	Notes
Groundwater	Yes	Yes	Restrict installation of groundwater wells and groundwater use.	City ordinance for properties within the City of Libby corporate limits.	EPA and the PRPs are developing additional restrictions for affected properties not within the City limits.
Soil	Yes	Yes	Prohibit activities that could disturb the source areas and treatment areas.	Restrictive covenant recorded in the property deed.	Additional ICs may be needed for portions of property still owned by International Paper Co.

Figure 4: Institutional Control Base Map

Disclaimer: This map and any boundary lines within the map are approximate and subject to change. The map is not a survey. The map is for informational purposes only regarding EPA's response actions at the Site.

6.5 Data Review

The data reviewed as part of this FYR included groundwater sampling analytical results, soil sampling results, water level data and NAPL observations. The review also included groundwater SAETS operational data, such as flow rates, volumes of groundwater extracted and treated, and mass removal data.

Monitoring data and the 2013 groundwater conceptual model indicate dissolved PCP concentrations in the aquifers are predominantly declining and the PCP plume extent in the upper aquifer is stable, or is slowly shrinking over time. PCP and naphthalene plumes in the upper aquifer are included in Figures 5 and 6. Concentrations are reported for different depths at the same location: the .1 series wells are most shallow at approximately 20 to 30 bgs, the .2 series at approximately 40 to 50 bgs, and and the .3 series wells are the deepest series in the upper aquifer at approximately 55 to 65 bgs.

The PCP plume in the upper aquifer extends laterally from about the waste pit area to more than 2,700 feet to the north-northwest. The leading edge of the plume (as defined by PCP concentrations above the 1 µg/L MCL) extends approximately 1,300 feet beyond the Stimson property line. An October 2009 plume stability analysis indicated the PCP plume is stable and not likely to increase in size under natural conditions. It is impossible for direct comparison of the current aerial size of the PCP plume to pre-2010 plume maps because of 2010 monitoring well network expansion. The aerial size of the PCP plume in 2013 is similar to the plume boundaries identified in 2012.

Step-out wells drilled in 2010 (6017, 6018, 6019 and 6020 clusters) did not contain PCP concentrations above the remediation level (1.0 µg/L) during 2013 sampling. Therefore, the monitoring well network in the upper aquifer properly bounds the PCP plume. Future collection of data from the monitoring well network will track changes in the COC concentrations. The updated groundwater monitoring plan will incorporate the additional sampling data.

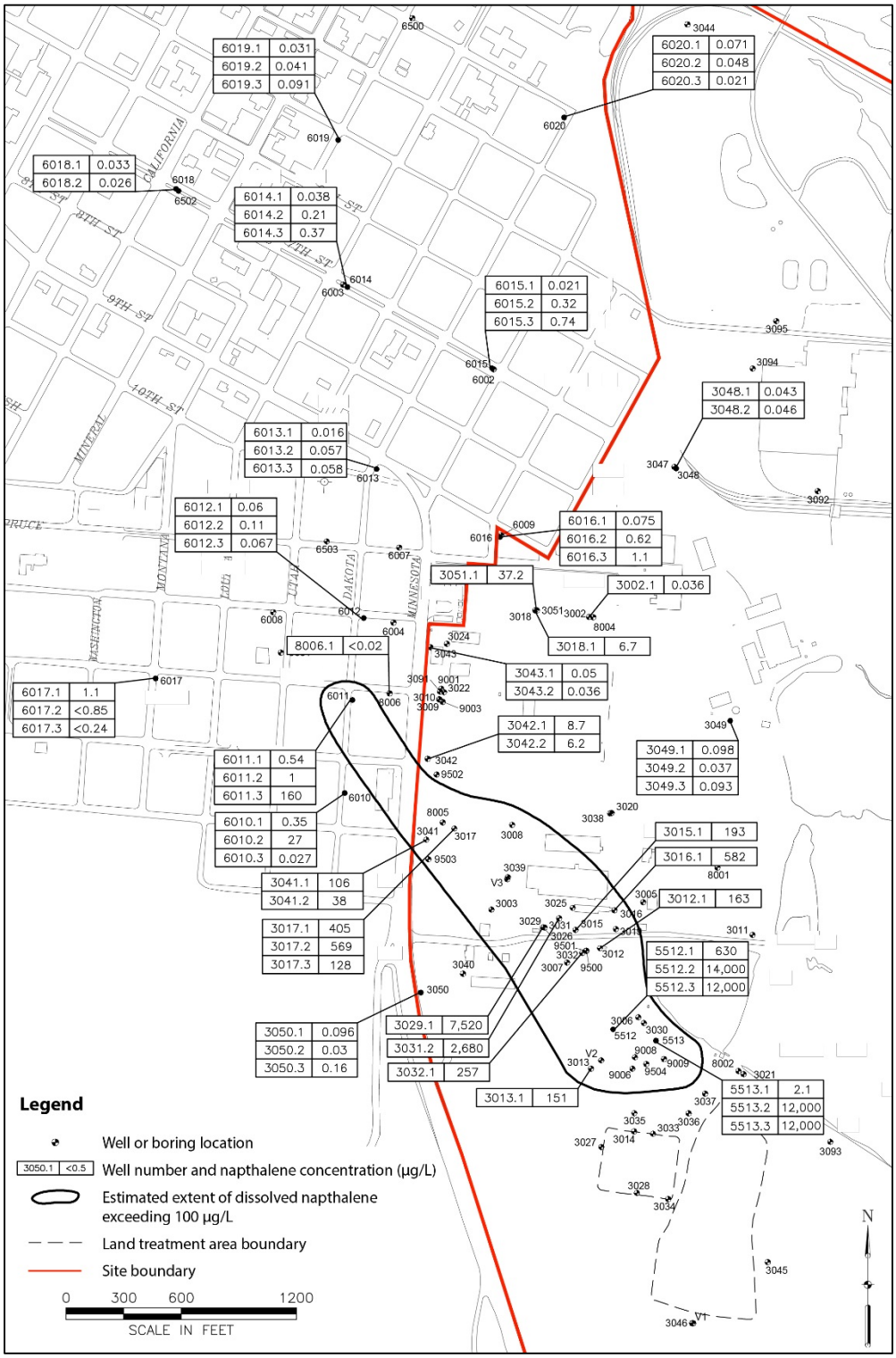
Naphthalene is the primary PAH detected in the upper aquifer, with a plume extending laterally from about the waste pit area to the north-northwest. Whenever naphthalene detection was above the cleanup level of 1,460 µg/L, PCP detection was also above its cleanup level of 1.0 µg/L. Therefore, the PCP plume determines the extent of contamination. PAHs will be included in the groundwater monitoring plan, which is currently being updated for the Site. The objectives for PAH monitoring will be included in the updated plan.

Five years ago, regular groundwater monitoring began to include arsenic. In each subsequent year, arsenic concentrations in several wells have exceeded the MCL of 10 µg/L. For 2013, nine wells had total arsenic results above the MCL, ranging from 10.7 µg/L (Well 6011.3) to 24.9 µg/L (Well 3049.2). Due to groundwater movement, it is difficult to determine the source and plume location for arsenic in the upper aquifer. To gain a better understanding of the arsenic concentrations and distribution, appropriate groundwater wells will include analysis for total arsenic in future monitoring events. The objectives of the arsenic sampling will be provided in the updated groundwater monitoring plan which is currently being prepared for the Site. Benzene was not detected above the cleanup level of 5 µg/L in any monitoring well during 2013 sampling.

Weekly monitoring of nutrients, temperature, dissolved oxygen and pH ensures optimal operation of the bioreactor system. Monitoring of PAHs and PCP in the bioreactor influent and effluent evaluates system performance. The estimation for 2013 is that the bioreactor successfully degraded 609 pounds of PAHs and 116 pounds of PCP.

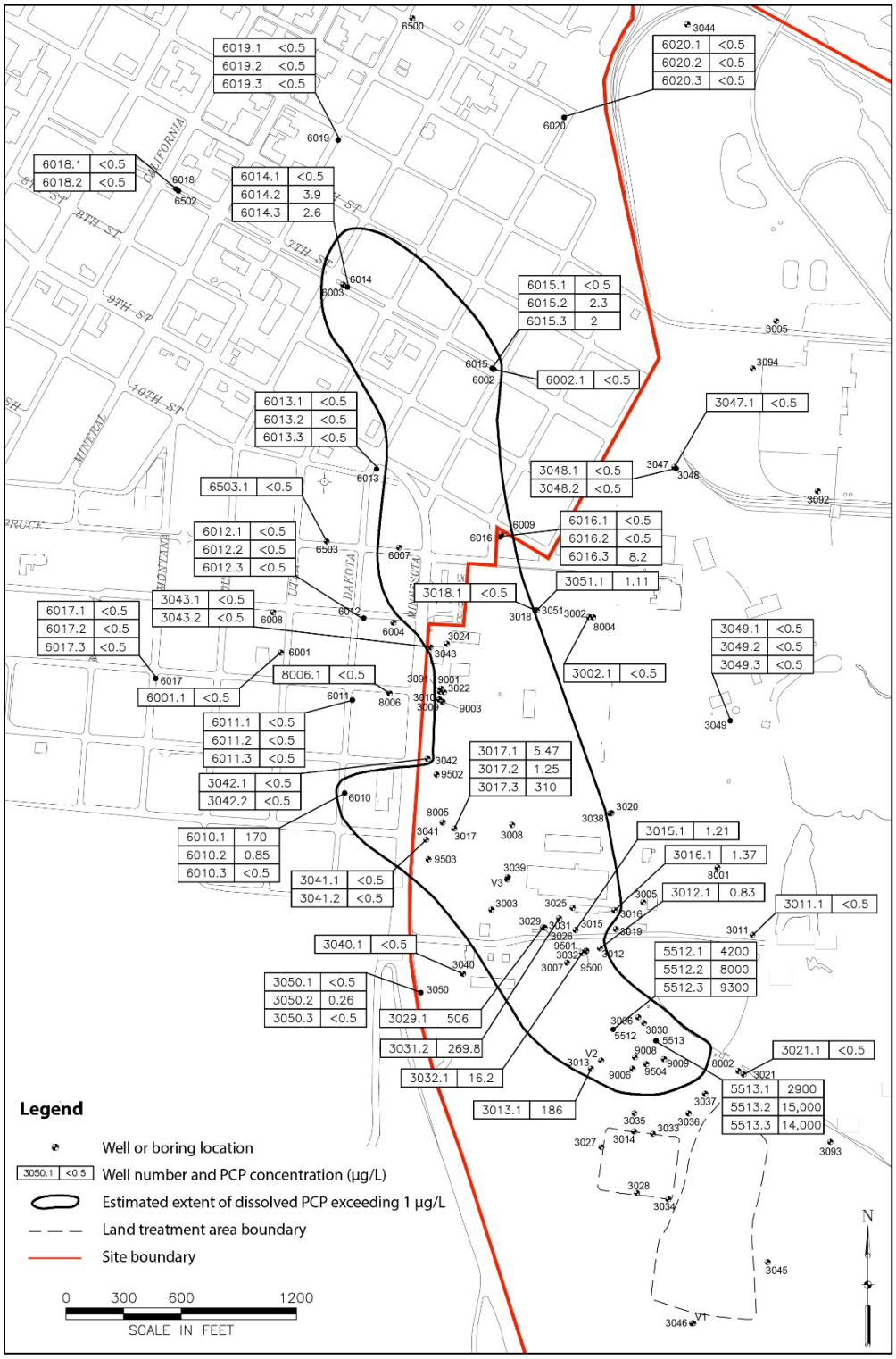
In 2012, confirmation soil samples were collected from Plots 2, 3 and 4 (May) and Plot 3, Quadrant 3 (July) of the ELF to assess PCP, PAH and dioxin degradation. Sampling indicates PAHs and PCP were below their respective remediation goals in Plots 2, 3 and 4. However, dioxin concentrations remain above the remediation goal. Sample collection did not occur during 2013.

Figure 5: 2013 Naphthalene Concentrations in Upper Aquifer



Disclaimer: This map and any boundary lines within the map are approximate and subject to change. The map is not a survey. The map is for informational purposes only regarding EPA's response actions at the Site. Concentrations are reported for different depths at the same location.

Figure 6: 2013 PCP Concentrations in Upper Aquifer



Disclaimer: This map and any boundary lines within the map are approximate and subject to change. The map is not a survey. The map is for informational purposes only regarding EPA's response actions at the Site. Concentrations are reported for different depths at the same location.

6.6 Site Inspection

EPA conducted a site inspection on August 5, 2014. Participants included Kathy Hernandez, EPA; Andrew Schmidt, EPA; Lisa Dewitt, MTDEQ; Ryan Burdge and Johnny Zimmerman-Ward, Skeo Solutions; Erin Trail, CH2M Hill; Tom Richardson, International Paper Co.; and David Cosgriff, International Paper Co. consultant with Arrowhead Engineering. The site inspection checklist is in Appendix C and the site photographs are in Appendix D.

Site inspection participants met at the International Paper office on site for an overview of the property. Participants then walked to the main site areas, including the waste pit and pilot test areas, the groundwater treatment building, the landfarm treatment area and the injection treatment building. All fencing and wells were in good condition and secured. The PRP reported no concerns related to erosion or trespassing or groundwater use on site, and noted the extent to which wildlife have made use of the Site.

On August 5, 2014, Skeo Solutions staff visited the designated site repository, the Lincoln County Department of Health, and confirmed that site documents are stored on site and are available for public review. Field visits also indicated no domestic use of groundwater was being done.

6.7 Interviews

The FYR process included interviews with parties affected by the Site, including the current landowners and regulatory agencies involved in site activities or aware of the Site. The purpose was to document the perceived status of the Site and any perceived problems or successes with the phases of the remedy implemented to date. Interviews took place during the site inspection or via email. The interview summaries follow. Appendix B provides the complete interviews.

Lisa Dewitt, MDEQ. Ms. Dewitt is the project manager for the state of Montana. She believes the remedy is proceeding as expected. EPA and MDEQ need to assess how to document the concentrations that remain in the treated soils and are not likely to degrade. For the groundwater remedy, the remedy as implemented has been progressing slowly. The results of the upcoming treatability studies should provide enhancement to the groundwater remedy, as appropriate. She also notes that MDEQ is working with EPA and Lincoln County to implement the appropriate institutional controls.

Tom Richardson, International Paper. Mr. Richardson is the project manager for International Paper. He believes the remediation has been handled well and has progressed as expected. He believes the goal should be containment rather than achieving MCLs.

Dave Cosgriff, Arrowhead Engineering. Mr. Cosgriff is the O&M manager for the Site. He believes the remedy has progressed as expected. He noted that the plume is stable and it is not migrating towards the river. Mr. Cosgiff is hopeful that the biosparge pilot will yield good results. He also noted that the land farming has been successful, but that attaining the dioxin cleanup levels in the ELF and LTU may no longer be practical.

Kathi Hooper, Lincoln County Department of Environmental Health. Ms. Hooper is the Director of the Lincoln County Department of Environmental Health. Although aware of the Site, she expressed no concerns with the remedy.

7.0 TECHNICAL ASSESSMENT

7.1 Question A: *Is the remedy functioning as intended by the decision documents?*

OU1

Yes, the interim remedy for OU1 is functioning as intended. The remedy for OU1 involved providing an alternative water supply source for Libby residents and adoption of a city ordinance prohibiting groundwater use. Champion's Buy Water Plan augmented the alternative water supply initiative. The remedy for OU1 incorporated a city ordinance prohibiting the installation of new water wells within city limits. Although the previous FYR reported anecdotes that Libby residents were circumventing the ordinance and using private wells, investigation into the claim identified no evidence of groundwater use. A CGWA or other institutional controls are under consideration to prevent the installation of wells and use of groundwater within all affected areas in both the City and County jurisdictions.

OU2

No, the remedy for OU2 is not functioning as intended due to the inability to meet RAOs in the intended timeframe. The treatment system continues to remove thousands of pounds of NAPL from the source area, but significant additional material remains, much of it as immobile NAPL that will continue to act as a long-term source of dissolved contaminants in groundwater. A significant reduction in source zone size and amount of product present is likely necessary in order to meet RAOs and cleanup levels for the upper aquifer. A focused remedial investigation and feasibility study is underway to evaluate additional remedial options to address source areas and groundwater contamination. Upon completion, EPA will decide if altered or additional remedial action is appropriate and record any modification to the remedy in the appropriate decision document. While these changes are under consideration, groundwater treatment and monitoring is ongoing.

The RAOs and cleanup levels for the soils have been not been achieved, and therefore treatment of contaminated soils must continue until the cleanup levels are met. Contaminant concentrations in soil are declining due to the treatment by periodic cultivation and irrigation to maintain consistent moisture and oxygen levels. However, in recent years, the soil dioxin concentrations remain elevated in the ELF so that removal to the LTU did not occur. The dioxin cleanup level is under review and a decision document will record any cleanup level or soil remedy modifications determined appropriate by EPA.

Institutional controls are in place to restrict groundwater use in the City of Libby and to prohibit activities that could disturb waste left in place beneath clean fill. However, no restrictions are in place to prohibit groundwater use in Lincoln County, where the source areas and plume origin are located. In addition, industrial land use forms the basis for soil cleanup levels. Although current property zoning is commercial and industrial, and expected to remain so, no mechanism is in place to ensure future land use at all areas within the Site does not change. Additional

groundwater restrictions are under development, to prohibit use of contaminated groundwater within Lincoln County, primarily the former Stimson property. Parcels owned by International Paper may require additional restrictions, including restrictions on disturbing soils in the former waste pit area, ELF or LTU.

7.2 Question B: *Are the exposure assumptions, toxicity data, cleanup levels and remedial action objectives (RAOs) used at the time of remedy selection still valid?*

No, the RAOs for OU2 may no longer be valid and are currently under EPA evaluation. Upon completion of a focused remedial investigation and focused feasibility study or earlier, EPA may modify the remedy as needed and record the changes in a decision document. Changes may include additional technologies, institutional controls or modified cleanup goals, including revising the groundwater cleanup goal for arsenic to reflect the current MCL, and for other contaminants to reflect the current Circular DEQ-7 Montana Numeric Water Quality Standards applicable to groundwater, and revising soil cleanup levels to reflect updated risk assessment information.

Toxicity values for several COCs with risk-based cleanup goals have changed, notably for the PAHs and dioxins/furans. Therefore, additional assessment of the residual soil concentrations and confirmation sampling from the remedial action must occur, along with a comparison of those residual concentrations to re-evaluated soil remediation goals/levels that resulted from the prior five-year review, to confirm whether on-site concentrations are protective of industrial uses.

Table 6: Comparison of Soil RGs to Current Screening Levels

COC	Soil Cleanup Goal (mg/kg)[a]	2014 Industrial RSL for Soil (mg/kg)[b]		Risk Calculation Based on Industrial RSL	
		Cancer Target = 1 x 10^{-6}	Noncancer HI=1.0	Risk[c]	HI[d]
Acenaphthene	166	NA	45,000	NA	0.004
Anthracene	33	NA	230,000	NA	0.000
Fluorene	250	NA	30,000	NA	0.008
Fluoranthene	250	NA	30,000	NA	0.008
Chrysene	59,400	290	NA	**2.0 x 10^{-4}**	NA
Benzo(a)anthracene	594	2.9	NA	**2.0 x 10^{-4}**	NA
Benzo(b)fluoranthene	594	2.9	NA	**2.0 x 10^{-4}**	NA
Benzo(k)fluoranthene	5940	29	NA	**2.0 x 10^{-4}**	NA
Benzo(a)pyrene	59	0.29	NA	**2.0 x 10^{-4}**	NA
Indeno (1,2,3-c,d) pyrene	594	2.9	NA	**2.0 x 10^{-4}**	NA
Dibenzo(a,h)anthracene	59	0.29	NA	**2.0 x 10^{-4}**	NA
PCP	36	4	2,900	9.0 x 10^{-6}	0.012
Dioxin TCDD	0.00289	0.000022	0.00073	**1.3 x 10^{-4}**	**3.95**
			Totals	**1.4 x 10^{-3}**	**4.0**

Table 6: Comparison of Soil RGs to Current Screening Levels

COC	Soil Cleanup Goal (mg/kg)[a]	2014 Industrial RSL for Soil (mg/kg)[b]		Risk Calculation Based on Industrial RSL	
		Cancer Target = 1 x 10^{-6}	Noncancer HI=1.0	Risk[c]	HI[d]
NA = Not Applicable a. Cleanup goal listed in the ESD. b. EPA Regional Screening Levels, dated May 2014, available at http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm c. Cancer risks calculated using the following equation, based on the fact that RSLs are derived based on 1 x 10^{-6} risk: Cancer risk = (Cleanup Level ÷ Soil RSL) × 10^{-6} d. Noncancer HI calculated using the following equation, based on the RSLs derived from a HI of 1: Noncancer HI = (Cleanup Level/Soil RSL)					

An evaluation in 2013 determined the potential for vapor intrusion does not pose a threat under current conditions. As conditions change, EPA will ensure reassessment of the potential risk from vapor intrusion.

7.3 Question C: *Has any other information come to light that could call into question the protectiveness of the remedy?*

The 1997 ESD set a groundwater cleanup level for dioxin in the upper aquifer, based on the federal MCL. Currently no sampling occurs for dioxin in groundwater at the Site, following special comprehensive groundwater sampling in 2008. As EPA continues its examination of RAOs and remediation goals/levels and development of a focused feasibility study, it will further consider this issue.

7.4 Technical Assessment Summary

OU1

The interim remedy for OU1 is functioning as intended. Libby residents whose wells were either contaminated or potentially contaminated by off-site upper aquifer contaminant plume migration have access to an alternative water supply and a city ordinance prohibits the installation of new water wells within city limits.

OU2 Groundwater

The remedy for OU2 is not functioning as intended due to the inability to meet RAOs in the intended timeframe. A focused remedial investigation and feasibility study is underway to evaluate additional remedial options to address source areas and groundwater contamination. Upon completion, EPA will make appropriate decisions and record any modification to the remedy in the appropriate decision document. While these changes are under consideration, groundwater treatment and monitoring is ongoing.

No restrictions are in place to prohibit groundwater use in Lincoln County where the source area and plume origin are located. A CGWA or other institutional controls are under consideration to prevent the installation of wells and use of groundwater within all affected areas in both the city and county jurisdictions.

Contaminant concentrations in soil are declining due to the treatment by periodic cultivation and irrigation to maintain consistent moisture and oxygen levels. However, in recent years, the dioxin concentrations remain elevated in the ELF soil and removal to the LTU has not occurred. The dioxin cleanup goal is under review and a decision document will record any cleanup level or soil remedy modification determined appropriate by the EPA.

Additional restrictions may be required for parcels owned by International Paper, including restrictions on disturbing soils in the former waste pit area, ELF or LTU. In addition, toxicity data for several COCs have changed and the soil cleanup levels may no longer be protective. EPA will make appropriate decisions following additional assessment of cleanup goals and residual soil contamination, with any modifications to the cleanup goals recorded in a decision document.

8.0 ISSUES

Table 7 summarizes the current site issues.

Table 7: Current Site Issues

Issue	Affects Current Protectiveness?	Affects Future Protectiveness?
The city ordinance does not include all properties overlying the contaminant plume.	No	Yes
Land use controls do not limit future land uses or protect all areas with waste.	No	Yes
The current OU2 remedy may not attain RAOs.	No	Yes
Groundwater cleanup levels may no longer be valid and a decision document is necessary to incorporate Circular DEQ-7 Montana Numeric Water Quality Standards.	No	Yes
Soil cleanup levels may no longer be valid.	No	Yes

9.0 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Table 8 provides recommendations from the Fifth Five-Year Review to address the current site issues. In addition, those recommendations from the 2010 Fourth Five-Year Review which are not yet complete will also be addressed by EPA.

Table 8: Recommendations to Address Current Site Issues

Issue	Recommendation / Follow-Up Action	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness?	
					Current	Future
The city ordinance does not include all properties overlying the contaminant plume.	Implement additional institutional controls to restrict use of contaminated groundwater in all affected areas.	PRP	EPA	3/29/2016	No	Yes

Issue	Recommendation / Follow-Up Action	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness?	
					Current	Future
The current OU2 remedy may not attain RAOs.	Complete focused remedial investigation and feasibility study and, if modifications to existing remedy are deemed appropriate by EPA, record modified remedy in a decision document.	PRP	EPA	3/29/2016	No	Yes
Land use controls do not limit future land uses or protect all areas with waste at certain locations on Site.	Implement additional institutional controls to restrict land use and protect areas with waste in place for those locations.	PRP	EPA	3/29/2016	No	Yes
Groundwater cleanup levels may no longer be valid.	A decision document is necessary to incorporate Circular DEQ-7 Montana Numeric Water Quality Standards.	PRP	EPA	3/29/2016	No	Yes
Soil cleanup levels may no longer be valid.	Assess risk from residual contamination and determine if soil remedy can meet appropriate cleanup levels.	PRP	EPA	3/29/2016	No	Yes

10.0 PROTECTIVENESS STATEMENTS

The interim remedy at OU1 currently protects human health and the environment because the city is implementing and enforcing its ordinance that prohibits use of contaminated groundwater within the city limits and there are no known users of contaminated groundwater outside of the city limits. However, for the remedy to be protective in the long term, it must include additional institutional controls to prohibit groundwater use outside of the city limits.

The remedy at OU2 currently protects human health and the environment because no known completed exposure pathways exist. As with OU1, a city ordinance prohibits groundwater use within the city limits and there is no known groundwater use in contaminated areas of Lincoln County. Areas with remaining soil contamination are fenced and some land use restrictions are in place. However, for the remedy to be protective in the long term, it must include the following additional actions:

- Implement additional institutional controls to restrict land use and activities which may interfere with remedial activities in all areas with remaining waste;
- Modify groundwater ARARs in a decision document;
- Assess risk-based cleanup levels and residual soil contamination; and
- Appropriately modify the remedy modifications to ensure RAO achievement.

Because the remedial actions at all OUs currently protect human health and the environment, the Site currently protects human health and the environment.

11.0 NEXT REVIEW

The next FYR will be due within five years of the signature/approval date of this FYR.

Appendix A: List of Documents Reviewed

Arrowhead Engineering, Inc. *2009 Annual Operations Report Source Area Extraction and Treatment System Libby Ground Water Site Libby, Montana*.

Arrowhead Engineering, Inc. *2010 Annual Operations Report Source Area Extraction and Treatment System Libby Ground Water Site Libby, Montana*.

Arrowhead Engineering, Inc. *2011 Annual Operations Report Source Area Extraction and Treatment System Libby Ground Water Site Libby, Montana*.

Arrowhead Engineering, Inc. *2012 Annual Operations Report Source Area Extraction and Treatment System Libby Ground Water Site Libby, Montana*.

Arrowhead Engineering, Inc. *2013 Annual Operations Report Source Area Extraction and Treatment System Libby Ground Water Site Libby, Montana*.

Arrowhead Engineering, Inc. *2009 Annual Landfarm Operations Report for the Libby Ground Water Site Libby, Montana.*

Arrowhead Engineering, Inc. *2010 Annual Landfarm Operations Report for the Libby Ground Water Site Libby, Montana*.

Arrowhead Engineering, Inc. *2011 Annual Landfarm Operations Report for the Libby Ground Water Site Libby, Montana.*

Arrowhead Engineering, Inc. *2012 Annual Landfarm Operations Report for the Libby Ground Water Site Libby, Montana.*

Arrowhead Engineering, Inc. *2013 Annual Landfarm Operations Report for the Libby Ground Water Site Libby, Montana.*

Arrowhead Engineering, Inc. *2009 Annual Ground Water Monitoring Report For The Upper And Lower Aquifer Libby Ground Water Site Libby, Montana*.

Arrowhead Engineering, Inc. *2010 Annual Ground Water Monitoring Report For The Upper And Lower Aquifer Libby Ground Water Site Libby, Montana.*

Arrowhead Engineering, Inc. *2011 Annual Ground Water Monitoring Report For The Upper And Lower Aquifer Libby Ground Water Site Libby, Montana.*

Arrowhead Engineering, Inc. *2012 Annual Ground Water Monitoring Report For The Upper And Lower Aquifer Libby Ground Water Site Libby, Montana.*

Arrowhead Engineering, Inc. *2013 Annual Ground Water Monitoring Report For The Upper And Lower Aquifer Libby Ground Water Site Libby, Montana.*

Arrowhead Engineering, Inc. *2013 Vapor Intrusion Assessment for the Libby Ground Water Site Libby, Montana.*

City of Libby, 1986. *Water Well Ordinance, Ordinance No. 1353.*

EPA, 1986. *Record of Decision Libby Ground Water Superfund Site Lincoln County, Montana*. December.

EPA, 1988. *Record of Decision Libby Ground Water Superfund Site Lincoln County, Montana.*

December.

EPA, 1993a. *Explanation of Significant Differences Libby Ground Water Contamination.*

EPA/ESD/R08-93/500. September.

EPA, 1995. *Five-Year Review for Libby Ground Water Superfund Site Lincoln County, Montana.* January.

EPA, 1997. *Explanation of Significant Differences Libby Ground Water Contamination*. January.

EPA, *2000a. Second Five-Year Review Report for Libby Ground Water Site Libby, Lincoln County, Montana*. March.

EPA, *2005. Third Five-Year Review Report for Libby Ground Water Site Libby, Lincoln County, Montana*. March.

EPA, *2010. Fourth Five-Year Review Report for Libby Ground Water Site Libby, Lincoln County, Montana*. March.

Appendix B: Interview Forms

Libby Groundwater Contamination Superfund Site Five-Year Review Interview Form

Site Name:	**Libby Groundwater Contamination**	**EPA ID No.:**	**MTD980502736**
Interviewer Name:	**Ryan Burdge**	**Affiliation:**	**Skeo Solutions**
Subject Name:	**Tom Richardson**	**Affiliation:**	**International Paper**
Time:	**4:00 p.m.**	**Date:**	**8/05/2014**
Interview Location:	**On Site**		

Interview Format (circle one): **In Person** **Phone** **Mail** **Other:**

Interview Category: Potentially Responsible Parties (PRPs)

1. What is your overall impression of the remedial activities at the Site and what is your assessment of the current performance of the remedy in place at the Site?

   The O&M is top notch. As far as the remediation goes, I think there are necessary things we are looking at because things change over time. Not sure we will ever get to the drinking water standards, but it is good to look at options. The goal should probably be containment instead of removal of the contamination. Why pump money into it if it is not going to change the results? Instead, the money could be better spent on the local economy. We have thought we had success with other remedies in the past and after time passed, we found that it was not as successful as originally thought. When the landfarm cleanup is completed, it is possible that area may be available for reuse.

2. What have been the effects of this Site on the surrounding community, if any?

   The Site impacts their groundwater resource. There are some positive effects from the Site because we have had a presence here. We are working with folks on potential reuse. We're also looking to cost share power line expansion with the Port Authority, which would be a benefit to the community.

3. Are you aware of any complaints or inquiries regarding environmental issues or the remedial action from residents since implementation of the cleanup?

   Every once in a while we receive inquiries, but they are about using the groundwater.

4. Do you feel well-informed regarding the Site's activities and remedial progress? If not, how might EPA convey site-related information in the future?

   Yes.

5. Do you have any comments, suggestions or recommendations regarding the management or operation of the Site's remedy?

   No, the Site is very well maintained.

Libby Groundwater Contamination Superfund Site Five-Year Review Interview Form

Site Name: Libby Groundwater Contamination **EPA ID No.:** MTD980502736

Interviewer Name: Ryan Burdge **Affiliation:** Skeo Solutions

Subject Name: Dave Cosgriff **Affiliation:** Arrowhead Engineering

Time: 4:00 p.m. **Date:** 8/05/2014

Interview Location: On Site

Interview Format (circle one): **In Person** **Phone** **Mail** **Other:**

Interview Category: **O&M Contractor**

1. What is your overall impression of the project, including cleanup, maintenance and reuse activities (as appropriate)?

   The groundwater remedy is progressing, but it not expected to achieve MCLs. The Site is complex with extensive NAPL. I think the TI waiver for the upper aquifer should have been granted.

   The landfarming has been effective until recently, when the soils have not been meeting the dioxin cleanup level.

   The bioreactor continues to remove NAPL, but a significant amount remains. It is a costly, minor component of the overall remedy. We are hopeful the pilot study will be effective at removing remaining source contamination.

2. What is your assessment of the current performance of the remedy in place at the Site?

   See response 1.

3. What are the findings from the monitoring data? What are the key trends in contaminant levels that are being documented over time at the Site?

   The plume is attenuating and is stable. Contamination is not migrating to the river. Additional wells were added since the last FYR to better identify the contaminant plume.

4. Is there a continuous on-site O&M presence? If so, please describe staff responsibilities and activities. Alternatively, please describe staff responsibilities and the frequency of site inspections and activities if there is not a continuous on-site O&M presence.

   O&M staff are present and inspect the remedy component five days a week.

5. Have there been any significant changes in site O&M requirements, maintenance schedules or sampling routines since start-up or in the last five years? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts.

   No significant changes.

6. Have there been unexpected O&M difficulties or costs at the Site since start-up or in the last five years? If so, please provide details.

   No, but the remaining dioxins in the ELF soils need to be addressed.

7. Have there been opportunities to optimize O&M activities or sampling efforts? Please describe changes and any resulting or desired cost savings or improved efficiencies.

   No.

8. Do you have any comments, suggestions or recommendations regarding O&M activities and schedules at the Site?

   No.

Libby Groundwater Contamination Superfund Site Five-Year Review Interview Form

Site Name: **Libby Groundwater Contamination** **EPA ID No.:** **MTD980502736**

Interviewer Name: **Ryan Burdge** **Affiliation:** **Skeo Solutions**

Subject Name: **Kathi Hooper** **Affiliation:** **Lincoln County Environmental Health**

Time: **Date:** **9/11/2014**

Interview Format (circle one): **In Person** **Phone** **Mail** **Other: Email**

Interview Category: **Local Government**

1. Are you aware of the former environmental issues at the Site and the cleanup activities that have taken place to date?

   Yes, through my employment.

2. Do you feel well-informed regarding the Site's activities and remedial progress? If not, how might EPA convey site-related information in the future?

   Yes, I have attended EPA and MDEQ meetings regarding remediation at the Site. I have also contacted David Cosgriff for updates and information.

3. Have there been any problems with unusual or unexpected activities at the Site, such as emergency response, vandalism or trespassing?

   Not to my knowledge.

4. Are you aware of any changes to state laws or local regulations that might affect the protectiveness of the Site's remedy?

   No.

5. Are you aware of any changes in projected land use(s) at the Site?

   No, it is still industrial.

6. Has EPA kept involved parties and surrounding neighbors informed of activities at the Site? How can EPA best provide site-related information in the future?

   The City of Libby has been informed. Recently the City and County Health Board was updated.

7. Do you have any comments, suggestions or recommendations regarding the project?

   No.

Libby Groundwater Contamination Superfund Site Five-Year Review Interview Form

Site Name: Libby Groundwater Contamination **EPA ID No.:** MTD980502736

Interviewer Name: Ryan Burdge **Affiliation:** Skeo Solutions

Subject Name: Lisa Dewitt **Affiliation:** MDEQ

Subject Contact Information: lidewitt@mt.gov

Time: **Date:** 9/22/2014

Interview Format (circle one): In Person Phone Mail Other: Email

Interview Category: State Agency

1. What is your overall impression of the project, including cleanup, maintenance and reuse activities (as appropriate)?
   My overall impression is that the project is moving ahead appropriately.
2. What is your assessment of the current performance of the remedy in place at the Site?
   The remedy for soils is going as expected, but EPA and DEQ need to assess how to document the concentrations that remain in the treated soils and are not likely to degrade. For the groundwater remedy, the remedy as implement has been progressing slowly. The results of the upcoming treatability studies should be used to enhance the groundwater remedy, as appropriate.
3. Are you aware of any complaints or inquiries regarding site-related environmental issues or remedial activities from residents in the past five years?
   Not that I am aware of.
4. Has your office conducted any site-related activities or communications in the past five years? If so, please describe the purpose and results of these activities.
   DEQ has the support role to EPA for this project, so has worked together with EPA over the last five years in developing plans for treatability studies, a focused feasibility study, and all other activities at the Site.
5. Are you aware of any changes to state laws that might affect the protectiveness of the Site's remedy?
   As part of the five-year review, the document writers should review the current version of DEQ's Circular 7 to ensure that the appropriate groundwater standards are included.
6. Are you comfortable with the status of the institutional controls at the Site? If not, what are the associated outstanding issues?
   The area of the industrial park between International Paper and the city limits of Libby does not currently have restrictions on drilling, thus leaving a gap in protections for dealing with the groundwater contaminant plume. DEQ is working with EPA and Lincoln County to find ways acceptable to the county to deal with this issue. Additionally, there have been anecdotes of instances where private wells have been drilled in Libby, in violation of the city ordinance prohibiting well drilling; these anecdotes have not been confirmed to date.
7. Are you aware of any changes in projected land use(s) at the Site?
   No.
8. Do you have any comments, suggestions or recommendations regarding the management or operation of the site's remedy?
   No.

Appendix C: Site Inspection Checklist

FIVE-YEAR REVIEW SITE INSPECTION CHECKLIST

I. SITE INFORMATION

Site Name: Libby Groundwater Contamination	**Date of Inspection: 8/5/2014**
Location and Region: EPA Region 8, Libby, MT	**EPA ID: MTD980502736**
Agency, Office or Company Leading the Five-Year Review: EPA Region 8	**Weather/Temperature: Sunny 90**

Remedy Includes: (Check all that apply)

- ☒ Landfill cover/containment
- ☐ Access controls
- ☒ Institutional controls
- ☒ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Other: _____
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls

Attachments: ☐ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (check all that apply)

1. **O&M Site Manager** Dave Cosgriff (Name) | Project Manager (Title) | 08/05/2014 (Date)
   Interviewed ☒ at Site ☐ at office ☐ by phone Phone: _____
   Problems, suggestions ☒ Report attached: _____

2. **O&M Staff** _____ (Name) | _____ (Title) | mm/dd/yyyy (Date)
   Interviewed ☐ at Site ☐ at office ☐ by phone Phone: _____
   Problems/suggestions ☐ Report attached: _____

3. **Local Regulatory Authorities and Response Agencies** (i.e., state and tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices). Fill in all that apply.

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone No.
Problems/suggestions ☐ Report attached: _____

Agency _____
Contact _____Name _____ _____ _____
Title Date Phone No.
Problems/suggestions ☐ Report attached:_____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone No.
Problems/suggestions ☐ Report attached:_____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone No.
Problems/suggestions ☐ Report attached: _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone No.
Problems/suggestions ☐ Report attached:_____

4. **Other Interviews** (optional) ☒ Report attached: _____

Tom Richardson, International Paper

Lisa Dewitt, MDEQ

Kathi Hooper, Lincoln County Department of Environmental Health

III. ON-SITE DOCUMENTS AND RECORDS VERIFIED (check all that apply)

1. **O&M Documents**

☒ O&M manual	☒ Readily available	☐ Up to date	☐ N/A
☒ As-built drawings	☒ Readily available	☒ Up to date	☒ N/A
☒ Maintenance logs	☒ Readily available	☒ Up to date	☐ N/A

Remarks: O&M plan could be updated to include changes in annual O&M reports.

2. **Site-Specific Health and Safety Plan**	☒ Readily available	☒ Up to date	☐ N/A
☒ Contingency plan/emergency response plan	☒ Readily available	☐ Up to date	☐ N/A

Remarks: _____

3. **O&M and OSHA Training Records**	☐ Readily available	☐ Up to date	☒ N/A

Remarks: _____

4.	**Permits and Service Agreements**				
	☐ Air discharge permit	☐ Readily available	☐ Up to date	☒ N/A	
	☐ Effluent discharge	☐ Readily available	☐ Up to date	☒ N/A	
	☐ Waste disposal, POTW	☐ Readily available	☐ Up to date	☒ N/A	
	☐ Other permits: _____	☐ Readily available	☐ Up to date	☒ N/A	
	Remarks: _____				
5.	**Gas Generation Records**	☐ Readily available	☐Up to date	☒N/A	
	Remarks: _____				
6.	**Settlement Monument Records**	☐ Readily available	☐Up to date	☒N/A	
	Remarks: _____				
7.	**Groundwater Monitoring Records**	☒ Readily available	☒Up to date	☐ N/A	
	Remarks: _____				
8.	**Leachate Extraction Records**	☐ Readily available	☐Up to date	☒N/A	
	Remarks: _____				
9.	**Discharge Compliance Records**				
	☐ Air	☐ Readily available	☐ Up to date	☒ N/A	
	☐ Water (effluent)	☐ Readily available	☐ Up to date	☒ N/A	
	Remarks: _____				
10.	**Daily Access/Security Logs**	☐ Readily available	☐Up to date	☒ N/A	
	Remarks: _____				

IV. O&M COSTS

1.	**O&M Organization**	
	☐ State in-house	☐ Contractor for state
	☐ PRP in-house	☒ Contractor for PRP
	☐ Federal facility in-house	☐ Contractor for Federal facility
	☐ _____	

2. **O&M Cost Records**

☐ Readily available ☐ Up to date

☐ Funding mechanism/agreement in place ☒ Unavailable

Original O&M cost estimate: _____ ☐ Breakdown attached

Total annual cost by year for review period if available

From: mm/dd/yyyy Date	To: mm/dd/yyyy Date	_____ Total cost	☐ Breakdown attached
From: mm/dd/yyyy Date	To: mm/dd/yyyy Date	_____ Total cost	☐ Breakdown attached
From: mm/dd/yyyy Date	To: mm/dd/yyyy Date	_____ Total cost	☐ Breakdown attached
From: mm/dd/yyyy Date	To: mm/dd/yyyy Date	_____ Total cost	☐ Breakdown attached
From: mm/dd/yyyy Date	To: mm/dd/yyyy Date	_____ Total cost	☐ Breakdown attached

3. **Unanticipated or Unusually High O&M Costs during Review Period**

Describe costs and reasons: _____

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. **Fencing Damaged** ☐ Location shown on site map ☒ Gates secured ☐ N/A

Remarks: _____

B. Other Access Restrictions

1. **Signs and Other Security Measures** ☐ Location shown on site map ☐ N/A

Remarks: _____

C. Institutional Controls (ICs)

1. **Implementation and Enforcement**

Site conditions imply ICs not properly implemented ☐ Yes ☒ No ☐ N/A

Site conditions imply ICs not being fully enforced ☐ Yes ☒ No ☐ N/A

Type of monitoring (e.g., self-reporting, drive by): On-site presence

Frequency: five days a week

Responsible party/agency: PRP Contractor and City

Contact _____ _____ mm/dd/yyyy _____

Name Title Date Phone no.

Reporting is up to date ☐ Yes ☐ No ☒ N/A

Reports are verified by the lead agency ☐ Yes ☐ No ☒ N/A

Specific requirements in deed or decision documents have been met ☐ Yes ☒ No ☐ N/A

Violations have been reported ☐ Yes ☒ No ☐ N/A

Other problems or suggestions: ☐ Report attached

2. **Adequacy** ☐ ICs are adequate ☒ ICs are inadequate ☐ N/A

Remarks: Additional ICs are needed to restrict groundwater use and land uses.

D. General

1. **Vandalism/Trespassing** ☐ Location shown on site map ☒ No vandalism evident

Remarks: _____

2. **Land Use Changes On Site** ☒ N/A

Remarks: _____

3. **Land Use Changes Off Site** ☐ N/A

Remarks: _____

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. **Roads Damaged** ☐ Location shown on site map ☒ Roads adequate ☐ N/A

Remarks: _____

B. Other Site Conditions

Remarks: Site is well maintained

VII. LANDFILL COVERS ☒ Applicable ☐ N/A

A. Landfill Surface

1. **Settlement** (low spots) ☐ Location shown on site map ☒ Settlement not evident

Arial extent: _____ Depth: _____

Remarks: _____

2.	**Cracks**	☐ Location shown on site map	☒ Cracking not evident
	Lengths: _____	Widths: _____	Depths: _____
	Remarks: _____		
3.	**Erosion**	☐ Location shown on site map	☒ Erosion not evident
	Arial extent: _____		Depth: _____
	Remarks: _____		
4.	**Holes**	☐ Location shown on site map	☒ Holes not evident
	Arial extent: _____		Depth: _____
	Remarks: _____		
5.	**Vegetative Cover**	☒ Grass	☐ Cover properly established
	☐ No signs of stress	☐ Trees/shrubs (indicate size and locations on a diagram)	
	Remarks: _____		
6.	**Alternative Cover** (e.g., armored rock, concrete)		☒ N/A
	Remarks: _____		
7.	**Bulges**	☐ Location shown on site map	☒ Bulges not evident
	Arial extent: _____		Height: _____
	Remarks: _____		
8.	**Wet Areas/Water Damage**	☒ Wet areas/water damage not evident	
	☐ Wet areas	☐ Location shown on site map	Arial extent: _____
	☐ Ponding	☐ Location shown on site map	Arial extent: _____
	☐ Seeps	☐ Location shown on site map	Arial extent: _____
	☐ Soft subgrade	☐ Location shown on site map	Arial extent: _____
	Remarks: _____		
9.	**Slope Instability**	☐ Slides	☐ Location shown on site map
	☒ No evidence of slope instability		
	Arial extent: _____		
	Remarks: _____		
B. Benches		☐ Applicable ☒ N/A	
	(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)		
1.	**Flows Bypass Bench**	☐ Location shown on site map	☐ N/A or okay
	Remarks: _____		
2.	**Bench Breached**	☐ Location shown on site map	☐ N/A or okay
	Remarks: _____		
3.	**Bench Overtopped**	☐ Location shown on site map	☐ N/A or okay
	Remarks: _____		

C. Letdown Channels ☐ Applicable ☒ N/A

(Channel lined with erosion control mats, riprap, grout bags or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** (Low spots) ☐ Location shown on site map ☐ No evidence of settlement
   Arial extent: _____ Depth: _____
   Remarks: _____

2. **Material Degradation** ☐ Location shown on site map ☐ No evidence of degradation
   Material type:_____ Arial extent: _____
   Remarks: _____

3. **Erosion** ☐ Location shown on site map ☐ No evidence of erosion
   Arial extent: _____ Depth: _____
   Remarks: _____

4. **Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting
   Arial extent: _____ Depth: _____
   Remarks: _____

5. **Obstructions** Type: _____ ☐ No obstructions
   ☐ Location shown on site map Arial extent: _____
   Size: _____
   Remarks: _____

6. **Excessive Vegetative Growth** Type: _____
   ☐ No evidence of excessive growth
   ☐ Vegetation in channels does not obstruct flow
   ☐ Location shown on site map Arial extent: _____
   Remarks: _____

D. Cover Penetrations ☐ Applicable ☒ N/A

1. **Gas Vents** ☐ Active ☐ Passive
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
   ☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ N/A
   Remarks: _____

2. **Gas Monitoring Probes**
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
   ☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ N/A
   Remarks: _____

3. **Monitoring Wells** (within surface area of landfill)

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition

☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ N/A

Remarks: _____

4. **Extraction Wells Leachate**

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition

☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ N/A

Remarks: _____

5. **Settlement Monuments** ☐ Located ☐ Routinely surveyed ☐ N/A

Remarks: _____

E. Gas Collection and Treatment ☐ Applicable ☒ N/A

1. **Gas Treatment Facilities**

☐ Flaring ☐ Thermal destruction ☐ Collection for reuse

☐ Good condition ☐ Needs maintenance

Remarks: _____

2. **Gas Collection Wells, Manifolds and Piping**

☐ Good condition ☐ Needs maintenance

Remarks: _____

3. **Gas Monitoring Facilities** (e.g., gas monitoring of adjacent homes or buildings)

☐ Good condition ☐ Needs maintenance ☐ N/A

Remarks: _____

F. Cover Drainage Layer ☐ Applicable ☒ N/A

1. **Outlet Pipes Inspected** ☐ Functioning ☐ N/A

Remarks: _____

2. **Outlet Rock Inspected** ☐ Functioning ☐ N/A

Remarks: _____

G. Detention/Sedimentation Ponds ☐ Applicable ☒ N/A

1. **Siltation** Area extent: _____ Depth: _____ ☐ N/A

☐ Siltation not evident

Remarks: _____

2. **Erosion** Area extent: _____ Depth: _____

☐ Erosion not evident

Remarks: _____

3. **Outlet Works** ☐ Functioning ☐ N/A

Remarks: _____

4.	**Dam**	☐ Functioning	☐ N/A
	Remarks: _____		
H. Retaining Walls		☐ Applicable	☒ N/A
1.	**Deformations**	☐ Location shown on site map	☐ Deformation not evident
	Horizontal displacement: _____		Vertical displacement: _____
	Rotational displacement: _____		
	Remarks: _____		
2.	**Degradation**	☐ Location shown on site map	☐ Degradation not evident
	Remarks: _____		
I. Perimeter Ditches/Off-Site Discharge		☐ Applicable	☒ N/A
1.	**Siltation**	☐ Location shown on site map	☐ Siltation not evident
	Area extent: _____		Depth: _____
	Remarks: _____		
2.	**Vegetative Growth**	☐ Location shown on site map	☐ N/A
	☐ Vegetation does not impede flow		
	Area extent: _____		Type: _____
	Remarks: _____		
3.	**Erosion**	☐ Location shown on site map	☐ Erosion not evident
	Area extent: _____		Depth: _____
	Remarks: _____		
4.	**Discharge Structure**	☐ Functioning	☐ N/A
	Remarks: _____		
VIII. VERTICAL BARRIER WALLS		☐ Applicable	☒ N/A
1.	**Settlement**	☐ Location shown on site map	☐ Settlement not evident
	Area extent: _____		Depth: _____
	Remarks: _____		
2.	**Performance Monitoring**	Type of monitoring: _____	
	☐ Performance not monitored		
	Frequency: _____		☐ Evidence of breaching
	Head differential: _____		
	Remarks: _____		
IX. GROUNDWATER/SURFACE WATER REMEDIES		☒ Applicable	☐ N/A
A. Groundwater Extraction Wells, Pumps and Pipelines		☒ Applicable	☐ N/A
1.	**Pumps, Wellhead Plumbing and Electrical**		
	☒ Good condition	☒ All required wells properly operating	☐ Needs maintenance ☐ N/A
	Remarks: _____		

2. **Extraction System Pipelines, Valves, Valve Boxes and Other Appurtenances**

☒ Good condition ☐ Needs maintenance

Remarks: _____

3. **Spare Parts and Equipment**

☒ Readily available ☒ Good condition ☐ Requires upgrade ☐ Needs to be provided

Remarks: _____

B. Surface Water Collection Structures, Pumps and Pipelines ☐ Applicable ☒ N/A

1. **Collection Structures, Pumps and Electrical**

☐ Good condition ☐ Needs maintenance

Remarks: _____

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes and Other Appurtenances**

☐ Good condition ☐ Needs maintenance

Remarks: _____

3. **Spare Parts and Equipment**

☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided

Remarks: _____

C. Treatment System ☒ Applicable ☐ N/A

1. **Treatment Train** (check components that apply)

☐ Metals removal ☒ Oil/water separation ☒ Bioremediation

☐ Air stripping ☒ Carbon adsorbers

☐ Filters: _____

☐ Additive (e.g., chelation agent, flocculent): _____

☐ Others: _____

☒ Good condition ☐ Needs maintenance

☐ Sampling ports properly marked and functional

☐ Sampling/maintenance log displayed and up to date

☒ Equipment properly identified

☐ Quantity of groundwater treated annually: _____

☐ Quantity of surface water treated annually: _____

Remarks: _____

2. **Electrical Enclosures and Panels** (properly rated and functional)

☐ N/A ☒ Good condition ☐ Needs maintenance

Remarks: _____

3. **Tanks, Vaults, Storage Vessels**

☐ N/A ☒ Good condition ☒ Proper secondary containment ☐ Needs maintenance

Remarks: _____

4. **Discharge Structure and Appurtenances**

☐ N/A ☒ Good condition ☐ Needs maintenance

Remarks: _____

5. **Treatment Building(s)**

☐ N/A ☒ Good condition (esp. roof and doorways) ☐ Needs repair

☒ Chemicals and equipment properly stored

Remarks: _____

6. **Monitoring Wells** (pump and treatment remedy)

☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition

☐ All required wells located ☐ Needs maintenance ☐ N/A

Remarks: _____

D. Monitoring Data

1. **Monitoring Data**

☒ Is routinely submitted on time ☒ Is of acceptable quality

2. **Monitoring Data Suggests:**

☒ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining

E. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition

☐ All required wells located ☐ Needs maintenance ☒ N/A

Remarks: _____

X. OTHER REMEDIES

If there are remedies applied at the Site and not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is designed to accomplish (e.g., to contain contaminant plume, minimize infiltration and gas emissions).

Although the contamination plume seems to be contained, pilot studies are being performed to address remaining groundwater contamination. Landfarm soils are not cleaned yet due to dioxin levels.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

O&M is adequate and the Site is well maintained.

C.	Early Indicators of Potential Remedy Problems
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future. EPA and the PRP are working to identify additional remedy options for remaining contamination.
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. None.

Appendix D: Site Inspection Photographs

Locked entrance and field office and laboratory.

Butt dip area and intermediate injection treatment building (green roof).

Waste pit area where pilot testing will occur.

Warning signage at entrance of waste pit area.

Pilot test area.

Well cluster 5513.

Biosparge pilot test well cluster 3055.

Groundwater treatment building.

Bioreactor 1 in groundwater treatment building.

Coalescing tank in groundwater treatment building.

Landfarm treatment area.

The land treatment unit is located on the right. Top soil to cover the land treatment unit in the future is located behind the land treatment unit.

Fire pond.

Appendix E: Cleanup Goals

	Soil		Ground Water	
Contaminants of Concern	Cleanup Level (mg/Kg)	Basis[(e)]	Cleanup Level (µg/L)	Basis
NON-CARCINOGENIC PAHS				
Acenapthene	166	Risk-Based Value HI=1.0	2190	Risk-Based Value HI=1.0
Anthracene	33		1100	
Fluorene	250		1460	
Fluoranthene	250		1460	
Naphthalene	NA		1460	
Pyrene	NA		1100	
Phenanthrene	NA		NA	
Acenapthylene	NA		NA	
Benzo (g,h,i) perylene	NA		NA	
CARCINOGENIC PAHS				
Chrysene	59,400	Risk-Based Value 10^{-5}	0.2	MCL
Benzo (a) anthracene	594		0.1	
Benzo (b) fluoranthene	594		0.2	
Benzo (k) fluoranthene	5,940		0.2	
Benzo (a) pyrene	59		0.2	
Indeno (1,2,3-c,d) pyrene	594		0.4	
Dibenzo (a,h)anthracene	59		0.3	
OTHER COMPOUNDS				
Pentachlorophenol	36	Risk-Based Value 10^{-5}	1.00	MCL
Benzene	NA		5.00	
Arsenic	NA		50.00	
FURANS				
tetra (2,3,7,8)	0.0289	Risk-Based Value 10^{-5}	NA	
tetra (non-2,3,7,8)	NA		NA	
penta (1,2,3,7,8)	0.0578	Risk-Based Value 10^{-5}	NA	
penta (2,3,4,7,8)	0.00587	Risk-Based Value 10^{-5}	NA	
penta (other)	NA		NA	
hexa (2,3,7,8)	0.0289	Risk-Based Value 10^{-5}	NA	

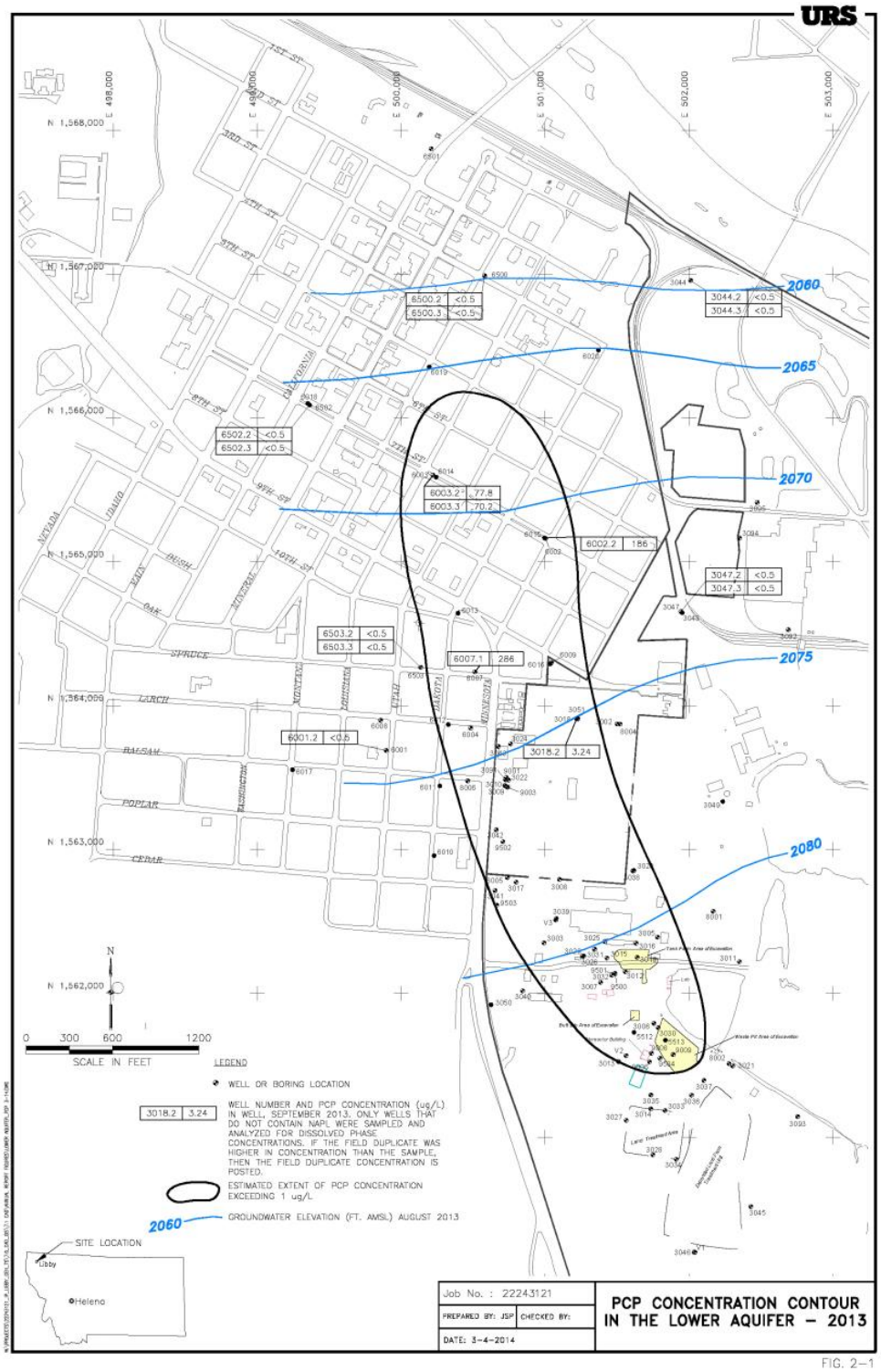
	Soil		Ground Water	
Contaminants of Concern	Cleanup Level (mg/Kg)	Basis[e]	Cleanup Level (µg/L)	Basis
hexa (non-2,3,7,8)	NA		NA	
hepta (2,3,7,8)	0.289	Risk-Based Value 10^{-5}	NA	
hepta (non-2,3,7,8)	NA		NA	
Octa	2.89	Risk-Based Value 10^{-5}	NA	
DIOXINS				
tetra (2,3,7,8)	0.00289	Risk-Based Value 10^{-5}	$3X10^{-5}$	MCL
tetra (non-2,3,7,8)	NA		NA	
penta (1,2,3,7,8)	0.00578	Risk-Based Value 10^{-5}	NA	
penta (non-2,3,7,8)	NA		NA	
hexa (2,3,7,8)	0.0289	Risk-Based Value 10^{-5}	NA	
hexa (non-2,3,7,8)	NA		NA	
hepta (2,3,7,8)	0.289	Risk-Based Value 10^{-5}	NA	
hepta (non-2,3,7,8)	NA		NA	
Octa	2.89	Risk-Based Value 10^{-5}	NA	

Notes:

NA: Not applicable

HI: Hazard Index

Appendix F: Groundwater Contamination Maps



Concentrations are reported for different depths at the same locations.

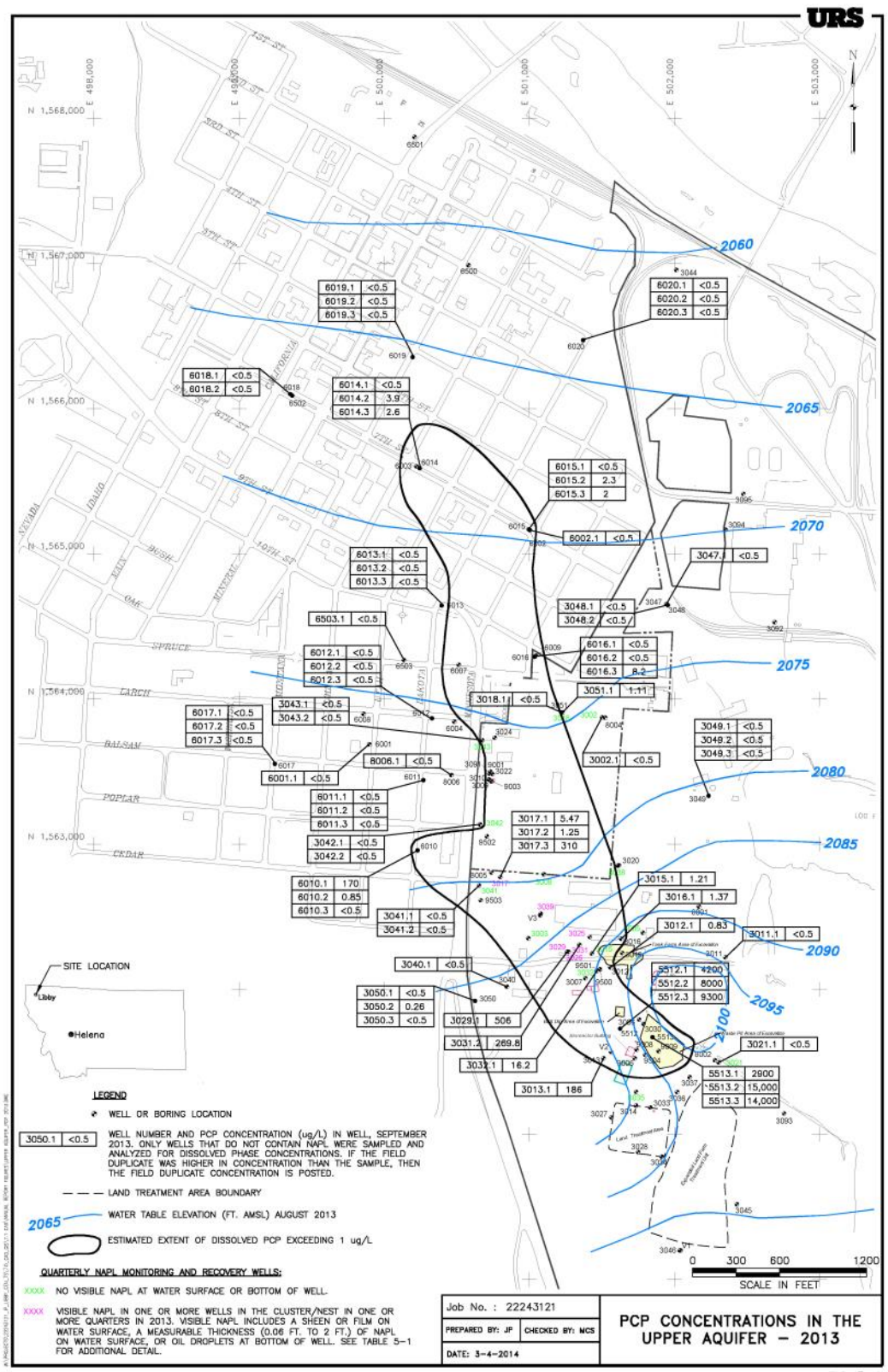


FIG. 3–1

Concentrations are reported for different depths at the same locations.

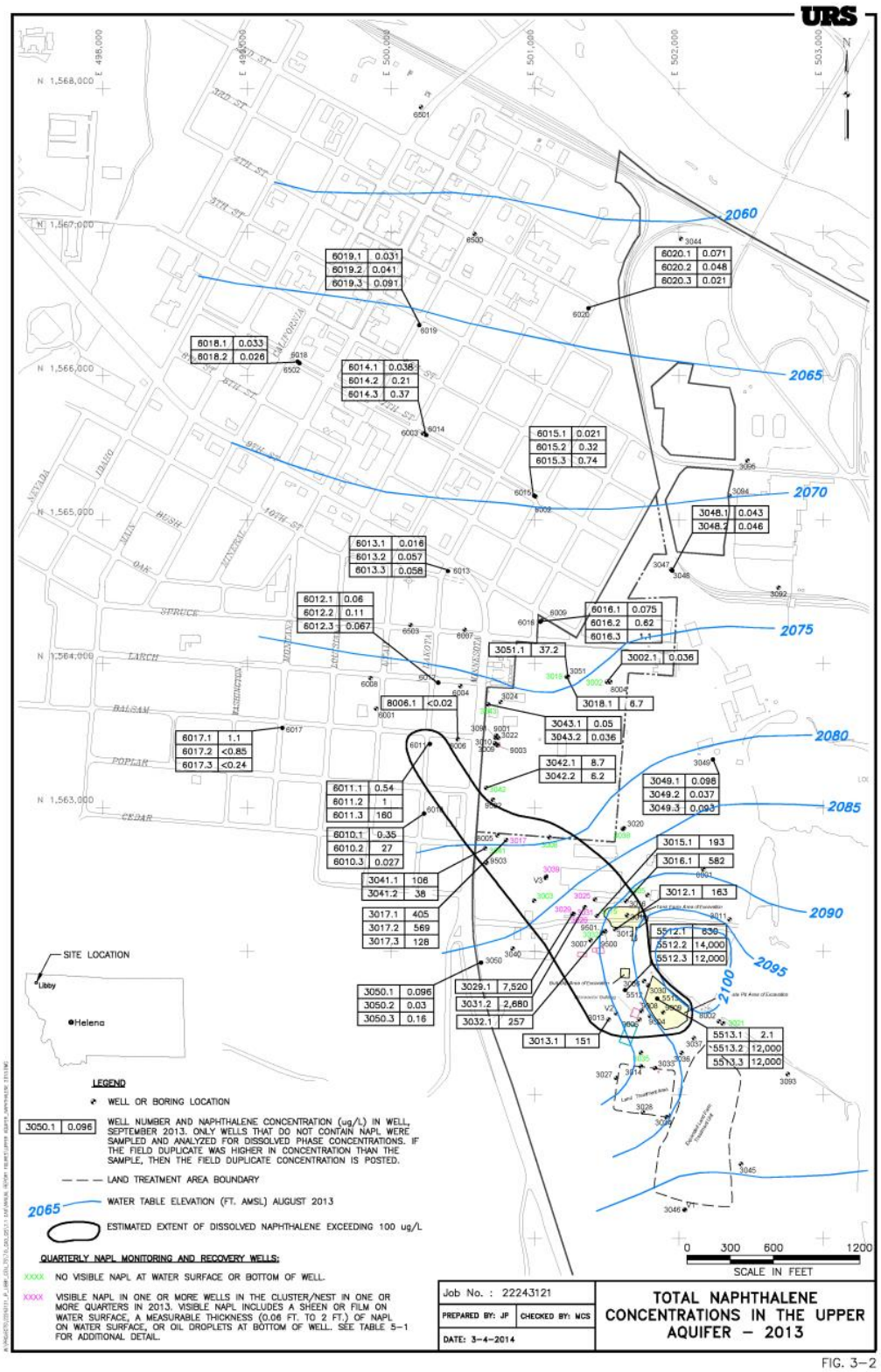
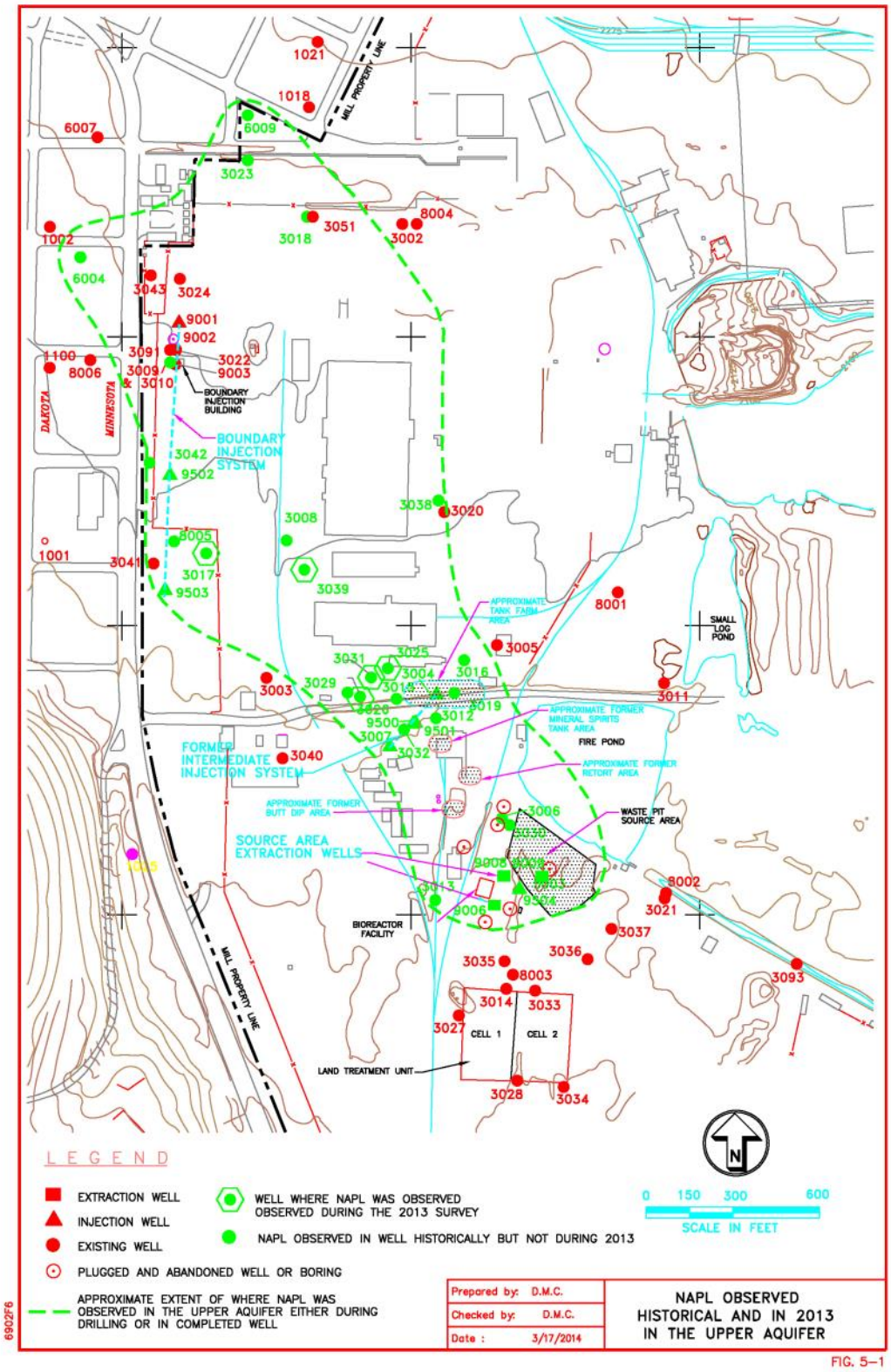


FIG. 3-2

Concentrations are reported for different depths at the same locations.


1021
1018
MILL PROPERTY LINE
6007
6009
3023
3051
3018
8004
3002
1002
6004
3043
3024
9001
9002
3091
3022
9003
1100
8006
3009
& 3010
BOUNDARY INJECTION BUILDING
DAKOTA
MINNESOTA
BOUNDARY INJECTION SYSTEM
3042
9502
3038
3020
3008
3005
1001
3041
3017
9503
3039
APPROXIMATE TANK FARM AREA
8001
SMALL LOG POND
3025
3031
3004
3016
3005
3003
3029
3018
3019
3011
3028
3012
9500
9501
3007
3032
APPROXIMATE FORMER MINERAL SPIRITS TANK AREA
FIRE POND
FORMER INTERMEDIATE INJECTION SYSTEM
3040
APPROXIMATE FORMER RETORT AREA
APPROXIMATE FORMER BUTT DIP AREA
3006
WASTE PIT SOURCE AREA
SOURCE AREA EXTRACTION WELLS
3008
3013
9006
8002
3021
BIOREACTOR FACILITY
3037
3036
3035
8003
3093
3014
3033
3027
CELL 1
CELL 2
LAND TREATMENT UNIT
3028
3034
N
0 150 300 600
SCALE IN FEET
LEGEND
EXTRACTION WELL
INJECTION WELL
EXISTING WELL
PLUGGED AND ABANDONED WELL OR BORING
APPROXIMATE EXTENT OF WHERE NAPL WAS OBSERVED IN THE UPPER AQUIFER EITHER DURING DRILLING OR IN COMPLETED WELL
WELL WHERE NAPL WAS OBSERVED OBSERVED DURING THE 2013 SURVEY
NAPL OBSERVED IN WELL HISTORICALLY BUT NOT DURING 2013
Prepared by: D.M.C.
Checked by: D.M.C.
Date : 3/17/2014
NAPL OBSERVED HISTORICAL AND IN 2013 IN THE UPPER AQUIFER
6902F6
FIG. 5-1