

Innovative remedial action at a wood-treating Superfund site

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By concentrating on remedial action instead of more studies, this site became one of very few Superfund success stories.

Much has been stated by industry, consulting engineers, Congress, and even the U.S. Environmental Protection Agency (EPA) about the slow progress of hazardous waste site cleanup under the Superfund program. Most of the criticism appears to be warranted. The program seems more focused on litigation support than on the cleanup of sites. There are presently over 1100 sites included on the National Priorities List, and cleanup has been performed at only a few.

A great deal of energy and financial resources are being directed at hazardous waste site remediation; current estimates range from US\$ 3 billion/year to US\$ 5 billion/year, and total costs may eventually be US\$ 500 billion (1). Due to an emphasis on risk minimization and the overly rigorous process of evaluating, reviewing, commenting, revising, proposing, defending, and deciding on the solution, much of our resources are spent on activities which do not have material benefit toward site cleanup.

There are no easy answers to the problems facing the Superfund program. However, our experience in working on a Superfund site in Montana has given us some ideas that may have broader application.

This paper summarizes our experience and some successes at the Libby, Mont., Superfund site. We hope there is a common thread between our positive experiences and those at other successful Superfund sites. It is the sharing of such experience that may lead us to a better understanding of how to move the remediation process ahead more rapidly and find cost-effective solutions.

Site background

Champion International and its consultant Woodward-Clyde recently initiated implementation of a remedial action to address groundwater and soils contamination at the Libby, Mont., Superfund site (Fig. 1). This contamination problem was inherited by Champion when it

merged with another company in 1985 and acquired the lumber and plywood mill in Libby. The problem came from the operation, between 1946 and 1969, of a wood-treating facility at the site. The disposal of chemical wastes used in wood-treating processes by the original operators contaminated the soil around the plant and the groundwater below it. However, the problem was not discovered until 1979, when Libby residents living near the mill began drilling wells for lawn irrigation after the public utility increased its water rates (Fig. 2). Residents adjacent to the mill found creosote and pentachlorophenol constituent chemicals that discolored and caused odor in the water from their newly drilled wells. As a result of the residents' concerns and the EPA's initial investigations, the site was placed on the first National Priorities List under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in September of 1983.

The remedial investigation and feasibility study activities for this site were conducted between 1983 and 1988. A feasibility study for the first operable unit was completed in July of 1986 (2). This operable unit addressed public exposure to contaminated groundwater and resulted in the implementation of a buy-water plan to replace contaminated well water and a local ordinance requiring city permits for the drilling of new wells. To gain acceptance of this action, Champion worked closely with the local community and the EPA to tailor the buy-water plan and ordinance for public acceptance and to ensure the effectiveness of the program in protecting public health. The implementation of this operable unit in 1986 has resulted in virtual elimination of the immediate concern for public exposure to contaminated groundwater. This action was part of a larger plan to first address the most critical concerns associated with potential public exposure to contaminants and then to follow with soil and groundwater remediation at the site to remove the source of contamination.

In November of 1988, a feasibility study (3) for site remediation was completed and submitted to the EPA. The study recommended bioremediation technologies for cleanup of soils and groundwater. The EPA issued a Record of Decision (4) approving the proposed cleanup remedies in December of 1988.

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Description of remedial action

Remediation of the Libby site principally involved the cleanup of polynuclear aromatic hydrocarbons (PAH) and pentachlorophenol (PCP) in soils and groundwater. Pilot studies during the development of the feasibility study indicated that bioremediation of both the soils and groundwater could be effective in reducing contaminant concentrations to levels protective of human health and the environment. Although many alternatives were considered, the following actions were proposed and approved for implementation in the EPA Record of Decision:

- *In situ* bioremediation of groundwater, whereby oxygen and nutrients are injected into the subsurface to degrade contaminants in-place
- Land treatment of contaminated soils, whereby soils are placed in one-foot lifts, watered, fertilized, and tilled to biodegrade the contaminants
- Biological treatment of surficial contamination on rocks removed from soils
- Bioreactor treatment of the highest levels of contaminated groundwater in the vicinity of the contaminant source areas.

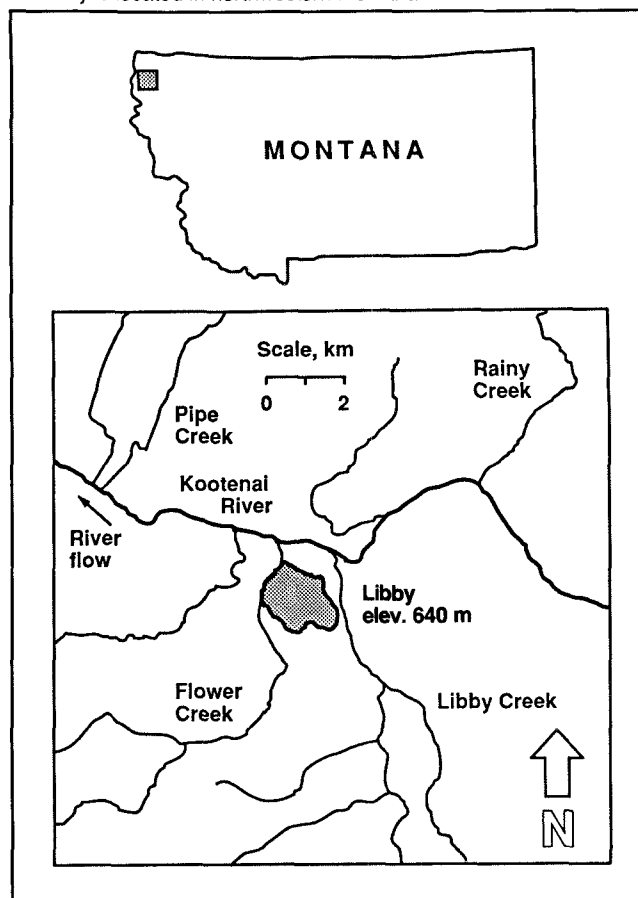
The design of these four major components of the remedial action began in the spring of 1989. However, final implementation of the remedial action depended upon a successful demonstration of "no migration" of contaminants during land treatment. While the EPA had approved the remedial action as proposed by Champion and Woodward-Clyde, the land disposal restrictions promulgated under the Resource Conservation and Recovery Act (RCRA) were considered applicable to the contaminated soil and would restrict the application of such soil to the land after Aug. 8, 1990. Thus, it was critical to initiate the proper demonstration studies to show no migration of contaminants from the designed land treatment unit. In addition, the volume of soil and rock had only been estimated during feasibility studies and was too uncertain to establish a cost-effective design for the land treatment unit.

In the spring of 1989, the companies proposed to the EPA the concept of design demonstrations whereby near-full-scale components of the major remedial activities would be initiated during the design process. In the case of remedial actions for soil and rock, this approach allowed the collection of critical information needed for establishing a cost-effective design. For instance, uncertainty over actual contaminated soil volumes would have necessitated the design of a treatment cell capable of holding the maximum possible volume of material. For groundwater remediation, this approach also allowed the implementation of phased, flexible designs that could be evaluated and modified prior to final design.

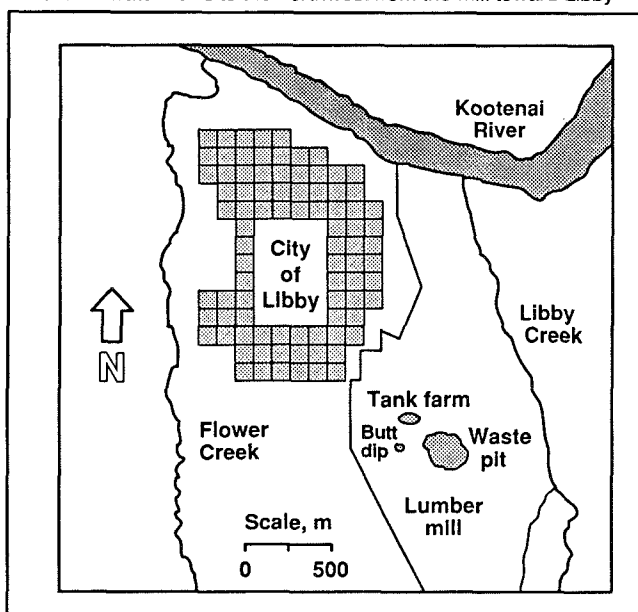
Soil and rock remediation

One of the first activities to be initiated in the spring of 1989 was excavation of all known contaminated soil so that treatment and disposal volumes could be accurately determined (Fig. 3). It was known from previous investigations that a considerable percentage of the soil

1. Libby is located in northwestern Montana



2. Groundwater flows to the northwest from the mill toward Libby



contained rock between one inch and several feet in diameter. However, an accurate estimate of the contaminated volume of soil and rock could not be obtained without excavation. Soils and rock were excavated from the three contaminant source locations: the waste-pit area,

3. Contaminated soils being excavated in the Fall of 1989



4. Soil excavation and de-rocking operations in the waste-pit area



5. Rocks are placed in liner for later treatment.



6. One-acre land treatment unit prior to placement of contaminated soil



where wastewater and sludges had been discharged during the operation of the pole-treating retort facility; the pole butt-dip tank area, where treating fluids had been spilled during operations; and the tank-farm storage area, where treating fluids were accidentally spilled into the surrounding bermed area (Fig. 2).

The plan for soils excavation was to start work in the waste-pit area and, concurrent with the excavations, to screen out the rocks. Screened rocks were placed on a low-permeability soil liner, which was designed and constructed earlier in 1989 to fit adjacent to the waste-pit area. The de-rocked soils were then temporarily stockpiled and, as available, placed back into the waste-pit excavation area (Fig. 4). When excavation was completed in the waste pit, operations moved to the tank-farm area and then to the butt-dip tank area.

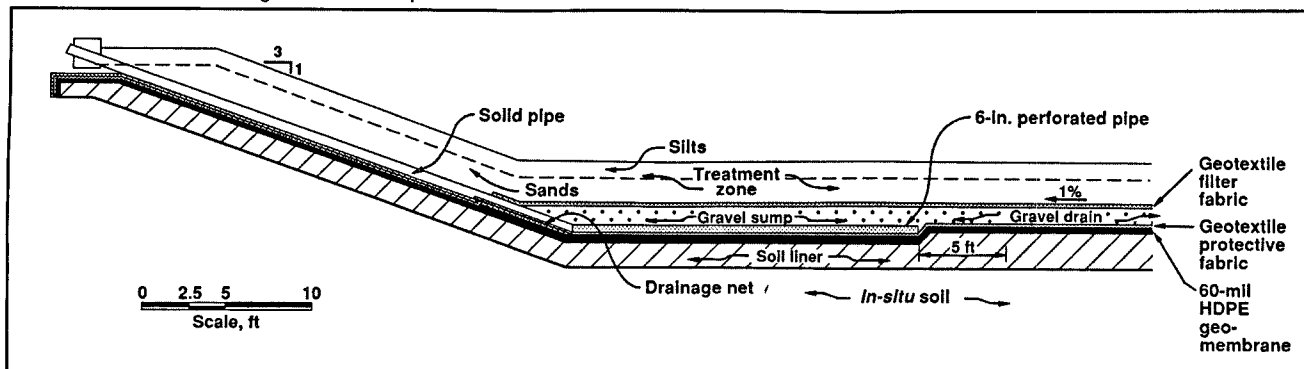
Excavation and de-rocking operations were conducted

through the summer and fall of 1989 and completed in the winter of 1990. A total of approximately 75,000 cubic yards of soil and rock were excavated. Approximately 40% (30,000 cubic yards) of the soil and rock materials were screened out as one-inch-plus rock and placed on the rock pad (Fig. 5).

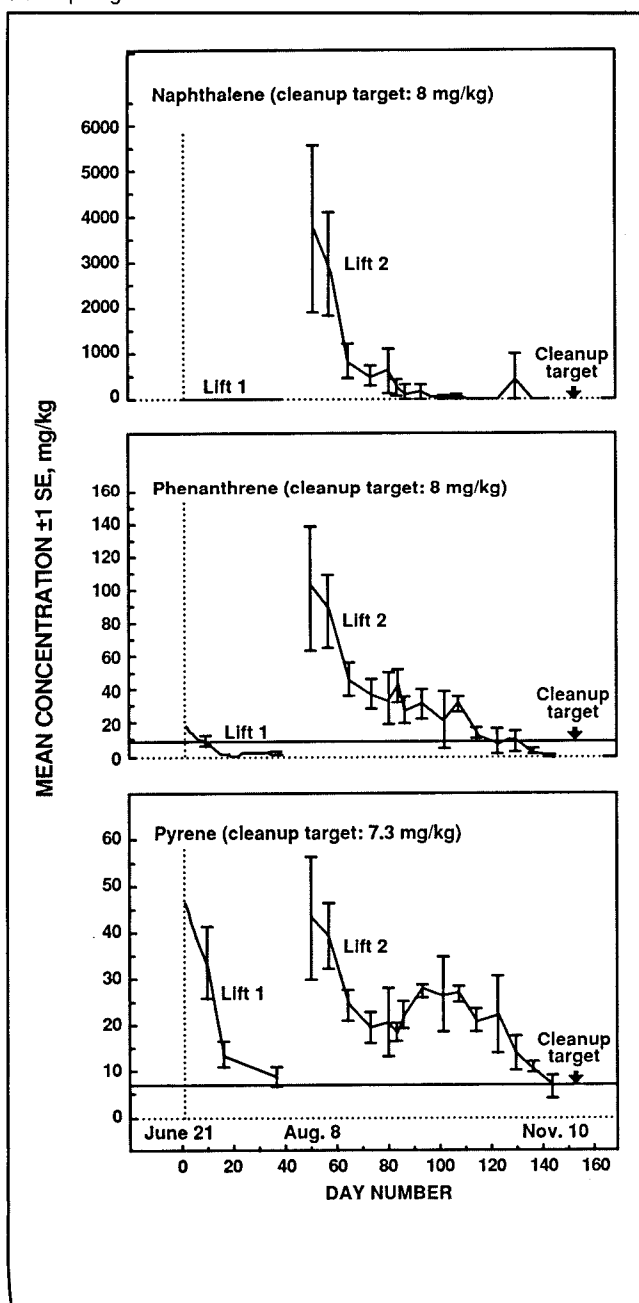
Separation of rock from soil allows for cost-effective treatment of both media, especially in reducing the volume of soil requiring land treatment. All 45,000 cubic yards of the de-rocked soil from the three source areas were placed into the waste-pit excavation where it is being pretreated by landfarming prior to final remediation in the designated land treatment unit. Pretreatment of soils provides for more rapid achievement of cleanup levels in the land treatment unit.

To provide the data necessary to demonstrate no migration of contaminants during land treatment, a one-

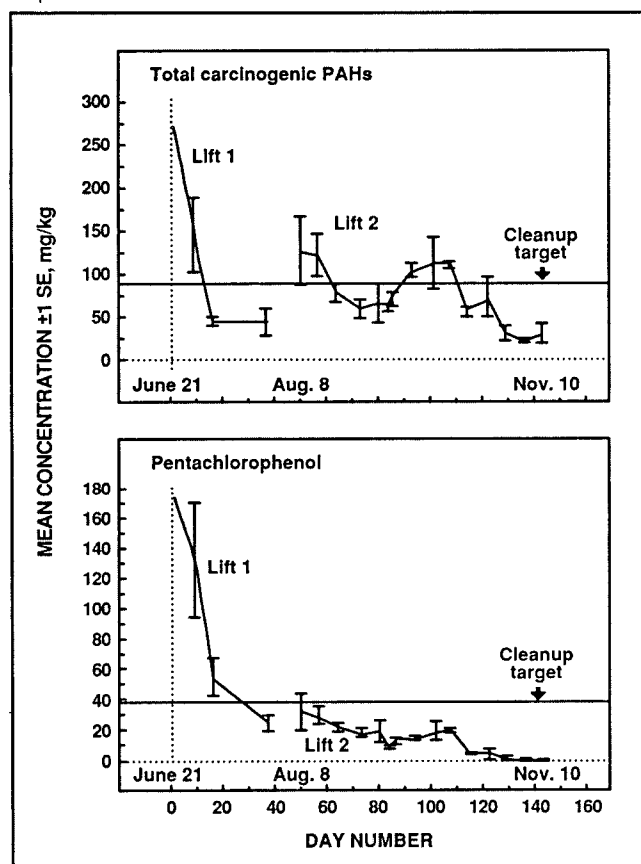
7. Land treatment unit design includes sump for collection of leachate.



8. PAH constituent compounds are biodegraded to meet required cleanup target.

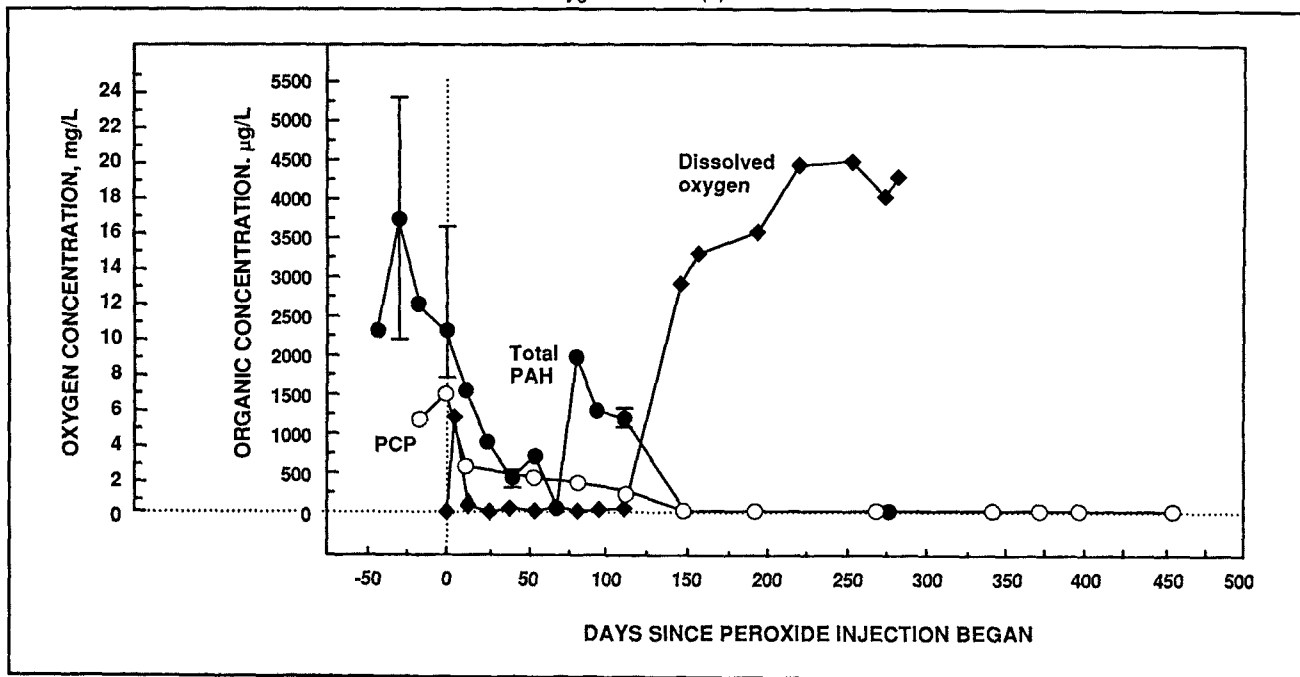


9. Carcinogenic PAH and PCP are biodegraded to meet cleanup requirements.



acre land treatment demonstration unit (LTDU) was designed and constructed in the spring of 1989 (Fig. 6). This unit was designed with a composite soil and synthetic liner to control migration of leachate and surface water runoff from the unit (Fig. 7). The first 12-in. lift of contaminated soil was placed on the LTDU in June 1989. Soil treatment consists of watering to control moisture to within prescribed limits, fertilization to add nutrients, and tilling of soil to aerate and provide oxygen to promote rapid growth of microorganisms that are already present in the soil. The contaminants provide the only other necessary ingredient: carbon. Microorganisms use the available oxygen and nutrients to metabolize the carbon-based chemical compounds. Based on operations to date, two to

10. *In situ* bioremediation of PAH and PCPs as dissolved oxygen increase (5)



three 12-in. soil lifts will be placed in the land treatment unit each year. All treatment of soil is expected to be completed by the year 2000. After treatment is completed, the unit will be closed by placement of a soil or synthetic liner cap, or both.

Operation of the land treatment demonstration during the summers of 1989 and 1990 proved the effectiveness of bioremediation in meeting cleanup levels for PAH compounds and PCP and provided the data necessary for preparation and submittal to the EPA of a petition to obtain a no-migration variance from land disposal restrictions (Figs. 8 and 9). EPA granted approval of the no-migration petition on Oct. 24, 1990; it is one of the few variances approved to date in the Superfund or RCRA programs.

Groundwater remediation

Pilot studies for the demonstration of *in situ* bioremediation of groundwater were initiated during feasibility study preparation in May of 1987. These pilot studies effectively demonstrated the feasibility of *in situ* bioremediation to degrade PAH and PCP contaminants to near or below instrument detection limits (Fig. 10). During the summer of 1989, a full-scale facility was designed and constructed involving the placement of two 4-in.-diameter wells for injection of up to 80 gal/min of hydrogen peroxide and nutrient-conditioned water. As in the pilot studies, a detailed monitoring program was implemented to evaluate the hydraulic and contaminant degradation effects of this injection program. The purpose of this full-scale demonstration was to provide data necessary for expansion of the system to effectively treat contaminants in the groundwater both on site and off site.

In the winter of 1989, construction of a full-scale bioreactor facility was initiated. The bioreactor is being used to treat the highest levels of contaminated groundwater that exist in the vicinity of the contaminant source area around the former waste pit. The bioreactor facility

includes an oil-water separator tank, nutrient addition tank, and two bioreactor vessels where oxygen is added to treat groundwater. After free product is removed, the influent groundwater stream is heated using steam from the mill to accelerate biological degradation. Bioreactor operations were initiated in February 1990 and operation at 10 gal/min has demonstrated the effectiveness of the facility in treating the PAH and PCP contaminants to levels below detection limits. The facility is expected to effectively treat a groundwater flow rate of up to 40 gal/min. The bioreactor effluent is discharged to an infiltration trench upgradient of the waste-pit area. Also, during warm weather months, bioreactor effluent is sprayed on the rock pile to treat the rock surfaces.

One of the primary purposes for the implementation of both surface and *in situ* bioremediation techniques was to take advantage of their relative strengths. In the case of *in situ* bioremediation, aqueous-phase PAH and PCP contaminants are readily degraded, and we believe that contaminants adsorbed to the aquifer soil matrix are also degraded. Thus, *in situ* bioremediation is most effective relative to other technologies because these contaminants are difficult to pump from the aquifer due to their low water solubility and high soil partitioning and because cleanup requirements are low (i.e., low parts per billion range). In the vicinity of the source area, where free product exists in the subsurface, the bioreactor presents an opportunity for collection of free product (i.e., nonaqueous-phase liquids) that can be separated from the groundwater stream in the bioreactor facility prior to treatment of aqueous-phase contamination. The bioreactor also provides treatment capacity for surface water and leachate collected from the land treatment unit after excess precipitation. Both *in situ* and bioreactor treatment processes are to be implemented in the source area and evaluated over several years to determine their relative effectiveness at this site.

Project accomplishments

As of December 1990, all of the facilities described have been constructed, and they are operating in an evaluation phase to provide information useful for completion of final designs. Costs to Champion during the past two years to implement these remedial actions have been approximately US\$ 3 million. Total construction and operational costs for final completion of the remedial action are estimated at around US\$ 10 million (present value). The costs to implement alternative remedial actions were estimated in the feasibility study to be from US\$ 14 million to more than US\$ 20 million.

To date, this project is considered to be a success by Champion, Woodward-Clyde, the people of Libby, the State of Montana, and the EPA. But what has made it successful? There are a number of key aspects of the Libby remedial action which, taken together, are a large part of the project's success.

This is the first Superfund site to rely on implementation of *in situ* bioremediation to clean up PAH- and PCP-contaminated groundwater. This technology was proven during a pilot study conducted at the site prior to completion of the feasibility study. The EPA considers *in situ* bioremediation to be an innovative technology, the use of which is encouraged by CERCLA. The success of the pilot study conducted prior to the Record of Decision provided federal and state regulators with the confidence needed to approve use of an innovative technology. Possibly more important, the pilot study focused the attention and efforts of all participants on remedial action. We believe that this emphasis on action, not just more study, and the successful demonstration of *in situ* bioremediation proved to be an important milestone for the project's overall success.

The remedial action design presents a comprehensive approach to soil and groundwater cleanup. Taken together, the components of the action described in this paper present an integrated and cost-effective design. The solution is built upon known biological treatment principles and has been demonstrated at the site to be effective in permanently destroying the contaminants of concern. The EPA has indicated its interest in the project's application of biotechnology by selecting the Libby site as one of several sites nationwide for performance evaluation in their bioremediation field initiative program.

The development and implementation of the remedial action demonstration design process has allowed full-scale facilities to be constructed and operated during the first two years after the Record of Decision, saving both time and money. For example, a one-acre land treatment cell was constructed rather than a smaller unit to initiate remediation and demonstrate our interest in action rather than further study. These demonstrations have provided the information needed to produce reliable and cost-effective remedial designs. As a result, our efforts and those of the EPA over the past two years have been focused more on getting an effective cleanup started than on debating regulatory refinements in the design. The development of the design demonstration approach has allowed us to focus on site remediation and on solving the real engineering problems.

To implement the most cost-effective remedial alternative for soils (i.e., land treatment), a variance from the

RCRA land disposal restrictions was necessary. The plan from the onset of remedial action was to design and operate a land treatment unit to obtain the evidence needed to successfully prepare and submit a petition to the EPA demonstrating no migration of contaminants from the unit. EPA's approval of the no-migration petition in October 1990 is significant in that it allows continued operation of the unit and that the approval is one of very few granted by the EPA to date.

These successful components of the Libby project were accomplished by the concerted, cooperative efforts of all parties involved in the project. Certainly the early action by Champion to implement a buy-water program to replace water from contaminated wells and the City's enactment of a well-permitting ordinance to prohibit new wells in the areas of contamination are evidence of this cooperative spirit. This cooperation may be the most unique aspect of the Libby project when compared to other Superfund projects. We believe these productive efforts were the result of Champion's early and constant recognition that the problem was theirs to solve, Woodward-Clyde's relentless pursuit of a cost-effective solution and implementation approach, the EPA's positive response to and continued support of an effective remedial action alternative, and the local community's overall understanding of what was important in getting the job done.

Many people have been involved and are responsible for the project's successes. These people include but are in no way limited to the Libby High School chemistry teacher who runs the on-site chemistry laboratory; the Mayor of Libby, who strongly supported the well-permitting ordinance; the Champion site manager, who directed the site remedial construction activities; the Woodward-Clyde scientist who promoted evaluation of *in situ* bioremediation; and the EPA project managers, whose support of the project has been critical to its success at many key stages.

The success of this and similar endeavors is due to the people involved and their concerted efforts as a team. We believe that the Superfund program as currently legislated and administered does not often promote teamwork; this may be the single greatest reason for its lack of success on many other projects. □

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Received for review Jan. 25, 1991.

Accepted March 8, 1991.

Presented at the TAPPI 1991 Environmental Conference.