Cost and Performance Summary Report
Land Treatment at the Bonneville Power Administration Ross Complex, Operable Unit A, Wood Pole Storage Area Vancouver, Washington

Summary Information [1, 2, 4, 6]

The Bonneville Power Administration (BPA) owns and operates a power distribution center in Vancouver, Washington, known as the Ross Complex. The site is an active facility that BPA has operated since 1939 to distribute hydroelectric power throughout the Pacific Northwest. The site also has been used for research and testing, maintenance construction operations, and storage and handling of hazardous and nonhazardous waste.

Operable Unit A (OU A) at the Ross complex consists of 21 contaminated areas, including the Wood Pole Storage Area. The Wood Pole Storage Area had been used to dry transmission line poles treated off site with pentachlorophenol (PCP) and creosote. The treated poles were transported to the site and placed on cross poles to dry. Contamination occurred when chemicals dripped from the poles onto the ground. A remedial investigation (RI) was performed at the Ross Complex in 1991. The RI identified high molecular weight polycyclic aromatic hydrocarbons (HPAHs) and PCP as the contaminants of concern. HPAHs consist of the sum of the eight carcinogenic polycyclic aromatic hydrocarbons that are found in creosote, specifically benz(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene, and benzo(g,h,i)perylene.

The RI identified concentrations ranging from nondetect (ND) to 150 milligrams per kilograms (mg/kg) for HPAHs and ND to 62 mg/kg for PCP. In hot spots at the site, where there were heavy deposits of wood preservatives, concentrations were reported as high as 5,000 mg/kg for HPAHs and 1,500 mg/kg for PCP. Following excavation of contaminated soil, average concentrations were identified as 35 and 33.9 mg/kg, respectively, in the excavated site soils.

Under a record of decision (ROD) signed May 6, 1993, land treatment was selected as the remedy for the Wood Pole Storage Area. BPA and the Electric Power Research Institute (EPRI) conducted remediation of the Wood Pole Storage Area from November 1994 through January 1996. EPRI agreed to split the cost of the remediation in exchange for use of the project as a research tool to evaluate the rates of degradation under various bioremediation enhancement techniques.

Approximately 2,300 cubic yards (yd^3) of material required treatment at this site. This amount consisted of 1,400 yd^3 from the pole storage areas and 900 yd^3 from the roadways. Of this material, 1,252 yd^3 were fines (material passing a 0.25-inch screen) and 1,048 yd^3 were gravel. Other materials at the site were identified in preliminary sampling as potentially requiring treatment. However results from additional sampling showed that treatment of these materials was not required.

CERCLIS ID Number:	WA1891406349
Lead:	Potentially Responsible Party

Timeline [3, 5]

May 6, 1993	ROD signed
November 1994 - January 1996	Land treatment conducted
September 23, 1996	Site deleted from National Priorities List (NPL)

Factors That Affected Cost or Performance of Treatment [6]

The table below lists the key matrix characteristics that affected the cost or performance of this technology and the values measured for each during site characterization.

Matrix Characteristics

Parameter	Value
Soil Classification:	Gravelly silt loam
Clay Content and/or Particle Size Distribution:	Gravel - 45.6%; Sand - 37%; Silt - 11%; Clay - 6.4%
Field Capacity:	25%
pH:	4.7

Treatment Technology Description [1, 2, 3, 4, 6]

The land treatment system implemented at the Wood Pole Storage Area consisted of a temporary treatment tent that housed four treatment beds. Contaminated soil first was passed through a 0.25-inch vibrating screen and then was placed in a treatment bed. According to EPRI, there were four series of treatment activities that each lasted an average of 84 days. Four treatment beds were used concurrently in each series of activities so that different treatment configurations could be tested. The four series of treatment activities, and the specific enhancements used in each of the beds, are shown below.

Treatment Series	Bed No.	Treatment Enhancement
1	1	UV (82 days)
1	2	Biodegradation (30 days), UV (30 days), and peroxide (22 days)
1	3	Biodegradation (30 days), peroxide (20 days), and biodegradation (32 days)
1	4	Biodegradation (82 days) - control bed
2	1	UV and ethanol (20%)
2	2	UV and ethanol (20%)
2	3	Biodegradation and ethanol (20%)
2	4	Biodegradation and ethanol (5%)
3	1	UV and ethanol (35%)
3	2	UV and ethanol (35%)
3	3	Biodegradation and ethanol (35%)
3	4	Biodegradation and ethanol (5%)
4	1	UV and ethanol (5%) - bed front 350 nm bulb; bed back 310 nm bulb
4	2	UV and ethanol (5%)
4	3	Biodegradation and ethanol (5%)
4	4	Biodegradation only

Treatment beds 1 and 2 were 27 ft by 17 ft and beds 3 and 4 were 34 ft by 17 ft. The volume of soil treated in each bed averaged 15 yd^3, with a range of 9.4 to 18.9 yd^3.

Biodegradation (land treatment) consisted of subterranean soil irrigation in each of the beds, with a nutrient solution added regularly. The nutrient solution was aerated by a pump that stirred the solution in a tank. Each of the four beds was sampled on an average of once every 11 days and analyzed using EPA Methods 8270 and 350, with sonification for extraction. Soils in each bed were mixed and replaced once every six weeks.

Initially, the nutrient solution was based on Alaska fish meal. However, test results showed that the microorganisms consumed the fish meal but did not degrade the contaminants of concern. A change was made to a new nutrient solution based on Miracle Grow™, a fertilizer containing nitrogen (31 percent by weight) and phosphorus (3 percent by weight) which EPRI typically had used for this technology. EPRI noted that results improved when a relatively large volume of nutrient solution was maintained in the soils and that the treatment efficiency was relatively consistent throughout the year, independent of ambient temperature and precipitation.

Listed below are the key operating parameters for each treatment series and the values measured for each.

Operating Parameters

Parameter	Value
Mixing Rate or Frequency:	Weekly during treatment series 1; beds changed once every 84 days
Depth of Lifts:	6 to 12 inches
Number of Lifts:	4
Moisture Content:	12%
pH:	4.7
Residence Time:	Average of 84 days
Temperature:	Ambient 47.2 +- 15.1 ºF; Maximum 97 ºF; Minimum 5 ºF
Rate of Degradation (for each treatment scenario):	0.20 mg/kg/day
Enhancements:	Hydrogen peroxide (35%), UV light at 350 nm and 310 nm, and combinations of UV, hydrogen peroxide, and ethanol

Performance Information [1, 2, 3, 4, 6]

According to EPA, there was concern that it would be difficult to achieve the primary target goals of 1 mg/kg for HPAH and 8 mg/kg for PCP identified in the ROD. A decision was made to include alternative goals for the site, should the primary goals not be achieved. Therefore, the ROD specified three different levels (tiers) of cleanup goals. Tier 1 goals were the primary target goals; soil treated to those levels could be placed on site without further controls. Soil treated to the less stringent Tier 2 or Tier 3 goals could be placed on site, but additional controls would be required, as described below.

- Tier 1: Enhanced land treatment - 1 mg/kg for HPAH; 8 mg/kg for PCP
- Tier 2: Enhanced land treatment with installation of gravel cap on soil and institutional controls - 23 mg/kg for HPAH; 126 mg/kg for PCP
- Tier 3: Enhanced land treatment, with installation of multilayered cap on soil and institutional controls, greater than 23 mg/kg HPAH, greater than 126 mg/kg PCP

Analytical results from the four treatment beds within each treatment series were combined by EPRI and reported as one value. No quantitative analytical data were provided to evaluate the performance of individual treatment enhancements. EPRI also analyzed soil in a storage pile and a "biopile". The storage pile was the original stockpile of material that had been excavated from the Pole Yard. The biopile was a portion of the stored material (approximately 3 ft thick) that had shallow basins cut into the top; waste nutrient media was pumped into these basins and allowed to soak into the pile. Analytical data on the concentrations of HPAH and PCP in treated soils (four treatment series, storage pile, and biopile) are shown below.

Treatment Series	HPAHs Initial (mg/kg)	HPAHs Final (mg/kg)	PCP Initial (mg/kg)	PCP Final (mg/kg)
1	15.43	15.08	25.17	20.70
2	34.48	21.83	41.75	18.05
3	16.14	11.71	20.39	18.15
4	10.03	6.76	13.59	6.80
Storage pile	37.16	10.03	35.76	13.59
Biopile	20.94	8.20	21.72	12.30

Soils from treatment series 1 were sampled again 120 days after the "final" samples were collected. In this additional sample, concentrations of HPAHs had decreased to 5.04 mg/kg and PCP to 9.64 mg/kg.

As these data illustrate, HPAH and PCP levels in soil were reduced by approximately 80 percent after treatment, and all soils met Tier 2 levels, at a minimum. After treatment, the average concentrations for the four treatment series ranged from 6.76 to 21.83 mg/kg for HPAHs and from 6.8 to 20.7 mg/kg for PCP. EPRI concluded that land treatment could not meet Tier 1 cleanup goals for all soil at the site.

Treated soils were placed in a storage cell located along the south fence line at the site and covered with approximately one foot of clean gravel. The area of the storage cell was less than one acre.

According to EPRI, the treatment enhancements achieved results that were similar to those for land treatment. Results of UV treatment demonstrated that only the top 1 to 10 millimeters (mm) of soil were affected by exposure to UV rays.

Performance Data Quality

Duplicate, split, and co-located samples were collected throughout the research effort. In addition, a random selection of samples were run using SW-846 Method 8270. EPRI reported that a comparison of the analytical results indicated that there was not a significant difference between the paired samples.

Cost Information [1, 2]

The ROD indicated that the remediation was projected to cost from $482,120 to $586,520 to achieve Tier 2 goals. In a summary of project costs, BPA reported the actual cost of the project to be $1,082,859 through November 1995 ($532,859 paid by BPA and $550,000 paid by EPRI). The total project cost consisted of costs for excavation, capital equipment, and operation and maintenance (O&M); no additional information was provided about the detailed components of the total project cost. In addition, no information was provided about the portion of the total project cost that was expended for testing and research. The total project cost reported may not be comprehensive because costs were reported only through November 1995, and the gravel cap was not completed until January 1996. The total cost of $1,082,859 corresponds to a unit cost of $470 per yd^3 for 2,300 yd^3 of soil treated.

Actual Project Costs

Cost Element	Cost ($ in 1995)
Excavation (of soil)	**Included in total**
Capital	**Included in total**
Operation & Maintenance	**Included in total**
Disposal of Residuals	**0**
Analytical (related to compliance monitoring, not technology performance)	**0**
Total Project Cost	**$1,082,859**

Observations and Lessons Learned [2, 3, 4, 5]

BPA completed remediation of the Wood Pole Storage Area in cooperation with EPRI. EPRI agreed to split the cost of the remediation in exchange for use of the project as a research tool to evaluate the rates of degradation under various bioremediation enhancement techniques. The PRP reported that overall project costs exceeded those projected in the ROD because additional activities were performed to support the research aspects of this application, including varying the treatment regimes to demonstrate variability in the rate of biodegradation.

For this application, the performance of land treatment was found to be comparable to land treatment enhanced with hydrogen peroxide, ethanol, or UV light or with combinations of these enhancements.

EPRI identified factors that could improve performance of UV-enhanced bioremediation for future applications, including: (1) using a higher-intensity UV light, (2) mixing soil more frequently, and (3) increasing the dissolution of contaminants to increase exposure to the UV rays. EPRI indicated that the Institute is considering obtaining a patent on the use of UV light as an enhancement to land treatment; no specific information was provided about the innovation to be submitted for a patent.

The vendor supporting EPRI initially used Alaska fish meal as the nutrient for this application because of the vendor's experience in the use of that approach to treat fuel spills. However, according to EPRI, the fish meal solution proved to be consumed quickly, and its use did not lead to sufficient biodegradation of the contaminants of concern.

Contact Information

For more information about this application, please contact:

EPA Remedial Project Manager:
Nancy Harney *
U.S. EPA Region 10
1200 6th Avenue
Seattle, WA 98101
Telephone: (206) 553-6635
E-mail: harney.nancy@epamail.epa.gov

PRP Representative:
Tony Morrell
BPA Ross Complex
5411 Northeast Highway 99
Vancouver, WA 98663
Telephone: (360) 418-2884

EPRI Representatives:
Dr. Benjamin J. Mason
ETHURA
Electric Power Research Institute
9671 Monument Drive
Grants Pass, OR 97526-8782
Telephone: (541) 471-1869
E-mail: ethbjm@cpros.com

Adda Quinn
Project Officer
Electric Power Research Institute
P.O. Box 10412
Palo Alto, CA 94303
Telephone: (650) 855-2478
E-mail: aquinn@epri.com

* Primary contact for this application

References

The following references were used in the preparation of this report.

1. EPA Region 10. 1993. *Final Record of Decision for Bonneville Power Administration, Ross Complex, Operable Unit A*. May 6.

2. Bonneville Power Administration. Not Dated. *Summary of Project Costs*.

3. EPA. 1997. Innovative Treatment Technologies Database, Annual Status Report (Eighth Edition). August.

4. Tetra Tech EM Inc. 1998. Record of Telephone Conversation Regarding Technology Performance of Land Treatment Application at BPA Ross Complex, OU A. Between Richard Weisman, Tetra Tech EM Inc., and Ben Mason, Electric Power Research Institute. June 9.

5. Tetra Tech EM Inc. 1998. Record of Telephone Conversation Regarding Availability of Data for BPA Ross Complex, OU A. Between Richard Weisman, Tetra Tech EM Inc., and Tony Morrell, Bonneville Power Administration. June 9.

6. Dr. Benjamin J. Mason, EPRI. 1998. Comments on Draft Cost and Performance Summary Report for Bonneville Power Administration. Provided by e-mail to Richard J. Weisman, Tetra Tech EM Inc. August 20.

Acknowledgments

This report was prepared for the U.S. Environmental Protection Agency's Office of Solid Waste and Emergency Response, Technology Innovation Office. Assistance was provided by Tetra Tech EM Inc. under EPA Contract No. 68-W5-0055.