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**STREAMLINED**  
**REMEDIATION SYSTEM EVALUATION (RSE-LITE)**  
**BENFIELD INDUSTRIES SUPERFUND SITE**  
**WAYNESVILLE, NORTH CAROLINA**

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Report of the Streamlined Remediation System Evaluation  
Conference Call Conducted August 21, 2007

Final Report  
September 2007

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## **NOTICE**

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Work described herein was performed by GeoTrans, Inc. (GeoTrans) for the U.S. Environmental Protection Agency (U.S. E.P.A.). Work conducted by GeoTrans, including preparation of this report, was performed under EPA contract 68-C-02-092 to Dynamac Corporation, Ada, Oklahoma. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

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## EXECUTIVE SUMMARY

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A Streamlined Remediation System Evaluation (SRSE or “RSE-lite”) involves a team of expert hydrogeologists and engineers, independent of the site, conducting a third-party evaluation of site operations. It is a broad evaluation that is based on the Remediation System Evaluation (RSE) process that was developed by the U.S. Army Corps of Engineers. Both the RSE and RSE-lite processes consider the goals of the remedy, site conceptual model, above-ground and subsurface performance, and site exit strategy. An RSE includes reviewing site documents, conducting a visit to the site for up to 1.5 days, and compiling a report that includes recommendations to improve the system. An RSE-lite reduces the resources and time committed for an evaluation by using a conference call with the site stakeholders in place of the site visit. Additional conference calls and/or email exchanges can be used for further communication. RSE or RSE-lite recommendations with cost and cost savings estimates are provided in the following four categories:

- improvements in remedy effectiveness
- reductions in operation and maintenance costs
- technical improvements
- gaining site closeout

The recommendations are intended to help the site team identify opportunities for improvements. In many cases, further analysis of a recommendation, beyond that provided in this report, may be needed prior to implementation of the recommendation. Note that the recommendations are based on an independent evaluation by the RSE-lite team, and represent the opinions of the RSE-lite team. These recommendations do not constitute requirements for future action, but rather are provided for the consideration of all site stakeholders.

The Benfield Industries site (Site) occupies a 6-acre parcel in Waynesville, North Carolina, that was once used as a bulk chemical mixing and packaging facility. A fire destroyed the facility in 1982. Site investigations around that time and later identified soil and ground water contamination. The Superfund Record of Decision (ROD) for the Site was signed in 1992 and amended in 1995. The specified soil remedy included excavation, ex-situ physical and biological treatment, and on-site backfill. For ground water, the specified remedy was hydraulic containment and plume remediation by ground water extraction, with discharge of untreated ground water to the Waynesville publicly owned treatment works (POTW). The soil remedy was executed between 1997 and 2000. The ground water extraction system began operating in April 2001. The extraction system was shut down on June 1, 2007 and has not been restarted. In 2004, a new owner redeveloped the Site into a manufacturing and warehouse facility.

The evaluation presented in this report concludes that the ground water extraction system should remain off because (1) there is only one well that currently has ground water concentrations above cleanup criteria, (2) there is little threat that ground water contamination will impact any receptors, and (3) the existing ground water extraction system was not very effective for hydraulic containment or aquifer restoration. It appears that monitored natural attenuation (MNA) would be a more appropriate remedy for the Site at this point. Keeping the system off will save approximately \$23,000 per year at the Site.

Recommendations are provided in four categories: effectiveness, cost reduction, technical improvement, and site closure. The recommendations for improving system effectiveness and for technical improvement are as follows:

- Document Potential Downgradient Receptor Locations and Adjust Monitoring Locations If Necessary
- Consider Sampling for Dioxins/Furans in Soil
- Document Rationale for Eliminating Metals Analysis
- Improve Sampling and Analysis Methods/Reports

Recommendations for cost reduction include the following:

- Do Not Restart the Extraction System
- Consider Monitored Natural Attenuation as the Ground Water Remedy

Finally, optional recommendations for gaining site closure include are given as potential alternatives to relying on MNA. They include:

- Assess Feasibility and Cost/Benefit of In-Situ Treatment of Remaining Soil Hot Spot(s)
- Consider Reassessing the Cleanup Criterion for 1,4 Dichlorobenzene

A table summarizing the recommendations, including estimated costs and/or savings associated with those recommendations, is presented in Section 7.0 of this report.

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## PREFACE

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This report was prepared as part of a project conducted by the United States Environmental Protection Agency Office of Superfund Remediation and Technology Innovation (U.S. EPA OSRTI) in support of the "Action Plan for Ground Water Remedy Optimization" (OSWER 9283.1-25, August 25, 2004). The objective of this project is to conduct Remediation System Evaluations (RSEs) at selected pump and treat (P&T) systems that are jointly funded by EPA and the associated State agency. The project contacts are as follows:

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## **1.0 INTRODUCTION**

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### **1.1 PURPOSE**

During fiscal years 2000, 2001, and 2002 Remediation System Evaluations (RSEs) were conducted at 24 Fund-lead pump and treat (P&T) sites (i.e., those sites with pump and treat systems funded and managed by Superfund and the States). Due to the opportunities for system optimization that arose from those RSEs, EPA OSRTI has incorporated RSEs into a larger post-construction complete strategy for Fund-lead remedies. To evaluate sites in a more timely and cost-effective manner, EPA OSRTI is also utilizing a Streamlined RSE (RSE-lite) process. An independent EPA contractor is conducting these RSEs and RSE-lites, and representatives from EPA OSRTI are participating as observers.

The Remediation System Evaluation (RSE) process was developed by the U.S. Army Corps of Engineers (USACE). The RSE-lite is based on the RSE process. Both RSEs and RSE-lites involve a team of expert hydrogeologists and engineers, independent of the site, conducting a third-party evaluation of site operations. They are broad evaluations that consider the goals of a remedy, site conceptual model, above-ground and subsurface performance, and site exit strategy. The RSE includes reviewing site documents, visiting the site for 1 to 1.5 days, and compiling a report that includes recommendations to improve the system. An RSE-lite reduces the resources and time committed for an evaluation by using a conference call with the site stakeholders in place of the site visit. Additional conference calls and/or email exchanges can be used for further communication. RSE and RSE-lite recommendations with cost and cost savings estimates are provided in the following four categories:

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The Benfield Industries Superfund Site (the Site) was selected by EPA OSRTI based on a recommendation from EPA Region 4. This report provides a brief background on the site and current operations, a summary of issues discussed during a conference call with the site team, and recommendations for changes and additional studies. The cost impacts of the recommendations are also discussed.

### **1.2 TEAM COMPOSITION**

The team conducting the RSE-lite consisted of the following individuals:

- Doug Sutton, Water Resources Engineer, GeoTrans, Inc.
- Greg Council, Civil and Environmental Engineer, GeoTrans, Inc.

The following individual participated as an observer:

- Chuck Sands from EPA OSRTI

### 1.3 DOCUMENTS REVIEWED

Author	Date	Title
B&V Waste Science and Technology	March 6, 1992	Remedial Investigation Report for the Benfield Industries Site, Hazelwood, North Carolina
GeoTesting Express	March 8, 1994	Results of Geotechnical Tests, Benfield Chemical, North Carolina, Final Report
CDM Federal Programs Corp.	November 18, 1994	Preliminary Design Report for the Benfield Industries Site, Hazelwood, North Carolina
CDM Federal Programs Corp., Norma L. Eichlin	May 10, 1995	Air Impact Analysis of Proposed Activities at the Benfield Industries Site in Hazelwood, North Carolina
CDM Federal Programs Corp., Paul Whittingham	March 14, 1997	Solicitation Number RFP-CN-7740-073-01, Amendment Number 01
CDM Federal Programs Corp.	March 11, 1999	Remedial Action Documents for Transfer of Work, Benfield Industries Site Remedial Action, Waynesville, North Carolina
Mountain Environmental Services, Inc., David Taylor	May 10, 2001	Superfund Preliminary Close-Out Report Benfield Industries Superfund Site, Waynesville, Haywood County, North Carolina
USEPA, Region 4	September 1, 2001	Superfund Preliminary Close-Out Report Benfield Industries Superfund Site, Waynesville, Haywood County, North Carolina
USEPA, Region 4	October 10, 2001	Results of Volatiles Sample Analysis 01-1111, Benfield Industries, Inc., Hazelwood, NC
Mountain Environmental Services, Inc.	October 17, 2001	Operation and Maintenance (O&M) Manual for the Groundwater Extraction System, Benfield Industries Site, 30 Riverbend street, Waynesville, North Carolina
USEPA, Region 4	May 1, 2002	Interim Remedial Action Report, Benfield Industries Superfund Site, Waynesville, Haywood County, North Carolina
Ground-Water Technical Support Center, David S. Burden	January 16, 2003	Technical Review Comments for the Benfield Superfund Site, Waynesville, NC (03-R04-002)
USACE, Nashville District	August 1, 2003	Superfund Five Year Review Report Benfield Industries Site, Waynesville, NC EPA ID: NC981026479
Mountain Environmental Services, Inc.	May 4, 2006	Groundwater Monitoring Report, December 2005, Benfield Industries Site, Waynesville, North Carolina
Mountain Environmental Services, Inc.	August 11, 2006	July 2006 Operating Report, Benfield Industries Superfund site, Waynesville, North Carolina
Mountain Environmental Services, Inc.	November 14, 2006	October 2006 Operating Report, Benfield Industries Superfund Site, Waynesville, North Carolina
Mountain Environmental Services, Inc.	February 23, 2007	Operating Report January 2 through February 2, 2007, Groundwater Extraction System, Benfield Industries Site, Waynesville, North Carolina

<b>Author</b>	<b>Date</b>	<b>Title</b>
Mountain Environmental Services, Inc.	May 2, 2007	Operating Report March 31 through May 1, 2007, Groundwater Extraction System, Benfield Industries Site, Waynesville, North Carolina
Mountain Environmental Services, Inc.	May 2, 2007	April 2007 Operating Report, Benfield Industries Superfund Site, Waynesville, North Carolina

## **1.4 PERSONS CONTACTED**

The following individuals associated with the site were present for the conference call:

- Jon Bornholm, Remedial Project Manager, EPA Region 4
- Nile Testerman, Project Manager, North Carolina Department of Environment and Natural Resources (NCDENR)
- Doug Williams, Mountain Environmental Services, Inc., Project Manager for Site O&M

## **1.5 SITE LOCATION, HISTORY, AND CHARACTERISTICS**

### **1.5.1 LOCATION**

The Benfield Site is located in the Hazelwood section of Waynesville, Haywood County, North Carolina (**Figure 1-1**). The site covers approximately 6 acres on the west side of Riverbend Street south of Hazelwood Avenue. The Site is bounded on the southwest by Browning Branch and on the northwest by the Southern Railway (**Figure 1-2**). The Site was redeveloped in 2004 and is now a manufacturing and warehouse facility for Haywood Vocational Opportunities, Inc. There are businesses and residences adjacent to or near the Site on all sides.

### **1.5.2 HISTORICAL PERSPECTIVE**

The Unagusta Furniture Company owned and occupied the Site from 1904 to 1961. During part of that time, a mattress manufacturer, Waynewood, Inc., also occupied the Site. Between 1961 and 1975, the Site was owned by Guardian Investment Company; little is known about activities at the Site during that time.

Benfield Industries, Inc. began operating at the site in 1976. Benfield Industries was a bulk chemical mixing and repackaging plant with several buildings and above-ground storage tanks. Various types of chemicals were handled at the plant, including wood-treating chemicals, solvents, and sealers. There were reports of chemical dumping at the Site. In 1981, after receiving citizen complaints, the North Carolina Department of Natural Resources and Community Development began investigating the Site. In 1982, a fire destroyed the plant.

Following additional investigations by the state after the fire, the Site was added to the National Priorities List (NPL) in 1989. The identified potentially responsible parties (PRPs) – Benfield Industries (then defunct) and its owner Mr. Thomas Benfield – were not capable of financing the CERCLA-required investigation and remediation activities. As a result, the Site became a Superfund-financed, EPA-lead Site. After completion of a Remedial Investigation (RI) and Feasibility Study (FS), the Record of Decision (ROD) was issued on July 31, 1992.

Due to identified soil and ground water contamination at the site and downgradient (north of) the site, the ROD specified the following remedial actions:

- Excavation of shallow on-site soils contaminated with polycyclic aromatic hydrocarbons (PAHs) and other semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs), and heavy metals.
- Ex-situ soil washing and biological treatment of the resulting slurry.
- Backfill of the excavation with the treated soils.
- On-site and off-site ground water extraction for contaminant plume capture.
- Treatment of extracted ground water via aeration, ion exchange, bioreactors, and granulated activated carbon (GAC) adsorption
- Reinfiltration of most extracted ground water after addition of nutrients to promote in-situ biodegradation; discharge of a portion of the extracted ground water to the Waynesville publicly owned treatment works (POTW) sewer.

Following a detailed Remedial Design (RD), the ROD was amended on June 15, 1995. The amendment removed the requirement for ground water treatment and reinfiltration, instead specifying that all of the extracted ground water could be discharged to the POTW under permit with the City of Waynesville. Also, based on treatability studies in the RD, the amendment also changed the ex-situ soil remedy to specify a combination of steam/pressure cleaning (for cobbles and large gravel) and solid-phase biological treatment using on-site land farming.

The soil remedy was implemented between December 1997 and October 2000. An on-site ground water extraction system consisting of two wells (EXT02 and EXT03, see **Figure 1-2**) was constructed in February-April 2001. A planned off-site ground water extraction well was not constructed because off-site ground water concentrations had decreased and met remediation goals.

In November 2001, EPA issued an Explanation of Significant Differences (ESD) to provide institutional control for the Site via a property deed restriction prohibiting digging in certain areas of the site. Subsequently, Haywood County sold the Site at auction to Haywood Vocational Opportunities, Inc. The Site was redeveloped in 2004 and now contains warehouse facilities that are, in part, used for providing vocation training. The facilities and associated parking lot cover the large majority of the site with impermeable cover. As part of the purchase agreement, Haywood Vocational Opportunities, Inc. signed a Prospective Purchaser Agreement (PPA) on March 19, 2002 with EPA. The PPA required HVO to place deed restrictions on this property, which they did.

The ground water extraction system operated between April 2001 and May 2007 with a significant interruption in 2004-2005. Extracted ground water was discharged untreated to the Waynesville POTW in accordance with a Site discharge permit. The system was shut down on June 1, 2007 due to relatively low ground water concentrations, lack of a significant threat to downgradient receptors, and close-out of EPA's existing contract mechanism.

### **1.5.3 POTENTIAL SOURCES**

The 1992 RI Report identified three areas of the site with elevated concentrations of constituents of concern (COCs) in soil:

- An area in the west-central portion of the site near a former packaging building and former creosote storage tanks (near MW03SH on **Figure 1-2**).
- An area in the northern portion of the site near a former warehouse (near MW05SH).

- An area in the south-central portion of the site where chemical dumping was reported to have occurred (near MW02SH).

Soil contamination in these areas, and in other areas of the site, was identified as a continuing source to ground water via leaching. The elevated concentrations were likely caused by chemical tank/pipe/fitting leaks prior to 1982, deliberate chemical dumping prior to 1982, chemical releases caused by the 1982 fire, and incomplete combustion byproducts of the 1982 fire. During excavation activities conducted as part of soil remediation, a previously unidentified underground storage tank was discovered in the northwestern corner of the Site. This tank had been breached and filled with ground water; based on ground water sample results it was determined that it had likely contained fuel.

Based on the RI and a site-specific human-health risk assessment, the ROD identified eight SVOCs as COCs in soil: seven PAHs (benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, indeno(1,2,3-cd)pyrene, naphthalene) and pentachlorophenol. These constituents are all associated with wood-treating chemicals. Ground water COCs in the ROD included the soil COCs plus one additional PAH (carbazole), six VOCs (benzene, chlorobenzene, 1,4-dichlorobenzene, 1,2-dichloropropane, vinyl chloride, and total xylenes), and eight heavy metals (antimony, barium, beryllium, chromium (total), lead, manganese, nickel, and vanadium). Surface water and sediment were not found to be impacted.

The risk assessment identified leaching from soil to ground water and exposure via future downgradient drinking-water wells as the principal chemical migration pathway of concern. It was also recognized that direct exposure to on-site surface soil could also be a concern if that soil contained benzo(a)pyrene (BAP) in excess of 300 µg/kg. Therefore, the 1995 ROD amendment specified that any excavated and biotreated soil containing more than 300 µg/kg BAP would be consolidated and covered with at least one foot of clean soil, and that those areas of the property would be institutionally controlled to prevent digging (effectuated in the 2001 ESD).

#### **1.5.4 HYDROGEOLOGIC SETTING**

The site is underlain, in order from shallow to deep, by alluvium, saprolite, and fractured bedrock. The uppermost alluvium layer is approximately 10-15 feet thick and exhibits high hydraulic conductivity. The underlying saprolite unit is approximately 25-30 feet thick and has a much lower hydraulic conductivity. The biotite gneiss bedrock unit exhibits moderate effective conductivity; the unit's hydraulic conductivity is primarily associated with fracture zones. Regionally, the fractured bedrock is tapped for drinking water supply wells.

Ground water flow at the Site is northward in the unconfined alluvium/saprolite/bedrock aquifer. The water table slopes with the land surface and is approximately 5 feet below ground surface, but this depth varies significantly over time. The average hydraulic gradient is approximately 0.017 based on December 2005 ground water elevations (**Figure 1-2**). Heads at the Site are typically slightly lower (0-1 ft) in the saprolite than in the alluvium, indicating that there is a small component of downward flow from alluvium to saprolite during system operation.

Based on slug tests results presented in the RI and RD, the average (geometric mean) hydraulic conductivity of the alluvium is approximately 7.8 ft/d and the average hydraulic conductivity of the saprolite is approximately 0.72 ft/d. Thus, for an assumed porosity of 30%, the ground water velocity is approximately 160 ft/yr in the alluvium and 15 ft/yr in the saprolite.

### **1.5.5 POTENTIAL RECEPTORS**

The 1992 risk assessment identified future residents on and north of the Site as potential ground water receptors, assuming that such residents may chose to install drinking water wells on their properties. EPA determined in the 1992 ROD that there were no drinking water wells near the site in the downgradient direction. Contaminated ground water does not appear to be discharging to surface water near the Site, and Browning Branch has shown no indication of impacts.

The soil remedial action and institutional control eliminated any potential soil receptor for site COCs. BAP is the only COC identified as potentially harmful for the soil exposure pathways. All soil with BAP above the risk-based standard was covered with at least one foot of clean soil, and the deed restriction prevents future digging in areas with buried BAP-impacted soil. At the time of the RSE, the area where soils containing BAP above the 300 µg/kg clean-up goal were covered by a cement truck driveway at the northern end of the facility

### **1.5.6 DESCRIPTION OF GROUND WATER PLUME**

At the time of the RD in 1994, a 250-foot wide ground water plume was identified that covered most of the Site and extended approximately 450 feet north of the Site. However, subsequent measurements of off-site concentrations were below cleanup criteria.

For the last site-wide sampling event in December 2006, the only well with concentrations exceeding cleanup criteria was well MW03SH. At that well, the concentrations of five PAHs and 1,4-dichlorobenzene exceeded remediation criteria. For several COCs, the cleanup level is below the reported analytical detection limit.

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## **2.0 SYSTEM DESCRIPTION**

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### **2.1 SYSTEM OVERVIEW**

The ground water remediation system at the Site consists of two on-site ground water extraction wells with direct discharge to the POTW sewer near the eastern property boundary (Riverbend Street). In the initial construction of the system, extracted ground water was piped to an effluent tank, and water was discharged to the sewer from the effluent tank. The tank was removed from the system in May 2004 during site redevelopment with the concurrence of the POTW.

The ground water extraction system began operation in April 2001. Operation was stopped by order of the EPA on June 1, 2007.

### **2.2 EXTRACTION SYSTEM**

The two on-site extraction wells – EXT02 and EXT03 – are shown in **Figure 1-2**. These 8-inch diameter stainless steel wells are 36 and 31.5 feet deep, respectively, with 10-foot screens in the saprolite. Based on initial pumping tests, it was determined that a maximum withdrawal rate of 4 gpm could be sustained at EXT02. The maximum withdrawal rate at EXT03 was determined to be 12 gpm. Dedicated 0.5 horsepower submersible pumps were installed in each well – a 5 gpm pump in EXT02 and a 10 gpm pump in EXT03.

The extraction system also consists of valves, flow meters, pressure gages, water-level sensors, sampling ports (spigots), and collection/discharge piping (above- and below-ground). The system originally included a 5,200 gallon effluent tank at the northeastern corner of the Site that was used to collect ground water pumped from both wells prior to POTW discharge. During redevelopment in 2004, the effluent tank was removed from the Site and the extraction well piping was routed directly to the POTW sewer beneath Riverbend Street near PZ05A.

The extraction system began operation on April 29, 2001 and was stopped on June 1, 2007. There was a lengthy disruption in operation beginning in September 2004 due to system flooding after two hurricanes passed through the area: EXT03 was out of service for three months and EXT02 was out of service for one year. Excluding this period of extended disruption, the average extraction rate for EXT02 was 3 gpm and the average extraction rate for EXT03 was 5 gpm. This was determined using the reported total gallons removed on April 30 and dividing by the number of days since operation began (excluding the out-of-service days beginning in September 2004). This averaging method accounts for pump cycling and occasional short-duration downtime for maintenance.

### **2.3 TREATMENT SYSTEM**

Extracted ground water is not treated prior to discharge to the POTW.

### **2.4 MONITORING PROGRAM**

Periodic ground water monitoring began at the Site in August 2001. Ground water monitoring is now conducted on an annual frequency. **Figure 1-2** shows the 17 wells that are included in the annual

monitoring program. At each sampling event, ground water samples are submitted for VOC and SVOC (extractable organics) analysis. Metals analysis was discontinued in 2003.

When it was operational, extraction well effluent was sampled during periodic ground water monitoring events. There was no additional routine sampling of extraction well effluent.

Ground water monitoring reports are generated to summarize periodic sampling results. These reports also include a depiction of the water table elevation at the site. Prior to extraction system shutdown, operating reports were prepared approximately monthly to summarize extraction amounts, electricity consumed, and any problems encountered for the extraction system.

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## **3.0 SYSTEM OBJECTIVES, PERFORMANCE, AND CLOSURE CRITERIA**

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### **3.1 CURRENT SYSTEM OBJECTIVES AND CLOSURE CRITERIA**

The ground water remedy and remedial objectives are specified in the 1992 ROD and 1995 ROD Amendment. The ROD specified that the ground water plume would be contained and remediated by a ground water pump-and-treat system. The ROD Amendment specified that untreated ground water could be discharged directly to the POTW.

The ROD established the following ground water cleanup criteria for Site COCs:

Contaminant	Cleanup Level ( $\mu\text{g/L}$ )	Basis
SVOCs		
Carcinogenic PAHs		
benzo(a)anthracene	0.1	proposed MCL (never finalized)
benzo(a)pyrene	0.2	proposed MCL (now final)
benzo(b)fluoranthene	0.2	proposed MCL (never finalized)
benzo(k)fluoranthene	0.2	proposed MCL (never finalized)
chrysene	0.2	proposed MCL (never finalized)
indeno(1,2,3-cd)pyrene	0.4	proposed MCL (never finalized)
Non-carcinogenic PAHs		
carbazole	5	risk assessment ( $10^{-6}$ cancer risk)
naphthalene	100	risk assessment ( $10^{-6}$ cancer risk)
Phenols		
pentachlorophenol	1	MCL
VOCs		
benzene	5	MCL
chlorobenzene	100	MCL
1,4-dichlorobenzene	1.8	NC GW criteria (now 1.4)
1,2-dichloropropane	0.56	NC GW criteria (now 0.51)
vinyl chloride	0.0015	NC GW criteria (now 0.015)
xylenes (total)	400	NC GW criteria (now 530)
Metals		
antimony	6	MCL
barium	1000	NC GW criteria (now 2000)
beryllium	4	MCL
chromium (total)	50	NC GW criteria
lead	15	action level
manganese	50	NC GW criteria
nickel	100	MCL (remanded)
vanadium	200	Risk

### **3.2 TREATMENT PLANT OPERATION STANDARDS**

Water is not treated prior to discharge to the POTW. The permit for discharging extracted water was not provided to the RSE-lite team. It is assumed that the common limit of 2.13 mg/L of total toxic organic compounds applied, and ground water contaminant concentrations are well below this limit.

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## 4.0 FINDINGS AND OBSERVATIONS

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### 4.1 FINDINGS

The observations provided below are not intended to imply a deficiency in the work of the system designers, system operators, or site managers but are offered as constructive suggestions in the best interest of the EPA and the public. These observations have the benefit of being formulated based upon operational data unavailable to the original designers. Furthermore, it is likely that site conditions and general knowledge of ground water remediation have changed over time.

### 4.2 SUBSURFACE PERFORMANCE AND RESPONSE

#### 4.2.1 WATER LEVELS

Contoured potentiometric surfaces are generated for periodic ground water monitoring reports. These surfaces are generated using data from approximately 15-20 on-site and off-site wells and piezometers.

The potentiometric surface generated for December 2005 (**Figure 1-2**) did not indicate a water-level response due to extraction at the two on-site extraction wells. Review of past water levels also suggests that a significant drawdown cone is not being created by the extraction wells.

#### 4.2.2 CAPTURE ZONES

Four different lines of evidence are typically appropriate for evaluating ground water capture:

- A comparison of ground water flowing through the contaminated area with the amount of ground water being extracted
- Evaluation of potentiometric surface maps
- Evaluation of trends in contaminant concentrations
- Ground water modeling with particle tracking

#### Darcy's Law Calculation

For the first line of evidence, it is helpful to relate capture zone width ( $w$ ) and flow rate ( $Q$ ) using Darcy's Law for given values of hydraulic conductivity ( $K$ ), hydraulic gradient ( $J$ ), and aquifer thickness ( $b$ ):

$$Q = wbKJ \quad \text{or} \quad w = \frac{Q}{bKJ}$$

While this method ignores the capture of infiltration near the well and ignores the effects of heterogeneity and surface-water interaction, it can be used as a good first-cut approximation of capture width for a given extraction rate (and vice-versa).

For this site, the two extraction wells were designed to withdraw water from both the relatively high-conductivity alluvium and the relatively low-conductivity saprolite. Because of this, it is helpful to replace the term  $bK$  in the above equations with the effective transmissivity ( $T$ ) of the alluvium/saprolite aquifer (it was assumed in the design the wells would not draw significant water from the bedrock):

$$bK = T = b_{alluvium} K_{alluvium} + b_{saprolite} K_{saprolite}$$

Based on information in the RI and RD documents, the saturated thickness of the alluvium is approximately 10 ft at the Site and the thickness of the saprolite is approximately 25 ft. Based on a geometric mean of slug test results, the hydraulic conductivities of these units are approximately 7.8 ft/d and 0.72 ft/d, respectively. Therefore, the approximate transmissivity is 96 ft<sup>2</sup>/d. This value is almost double the transmissivity of 50 ft<sup>2</sup>/d that was determined from an aquifer-test and reported in the RD report. That aquifer test involved pumping 1.3 gpm from MW05S.

Significantly higher transmissivity values were determined during testing of extraction wells EXT02 (4 gpm) and EXT03 (12 gpm) in 2001. For the aquifer test conducted at EXT02, estimates of  $T$  ranged from 125 ft<sup>2</sup>/d to 645 ft<sup>2</sup>/d; the geometric mean was 310 ft<sup>2</sup>/d. At EXT03, the  $T$  estimates ranged from 1,008 ft<sup>2</sup>/d to 8,471 ft<sup>2</sup>/d with a geometric mean of 2,700 ft<sup>2</sup>/d. These estimates, based on higher pumping rates, are probably more indicative of the effective aquifer transmissivity of the aquifer in those areas, as actually stressed by these extraction wells. Also, the higher estimates of  $T$  help explain the limited Site drawdown noted during extraction system operation. These estimated  $T$  values may include some contribution from the bedrock.

For EXT02, the average extraction rate was approximately 3 gpm (600 ft<sup>3</sup>/d), which leads to a calculated approximate capture width of 110 ft using the geometric mean transmissivity for that well's aquifer test. For EXT03, the average extraction rate was 5 gpm (1000 ft<sup>3</sup>/d), which leads to a capture width of approximately 20 ft given the high transmissivity estimate for that well. The total width from the two wells (130 ft) is about half the width of the plume as depicted in the RD.

#### Potentiometric Surface Maps

For the second line of evidence – potentiometric surface maps – to indicate capture, there must be a sufficient number of water levels measured near (but not in) the extraction well(s) to show how flow converges toward the extraction wells. At this Site, the measured/interpreted potentiometric surface does not show converging flow toward the extraction wells. Note that the contour lines of **Figure 1-2**, based on December 2005 data (when the extraction system was operational), do not show flow converging toward EXT02 and EXT03. In fact, flow appears to be diverging slightly toward the northwest and northeast in this depiction.

#### Concentration Trends

There are no wells within 300 ft of either extraction well in the downgradient direction (north). COC concentrations at wells further downgradient of the extraction wells were low or non-detect prior to system startup and have remained low. Also, any concentration decreases that have occurred might also be attributed to the soil source removal activities.

#### Numerical Modeling

Numerical modeling for the Site was last conducted during the RD and assumed a much larger ground water plume than currently exists. The model used relatively high estimates of hydraulic conductivity (needed for model calibration) and determined that three extraction wells pumping at a total rate of 58 gpm would be needed for plume capture. One of the extraction wells – the main well for the containment aspect of the remedy – was to be located off site to the north. The results of this 1994 model do not appear to be useful for evaluating capture of the two-well extraction system that was actually operated at the site.

### Summary of Evidence

In conclusion, based on the information available at the Site and all applicable lines of evidence, it is not likely that Site extraction system was an effective ground water plume capture system. The Darcy's Law calculation suggests that the actual withdrawal was sufficient to capture much, but not all, of the ground water plume as originally depicted. The potentiometric surface map does not show any converging-flow effect due to pumping.

The ground water contamination appears now to be limited to the area of MW03SH, as discussed in the next Section. It is not clear whether this area is within the capture zone of EXT03.

It is possible that some flow in the extraction wells was coming from the fractured bedrock system below the saprolite. Slug testing in the RD suggested that the fractured bedrock is more permeable than the saprolite.

Also, withdrawing water from the low-conductivity saprolite rather than the alluvium appears to be inefficient and perhaps detrimental to remedy performance. This conclusion is based on the fact that almost all ground water impacts have been in the shallow alluvium wells and this unit has a much higher hydraulic conductivity, making it a more effective transport pathway. Drawing from the saprolite potentially pulls contaminated water from the alluvium into the relatively clean saprolite. A similar conclusion is reached in the Site's 2003 Five-Year Review report.

#### **4.2.3 CONTAMINANT LEVELS**

For the last site-wide sampling event in December 2006, the only well with concentrations exceeding cleanup criteria was well MW03SH. At that well, the concentrations of five PAHs and 1,4-dichlorobenzene exceeded cleanup criteria. In prior sampling events (2001-2005), there have been detections of some COCs, generally near or below the cleanup criteria. For several COCs, the cleanup criterion is below the reported analytical detection limit.

During operation, concentrations in the extraction wells were also low – rarely exceeding the cleanup level for any COC. This indicates that (a) the ground water plume was not very extensive and/or (b) a significant fraction of the extracted ground water came from uncontaminated areas or depths.

#### Carcinogenic PAHs

There are six PAHs that have frequently been detected at MW03SH (BAP, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and chrysene, and indeno(1,2,3-cd)pyrene). All six were detected in December 2005 and all but indeno(1,2,3-cd)pyrene were detected in December 2006. These are all carcinogenic PAHs that are relatively immobile. They each have a low water solubility (water solubility less than detected concentration) and high affinity for adsorption (organic-carbon partition coefficient greater than 10,000 L/kg). The cleanup level for each of these constituents is below 1 µg/L; however, the reported quantitation limit for each of these constituents is 10 µg/L. Detections lower than the quantitation limit are reported with an estimated (J) flag. The method detection limit is not reported in the project files reviewed, but it is probably close to 1 µg/L for each of these constituents (still higher than the remediation goals).

The concentrations of these constituents at MW03SH had declined to below detection limits in late 2002; however, they have been consistently detected since December 2004. These PAHs have never been detected at the nearby downgradient extraction well EXT03. It is therefore determined that the PAH concentrations detected at this well do not represent a significant ground water plume, but are rather

likely due to a small amount of residual non-aqueous phase liquid (NAPL, probably creosote) very near the monitoring well that (a) was below the soil excavation in the area and (b) is trapped beneath the ground water table but remains relatively immobile. The increased concentrations of these PAHs starting in December 2004 was probably due to very high precipitation in September 2004 from two hurricanes passing through the area; this resulted in a significant water-table rise and may have caused NAPL that was previously in the vadose zone to become trapped in ground water.

Carcinogenic PAHs were also detected at MW07SH in 2001 and 2002, but were not detected after that. This well was removed in May 2004 during site redevelopment.

One carcinogenic PAH compound – benzo(a)anthracene – was detected in well MW05SH in February 2002 (estimated value of 1 µg/L). There have been no other carcinogenic PAH detections since August 2001.

There have never been off-site detections of carcinogenic PAHs.

#### Non-Carcinogenic PAHs

Naphthalene and carbazole are relatively mobile non-carcinogenic PAHs. Naphthalene was detected above the cleanup level (100 µg/L) at MW03SH in February 2002, but has been detected at lower concentrations (approximately 20 µg/L) in the last few years. Since 2000, carbazole has been detected at concentrations near its cleanup level (5 µg/L) at MW03SH, MW05SH, MW05S, and MW07SH. At MW03SH, the last detection above the cleanup level was in July 2005 (estimated concentration equal to the cleanup level). At the other three wells, the last detection of carbazole above the cleanup level was in 2002.

Carbazole and naphthalene have also been detected in the two on-site extraction wells, EXT02 and EXT03, but at concentrations equal to or less than the cleanup levels. The reported quantitation limit for carbazole is twice the remediation level.

#### 1,4-Dichlorobenzene

Of the remaining organic COCs, only 1,4-dichlorobenzene (also known as para-dichlorobenzene or p-DCB) has been detected at concentrations exceeding cleanup criteria since 2001. This VOC, commonly used as an insecticide and deodorizer, is mobile in ground water and has been detected at many Site wells. Since 2000, measured concentrations exceeded the cleanup level (1.8 µg/L) for at least one sample at each of the following wells: MW03SH, MW05SH, MW05S, MW07SH, MW07S, EXT02, and EXT03.

There were also detections of p-DCB in off-site wells MW08SH and MW08S in 2005, but at concentrations below the cleanup level.

The federal maximum contaminant level (MCL) for p-DCB in drinking water is 75 µg/L, which is much greater than the Site cleanup level. The ground water concentrations of p-DCB at and near the Site have all been much lower than the MCL.

#### Metals

When low-flow sampling methodologies were started at the Site 2002, metals concentrations dropped significantly. Only manganese and lead have since been detected above or near the ground water cleanup criteria, and the detected concentrations may be in the range of background levels. Metals analysis was stopped in 2003 but will be included as part of the sampling effort for the Five-Year Review process.

### Summary

Only well MW03SH presently exhibits concentrations above cleanup levels. There is likely a small source of carcinogenic PAHs near that well, such as residual NAPL near the water table. Of mobile COCs, p-DCB is the most often detected in ground water.

## **4.3 COMPONENT PERFORMANCE**

### **4.3.1 EXTRACTION WELLS**

The extraction system has been shut down. Prior to shut-down, the two extraction wells operated at an average flow rate significantly less than design. Operating reports from 2006-2007 indicated two failures that required pump maintenance or replacement.

### **4.3.2 PIPING, FITTINGS, AND VALVES**

The pipes, fittings, and valves appeared to generally perform as expected. The operating reports noted some maintenance that was required to fix leaking pipes. The Five Year Review report also noted that freeze protection had to be added to the pipes during the first year of operation as a result of pipe failures.

### **4.3.3 SYSTEM CONTROLS**

Based on operating reports it appears that system controls required more adjustments and maintenance during operations than one would expect. Flow-meter failures caused the system to be fully shut down for three months in 2004 and caused EXT02 to remain off line for one year. There was also some loss of flow data due to battery back-up failure. The control panel was not always properly indicating the operational time of EXT03 correctly. In 2005, adjustments were made to the automatic controls to allow for longer duration of pumping for EXT03.

## **4.4 COMPONENTS OR PROCESSES THAT ACCOUNT FOR MAJORITY OF ANNUAL COSTS**

Assuming an operating extraction system, annual O&M costs are approximately \$28,100 per year as summarized below.

<b>Item Description</b>	<b>Estimated Annual Cost</b>
Labor: oversight and project management	\$4,800
Labor: system operation and effluent sampling	\$7,200
Labor: ground water sampling and reporting	\$5,100
Analytical: ground water sample analysis	\$0
Analytical: effluent sample analysis	\$0
Utilities: electricity	\$1,400
Utilities: POTW discharge fees	\$7,600
Utilities: Non-electric utilities and other services	\$0
Non-utility consumables, disposal, and small repairs	\$2000
Treatment plant analytical costs	\$0
Total Estimated Annual Cost	\$28,100

#### **4.4.1 UTILITIES AND DISPOSAL FEES**

Utilities costs are divided between electricity and POTW disposal. The average electricity cost from the utility is estimated by the site contractor as \$118 per month. POTW disposal costs are \$1.69 per 1,000 gallons (rate effective July 1, 2007), or approximately \$630 per month for an estimated monthly discharge of 370,000 gallons.

Non-electric utilities and other services include potable water, garbage collection, cell phones, telephone, portable toilets, cable internet service, and shipping. Operation of this system required no such utilities or services.

#### **4.4.2 NON-UTILITY CONSUMABLES AND REPAIRS**

No other consumables were required for the operation of the extraction and discharge system. However, there were occasional maintenance issues that required repairs. It is estimated that such repairs cost an average of \$2,000 per year.

#### **4.4.3 LABOR**

There are three general areas involving labor: contractor project management, operator labor, and ground water sampling. The contractor project management is estimated to be approximately \$4,800 per year based on the contractor's estimate of 4 hours per month. The operator labor is approximately \$7,200 per year based on the contractor's estimate of 10 hours per month (including reporting). The ground water sampling labor (and associated equipment) is approximately \$5,100 per year according to the contractor.

#### **4.4.4 CHEMICAL ANALYSIS**

Chemical analysis for the ground water sampling is provided by the Region 4 Laboratory at no cost to the Site budget.

### **4.5 RECURRING PROBLEMS OR ISSUES**

The extraction system is now shut down. Prior to shut down there were no known significant recurring problems or issues that prevented operation of the system.

### **4.6 REGULATORY COMPLIANCE**

No violations of the discharge standards were reported to the RSE-lite team during this evaluation.

### **4.7 TREATMENT PROCESS EXCURSIONS AND UPSETS, ACCIDENTAL CONTAMINANT/REAGENT RELEASES**

The extraction system was shut down due to flooding in September 2004. EXT03 remained out of service for three months and EXT02 remained out of service for one year. Other, shorter-duration outages were caused by pump failure or maintenance downtime. However, based on recent ground water concentrations, it is highly unlikely that any of these events resulted in a significant contaminant release.

## **4.8 SAFETY RECORD**

The site team reports no health and safety reportable incidents for the extraction and discharge system. Site procedures had been altered to avoid potential confined-space entry concerns at EXT02 during maintenance visits. The site team had no unaddressed concerns for potential safety issues.

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## **5.0 EFFECTIVENESS OF THE SYSTEM TO PROTECT HUMAN HEALTH AND THE ENVIRONMENT**

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### **5.1 GROUND WATER**

As of the latest sampling event in 2006, ground water concentrations are below cleanup criteria for all COCs at all wells except MW03SH. At that well, several carcinogenic PAHs have been consistently detected above cleanup levels since December 2004. These constituents are relatively immobile and are therefore not likely to impact any potential downgradient receptor.

Also at MW03SH, p-DCB has been consistently detected at concentrations above the cleanup level. There have also been detections of p-DCB at or near the cleanup level at other wells in recent years. However, the cleanup level for p-DCB is much lower than the federal MCL for drinking water and the measured concentrations of p-DCB are well below the MCL.

Additionally, the extraction system that operated between April 2001 and May 2007 was not optimally placed for ground water remediation, especially given that it removed considerable water from the clean saprolite rather than focusing extraction on the contaminated ground water in the alluvium. Furthermore, due to lower than intended flow rates, it may not have been providing complete capture of contaminated ground water in the alluvium.

Based on these facts, the RSE-lite team believes that the extraction system should not be restarted and that no active ground water remediation is necessary to be protective of human health.

### **5.2 SURFACE WATER AND SEDIMENTS**

The RI/RD reports indicated that surface water and surface-water sediments were not significantly impacted. Sampling conducted as part of the Five Year Review report supported this assessment. As a result, the RSE-lite team believes that there are no human health or environment concerns with respect to surface water.

### **5.3 AIR**

Air does not appear to be an important exposure route for contaminants at the Site.

### **5.4 SOIL**

The soil remediation, institutional control, and recent redevelopment of the Site have eliminated all human health and environment concerns with respect to Site COCs in soil.

### **5.5 WETLANDS AND WETLAND SEDIMENTS**

No wetlands are threatened by ground water contamination at this Site.

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## **6.0 RECOMMENDATIONS**

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Cost estimates provided herein have levels of certainty comparable to those done for CERCLA Feasibility Studies (-30%/+50%), and these cost estimates have been prepared in a manner consistent with EPA 540-R-00-002, *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*, July, 2000.

### **6.1 RECOMMENDATIONS TO IMPROVE EFFECTIVENESS IN PROTECTING HUMAN HEALTH AND THE ENVIRONMENT**

#### **6.1.1 DOCUMENT POTENTIAL DOWNGRADIENT RECEPTOR LOCATIONS AND ADJUST MONITORING LOCATIONS IF NECESSARY**

The Site risk assessment identified future residents who drill private ground water supply wells as the most important potential receptors of Site COCs. The ROD apparently noted that there were no downgradient wells at that time, and public water supply is available in the area. Given that there is no effective ground water containment aspect to the remedy currently in place (or planned), a new search for current downgradient receptors, including private wells, is warranted. Also, availability of public water does not guarantee that private wells will not be installed downgradient of the Site in the future. The receptor search should also identify the most likely location(s) of future downgradient supply wells unless there is a legal prohibition against installing supply wells in the area.

Also, the most likely locations for discharge from ground water to surface water should be identified based on potentiometric surfaces and topography. In particular, the elevation of Browning Branch near the Site should be documented and compared with water-table elevations and water-table surface slopes on-Site and northwest of the Site.

The likely potential receptor locations should be mapped along with the current Site monitoring network. If necessary, the monitoring network should be changed to ensure that there are wells upgradient of any likely receptor locations that would detect contamination originating from the Site.

Completion of a receptor identification study would cost an estimated \$10,000. Additional costs could be required for installation or relocation of monitoring wells based on the study.

#### **6.1.2 CONSIDER SAMPLING FOR DIOXINS/FURANS IN SOIL**

In reviewing Site documents, it does not appear that there was ever any analysis of dioxins/furans in surface soil. Given other Site COCs, particularly pentachlorophenol, it can be reasonably expected that dioxins/furans were present at the Site. It is recommended that a few soil samples be taken at the Site and potentially at background (upwind) locations in hopes of eliminating dioxins/furans as a potential risk concern. Dioxins/furans are not very mobile in ground water; the main concern would be direct soil exposure.

The sampling required for this (approximately 15 samples) could be conducted in two or three days. Analytical costs for dioxins/furans are high (approximately \$800 per sample). If the EPA lab does this analysis at no cost to the project, the total costs incurred by the Site would be limited. The total labor cost for this recommendation, including reporting, is estimated to be \$7,000.

### **6.1.3 DOCUMENT RATIONALE FOR ELIMINATING METALS ANALYSIS**

When low-flow sampling methodologies were started at the Site 2002, metals concentrations dropped significantly. Only manganese and lead have since been detected above or near the ground water cleanup criteria, and the detected concentrations may be in the range of background levels. Metals analysis was stopped in 2003, but the complete rationale was not evident in documents reviewed by the RSE-lite team. Such documentation is warranted in the Site file. The cost would be negligible unless a background study is required; such a study would cost perhaps \$5,000 and would involve sampling ground water at several locations upgradient of the site and comparing the results to metals concentrations detected in on-site monitoring wells.

## **6.2 RECOMMENDATIONS TO REDUCE COSTS**

### **6.2.1 DO NOT RESTART THE EXTRACTION SYSTEM**

As stated in Section 4, the extraction system was probably not an effective capture system for ground water contamination. Furthermore, there does not appear to be a significant ground water contaminant plume remaining at the Site. The implementation of the soil remedy followed by natural degradation is likely the largest contributing factor to the observed decrease in ground water concentrations. The most significant remaining contamination at MW03SH is not likely be captured by the extraction system if it is restarted.

By keeping the system off, EPA will realize a cost savings of approximately \$23,000 per year, which is based on eliminating all annual activities except for ground water monitoring and reporting.

### **6.2.2 CONSIDER MONITORED NATURAL ATTENUATION AS THE GROUND WATER REMEDY**

Since there is relatively little remaining ground water contamination at the Site, and since off-site impacts are unlikely, a monitored natural attenuation (MNA) remedy is appropriate and should be seriously considered. Monitoring would likely continue at site wells, including the inactive extraction wells over a two to five year period to demonstrate a stable or decreasing ground water plume. Parameters would likely include the constituents of concern plus natural attenuation parameters such as dissolved oxygen and other potential terminal electron receptors. Development of a monitoring program for MNA could likely be developed for under \$10,000. One concern regarding the MNA approach is persisting concentrations at MW03SH. If a continuing source of ground water contamination is present, the plume may persist for many years in the absence of focused remediation. The cost savings for this recommendation are included in those reported for Recommendation 6.2.1.

## **6.3 RECOMMENDATIONS FOR TECHNICAL IMPROVEMENT**

### **6.3.1 IMPROVE SAMPLING AND ANALYSIS METHODS/REPORTS**

Several Site COCs have reported detection limits that are above the cleanup levels. These limits are apparently nominal quantitation limits for SW-846 methods 8260B and 8270C. Attempts should be made periodically to search for and use analytical methods with the lower detection limits, ideally below the cleanup levels. Lower PAH detection limits may be achieved by using SW-846 method 8310.

Also, for the methods that are used, the method detection limit (MDL) for each analyte should be included in analytical reports and the monitoring-report summaries should list the MDL with all non-

detects. This will make reporting of non-detects more meaningful. The name of the method used and full QA/validation reports should be included in ground water monitoring reports.

Finally, if and when samples are lost (e.g., bottle breaking in transport), a new sample should be obtained as quickly as possible.

No change in cost to the project is expected for this recommendation.

## **6.4 CONSIDERATIONS FOR GAINING SITE CLOSE OUT**

### **6.4.1 ASSESS FEASIBILITY AND COST/BENEFIT OF IN-SITU TREATMENT OF REMAINING SOIL HOT SPOT(S)**

While MNA may be the most appropriate and least expensive approach to remediation at the Site going forward, it will not likely result in elimination of the remaining hot-spot of contamination near MW03SH in the near future. If the EPA and NCDENR desire to eliminate all concentrations above cleanup criteria in the next few years, then some additional remediation near this well will likely be required.

One technology worth considering is in-situ chemical oxidation using ozone, Fenton's Reagent (hydrogen peroxide) or activated persulfate. This technology has proven to be effective on PAHs and VOCs. If implemented, the extent of PAH contamination near MW03SH should first be determined by installing temporary wells for sampling and potential oxidant injection.

If this approach is taken, it is assumed that 10 Geoprobe borings and temporary wells would be installed near MW03SH for delineation and possible oxidant delivery. Contaminated cuttings could then be used to conduct a bench test of chemical oxidation, which would cost approximately \$25,000. Such a bench test would result in a detailed proposal for appropriate oxidant delivery at field scale and would provide a field application cost. Assuming a target area that is approximately 5,000 square feet, the cost of a field-scale application would be approximately \$250,000. Including delineation costs, the total estimated cost for a chemical oxidation remedy is approximately \$300,000. Depending on the extent and depth of the contamination, the amount of dewatering necessary to reach the contamination, the amount of contaminated material to be disposed of, and the classification of that material (hazardous or non-hazardous), excavation may also be a reasonable remedial approach.

### **6.4.2 CONSIDER REASSESSING THE CLEANUP CRITERION FOR 1,4-DICHLOROBENZENE**

Another potential obstacle to complete site close-out (and NPL de-listing) may be p-DCB, which is present at low levels at multiple wells on- and off-Site. The cleanup level for this contaminant is 1.4 µg/L, which is over 40 times lower than the federal MCL for drinking water. Depending on the path chosen by EPA and NCDENR, it may be prudent to reassess the site-specific cleanup level for this COC. The estimated cost for such a reassessment, which involves assessing risk, is \$10,000.

## **6.5 SUGGESTED APPROACH TO IMPLEMENTATION**

The next sampling event, in December 2007, will be critical because it will be the first post-shutdown sampling event. Care should be taken to get all samples analyzed with the best methods and with proper QA and full reporting. It is suggested that on-site and background soil samples also be collected for dioxin/furan analysis at that time.

While resumption of the extraction system is not recommended in any case, EPA and NCDENR should settle on a long-term strategy for this site, especially whether or not to aggressively treat the remaining hot spot at MW03SH or simply move to a long-term MNA strategy. Either method would be protective of human health and the environment. The MNA strategy would probably be most cost-effective, even with an annual cost of \$10,000 for monitoring, reporting, and management (conservatively higher than the current \$5,000 for these items), the net present value of continued monitoring for 30 years would be substantially less than addressing a 5,000 square foot hot spot. The aggressive strategy, however, has the potential benefit of faster Site close-out. If the aggressive path is chosen, then a reassessment of the p-DCB cleanup level may also be required. A reasonable approach is to delineate the hot spot area near MW03SH and then evaluate the costs for remediation based on the extent of the contamination against the competing costs for following a long-term MNA strategy.

The other recommendations involve documentation that may be needed to provide closure on any potential concerns about protectiveness. Implementing these recommendations – (1) to assess receptors and monitoring locations and (2) to document the rationale for removing metals from the analytes list – should not be costly exercises.

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## **7.0 SUMMARY**

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The observations and recommendations contained in this report are not intended to imply a deficiency in the work of either the system designers or operators, but are offered as constructive suggestions in the best interest of the EPA and the public. These recommendations have the benefit of being formulated based upon operational data unavailable to the original designers.

Recommendations are provided in all four categories: effectiveness, cost reduction, technical improvement, and gaining site closure. The main recommendation – to leave the extraction system off – will result in a cost savings of approximately \$23,000 per year, but would likely require a one-time cost of \$10,000 to define the MNA approach at the Site.

Reductions for greater effectiveness and technical improvement include:

- Document potential (future) receptors and adjust monitoring locations if necessary
- Sample for dioxins/furans in soil
- Document rationale for deleting metals (particularly lead and manganese) from the periodic sampling analyte list
- Improve data reporting, especially reporting of method detection limits

These improvements would cost less than \$20,000 total.

If MNA is not acceptable as the Site ground water remedy, a more aggressive approach may be taken at the remaining hot-spot near MW03SH. Chemical oxidation is one technology that could be considered, which would cost perhaps \$300,000 (cost highly uncertain without knowing the extent of contamination and bench testing). Also, it may be necessary to reevaluate the cleanup level for p-DCB. Such an evaluation may cost \$10,000.

The current frequency of sampling – once a year – appears to be appropriate for this site.

Table 7-1 summarizes the costs and cost savings associated with each recommendation. Capital costs, the change in annual costs, and the change in life-cycle costs are presented for each recommendation.

**Table 7-1. Cost Summary Table**

Recommendation	Reason	Additional Capital Costs (\$)	Estimated Change in Annual Costs (\$/yr)	Estimated Change in Life-cycle Costs (\$) *	Estimated Change in Life-cycle Costs (\$) **
6.1.1 Document Potential Downgradient Receptor Locations and Adjust Monitoring Locations If Necessary	Effectiveness	\$10,000	\$0	\$10,000	\$10,000
6.1.2 Consider Sampling for Dioxins/Furans in Soil	Effectiveness	\$7,000	\$0	\$7,000	\$7,000
6.1.3 Document Rationale for Eliminating Metals Analysis	Effectiveness	negligible	\$0	negligible	negligible
6.2.1 Do Not Restart the Extraction System	Cost Reduction	\$0	(\$23,000)	(\$690,000)	(\$371,000)
6.2.2 Consider Monitored Natural Attenuation as the Ground Water Remedy	Cost Reduction	\$10,000	\$0	\$10,000	\$10,000
6.3.1 Improve Sampling and Analysis Methods/Reports	Technical Improvement	negligible	\$0	negligible	negligible
6.4.1 Assess Feasibility and Cost/Benefit of In-Situ Treatment of Remaining Soil Hot Spot(s)	Site Closeout	Optional – see text	\$0	Optional – see text	Optional – see text
6.4.2 Consider Reassessing the Cleanup Criterion for 1,4-Dichlorobenzene	Site Closeout	Optional – see text	\$0	Optional – see text	Optional – see text

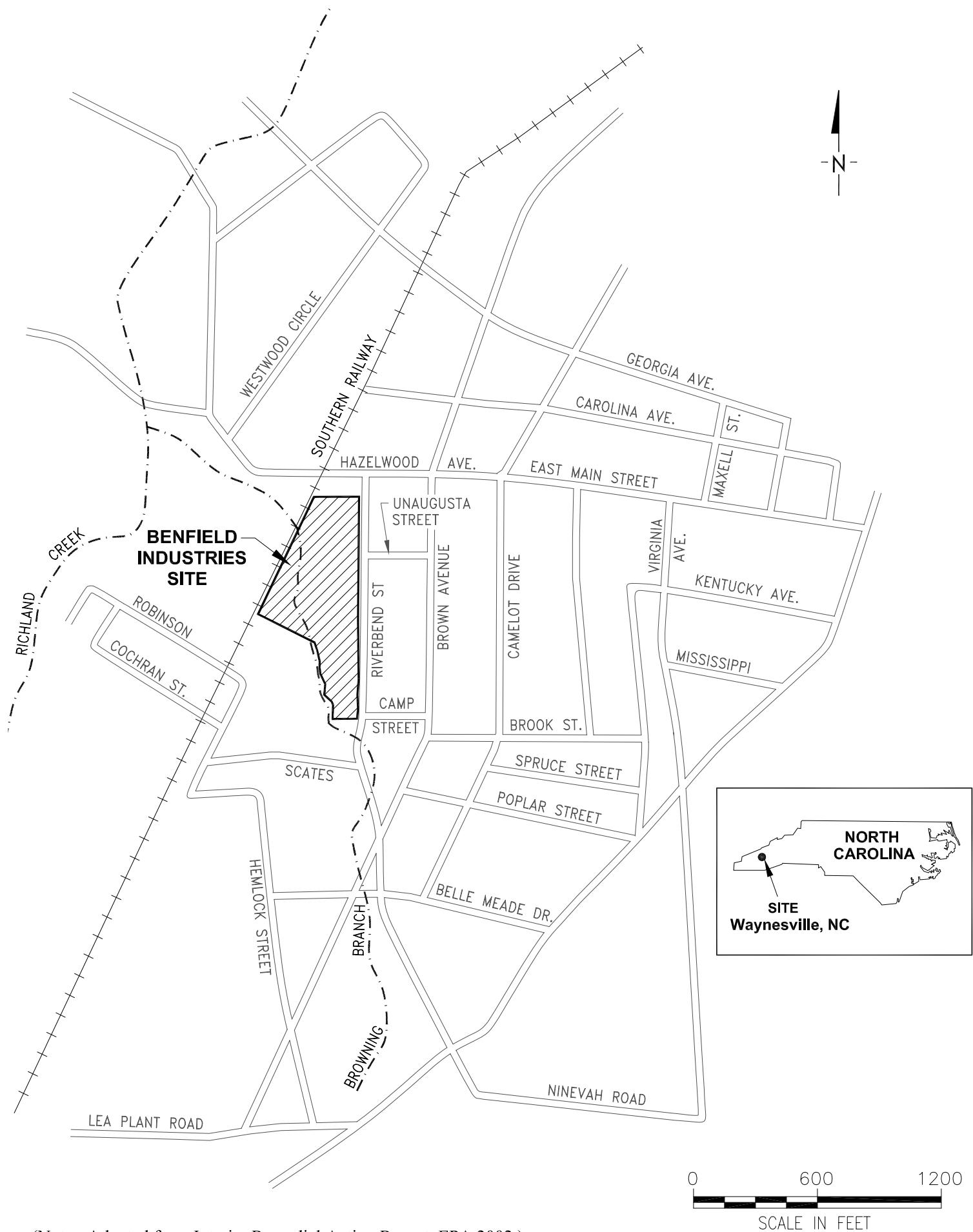
Costs in parentheses imply cost reductions

\* assumes 30 years of operation with a discount rate of 0% (i.e., no discounting)

\*\* assumes 30 years of operation with a discount rate of 5% and no discounting in the first year

## **FIGURES**

FIGURE 1-1. SITE LOCATION MAP.



(Note: Adapted from Interim Remedial Action Report, EPA 2002.)

**FIGURE 1-2. SITE LAYOUT SHOWING WELL LOCATIONS AND GROUNDWATER ELEVATIONS.**

