FIVE-YEAR REVIEW REPORT

Third Five-Year Review Report
for
Libby Ground Water Site
Libby,
Lincoln County, Montana

March 2005

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Third Five-Year Review Report

Libby Ground Water Site

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Executive Summary

The third five-year review of the Libby Ground Water Site, located in Libby, Montana, was completed in March 2005. The results of the five-year review indicate that the remedies for soil and ground water are protective of human health and the environment. The OU1 remedy which consists of an alternative water supply initiative sponsored by Champion International Corporation (Champion was purchased in 1996 by International Paper), continues to function as designed. The OU2 remedy consists of a soils component and a groundwater component. The soil component of the remedy has achieved the remediation levels specified in the 1988 Record of Decision (ROD) for all soil placed on the land treatment units (LTUs) to date. An Expanded Land Farm (ELF) was constructed in 1998 and was loaded with all of the untreated soils remaining on the site, except a small amount of high strength soils in the waste pit. Soils remaining in the waste pit will be moved to the ELF in 2005. Treatment of these soils is ongoing and remediation levels are expected to be met in several years. The ground water treatment system continues to operate as designed, with some modifications since the last five-year review.

The first five-year review, performed in 1995, identified several modifications to the 1988 ROD that were required to reflect changes in standards made since 1988. The changes were incorporated in an Explanation of Significant Differences (ESD) issued in 1997. No deficiencies in the design and operation and maintenance of the remedy were noted during the second five-year review. Recommendations from the second five- year review, conducted in 2000, included incorporating the TI waiver provisions into the ROD and implementation of a controlled ground water area. EPA approved a TI waiver for the site in 1999. The controlled ground water area was not established because of administrative difficulties. EPA believes that the existing municipal water supply and the associated city ordinance provide adequate institutional control protection of human health at this time. EPA will continue to evaluate the need for establishment of a controlled groundwater area.

The protection of human health and the environment by each component of the remedial action at the Libby site is discussed below:

OU1 Drinking Water Initiative

The remedy selected for OU1 continues to be protective of human health and the environment. The abandonment of additional residential wells since the first 5-year review has increased the effectiveness of this remedy. A review of the existing municipal ordinance prohibiting the installation of new water wells within the city limits was conducted and the ordinance was determined to be effective.

OU2 Soil Component

An additional 10-ac LTU was constructed at the Libby site during 1998 to expedite soil treatment by increasing the overall treatment area. The two one-acre LTUs at the site have successfully treated soil to remediation levels since their construction in 1989. The three units are located in a fenced area and are operated and monitored as designed. The soil component of the remedy at the Libby Ground Water Site is protective of human health and the environment.

OU2 Ground Water Component

The ground water component of the remedy at the Libby Ground Water Site consists of an extraction and biological treatment system. The system is currently operating as designed and continues to remove contaminants from the ground water. The dissolved contaminant plume associated with the site has stabilized and has decreased slightly in area. More than 19,000 gallons of oily wood treating fluid have been recovered from the subsurface since the system began operation in 1989. The ground water component of the remedy at the Libby Ground Water Site is protective of human health and the environment.

References to past activities by Champion International Corporation, “Champion”, contained in this document have been modified to reflect the party currently responsible for remedial activities at the site, International Paper.

This third five-year review report is an update of the second five-year review report reflecting the status of the last 5 years of continued soil and ground water treatment. This report contains data describing site activities from 2000 through the latest reporting period. All site status evaluations and determinations have been updated for this report.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site name *(from WasteLAN)*: Libby Ground Water Contamination		
EPA ID *(from WasteLAN)*: MTD980502736		
Region: 8	**State:** MT	**City/County:** Libby/Lincoln

SITE STATUS	
NPL status: X Final ☐ Deleted ☐ Other (specify)_____	
Remediation status (choose all that apply): ☐ Under Construction X Operating ☐ Complete	
Multiple OUs?* X YES ☐ NO	**Construction completion date:** 09 / 20 / 93
Has site been put into reuse? ☐ YES X NO	

REVIEW STATUS	
Reviewing agency: X EPA ☐ State ☐ Tribe ☐ Other Federal Agency	
Author name: Jim Harris	
Author title: RPM	**Author affiliation:** EPA Region 8
Review period: 03 / 31 /00 to 03/31/2005	
Date(s) of site inspection: 03 / 01 / 2005	
Type of review: X Statutory ☐ Policy (☐ Post-SARA ☐ Pre-SARA ☐ NPL-Removal only ☐ Non-NPL Remedial Action Site ☐ NPL State/Tribe-lead ☐ Regional Discretion)	
Review number: ☐ 1 (first) ☐ 2 (second) X 3 (third) ☐ Other (specify)	
Triggering action: ☐ Actual RA Onsite Construction at OU #_____ ☐ Construction Completion ☐ Other (specify)	☐ Actual RA Start at OU#____ X Previous Five-Year Review Report
Triggering action date *(from WasteLAN)*: 03 / 31 / 2000	
Due date *(five years after triggering action date)*: 03 / 31 / 2005	

* ["OU" refers to operable unit.]

Five-Year Review Summary Form

Deficiencies:

- No deficiencies in the Remedial Action implementation at the Libby Ground Water Site were identified during the third five-year review. A Technical Impracticability (TI) Petition for Ground Water Remediation has been submitted,to EPA and approved.

- Because of the currently effective city ordinance prohibiting new water supply wells within the city limits, and the NPL listing of the Libby Asbestos Site, further action to incorporate the TI waiver provisions into the ROD and to secure a controlled ground water area through state authorities has been postponed.

Recommendations and Follow-up Actions:

- Incorporate the TI waiver conditions into the Record of Decision for the Libby Ground Water Site through a ROD modification process.

- Complete the controlled ground water use designation through DNRC for the Libby Ground Water Site should the conditions of the city ordinance become ineffective.

Protectiveness Statement(s):

The third five-year review of the remedial actions for soil and ground water at the Libby Ground Water Site has resulted in the determination that the remedial actions are protective of human health and the environment.

Other Comments:

Construction completion at the Libby Ground Water Site was accomplished on September 20, 1993.

Libby Ground Water Site
Third Five-Year Review Report

I. Introduction

EPA Region 8 has conducted the third five-year review of the remedial actions implemented at the Libby Ground Water Site located in Libby, Montana. This review was conducted from December 2004 through March 2005. This report documents the results of the review. The purpose of five-year reviews is to determine whether the remedy at a site is protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in five-year review reports. In addition, five-year review reports identify deficiencies found during the review, if any, and identify recommendations to address them.

This review is required by statute. EPA must implement five-year reviews consistent with the Comprehensive Environmental Response, Compensation, and Liability Act, as amended, (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). CERCLA § l2l(c), as amended, 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 five 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.

The NCP at 40 C. F. R. Section 300.430(f)(4)(ii) of the Code of Federal Regulations (CFR) 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 the initiation of the selected remedial action.

This is the third five-year review for the Libby Ground Water Site. The triggering action for this review is the completion of the second five-year review on March 30, 2000. Due to the fact that hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unrestricted use and unlimited exposure, another five-year review is required.

II. Site Chronology

Table 1 lists the chronology of events for the Libby Ground Water Site.

Table 1: Chronology of Site Events

Date	Event
1979	Initial discovery of the problem
9/8/83	NPL listing
9/26/86	OU1 ROD signature
10/1/86	OU1 Remedial Design Completion
11/1/86	OU1 Remedial Action Completion
12/30/88	OU2 ROD signature
3/27/89	OU2 Remedial Design start
9/26/91	OU2 Remedial Design completion
10/18/89	OU2 Remedial Action start
11/01/1993	Champion sells Mill to Stimson Lumber Co.
9/20/93	Construction completion
1/24/95	First five-year review report
1998	LTU Expansion
1/11/99	Technical Impracticability (TI) Evaluation Report
3/99	TI Report approval
1/2000	Coalescing Separator added
3/2000	Second 5-year Review
6/20/2000	International Paper purchases Champion International
2003	Stimson sells Mill to Lincoln County Port Authority
3/2003	Boundary Injection System discontinued
3/2005	Third 5-year Review

III. Background

Location

The Libby Ground Water Superfund site is located at the former Stimson Lumber and Plywood Mill in northwestern Montana in the town of Libby, approximately 70 miles south of the Canadian border. The site is situated on the eastern edge of Libby and is bounded on the east by Libby Creek, on the south by private property, on the west by U.S. Highway 2, and on the north by the Kootenai River (see Figure 2-1).

Northwestern Montana is comprised of mountainous terrain, heavily timbered with abundant surface water. The Cabinet Mountains Wilderness is west and south of Libby, while the Purcell Mountains are to the north of town, and the Salish Mountains are east. Although the area is mountainous, the site is situated in a relatively flat intermontane valley, with local elevations ranging from about 2,125 mean sea level (msl) to about 2,070 msl.

The location of the site within a valley bordered by mountains has had important implications for the distribution of contaminants in the subsurface. The valley has received deposits of both alluvial and glacial sediments, as well as erosional remnants from the surrounding mountains. These varied and highly active sources of geologic materials have resulted in a complex stratigraphic system below the site. Simply put, because the geology is not uniform contamination from wood treating processes have not been distributed uniformly in the subsurface. As a consequence there is no well defined method to locate underground contamination or predict contaminant migration patterns.

Surface water is abundant in this part of Montana. Mountain valleys contain small streams which are recharged by high-country snowpack. These feed into regionally important rivers such as the Kootenai. Both Libby Creek and Flower Creek recharge the Kootenai River, which varies in average flow from about 4,000 cubic feet per second (cfs) to more than 30,000 cfs as measured at the river staff gauge near Libby.

Facility Description

The Libby Site is located on a facility that has been an active forest products processor for many years. The facility was known as the J. Neils Lumber Company when wood treating began in approximately 1946. St. Regis Corporation purchased the company and facility in 1957 and continued to treat wood until 1969, when the wood treating plant was disassembled. In 1985 Champion International Corporation bought the facility; Champion later sold the mill to Stimson Lumber Company in 1993 and International Paper purchased Champion in 2000. The mill property boundaries have changed somewhat since 1993, as reflected by the historic and current borders shown on Figure 2-1. In 2003 Stimson sold the mill property to the Lincoln County Port Authority; ownership of the remediation units was retained by International Paper.

Creosote (the primary source of polynuclear aromatic hydrocarbons, or PAHs, found at the site) and pentachlorophenol (PCP) were used to protect and preserve wood products such as telephone poles. These compounds were disposed and/or spilled at different locations on the plant property. Waste water was placed in unlined waste pits after treatment by a condenser and oil separator. Sludges from treatment tanks were

periodically removed and placed into the waste pits. Spills probably occurred during wood treating and maintenance activities. Ground water and soil at the Libby site were contaminated as a result of wood treating operations and waste disposal practices. The site was placed on the final National Priorities List (NPL) in 1983 as a result of the ground water and soil contamination.

Although Champion sold the facility to Stimson, Champion retained ownership of certain properties at the site deemed necessary to continue Superfund remedial actions. Details of the transfer of the property from Champion to Stimson are provided in Section 2.0 of the 1993 Annual Upper Aquifer Operations Report (Woodward-Clyde Consultants (WWC) 1994). In 2000, International Paper purchased Champion International Corporation and has maintained responsibility for monitoring and contaminant remediation activities at the site.

Contamination History

The presence of wood treating compounds in ground water was first discovered in April 1979 when a creosote smell was noticed in water from a newly drilled residential well. Initial investigation of the lumber mill was undertaken by the U.S. Environmental Protection Agency (EPA) in 1980. Results from the early site investigation were presented in a June 1982 report. This initial study reported the presence of creosote compounds and PCP in 3 of 11 wells sampled. The dismantled St. Regis wood treating facilities and waste disposal pits were identified as likely sources for the ground water contamination. Because of the potential risk to human health and the environment posed by ground water contamination the Libby site was placed on the NPL in September 1983. The listing made the site eligible for remedial response action under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, referred to in this Report as “Superfund”).

EPA has designated two separate operable units (OUs) at the Libby Ground Water site: 1) OU1 consists of the alternative drinking water supply initiative sponsored by Champion for the affected residents of Libby, and 2) OU2 consists of the effected environmental media including the contaminated soils, the Upper Aquifer, and the Lower Aquifer present beneath the site. Under OU1, studies were conducted in 1985 to determine public exposure to contaminated groundwater in the city of Libby. As a result of these investigations, EPA recommended that an alternate water source be supplied to residents whose wells were contaminated by groundwater emanating from the facility. This recommendation was approved in a September 26, 1986 Record of Decision (ROD). In 1986, Champion began additional remedial investigation studies related to the contaminated media identified under OU2. These studies involved the characterization of all contaminated media, including bench and pilot-scale testing of remedial technologies.

Enforcement History

St. Regis entered into an Administrative Order on Consent with the EPA on October 11, 1983. The Order directed St. Regis to begin remedial investigations, feasibility studies, and remedial action programs. Objectives of the investigations were to define the limits and extent of site contamination, and to develop and evaluate available alternatives to remove or reduce potential threats to human health and the environment. Four phases of work were conducted in the ensuing years until the 1988 Record of Decision documenting plans for site cleanup. This work included:

Phase I - Initial and early investigations by the Montana Department of Environmental Quality's Water Quality Bureau and U.S. EPA, as well as notification of concerns and listing on NPL.

Phase II - Initial St. Regis sampling and investigations, and preparation of plans for additional field investigations.

Phase III - Interim remedial measures and continued investigations, including final report titled "Impact of Wood Treating Facilities at Libby, Montana" (June 1985). This work, conducted by Alsid/Carr and Associates, involved drilling 18 monitoring wells, installing 40 nested piezometers in these wells, and quarterly sampling and analysis of ground water samples from the piezometers for wood treating compounds. In addition, 51 private off-site wells were monitored by quarterly sampling and analysis. The results of the Phase III investigation concluded that wood treating compounds in the upper aquifer zone were migrating off of the Champion property. The Phase III report recommended additional investigations to refine the understanding of ground water and contaminant movement in the area and to further define the character and spatial distribution of wood treating compounds in deeper sediments.

Phase IV - Two field investigation campaigns were conducted, in May 1985 and January 1986, under the Phase IV Remedial Investigation program. The remedial investigation (RI) was initiated to characterize the subsurface conditions and the nature and extent of contamination. The primary sources of ground water contamination identified during this RI were the waste pit area, the former butt dip and retort area, and the former tank farm (see Figure 2-2). The RI was completed in 1988 (WCC 1988a).

A feasibility study (FS) was performed to evaluate alternatives for remediation of the site (WCC 1988b). As part of the FS, a pilot-scale test was conducted in 1987 and 1988 to evaluate *in situ* bioremediation as a remedial action alternative for the upper aquifer. This technique consisted of injecting oxygenated water and nutrients into the aquifer to promote the microbial degradation of PCP and PAHs dissolved in the ground water. Based on the results of the pilot test, *in situ* bioremediation was considered a viable remedial technology (WCC 1988b).

In December 1988, a Record of Decision (ROD) was issued for the Libby site and an integrated bioremediation system was selected as the process to clean up contamination in upper aquifer ground water (Section 3.0 of this report contains a more detailed explanation of ground water remedy components). Cleanup levels based on regulatory criteria and potential risks to human health were set forth in the ROD. Some of the cleanup criteria were amended in January 1997 when EPA issued a Final Explanation of Significant Difference to reflect more recent risk assessment practices and updated MCLs for the upper aquifer.

A Consent Decree for cleanup of the Libby site was finalized in October 1989, providing final governmental approval and authority for Champion to proceed with design and implementation of the selected remedies. A demonstration program was conducted in 1990 to perform additional testing of *in situ* bioremediation, ground water extraction and above-grade treatment of ground water in a bioreactor system. This information and the pilot test results were used to design the full-scale bioremediation system for the upper aquifer. Since initial design and construction, modifications have been made to the remediation system to improve performance and/or reduce operating costs (see Section 3.0).

Remedial strategies for the lower aquifer and contaminated surface soil have been implemented independently of the upper aquifer. An ARAR waiver was granted for the lower aquifer due to the technical impracticability of removing NAPLs in ground water and the improbability that the lower aquifer poses a risk to human health and the environment. Institutional controls and long- term monitoring are currently in place for the lower aquifer. Contaminated surface soil was excavated from source areas and placed in the waste pit for temporary storage, then transferred incrementally from the waste pit to a land treatment unit for biological treatment.

A comprehensive ground water monitoring program was initiated in the fall of 1991 to evaluate the overall distribution of contamination in the upper aquifer, and to assess the performance of the *in situ* bioremediation system by monitoring ground water quality. Modifications to the monitoring program have been made to optimize performance feedback, to improve monitoring efficiency, and reduce monitoring program cost. These modifications have been documented in the upper aquifer annual reports (WCC l992,1993a, 1994 and 1995). The wells selected for monitoring are located downgradient of the intermediate and boundary systems to provide performance information concerning the injection systems. A number of wells are located around the site and downgradient of the site in the City of Libby, to assess the overall distribution of the contaminant plumes. Many of these monitoring wells were installed during the early phases of site work, prior to selection of the remedy in the 1988 ROD. A total of approximately 30 wells are currently monitored each year, including 8 domestic wells.

IV. Remedial Actions

Remedy Selection

The objective of the remedy selected in the 1988 ROD is to reduce human exposure to both the soil and groundwater contaminants of concern. The major components of this remedy consist of excavation and biological treatment of contaminated soils within an onsite Land Treatment Unit (LTU), and the *in situ* biological treatment of contaminated groundwater within the Upper Aquifer (including a pump and treat system for the heavily contaminated groundwater and oily product, with treatment occurring within a bioreactor system). As described earlier, an interim remedy was selected for the Lower Aquifer that consisted of feasibility testing of biorestoration remedial technologies, both alone and in conjunction with oil recovery and oil dispersion techniques.

A complete list of the components to the original remedy selected for the site can be found on pages 2 through 5 of the 1988 ROD (EPA 1988). A brief summary of the original remedy includes the following excerpts. Champion's efforts towards meeting the components of the remedy described below are discussed in Section 3.0. The original cleanup goals for both contaminated water and soils are listed in Tables 1 and 2.

- Contaminated soils from the identified source areas were excavated and placed within a waste pit that already contained contaminated soils and debris from past disposal practices at the site. These contaminated soils underwent a two-step enhanced biodegradation process. The initial treatment phase was conducted in the waste pit area and the contaminants are further degraded biologically after transfer to the LTU. The LTU, which is lined and may be capped with low permeability materials, will serve as a final disposition location.

- The property owner was required to insert language within the current registered deed identifying the locations of the hazardous substances disposal and treatment areas, and will restrict the future land use of these areas. This deed restriction is considered part of the selected remedy for the soil/source area.

- A combination of *in situ* bioremediation treatment processes are being utilized to degrade organic contaminants in the saturated zone of the waste pit area. A closed-loop, bacteria rich groundwater injection and extraction system is being employed in the waste pit area to remove and degrade contaminants adsorbed on soil matrices.

- The oil recovery wells are used to collect highly-contaminated groundwater, which is treated in a fixed film bioreactor prior to reinjection through a rock percolation bed.

- An *in situ*, enhanced biorestoration program has been initiated in the Upper Aquifer to reduce contaminant concentrations to required risk and ARAR-based levels. This innovative treatment technology addresses both the dissolved constituents in groundwater as well as adsorbed contaminants on the aquifer matrices concurrently.

- An interim remedy was selected for the Lower Aquifer which required the PRP to conduct a pilot test to determine if enhanced biorestoration of the aquifer, both alone and in conjunction with. oil recovery and oil dispersion techniques, is an effective method of remediation.

- The city ordinance prohibiting drilling new water supply wells within city limits (both within the Upper and Lower Aquifers) was continued.

- Monitoring activities required to assess the performance of the components of the remedy will be performed throughout the life of the remedial activities at the site. Long-term monitoring of the Lower and Upper Aquifer water quality is also required to determine further movement of the respective contaminant plumes, ensure protection of public health and assess potential degradation of the Kootenai River.

- The site conditions will be reviewed no less often than each five years after initiation of remedial action to ensure that human health and the environment are being protected by the remedy.

In 1993, EPA modified the remedy selected for the site through an ESD. The significant differences between the remedy described in the 1988 ROD and the ESD are described below:

1. The 1988 ROD described how the final remedy selected for the Lower Aquifer would be documented within a separate ROD. EPA determined that based on the simplicity of the final remedy, documentation of the selected remedy within an ESD would be sufficient.

2. Based on information described within three Lower Aquifer reports submitted by Champion (Lower Aquifer Characterization Report [WCC 1993a]; Technology Evaluation Report for the

Lower Aquifer [WCC 1993b]; and the Focused Risk Assessment Report for the Lower Aquifer [WCC 1993c]), EPA, in consultation with the Montana Department of Environmental Quality (MDEQ) determined that the final remedy for the Lower Aquifer shall consist of the continuance of both institutional controls prohibiting installation of new water supply wells (in both the Upper and Lower Aquifers) within the City of Libby and the long- term groundwater monitoring program initiated by Champion.

3. The limitations established in the 1988 ROD for pyrene, naphthalene and phenanthrene were removed. EPA cited the rationale provided by field data and the language provided within the No-Migration Petition (WCC 1990) as reasons behind removing these requirements.

All other aspects of the remedy documented in the 1988 ROD remained the same. A more detailed description of the revised components to the original remedy is presented in EPA's ESD for the Libby site (EPA 1993a).

In 1997, as the result of the first five-year review, EPA again modified the remedy selected for the site through a second ESD. The significant differences between the remedy described in the 1988 ROD, the 1993 ESD and the 1997 ESD are described below:

1. The Maximum Contaminant Level (MCL) for Pentachlorophenol (PCP) in ground water, adopted as a federal standard in 1992, replaced the current PCP remediation level found in the ROD for the Upper Aquifer. The MCL is 1.0 microgram per liter (ug/l).

2. The MCL for Dioxin TCDD in ground water, also adopted since the 1988 ROD was issued, calculated using Toxicity Equivalence Factors (TEF), was added to the remediation parameters in the ROD for the Upper Aquifer. The MCL for Dioxin TCDD is 3.0×10^{-5} ug/l.

3. The MCL for each of the carcinogenic Polycyclic Aromatic Hydrocarbons (PAHs) in ground water listed in Table 2 replaced the Total Carcinogenic PAH remediation level found in the 1988 ROD for the Upper Aquifer.

4. The soil remediation level for Total Carcinogenic PAHs was revised to 59 milligrams per kilogram (mg/kg) calculated as Benzo-a-Pyrene (BaP) equivalents using the EPA 1993 relative potency factors (RPFs).

5. The soil remediation levels for Total Noncarcinogenic PAHs, based on a Hazard Index Value of 1.0, listed in Table 2, were added to the list of remediation parameters.

6. The soil remediation levels for Dioxins/Furans were revised as indicated in Table 3 to reflect the most recent TEF methodologies for risk-based value calculation.

TABLE 2
COMPARISON OF 1988 CLEAN-UP GOALS, MAXIMUM CONTAMINANT LEVELS (MCLs), AND 1994 RISK-BASED CLEAN-UP CONCENTRATIONS (GROUNDWATER)

	1988 VALUES		1994 VALUES	
CONTAMINANTS OF CONCERN	**CLEAN-UP GOAL (µg/L)**	**BASIS [e]**	**CLEAN-UP CONCENTRATION (µg/L)**	**BASIS**
Noncarcinogenic PAH Compounds				
Naphthalene	(a)	Evidence of promoting carcinogenic activity of other cancer-causing compoounds	1460	Risk-Based Value HI=1.0
Acenapthylene			N/A	
Acenapthene			2190	
Fluorene			1460	
Phenanthrene			N/A	
Anthracene			11000	
Fluoranthene [c]			1460	
Pyrene [c]			1100	
Benzo (g,h,i) perylene			N/A	
Carcinogenic PAH Compounds				
Fluoranthene [c]	(d)	Risk-Based Value 10^{-5} and Achievable Detection Limits	N/A	N/A
Pyrene [c]			N/A	N/A
Chrysene			0.2	MCL
Benzo (a) anthracene			0.1	MCL
Benzo (b) fluoranthene			0.2	MCL
Benzo (k) fluoranthene			0.2	MCL
Benzo (a) pyrene			0.2	MCL
Indeno (1,2,3-c,d) pyrene			0.4	MCL
Dibenzo (a,h)anthracene			0.3	MCL
Pentachlorophenol	1050	Lifetime Health Advisory	1.00	MCL
Benzene	5.00	MCL	5.00	MCL
Arsenic	50.00	MCL	50.00	MCL

(a) = Cumulative concentration for all noncarcinogenic PAHs shall not exceed 0.4 µg/L.
(c) = Assessed as a potential carcinogen in 1988º, not classifiable as to human carcinogenity and assessed as a noncarcinogen in 1994.
(d) = Cumulative concentration for all carcinogenic PAHs shall not exceed 0.04 µg/L.
(e) = Taken from 1988 Record of Decision
HI = Noncarcinogenic Hazard Index
MCL = Maximum Contaminant Level
NA = not applicable
PAH = polycyclic aromatic hydrocarbon
µg/L = micrograms per liter

TABLE 3
COMPARISON OF 1988 CLEAN-UP GOALS AND 1994 RISK-BASED CONCENTRATIONS (SOILS)

	1988 VALUES		1994 VALUES	
CONTAMINANTS OF CONCERN	**CLEAN-UP GOAL (mg/kg)**	**BASIS [e]**	**CLEAN-UP CONCENTRATION (mg/kg)**	**BASIS**
Furans:				
tetra (2,3.,7,8) tetra (non-2,3,7,8) penta (1,2,3,7,8) penta(2,3,4,7,8) penta (other) hexa (2,3,7,8) hexa (non-2,3,7,8) hepta(2,3,7,8) hepta (non-2,3,7,8) octa	(a)	Risk-Based Value [b] 10^{-5}	0.0289 NA 0.0578 0.00578 NA 0.0289 NA 0.289 NA 2.89	Risk-Based Value 10^{-5}
Dioxins:				
tetra (2,3,7,8) tetra (non-2,3,7,8) penta (2,3,7,8) penta (non-2,3,7,8) hexa (2 3,7,8) hexa (non-2 3,7,8) hepta (2 3,7,8) hepta (non-2,3,7,8) octa	(a)	Risk-Based Value [b] 10^{-5}	0.00289 NA 0.00578 NA 0.0289 NA 0.289 NA 2.89	Risk-Based Value 10^{-5}
Pentachlorophenol	≤37	BDAT	36	Risk-Based Value 10^{-5}
Carcinogenic PAHs:				
Benzo(a)pyrene Benzo(a)anthracene Benzo(b)fluoranthene Benzo(k) fluoranthene Chrysene Dibenzo (a,h)anthracene Indeno(1,2,3-cd)pyrene	(c)	Risk-Based Value 10^{-5}	59 594 594 5,940 59,400 59 594	Risk-Based Value 10^{-5}
Noncarcinogenic PAHs:				
Acenaphthene Acenaphthylene Anthracene Fluoranthene Fluorene	NA NA NA NA NA	(d)	166 NA 33 250 250	Risk-Based Value HI=1.0

(a) = 2,3,7,8 - TCDD equivalency concentrations of chlorinated dibenzo-p-dioxins and dibenzofurans combined <0.001 mg/kg.
(b) = Proportional value based on proportionate risk of dioxins/furans and PAHs (90% for PAHs and 10% for dioxins in each scenario).
(c) = Total carcinogenic PAH concentrations < 88 mg/kg.
(d) = Noncarcinogenic health risks associated with soils determined to be not of concern according to 1988 baseline risk assessment.
(e) = Taken from 1988 Record of Decision.
BDAT= Best Demonstrated Available Technology
HI = Noncarcinogenic Hazard Index
NA = not applicable
PAH = polycyclic aromatic hydrocarbon
mg/kg= milligrams per kilogram

Remedial Objectives

The objective of the response actions implemented at the site is to alleviate the primary threats to human health and the environment posed by contaminant sources and contaminant migration. Specifically, the response actions proposed by EPA and MDEQ for the remedial subunits (i.e., Upper Aquifer, Lower Aquifer, Soils/Source Area) were designed to prevent the residents of Libby from exposure to contaminated groundwater found both in the Upper and Lower Aquifers. In addition, the potential for exposure to contaminated soils is to be eliminated through the treatment and ultimate disposal of contaminated soils in a lined LTU. The protection of the environment is accomplished through contaminant source removal as well as the cleanup of contaminated media through enhanced biodegradation processes designed exclusively for the contaminated soils and groundwater of the Libby site.

Status of OU Remedial Actions

As part of the third five- year review process, the status of the remedy pertaining to each operable unit is summarized below:

Operable Unit 1

OU1 involved an alternate water supply source for the affected residents of Libby whose domestic wells were either influenced or potentially influenced by off-site contaminant plume migration in the Upper Aquifer. The alternate water supply initiative was augmented by Champion's "Buy Water" plan. In addition, OUl incorporates a city ordinance prohibiting the installation of new water supply wells within city limits. During 1998, 44 residential wells were abandoned by Champion. The well owners were compensated for their wells and the abandonment costs were covered by Champion. At the time of the 1998 well abandonment project, the "Buy Water" plan was discontinued.

The city ordinance remains intact and is not anticipated to change in regard to domestic wells proposed to be installed in either the Upper or Lower Aquifer units. For the Lower Aquifer, the decision to continue this ordinance was described in EPA's ESD (EPA 1993a).

Operable Unit 2

The components of the remedy selected for OU2 have been summarized in Section IV. Since the 1988 ROD was signed, Champion designed, constructed and commenced operation on all portions of the remedy pertaining to the remedial subunits of OU2. EPA filed a Construction Completion notice for the site in the form of a Superfund Preliminary Site Close Out Report (EPA 1993b). However, since the remedy consists of innovative technologies (*in situ* and *ex situ* bioremediation techniques), the specific remedial design components for the remedial subunits described above are subject to design modifications as warranted. These modifications are first reviewed and approved by EPA prior to implementation by Champion. A brief summary of the current status of the remedial subunits that comprise OU2 is presented below.

Soils/Source Area

The soils/source area remedial subunit contains separate remedial measures designed to address the contaminated soils and the non- aqueous phase liquids (NAPLs) present in the waste pit area (Figure 2). The contaminated soils are treated biologically in the LTUs while the NAPLs are extracted and separated in the source area extraction and treatment system. The treatment system consists of a series of bioreactors that are designed to biologically treat the dissolved phase of NAPLs present in the extracted groundwater. The following excerpts provide a brief summary of the remedial actions that have been completed for this remedial subunit.

- Contaminated soil from the identified source areas was excavated and placed within a waste pit that contained contaminated soils and debris from past disposal practices at the site. These contaminated soils undergo a two-step enhanced biodegradation process. The initial treatment phase is conducted in the waste pit area, and the contaminants are further biodegraded after transfer to the LTU. To date, approximately 14,000 cubic yards (yd^3) of contaminated soils have been treated within the LTU. An additional 10 ac LTU was constructed in 1998 to expedite soil treatment.

- An extensive performance monitoring program was established and is maintained by International Paper for the LTU consisting of soils, leachate, air and groundwater samples. This performance monitoring program has been implemented since 1989 and has provided a means by which the protectiveness of the LTU operation can be evaluated. A revised plan was developed in 2004 and is currently being reviewed.

- A groundwater free product extraction and treatment system was constructed near the waste pit area to remove NAPLs from the source area and to biologically treat the dissolved phase of the contaminants in the groundwater. The extraction process consists of a series of recovery wells that pump the available product to an oil/water separator. Once the NAPL is removed, the dissolved phase of the contaminants are biodegraded in a series of bioreactors. The final effluent is discharged to a rock percolation pad. To date, approximately 19,000 gallons of free product have been removed from the source area. International Paper reports that the bioreactors have maintained an 80 percent or greater efficiency rating for the removal of PAHs and PCP from the contaminated groundwater since the bioreactor operations commenced.

- International Paper added language to the current registered deed identifying the locations of the hazardous substances disposal and treatment areas, and restricted the future land use of these areas. A fence was constructed in 2004 to isolate the property owned by International Paper from the rest of the former mill site because there is no longer mill site security.

Upper Aquifer

The remedy for the Upper Aquifer component of the remedy originally consisted of an innovative *in situ*, enhanced biorestoration program. The ground water treatment system consisted of two lines of injection

wells designed to introduce oxygen and nutrients (where needed) to biologically degrade the dissolved contaminants (PAHs and PCP) observed in the Upper Aquifer. These two injection systems are referred to as (1) the intermediate injection system and (2) the boundary injection system (Figure 3). International Paper monitored the effectiveness and design criteria of the first two injection systems and requested the discontinuation of the Intermediate system. International Paper's request was granted and the intermediate system was removed in 1998. A subsequent request was submitted to discontinue operation of the Boundary Injection system which was approved in 2003.

International Paper installed and implemented a performance monitoring network for the *in situ* biorestoration program consisting of over 20 ground water monitoring wells located both onsite and offsite. The monitoring program allowed EPA to assess the effectiveness of this restoration program. Based on the results of this monitoring program, EPA requested that International Paper prepare a Technical Impracticability Evaluation Report which was submitted in January 1999 and subsequently approved by the Agency.

Source Area Extraction and Treatment System

The objective of the system is to remove oil (NAPL) from the upper aquifer to improve the performance of the downgradient *in situ* systems. The source area extraction and treatment system (Bioreactor System) was constructed in late 1989 and consists of extraction wells, an oil/water separator, nutrient addition, and two fixed-film bioreactors operated in series with ancillary equipment. Heavily contaminated ground water is extracted from the upper aquifer and the non-aqueous phase liquid (NAPL) is separated from water in the oil/water separator. Recovered oil is stored in a tank until shipment off-site to be recycled and reused. Process water is amended with nutrients, after which the dissolved-phase contamination is treated in the bioreactors. From the bioreactors, the treated effluent is discharged to open infiltration trenches. Figure 3-1 shows a schematic of the bioreactor system.

Both well 9006 and 9008 have similar completions. They consist of a 10-inch diameter casing perforated for nearly 10 feet at the bottom. The total depth of each well is close to 75 feet and each has a 10-foot long, stainless-steel screen installed. A progressive-cavity pump manufactured by Protec Industries (Protec) is installed in each well. These pumps have the capacity of pumping 21 gpm at a rotation speed of 350 rpms. Free phase NAPL along with contaminated ground water is piped to the oil/water separator, then on to the bioreactors.

International Paper experienced some difficulty in identifying a pump that can withstand the high concentrations of oil in the extraction wells and also minimize emulsification of the oil (emulsification inhibits the oil/water separation process). As a result, the extraction system has been shut down temporarily over the years to replace the pumps. Generally the system was not shut down for more than about 10 to 40 days each year. The Protec pumps have been selected based on extensive testing by International paper. The testing results have been reported in previous annual reports (WCC 1995, 1996, and 1997). The Protec pumps were found to be capable of operating reliably under the oily conditions and they minimize emulsification of the oil compared to other pumps. It is anticipated that fewer shut downs will occur as a result of pump failure in the future. Other infrequent interruptions in operations have occurred as a result of power outages and normal maintenance of the system.

The extraction system has operated since 1991 at a total pumping rate of up to approximately 16 gpm, with an average rate of about 6 gpm. Both oil and dissolved phase contaminants are removed at these rates. In 1997, well 9006 produced nearly three times the mass of contaminants compared to well 9008. Therefore, well 9006 is currently the principal extraction well. A new extraction well was drilled in the waste pit to assist in the recovery of oil from the ground water. Operation of this well began in December 1999 and oil recovery has increased since that date.

The oil/water separator consists of a horizontal, 10,000-gallon tank. The design of the separator includes an inlet baffle, float controls for the extraction pumps, sight glasses for level indication, and an inlet and outlet in the center of the tank. The separator was designed to collect both floating (light) and sinking (dense) NAPLs. However, only the dense NAPLs are recovered in significant quantities. After free-phase NAPLs are removed, the remaining water flows to the bioreactors for treatment. The separated oil is sent to a wood treating facility in South Dakota. Several studies have been conducted to optimize the operation of the oil/water separator. Options evaluated included dissolved-air floatation, flocculation, coalescence, and longer retention times. The purpose of these evaluations was to find ways to increase the oil droplet size. By increasing the oil droplet size, the oil and water can be separated more effectively. It was found that the most effective method for increasing the droplet size was by operating the Protec pump. In conjunction with the Protec pumps, the oil/water separator has been able to operate as designed. A new oil/water separator was installed in the system during 1999 and has improved the oil removal efficiency dramatically.

The bioreactor system consists of two, 10,000-gallon tanks filled with a polyethylene media to physically support bio-growth. The plastic media is designed to increase the surface area of the bio-film in contact with the contaminated ground water. Liquid nutrients for the bio-film bacteria, in the form of ammonium polyphosphate and urea ammonium nitrate, are added to the process water prior to entering the first bioreactor. The addition rate is adjusted based on the ammonium concentration in the effluent from the second reactor. The residual ammonium concentration target of 0.1 to 1 ppm is monitored on a weekly schedule.

The reactors are heated to approximately 22 degrees Celsius using a propane-fired boiler, which heats a water/glycol solution. The heated solution flows through in-tank and in-line heat exchangers to heat the process water. The reason for heating the water is to stimulate biologic activity, as the microbes work most efficiently at warmer temperatures. However, a study conducted in 1992 on the system demonstrated that efficiency increases with heating only up to a certain point. Results of the study indicated no significant difference in the performance of the system between the temperatures of 20 to 30 degrees Celsius. Therefore, the final temperature of 22 degrees was chosen to reduce operating costs and conserve energy.

Inside the reactors compressed air is supplied to in-tank air diffusers and added to the reactor with the process water using the distribution manifold at the bottom of each reactor. The air provides dissolved oxygen to the microbes living within the reactors. The oxygen concentrations are monitored on a weekly basis, along with ammonium, temperature, and pH.

Process water flows up through the plastic media and gravity flows to the next reactor. From the second reactor, the process water flows to an open trench for infiltration back to the ground water. As the water travels through the media inside each reactor, dissolved-phase contaminants are adsorbed from the water

to the bio-film. Once the contaminants become diffused into the bio-film, they can be used by the microbes as a food source. Complete aerobic biodegradation of the contaminants results in the formation of carbon dioxide, water, and additional bio-mass. Operating experience of the system has shown the first bioreactor has developed a bio mass capable of degrading most of the PAHs (70 to 80 percent) and some of the PCP (approximately 10 percent), while the second reactor generally treats the remainder of the PAHs and most of the PCP (70 to 80 percent). This indicates that PAHs are more amenable to biological breakdown than PCP under existing conditions in the bioreactor. Samples are collected from the entire system on a weekly basis. The results of the analyses are used to monitor the performance of the oil/water separator and each bioreactor. These results are presented in the annual reports for the Upper Aquifer.

Lower Aquifer

As described above, a final remedy for the Lower Aquifer remedial subunit was not prescribed in the 1988 ROD; rather, an interim remedy was selected until International Paper could study dense non-aqueous phase liquids (DNAPLs) removal and treatment technologies through treatability studies and literature research. In 1993, EPA prepared an ESD that established an institutional control/long-term monitoring final remedy for the Lower Aquifer. Specifically, the Lower Aquifer final remedy called for the city ordinance that prohibits the installation of domestic wells within city limits (first introduced under OU1) to be continued indefinitely for the Lower Aquifer. In addition to the city ordinance regarding domestic wells, International Paper is required to continue monitoring the lower aquifer water quality to assess potential plume migration and/or degradation with time. The following excerpts provide a brief summary of the remedial actions that have been completed for this remedial subunit as they relate to the final remedy described in the ESD.

- International Paper installed several additional monitoring wells in the Lower Aquifer to provide a means by which the potential migration of both the DNAPL and the dissolved plume may be monitored. These additional wells are part of an existing monitoring program that International Paper used during the earlier investigative stages of the Lower Aquifer.

- International Paper initiated a long-term groundwater monitoring program for the Lower Aquifer as part of the final remedy selected in the ESD. The first round of sampling was conducted in March 1994. International Paper outlined their proposed monitoring program to EPA in their Lower Aquifer Monitoring Program report submitted to EPA in August 1994 (WCC 1994a). Lower Aquifer monitoring reports have been submitted on schedule since the monitoring program was approved by EPA. International Paper has prepared an updated program currently being reviewed by EPA.

- The city ordinance prepared for OU1 was incorporated in the final remedy for the Lower Aquifer. The city ordinance remains intact and is not anticipated to change in regard to the prohibition to domestic wells installation in the Lower Aquifer.

Table 4

List of Domestic Wells Plugged and Abandoned by Champion

Well #	Address	Buy/Water	Heat Pump	Monitoring Well	Abandoned	Paid
1001	1415 Dakota Avenue	yes	no	yes	8/12/97	8/12/97
1002	1119 Dakota Avenue	yes	no	no	8/11/97	8/11/97
1003	222 Balsam Street	yes	no	no	8/15/97	8/15/97
1005	1004 Main Avenue	yes	no	yes	8/11/97	8/11/97
1006	301 California Avenue (not wel loc)	yes	no	yes	8/12/97	8/20/97
1007	1592 Hwy 2 West	no	no	yes	agreement not returned	
1009	407 Utah Avenue	yes	no	no	8/11/97	8/11/97
1010	747 5th Street Ext.	yes	no	no	8/12/97	8/12/97
1011	113 West Oak Street	yes	no	no	8/12/97	8/12/97
1016	110 East Oak	no	no	yes	agreement not returned	
1018	814 Michigan Avenue	yes	no	no	8/11/97	8/8/97
1019	1004 Nevada Avenue	yes	no	no	8/15/97	8/22/97
1019	1016 Nevada Avenue	yes	no	no	not owner	
1020	1014 California Avenue	yes	no	yes	8/15/97	8/15/97
1021	sold property		no		1996	paid
1022	688 Kootenai River Rd.	no	yes	yes	Nov. 97 deed restrict.	12/18/97
1023	c/o Valerie Haarstick 1800 Iron Cr	yes	yes	no	Nov. 97 deed restrict.	12/18/97
1027		no	yes	no		
1028	714 Wisconsin Avenue	no	no	no	not returned (1)	
1030	720 Michigan Avenue	no	no	no/closed '95	1995/new well monitor	
1031	1022 Dakota Avenue	no	no	no	agreement not returned	
1032	303 Lincoln Ave. Snohomish, Wa.	no	no	yes	8/8/97	8/8/97
1052	1322 Dakota Avenue	yes	no	no	8/11/97	8/11/97
1053	1315 Utah Avenue	yes	no	yes	8/11/97	8/11/97
1054	103 East Oak Street	yes	no	no	8/15/97	8/15/97
1055	1312 Dakota Avenue	yes	no	no	8/11/97	8/11/97
1056	c/o Dean Byrnes 308 Main Ave.	yes	no	no	8/8/97	8/11/97
1057	3214 N. 11th Court' Alene, Id 83814	yes	no	no	8/11/97	8/11/97
1058	412 E .6th Street	yes	no	no	8/11/97	8/11/97
1060	205 W. Casino-Everett, Wa 98204	yes	no	no	9/24/97	10/3/97
1061	205 Woodland Heights Rd.	yes	no	no	8/11/97	8/8/97
1063	415 Utah Avenue	yes	no	no	8/8/97	8/8/97
1064	518 East 5th Street	yes	no	no	8/27/97	9/10/97

Table 4
(Continued)

1067	1113 Utah Avenue	Yes	no	no	8/12/97	8/12/97
1068	1205 Washington Avenue	Yes	no	no	8/12/97	8/13/97
1069	1312 Montana Avenue	No	no	no	8/15/97	8/15/97
1071	1221 Nevada Avenue	Yes	no	yes	8/12/97	8/12/97
1074	1012 Main Street	Yes	no	no	8/11/97	8/11/97
1083	516 East 4th Street	Yes	no	no	8/11/97	8/11/97
1084	712 Wisconsin Avenue	No	no	no	refused 7-15-97 (2)	
1100	1305 Dakota Avenue	Yes	no	yes	8/11/97	8/12/97
1103	746 East 5th Street Ext.	Yes	no	no	8/15/97	8/15/97
1105	1314 Louisiana Avenue	Yes	no	no	8/12/97	8/13/97
1106	910 East Lincoln Blvd.	Yes	no	yes	refused 7-5-97 (3)	
1107	801 Wisconsin Avenue	No	no	no	8/27/97	8/27/97
1108	617 East 5th Street	Yes	no	no	8/8/97	8/8/97
1109	514 East 8th Street	Yes	no	no	8/11/97	8/8/97
1110	300 Flower Creek Rd	Yes	no	no	8/8/97	8/8/97
1111	720 Michigan Avenue	Yes	no	yes (see well 1030)	8/12/97	8/22/97
1112	305 Dakota Avenue	Yes	no	no	8/8/97	8/8/97
1113*	Box 1525 Libby	no - new 1997	no	no	8/11/97	8/12/97
1114*	507 Minnesota Avenue	no - new 1997	no	no	8/11/97	8/11/97
1115*	604 Dakota Avenue	no - new 1997	no	no	8/15/97	8/15/97
1116*	517 E. 6th Street	no - new 1997	no	no	9/24/97	10/3/97

Systems Operations

Soils/Source Area

The effectiveness evaluation for the soils/source area remedial subunit will be discussed separately below for the LTU operations and source area extraction and treatment system.

Land Treatment Unit Operations

The LTU operations have been in effect since the land treatment demonstration unit began treating PAH and PCP contaminated soils in 1989. Since then, the LTU has treated approximately 15,400 cubic yards (yd^3) of contaminated soils to the target cleanup goals specified in the ROD. An expanded 10 ac LTU was constructed with EPA approval in 1998 and all of the soil in the waste pit except 3000 yd^3 of highly contaminated soil was placed on the new LTU. The waste pit was backfilled with clean soil and rock and the 3000 yd^3 that were not moved to the new LTU were placed on top of the backfilled area for intensive treatment. A proprietary amendment, X-19, was added to the waste pile soils and the contaminated soil was covered with a plastic membrane. The contaminant levels in the waste pit soil pile have decreased dramatically since 2000. EPA has approved placement of the waste pit soils on the ELF in 2005.

Regarding the protectiveness of the LTUs in terms of prevention of exposure to onsite workers and the general public, International Paper's monitoring data for air, groundwater, and leachate have shown over the last 15 years that contaminant migration has been minimal. Air quality monitoring data reported annually in International Paper's LTU operations reports have shown that there is little concern for worker exposure during active management of the contaminated soils. Leachate concentrations reported in the same documents referenced above have also been relatively low.

Ground water monitoring in the area of the LTU has been questionable in terms of representativeness of data. Both monthly progress reports and LTU operations reports discussed how the LTU monitoring wells may be influenced by contaminant migration originating from the waste pit area. Since the LTU reached cleanup levels several years ago and no additional soil has been applied, the significance of the ground water monitoring has decreased.

The overall assessment for the LTU is that the past operation for treating contaminated soils was effective at meeting the remediation goals presented in the ROD as well as being protective of human health and the environment.

Source Area Extraction and Treatment System

The effectiveness of the source area extraction and treatment system has been limited in the past because of the inability of the oil/water separator design to effectively remove the NAPLs from the extracted water before treatment in the bioreactors. The problems associated with the oil/water separator involved both the specific density of the NAPL recovered and the pumping method used to extract the contaminated ground water. The specific density of the free product removed from the extraction wells was measured to be so close

to that of the ground water in which it was found that the oil/water separator did not allow enough residence time for the NAPL droplets to settle out before being introduced to the bioreactors. In addition, the NAPL was emulsified within the pumped water by the shearing action of the centrifugal pump used within the extraction wells. This reduction in the NAPL droplet size also reduced the capacity of the oil/water separator to settle out the recovered product. New progressive cavity pumps were installed in the extraction wells and have reduced the emulsification of oil during pumping. A new oil/water separator was installed in 1999 and approximately 16,000 gallons of product have been collected since the installation.

International Paper's ongoing management of the bioreactors has been successful in removing more than 80 percent of the influent concentrations of PAHs and PCP.

The overall effectiveness of the source area extraction and treatment system appears to have improved since the second five- year review. International Paper's proven management skills with the performance of the bioreactors have shown that regardless of the effectiveness of the oil/water separator, the bioreactors can still be operated in a manner that meets the target efficiency rate of 80 percent removal of the PAHs and PCP found within the extracted groundwater. The addition of the coalescing separator has dramatically improved the recovery of product.

Upper Aquifer

The effectiveness evaluation for the Upper Aquifer remedial subunit will be discussed separately below for the intermediate and boundary injection systems.

Intermediate Injection System

The intermediate injection system formerly pumped a total of 98 gpm to six injection wells located north of the former tank farm area in an effort to introduce oxygen and nutrients to the Upper Aquifer (Figure 3). The injection water was oxygenated through four Bubbleless Membrane Aeration (BMA) elements produced by Membran Corporation (Jacobs 1994a). The BMA elements replaced Champion's need for hydrogen peroxide and produce a dissolved oxygen concentration (35 parts per million [ppm]) that is comparable to the former oxygenation system. However, the effectiveness of the *in situ* bioremediation system was limited.

As reported in International Paper's 1999 TI Evaluation Report, the effectiveness of the intermediate injection system in reducing concentrations of PAHs and PCP appeared to be limited in those areas characterized by detectable quantities of NAPL. International Paper reported that seven monitoring wells located downgradient of the intermediate injection system consistently contained measurable quantities of NAPL. These wells did not show an increase in DO concentrations as had the monitoring wells located within the immediate vicinity of the injection wells. The system's inability to adequately reduce contaminant concentrations in areas where NAPL is present created uncertainty about the ability of the design that was applied in this area to meet the remedial goals established in the ROD. International Paper requested that the Intermediate System be discontinued in 1999 and EPA approved the request.

For the Upper Aquifer unit, the city ordinance will remain in effect as long as the groundwater remedial goals, identified in the 1988 ROD, have not been met. To date, ground water samples collected both onsite and offsite have shown that remedial goals established for PAHs and PCP have not been met at any Upper Aquifer performance monitoring stations. This ordinance may be modified by EPA once the remedial goals have been met for a specified length of time.

Boundary Injection System

Since the boundary injection system (BI) became operational in 1993, a total of eight monitoring wells have shown increases in DO concentrations with corresponding PAH and PCP concentrations that were either very low or non-detectable. These eight wells are all located within 100 to 200 feet of the boundary injection well line. To date, no substantial water quality changes have been observed at monitoring wells located farther than 200 feet from the boundary system.

International Paper requested that the BIS operation be discontinued in 2003 in order to determine if mounding of ground water caused by operation of the system was causing unanticipated effects by pushing the dissolved plume away from the site. EPA and MDEQ agreed to allow the system to be shut down, however International Paper was required to leave the BIS in operational condition in case it was determined that operation should resume.

Lower Aquifer

The ordinance that prohibits the installation of domestic wells within city limits continues to be upheld and observed by the residents and businesses of the City of Libby. The ordinance has been effective in protecting both human health and the environment by preventing exposure to the groundwater contamination. With the abandonment of residential wells, the city ordinance and a long-term monitoring program, the final remedy for the Lower Aquifer is anticipated to remain protective.

Progress Since the last Five-Year Review

During the second five-year review, the remedy was found to be protective of human health and the environment, however some deficiencies were noted. The following recommendations were contained in the second five-year review as the result of the protectiveness evaluation:

Operable Unit 1

No changes are recommended to the remedy selected for OU1 at this time. The remedy has been implemented successfully and remains protective of human health in its current state.

Operable Unit 2

There were two recommendations from the second five-year review:

1. The TI waiver provisions should be incorporated into the Record of Decision as specified in EPA guidance. In conjunction with this activity, the boundaries of the area within which the waiver will apply must be determined and future operational modifications to the ground water treatment system must be identified.

2. A petition for designation of a controlled ground water use area should be prepared and submitted to the Montana Department of Natural Resources and Conservation. This process will provide another level of institutional control on ground water use in addition to the city ordinance.

Actions Taken Since Second Five-Year Review

Status of Recommendations

EPA approved a TI waiver petition for the site on March 26, 1999, however, completion of the TI process and issuance of a modification to the ROD has been postponed due to the recent listing of the Libby Asbestos Site on the NPL. Once remedial activities have progressed at the Libby Asbestos Site, modification of the Libby Ground Water Site ROD will be reviewed.

The Libby City ordinance prohibiting new ground water extraction wells has been effective at protecting the public from exposure to contaminated ground water. The ordinance also provides protection to the ground water remediation system for the Libby Ground Water site. Discussions with the Lincoln County Health Department have resulted in the decision to postpone efforts to secure a controlled ground water area designation. This decision may be reviewed at any time.

Land Treatment Units

All soil treated on the LTUs has reached the ROD remediation levels for PCP and PAH and no additional soil has been placed on these units since 2000, as shown in Table 5. Soil remaining in the waste pit treatment area will be moved to the ELF in 2005 and the ELF will continue to be managed to reduce contaminant levels as required in the ROD. It is anticipated at this time that the soil component of the remedy will take several years to complete.

Upper Aquifer

Currently there are no municipal water supply wells in the City of Libby. Potable water is supplied to businesses and residents in Libby from a reservoir on Flower Creek located upstream from the city. However, some of the residents in Libby own wells that were used in the past primarily for irrigation. After ground water contamination was discovered in Libby, the City passed an ordinance prohibiting new wells from being constructed for any purpose except to supply heat pumps. The City ordinance has been effective in preventing new wells from being drilled in Libby.

In 1997 Champion offered to reimburse well owners affected by the site contamination, in the amount of

$2,000. In return, the well owners allowed Champion to permanently plug and cap the wells according to State of Montana well abandonment regulations. Champion incurred all costs to abandon the wells. The wells that were plugged and abandoned are listed in Table 4.

International Paper requested that EPA allow the Boundary Injection System (BIS) to be temporarily decommissioned in 2003 to determine if the BIS was actually providing significant ground water remediation. EPA and MDEQ approved International Paper's request with several conditions: 1) The ground water monitoring results from the area down gradient from the BIS will be evaluated annually to determine the effect of discontinuing operation and 2) The BIS can be placed back in operation if it is determined that there is sufficient benefit to be achieved by continued operation of the system. Ground water data provided in the annual Upper Aquifer Reports is evaluated each year to determine the effects of the BIS. Data from 2003 has been evaluated and a change in the status of the BIS was not required. Data from 2004 has not been submitted as of the date of this review.

V. Five-Year Review Process

The Libby Ground Water site third five-year review was led by Jim Harris, Remedial Project manager for the Libby site. The following team members assisted in the review:

- Lisa DeWitt, MDEQ Environmental Specialist
- Tom Ross, Manager- Environmental Projects, International Paper
- David Cosgriff, Consulting Engineer, Arrowhead Engineering, Inc.
- Robert Fox, Superfund Branch Chief, USEPA
- Kathy Chiotti, Environmental Protection Specialist, USEPA
- Diana Hammer, Community Involvement Coordinator, USEPA
- D. Henry Elsen, Site Attorney, USEPA

This five-year review consisted of the following activities: a review of relevant documents and a site inspection. The completed report is available in the EPA information repositories in Helena and Libby. Notice of its completion will be placed in the local newspaper and local contacts will be notified by letter. A brief summary of this report will be distributed to community members.

VI. Five-Year Review Findings

Interviews

Interviews were not conducted during the second-five year review. EPA has not received any complaints about site activities since the second five-year review.

Site Inspection

An inspection of the Libby Ground Water site was performed on March 1, 2005 by EPA and an International Paper representative. During the site inspection, areas visited included the on-site laboratory, the Waste Source Extraction and Treatment System and the Land Treatment Units (LTUs). A summary of the inspection findings is presented below and the detailed inspection check- list is attached as Appendix 3.

Site Security

The Libby site is physically located on the former Stimson Lumber Mill property now owned by the Lincoln County Port Authority. International Paper has constructed a chain-link fence around all of their property located on the former mill site. The gates in the fence are locked at all times when an International Paper representative is not present. At the time of the recent inspection the fence had no damage and the locks were in place.

Source Area Extraction and Treatment System

Two suspended growth bioreactors were tested in the summer of 1992 and 1993 in an effort to expand the capacity of the bioreactor treatment system. Although these bioreactors were successful in increasing the capacity, it was determined that increasing the efficiency of the oil/water separator provided an increase in contaminants by weight at the rate of about two times that of the fixed-film and suspended growth reactors combined. Therefore, further testing of the suspended growth reactors was terminated and subsequent efforts were focused on increasing the efficiency of the oil/water separator.

The coalescing oil/water separator, along with the ancillary equipment to operate the system, was placed on-line in early January 2000. The system was started with the extracted water coming from extraction well (well 9009) at a flow rate of 16 gpm. Initially the treated water was directed to the infiltration galleries, but then a new injection well was drilled to receive the treated effluent from the coalescing oil/water separator. The new injection well (well 9504) was drilled between the existing extraction wells in an effort to increase product removal efficiency by increasing the groundwater velocity to the extraction wells. For most of the year (2000), January until September, only well 9009 was utilized as the extraction well. Beginning on September 13,2000, well 9008 was started at an extraction rate of 5 gallons per minute (gpm). For 2003, the extraction rate from the extraction wells, when operating, was approximately 8.7 gpm and 4.0 gpm from extraction wells 9009 and 9008, respectively.

The coalescing separator system was monitored by collecting samples of the influent and effluent for analysis by the Libby On-Site Laboratory (LOSL) of PAHs and PCP. The oil layer within the separator was also measured monthly with the oil/water interface probe to determine collection performance. The flowrate and total gallons treated were recorded nearly daily.

The contaminant concentration monitoring results for the coalescing separator are presented in Table 9. Based on these results using time-weighted averaging, the coalescing separator was collecting approximately 11.4 lbs/day PAHs and 0.62 lbs/day PCP while it was operating (340 days). The average removal efficiency

for PAHs was 53 percent and 24 percent for PCP. This is below the targeted removal efficiency of 80 percent for PAHs and PCP for the bioreactor system, however, the removal of free product from the upper aquifer by the coalescing separator system during 2003 is significant. Based on physical measurements of recovered product, the coalescing separator collected approximately 1,688 gallons of free product during 2003. The recovered product was transferred from the coalescing separator to the outside accumulation tank on May 12, 2003.

The coalescing separator treated a total of 5.76 million gallons of water in 2003. Of this total volume, approximately 4.32 million gallons were recovered from well 9009 and the remaining 1.44 million gallons were recovered from well 9008. In 2002, the coalescing separator treated a total of 6.49 million gallons of water. Also during 2002, the coalescing separator was collecting approximately 10.9 lbs/day PAHs and 0.56 lbs/day PCP.

Table 8 compares system performance between the bioreactor system, gravitational separator and coalescing separator. This table shows the PAH recovery/degradation for each of the three systems in units of pounds PAH per day and also provides the total number of gallons of ground water treated in the corresponding year. Based on these results, the oil water separators have historically removed a much larger mass of PAH contaminants than the bioreactors. This trend remained the same for 2003. The improvement from 2002 to 2003 was the result of replacing the Protec pump in well 9006, which allowed for a higher extraction rate at a lower speed for the pump.

The inspection performed on March 1, 2005 verified that the remedial systems at the Libby Ground Water site were operating as designed and in compliance with the conditions specified in the 1988 ROD and subsequent ESDs.

Risk Information Review

As discussed above, several modifications to the remediation levels in the 1988 ROD were made by issuing an ESD in 1997. The modifications to the remediation levels were made as the result of a protectiveness evaluation which was a component of the first five-year review performed in 1995. The MCL for PCP has not changed since the first five year review nor have the remediation levels for the other contaminants of concern.

There are currently no exposures to contaminated ground water from the Libby site and future exposures are not anticipated because of the existing municipal water supply and the city ordinance prohibiting construction of new wells. International Paper prepared a Technical Impracticability Evaluation that has been approved by EPA and MDEQ; the ROD for the site will be modified to incorporate a waiver of ground water standards. The boundaries of the area where standards will be waived will coincide with the existing dissolved contaminant plume.

No changes in action or location specific requirements have been promulgated since the last five-year review.

Data Review

Champion is required to submit an annual report on the ground water components (Upper and Lower Aquifer) and the soil component of the remedy. A review of the ***Annual Operations Report for the Upper Aquifer***, the ***Lower Aquifer Letter Report*** and the ***LTU Operations Report*** has taken place on an annual basis since the remedies were implemented.

Table 5 summarizes the soil lifts that have been treated to the remediation levels specified in the ROD. As can be seen from the table, approximately 15,400 yd^3 of contaminated soil have been treated since 1989. The expanded land farm will greatly increase the effectiveness of the soil remedy by providing greater treatment area.

Table 7 displays the performance of the bioreactors during 2003 including influent, intermediate and effluent PAH concentrations. As can be seen from the table, the bioreactors removed an average of 97% of the PAH from the system influent.

VII. Assessment

The following conclusions support the determination that the remedy at the Libby Ground Water site is currently, and is expected to remain protective of human health and the environment.

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

- ***HASP/Contingency Plan***: Both the HASP and the Contingency Plan are in place, sufficient to control risks, and properly implemented.

- ***Implementation of Institutional Controls and Other Measures***: The City ordinance prohibiting the installation of new water supply wells within the city limits is currently in effect and is enforced. Additional restrictions on ground water use will be sought through a controlled ground water use area designation if necessary.

- ***Remedial Action Performance***: The soil component of the remedy continues to perform as designed and remediation levels are being met through land treatment of contaminated soil. The soil component will be completed in several years. The ground water treatment system is performing as designed with reductions in source area loadings and with dissolved plume stabilization.

- ***System Operations/O&M***: System operations procedures are consistent with site requirements and no deficiencies were identified.

- ***Cost of System Operations/O&M***: Costs for the most part have been within an acceptable range.

- ***Opportunities for Optimization***: International Paper has discontinued use of the Intermediate Injection System and the Boundary Injection System with approval from EPA due to poor system performance.

- ***Early Indicators of Potential Remedy Failure***: No early indicators of potential remedy failure were noted during the review.

Question B: Are the assumptions used at the time of remedy selection still valid?

- ***Changes in Standards and To Be Considereds***: This five-year review did not identify new standards.

- ***Changes in Exposure Pathways***: No changes in the site conditions that affect exposure pathways were identified as part of the five-year review. The dissolved contaminant plume has stabilized based on fourteen years of ground water monitoring data.

- ***Changes in Toxicity and Other Contaminant Characteristics***: Toxicity and other factors for contaminants of concern have not changed.

- ***Changes in Risk Assessment Methodologies***: Changes in risk assessment methodologies since the time of the ROD do not call into question the protectiveness of the remedy.

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

No additional information has been identified that would call into question the protectiveness of the remedy.

VIII. Deficiencies

As noted and documented above, there were no deficiencies identified during the third five-year review process for the Libby Ground Water site.

IX. Recommendations

There are two recommendations relating to this five-year review:

1. The TI waiver provisions should be incorporated into the Record of Decision as specified in EPA guidance (As previously recommended in the second five-year review). In conjunction with this activity, the boundaries of the area within which the waiver will apply must be determined.

2. Observation of the effectiveness of the city ordinance prohibiting new wells should continue. Should the ordinance become ineffective, a petition for designation of a controlled ground water use area should be prepared and submitted to the Montana Department of Natural Resources and Conservation.

X. Protectiveness Statements

The protection of human health and the environment by the remedial actions at OU1 and OU2 are discussed below. Both the HASP and the Contingency Plan are in place, sufficient to control risks, and properly implemented. Because the remedial action at OU1 is protective of human health and the environment and the remedial action at OU2 is protective of human health and the environment, the remedy for the site is expected to be protective of human health and the environment.

Operable Unit 1

The OU1 remedy is protective of human health and the environment. OU1 involved an alternative water supply source for the affected residents of Libby whose domestic wells were either influenced or potentially influenced by off-site contaminant plume migration in the Upper Aquifer. The wells listed in Table 4 have been abandoned and the property owners have been compensated for the potential loss of use of those wells. In addition, OU1 incorporates a city ordinance against the installation of new water supply wells within city limits. The city ordinance remains intact and is not anticipated to change in regard to domestic wells proposed to be installed in either the Upper or Lower Aquifer units.

Operable Unit 2

The remedy at OU2 is protective of human health and the environment. Levels of contaminants are decreasing as needed to achieve cleanup levels within a shorter time frame than that anticipated at the time of the ROD, and migration of the ground water plume has been stabilized. Institutional controls are in place to prevent ground water use downgradient of the plume and a TI waiver has been approved.

XI. Next Review

This is a statutory site that requires ongoing five-year reviews. The next review will be conducted within five years of the completion of this five-year review report. The completion date is the date of the signature shown on the signature cover attached to the front of the report.

XII. Documents Reviewed and References

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Woodward-Clyde Consultants (WCC). 1993b. Focused Risk Assessment Report For The Lower Aquifer. Prepared for Champion International Corp. Stamford, Connecticut. May 1993.

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

Woodward-Clyde Consultants (WCC). 1994. 1993 Annual Operations Report for the Upper Aquifer. February.

Woodward-Clyde Consultants (WCC). 1995. 1994 Annual Operations Report for the Upper Aquifer. February.

Woodward-Clyde Consultants (WCC). 1996. 1995 Annual Operations Report for the Upper Aquifer. February.

Woodward-Clyde Consultants (WCC). 1997. 1996 Annual Operations Report for the Upper Aquifer. February

APPENDICES

A. Site Inspection Form
B. Figures
C. Tables
D. Second Five-Year Review Report
E. Photos Documenting Site Conditions

APPENDIX A

Inspection Report Form

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: Libby Ground Water	**Date of inspection:** September 15, 1999
Location and Region: Libby, Montana	**EPA ID:** MTD 980502736
Agency, office, or company leading the five-year review: EPA Region 8, Montana Office	**Weather/temperature:** Clear 60 F

Remedy Includes: (Check all that apply)

☐ Landfill cover/containment
X Access controls
X Institutional controls
X Groundwater pump and treatment
☐ Surface water collection and treatment
☐ Other Land Treatment Units

Attachments: X Inspection team roster attached X Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** Tom Ross, International Paper Manager Environmental Remediation
   Name Title
   Interviewed X at site X at office X by phone Phone no. 901 419-3899
   Problems, suggestions; ☐ Report attached _____

2. **O&M staff** David Cosgriff , Arrowhead Engineering Environmental Engineer
   Name Title
   Interviewed X at site X at office X by phone Phone no. _406 293-9387
   Problems, suggestions; ☐ Report attached _____

III. ONSITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1.	**O&M Documents**			
	☐ O&M manual	X Readily available	X Up to date	☐ N/A
	☐ As-built drawings	X Readily available	X Up to date	☐ N/A
	☐ Maintenance logs	X Readily available	X Up to date	☐ N/A
	Remarks_____			
2.	**Site-Specific Health and Safety Plan**	X Readily available	X Up to date	☐ N/A
	☐ Contingency plan/emergency response plan	X Readily available	X Up to date	☐ N/A
	Remarks_____			
3.	**O&M and OSHA Training Records**	X Readily available	X Up to date	☐ N/A
	Remarks_____			
4.	**Permits and Service Agreements**			
	☐ Air discharge permit	☐ Readily available	☐ Up to date	X N/A
	☐ Effluent discharge	☐ Readily available	☐ Up to date	X N/A
	☐ Waste disposal, POTW	☐ Readily available	☐ Up to date	X N/A
	☐ Other permits_____	☐ Readily available	☐ Up to date	X N/A
	Remarks_____			
5.	**Gas Generation Records**	☐ Readily available	☐ Up to date	X N/A
	Remarks_____			
6.	**Settlement Monument Records**	☐ Readily available	☐ Up to date	X N/A
	Remarks_____			
7.	**Groundwater Monitoring Records**	X Readily available	X Up to date	☐ N/A
	Remarks_____			
8.	**Leachate Extraction Records**	X Readily available	X Up to date	☐ N/A
	Remarks_____			
9.	**Discharge Compliance Records**			
	☐ Air	☐ Readily available	☐ Up to date	X N/A
	☐ Water (effluent)	☐ Readily available	☐ Up to date	X N/A
	Remarks_____			
10.	**Daily Access/Security Logs**	X Readily available	X Up to date	☐ N/A
	Remarks_____			

IV. O&M COSTS

1. **O&M Organization**
   ☐ State in-house ☐ Contractor for State
   X PRP in-house ☐ Contractor for PRP
   ☐ Other___Documents on O&M not submitted or required by PRP settlement.

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

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map X Gates secured ☐ N/A
   Remarks_____
   _____

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☐ N/A
   Remarks Full time security for site.

C. Institutional Controls

1. **Implementation and enforcement**
   Site conditions imply ICs not properly implemented ☐ Yes X No ☐ N/A
   Site conditions imply ICs not being fully enforced ☐ Yes X No ☐ N/A

   Type of monitoring (e.g., self-reporting, drive by) _____
   Frequency _____
   Responsible party/agency _____
   Contact _____ _____ _____ _____
   Name Title Date Phone no.

   Reporting is up-to-date X Yes ☐ No ☐ N/A
   Reports are verified by the lead agency ☐ Yes ☐ No X N/A

   Specific requirements in deed or decision documents have been met X Yes ☐ No ☐ N/A
   Violations have been reported ☐ Yes X No ☐ N/A
   Other problems or suggestions: ☐ Report attached
   _____
   _____
   _____
   _____

2. **Adequacy** X ICs are adequate ☐ ICs are inadequate ☐ N/A
   Remarks_____
   _____
   _____

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map X No vandalism evident
   Remarks_____
   _____

2. **Land use changes onsite** X N/A
   Remarks_____
   _____

3. **Land use changes offsite** X N/A
   Remarks_____
   _____

VI. GENERAL SITE CONDITIONS

A. Roads ☐ Applicable X N/A

1. **Roads damaged** ☐ Location shown on site map ☐ Roads adequate ☐ N/A
   Remarks_____

B. Other Site Conditions

Remarks

VII. LANDFILL COVERS ☐ Applicable X N/A

A. Landfill Surface

1. **Settlement** (Low spots) ☐ Location shown on site map ☐ Settlement not evident
   Areal 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
   Areal extent_____ Depth_____
   Remarks_____

4. **Holes** ☐ Location shown on site map ☐ Holes not evident
   Areal 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 (armored rock, concrete, etc.)** ☐ N/A
   Remarks_____

7. **Bulges** ☐ Location shown on site map ☐ Bulges not evident
   Areal extent_____ Height_____
   Remarks_____

8. **Wet Areas/Water Damage** ☐ Wet areas/water damage not evident
☐ Wet areas ☐ Location shown on site map Areal extent_____
☐ Ponding ☐ Location shown on site map Areal extent_____
☐ Seeps ☐ Location shown on site map Areal extent_____
☐ Soft subgrade ☐ Location shown on site map Areal extent_____
Remarks_____

9. **Slope Instability** ☐ Slides ☐ Location shown on site map ☐ No evidence of slope instability
Areal 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** ☐ Location shown on site map ☐ No evidence of settlement
Areal extent_____ Depth_____
Remarks_____

2. **Material Degradation** ☐ Location shown on site map ☐ No evidence of degradation
Material type_____ Areal extent_____
Remarks_____

3. **Erosion** ☐ Location shown on site map ☐ No evidence of erosion
Areal extent_____ Depth_____
Remarks_____

4. **Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting
Areal extent_____ Depth_____
Remarks_____

5. **Obstructions** Type_____ ☐ No obstructions
☐ Location shown on site map Areal 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 Areal 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 O&M ☐ N/A
Remarks_____
_____

2. **Gas Monitoring Probes**
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs O&M ☐ 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 O&M ☐ N/A
Remarks_____
_____

4. **Leachate Extraction Wells**
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs O&M ☐ 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 O&M
Remarks_____
_____

2. **Gas Collection Wells, Manifolds and Piping**
☐ Good condition ☐ Needs O&M
Remarks_____
_____

3. **Gas Monitoring Facilities** (e.g., gas monitoring of adjacent homes or buildings)
☐ Good condition ☐ Needs O&M ☐ 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** Areal extent_____ Depth_____ ☐ N/A
☐ Siltation not evident
Remarks_____
_____

2. **Erosion** Areal 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
   Areal extent_____ Depth_____
   Remarks_____
   _____

2. **Vegetative Growth** ☐ Location shown on site map ☐ N/A
   ☐ Vegetation does not impede flow
   Areal extent_____ Type_____
   Remarks_____
   _____

3. **Erosion** ☐ Location shown on site map ☐ Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____
   _____

4. **Discharge Structure** ☐ Functioning ☐ N/A
   Remarks_____
   _____

VIII. VERTICAL BARRIER WALLS ☐ Applicable X N/A

1. **Settlement** ☐ Location shown on site map ☐ Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____
   _____

2. **Performance Monitoring** Type of monitoring_____
   ☐ Performance not monitored
   Frequency_____ ☐ Evidence of breaching
   Head differential_____
   Remarks_____
   _____

IX. GROUNDWATER/SURFACE WATER REMEDIES	X Applicable	☐ N/A
A. Groundwater Extraction Wells, Pumps, and Pipelines	X Applicable	☐ N/A
1. **Pumps, Wellhead Plumbing, and Electrical** X Good condition X All required wells located ☐ Needs O&M ☐ N/A Remarks_____		
2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances** X Good condition ☐ Needs O&M 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	X Applicable	☐ N/A
1. **Collection Structures, Pumps, and Electrical** X Good condition ☐ Needs O&M Remarks_____		
2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances** X Good condition ☐ Needs O&M Remarks_____		

3. **Spare Parts and Equipment**
☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided
Remarks_____

C. Treatment System X Applicable ☐ N/A

1. **Treatment Train** (Check components that apply)
☐ Metals removal X Oil/water separation X Bioremediation
☐ Air stripping ☐ Carbon adsorbers
☐ Filters_____
☐ Additive (e.g., chelation agent, flocculent)_____
☐ Others_____
☐ Good condition ☐ Needs O&M
X Sampling ports properly marked and functional
X Sampling/maintenance log displayed and up to date
X Equipment properly identified
☐ Quantity of groundwater treated annually__5M gal_____
☐ Quantity of surface water treated annually_____
Remarks_____

2. **Electrical Enclosures and Panels** (properly rated and functional)
☐ N/A X Good condition ☐ Needs O&M
Remarks_____

3. **Tanks, Vaults, Storage Vessels**
☐ N/A X Good condition ☐ Proper secondary containment ☐ Needs O&M
Remarks_____

4. **Discharge Structure and Appurtenances**
X N/A ☐ Good condition ☐ Needs O&M
Remarks_____

5. **Treatment Building(s)**
☐ N/A X Good condition (esp. roof and doorways) ☐ Needs repair
☐ Chemicals and equipment properly stored
Remarks_____

6. **Monitoring Wells** (pump and treatment remedy)
X Properly secured/locked X Functioning X Routinely sampled X Good condition
X All required wells located ☐ Needs O&M ☐ N/A
Remarks_____

D. Monitored Natural Attenuation

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

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ All required wells located ☐ Needs O&M ☐ N/A
Remarks_____

X. OTHER REMEDIES

If there are remedies applied at the site which are 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 to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

Both the soil and ground water components of the remedy were functioning as designed. The LTUs are reducing contaminant levels in soil to the required levels and the ground water treatment system is removing product, reducing dissolved contaminant concentrations and providing plume capture.

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 activities are being implemented as required by the site O&M manual and are providing assurances that the site remedy will continue to be protective.

C.	**Early Indicators of Potential Remedy Failure**
	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. None
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. IP, with EPA approval, has modified operations of the ground water treatment system that will result in dollar savings.

APPENDIX B
FIGURES

Libby Ground Water Site
Third Five-Year Review

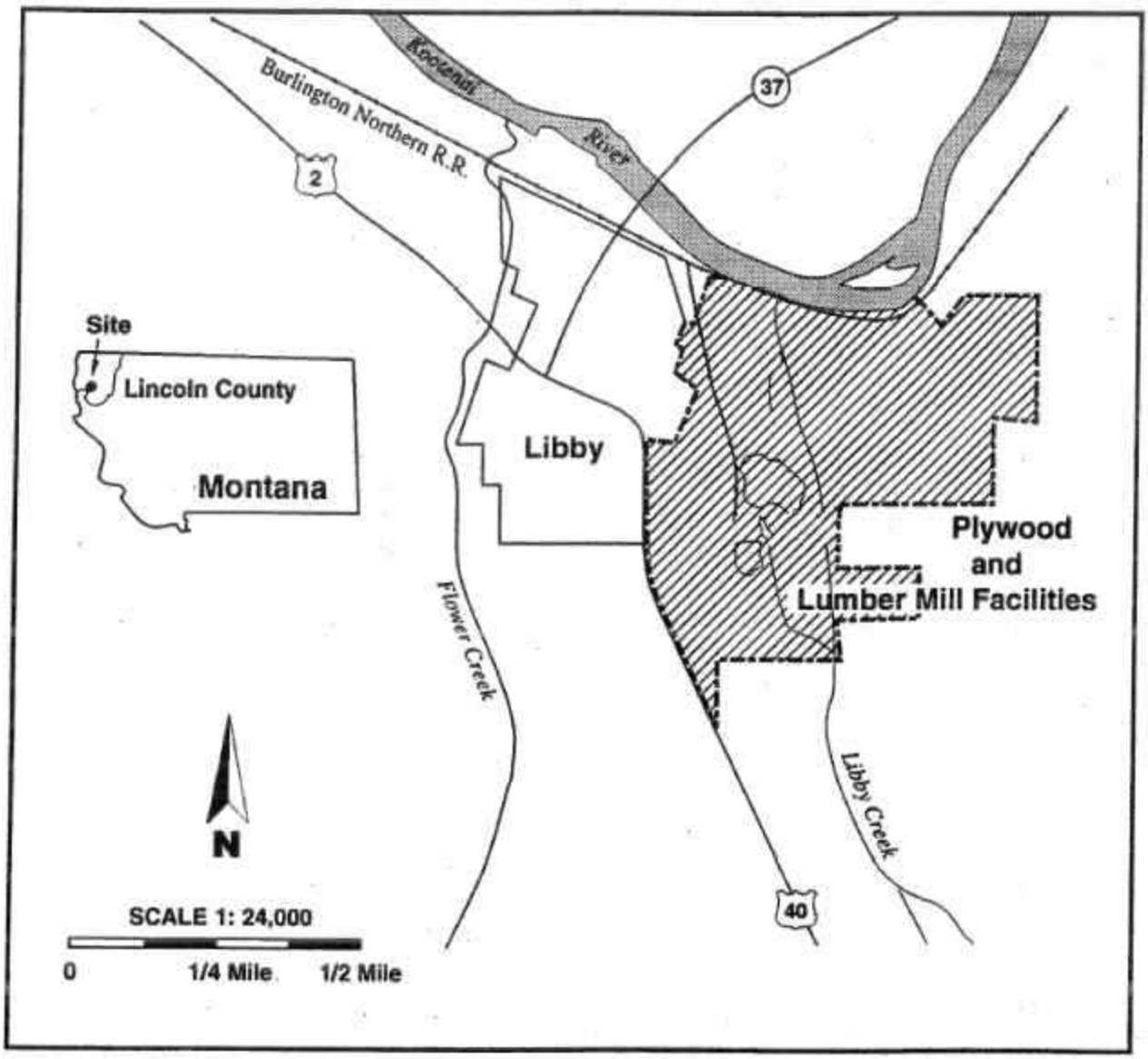
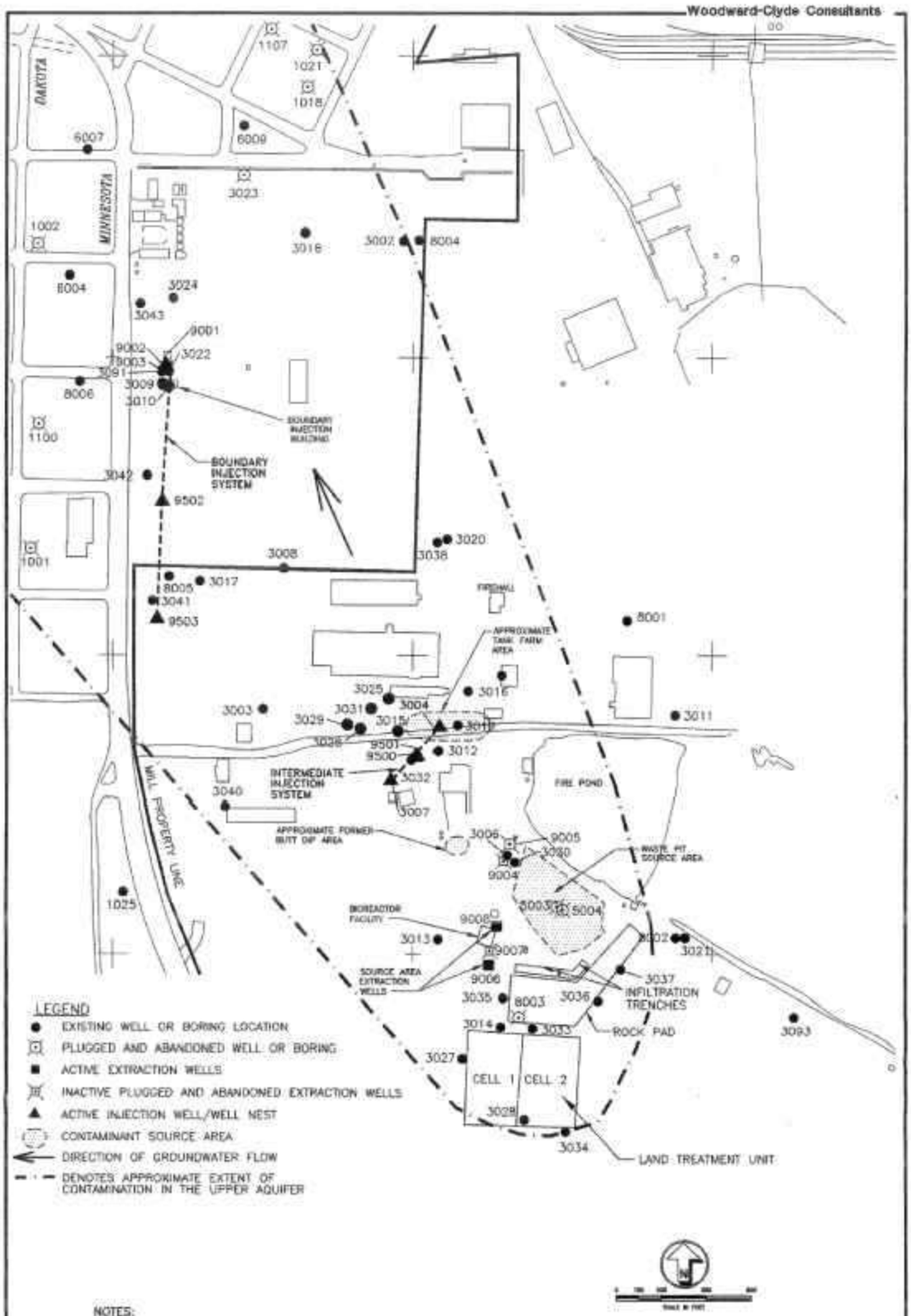


Figure 1

LIBBY GROUND WATER SITE
LIBBY, MONTANA

Woodward-Clyde Consultants



NOTES:

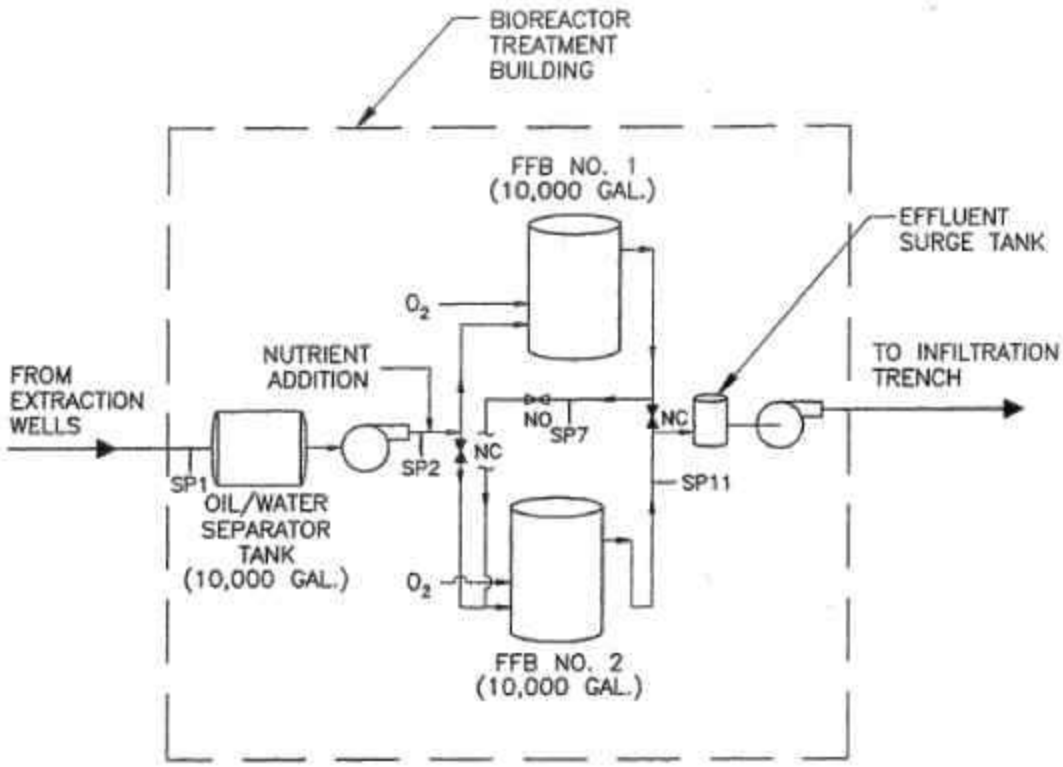
1. MANY OF THE 3000, 5000, 6000, 8000, AND 9000 SERIES WELLS ARE COMPLETED AS WELL NESTS. THEREFORE THERE MAY BE MORE THAN ONE WELL AT THE NOTED LOCATION.

Job No. :	22669E
Prepared by :	M.C.P.
Date :	10/3/97

LOCATION OF REMEDIAL SYSTEMS AT THE LIBBY SITE

11/20/97
REV. 1997-03

FIG. 2-2



LEGEND

FFB = FIXED FILM BOIREACTOR

NC = NORMALLY CLOSED VALVES

NO = NORMALLY OPEN VALVES

SP = SAMPLE PORT

Job No. : 22669E	BIOREACTOR TREATMENT SYSTEM SCHEMATIC
Prepared by : S.L.C.	
Date : 10/6/97	

2669004

FIG. 3-1

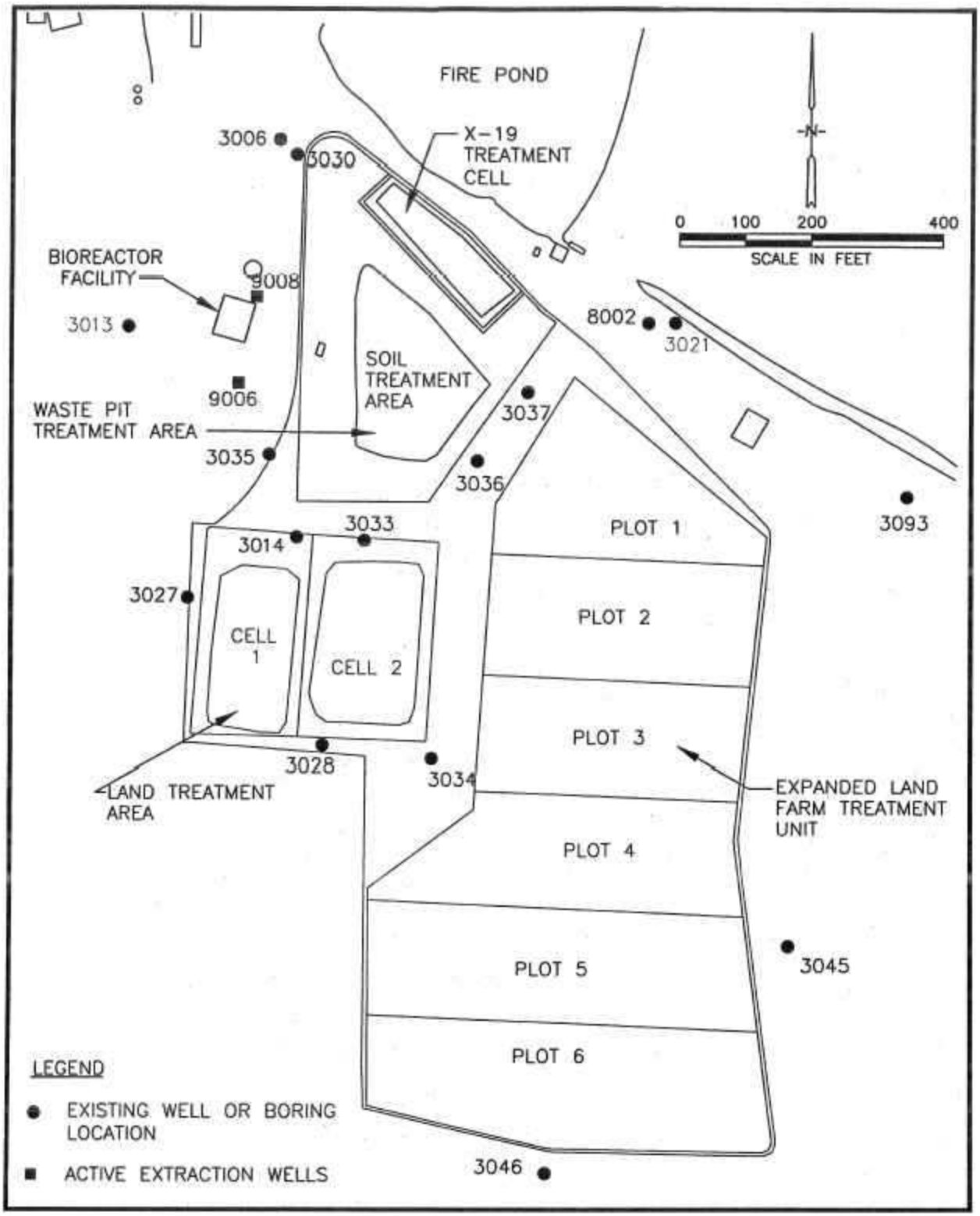


Figure 4
Land Treatment Units
Libby Ground Water Site

APPENDIX C
TABLES

Libby Ground Water Site
Third Five-Year Review

Table 5
LTU Soil Lift Log - 2003[1]

Lift #	Date Applied	Volume (yd^3)
Cell #1		
01	6/29/89	552
02	8/8/89	624
03	7/11/90	540
04	5/9/91	636
05	7/23/91	600
06	5/5/92	616
09	10/5/93	576
10	6/21/94	712
11	8/21/96	680
12	10/08/00	784
Cell #2		
01	7/25/91	750
02	6/24/92	704
03	4/20/93	720
07[2]	9/29/93	480
08[2]	9/30/93	720
04	10/4/93	720
05	6/27/94	792
06	5/10/95	848
07	7/20/95	832
08	7/16/96	824
09	8/26/97	832
10	10/08/00	880
Total Soil Volume Treated to Date		15,422

1 There were no new lifts added during 2003.

2 Lifts 07 and 08 were moved from Cell 1 to Cell 2 to bring the soil in the Cells to an approximate equal elevation.

Table 6
Bioreactor 2003 PCP Data

Sample Date	Influent PCP (SP2) (µg/L)	FFB#1 Effluent PCP (SP7) (µg/L)	FFB#2 Effluent PCP (SP11) (µg/L)	Percent Removal[1] (%)
1/3/03	5600	1100	648	88%
3/28/03	6180	0	3722	40%
5/12/03	5488	4778	1117	80%
5/31/03	5760	3000	0	100%
7/5/03	9040	2443	383	96%
8/1/03	8560	4726	0	100%
10/7/03	4560	12609	691	85%
11/6/03	6280	15217	391	94%
12/6/03	5760	8643	217	96%
AVERAGE	6359	5835	797	89%

[1]Percent removal based on weekly operational sample.

Table 7

Sample Date	Influent PAH (SP2) (µg/L)	FFB#1 Effluent PAH (SP7) (µg/L)	FFB#2 Effluent PAH (SP11) (µg/L)	Percent Removal[1] (%)
1/3/03	18000	6052	743	96%
3/28/03	15260	23761	0	100%
5/12/03	11184	14778	161	99%
5/31/03	18260	7961	0	100%
7/5/03	16740	24352	0	100%
8/1/03	41740	3187	0	100%
10/7/03	27040	107348	3035	89%
11/6/03	40360	97957	1265	97%
12/6/03	23480	9739	0	100%
AVERAGE	23563	32793	578	97%

Bioreactor 2003 PAH Data

[1]Percent removal based on weekly operational sample.

Table 8

Source Area Extraction and Treatment System

System Performance Summary
PAH Recovery/Degradation and Annual Volume Treated

Year	Oil Water Separators (lbs PAHs/day)		Bioreactors (lbs PAHs/day)	Gravity Sep. Gallons per Year[3] (Millions)	Coalescing Sep. Gallons per Year (Millions)
	Gravity	Coalescing			
1992	----[1]	----[2]	4.3	4.648	----[2]
1993	----[1]	----[2]	13	2.62	----[2]
1994	----[1]	----[2]	10.3	1.11	----[2]
1995	65	----[2]	2.2	3.47	----[2]
1996	118	----[2]	6.1	3.52	----[2]
1997	41	----[2]	7.7	5.67	----[2]
1998	55	----[2]	10.3	7.76	----[2]
1999	92.4	----[2]	13.6	4.71	----[2]
2000	83.8	53.9	4.9	4.07	7.73
2001	39.7	36.5	6.1	4.91	8.37
2002	3.0	10.9	0.56	4.87	6.49
2003	9.3	11.4	4.0	5.5	5.76
Ave.	56	28	6	4.07	7.09

1 – Gravitational Separator not working – improper pump configuration (centrifugal), Protec pump (progressive-cavity) installed in extraction wells in 1995.
2 – Coalescing Separator system installed in January of 2000.
3 – Flow through Gravitational Separator continues through Bioreactors.

Table 9
Coalescing Separator 2003 Performance

Date	Sample Point A		Sample Point B		Percent Removal	
	PAHs (µg/l)	PCP (µg/l)	PAHs (µg/l)	PCP (µg/l)	PAHs (%)	PCP (%)
1/3/03	40440	14440	39760	11840	2%	18%
1/31/03	69160	12400	84360	13400	-22%	-8%
2/28/03	63440	8860	45560	6620	28%	25%
3/28/03	122440	48400	54160	20960	56%	57%
5/12/03	49360	9900	84380	13260	-71%	-34%
5/31/03	179920	13760	108040	14280	40%	-4%
7/5/03	280400	26720	51800	16320	82%	39%
8/1/03	376920	29840	64960	17840	83%	40%
10/7/03	186000	15120	51840	9520	72%	37%
11/6/03	46360	3960	78560	8560	-69%	-116%
12/6/03	223880	24600	68800	14600	69%	41%
Average	148938	18909	66565	13382	55%	29%

APPENDIX E

Photographs

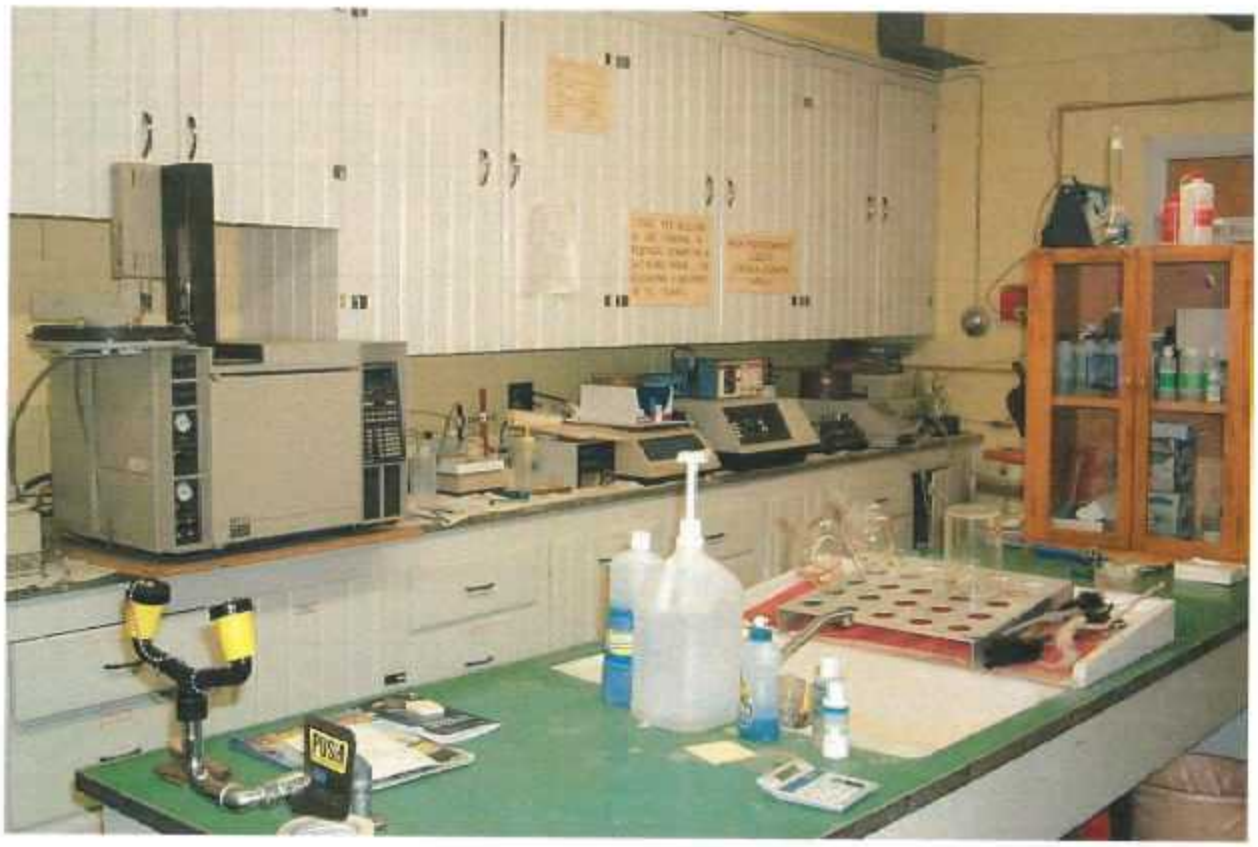
Libby Ground Water Site

Photograph 1
Libby Ground Water Site

Photograph 2
Libby Ground Water Site
Town of Libby

Photograph 3
Libby Ground Water Site
Land Treatment Units

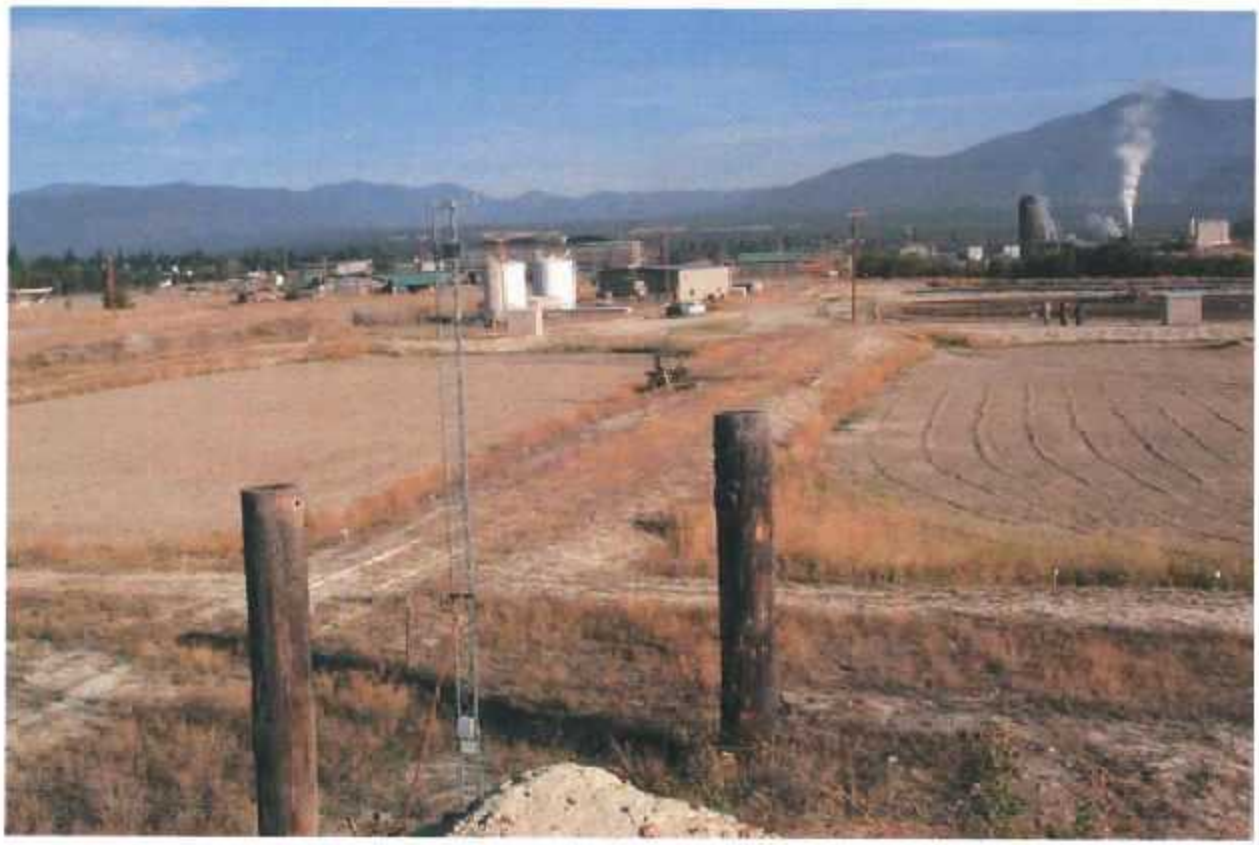
Photograph 4
Libby Ground Water Site
Land Treatment Units
and Bioreactor Facility



Photograph 5
Libby Ground Water Site
Champion's On Site Laboratory

Photograph 6
Libby Ground Water Site
Bioreactor Building

Photograph 7
Libby Ground Water Site
Inside Bioreactor Building



Photograph 8
Libby Ground Water Site
Old LTU and MET Station