STREAMLINED REMEDIATION SYSTEM EVALUATION (RSE-LITE)

CAPE FEAR WOOD PRESERVING SITE
FAYETTEVILLE, NORTH CAROLINA

Report of the Streamlined Remediation System Evaluation
Conference Call Conducted
August 5, 2004

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Cape Fear Wood Preserving Site
Fayetteville, North Carolina

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NOTICE

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EXECUTIVE SUMMARY

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 Cape Fear Wood Preserving Site is located in Cumberland County, North Carolina, on the western side of Fayetteville near Highway 401. The site consists of about nine acres of a 41-acre tract of land that is adjacent to other industrial/commercial establishments, as well as private residences. The facility operations involved wood treatment processes from 1953 to 1983, which caused contamination in site soil, sediment, and ground water. The site investigation was conducted by EPA in October 1984. Polycyclic aromatic hydrocarbons (PAHs) and metals were detected in surface water, ground water, soil, and sediment samples. The 1989 Record of Decision (ROD) for the site specified remedies for both soil and ground water contamination. However, during the remedial activities in 1998 through 1999, dense non-aqueous phase liquid (DNAPL) was found at the site. At the time of the RSE-lite, soil and sediment contamination had been fully addressed, and only ground water contamination, including DNAPL, remained. The primary constituents of concern include benzene, non-carcinogenic PAHs, carcinogenic PAHs, and carbazole.

The 1989 ROD and the three following ESDs and a ROD amendment specified the ground water remedy consisting of a pump and treat (P&T) system, an air sparging system, nutrient-enhanced degradation, and monitored natural attenuation (MNA). DNAPL extraction was also specified. The remedy as a whole began operation in August 2001.

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, the public, and the facility. These recommendations have the obvious 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 site closeout. The recommendations to improve system effectiveness include the following:

- Install and sample a monitoring well to further delineate the plume. MW-16 has contaminant concentrations that are more than 10 times the cleanup criteria. In addition, it is screened in the lower aquifer, and there are no monitoring wells that are downgradient of it. A monitoring well should be installed downgradient of MW-16 and at the same depth as MW-16 to determine if or how far the contamination is continuing to migrate.

- Sample additional outer monitoring wells on an annual basis. Eight existing monitoring wells should be added to the monitoring program on an annual basis to the south, southwest, west, northwest, and north. Monitoring of these wells is an important component in evaluating plume capture at this site.

- Exclude water level measurements from active recovery wells and infiltration galleries when generating potentiometric surface maps. The water level measurements should not be used to generate potentiometric surface maps due to well losses. Also, the potentiometric surface maps should be generated for both the upper and lower aquifers using the data from the corresponding aquifers.

Recommendations for cost reduction include the following:

- Use local labor for O&M services and ground water sampling. The high cost associated with O&M labor is in large part due to the use of an out-of-state O&M contractor. The RSE-lite team strongly recommends that the site team hire a local contractor to provide O&M services. The RSE-lite team estimates that implementing this recommendation should save the site over $60,000 per year and recognizes that the site team was considering this change prior to this RSE-lite. The RSE-lite team also suggests using a local contractor to perform the ground water sampling, which would provide a savings of approximately $25,000 per year.

- Eliminate redundant samples and reduce sampling frequency. Routine sampling at some monitoring wells in the source area provides little or no useful information due to the presence of DNAPL. Thus, the RSE-lite team recommends eliminating two monitoring wells in the source area from the ground water monitoring program, and furthermore reducing the ground water sampling frequency from quarterly to annually. These two items should provide a cost savings of approximately $35,000 per year.

Recommendations for technical improvement include the following:

- Consider alternatives before adding a sequestering agent. The site team is considering the addition of a sequestering agent to reduce bag filter and GAC changeouts. The RSE-lite team does not believe that adding a sequestering agent at this site will significantly reduce changeouts. If the changeout frequency increases and/or the site team wants to reduce the changeout, the RSE-lite team suggests adding additional bag filters in parallel rather than using a sequestering agent.

- Reduce the frequency of water level measurements, eliminate the dissolved oxygen measurements, and simplify corresponding monthly O&M reports. The RSE-lite team suggests that the site reduce the frequency of water level measurements at monitoring wells from a monthly basis to a quarterly basis, discontinue routine measurements of dissolved oxygen, and simplify the monthly O&M reports.

- Identify shallow versus deep wells by adding a suffix to the well label. The RSE-lite team recommends the site team consider adding a "S" suffix for wells screened in the upper aquifer and a "D" suffix for wells screened in the lower aquifer.

Recommendations with regard to site close out are as follows:

- Evaluate various remedy components. The site has applied three different ground water remedial approaches: P&T system, enhanced degradation, and MNA. The RSE-lite team suggests that to better understand the contribution of each component the site team evaluate the effectiveness of those components. The site team could start by discontinuing P&T for a period of one year to evaluate the air sparging system. If air sparging alone is not sufficient to provide a protective remedy, then the site team could restart the P&T system and discontinuing the air sparging for a period of one year to see if P&T and MNA are sufficient.

- Evaluate potential scale-up issues and costs for the thermal pilot study and determine the cost-effectiveness by comparing the costs with the life-cycle costs for continuing a long-term remedy. The site contractor estimates that a full-scale thermal application might be $8 to $10 million, but the RSE-lite team is concerned that actual costs might be much higher and that even after full-scale thermal remediation additional active remediation (e.g., P&T) may be required. If the site team moves forward with full-scale thermal remediation, the RSE-lite team suggests that the thermal remediation option should be cost-effective relative to a continued long-term remedy and the cost and the performance should be guaranteed.

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

SITE UPDATE

During the time period between the RSE-lite conference call on August 5, 2004 and the finalization of this report, the site team has made progress with respect to evaluating and implementing recommendations provided in this report. The following efforts have either taken place or are in progress as of the finalization of this report. RSE recommendations that correspond to these efforts are indicated in parentheses.

- Water level measurements from the recovery wells and infiltration galleries have not been utilized in development of the potentiometric surface maps since the July 2004 reporting period. Additional piezometers have been installed in the vicinity of the recovery wells during the thermal pilot study well and electrode installation. These piezometers were recently surveyed and will be utilized to develop the potentiometric surface map in future reporting periods. (Recommendation 6.1.3)

- A reduced sampling frequency of semi-annual sampling had been contemplated in the approved work plan following completion of the DNAPL pilot study. Only one sampling event (an annual event in late July) was performed during 2004. (Recommendation 6.2.2)

- The P&T system phase separator was cleaned out in October 2004 in an effort to improve the performance of the bag filters. The performance of the bag filters has improved, and the site team attributes the improved performance to cleaning out the phase separator. The addition of bag filters or a sequestering agent will only be considered if the performance of the existing bag filters declines. (Recommendation 6.3.1)

- The EPA approved work plan for the thermal pilot study specifies that B&V will re-bid the O&M services to coincide with the completion of the DNAPL pilot study. Qualified local contractor's have been identified and will be included in the procurement. Optional pricing will be requested for the performance of ground water sampling. Assuming favorable pricing is received for sampling, B&V will utilize the selected contractor for these services. (Recommendation 6.2.1)

- Recommendation 6.4.1 suggests a two-step evaluation program to evaluate the various components of the remedy. The first step involves shutting down the P&T system and continuing air sparging operation to evaluate the effectiveness of an air-sparging-only remedy. If the evaluation showed air sparging was sufficiently effective, then the P&T system could remain off. If the evaluation showed that P&T was necessary to prevent unacceptable migration, then the site team would proceed with step two of the evaluation. Step two would involve restarting the P&T system and discontinuing the air sparging component to evaluate the effectiveness of a P&T-only remedy. The site team has skipped the first step of the recommended evaluation and has implemented the second step (e.g., shutting of the air sparging system). The air sparging system has been offline since September. This effort by the site team represents timely action by the site team to address the RSE-lite Recommendation 6.4.1, but the RSE-lite team encourages the site team to conduct the first step (e.g., operating the air sparging system and shutting down the P&T system). An air-sparging-only remedy will likely be more cost-effective in the long-term than a P&T-only remedy.

PREFACE

This report was prepared as part of a project conducted by the United States Environmental Protection Agency (U.S. EPA) Office of Superfund Remediation and Technology Innovation. The objective of this project is to conduct streamlined Remediation System Evaluations (RSE-lites) 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:

Organization	Key Contact	Contact Information
U.S. EPA Office of Superfund Remediation and Technology Innovation (OSRTI)	Jennifer Griesert	1235 S. Clark Street, 12th floor Arlington, VA 22202 Mail Code 5201G phone: 703-603-8888 griesert.jennifer@epa.gov
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1.0 INTRODUCTION

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) and is documented on the following website:

http://www.environmental.usace.army.mil/library/guide/rsechk/rsechk.html

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 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, might 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 Cape Fear site was selected by EPA OSRTI based on the level of funding requested for site activities in FY04 and a recommendation from the associated EPA Region. 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:

Peter Rich, Civil and Environmental Engineer, GeoTrans, Inc.
Doug Sutton, Water Resources Engineer, GeoTrans, Inc.

The following individuals participated as observers:

- Jennifer Griesert from EPA OSRTI
- Charles Sands from EPA OSRTI
- Silvina Fonseca from EPA OSRTI
- Wayne Kellogg from Dynamac Corporation

1.3 DOCUMENTS REVIEWED

Author	Date	Title
U.S. EPA	6/30/1989	Record of Decision
U.S. EPA	9/24/1991	Explanation of Significant Differences
U.S. EPA	8/27/1995	Explanation of Significant Differences
U.S. EPA	5/31/1996	Explanation of Significant Differences
U.S. EPA	3/23/2001	Amendment to the Record of Decision
Bechtel Environmental, Inc.	9/1999	Remedial Action Completion Report, Volume I
Black & Veatch Special Projects Corp. (BVSPC)	5/23/2000	Final Groundwater Characterization and Hydrogeology Investigation Study
BVSPC	8/2000	Construction Plans for the Groundwater Extraction and Treatment System Design
BVSPC	8/30/2000	Final Groundwater Design Report
U.S. EPA	9/25/2001	Superfund Preliminary Close-out Report
WRS Infrastructure & Environment, Inc. (WRS)	11/16/2001	Operation and Maintenance Manual
BVSPC	12/20/2001	Baseline (Data Evaluation) Report (Prior to GW System Startup) for the Groundwater Remediation System
WRS	1/11/2002	Monthly Operation & Maintenance Report, November 2001

Author	Date	Title
BVSPC	3/7/2002	Remedial Action Report, Phase IV Groundwater Extraction/Treatment System
BVSPC	4/2002	Draft NAPL Investigation Report
U.S. EPA	6/24/2002	Interim Remedial Action Report
Intera, Inc.	5/8/2003	Draft Overview of the Cape Fear DNAPL Source Zone GeoSystem
BVSPC	9/2003	Bench-Scale Treatability Study Report Multiple DNAPL Recovery Technologies
BVSPC	9/26/2003	1st Quarter 2003 Report for the Groundwater Pump and Treat System, January 1, 2003 to March 31, 2003
BVSPC	10/27/2003	2nd Quarter 2003 Report for the Groundwater Pump and Treat System, April 1, 2003 to June 30, 2003
BVSPC	12/31/2003	3rd Quarter 2003 Report for the Groundwater Pump and Treat System, July 1, 2003 to September 30, 2003
WRS	1/23/2004	Monthly Operation & Maintenance Report, December 2003
WRS	2/9/2004	Monthly Operation & Maintenance Report, January 2004
WRS	3/26/2004	Monthly Operation & Maintenance Report, Februray 2004
BVSPC	4/9/2004	4th Quarter 2003 Report for the Groundwater Pump and Treat System, October 1, 2003 to December 31, 2003
WRS	4/15/2004	Monthly Operation & Maintenance Report, March 2004
BVSPC	3/4/2004	Revised DNAPL Recovery Field Pilot Study Work Plan

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
- Ed Hicks, BVSPC

1.5 SITE LOCATION, HISTORY, AND CHARACTERISTICS

1.5.1 LOCATION

The Cape Fear Wood Preserving Site is located in Cumberland County, North Carolina, on the western side of Fayetteville near Highway 401. A site location map is presented in Figure 1-1. The site consists of about nine acres of a 41-acre tract of land. The site is adjacent to other industrial/commercial establishments, as well as private residences. At the time of the Record of Decision, four homes were located near the site. These homes have since been abandoned. A subdivision named "Southgate" is located approximately a quarter of a mile south of the site and houses approximately 1,000 people.

Site soil, sediment, and ground water contamination resulted from wood treating activities that occurred between 1953 and 1983 (see Figure 1-2 for a historical site layout). At the time of the RSE-lite, soil and sediment contamination had been fully addressed, and only ground water contamination, including dense non-aqueous phase liquid (DNAPL) remained. The primary constituents of concern include benzene, non-carcinogenic polycyclic aromatic hydrocarbons (PAHs), carcinogenic PAHs, and carbazole. This RSE-lite focuses on the current ground water remedy and provides consideration for addressing DNAPL. For additional information on the soil and sediment remediation, the reader is referred to the Remedial Action Completion Report (September 1999). Figure 1-3 shows the site layout at the time of the RSE-lite.

1.5.2 POTENTIAL SOURCES

The facility produced creosote-treated wood from 1953 until 1978 when demand for creosote-treated products declined. Wood was then treated by a wolmanizing process called the copper-chromium-arsenic (CCA) process. The date the CCA process was initiated and whether the processes occurred simultaneously is unknown. Both liquid and sludge wastes were generated by these two treatment processes. Wastes from the creosote process were pumped into a concrete sump north of the treatment unit. As liquid separated from the sludge, it was pumped into a drainage ditch that lies southeast of the developed portion of the site and discharged into a diked pond. Stormwater runoff from the treatment yard also appears to drain into this ditch. Waste from the CCA treatment process was pumped into an unlined lagoon north of the dry kiln and allowed to percolate into the ground. Wood treating activities were discontinued at the site in 1985. Underground storage tanks used for gasoline were also present on the site and may have been the source of the benzene contamination that is present in ground water.

The EPA conducted a site reconnaissance and site investigation in October 1984. Surface water, ground water, soil, and sediment samples were collected from the northeast swamp, diked pond, lagoon, drainage ditch, and a domestic well west of the site. Polycyclic aromatic hydrocarbons (PAHs), which are creosote-related compounds, and the CCA metals were detected in all samples. Consequently, EPA began a series of removal actions in January 1985. In June 1989 the Record of Decision (ROD) for the site was finalized specifying remedies for both soil and ground water contamination. In 1998 through 1999, the waste removal, decontamination/demolition, and on-site soil treatment remedial actions were completed at the site. However, during these activities, dense non-aqueous phase liquid was found at the site.

DNAPL investigations were conducted with cone penetration testing coupled with the Rapid Optical Scanning Tool (CPT/ROST). Both free phase and residual DNAPL have been identified. Based on a revised figure dated October 7, 2003 in the Draft Bench-Scale Treatability Study Report (BVSPC, September 2003), the area impacted by free phase DNAPL is approximately 3.26 acres (see Figure 1-4). Using the same figure, the area impacted by both residual and free phase DNAPL is approximately 5.33

acres. These estimates are based on correlations provided in the report where a laser-induced fluorescence (LIF) response of greater than 2.0 indicates residual DNAPL, and an LIF response of greater than 4.0 indicates free-phase DNAPL. DNAPL is estimated to be present to depths of up to 25 feet below ground surface in some areas, and the total estimated mass of DNAPL at the site is 78,000 kg, assuming a DNAPL density of 1.12 g/cm^3 (Intera, May 8, 2003).

1.5.3 HYDROGEOLOGIC SETTING

The site is at a topographic high point and is underlain by unconsolidated sands and clays to a depth of approximately 25 feet. A semi-confining layer that has an approximate thickness of 15 feet separates this upper unit from a lower unit of sands and clays that are approximately 50 feet thick. The semi-confining layer is generally continuous across the site but was reported missing near monitoring well MW-8. A stiff clay unit is present beneath the lower unit of sands and clays and is assumed to act as an aquitard. Depth to water at the site generally ranges from 0 to 10 feet below ground surface (bgs). The saturated portion of the subsurface above the semi-confining unit is referred to as the upper aquifer, and the saturated zone between the semi-confining unit and the aquitard are referred to as the lower aquifer.

Ground water flow in the upper aquifer is radial, primarily as a result of the topographic high and sandy materials at the site that result in higher recharge relative to the surrounding area. The hydraulic gradient magnitude of the upper aquifer is approximately 0.007 feet per foot. Given an average hydraulic conductivity of 0.7 feet per day based on slug tests and an estimated porosity of 0.20, the average horizontal ground water velocity is estimated at approximately 9 feet per year.

Ground water flow in the lower aquifer is to the southwest. The hydraulic gradient magnitude of the lower aquifer is approximately 0.003 feet per foot. Given an average hydraulic conductivity of 2.9 feet per day based on slug tests and an estimated porosity of 0.20, the average horizontal ground water velocity is estimated at approximately 16 feet per year.

The hydraulic head in the upper aquifer is approximately 28 feet higher than the hydraulic head in the lower aquifer, which indicates a potential for downward flow. The semi-confining unit, however, has an estimated hydraulic conductivity of approximately 0.00044 feet per day based on laboratory analyses of Shelby tube samples, which is quite low. Therefore, vertical ground water flow from the upper to the lower aquifer, except in the areas where the semi-confining unit is not present, is likely limited.

1.5.4 POTENTIAL RECEPTORS

There are no current receptors adjacent to the site. Four houses are located near the site, and although they were inhabited at the time of the ROD, these houses have since been abandoned. A residential community is located approximately 1,000 to 1,500 feet south of the site. The September 1999 Remedial Action Completion Report states that several potable wells within the subdivision supply water to the residences.

Surface soil and sediment contamination have been addressed; therefore, typical exposure pathways at the surface are incomplete. Seasonal wetlands are present northeast of the site, but this area discharges to ground water and would not be impacted by contaminated ground water. Nearby surface water includes Sanders Irrigation Pond (located approximately 2,000 feet northwest of the site), Bones Creek (located approximately 3,000 feet west of the site), and Lake Rim (located approximately 3,000 feet southwest of the site). Bones Creek and Lake Rim are downgradient of the site given flow directions in the upper and lower aquifers. A fish hatchery is located at the southern end of Lake Rim, approximately 1.5 miles southwest of the site.

1.5.5 DESCRIPTION OF GROUND WATER PLUME

The primary contaminants of concern include benzene, non-carcenogenic PAHs, carcinogenic PAHs, and carbazole. Naphthalene is the predominant non-carcinogenic PAH. Carcinogenic PAHs are limited in extent.

The extent of ground water contamination as determined by the 4th Quarter 2003 sampling event is illustrated in Figure 1-5. The figure indicates the magnitude of benzene, naphthalene, and/or carbazole concentrations at each sampling location compared to the cleanup standards. Although there are other contaminants of concern, these three contaminants are generally representative of the contaminant plume. All wells with sampling results depicted are from the upper aquifer with the exception of MW-3, MW-5, and MW-16, which are from the lower aquifer. The figure demonstrates that contamination has migrated approximately 500 feet to the west, southwest, and south from the historical source areas. Limited ground water contamination is also indicated at MW-07 and MW-22. The contamination at MW-07 may result from ground water transport, but the contamination at MW-22 is likely due to contamination that had historically migrated above ground via the drainage ditch rather than through the aquifer.

Based on the depicted sampling results, the plume is not delineated to the north or to the southwest near MW-16. The recent sampling shown in Figure 1-5 does not delineate the plume to the west; however, historical sampling at MW-1 and MW-2 from the baseline event delineates the plume to the west as of 2001.

2.0 SYSTEM DESCRIPTION

2.1 SYSTEM OVERVIEW

The ground water remedy includes the following:

- ground water extraction from the drain installed in Area 10A and from seven recovery wells
- DNAPL extraction from the drain and three of the seven recovery wells
- ground water treatment with phase separation, filtration, carbon adsorption
- nutrient addition to the treated water
- reinjection of the nutrient amended water (with contingency to discharge to the POTW, if needed)
- air sparging at 12 sparge points
- monitored natural attenuation (MNA) of the deep aquifer

Air sparging is avoided in the areas with DNAPL. The nutrient addition and air sparging is intended to accelerate natural degradation of ground water contaminants. The remedy was specified in the 1989 ROD and modified with three following ESDs and a ROD amendment. The air sparging and MNA were added with the ROD Amendment in March 2001. The remedy as a whole began operating in August 2001 (June 2002 Interim Remedial Action Report).

2.2 EXTRACTION AND INJECTION SYSTEMS

The locations of the french drain, seven recovery wells, and ten infiltration galleries are depicted in Figure 1-3. The recovery wells and the french drain are constructed with polyvinyl chloride (PVC) and are completed in the upper aquifer at depths of approximately 25 to 30 feet bgs. The recovery wells are outfitted with pneumatic submersible pumps, each with a capacity of 9 gpm, and the french drain is outfitted with a double diaphragm pump with a capacity of 15 gpm. RW-1, RW-4, and RW-7 also have bladder pumps for DNAPL recovery. All of the recovery wells have a 6-inch diameter, with the exception of RW-5, which has a 4-inch diameter. Each infiltration gallery is 100 feet long. Piping that conveys extracted ground water to the treatment system and treated water to the infiltration galleries is constructed with schedule 80 PVC. Piping that conveys recovered DNAPL to the DNAPL storage tanks is constructed with high density polyethylene (HDPE). The locations of the air sparge points are also indicated on Figure 1-3. Each of the sparge wells has a 2-inch diameter.

The design flow rate for the P&T system is 40 to 50 gpm; however, the site team reports that the optimal extraction rate for the system is approximately 10 gpm based on operational data and experience at the site. Measured extraction rates from individual wells are reportedly not reliable because the extraction rates are lower than the specified flow rate for the flow meters. However, qualitatively, the March 2004 data suggest that the majority of extracted ground water is relatively evenly distributed among RW-1, RW-4, RW-5, and the french drain. Somewhat less water is extracted from RW-6, and extraction from RW-2 and RW-3 is nearly negligible. The total Influent concentration for the contaminants of concern in March 2004 was approximately 4,850 ug/L. Given this influent concentration and an influent flow rate of approximately 10 gpm, mass removal via ground water extraction and treatment is approximately 0.6 lbs per day.

$$\frac{10\text{ gal.}}{\text{min.}} \times \frac{4{,}850\text{ ug}}{\text{L}} \times \frac{1{,}440\text{ min.}}{\text{day}} \times \frac{3.785\text{ L}}{\text{gal.}} \times \frac{\text{kg}}{10^9\text{ ug}} \times \frac{2.2\text{ lbs.}}{\text{kg}} = \frac{0.6\text{ lbs.}}{\text{day}}$$

Approximately 9,500 gallons of DNAPL had been recovered from RW-1, RW-4, RW-7, and the french drain as of March 2004. DNAPL recovery volumes have generally decreased to less than 200 gallons per month since February 2003. The DNAPL recovery at each well is not measured, and the best available indication of potential DNAPL recovery by location is the product thickness. In March 2004, the product thickness was not measurable at RW-1 and not recorded at the french drain but was approximately one foot at RW-4 and RW-7.

The flow rates to each of the infiltration galleries are also reportedly unreliable. Qualitatively, data from the March 2004 O&M report suggest that the majority of the reinjected water is distributed to IG-1, IG-3, and IG-7. Although the site team has the infrastructure and permitting to discharge to the POTW, none of the extracted water from the site has been discharged to the POTW.

Air flow rates for the air sparging system generally range from 1 to 5 standard cubic feet per minute (scfm) at each of the sparge points.

2.3 TREATMENT SYSTEM

The treatment system is contained in a 40-foot by 40-foot pre-engineered metal building, including a small office. The building is heated and insulated to provide freeze protection and the office is air conditioned. The treatment system has a design capacity of 40 to 50 gpm and was designed for an influent concentration of approximately 10,000 ug/L total PAHs (November 2001 O&M Manual). The primary treatment components are as follows:

- two 30 horsepower (HP) compressors to run recovery and air sparging system
- a phase separator with a 50-gpm capacity
- a 10,000-gallon reinforced fiberglass influent tank
- six 5-HP transfer pumps, each with a capacity of 20 gpm
- two 50 micron bag filters arranged in parallel
- two 25 micron bag filters arranged in parallel
- two 10,000-pound granular activated carbon (GAC) vessels arranged in series
- a 10,000-gallon reinforced fiberglass effluent tank

Extracted water can be directed to either the 10,000-gallon influent tank or the phase separator. Water that is treated by the phase separator is directed to a holding tank and then to the influent tank. From the influent tank, water is pumped via two of the transfer pumps to the 50 micron bag filters and then to the 25 micron bag filters. The filtered water passes through the GAC units and then to the effluent tank. Prior to discharge to the infiltration galleries, the treated water is amended with a combination of urea and ammonium phosphate.

2.4 MONITORING PROGRAM

The monitoring program consists of both ground water monitoring and process monitoring for the P&T system and the air sparging system.

The site team has made some recent modifications to the ground water monitoring program and plans for continued changes. The ground water monitoring program officially consists of quarterly sampling of 19 monitoring wells, the seven recovery wells, and the french drain. Samples are analyzed for VOCs and SVOCs. However, in preparation for the upcoming thermal pilot test, two of the sampling events were canceled to conserve funding for the pilot test. The other two events were rescheduled such that one would provide a baseline event for the pilot test. Therefore, the actual monitoring program during the 2004 operating year consisted of semi-annual sampling rather than quarterly.

Water levels from the recovery wells, french drain, and infiltration galleries are measured semi-monthly. Water levels and dissolved oxygen from the monitoring wells are measured monthly. VOC and SVOC data are presented on site maps for each sampling event, and potentiometric surface maps are prepared for each round of water level measurements that includes data from the monitoring wells. Water level measurements from operating recovery wells and infiltration galleries are used in preparing the potentiometric surface maps.

Process monitoring includes monthly sampling of the influent, process water between the two GAC units, and effluent analyzed for both VOCs and SVOCs. There is no air, surface water, soil, or sediment sampling that is conducted as part of system O&M.

Two sets of reports are generated: monthly O&M reports and quarterly reports. Among other operational information, the detailed O&M reports include process sampling, as well as current and historic water level and dissolved oxygen measurements. Potentiometric surface maps and dissolved oxygen contour maps are also included in these monthly reports. The quarterly reports summarize the monthly reports and also include interpretation of data associated with the ground water sampling and analysis.

3.0 SYSTEM OBJECTIVES, PERFORMANCE AND CLOSURE CRITERIA

3.1 CURRENT SYSTEM OBJECTIVES AND CLOSURE CRITERIA

The ground water remedy and remedial objectives are specified in the following decision documents:

- 1989 ROD
- 1991 ESD
- 1995 ESD
- 1996 ESD
- 2001 ROD Amendment

The 1989 ROD specified P&T as the ground water remedy, and the subsequent ESDs specified the various components of the treatment system and various discharge options. The 2001 ROD Amendment introduced the following aspects of the remedy:

- treated water would be amended with nutrients and reinjected through on-site infiltration galleries to cost-effectively discharge treated water and enhance microbial degradation of site contaminants
- the POTW would be retained as an alternative discharge option
- air sparging would be conducted (in areas not impacted by DNAPL) to enhance contaminant removal and foster microbial degradation
- monitored natural attenuation (MNA) would address impacts detected in the lower aquifer because pumping from the lower aquifer could draw additional contamination downward

In addition to the above-specified remedy components, the site team is conducting a pilot test of thermally enhanced remediation in an effort to reduce DNAPL volume and contaminant concentration levels to an extent that MNA would be appropriate, and active remediation could be discontinued. However, the contaminant concentrations at which MNA alone might apply have not yet been determined.

Although not explicitly stated in the decision documents, the site team sees the remedy objective as providing plume capture while reducing contamination to cleanup levels.

The cleanup standards for the site contaminants are provided in the following table. They are specified in Chapter 15A of the North Carolina Administrative Code, Section 2L for all of the site contaminants except for carbazole. The North Carolina Administrative Code does not specify an appropriate standard for carbazole; therefore, the tentative U.S. EPA Region 9 Preliminary Remedial Goal (PRG) for carbazole has been adopted for that contaminant.

Contaminant	Cleanup Level (ug/L)
Benzene	1.0
Carcinogenic PAHs	
Benzo(a)anthracene	0.05
Benzo(b)fluoranthene	0.047
Benzo(k)fluoranthene	0.047
Benzo(a)pyrene	0.0047
Chrysene	5
Dibenzo(a,h) anthracene	0.0047
Indeno(1,2,3-cd)pyrene	0.047
Non-Carcinogenic PAHs	
Acenaphthene	80
Acenaphthylene	210
Anthracene	2,100
Fluorene	280
Fluoranthene	280
Naphthalene	21
Phenanthrene	210
Pyrene	210
Carbazole	5

3.2 TREATMENT PLANT OPERATION STANDARDS

According to the 2002 Final Remedial Action Report, the performance standard for the treatment system is that concentrations of contaminants of concern in the influent shall be reduced by either 95% or to 2L standards (whichever is higher) in effluent to on-site infiltration galleries. The 2L standards are provided in Section 3.1 of this report.

4.0 FINDINGS AND OBSERVATIONS

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 obviously 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

Water level data from recovery wells and infiltration galleries are recorded semi-monthly, but the site team maintains that flow rate measurements are unreliable. Therefore, the specific capacity cannot be calculated and used as an indicator of well fouling.

Water levels from monitoring wells are measured monthly. These data and the data from operating recovery wells and infiltration galleries are used to generate potentiometric surface maps monthly. However, water levels from operating recovery wells and infiltration galleries should generally not be used in developing potentiometric surface maps. Due to well losses, the water levels from recovery wells generally over-emphasize the effect of pumping on the surrounding aquifer, and due to fouling, water levels from operating infiltration galleries generally over-emphasize the degree of mounding. For the Cape Fear site, the potentiometric surface maps appear particularly biased by the water levels from the operating recovery wells. Therefore, these potentiometric surface maps should not be used for evaluating plume capture.

Qualitative analysis of the recovery and reinjection rates suggest that the majority of extraction may be occurring from RW-1, RW-4, and RW-5 and that the majority of reinjection may be occurring at IG-1, IG-2, and IG-3. A more quantitative evaluation would not be appropriate given that the flow rate measurements for each recovery well and infiltration gallery are unreliable. If this distribution of extraction and injection is correct, then more water would be added to the aquifer on the western portion of the site than is extracted, potentially compromising the capture of contaminants in this area. Consequently, more water may be extracted from the eastern portion of the site than is reinjected, potentially favoring capture.

4.2.2 CAPTURE ZONES

The ground water remedy consists of P&T, nutrient-enhanced degradation, and MNA. Nutrient-enhanced degradation involves the discharge of amended water within the plume boundaries, and MNA applies to the deeper aquifer. Therefore, a traditional evaluation of hydraulic capture for the entire plume is not appropriate for this site. Rather, it appears that the ability of the remedy to prevent unacceptable plume migration should be evaluated through monitoring of sentinel monitoring wells and performance monitoring wells. That is, monitoring at sentinel locations downgradient of the plume should continue to show no impacts, and performance monitoring at locations along the plume boundary should show stable or decreasing concentrations. This approach, however, requires that monitoring wells are present and are sampled routinely along the plume boundary and downgradient of the plume.

Current monitoring is likely insufficient in some areas. For example, there is no monitoring well located downgradient (i.e., southwest) of MW-16, which screens the lower aquifer and has impacts that are at least 10 times greater than applicable standards. Although MW-19 is located south of MW-16, it has not been sampled recently, and it appears to be more downgradient of MW-35 than MW-16. Monitoring to the north is also limited. The highest contaminant concentrations at the site are in RW-7 and RW-4, and there is no consistent sampling north of these points. Therefore, additional data are required to determine if plume migration is being adequately prevented.

The presence of contamination in the lower aquifer (MW-16) suggests the potential for downward migration of contamination, which is consistent with the measured downward hydraulic gradient. The concentrations at MW-16 are generally stable or decreasing, suggesting the potential for natural degradation and the applicability of an MNA remedy for this location.

4.2.3 CONTAMINANT LEVELS

Contaminant levels in the source area (MW-05, MW-29, RW-04, RW-07, and the french drain) remain elevated and are expected to remain elevated due to the presence of DNAPL. Concentrations to the southwest (MW-16) have generally decreased but remain well above cleanup standards. Concentrations to the west (MW-3, MW-23, and MW-31) have remained relatively stable over the past five quarters of monitoring. Therefore, as would be expected at a site with DNAPL, ground water monitoring suggests that aquifer restoration will likely not occur within a reasonable time with the current remedy.

4.3 COMPONENT PERFORMANCE

4.3.1 EXTRACTION SYSTEM WELLS, PUMPS, AND HEADER

The extraction system is operating at approximately 10 gpm rather than the design rate of 50 gpm. The site team, however, believes that the 10 gpm is reasonable for the site based on operational data. The site team has generally been able to maintain a consistent extraction rate.

4.3.2 PHASE SEPARATOR/EQUALIZATION/INFLUENT TANK

The influent tank and phase separator perform as expected. Little, if any, product is removed via phase separation. Most of the product recovery is achieved with the DNAPL recovery pumps, which transfer recovered fluids directly to the DNAPL storage tank.

4.3.3 BAG FILTERS

Elevated iron in the influent results in frequent replacements of the bag filter. In March 2004, all four filters required replacement four times. In an attempt to reduce the frequency of bag filter replacements, the site team is considering adding a sequestering agent.

4.3.4 GAC

The lead GAC unit (10,000 pounds) is replaced approximately once per year. On the basis of contaminant loading, 10,000 pounds of GAC would be expected to last longer than one year; however, substantial solids loading due to high iron concentrations results in more frequent GAC replacements. There were no GAC replacements in 2003, but two replacements will be required in 2004. One GAC replacement is anticipated for 2005.

4.3.5 DISCHARGE

The infiltration galleries utilize 100 feet of interlocking Infiltration Systems ™ Infiltrators to distribute water inside the gallery. Each gallery is equipped with a mechanical level float shut-off valve. The shutoff valve ensures that the discharge rate into a particular gallery does not exceed the infiltration capacity at the gallery. Each infiltration gallery includes a gravel sump contained inside a vault equipped with a piezometer to facilitate collection of depth-to-water measurements within each of the infiltration galleries.

In the event the infiltration galleries will not accept the discharge from the system, or when the removal efficiency of dissolved phase compounds is assessed to be less than 95%, the treated ground water can be discharged into the lift station located at the northwest corner of the site. To date, no water has been discharged to the lift station that transfers water to the POTW.

4.3.6 NUTRIENT INJECTION AND AIR SPARGING

To promote degradation of contaminants in the subsurface, urea and ammonium phosphate are added to the treated water prior to discharge to the infiltration galleries, and dissolved oxygen has been added using air sparging. The urea and ammonium phosphate are added as a liquid mixture at a flow rate of 0.6 gallons per day. Air sparging occurs at 12 sparge points located outside of the DNAPL-impacted area. Air flow rates at each location range from 1 to 10 cubic feet per minute in an attempt to maintain dissolved oxygen concentrations above 2 mg/L. The sparge points are cycled on and off every three hours to avoid air channeling. The air supply is provided by two 30 HP air compressors that operate intermittently and also power the pneumatic submersible pumps used for ground water extraction and DNAPL recovery.

It is difficult, however, to determine if this nutrient and oxygen addition has been effective. Performance monitoring of natural degradation has been limited to measuring dissolved oxygen concentrations on a monthly basis and routine ground water monitoring. The dissolved oxygen data appear to vary substantially at each sampling point suggesting that the data may not be reliable. Furthermore, where decreases in contaminant concentrations have occurred, it is unclear from monitoring data what role the nutrient and oxygen addition has played relative to natural degradation or ground water extraction. However, it is possible, and perhaps likely, that the nutrient injection and air sparging is contributing to the elevated iron concentrations and solids loading to the ground water treatment system.

4.3.7 SYSTEM CONTROLS

A programmable logic controller (PLC) enables automated control of system variables, such as tank levels, on/off cycles of recovery well pumps and sparge points, and process flow rates. The PLC enables full automation, requiring only weekly or biweekly visits for system checks and maintenance.

4.4 COMPONENTS OR PROCESSES THAT ACCOUNT FOR MAJORITY OF ANNUAL COSTS

Total combined expenditures for fiscal years 2003 and 2004 are approximately $1.5 million. Approximately $845,000 is due to non-routine expenses, and the remainder is due to routine annual O&M over the two year period. The non-routine costs include $245,000 in 2003 for a variety of tasks, including a DNAPL investigation and treatability studies, and approximately $530,000 in 2004 for a thermal pilot study. The actual annual O&M cost for 2003 was $319,000, and the estimated cost for 2004 is $314,000. Therefore, over the past two years, the majority of costs have been for non-routine expenses. The estimated annual O&M cost during design was $260,000 per year, which is not far off the actual O&M costs when accounting for inflation.

The following table provides the projected annual O&M costs for 2005. Non-routine costs for 2005 were not estimated at the time of the RSE-lite conference call.

Item Description	Estimated Cost
Labor: Project management, reporting, etc.	$28,000
Labor: Plant operator	$106,000
Labor: Ground water monitoring (assuming a quarterly schedule)	$75,000
Utilities: Electricity	$37,000
Utilities: Other	$6,000
Non-utility consumables (GAC, chemicals, other materials or parts)	$20,000
Chemical Analysis	$12,000
Discharge fees and waste disposal	$9,000
Other (parts, routine maintenance, etc.)	$6,000
Total Estimated Cost	**$299,000**

4.4.1 UTILITIES

The primary utility expenditure is the electricity that is used to power the two air compressors. Electrical demand for a given month varies from approximately 27 kW to 54 kW, and electrical usage ranges from approximately 7,000 kWh to 32,000 kWh per month, but there is little or no seasonal variation.

4.4.2 NON-UTILITY CONSUMABLES AND DISPOSAL COSTS

Non-utility consumables include GAC replacements and nutrient addition. The GAC is the primary cost. One GAC replacement is anticipated for 2005 at a cost of $15,000. The remaining $5,000 is apparently for the urea and ammonium phosphate that are used for nutrient addition.

4.4.3 LABOR

There are three primary labor cost categories. Project management and reporting is $28,000 per year. This is consistent with a monthly cost of between $2,000 and $2,500 per month, which is reasonable for a site of this complexity. Operator labor is approximately $106,000 and involves two O&M contractors.

One of the O&M contractors is WRS, which makes bi-weekly visits to the site from either Florida or Georgia. The other O&M contractor is a local firm, which makes site visits to change bag filters and accomplish other routine tasks in between each of the WRS visits. The labor for quarterly ground water sampling is typically $75,000 at this site and involves the prime contractor (BVSPC) traveling from Atlanta. During the 2004 operating year, there were only two ground water sampling events, and the associated savings were put toward the thermal remediation pilot test.

4.4.4 CHEMICAL ANALYSIS

Laboratory analysis for the ground water sampling program is conducted through the Contract Laboratory Program (CLP), and the costs are not incurred by the site. Approximately $12,000 in analytical costs is incurred for VOC and SVOC analyses for samples collected from the treatment plant influent, the treatment plant effluent, and from in between the two GAC units.

4.5 RECURRING PROBLEMS OR ISSUES

The primary recurring problem is the solids loading that results in frequent bag filter replacements.

4.6 REGULATORY COMPLIANCE

The site team did not report any problems with regulatory compliance.

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

The site team reports that there have not been any exceedances of discharge requirements or releases of contaminants or reagents.

4.8 SAFETY RECORD

The site has a clean health and safety record.

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

5.1 GROUND WATER

Based on the site documentation that was reviewed and the RSE-lite conference call, the ground water remedy is likely protective of human health and the environment. There are areas of the contaminant plume that are not fully delineated, and contaminant migration beyond the current plume boundary may be occurring (perhaps near MW-16), but there are no receptors in the immediate area that would be impacted. The nearest surface water and potable wells are located more than 1,000 feet from the site. Additional monitoring and/or remedial efforts may be required to ensure protection of human health and the environment in the future.

5.2 SURFACE WATER

The nearest surface water is approximately 2,000 feet from the site and does not appear to be impacted by site contamination.

5.3 AIR

Air is not expected to be impacted by the current ground water remedy. Air sparging is used primarily in areas with low dissolved concentrations and is not used in areas with DNAPL. Air sparging is primarily used to enhance degradation and volatilization is expected to be minimal, particularly since the air flow is cycled on and off. Furthermore, the air sparging does not occur in areas where there are basements or other underground structures where contaminant vapors would accumulate.

The thermally enhanced remediation that is being piloted at the site could impact air quality. The aquifer heating is expected to volatilize DNAPL, potentially resulting in large releases of contaminants to the atmosphere. The site team estimates that approximately eight pounds of naphthalene will be emitted per day over the course of four months. This is an average, and there may be periods with higher and/or lower contaminant emissions.

5.4 SOILS

Soil contamination has previously been addressed with the exception of the saturated soil that is impacted by DNAPL.

5.5 WETLANDS AND SEDIMENTS

Wetland and sediment contamination has been previously addressed and is not evaluated as part of this evaluation.

6.0 RECOMMENDATIONS

The recommendations provided in this section are based on a review of site documents and a conference call with the site team. There was no site visit as part of this evaluation. Therefore, these recommendations do not address items such as fence repairs, health and safety issues, or pipe repairs that could potentially be observed during a site visit.

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 INSTALL AND SAMPLE A MONITORING WELL DOWNGRADIENT OF MW-16

MW-16 has contaminant concentrations that are more than 10 times the cleanup criteria. In addition, it is screened in the lower aquifer, and there are no monitoring wells that are downgradient (i.e., southwest) of it. Although MNA has been selected for the contamination detected by this well, there is insufficient monitoring in the area to determine if or how far the contamination is continuing to migrate. The concentrations for naphthalene have decreased from 1,600 ug/L to 360 ug/L between December 2002 and December 2003, but 360 ug/L is still well above the cleanup standard of 21 ug/L, and benzene concentrations are relatively stable at approximately 60 ug/L.

A monitoring well should be installed approximately 200 feet downgradient (i.e., southwest) of MW-16 and at the same depth as MW-16. MW-16 and this new well should be sampled and analyzed for VOCs to determine the extent of naphthalene and benzene migration beyond MW-16. This new well should also be added to the ground water monitoring program.

Data from this well will hopefully delineate the plume to the southwest beyond MW-16, demonstrating that the contamination at MW-16 degrades before reaching the new well. If the sampling of the new well indicates impacts to ground water at that location, the site team may be able to estimate the downgradient extent of contamination by using the contaminant concentrations from the new well and MW-16 for extrapolation. However, if the concentrations at the downgradient well are comparable to those at MW-16, then additional downgradient wells and sampling may be required. In addition, if contaminant migration is significant, the site team may need to consider active remediation near MW-16 to either enhance the degradation or provide containment.

To avoid the extra travel costs, the well installation and sampling should correspond to a time period when the contractor is already at the site. If this is not possible, site team should consider using a local firm for oversight and sampling. The RSE-lite team estimates that installing the new well, sampling it and MW-16 once, and analyzing samples for VOCs should cost up to $15,000. The results can be included in the next scheduled ground water monitoring report, but the site team should not wait until that time to discuss the data and determine if additional wells or remediation in this area is required.

6.1.2 SAMPLE OUTER MONITORING WELLS ANNUALLY

As discussed in Section 4.2.2 of this report, the effectiveness of this remedy to prevent plume migration cannot easily be evaluated by evaluating hydraulic containment. Much of the remedy effectiveness depends on the degradation of the site contaminants, whether that degradation occurs naturally as part of an MNA remedy or occurs as a result of the air sparging and nutrient injection. For this reason, it may be most appropriate to evaluate remedy effectiveness by monitoring at and downgradient of the plume boundaries. The following monitoring wells should be added to the ground water monitoring program and sampled annually:

- MW-34 to evaluate plume migration to the south near MW-33
- MW-19 to evaluate plume migration to the southwest of MW-35
- MW-24 to evaluate plume migration to the southwest
- MW-01 and MW-02 to evaluate plume migration to the west
- MW-17 to evaluate plume migration to the northwest
- MW-18 to evaluate plume migration to the north
- MW-28 to evaluate plume migration to the northeast

It appears that sufficient monitoring already occurs to the east. Monitoring for plume migration is recommended on all sides of the site because it has been documented that the flow pattern is radial. If over time, the site team learns that there is little or no flow component in certain directions, then the suggested monitoring in those directions can be eliminated or reduced in frequency.

Adding these wells to the monitoring program on an annual basis should increase the annual costs by approximately $4,000 per year, assuming that the sampling is conducted by a local firm.

6.1.3 DO NOT USE WATER LEVELS FROM OPERATING RECOVERY WELLS OR INFILTRATION GALLERIES WHEN GENERATING POTENTIOMETRIC SURFACE MAPS

The potentiometric surface maps that are currently generated are not reliable because they are biased by water level measurements from operating recovery wells and infiltration galleries. Due to well losses, the water levels from recovery wells generally over-emphasize the effect of pumping on the surrounding aquifer, and due to fouling, water levels from operating infiltration galleries generally over-emphasize the degree of mounding. Thus, the water levels from operating recovery wells and infiltration galleries should generally not be used in developing potentiometric surface maps.

The RSE-lite team recommends that future potentiometric surface maps be generated using only water level measurements from monitoring wells. Potentiometric surface maps should be generated for both the upper and lower aquifers, and data from all monitoring wells should be used. The site team, however, should avoid using water level measurements from the lower aquifer when developing potentiometric surface maps for the upper aquifer and vice versa. Although the P&T system influences the upper aquifer and not the lower aquifer, it is still useful to generate a potentiometric surface for the lower aquifer. There is contamination in the lower aquifer (e.g., MW-16), and it is useful to document the direction of ground water flow, especially since water levels are already collected from six monitoring wells in the lower aquifer. The RSE-lite team does not recommend additional piezometers or monitoring wells in the lower aquifer for the sole purpose of providing water levels.

Implementing this recommendation should not increase or decrease the annual O&M costs. The resulting potentiometric surface maps, however, should give a more reliable picture of ground water flow directions. If analysis of the newly generated maps suggests that the water level data are too sparse to provide useful maps, the site team could consider installing additional piezometers. However, it should be noted that the effectiveness of the remedy is not wholly dependent on hydraulic containment and that the ground water quality monitoring may provide enough information to evaluate effectiveness.

6.2 RECOMMENDATIONS TO REDUCE COSTS

6.2.1 CONTRACT O&M SERVICES AND GROUND WATER SAMPLING TO A LOCAL CONTRACTOR

The cost for O&M labor is approximately $106,000 per year, which is very high for a system of this complexity. The site appears to require one site visit per week, which should cost approximately $30,000 per year for a skilled operator at $75 per hour to visit the site 8 hours per week, and most of the visits would likely require someone with a lower billing rate. Even with the detailed O&M reports that are submitted, the O&M costs should be under $40,000 per year. The additional $66,000 likely results, in large part, from the O&M contractor traveling from Georgia or Florida every other week and having a local contractor conducting the balance of the visits. The RSE-lite team strongly suggests that the site team hire a local contractor to provide the O&M services so that the additional costs associated with travel can be eliminated. The RSE-lite team estimates that using a local firm for O&M services should save the site over $60,000 per year.

Ground water monitoring at this site has typically been conducted on a quarterly basis. The labor for sampling costs approximately $75,000 per year. The laboratory analyses are provided by the CLP at no charge to the site. The quarterly monitoring includes sampling at 19 monitoring wells, seven recovery wells, and the french drain. The sampling should reasonably be accomplished in five full days per event at a cost of approximately $40,000 per year if the sampling labor is local. This assumes a cost of approximately $2,000 per day for sampling labor, equipment, and per diem. It does not include any extra cost for dealing with CLP paperwork, but even with this paperwork and other contingencies, the ground water monitoring should be accomplished for well under $50,000 per year with local labor. This would represent a savings of approximately $25,000 per year to the site. The savings would have been lower in operating year 2004 because only two sampling events (rather than four) were conducted.

In sum, using local labor for O&M services and ground water monitoring should save the site approximately $85,000 per year by reducing travel expenses and the additional labor that would be associated with that travel.

6.2.2 ELIMINATE SELECT MONITORING WELLS FROM GROUND WATER MONITORING PROGRAM AND REDUCE SAMPLING (AND ASSOCIATED REPORTING) FREQUENCY FROM QUARTERLY TO ANNUALLY

The monitoring program can be modified to eliminate redundant samples and reduce costs without sacrificing remedy effectiveness. Due to the presence of DNAPL at the site, aquifer restoration will likely take a number of decades with the current remedy. As a result, ground water monitoring in the source area provides little value. Routine sampling from MW-05 and MW-29 can be eliminated from routine monitoring. Monitoring at these wells would eventually be necessary to demonstrate aquifer restoration, but this will not likely be relevant for several decades. To evaluate cleanup progress, sampling at these two wells might be appropriate every five years and could coincide with the Five-Year Review process.

Furthermore, the ground water sampling frequency should be reduced from quarterly to annually. The site team effectively reduced the sampling frequency to semi-annual in operating year 2004 by eliminating two sampling events. Annual sampling should be adequate to monitor progress toward restoration and evaluate the attenuation of contaminants at the plume boundaries. This should further reduce the cost of ground water monitoring from the $50,000 per year stated in Section 6.2.1 of this report to approximately $15,000 per year.

6.3 MODIFICATIONS INTENDED FOR TECHNICAL IMPROVEMENT

6.3.1 CONSIDER ALTERNATIVES BEFORE ADDING A SEQUESTERING AGENT

The site team is considering the use of a sequestering agent to reduce the frequency of bag filter and GAC changeouts. The addition of a sequestering agent is not likely to reduce operating costs significantly. If the frequency of filter or GAC changeouts increases or the site team is looking to reduce the filter changeout frequency, the site team should consider adding additional filtration units in parallel. Doubling the number of units in parallel should reduce the changeout frequency by half.

6.3.2 REDUCE FREQUENCY OF WATER LEVEL MEASUREMENTS FROM MONITORING WELLS AND DISCONTINUE DISSOLVED OXYGEN MONITORING, AND SIMPLIFY MONTHLY O&M REPORTS

Water levels from monitoring wells are currently measured on a monthly basis and are used to generate potentiometric surface maps. Although potentiometric surface maps can be useful for the site, sufficient information about ground water flow could be achieved through quarterly measurements rather than monthly measurements. The semi-monthly water level measurements from the recovery wells, french drain, and infiltration galleries should continue at that frequency.

The dissolved oxygen measurements are also collected monthly, but the resulting information is not useful for the site. The measurements are quite variable and may not be reliable. Furthermore, on the RSE-lite conference call, the site team acknowledged that the current monitoring is not useful in evaluating the effectiveness of the air sparging and nutrient addition to enhance contaminant degradation. The routine measurement of dissolved oxygen measurements should be discontinued.

Reducing the frequency of water level measurements and eliminating the dissolved oxygen measurements, should help simplify the monthly O&M reports because there will be less data to report.

The RSE-lite team does not provide additional cost savings associated with implementing this recommendation. The reductions in operator labor are already considered in Section 6.2.1. If these changes are not implemented, the cost savings from Section 6.2.1 might be reduced.

6.3.3 ADD A SUFFIX TO WELL LABELS TO INDICATE SHALLOW AND DEEP WELLS

Some of the site monitoring wells screen the upper aquifer, and some of them screen the lower aquifer; however, this is not evident from the site maps and data tables. The site team should consider adding a "S" suffix for those wells that are screened in the upper aquifer and a "D" suffix for those wells that are screened in the lower aquifer. If there are intermediate wells, then an "I" suffix can be used. To avoid confusion in the future, a table should be created with the current labels and the revised labels. This table could be included in future reports so that a reader knows that the new labels do not correspond to new wells.

6.4 CONSIDERATIONS FOR GAINING SITE CLOSE OUT

6.4.1 EVALUATE EFFECTIVENESS OF VARIOUS REMEDY COMPONENTS

The site team is currently employing three different ground water remedial approaches at this site, excluding the thermal pilot test and direct DNAPL extraction. The approaches include P&T, enhanced degradation through nutrient and oxygen injection, and MNA. It is unclear, however, how these various approaches are contributing to the success of the remedy or are interfering with each other. It is possible that the majority of contaminant mass removal is occurring due to enhanced degradation, or possibly even due to natural conditions. On the other hand, it is possible that the P&T system is providing a vital role in containing the source area and allowing contaminant degradation to effectively limit further migration and that the air sparging is contributing to the iron problems that the treatment plant is experiencing. The RSE-lite team recommends consideration of the following evaluations:

- The site team could discontinue P&T for a period of one year and monitor contaminant concentrations at up to 10 locations on a quarterly basis to evaluate the effectiveness of air sparging to enhance contaminant degradation and prevent plume migration. If a one-year period does not provide enough information, the site team can continue non-pumping and enhanced monitoring conditions for longer. The cost savings from O&M labor for this period will likely off-set the increased costs of monitoring and data analysis. Based on this evaluation, the site team might conclude that air sparging to enhance contaminant degradation is sufficient for an effective remedy. The DNAPL recovery system is independent of the P&T system, and its operation should continue as long as free phase DNAPL is readily recoverable.

- If it is determined that P&T is necessary for remedy effectiveness, the site team should consider discontinuing the air sparging and nutrient injection for a period of up to one year to see if P&T and MNA are sufficient. MNA is currently selected for MW-16, and it may be appropriate for other fringe areas of the plume. This evaluation may also help determine if the air sparging is contributing to the iron problems in the treatment plant. As with the previous evaluation, quarterly monitoring will likely be necessary.

It is recommended that the discontinuation of the P&T system be attempted first. The RSE-lite team believes there is a realistic chance that air sparging alone will provide adequate protection for the following reasons:

- The contaminants of concern are primarily creosote related, and creosote operations at the facility stopped in 1978. This means that the latest likely release of creosote compounds occurred in 1978, and releases likely began much earlier. Creosote related operations began in 1953, and releases may have begun at that time. Regardless, creosote related contaminants of concern have had at least 20 to 25 years to migrate before the P&T system began operation, and during that time, contaminant migration in the upper aquifer was relatively limited. To the north and south, the contaminant migration in the upper aquifer corresponds with the extent of DNAPL. To the east and west, the contamination extended up to 500 feet; however, the concentrations have decreased substantially, very possibly as a result of enhanced degradation due to air sparging.

- Another primary constituent of concern is benzene, which was likely released to the surbsurface from a gasoline tank at the site more recently than the creosote releases. The benzene concentrations have also decreased substantially over time, very possibly as a result of enhanced degradation due to the air sparging. The highest benzene concentrations are at MW-16, which is a lower aquifer well that is outside the influence of the P&T system and is under an monitoring only remedy.

- If the P&T system were to provide an important role in containment, the site team would likely see recontamination of MW-3, MW-07, and MW-23, and other wells that have proven to be favorably affected by the remedy thus far. Therefore, the site team would very likely have a warning that the system would need to be restarted before contamination would migrate beyond the area of current remedy influence.

The RSE-lite team encourages the site team to use an independent party to help analyze the data from these evaluations since the evaluations could result in a decreased level of effort for the site contractor. If the independent analysis suggests that neither P&T nor air sparging can be discontinued, the site team could continue P&T from the french drain, RW-04, and RW-07, but discontinue pumping from the other recovery wells. The site team might conclude that pumping from five recovery wells is not necessary for the remedy to be effective. The french drain, RW-04, and RW-07 may provide adequate source control, and air sparging may provide adequate mass reduction for the plume fringes. Quarterly monitoring at some locations may be needed as part of this evaluation. If air sparging is found to be effective with limited pumping, the site team should consider discontinuing nutrient injection for an extended period (perhaps six months to a year) to determine if the nutrient injection is necessary for remedy effectiveness.

The RSE-lite team notes that a substantial portion of site costs for the past two years has been due to non-routine items, such as DNAPL evaluations and a pilot test. The proposed non-routine evaluations suggested above should not substantially add to the site costs. In fact, the first evaluation might result in a net cost savings because cost savings from temporarily shutting down some components could be used to offset the costs for increased monitoring and data analysis. The site team should also use local labor for O&M and ground water monitoring, as discussed in section 6.2.1.

6.4.2 CONSIDERATIONS FOR EVALUATING THE THERMAL PILOT STUDY

The thermal pilot study is scheduled to begin in the months following the RSE-lite conference call and will not likely be concluded before the RSE-lite report is finalized. The RSE-lite team will not comment on the implementation of the pilot since it has been in the planning stage for a number of months; however, the RSE-lite team does have a few suggestions for evaluating the study.

The cost estimate for the pilot study in a 40-foot by 40-foot area is $473,465. In evaluating the success of the pilot study, the site team should carefully consider the scale-up cost for full-scale operation. The scale-up cost might include economies of scale, but it might also include additional costs such as treatment of extracted vapors. If the current unit cost of $473,465 for a 1,600 foot area apply to the 4.2 acres that are impacted by free or residual product, the cost for full-scale operation would be approximately $54 million if the costs scaled directly with the volume to be treated. This cost, or even half of that cost ($27 million), would not be financially favorable for EPA compared to continuing to operate the current remedy (or especially an optimized form of the current remedy). The site contractor provided a vendor estimate for $8 million to $10 million dollars for a full-scale application; however, the RSE-lite team is concerned about the potential for actual costs to be much higher. As one simple example, during the pilot test, treatment of extracted vapors is not planned, but treatment of extracted vapors for a full-scale remedy would likely be required. The RSE-lite team has seen technical problems associated with the extraction and treatment of vapors from thermal remedies at other sites, and similar problems could occur at this site and not be accounted for in the $8 to $10 million estimate.

It is understood that over the long-term, the State would likely benefit financially if more aggressive remediation were conducted during LTRA. However, it is unclear if a full-scale thermal remedy will allow P&T to be discontinued or that an estimated cost of $8 million to $10 million or higher would be a viable upfront investment for EPA at this site. If funding is available for a large upfront investment, the RSE-lite team suggests that a full-scale thermal remedy might be cost-effective to EPA if it could be conducted for a guaranteed price of $9 million, and there is a guarantee that active remediation would not be required upon completion of thermal remediation. The RSE-lite team estimated the guaranteed price by determining the cost of operating a P&T system under the following assumptions:

- a conservative annual cost of approximately $300,000 (i.e., $250,000 per year for O&M and $50,000 per year for non-routine costs, such as equipment replacement)
- a conservative discount rate of 3%
- a remedy duration of approximately 90 years (i.e., three times the typical time frame used by EPA for calculating net present value)

It should be noted that the RSE-lite team believes the remedy can be run more cost-effectively than the assumed $300,000 per year and that this higher value was only included as a conservative assumption.

If a guaranteed cost of approximately $9 million is achievable, including financial assurance in case of a failed remedy and an insolvent thermal vendor, then the site team should determine the concentrations that need to be achieved by thermal remediation to obviate the need for further active remediation (i.e., continued P&T). These concentrations would be an important factor for a thermal contractor to know before offering a guarantee on the thermal remedy performance. The site team might use ground water flow and transport modeling to help determine these target concentrations, but such an evaluation should not be conducted unless it is clearly proven that quality full-scale thermal remedy can be conducted for a guaranteed cost of $9 million or less.

In addition, before proceeding with thermal remediation or other steps in preparing for thermal remediation, the site team should conduct an evaluation of the P&T component of the remedy by temporarily discontinuing P&T and continuing air sparging as suggested in Recommendation 6.4.1. This evaluation would give the site team critical information about future O&M costs (which would be much lower if P&T could be discontinued), about the potential for migration in the absence of pumping, and about remediation standards that the thermal application would need to reach to prevent followup active remediation. If air sparging alone is protective and P&T is no longer required, then the annual O&M costs would be lower, and the thermal remediation cost would have to be lower before to be cost-effective.

6.5 SUGGESTED APPROACH TO IMPLEMENTATION

The effectiveness recommendations (6.1.1 through 6.1.3) and the cost reduction recommendations (6.2.1 and 6.2.2) are high priority items, do not conflict with each other, and would need to be implemented regardless of the site's path forward. They should be implemented first. Implementation of the technical improvement recommendations should not conflict with implementing the other recommendations, but implementation of these technical improvement recommendations are not as high a priority. They should be implemented as soon as practicable without interfering with implementation of the other recommendations.

Recommendations 6.4.1 and 6.4.2 are timely given the impending conclusion of the thermal pilot study. Because the cost-effectiveness of full-scale thermal remediation depends on the expected life-cycle costs of the existing long-term, Recommendation 6.4.1 should be implemented before taking significant steps toward full-scale thermal remediation and before comparing the life-cycle costs of thermal remediation vs. ongoing P&T and/or air sparging. With respect to Recommendation 6.4.1, the site team should evaluate the role of the P&T system (by temporarily shutting it down and using only air sparging) before evaluating the role of the air sparging system (by temporarily shutting it down and using only P&T).

7.0 SUMMARY

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 obvious 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 site closeout. Recommendations for effectiveness are primarily focused on plume delineation and construction of potentiometric surface maps. Recommendations for cost reduction include changing to a local contractor for O&M services and ground water sampling, and reducing ground water sampling locations and sampling frequency. The technical improvement recommendations include considering an alternative to using a sequestering agent, reducing frequency of water level measurements, and discontinuing dissolved oxygen monitoring. They also include adding a suffix to well labels to differentiate the shallow and deep wells when generating site maps and data tables. The recommendations for site closeout document the RSE-lite team's suggestions regarding evaluating various current remedy components by running them independently and suggestions regarding potential scale-up issues associated with the thermal pilot study.

Table 7-1 summarizes the costs and cost savings associated with each recommendation in Sections 6.1 through 6.3. Both capital and annual costs are presented. Also presented is the expected change in life-cycle costs over a 30-year period for each recommendation both with discounting (i.e., net present value) and without it.

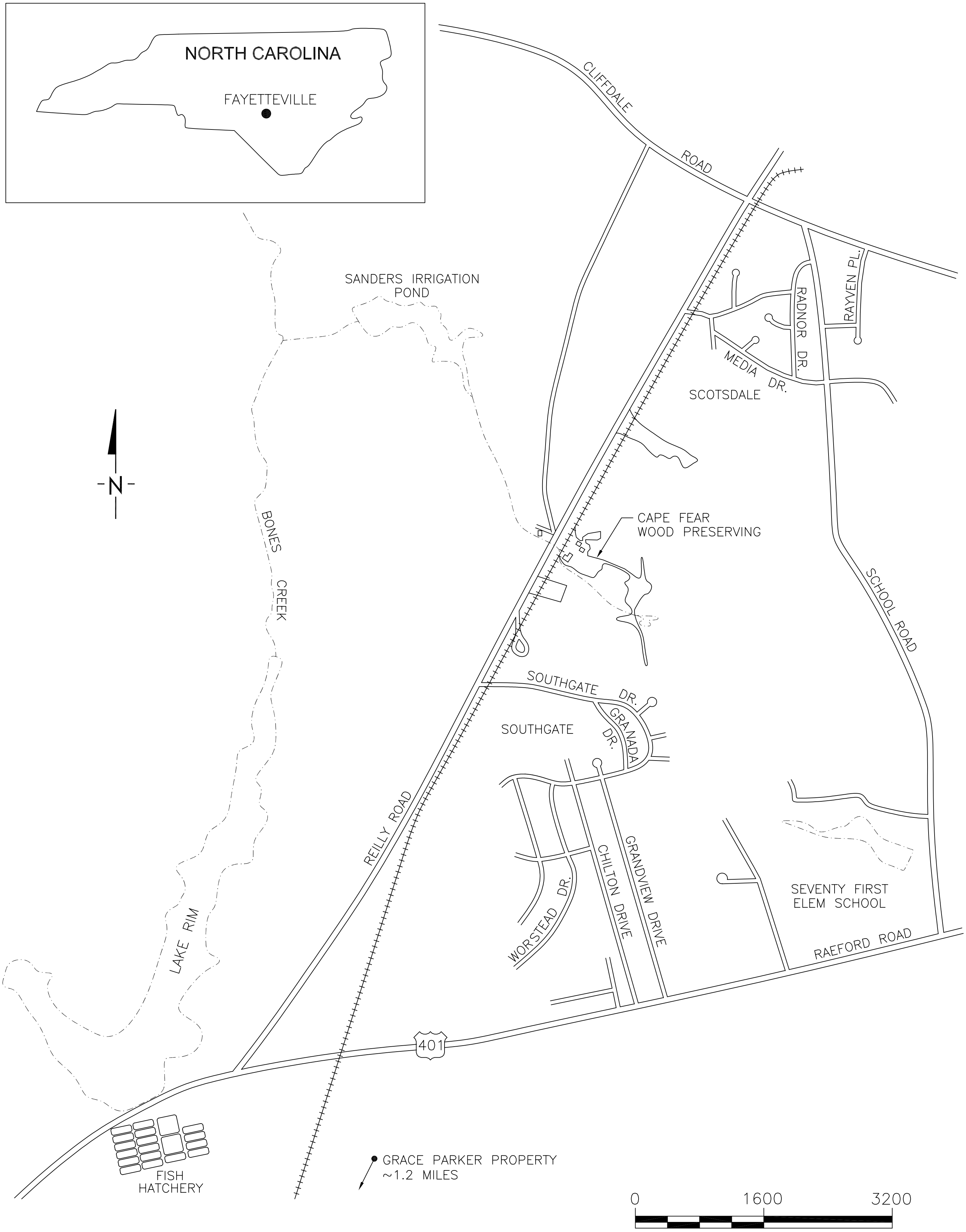
Table 7-1. Cost Summary Table

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 Install and Sample a Monitoring Well Downgradient of MW-16	Effectiveness	$15,000	negligible	$15,000	$15,000
6.1.2 Sample Outer Monitoring Wells Annually	Effectiveness	negligible	$4,000	$120,000	$65,000
6.1.3 Do Not Use Water Levels from Operating Recovery Wells or Infiltration Galleries when Generating Potentiometric Surface Maps	Effectiveness	$0	$0	$0	$0
6.2.1 Contract O&M Services and Ground Water Sampling to a Local Contractor	Cost Reduction	negligible	($85,000)	($2,550,000)	($1,372,000)
6.2.2 Eliminate Select Monitoring Wells from Ground Water Monitoring Program and Reduce Sampling (and Associated Reporting) Frequency from Quarterly to Annually	Cost Reduction	negligible	($35,000)	($1,050,000)	($565,000)
6.3.1 Consider Alternatives Before Adding a Sequestering Agent	Technical Improvement	Not quantified	Not quantified	Not quantified	Not quantified
6.3.2 Reduce Frequency of Water Level Measurements from Monitoring Wells, Discontinue Dissolved Oxygen Monitoring, and Simplify Monthly O&M Reports	Technical Improvement	Included in 6.2.1	Included in 6.2.1	Included in 6.2.1	Included in 6.2.1
6.3.3 Add a Suffix to Well Labels to Indicate Shallow and Deep Wells	Technical Improvement	$0	$0	$0	$0
6.4.1 Evaluate Effectiveness of Various Remedy Components	Site Closeout	Not quantified	Not quantified	Not quantified	Not quantified
6.4.2 Considerations for Evaluating the Thermal Pilot Study	Site Closeout	$0	$0	$0	$0

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

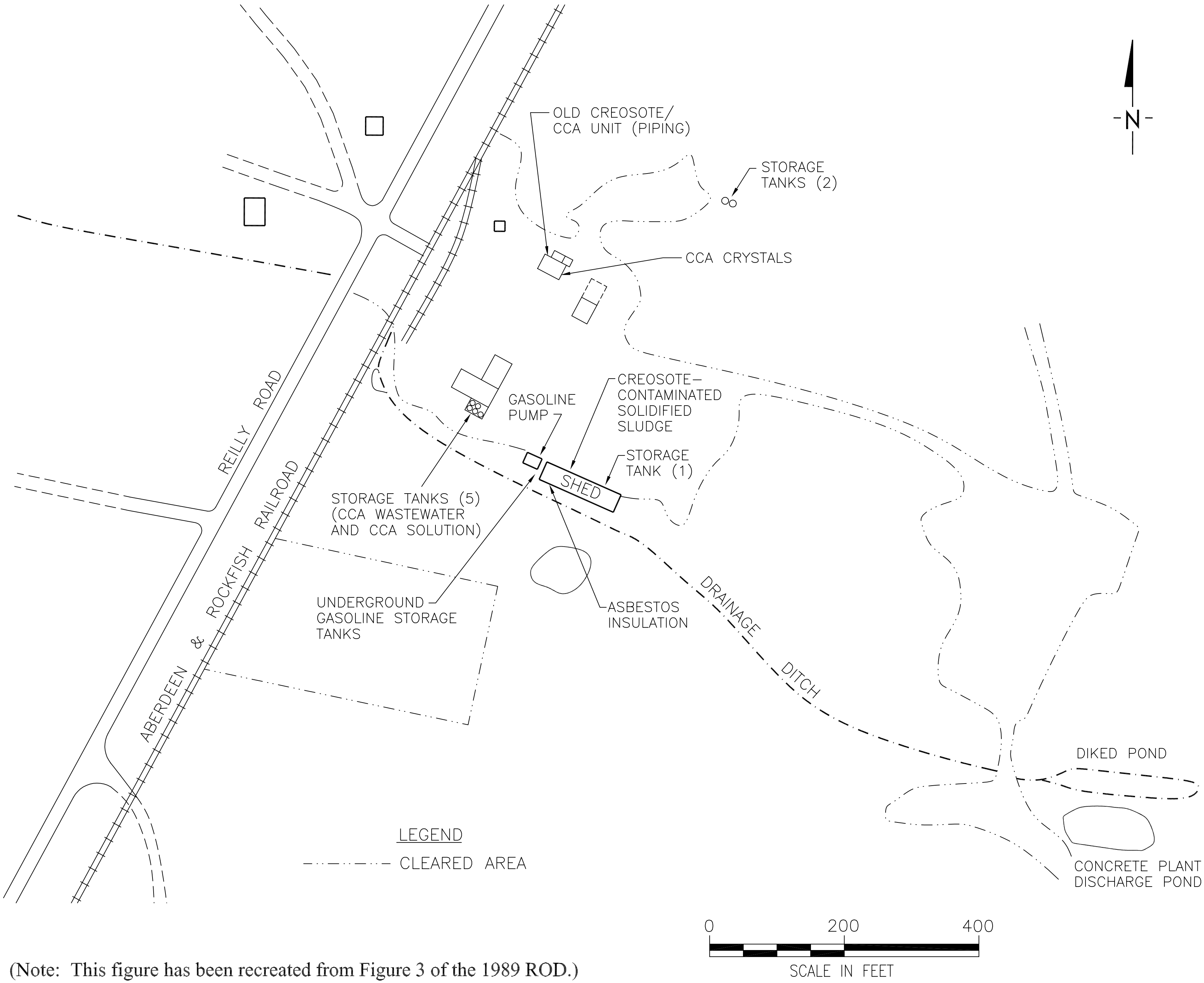
FIGURES

FIGURE 1-1. SITE LOCATION MAP.



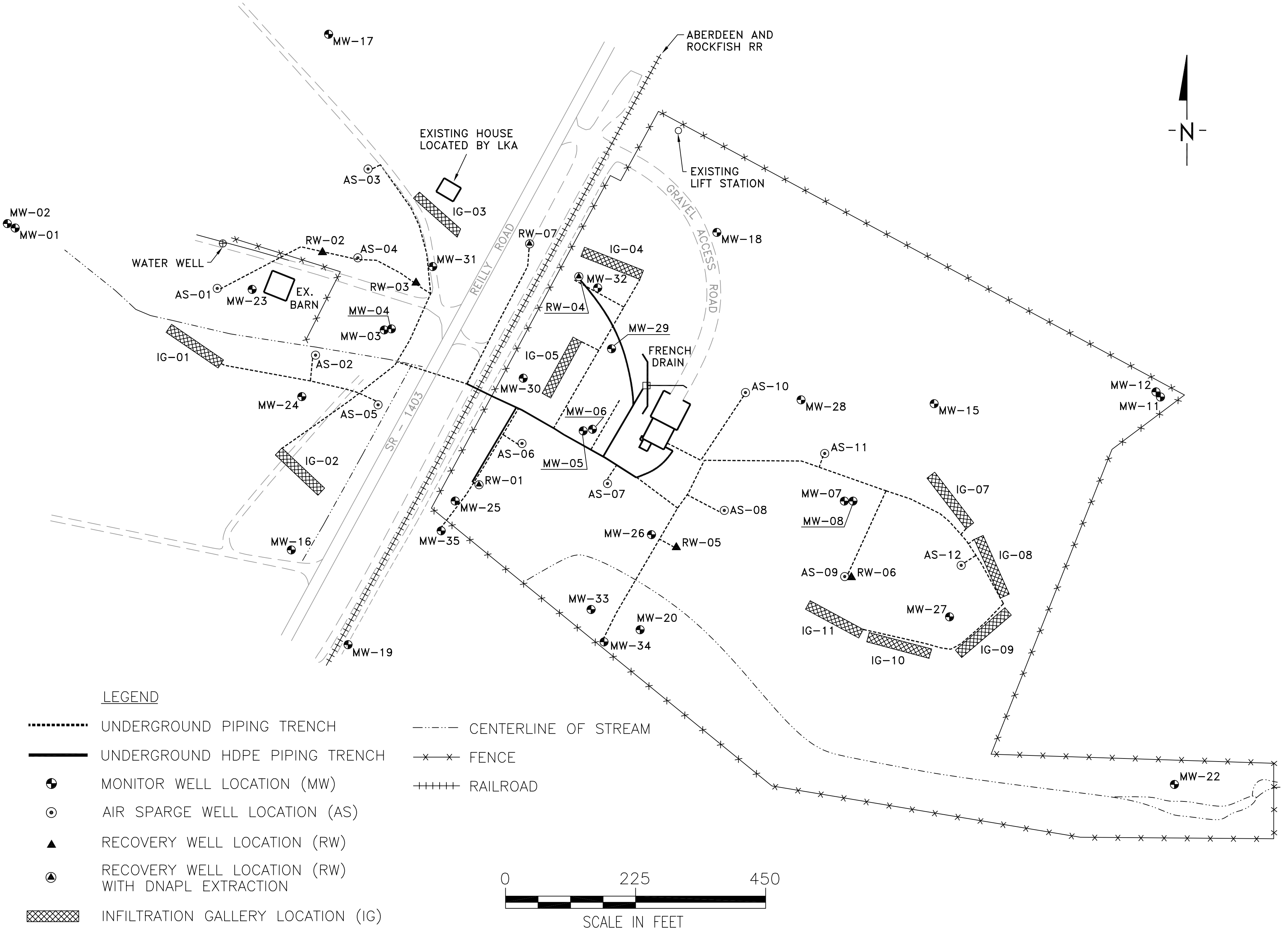
(Note: This figure has been recreated from Figure 1 of the 1989 ROD.)

FIGURE 1-2. HISTORICAL FACILITY LAYOUT.



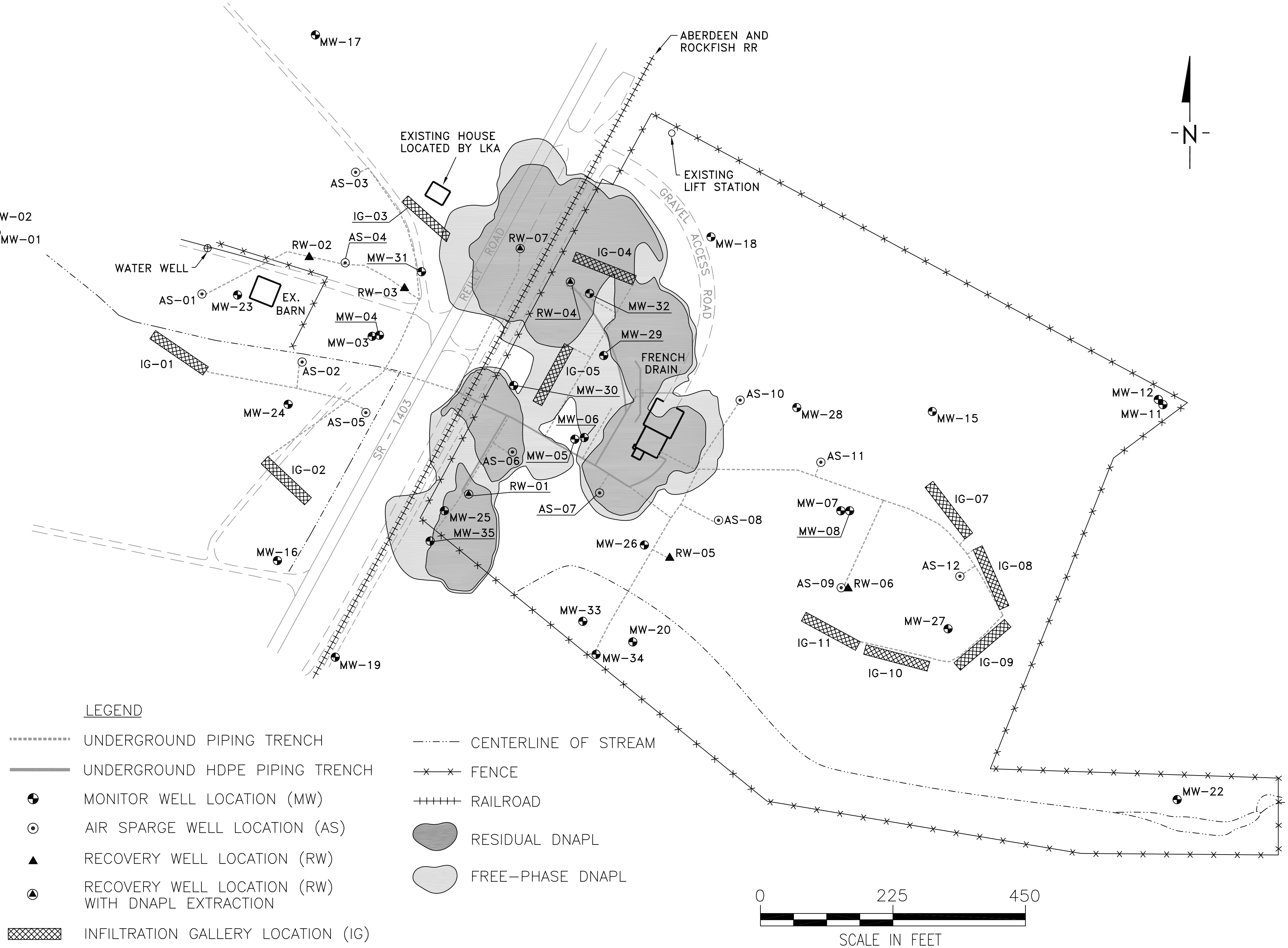
(Note: This figure has been recreated from Figure 3 of the 1989 ROD.)

FIGURE 1-3. SITE LAYOUT WITH WELL LOCATIONS.



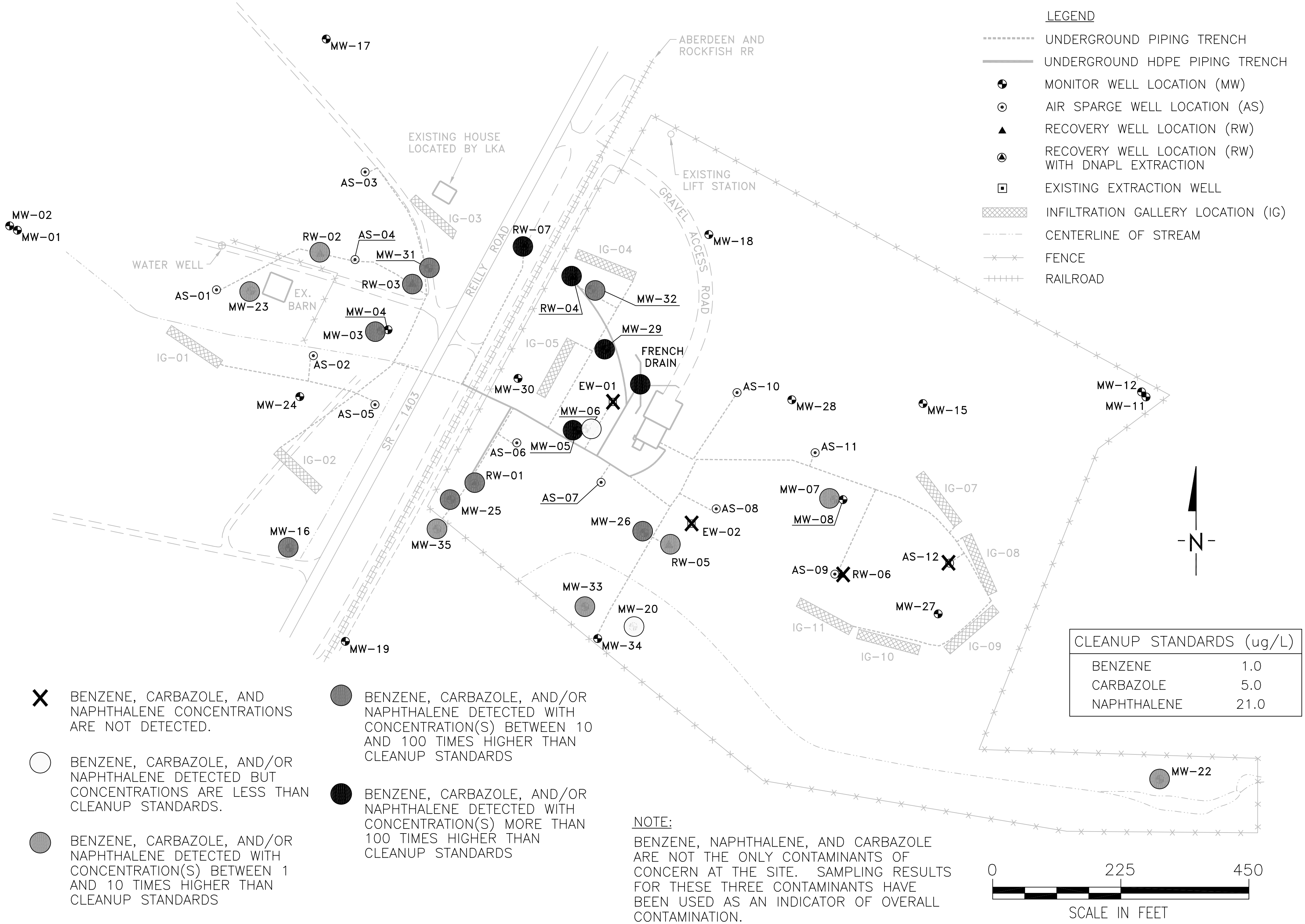
(Note: This figure has been recreated from Figure 2 of the March 2004 Monthly Operation & Maintenance Report, WRS, 2004.)

FIGURE 1-4. ESTIMATED EXTENT OF DNAPL.



(Note: This figure has been recreated from Figure 2 of the March 2004 Monthly Operation & Maintenance Report, WRS, 2004.)

FIGURE 1-5. EXTENT OF DISSOLVED GROUNDWATER CONTAMINATION BASED ON THE 4TH QUARTER 2003 SAMPLING RESULTS.



(Note: This figure has been recreated from Figure 2 of the March 2004 Monthly Operation & Maintenance Report, WRS, 2004 using data presented in Figure 5-1 of the 4th Quarter 2003 Report for the Groundwater Pump and Treat System, BVSPC, 2004.)