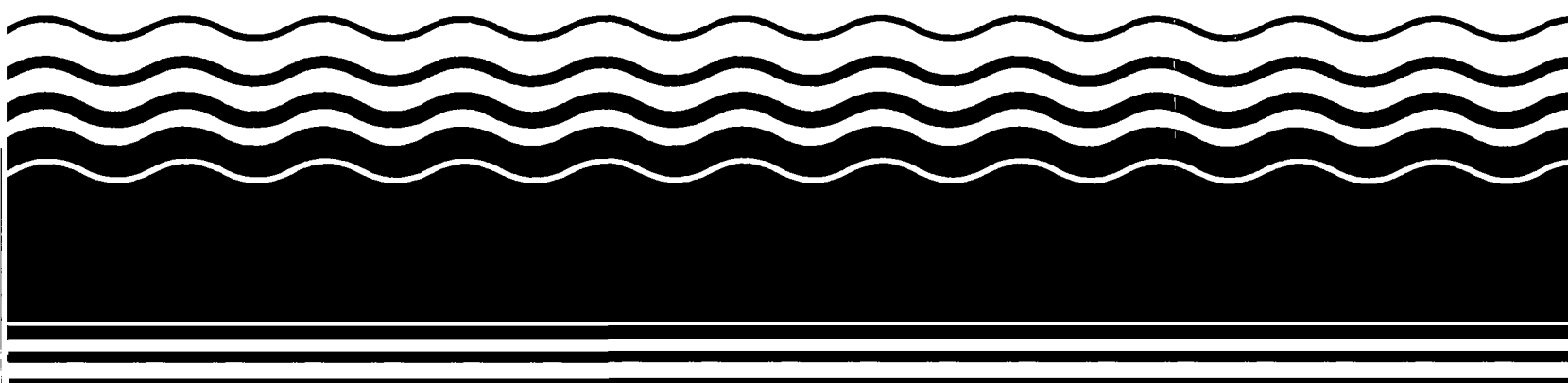




Superfund Record of Decision:

Elmore Waste Disposal, SC



REPORT DOCUMENTATION PAGE		1. REPORT NO. EPA/ROD/R04-93/142	2.	3. Recipient's Accession No.
4. Title and Subtitle SUPERFUND RECORD OF DECISION Elmore Waste Disposal, SC First Remedial Action - Final			5. Report Date 04/26/93	
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7. Author(s)			8. Performing Organization Rept. No.	
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12. Sponsoring Organization Name and Address U.S. Environmental Protection Agency 401 M Street, S.W. Washington, D.C. 20460			13. Type of Report & Period Covered 800/800	
			14.	
15. Supplementary Notes PB94-964040				
16. Abstract (Limit: 200 words) <p>The one-half-acre Elmore Waste Disposal site is a waste disposal facility located in Greer, Spartanburg County, South Carolina. Land use in the area is mixed light commercial, industrial, and residential. In addition, the site and surrounding area lie within the Inner Piedmont Belt Core of the Piedmont Physiographic Province outside of the 100-year flood elevation. Residents within Greer use the municipal water system for their drinking water supply; and no private water wells are located within one mile of the site. Between 1975 and 1977, the site owner accepted numerous drums containing various liquid and solid waste. In 1977, a State inspection discovered a number of drums, some of which were leaking, and in 1977, the State ordered the site owner to clean up the site and properly dispose of the waste materials. In 1979, the State notified the site owner of non-compliance, and in 1980, EPA identified a partially buried 6,000-gallon storage tank, containing what appeared to be waste oil, and approximately 100 unmarked leaking drums during a site investigation. In 1981, another EPA site investigation revealed that twenty-five 55-gallon drums containing soil and/or wood chips remained onsite. A soil sample revealed the presence of elevated concentrations of numerous inorganic contaminants including chromium, copper, cyanide, lead, and zinc, as well as twenty-two organic compounds. In 1983, another State</p> <p>(See Attached Page)</p>				
17. Document Analysis				
a. Descriptors Record of Decision - Elmore Waste Disposal, SC First Remedial Action - Final Contaminated Media: soil, gw Key Contaminants: VOCs (benzene, PCE, TCE), metals (arsenic, chromium, lead)				
b. Identifiers/Open-Ended Terms				
c. COSATI Field/Group				
18. Availability Statement		19. Security Class (This Report) None		21. No. of Pages 120
		20. Security Class (This Page) None		22. Price

Abstract (Continued)

inspection identified 250 to 300 drums in various stages of decay; a large, partially buried storage tank; and an empty tanker trailer. In 1984, further soil sampling for a site screening study confirmed elevated levels of inorganic and organic contaminants in onsite soil as a result of these improper disposal activities. In 1986, the State conducted a removal action which included excavation, transportation, and disposal of approximately 5,000 yd³ of contaminated soil and 16,840 pounds of liquids, backfilling excavated areas with 5,456 yd³ of clean dirt, and installing four monitoring wells onsite after the removal was completed. In 1986 and 1987, samples from these wells revealed ground water contamination by VOCs and metals. This ROD addresses a first and final action to prevent contaminated shallow soil from leaching to ground water and to remove future risks posed by usage of contaminated ground water. The primary contaminants of concern affecting the soil and ground water are VOCs, including benzene, PCE, and TCE; and metals, including arsenic, chromium, and lead.

The selected remedial action for this site includes excavating contaminated soil until remaining soil achieves the concentrations of arsenic 10 mg/kg and lead 500 mg/kg; conducting verification sampling, pretreating the excavated soil, if necessary, and transporting the soil to a permitted RCRA hazardous waste landfill; backfilling and revegetating excavated areas; designing, constructing, and operating a ground water extraction system; treating extracted ground water onsite using aeration by oxidation, chemical reduction, and chemical precipitation through pH adjustment, in combination with phase separation by flocculation, sedimentation, and filtration to remove metals; dewatering solids from the treatment process and temporarily storing these onsite for later disposal in a RCRA landfill; using an air-, gas-, or steam stripping unit to remove VOCs, followed by treatment using an activated carbon "polishing" unit; discharging the treated ground water offsite to an industrial sewer or other appurtenance of the local POTW; and monitoring ground water and surface water. The estimated present worth cost for this remedial action is \$2,823,300, which includes an estimated total O&M cost of \$1,494,200 for 30 years.

PERFORMANCE STANDARDS OR GOALS:

Soil excavation goals are based on either health-based remediation goals, EPA Region health-based level of concern, or leachability-based remediation goals. Chemical-specific soil excavation levels for surface soil for metals include arsenic 10 mg/kg; beryllium 4 mg/kg; and lead 500 mg/kg. Chemical-specific subsurface soil cleanup levels include arsenic 300 mg/kg; beryllium 9 mg/kg; cadmium 4 mg/kg; chromium 800 mg/kg; manganese 10,000 mg/kg; nickel 400 mg/kg; and vanadium 600 mg/kg. Ground water clean-up goals are based on either MCLs, proposed State MCLs, EPA action levels, or health-based remediation goals. Chemical-specific ground water cleanup goals include benzene 5 ug/l; beryllium 4 ug/l; cadmium 5 ug/l; carbon tetrachloride 5 ug/l; chromium 100 ug/l; cis-1,2-DCE 70 ug/l; lead 15 ug/l; manganese 3,000 ug/l; methylene chloride 5 ug/l; nickel 100 ug/l; PCE 5 ug/l; 1,1,1-TCA 200 ug/l; 1,1,2-TCA 5 ug/l; TCE 5 ug/l; vanadium 200 ug/l; and vinyl chloride 2 ug/l.

RECORD OF DECISION
SUMMARY OF REMEDIAL ALTERNATIVE SELECTION

ELMORE WASTE DISPOSAL SUPERFUND SITE

GREER, SPARTANBURG COUNTY
SOUTH CAROLINA

PREPARED BY:

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IV
ATLANTA, GEORGIA

DECLARATION FOR THE RECORD OF DECISION

SITE NAME AND LOCATION

Elmore Waste Disposal
Greer, Spartanburg County, South Carolina

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial action for the Elmore Waste Disposal Superfund Site (the Site) in Greer, South Carolina, which was chosen in accordance with the the Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986 and, to the extent practicable, the National Oil and Hazardous Substances Contingency Plan (NCP). This decision is based on the administrative record file for this Site.

The State of South Carolina concurs with the selected remedy.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDY

This remedial action addresses onsite soil contamination, the principal threat at this Site; as well as onsite and offsite groundwater contamination.

The major components of the selected remedy include:

SOURCE CONTROL

- ☐ Excavation of contaminated surface and shallow subsurface soil, with verification sampling;
- ☐ Transport of the soil to a permitted RCRA hazardous waste landfill;
- ☐ Disposal at the RCRA landfill facility, including treatment of the soils if necessary to comply with Land Disposal Restrictions (LDRs).

GROUNDWATER

- ☐ Extraction of contaminated groundwater from the surface (shallow) and intermediate aquifers;
- ☐ Treatment using aeration, chemical precipitation and filtration to remove inorganic contaminants; and air/gas/steam stripping to remove organic contaminants;
- ☐ Discharge of the treated groundwater to a local Publicly-Owned Treatment Works (POTW).

CONFIRM EXTENT OF GROUNDWATER CONTAMINATION

- ☐ Further sampling to confirm the absence of contributing sources of contamination east and north of the Site;
- ☐ Further sampling to confirm or further delineate the vertical extent of groundwater contamination.

SITE MONITORING

- ☐ Quarterly sampling of groundwater and surface water samples to monitor the concentrations and movement of contaminants.

STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost effective. This remedy utilizes permanent solutions and alternative treatment technology to the maximum extent practicable for this Site. However, because treatment of the contaminated soil was not found to be practicable, the soil remediation component of this remedy does not satisfy the statutory preference for treatment as a principal element. The selected groundwater remedy component satisfies the preference for treatment.

Since selection of this remedy will result in contaminated groundwater remaining onsite above health-based levels until remedy implementation is complete, a review will be conducted within five years after commencement of remedial action to insure that the remedy continues to provide adequate protection of human health and the environment.

Patrick M. Tobin

Patrick M. Tobin
Acting Regional Administrator

4-26-93

Date

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DECISION SUMMARY
ELMORE WASTE DISPOSAL SUPERFUND SITE
GREER, SPARTANBURG COUNTY, SOUTH CAROLINA

Page 1

1.0 SITE LOCATION AND DESCRIPTION

The Elmore Waste Disposal Site (the Site) is located near the intersection of Sunnyside Drive and East Poinsett Street (South Carolina Highway 290) in the City of Greer, Spartanburg County, South Carolina (Figure 1). Site coordinates are 34°56'07.3" North latitude and 82°13'00.5" West longitude.

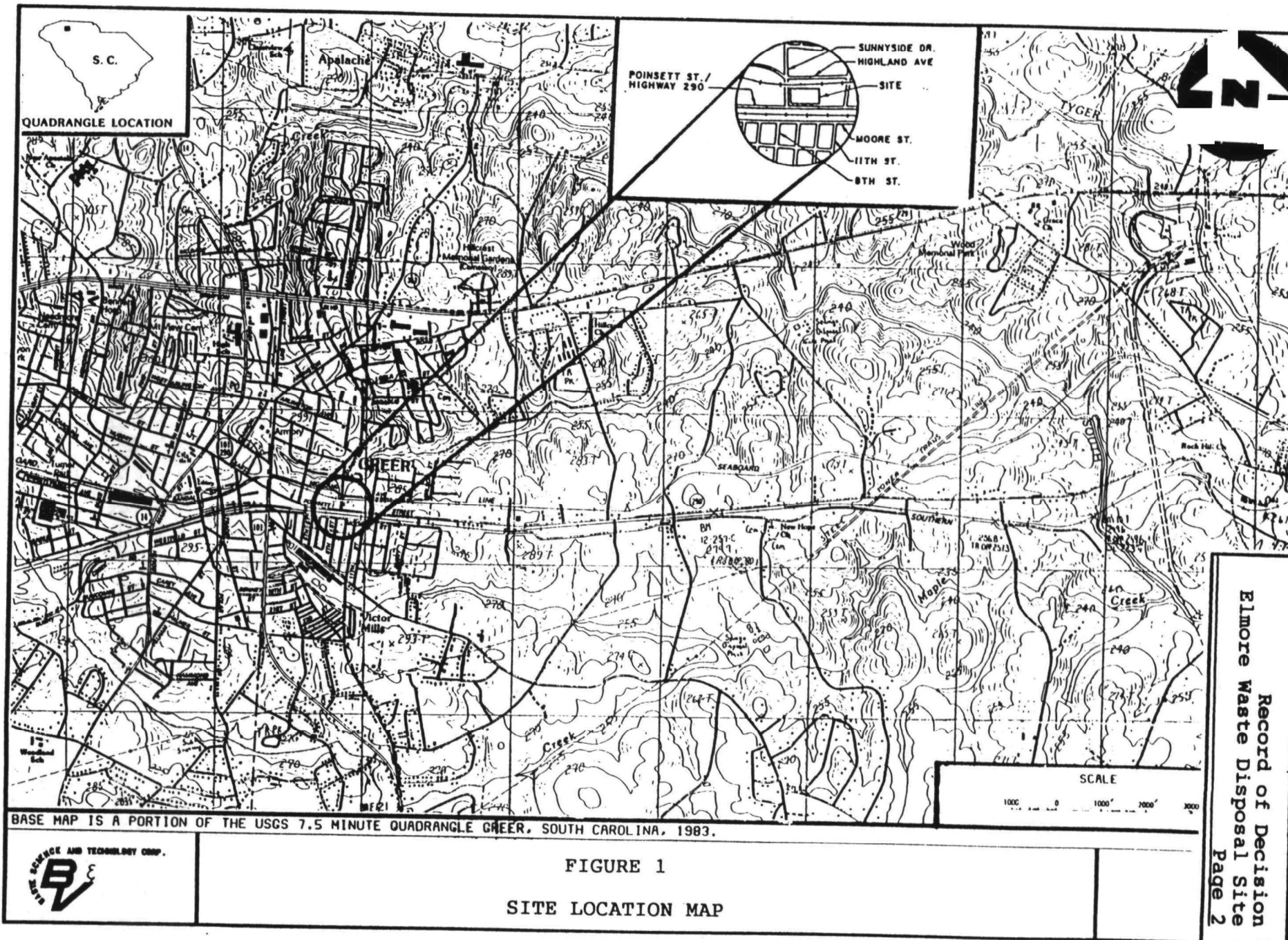
1.1 Site Description

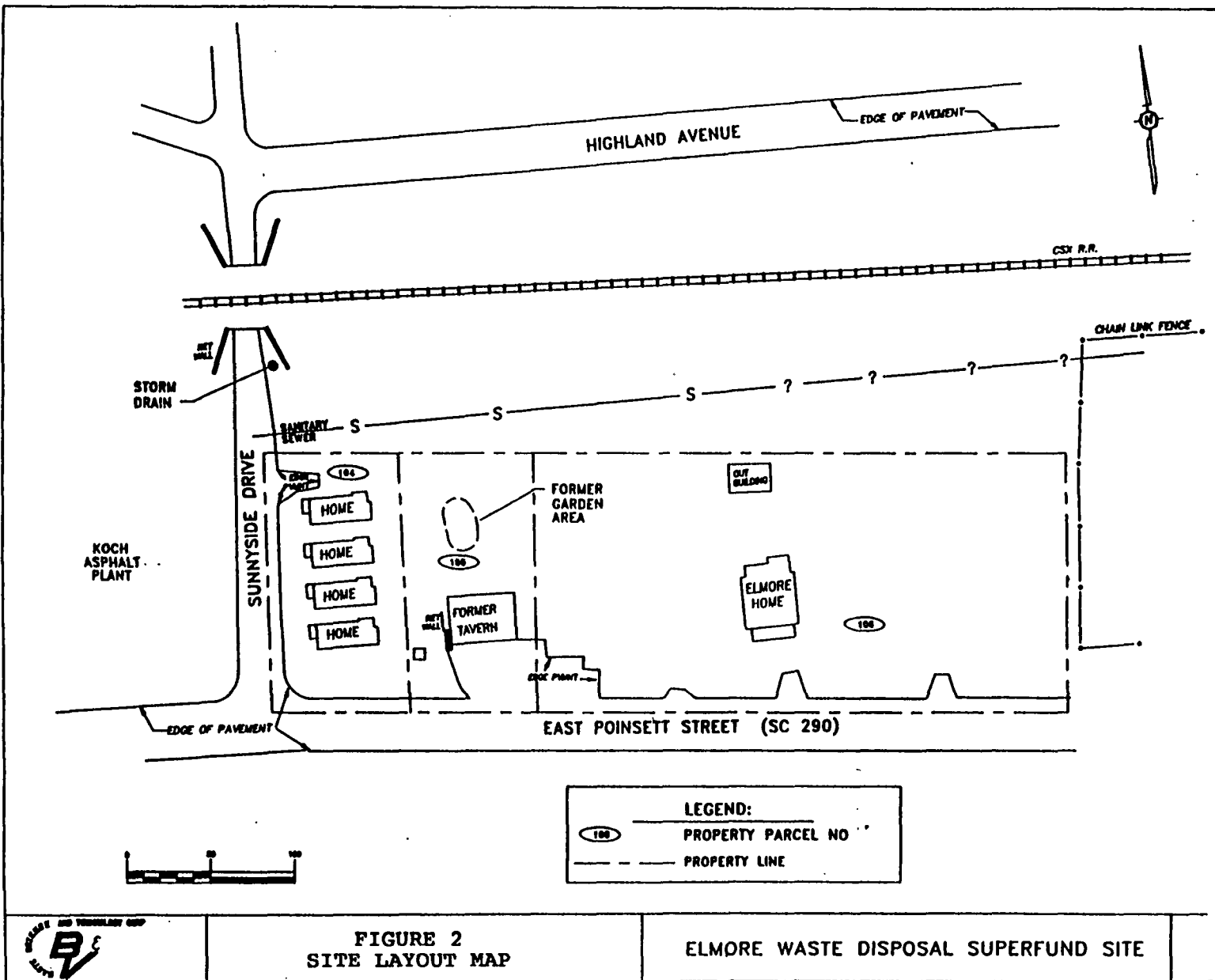
The Site is a grassy field approximately one-half acre in size. The Elmore home and the largest Site land parcel (Figure 2) is owned by William J. Elmore, Sr. The site is not enclosed by a fence, and access is unrestricted.

On the west side of the Elmore Site are an empty building (a former tavern) and four residential homes. These two land parcels are owned by Mrs. Betty K. Pearson, sister of William Elmore, and Mr. Thomas Wood, respectively. A railroad owned by CSX Transportation, Inc., borders the Site on the north, and Poinsett Street (SC Highway 290, a two-lane highway) is the southern boundary. A single family residence borders the Site to the east. The area between East Poinsett Street and the northern set of CSX Railroad tracks, encompassing the Site, is zoned for "light commercial" use. Just across Sunnyside Drive west of the Site, an asphalt plant occupies land zoned industrial. To the north of the Site, beyond the CSX Railroad tracks, is an area of single family homes which is zoned residential.

Most of the city of Greer lies within one mile to the west/northwest of the Site. Land to the east and southeast of the Site is mainly used by small businesses and industries. These businesses and industries are surrounded by large tracts of pasture land. According to the Spartanburg County Planning Department, most residential expansion in the vicinity of the Site is toward the south and southeast.

A well search/survey early in the Remedial Investigation verified that all area residences are on the Greer city water system, and that no private water wells are located within one mile of the Site. The source of the Greer public water system is Lake Cunningham on the South Tyger River. Lake Cunningham is located approximately 3.4 miles north of Greer, five miles upstream from the confluence of Wards Creek and the South Tyger River. Wards Creek is a small tributary located approximately 700 feet north of the Site, which flows northeasterly into the South Tyger River. The South Tyger River and its tributaries are classified by the State of South Carolina as Class B waters, suitable for fishing and as a drinking water source after standard treatment.





1.2 Site Topography and Drainage

The Site is a grassy field with a dense incursion of kudzu in the north and western portions. Surface elevations at the Site decrease toward the northwest, with slopes ranging from 5 to 10 percent (Figure 3). Surface drainage and runoff from the Site flows northwestward and discharges into a storm drain inlet (shown on Figure 2) located at the intersection of Sunnyside Drive and the CSX Railroad tracks overpass. This storm drain consists of both below-grade concrete pipe sections and open concrete ditch sections. The storm drain also receives runoff from the asphalt plant, Sunnyside Drive south of the railroad overpass, and Highland Avenue. From the inlet, the drainage ditch runs northward along Sunnyside Drive and discharges into Wards Creek approximately 700 feet north of the Site. Based on the 1978 floodplain map for the area, the Site lies outside the 100-year flood elevation.

1.3 Meteorology

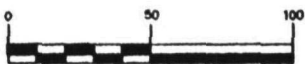
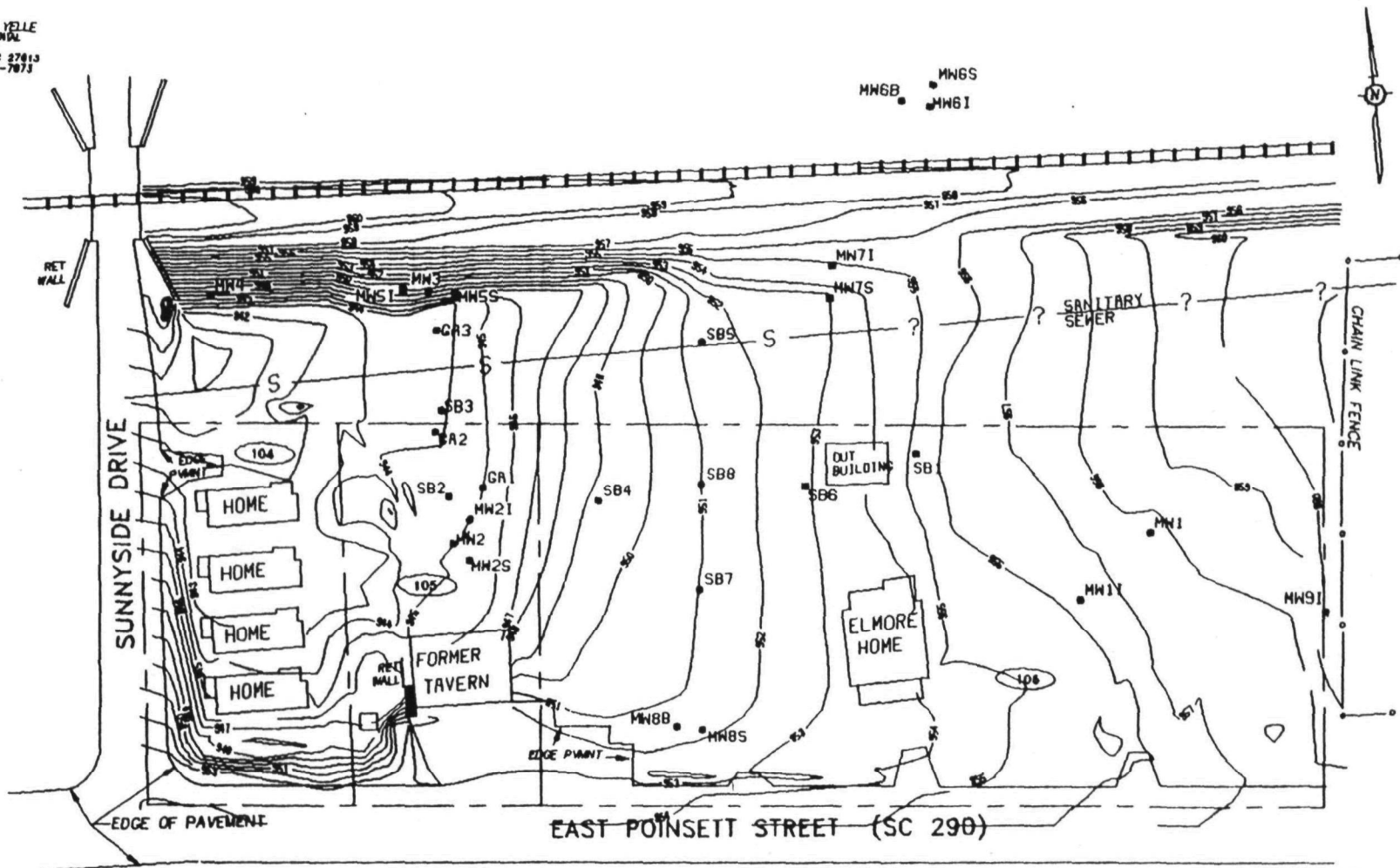
The annual precipitation in Greer is 51.18 inches and is well distributed throughout the year. However, at most only one-quarter to one-third of the precipitation filters down into the saturated zone, while the remainder is lost to surface runoff or evapotranspiration. The mean annual lake evaporation is 40 inches. Average monthly temperatures range from 39.7°F in January to 78.2°F in July. The normal daily minimum and maximum temperatures in the coldest month, January, are 29.7°F and 49.7°F, respectively. The normal daily minimum and maximum temperatures for the warmest month, July, are 68.3°F and 88.0°F, respectively. The annual prevailing winds are from the northeast at a mean speed of 6.8 mph.

1.4 Geologic and Hydrogeologic Setting

The Site and surrounding area lie in the Inner Piedmont Belt Core of the Piedmont Physiographic Province (Figure 4). The Piedmont Physiographic Province is characterized by very dense dendritic stream drainage and well developed topography.

The soil of the Inner Piedmont Core Belt can be classified as Cecil sandy loam with a typical slope of six to ten percent. The pH of Cecil soils is generally in the range of 4.5 to 6.5 at the surface layer to 4.5 to 5.5 at deeper levels. The upper soil zone is a grayish-brown, yellowish-brown, and brown very friable sandy loam varying from one to ten inches thick. According to the Unified Soil Classification System, the soil consists of approximately 35 percent to 40 percent silts and clays, and 60 percent to 65 percent sand. It is a well drained soil that was formed from weathered granite, gneiss, and schist. The

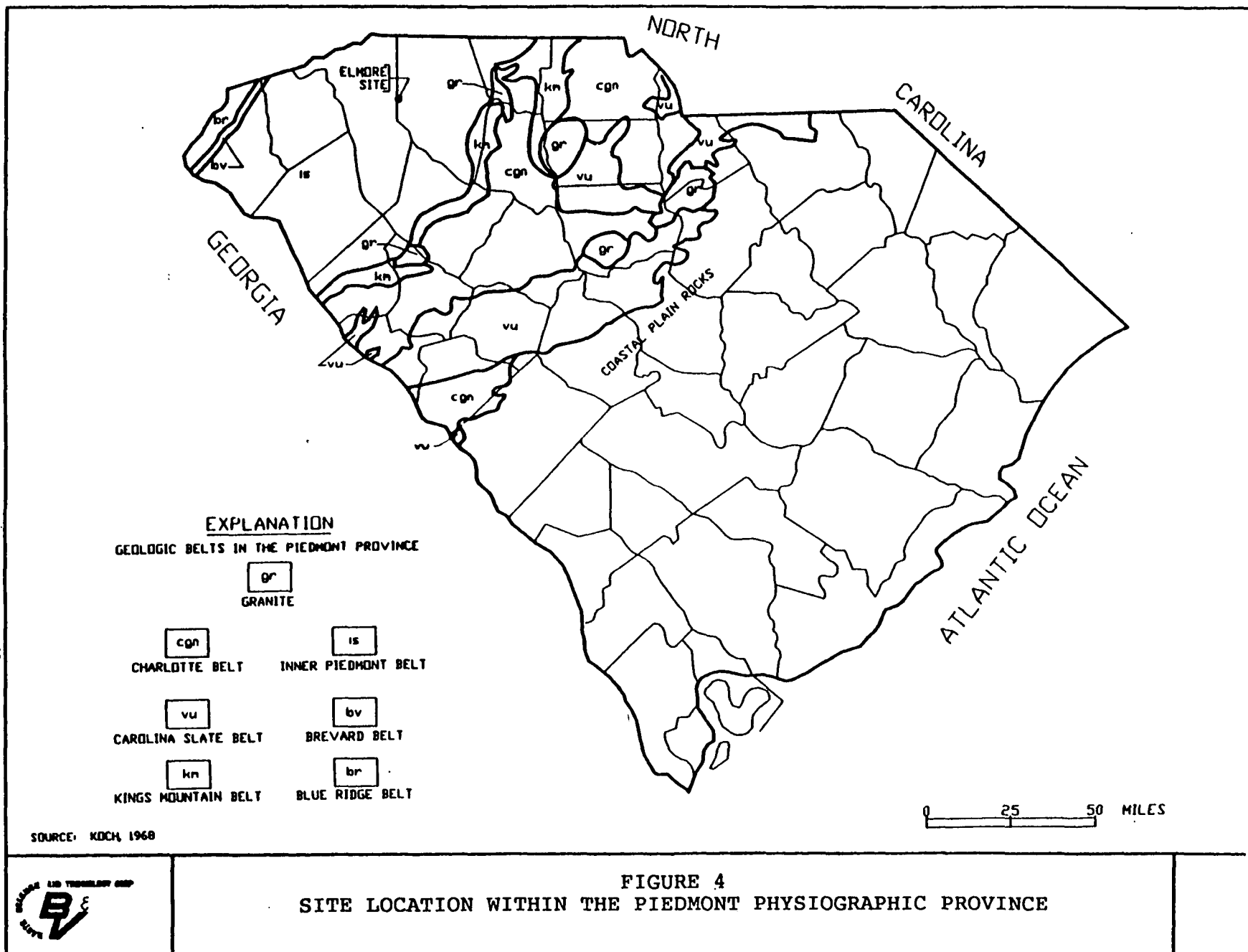
SOURCE:
MURPHY YELLE
ENVIRONMENTAL
SURVEYING
Raleigh, NC 27613
(919) 787-7873



LEGEND	
GA	SHALLOW SOIL SAMPLE
SB	SOIL BORING
MW	MONITORING WELL
---	PROPERTY LINES

FIGURE 3
SITE TOPOGRAPHIC MAP

ELMORE WASTE DISPOSAL SUPERFUND SITE



infiltration, permeability, and available water capacity fall into moderate ranges. The subsoil is a red, firm clay that is exposed in many high degree slope areas due to the occurrence of severe erosion.

The bedrock of the Inner Piedmont Geological Belt consists predominantly of a blue to gray granitic bedrock. This bedrock has undergone regional metamorphism to form biotite gneiss, biotite schist, quartzite, hornblende gneiss, and related metamorphic rock types. At the Elmore Waste Disposal Site, the biotite gneiss consists of a medium to coarse-grained quartz and feldspar with accessory biotite and muscovite which weathers to dark red, clay-rich saprolite. In less weathered zones, fractures develop along bedding and cleavage planes within individual geologic units, and are capable of transmitting significant amounts of water. Volcanic intrusions are common throughout the Inner Piedmont Core Belt.

Across the bulk of the region, the hard crystalline rocks have weathered into a soft clayey or sandy saprolite. Often, the saprolite retains much of the original rock structure. The saprolite may occur at the surface to as deep as 140 feet or more below land surface.

The primary source of recharge to the aquifers in the Piedmont Physiographic Province of South Carolina is surface infiltration from precipitation and snowmelt. Since all of the region experiences steady and plentiful rainfall throughout most of the year, the water table is affected more by surface features than by climate. Groundwater is thus recharged more heavily in low lying regions than in upper elevations, and the water table tends to generally conform to surface topography. The water table occurs at depths ranging from a few feet below the surface in low valleys, to more than 100 feet in the higher elevations.

Groundwater throughout the region occurs in both the fractured metamorphic bedrock and the overlying saprolitic zone. The two layers are frequently hydraulically connected, allowing the weathered saprolite to recharge the unweathered metamorphic bedrock. Because of the geology of the region and the pathways of recharge, groundwater flow can be expected to mirror the regional surface flow to the southeastern and lower elevations.

Saprolite in the Greer area generally ranges from 40 to 60 feet thick. The saprolite may be as thick as 200 feet in valleys where well yields are generally sufficient for domestic use. Higher yield wells typically extend to the fractured metamorphic bedrock at depths of 150 to 250 feet. These deep rock wells intersect water-bearing fractures and faults and yield up to 200

gallons per minute, depending on the abundance and interconnection of the fractures in the metamorphic rock units. The groundwater aquifer in the Greer area is classified by EPA as Class IIB and by South Carolina as Class GB groundwater. Both classifications define groundwater from this aquifer as a potential source of drinking water.

In areas close to the Site, the average yield of domestic wells drilled to obtain maximum yield is approximately 50 gallons per minute. The highest yields are obtained from wells in biotite gneiss and migmatite. Typical depths to the water table in the area range from under 10 feet in river flood plains, to approximately 40 feet in other areas. Seasonal fluctuations of water table elevation are on the order of 5 feet. During the summer and the early fall, the rainfall events are typically intense and short, resulting in surface runoff, and thus considerably less seepage into the aquifer. During the same period, evaporation and transpiration take place at maximum rates and a large percentage of the rainfall is returned to the atmosphere that might have otherwise recharged the aquifer. During the winter, rainfall events tend to be less intense but have longer durations, and the water table rises to higher levels.

2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

2.1 Site History

The earliest evidence of Site activities is provided by a report by the EPA Environmental Photographic Interpretation Center (EPIC) prepared in September 1992 (Report No. TS-PIC-92085). The report notes a "probable" tank trailer and associated dark stains on a 1965 aerial photograph of the Site. The 1970 aerial photograph shows a larger stained area, a crescent-shaped berm, a dark "possible stain" area within the berm, a probable tank trailer, and probable horizontal tanks.

Between 1975 and 1977, the Site owner, Mr. Robert Lee Elmore, received and placed onsite numerous drums containing various liquid and solid wastes. Contaminated waste oil and possibly other liquids were also stored onsite in an open-top, bulk storage tank estimated to contain 5,000 to 6,000 gallons.

In response to odor complaints from neighboring residents in 1977, the South Carolina Department of Health and Environmental Control (SCDHEC) conducted an inspection of the Elmore Site. SCDHEC personnel discovered a number of drums onsite, some of which were leaking. In October 1977, Robert Lee Elmore entered into a Consent Order with SCDHEC for the clean-up of the Site and

the proper disposal of the waste materials. Later in 1977, a few of the drums were removed to an undisclosed location, and piles of wood chips were placed in areas where drum leakage occurred. The remaining Site history centers around enforcement activities undertaken by SCDHEC and EPA.

For an unknown period prior to 1986, residents of the four rental homes on the western border of the Site used a small area behind the former tavern for produce gardening. Residents have not been gardening in this area since 1986, when SCDHEC issued warning letters to the landowner. The letters were based on results from confirmation soil samples taken just after the 1986 removal action (described in the following section) in the areas formerly gardened, which showed significant concentrations of metals. After receipt of the Remedial Investigation (RI) soils data, EPA sent letters to the property owners in November 1991 reiterating that gardening should be prohibited as a health precaution. The former garden and the area immediately surrounding it are heavily overgrown with kudzu, somewhat limiting access to garden area soils.

During the offsite groundwater work in early 1992, EPA learned that a former dump had existed within the present area of Sunnyside Circle subdivision north of the Site. Aerial photos obtained through EPIC confirmed the dump's location and size. However, offsite sampling conducted to date has not identified any contaminants that cannot be attributed to the Elmore Waste Disposal Site. There is no known connection between the two sites at present. The SCDHEC has initiated a sampling investigation of the former dump area.

2.2 Enforcement Activities

In October 1979, SCDHEC notified Robert Lee Elmore that the terms of the October 1977 Consent Order had not been fully complied with. The wastes onsite had been containerized, but proper disposal had not been initiated. Then, in January 1980, SCDHEC directed Mr. Elmore to stop cleanup and disposal activities until potential disposal methods could be determined by SCDHEC. Later in August 1981 SCDHEC sent R.L. Elmore a letter outlining the methods by which the wastes should be disposed of. These included incineration for the liquid wastes and disposal at a secure landfill for the solids. Information was provided on approved landfills and incinerators in the region.

The Site was referred to EPA through a citizen's complaint on June 12, 1980. In September 1980, EPA personnel inspected the Site and found a partially buried, 6,000-gallon storage tank containing what appeared to be waste oil, and approximately 100 unmarked leaking drums in various stages of decay.

During the period August 17, 1981, through August 21, 1981, an EPA Field Investigation Team (FIT) contractor investigated Site conditions under EPA direction. At that time, 25 55-gallon drums remained onsite, all containing soil and/or wood chips. A soil sample taken from the northwest portion of the Site, in the path of the storm water runoff, revealed the presence of elevated concentrations of numerous inorganic contaminants including chromium, copper, lead, zinc and cyanide. Twenty-two organic compounds also were detected; however, the contractor's report, dated January 1982, noted that some of the organic contaminants possibly could be attributed to wood-preserving chemicals used on railroad timbers of the adjacent Piedmont and Northern Railroad (now owned by CSX Transportation Inc.).

In September 1981, an attorney for Mr. Robert Lee Elmore wrote SCDHEC stating that the waste on the Site involved Mr. Elmore's son Lee Frank Elmore (a.k.a., Frank Elmore). The Site was said to be no longer owned by Robert Lee Elmore but rather was "in an estate." However, property records show that Robert Lee Elmore owned the Site up until his death in May 1983. The letter further stated that Robert Lee Elmore was in poor health and under a doctor's care, and that he could not afford the cleanup costs.

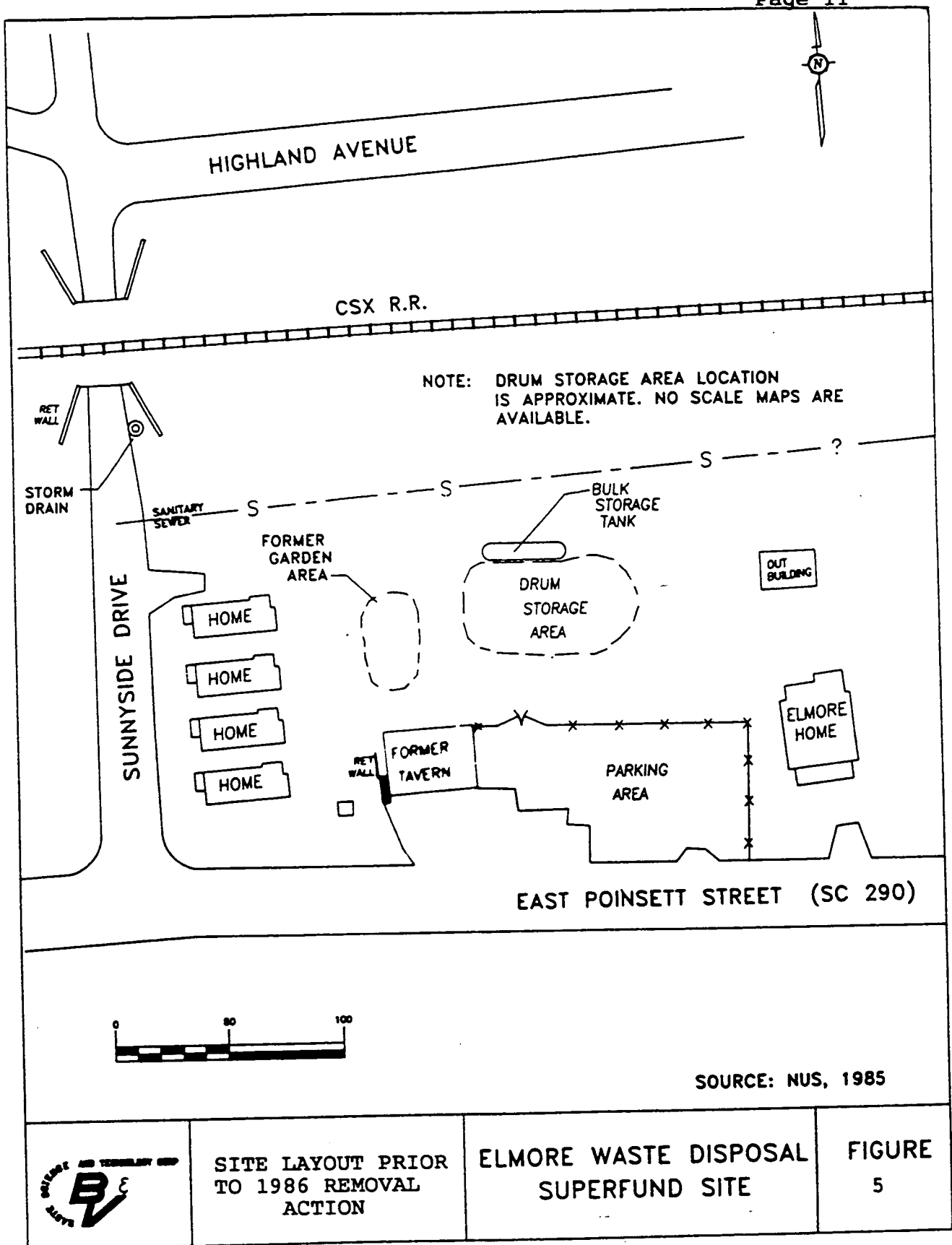
Frank Elmore applied for a permit to transport hazardous wastes in February 1983. The substance to be transported was given as "waste oil" and the type of business was listed as "the purchase and transport of waste oil to permitted facilities."

In February 1983, SCDHEC again inspected the Site and found 250 to 300 drums in various stages of decay scattered over the Site. A large, partially buried storage tank and an empty tanker trailer were also present onsite.

Further soil sampling was conducted in June 1984, by an EPA contractor (NUS Corporation) for a Site Screening Study. Analyses again showed elevated levels of inorganic and organic contaminants in Site soils. Based on these results, EPA prepared a Hazard Ranking System (HRS) package which was completed and finalized in January 1986. The Site received a score of 31.45 under the HRS procedure.

In January 1986, SCDHEC attempted to contact Frank Elmore and establish a new agreement for cleanup of the Site. However, Frank Elmore could not be located.

Between June and August 1986, under the direction of SCDHEC, GSX Services Inc. (GSX) conducted a removal clean-up of the Elmore Waste Disposal Site. Site layout at the time of the removal is illustrated in Figure 5. The removal action included the



excavation, transportation and disposal of 5,477 tons (approximately 5,000 cubic yards) of contaminated soil and 16,840 pounds of liquids. The solids were landfilled at GSX's chemically secure landfill in Pinewood, South Carolina, and the liquids were incinerated at Thermal Oxidation Corporation in Roebuck, South Carolina. The excavated area, shown in Figure 6, was backfilled with 5,456 cubic yards of clean fill dirt. The total cost of this state-funded operation was \$927,207.91. To facilitate groundwater monitoring, four monitoring wells were installed onsite after the operation was completed. Samples from these wells in 1986 and 1987 revealed groundwater contamination by barium, cadmium, lead, zinc, tetrachloroethene, trichloroethene, and 1,1,2-trichloroethane.

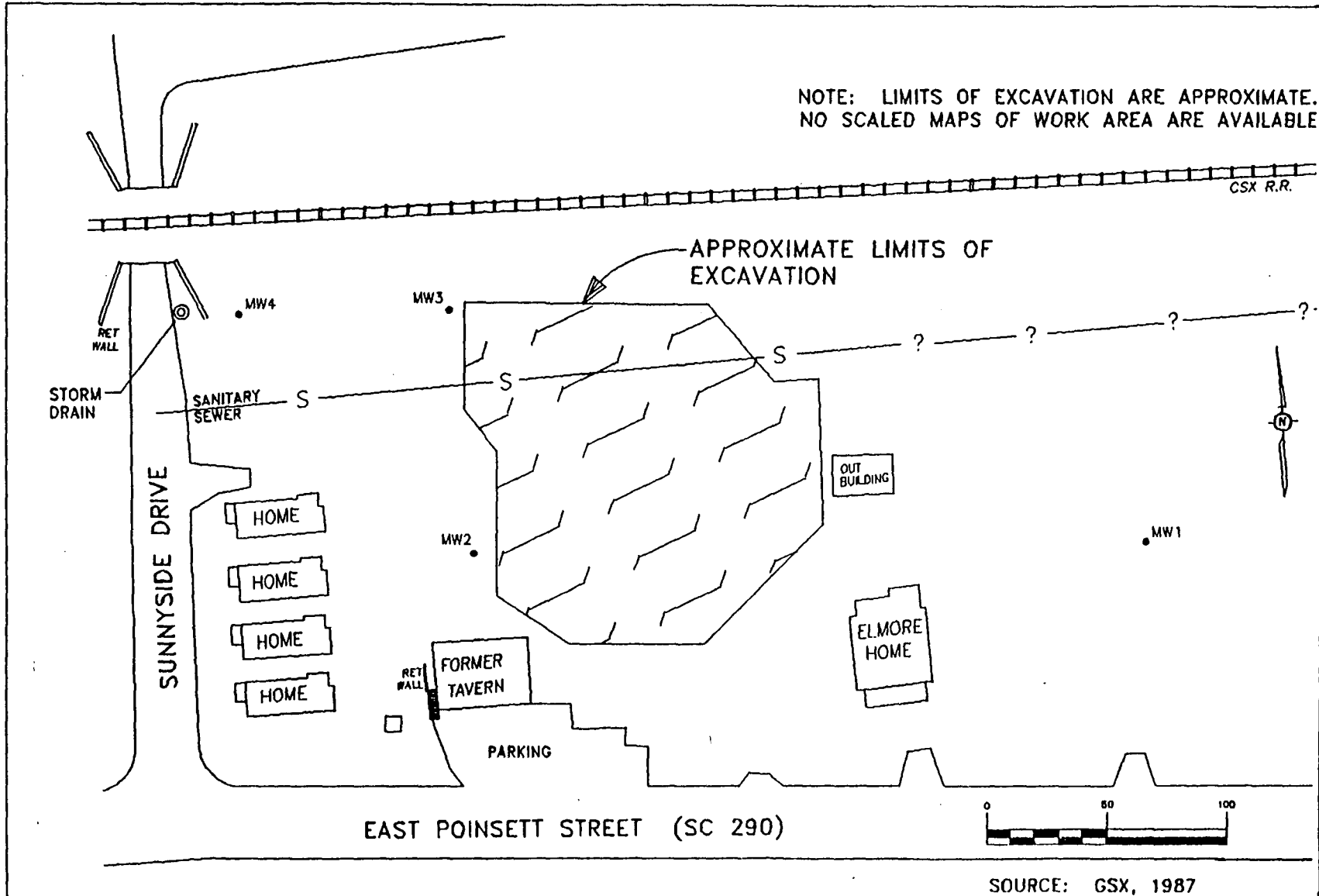
Pursuant to §107(g) of CERCLA, as amended by SARA, 42 U.S.C. §9607(g), and the applicable state statute, SCDHEC assigned a lien to the property in an attempt to recover its costs for the 1986 removal action.

In June 1988, the Elmore Waste Disposal Site was proposed for addition to the National Priorities List (NPL), and was added to the NPL on March 30, 1990.

A Potentially Responsible Party (PRP) Search completed in November 1988 did not result in identification of any viable PRPs. In May of 1989, EPA Region IV sent out PRP Notification/CERCLA Section 104(e) Information Request letters to the Elmore family members and those who were believed knowledgeable of the Elmore Waste Disposal Site. Based on the PRP Search Report and the information received in response to the CERCLA Section 104(e) Information Request letters, no viable PRPs were identified, and EPA elected to perform a Remedial Investigation/ Feasibility Study (RI/FS) using public funds under CERCLA.

Planning of the RI/FS took place in late 1989 and early 1990. A public meeting concerning the start of the RI/FS was held at the Greer City Hall on March 22, 1990. However, the start of field work was delayed due to problems gaining access. While surrounding property owners readily granted EPA access, the two main Site property owners refused to grant EPA access to do the study.

After numerous attempts to obtain voluntary access failed, EPA submitted a Request for Civil Action (Order in Aid of Immediate Action) to the U.S. Department of Justice (DOJ) on August 13, 1990. In November 1990, in accordance with DOJ instructions, EPA issued an Administrative Order (AO) for Access to the Site owners. Certified mail records indicated that the AOs were received. No responses were received to this Order.



	<p align="center">FIGURE 6 AREA OF 1986 REMOVAL ACTION</p>	<p align="center">ELMORE WASTE DISPOSAL SUPERFUND SITE</p>	
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Further efforts to reach agreement on the terms of access with the landowners were successful in early 1991. Signed access agreements were obtained in late February 1991, and RI/FS field work began on March 12, 1991. Site field work ended in late June 1991. Offsite groundwater sampling events were conducted in January, April and May of 1992.

3.0 HIGHLIGHTS OF COMMUNITY PARTICIPATION

Initial community relations activities at the Elmore Waste Disposal Site included conducting community interviews in late 1989, and finalization of the Community Relations Plan in January 1990. An information repository was established at the Greer Branch of the Greenville City Library in January 1990.

A "kickoff" fact sheet announcing the start of the RI/FS was issued in early March 1990. On March 22, 1990, EPA held a public meeting at Greer City Hall to present the Agency's plans for the RI/FS. The meeting was attended by more than 60 citizens and covered by three local newspapers (Greer, Greenville, Spartanburg) and two television stations. EPA's presentation to the public included information on how to participate in the investigation and remedy selection process under Superfund. At the meeting, many questions were asked and a fair amount of interest was expressed by the community.

Between April 1990 and March 1991, the start of the RI was delayed while the Agency tried to reach an agreement for access to the Site properties. As described above in Section 1.2, access agreements had been obtained from adjacent landowners but not from the two main Site landowners. The public was aware of the situation due to steady coverage by the three local newspapers. RI field work was initiated in early March 1992 following resolution of the access issue.

EPA prepared and released another "RI begins" fact sheet at that time (March 1991) because one year had elapsed since the announcement of the RI/FS start. Additionally, EPA personnel visited Greer on March 11 and 12, 1991, to meet with local officials of the City of Greer and of SCDHEC to brief them on the planned RI field work. News coverage of the RI by the local newspapers continued steadily throughout the remainder of 1991 and 1992.

A second public meeting was held in March 1992, to update the public on the RI findings to date, and to explain the planned additional groundwater sampling in an area north of the Site. The meeting was only attended by a few members of the public, but was extensively covered by the press. At this meeting, concerns

were expressed by nearby residents about a former dump area in the Sunnyside Circle subdivision just north of the Site. The former dump location is within the area of offsite groundwater contamination attributed to the Elmore Waste Disposal Site. It was explained that the planned sampling would aid EPA in determining if any contamination was emanating from the former dump, and whether Wards Creek was impacted. Continued public interest was encouraged at the meeting, and the various opportunities for public involvement were emphasized.

Offsite groundwater and surface water sampling events were conducted in April, May, and June 1992. While work on the Feasibility Study (FS) continued, the final Remedial Investigation Report was placed in the information repository on June 24, 1992. At this time and throughout the RI, the information repository was visited periodically to insure that it was well-stocked and available to the public.

Following completion of the FS, Proposed Plan fact sheets were sent out on December 21, 1992. An advertisement was published in two of the local newspapers on December 30, 1992. Both the advertisement and the fact sheet highlighted the Public Comment period extending from December 30, 1992, to January 28, 1993.

The Proposed Plan public meeting was held on January 14, 1993, to present the Agency's selection of Preferred Alternatives for addressing soil and groundwater contamination at the Site. Public comments and questions are documented in the Responsiveness Summary, Appendix A. A request was received on January 28, 1993, for an extension of the public comment period. Therefore, the comment period was extended another 30 days through February 27, 1993.

4.0 SCOPE AND ROLE OF THIS ACTION WITHIN SITE STRATEGY

The purpose of the remedial alternative selected in this ROD is to reduce current and future risks at this Site. The remedial action for soil will remove current and future health threats posed by contaminated shallow soil and will prevent leaching of the soil contaminants to groundwater. The groundwater remedial action will remove future risks posed by potential usage of contaminated groundwater. It will also remove the threat to surface water (Wards Creek), by reducing the concentrations of surficial aquifer contaminants reaching Wards Creek. This is the only ROD contemplated for this Site.

5.0 SUMMARY OF SITE CHARACTERISTICS

The RI investigated the nature and extent of contamination on and near the Site, and defined the potential risks to human health and the environment posed by the Site. A supporting RI objective was to characterize the Site-specific geology and hydrogeology. A total of 37 soil samples, 27 groundwater samples, and 8 surface water samples were collected during the RI. The main portion of the RI was conducted from April 1991 through January 1992, followed by offsite groundwater sampling and surface water sampling between February and June 1992. Onsite locations of soil borings, soil samples, and monitor wells are shown in Figure 7. Figure 8 shows the offsite groundwater and surface water sampling locations.

5.1 Site-Specific Geology and Hydrogeology

5.1.1 Geology

To gain Site-specific geologic information, 21 borings were completed during the RI, 16 of which were logged in detail.

Borings in the area excavated in the 1986 SCDHEC remedial action revealed little topsoil cover. In the borings located away from the fill area, a topsoil layer, one to two feet thick, of black or brown soil was encountered. The topsoil had a low plasticity and minor amounts of organic matter.

One soil boring, SB-2, revealed a shallow layer of fill containing ashes and burned material, and ash piles were present near the boring location. Residents of the four small houses at the west end of the Site burn scrap lumber (much of it painted) for heat or other purposes, and apparently deposit the ashes in this area. The ashes may contribute to the levels of metals found in soil in this area.

Below the top soil (and below the fill layers in the area of the 1986 remediation), a region of silty-clay saprolite was found varying from 10 to 30 feet in thickness. Throughout the Site, interspersed within the saprolite, discontinuous zones of silty-clay and silty-sand were interlayered with more competent biotite gneiss. These zones varied from approximately six inches to 10 feet in thickness. In the most southern and deepest boring, MW-8B, a layer of variably-weathered hornblende biotite gneiss was observed beginning at an approximate depth of 45 feet that continued to the bottom of the boring. Weathered biotite gneiss was encountered in the two deep borings at depths of 51 and 44 feet below the surface. Truly competent, relatively unweathered bedrock was not encountered in either of the two borings.

SOURCE:
MURPHY YELLE
ENVIRONMENTAL
SURVEYING
Raleigh, NC 27613
(919) 787-7873

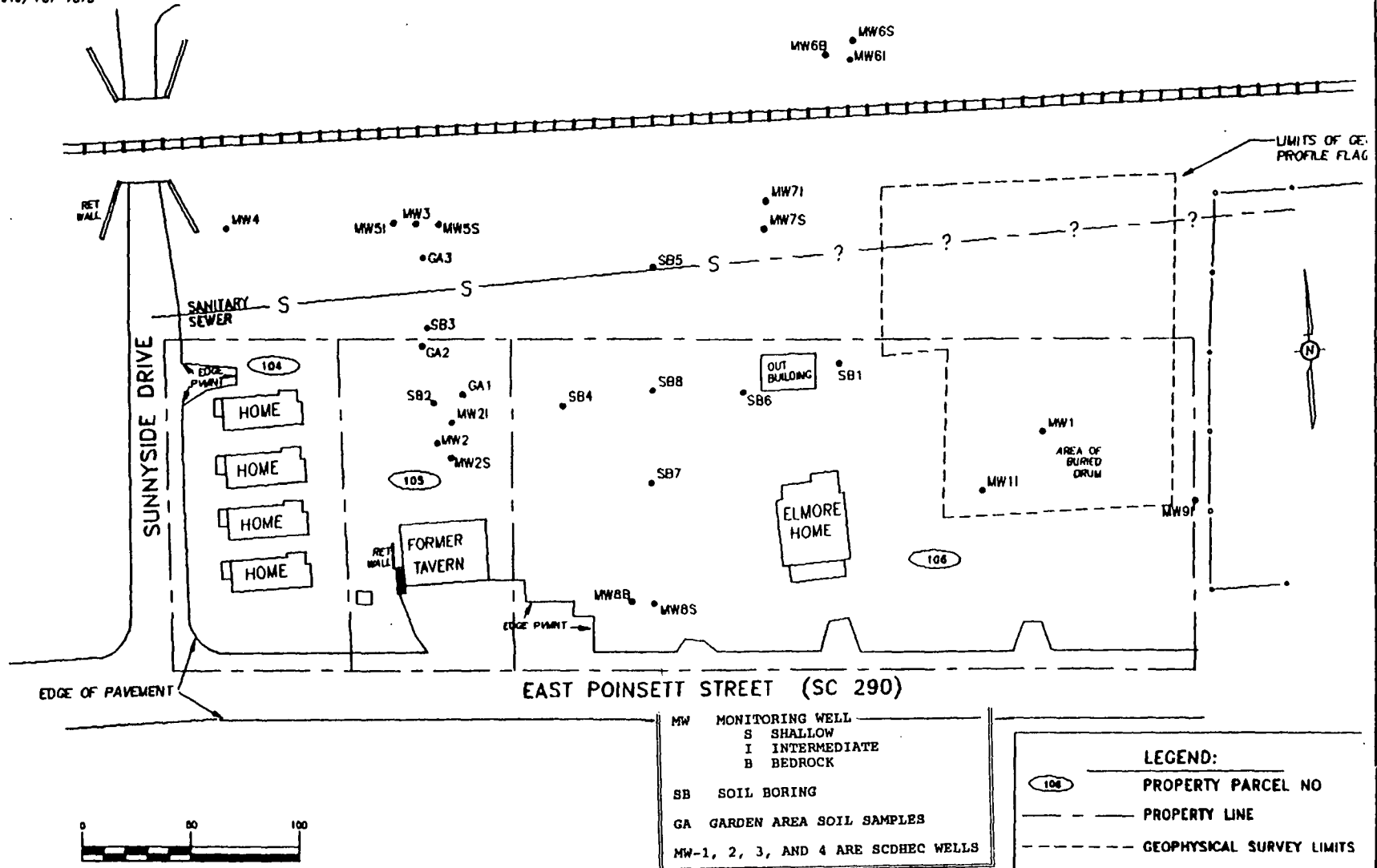
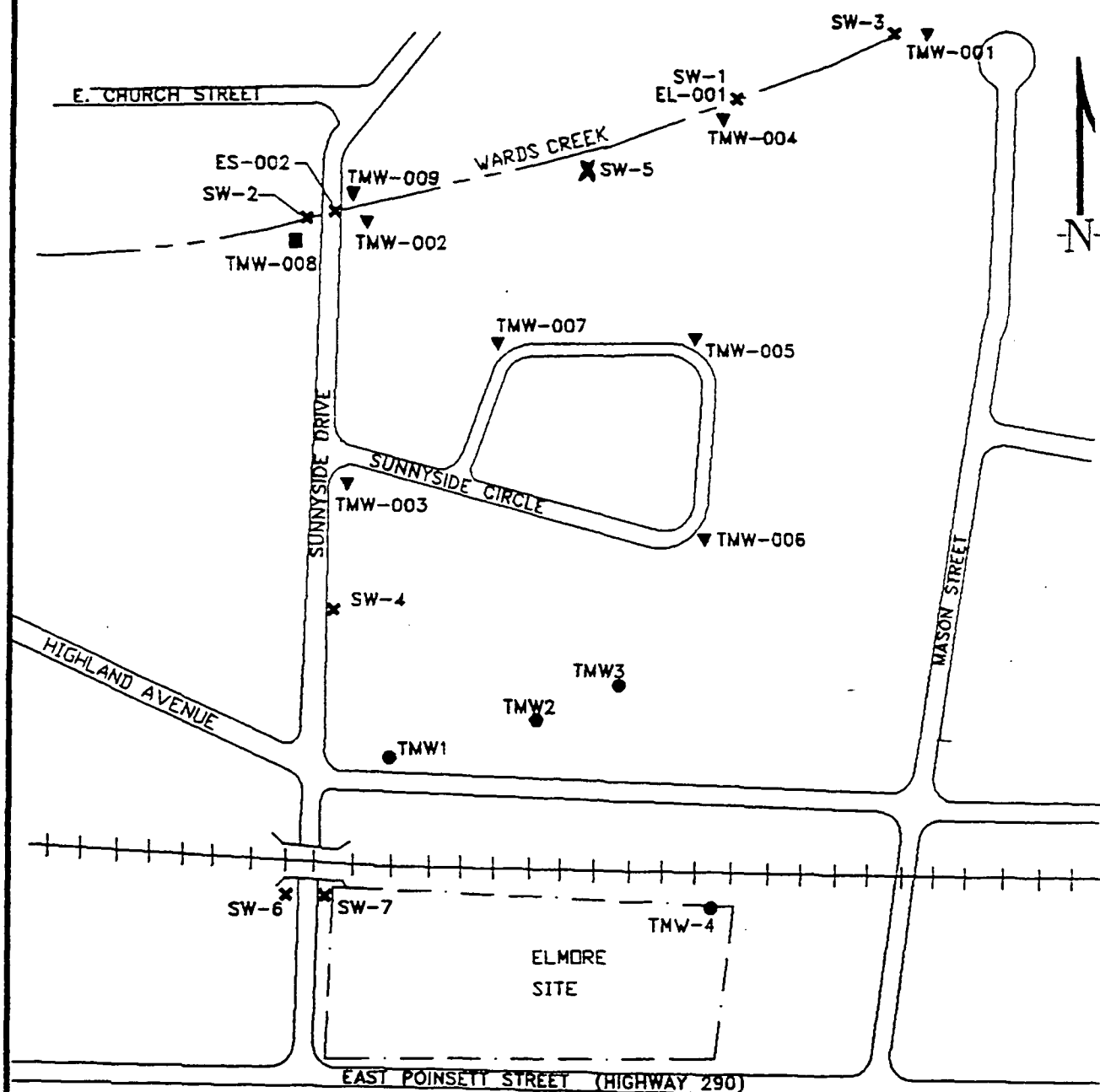


FIGURE 7
SITE SAMPLING LOCATIONS

ELMORE WASTE DISPOSAL SUPERFUND SITE

300 200 100 0 100
SCALE IN FEET (APPROXIMATE)



LEGEND

- | | | | |
|-----------|--|------------------|-------------------------------|
| ● TMW2 | ESD TEMP MONITORING WELLS | ▼ TMW-001 | GEOPROBE SAMPLE LOCATION |
| ■ TMW-008 | HAND AUGERED BORING
GROUNDWATER SAMPLING LOCATION | × SW-1
EL-001 | SURFACE WATER SAMPLE LOCATION |



FIGURE 8
OFFSITE SAMPLING LOCATIONS

5.1.2 Hydrogeology

Site-specific hydrogeology was investigated in the RI. Of the 21 borings performed during the RI, thirteen were completed as monitoring wells. These wells were installed into the shallow, interface, and bedrock zones of the aquifer, and are designated with the suffixes "S", "I", and "B" as appropriate. The only significant deviation from the RI work plans was the need to install the interface wells and bedrock wells at different depths than originally planned, due to the absence of a distinct interface between bedrock and saprolite as had been anticipated. The interface wells were screened two to three feet below the top of a locally continuous stratum of weathered biotite gneiss. This contact may represent a poorly-defined interface zone between the saprolite and deeper weathered gneiss. Because of this uncertainty, the wells screened as described above are referred to as intermediate depth wells.

Two sets of groundwater elevation data were obtained during the RI (Table 1). The general direction of groundwater flow is toward the north and northwest for both the shallow and interface aquifers (Figures 9 and 10). The data suggest that there may be a slight upward gradient in the northern portions of the Site (near MW-6S/6I/6B), and a slight downward gradient in the western portion of the Site (near MW-2S/2I and MW-5S/5I). No evidence of any confining conditions was observed during drilling.

Rising and falling head tests were performed on the monitoring wells in order to estimate the hydraulic conductivity (K) of the aquifer beneath the Site. The calculated K values are presented in Table 2. For the shallow wells, K varied from 4.8×10^{-4} cm/s at MW-7S, to 1.4×10^{-3} cm/s at MW-2S. For the intermediate wells, the values ranged from 1.1×10^{-4} cm/s in MW-1I, to 2.1×10^{-3} cm/s in MW-9I. The geometric means were:

Shallow Zone:	9.5×10^{-4} cm/s
Interface Zone:	4.7×10^{-4} cm/s

A piezometric surface gradient of 0.0175 ft/ft was calculated for the water table measured by both the shallow and interface wells. Using this gradient and the calculated Site-specific K values, groundwater velocity in the horizontal direction was calculated to be 34.4 ft/yr in the surface aquifer and 17.0 ft/yr in the deeper saprolite/interface aquifer.

TABLE 1
GROUNDWATER POTENTIOMETRIC SURFACE ELEVATIONS

Well	Top of Casing Elevation (ft msl)	Water Level Measurements (ft below TOC)		Water Level Elevations (ft msl)	
		6/5 - 19/91	9/11/91	6/5-19/91	9/11/91
MW-1	961.09	-	20.25	-	940.84
MW-1I	956.55	13.44	-	943.11	-
MW-2	946.77	-	7.50	-	939.27
MW-2S	947.36	5.60	7.33	941.76	940.03
MW-2I	947.46	6.10	8.00	941.36	939.46
MW-3	946.41	7.25	8.67	934.16	937.74
MW-4	942.84	-	8.83	-	934.01
MW-5S	945.69	9.00	8.08	936.69	937.61
MW-5I	945.44	9.00	11.00	936.44	934.44
MW-6S	953.20	14.83	15.75	938.37	937.45
MW-6I	953.53	14.17	15.00	939.36	938.53
MW-6B	952.99	14.68	15.67	938.31	937.32
MW-7S	955.43	10.85	16.25	944.58	939.18
MW-7I	957.80	17.33	15.50	940.47	942.30 *
MW-8S	953.73	10.29	12.08	943.44	941.65
MW-8B	953.80	21.25	12.58	932.55	941.22
MW-9I	959.19	15.92	18.92	943.27	940.27

* Data from field notes were suspect and not used in creating elevation contours.
-: Data not obtained

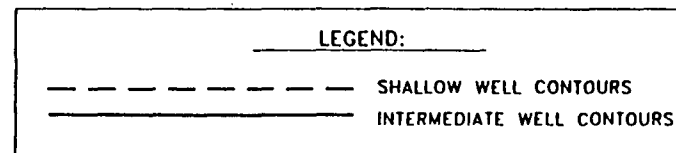
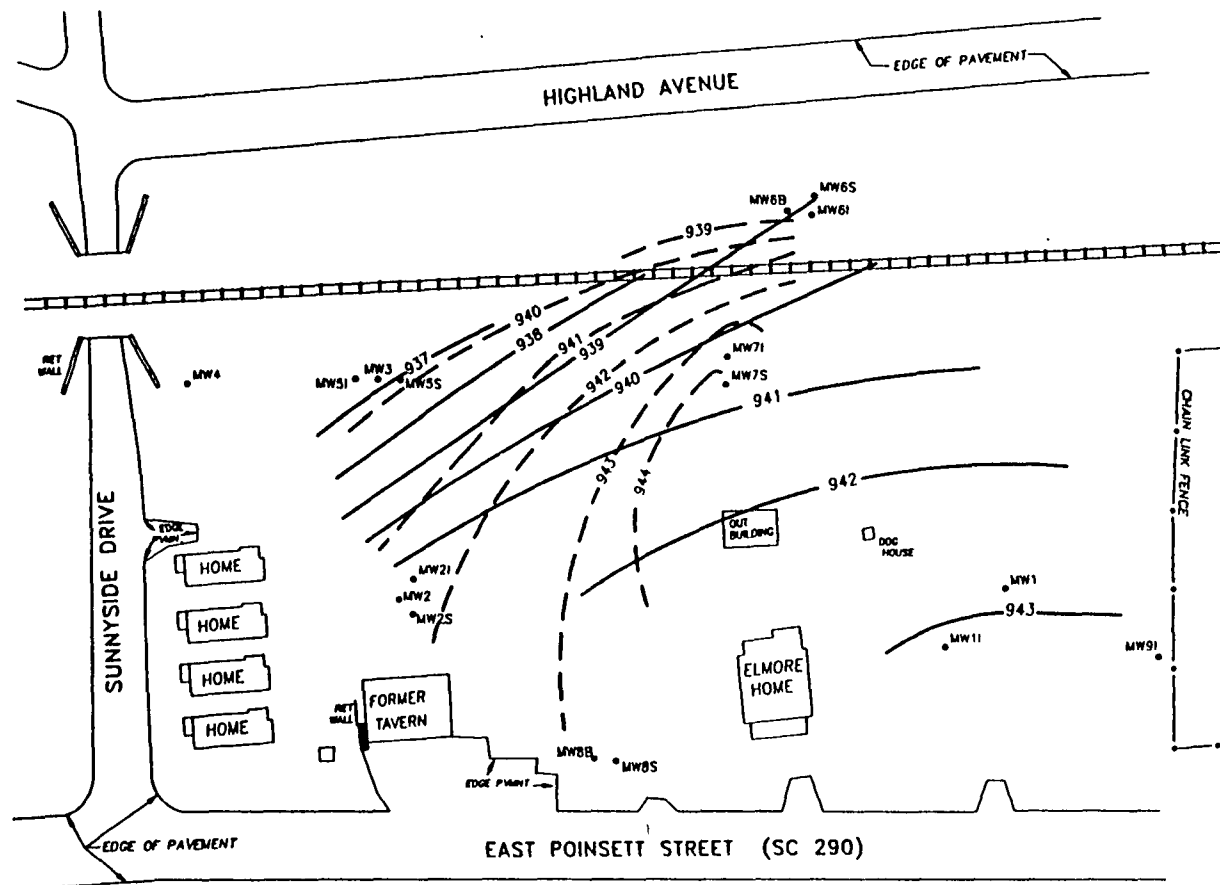
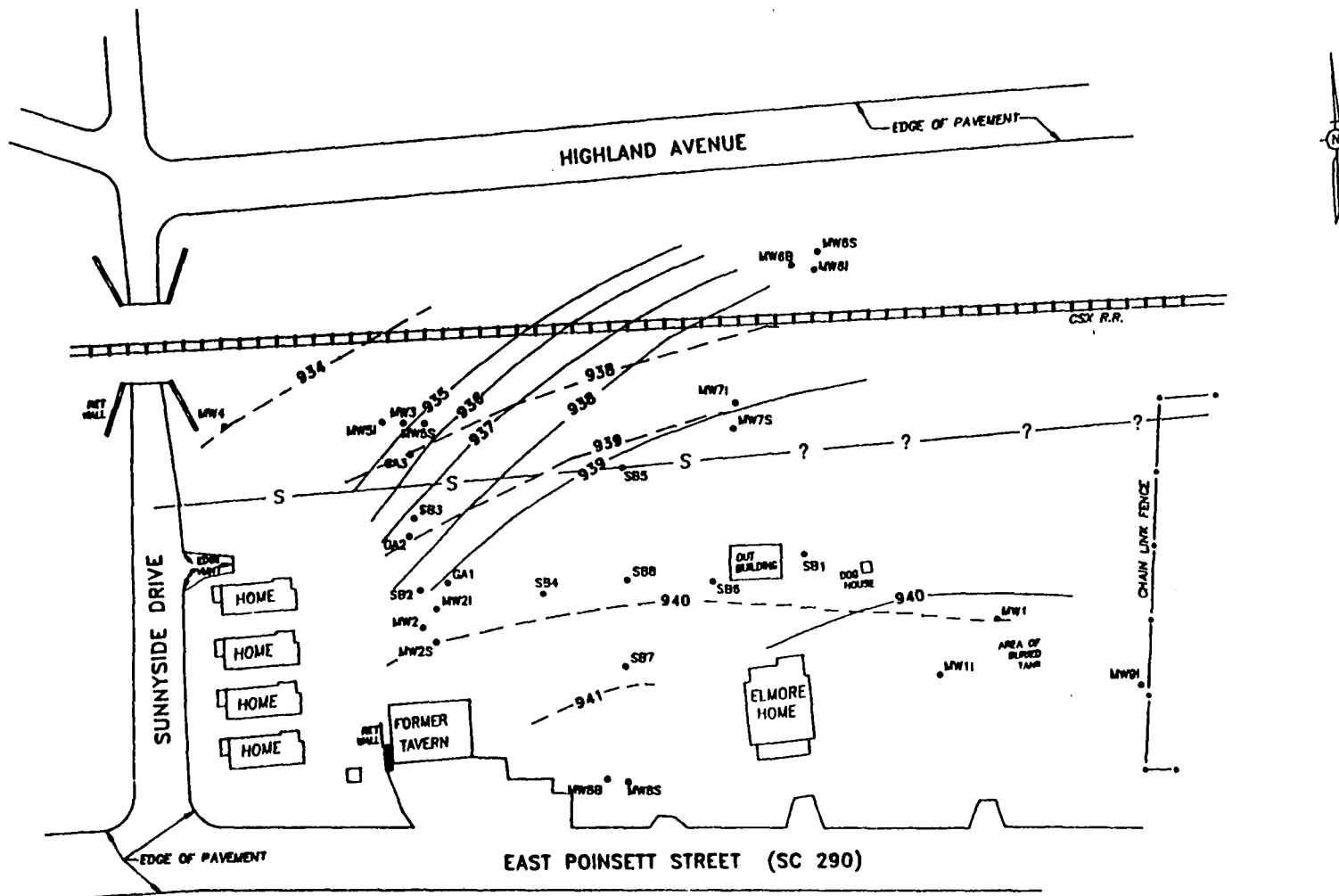


FIGURE 9
GROUNDWATER POTENTIOMETRIC MAP
JUNE 1991

ELMORE WASTE DISPOSAL SUPERFUND SITE



LEGEND:

- SHALLOW WELL CONTOURS
- INTERMEDIATE WELL CONTOURS



FIGURE 10
GROUNDWATER POTENTIOMETRIC MAP
SEPTEMBER 1991

ELMORE WASTE DISPOSAL SUPERFUND SITE

TABLE 2
ESTIMATED HYDRAULIC CONDUCTIVITY (K)

Well	K		
	Rising (cm/s)	Falling (cm/s)	Overall (cm/s)
MW-11	1.7E-04	1.1E-04	
MW-2S	1.4E-03	-	
MW-21	1.6E-03	1.7E-03	
MW-5S	1.1E-03	-	
MW-51	2.3E-04	1.9E-04	
MW-6S	-	-	
MW-61	4.6E-04	4.2E-04	
MW-7S	4.8E-04	-	
MW-71	5.2E-04	1.8E-04	
MW-8S	1.1E-03	-	
MW-91	2.1E-03	1.3E-03	
Shallow Wells, Geo. Mean	9.5E-04	-	9.5E-04
Intermediate Wells, Geo. Mean	5.6E-04	3.9E-04	4.7E-04
Site, Geo. Mean	6.9E-04	3.9E-04	5.2E-04

-: Data not obtained.

Note: Falling head test not performed on shallow wells.

5.2 Nature and Extent of Contamination

Environmental contamination at the Site can be summarized as follows:

1. Surface and shallow subsurface soils contain greatly elevated levels of several metals, and trace levels of polyaromatic hydrocarbons (PAHs) and volatile organic compounds (VOCs).
2. Groundwater in the surficial and intermediate-depth aquifer is contaminated by VOCs at levels ranging from the detection limit to 16,000 ug/l total VOCs, and by several metals. The surficial aquifer is the most highly impacted.
3. Contaminated groundwater in the surficial aquifer, migrating northward from the Site, is entering Wards Creek. Two VOCs, trichloroethene and tetrachloroethene, are present in the creek at levels of 16 ug/l and 84 ug/l, respectively. Two other VOCs were found at less than 3 ug/l.

5.2.1 Surface and Shallow Subsurface Soils

Surface and shallow subsurface soil analytical results are presented in Table 3. These 16 samples were collected by split spoon from the surface to either one or two feet below land surface, except for samples SB2-S-1 and SB4-S-1. During the planning of the RI, surface and shallow subsurface soils were considered to be a single potential exposure point, due to the past gardening activities and the lack of clear garden boundaries.

Figure 11 illustrates the area of surface and shallow subsurface soil contamination. Lead, arsenic, cadmium, chromium, nickel, and zinc are among the nine metals present at levels significantly elevated (greater than 1.5 times) above background. The principal contaminant of concern is lead, which was present at levels exceeding EPA's level of concern (500mg/kg) in surface samples SB3-S-1 and GA3-S-5, and shallow soil samples GA2-S-4 and GA3-S-6. Trace levels of organic compounds, specifically VOCs, PAHs and dioxin, are present. The maximum levels present were: VOCs, 37 ug/kg; PAHs, 2.6 mg/kg; and dioxin, 84 nanograms per kilogram (ng/kg).

The estimated volume of the contaminated soil, based on a depth of 2 feet, was calculated to be 650 cubic yards.

5.2.2 Subsurface Soils

Table 4 presents analytical results from the 11 intermediate (5 -

TABLE 3
SURFACE AND SHALLOW SUBSURFACE SOILS ANALYTICAL RESULTS

Sample No. Station No. Sample Date	Freq of Detected	Background				Background		Background			
		57969 MW116-1 050191	57660 MW256-1 042591	58297 MW516-1 050891	58782 MW616-1 052191	57640 MW866-1 041091	57962 MW916-1 043091	57663 SB1-6-1 042691	57659 SB2-6-1 042591	57658 SB3-6-1 042591	57648 SB4-6-1 042491
Inorganics		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Aluminum	16/16	54,000	29,000	24,000	20,000	24,000	20,000	32,000	30,000	16,000	36,000
Arsenic	15/16	9.1 J	4.6 J	10	3.0 UJ	14 J	2.5 J	8.1 J	6.0 J	24 J	6.4 J
Barium	16/16	22	47	270 J	8.6	80	20	52	42	160	80
Beryllium	4/16	1 U	0.25 U	1.8	1 U	0.98	0.22	1 U	1 U	0.24 U	1 U
Cadmium	3/16	0.49 U	0.51 U	0.74 U	0.45 U	1 U	0.44	0.46 U	0.48 U	1.0 U	0.48 U
Calcium	15/16	490	530	500	30 U	2,000	180	210	750	4,000	610
Chromium	16/16	59	31	55 J	16	32	20	41	40	24	23
Cobalt	8/16	2.6	3.0 U	10.0	2 U	2 U	1.0 U	7 U	4 U	5 U	4 U
Copper	14/16	17	20 U	78 J	20 UJ	56	6.8	29	18	44	34
Iron	16/16	57,000	28,000	24,000	23,000	28,000	16,000	38,000	33,000	18,000	20,000
Lead	15/16	26 J	47	60	13 J	140 J	7.9 J	30 U	57	530 J	45
Magnesium	16/16	270	880	4,300	320	1,800 J	260	2,200	1,200	790	770
Manganese	16/16	75	61	132	28	170	19	100	63	120	65
Mercury	1/16	0.11 U	0.11 UJ	0.12 U	0.11 U	0.11 U	0.11 U	0.11 UJ	0.12 UJ	0.11 UJ	0.11 UJ
Nickel	16/16	5.5	6.5	26	2.8	5.9	3.6	15	5.5	9.8	6.0
Potassium	16/16	460	1,200	3,600	500	2,300	380	2,700	1,600	910	930
Silver	1/16	0.73 U	0.76 U	1.2 U	1 U	0.34 UJ	0.66	0.69 U	0.72 U	0.73 U	0.72 U
Sodium	3/16	40 U	40 U	76	20 U	120 U	27	40 U	50 U	120	30 U
Vanadium	16/16	120	56	50	42	48 J	35	83	69	38	31
Zinc	15/16	97	61 J	220	14	87	20 U	80 J	57 J	350 J	94 J
Cyanide	1/16	6.3 U	6.2 U	5.9 U	6 U	0.55 U	5.3 U	5.8 U	5.9 U	6.1 U	6.2 U
Purgeable Organics		ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
1,2-Dichloroethene	1/16	7 U	12 U	2 J	6 U	12 U	6 U	12 U	12 U	13 U	13 U
Trichloroethylene	2/16	7 U	12 U	4 J	6 U	12 U	6 U	12 U	12 U	13 U	13 U
Tetrachloroethylene	2/16	7 U	12 U	37	6 U	12 U	6 U	12 U	12 U	13 U	13 U
Toluene	1/16	7 U	12 U	12 U	6 U	12 U	6 U	12 U	12 U	13 U	13 U
Extractable Organics		ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Naphthalene	6/16	860 U	410 U	410 UR	400 U	53 J	760 U	390 U	410 U	150 J	430 U
2-Methylnaphthalene	8/16	860 U	410 U	410 UR	400 U	62 J	760 U	390 U	410 U	220 J	430 U
Acenaphthylene	1/16	860 U	410 U	410 UR	400 U	400 U	760 U	390 U	410 U	420 U	430 U
Acenaphthene	1/16	860 U	410 UR	410 UR	400 U	400 U	760 U	390 UR	410 UR	420 UR	430 UR
Dibenzofuran	1/16	860 U	410 U	410 UR	400 U	400 U	760 U	390 U	410 U	67 J	430 U
Fluorene	1/16	860 U	410 U	410 UR	400 U	400 U	760 U	390 U	410 U	420 U	430 U
Phenanthrene	2/16	860 U	410 U	410 UR	400 U	61 J	760 U	390 U	410 U	330 J	430 U
Anthracene	2/16	860 U	410 U	410 UR	400 U	400 U	760 U	390 U	410 U	62 J	430 U
Carbazole	1/16	NA	410 U	410 UR	NA	400 U	NA	390 U	410 U	42 J	430 U
Fluoranthene	7/16	860 U	410 U	410 UR	400 U	91 J	760 U	390 U	410 U	390 J	59 J
Pyrene	8/16	860 U	410 U	410 UR	400 U	82 J	760 U	390 U	410 U	360 J	72 J
Benzyl Butyl Phthalate	2/16	860 U	410 U	410 UR	400 U	400 U	760 U	390 U	410 U	420 U	430 U

TABLE 3 (continued)
SURFACE AND SHALLOW SUBSURFACE SOILS ANALYTICAL RESULTS

Sample No. Station No. Sample Date	Freq of Detect	Background				Background		Background			
		57969 MW11-S-1 050191	57660 MW2S-S-1 042591	58297 MW51-S-1 050891	58782 MW61-S-1 052191	57640 MW8B-S-1 041091	57962 MW91-S-1 043091	57663 SB1-S-1 042691	57659 SB2-S-1 042591	57658 SB3-S-1 042591	57648 SB4-S-1 042491
Extractable Organics (continued)		ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Benzo(a)Anthracene	6/16	860 U	410 U	410 UR	400 U	400 U	760 U	390 U	410 U	220 J	52 J
Chrysene	3/16	860 U	410 U	410 UR	400 U	80 J	760 U	390 U	410 U	250 J	66 J
Benzo(b and/or k) Fluoranthene	6/16	860 U	410 U	410 UR	400 U	180 J	760 U	390 U	410 U	580 J	430 U
Benzo-a-Pyrene	5/16	860 U	410 U	410 UR	400 U	400 U	760 U	390 U	410 U	210 J	51 J
Indeno (1,2,3-cd) Pyrene	2/16	860 U	410 U	410 UR	400 U	400 U	760 U	390 U	410 U	420 U	430 U
Benzo(ghi)Perylene	1/16	860 U	410 U	410 UR	400 U	400 U	760 U	390 U	410 U	180 J	430 U
Pesticides		ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Delta-BHC	1/16	10 U	2.1 U	2.1 U	10 U	2.1 UJ	9.2 U	2 U	2 U	2 U	2 U
Aldrin	4/16	10 U	2.1 U	2.1 U	10 U	2.1 UJ	9.2 U	2 U	2 U	2 J	2 U
Endosulfan I (Alpha)	1/16	10 U	2.1 U	2.1 U	10 U	2.1 UJ	9.2 U	2 U	2 U	2 U	2 U
4,4'-DDE (P,P'-DDE)	4/16	21 U	4.1 U	4.1 U	19 U	4.1 UJ	18 U	2 J	4 J	16	5
Endrin	2/16	21 U	4.1 U	4.1 U	19 U	5.5 J	18 U	4 U	4 U	2 J	4 U
4,4'-DDD (P,P'-DDD)	2/16	21 U	4.1 U	4.1 U	19 U	4.1 UJ	18 U	4 U	4 U	5	3 J
Endosulfan Sulfate	1/16	21 U	4.1 U	4.1 U	19 U	4.1 UJ	18 U	4 U	4 U	4 U	4 U
4,4'-DDT (P,P'-DDT)	6/16	21 U	4.1 U	4.1 U	19 U	4.1 UJ	18 U	4 U	4 U	26	3 J
Endrin Aldehyde Chlordane /1	1/16	NA	4.1 U	4.1 U	NA	4.1 UJ	NA	4 U	4 U	4 U	4 U
Gamma-Chlordane	3/16	100 U	2.1 U	2.1 U	95 U	2.1 UJ	92 U	2 U	2 U	2 U	2 U
Alpha-Chlordane	2/16	100 U	2.1 U	2.1 U	95 U	2.1 UJ	92 U	2 U	2 U	2 U	2 U
Miscellaneous Extractable Organics		ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Unidentified Compounds	11/16		10,000 J		3,000 J	7,000 J				2,000 J	800 J
Diethylmethybenzamide	1/16		200 JN								
Hexadecanoic Acid	1/16										200 JN
Benzo(a)pyrene (not a)	1/16									300 JN	
Trimethylnaphthalene	1/16									100 JN	
1-Methylnaphthalene	1/16									200 JN	
Methylphenanthrene	1/16									200 JN	
Methylanthracene	1/16									100 JN	
Petroleum Product	6/16										
Bis(Dimethylethyl)Cyclohexadi- enedione	3/16										
Diphenylfluorene	3/16										
Benzofluorene	1/16										
Methylpyrene	1/16										
Benzonaphthothiofene	1/16										
Benzocephenanthrylene	1/16										
Dioxin/Furans		ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg
Toxic Equivalent Value (TEQ)	3/4	NA	84 J	NA	NA	NA	NA	NA	—	32 J	0.25 J

TABLE 3 (continued)
SURFACE AND SHALLOW SUBSURFACE SOILS ANALYTICAL RESULTS

Sample No. Station No. Sample Date	57629 GA1-S-1 041791	57630 GA1-S-2 041791	57631 GA2-S-3 041791	57632 GA2-S-4 041791	57633 GA3-S-5 041791	57634 GA3-S-6 041791
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Inorganics						
Aluminum	12,000	13,000	18,000	9,400	29,000	31,000
Arsenic	12	25	13	15	9.5	37
Barium	190	190	200	210	300	410
Beryllium	1 U	1 U	1 U	1 U	2 U	1.5
Cadmium	1 U	1 U	1 U	0.7 U	2.3	1.8
Calcium	1,600	2,600	2,100	1,600	3,200	2,300
Chromium	24	28	25	18	72	55
Cobalt	3.5	4.1	4.1	3.4	8.9	6.2
Copper	110 J	61 J	52 J	48 J	100 J	120 J
Iron	19,000	19,000	18,000	14,000	31,000	37,000
Lead	420	400	350	560	620	1,900
Magnesium	790	770	990	700	1,900	1,500
Manganese	150	120	130	87	410	200
Mercury	0.20 U	0.10 U	0.12 U	0.10 U	0.14 U	0.27
Nickel	7.5	9.5	7.5	7.1	14	16
Potassium	960	760	1,300	830	2,400	1,800
Silver	1.1 U	1.2 U	1.2 U	1.2 U	1.4 U	1.4 U
Sodium	50 U	80 U	60 U	60 U	60 U	70 U
Vanadium	27	35	32	26	59	79
Zinc	340 J	280 J	300 J	310 J	830 J	730 J
Cyanide	6 U	6.1 U	6.4 U	5.9 U	11	6.5 U
Purgeable Organics	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
1,2-Dichloroethene	13 U	13 U	12 U	12 U	12 U	12 U
Trichloroethylene	13 U	13 U	12 U	12 U	12 U	4 J
Tetrachloroethylene	13 U	13 U	12 U	12 U	12 U	4 J
Toluene	3 J	13 U	12 U	12 U	12 U	12 U
Extractable Organics	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Naphthalene	63 J	2,100 U	89 J	120 J	55 J	4,000 U
2-Methylnaphthalene	85 J	240 J	130 J	180 J	58 J	510 J
Acenaphthylene	420 U	2,100 U	410 U	400 U	98 J	4,000 U
Acenaphthene	420 U	2,100 U	410 U	400 U	43 J	4,000 U
Dibenzofuran	420 U	2,100 U	410 U	400 U	400 U	4,000 U
Fluorene	420 U	2,100 U	410 U	400 U	43 J	4,000 U
Phenanthrene	420 U	2,100 U	410 U	400 U	500 U	4,000 U
Anthracene	420 U	2,100 U	410 U	400 U	210 J	4,000 U
Carbazole	420 U	2,100 U	410 U	400 U	780	4,000 U
Fluoranthene	360 J	730 J	360 J	320 J	2,000 U	780 J
Pyrene	260 J	640 J	250 J	260 J	1,400	690 J
Benzyl Butyl Phthalate	97 J	2,100 U	410 U	400 U	200 J	4,000 U

TABLE 3 (continued)
SURFACE AND SHALLOW SUBSURFACE SOILS ANALYTICAL RESULTS

Sample No. Station No. Sample Date	57629 GA1-6-1 041791	57630 GA1-6-2 041791	57631 GA2-6-3 041791	57632 GA2-6-4 041791	57633 GA3-6-5 041791	57634 GA3-6-6 041791
Extractable Organics (continued)	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Benzo(a)Anthracene	250 J	320 J	240 J	210 J	1,300 U	4,000 U
Chrysene	420 U	2,100 U	410 U	400 U	1,000 U	4,000 U
Benzo(b and/or k) Fluoranthene	620	680 J	530	600	2,000	4,000 U
Benzo-a-Pyrene	120 J	2,100 U	190 J	400 U	660	4,000 U
Indeno (1,2,3-cd) Pyrene	150 J	2,100 U	130 J	400 U	420 U	4,000 U
Benzo(ghi)Perylene	420 U	2,100 U	410 U	400 U	400 U	4,000 U
Pesticides	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Delta-BHC	3	2 U	2 U	2 U	2 U	2 U
Aldrin	0.63 J	1 J	2 U	0.81 J	2 U	2 U
Endosulfan I (Alpha)	2 U	2 U	2 U	2 U	2 U	0.43 J
4,4'-DDE (P,P'-DDE)	4 U	4 U	4 U	4 U	4 U	4 U
Endrin	4 U	3 J	3 J	4 U	4 U	7 U
4,4'-DDD (P,P'-DDD)	4 U	4 U	4 U	4 U	4 U	4 U
Endosulfan Sulfate	3 J	4 U	4 U	4 U	4 U	4 U
4,4'-DDT (P,P'-DDT)	15	12	17	4 U	28 U	26
Endrin Aldehyde Chlordane /1	4 U	4 U	4 U	12	4 U	4 U
Gamma-Chlordane	3	2 U	2 U	2 U	11	4
Alpha-Chlordane	2 U	2 U	1 J	2 U	2 U	3
Miscellaneous Extractable Organics	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Unidentified Compounds	20,000 J	3,000 J	20,000 J	10,000 J	20,000 J	20,000 J
Diethylmethylbenzamide						
Hexadecanoic Acid						
Benzopyrene (not a)						
Trimethylnaphthalene						
1-Methylnaphthalene						
Methylphenanthrene						
Methylantracene						
Petroleum Product	—N	—N	—N	—N	—N	—N
Bis(Dimethylethyl)Cyclohexadi- enedione	400 JN		500 JN		1,000 JN	
Diphenylfluorene	900 JN		400 JN		3,000 JN	
Benzofluorene					500 JN	
Methylpyrene					500 JN	
Benzonaphthothioephene					500 JN	
Benzocephenanthrylene					900 JN	
Dioxin/Furans	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg
Toxic Equivalent Value (TEQ)	NA	NA	NA	NA	NA	NA

/1 When no value is reported, see chlordane constituents.

NA = Not Analyzed; U = Material was analyzed for but not detected—Value is minimum quantitation limit; J = Estimated value; R = QC indicates that the data is unusable; N = Presumptive evidence.

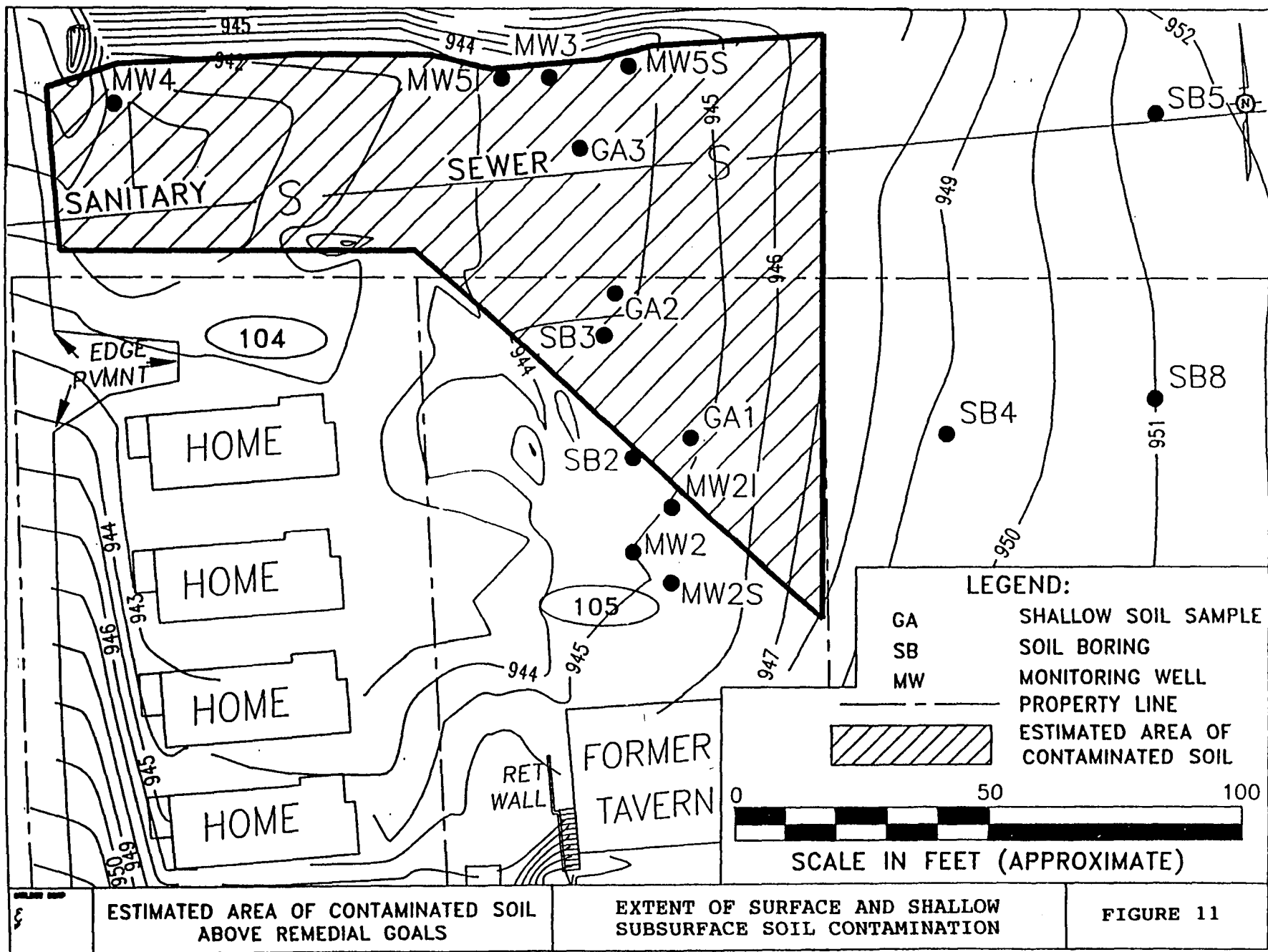


TABLE 4
INTERMEDIATE SOILS ANALYTICAL RESULTS

Sample No. Station No. Sample Date	Freq of Detect	Background			Background		Background		Background		Background	
		57970 MW11-S-2 050191	58783 MW61-S-2 052191	57978 MW71-S-1 050291	57841 MW8B-S-2 041091	57983 MW91-S-2 043091	57864 SB1-S-2 042891	57849 SB4-S-2 042491	57862 SB5-S-1 042891	57852 SB6-S-1 042491	57665 SB7-S-1 042891	57650 SB8-S-1 042491
Inorganics		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Aluminum	11/11	22,000	15,000	50,000	18,000	19,000	30,000	33,000	43,000	15,000	30,000	16,000
Arsenic	9/11	2.0 UJ	2.5 J	5.1 J	5.0 J	2.0 UJ	4.9 J	7.0 J	20.0 J	6.7 J	9.4 J	9.3 J
Barium	11/11	16	23	38	15	12	59	100	59	13	19	6
Beryllium	5/11	4.1	1.6	1.8	1.5	1.0 U	1.8	1.0 U	2.0 U	1.0 U	0.25 U	1.0 U
Calcium	5/11	50 U	40 U	590	240 U	80 U	80 U	690	340	270	100 U	250
Chromium	11/11	18	17	81	27	18	36	30	68	15	41	34
Cobalt	5/11	3.5	5.3	4.7	0.39 U	1.9	36.0	5.0 U	7.0 U	3.0 U	3.0 U	2.0 U
Copper	10/11	6.2	23.0 J	29.0	14.0	14.0	33.0	35.0	32.0	19.0	20.0 U	17.0
Iron	11/11	43,000	18,000	68,000	27,000	35,000	34,000	27,000	47,000	31,000	44,000	18,000
Lead	8/11	11 J	18 J	24 J	14 J	14 J	20 U	120	110	20 U	20 U	11
Magnesium	11/11	79	1,900	16,000	1,200 J	260	4,300	1,500	2,500	470	790	190
Manganese	11/11	130	170	87	51	41	480	160	110	41	60	280
Mercury	1/11	0.10 U	0.12 U	0.11 U	0.12 U	0.10 U	0.10 UJ	0.10 UJ	0.39 J	0.11 UJ	0.12 UJ	0.11 UJ
Nickel	11/11	4.9	13	10	4.8	3.7	17.0	7.2	10.0	6.4	4.3	6.5
Potassium	10/11	180	2,800	2,700	1,300 U	470	5,600	1,900	3,500	740	880	290
Sodium	2/11	40 U	40 U	40 U	130 U	30 U	53	50 U	56	20 U	20 U	20 U
Vanadium	11/11	38	29	140	50 J	70	77	50	110	44	91	35
Zinc	6/11	20 U	51	42	13	20 U	120 J	150 J	260 J	20 UJ	30 U	20 UJ
Purgeable Organics		ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Toluene	1/11	6 U	6 U	7 U	12 U	6 U	11 U	12 U	12,000	12 U	13 U	12 U
Ethyl Benzene	1/11	6 U	6 U	7 U	12 U	6 U	11 U	12 U	9,000 J	12 U	13 U	12 U
Total Xylenes	1/11	6 U	6 U	7 U	12 U	6 U	11 U	12 U	56,000	12 U	13 U	12 U
Extractable Organics		ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Naphthalene	1/11	790 U	400 U	870 U	390 U	830 U	370 U	400 U	1,800 J	410 U	420 U	400 U
2-Methylnaphthalene	1/11	790 U	400 U	870 U	390 U	830 U	370 U	400 U	1,800 J	410 U	420 U	400 U
Di-n-Butylphthalate	1/11	790 U	400 U	870 U	390 U	830 U	370 U	400 U	32,000 J	410 U	420 U	400 U
Fluoranthene	1/11	790 U	400 U	870 U	390 U	830 U	370 U	150 J	13,000 UJ	410 U	420 U	400 U
Pyrene	1/11	790 U	400 U	870 U	390 U	830 U	370 U	170 J	13,000 UJ	410 U	420 U	400 U
Benzo(a)Anthracene	1/11	790 U	400 U	870 U	390 U	830 U	370 U	140 J	13,000 UJ	410 U	420 U	400 U
Chrysene	1/11	790 U	400 U	870 U	390 U	830 U	370 U	180 J	13,000 UJ	410 U	420 U	400 U
Benzo(b and/or k) Fluoranthene	1/11	790 U	400 U	870 U	390 U	830 U	370 U	500 J	13,000 UJ	410 U	420 U	400 U
Benzo-a-Pyrene	1/11	790 U	400 U	870 U	390 U	830 U	370 U	120 J	13,000 UJ	410 U	420 U	400 U
Indeno (1,2,3-cd) Pyrene	1/11	790 U	400 U	870 U	390 U	830 U	370 U	130 J	13,000 UJ	410 U	420 U	400 U
Pesticides		ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Alpha-BHC	1/11	2 U	2 U	2 U	2 U	2 U	2 U	2 U	4.7	2 U	2 U	2 U
4,4'-DDE (P,P'-DDE)	1/11	19 U	19 U	21 U	3.9 UJ	20 U	3.7 U	4.4	4.1 U	4.1 U	4.1 U	4 U
4,4'-DDD (P,P'-DDD)	1/11	19 U	19 U	21 U	3.9 UJ	20 U	3.7 U	1.5 J	4.1 U	4.1 U	4.1 U	4 U
4,4'-DDT (P,P'-DDT)	1/11	19 U	19 U	21 U	3.9 UJ	20 U	3.7 U	2.1 J	4.1 U	4.1 U	4.1 U	4 U

**TABLE 4 (continued)
INTERMEDIATE SOILS ANALYTICAL RESULTS**

Sample No. Station No. Sample Date	Freq of Detect	Background			Background		Background		Background		Background	
		57970 MW11-G-2 050191	58783 MW81-G-2 052191	57978 MW71-G-1 050291	57841 MW8B-G-2 041091	57983 MW91-G-2 043091	57884 SB1-G-2 042691	57849 SB4-G-2 042491	57882 SB5-G-1 042691	57852 SB6-G-1 042491	57665 SB7-G-1 042691	57650 SB8-G-1 042491
Miscellaneous Extractable Organics		ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Methyphenylazobenzene	1/11		200 JN									
Unidentified Compounds	3/11		5,000 J		600 J			3,000 J				
Hexadecanoic Acid	1/11							400 JN				
Benzaldehyde	2/11							300 JN			200 JN	
Benzopyrene (not a)	1/11							200 JN				
Bis(dimethylethyl)Methylphenol	1/11								20,000 JN			
Butylbenzenamine	1/11								4,000 JN			
Obutylbenzenamine	1/11								5,000 JN			
Bis(dimethylethyl)Ethylphenol	1/11								10,000 JN			
Miscellaneous Purgeable Organics		ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Nonane	1/11								10,000 JN			
Ethylmethylbenzene	1/11								10,000 JN			
Trimethylbenzene (2 Isomers)	1/11								20,000 JN			
Decane	1/11								40,000 JN			
Dioxin/Furans		ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg
Toxic Equivalent Value (TEQ)	0/2	NA	NA	NA	NA	NA	NA	NA	NA	—U	NA	—U

NA = Not Analyzed; U = Material was analyzed for but not detected - Value is minimum quantitation limit; J = Estimated value; R = QC indicates that the data is unusable; N = Presumptive evidence.

10 feet) soil samples. For deep soils, those more than 10 feet below land surface, analytical results are presented in Table 5.

Several intermediate-depth samples contained metals at concentrations more than 1.5 times above background, and trace levels of volatile and extractable organic compounds. The only sample having significant levels of organic compounds, SB5-S-1, contained ethylbenzene, toluene, and total xylenes at 9, 12, and 56 parts per million (ppm) respectively. These gasoline-component compounds may represent spillage from lawnmowing activities and may not be Site-related. No significant contamination was found in the deep soil samples.

Soil samples from the RI borehole cuttings were analyzed using the Toxicity Characteristic Leachate Procedure (TCLP). Pursuant to 40 CFR § 261.24, substances for which TCLP results are above specified levels are considered hazardous wastes. The results of the TCLP analyses suggest that there are no hazardous wastes remaining onsite.

5.2.3 Groundwater

Groundwater analytical results from the surficial (shallow) aquifer both onsite (Table 6) and offsite to the north (Table 7) indicate contamination by both inorganic contaminants (metals) and VOCs. Levels of individual VOCs ranged from below the quantification limit to 1,400 ug/l onsite, and up to 12,000J ug/l offsite just across Highland Avenue to the north. Five of the inorganic concentrations and seven of the VOC concentrations violate Maximum Contaminant Levels (MCLs), or other applicable standards, for those substances.

The seven VOCs exceeding MCLs and their maximum concentrations are as follows:

trichloroethene	12,000J ug/l	tetrachloroethene	4,000J ug/l
cis-1,2-dichloroethene	140 ug/l	1,1,1-trichloroethane	310 ug/l
benzene	48 ug/l	vinyl chloride	69 ug/l
methylene chloride	32 ug/l		

Among the inorganic contaminants, lead (270 ug/l) exceeds the EPA Action Level of 15 ug/l. Maximum concentrations of metals exceeding MCLs are:

chromium	300 ug/l	nickel	230 ug/l
cadmium	6 ug/l	beryllium	51 ug/l

Groundwater flow is toward the north-northwest (Figures 9 and 10). Contamination of the surficial aquifer extends northward to Wards Creek, located 700 to 1100 feet north of the Site.

**TABLE 5
DEEP SOILS ANALYTICAL RESULTS**

Sample No. Station No. Sample Date	Freq of Detect	Background	Background			Background	Background	Background	Background		
		57971 MW11-S-3 050191	57972 MW11-S-4 050191	58784 MW61-S-3 052191	57979 MW71-S-2S 050291	57642 MW8B-S-3 041091	57964 MW91-S-3 043091	57965 MW91-S-4 043091	57966 MW91-S-5 043091	57653 SB6-S-2 042491	57651 SB8-S-2 042491
Inorganics		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Aluminum	10/10	9,400	12,000	13,000	27,000	11,000	15,000	20,000	26,000	28,000	30,000
Arsenic	6/10	2 UJ	1 UJ	16 J	3.6 J	7.7 J	13 J	1 UJ	2 UJ	6.2 J	10 J
Barium	10/10	19	32	33	200	18	21	79	100	110	110
Beryllium	8/10	2 U	2 U	2	3.9	2.4	3.1	2.7	3.4	3.1	3.1
Cadmium	1/10	0.47 U	0.50 U	0.46 U	0.54 U	0.39 U	0.53	0.53 U	0.48 U	0.48 U	0.52 U
Calcium	3/10	27	110 U	30 U	180	90 U	40 U	50 U	40 U	58	70 U
Chromium	10/10	2.8	5.7	9.6	17	20	9	18	50	47	53
Cobalt	9/10	4.2	4.5	20.0	7.7	7.0 U	1.5	16	20	13	22
Copper	10/10	1.3	3	20 J	25	17	9.6	17	30	46	42
Iron	10/10	11,000	14,000	16,000	40,000	24,000	44,000	36,000	47,000	48,000	36,000
Lead	10/10	20 J	13 J	16 J	18 J	18 J	14 J	18 J	37 J	23	46
Magnesium	10/10	37	700	1,500	6,200	1,800 J	470	2,700	5,100	5,500	5,900
Manganese	10/10	870	790	820	210	120	47	210	370	200	590
Nickel	10/10	29	39	27	9.1	6.5	7.9	19	16	15	33
Potassium	9/10	130	1,100	2,100	9,500	2,100 U	880	3,600	7,800	7,800	6,900
Sodium	4/10	30	34	40 U	60 U	130 U	40 U	60 U	90 U	100	190
Vanadium	10/10	8.3	14	23	82	37 J	60	72	95	92	92
Zinc	8/10	20 U	32	43	95	17	30 U	70	130	120 J	92 J
Purgeable Organics		ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
None Detected	0/10										
Extractable Organics		ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
None Detected	0/10										
Pesticides		ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
None Detected	0/10										
Miscellaneous Extractable Organics		ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Unidentified Compounds	1/10					500 J					
Benzaldehyde	1/10										100 JN

NA = Not Analyzed; U = Material was analyzed for but not detected - Value is minimum quantitation limit; J = Estimated value; R = QC indicates that the data is unusable; N = Presumptive evidence.

TABLE 6
SHALLOW WELLS ANALYTICAL RESULTS

	Sample No. Station No. Sample Date	Freq of Detect	Background					Background
			58798 MW1-GW 060491	58796 MW2S-GW 060591	58791 MW5S-GW 060591	59594 MW6S-GW 061891	58799 MW7S-GW 060491	58789 MW8S-GW 060591
Inorganics			ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Aluminum	6/6		7,300	91,000	98,000	230,000	220,000	180,000
Barium	5/6		150 U	900	420	1,100	1,400	590
Beryllium	5/6		3 U	18	12	51	45	30
Cadmium	1/6		3 U	3 U	3 U	4 U	6	3 U
Calcium	2/6		4,400 UJ	20,000 J	6,000 UJ	2,600	6,000 UJ	2,800 UJ
Chromium	6/6		17	100	130	300	230	220
Cobalt	6/6		19	74	130	250	340	93
Copper	5/6		20 U	110	150	260	320	160
Iron	6/6		14,000	150,000	140,000	360,000	360,000	240,000
Lead	6/6		6 J	69 J	270 J	97	63 J	100 J
Magnesium	6/6		5,900	18,000	6,700	39,000	30,000	27,000
Manganese	6/6		430	2,500	2,000	7,500	9,100	1,500
Nickel	5/6		20 UJ	78	71	220	230	140
Potassium	6/6		5,100	22,000	9,000	51,000	35,000	34,000
Sodium	4/6		17,000	10,000 U	24,000	4,900	16,000	4,100 U
Vanadium	5/6		30 U	290	240	650	810	390
Zinc	6/6		55	290	640	880	700	460
Cyanide	1/6		10 U	10 U	11	10 U	10 U	10 U
Purgeable Organics			ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Methylene Chloride	1/6		6 U	5 U	5 U	32	5 U	5 U
1,1-Dichloroethene	3/6		7	5 U	5 U	26	41	5 U
1,1-Dichloroethane	3/6		2 J	5 U	5 U	3 J	9	5 U
1,2-Dichloroethene	3/6		5 U	5 U	9	3 J	110	5 U
1,1,1-Trichloroethane	3/6		60	5 U	5 U	120	310	5 U
Carbon Tetrachloride	1/6		2 J	5 U	5 U	10 U	5 U	5 U
1,2-Dichloropropane	1/6		5 U	5 U	5 U	10 U	2 J	5 U
Trichloroethylene	2/6		20 U	5 U	9 U	910	470	5 U
1,1,2-Trichloroethane	1/6		5 U	5 U	5 U	2 J	5 U	5 U
Benzene	1/6		5 U	5 U	5 U	4 J	5 U	5 U
Tetrachloroethylene	3/6		75	6 U	20 U	1,400	360	5 U
Toluene	2/6		2 J	5 U	1 J	10 U	5 U	5 U
Total Xylenes	1/6		5 U	5 U	5 U	2 J	5 U	5 U
Miscellaneous Purgeable Organics			ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Unidentified Compounds	1/6				10 J			
Extractable Organics			ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
2-Nitroaniline	1/6		50 U	50 U	50 U	25 UJ	50 U	50 J
Dimethyl Phthalate	1/6		10 U	10 U	10 U	10 UJ	10 U	8 J
Diethyl Phthalate	2/6		10 U	2 J	10 U	10 UJ	10 U	13
Miscellaneous Extractable Organics			ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Unidentified Compounds	4/6				30 J	100 J	300 J	30 J
Caprolactam	1/6					40 JN		
Cyclohexenal	1/6						10 JN	
Cyclohexenone	3/6			8 JN	10 JN		30 JN	
Diethylmethybenzamide	1/6						20 JN	
Octadecanol	2/6		40 JN		200 JN			
Oxybis(Ethanedioxy)Bisethanol	1/6					7 JN		
(Ethoxymethoxyethoxy) Ethene	1/6					8 JN		
Butoxyethanol	1/6					60 JN		
Triethyleneglycol	1/6					20 JN		
Butylindenebis(Dimethylethyl)- Methylphenol	1/6		40 JN					
Pesticides/PCB's			ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Endosulfan Sulfate	1/6		0.17	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U

U = Material was analyzed for but not detected - Value is minimum quantitation limit;
J = Estimated value; N = Presumptive evidence.

TABLE 7
OFFSITE SURFICIAL AQUIFER ANALYTICAL RESULTS

VOLATILE ORGANIC COM- POUNDS	TMW-001	TMW-002	TMW-003	TMW-004	TMW-005	TMW-006	TMW-007	TMW-008	TMW-009
1,1-Dichloroethane (DCA)	--	4.1J	99	--	--	--	--	--	--
1,1-Dichloroethene	--	--	11J	--	--	--	--	--	--
1,2-Dichloroethane	--	--	3.8J	--	--	--	--	--	--
Acetone	--	--	390	78	--	490J	--	--	--
Benzene	3.6J	--	48	--	--	--	--	--	--
Carbon Disulfide	--	--	--	--	--	1.4J	--	1.4J	--
Chloroethane	--	--	7.4J	--	--	--	--	--	--
Chloroform	--	--	--	0.93J	--	--	--	--	--
Cis-1,2-Dichloroethene	--	6.2	140	--	--	--	--	--	--
Isopropanol	40JN	20JN	40JN	40JN	10JN	--	--	--	--
Methyl Butyl Ketone	--	--	--	1.7J	--	--	--	--	--
Methyl Ethyl Ketone	--	100	--	540J	72	670J	--	--	--
Tetrachloroethene (PCE)	--	--	17J	--	--	--	340J	--	--
Tetrahydrofuran	--	--	100JN	--	--	200JN	--	--	--
Toluene	4.5J	--	--	--	--	--	--	--	--
Trichloroethene (TCE)	--	0.94	20J	--	--	--	2,300	--	--
Vinyl Chloride	--	--	69	--	--	--	--	--	--
Total Volatiles (2)	8.1	11.24	415.2	0.93	0	1.4	2,640	1.4	0

ALL VALUES IN UG/L.

- Not detected above quantitation limit.
J Estimated value.
N Presumptive evidence of presence of substance.

- NOTES: (1) Data collected on 4/30/92 and 5/28-29/92.
(2) Total VOC value does not include five compounds detected but shown to be sampling artifacts: methyl ethyl ketone (MEK), methyl butyl ketone, isopropanol, tetrahydrofuran, or acetone. Details are provided in the FS, Appendix B.

SAMPLE NO.	COMPOUND	UG/L	TOTAL VOCs
TMW-1	Vinyl Chloride 1,1-Dichloroethane Cis-1,2-Dichloroethene Benzene Trichloroethene Tetrachloroethene O-xylene	20J 5.4J 99 12J 47 47 2.1J	232.5
TMW-2	1,1,1-Trichloroethane Trichloroethene Tetrachloroethene	160J 2,000 1,600	3,760
TMW-3	Trichloroethene Tetrachloroethene	12,000 4,000	16,000
TMW-4	Trichloroethene Tetrachloroethene	300 750	1,050

FOOTNOTES:

Data collected January 1992.

J -- Estimated value

Figure 12 shows the approximate extent of contamination of the surficial aquifer. The offsite groundwater samples were collected only from the surficial aquifer because onsite groundwater samples from it showed it to be more contaminated than the intermediate aquifer, and because monitor well conductivity tests indicated that groundwater in the surficial aquifer moves much faster than groundwater in the underlying intermediate aquifer.

Samples from the intermediate aquifer (Table 8), in comparison, show less contamination than the surficial aquifer. Three VOCs are present at levels above MCLs:

tetrachloroethene	120 ug/l	trichloroethene	98 ug/l
1,2-dichloroethene(*)	74 ug/l		

Six other VOCs were detected at levels ranging from 1J or 2J ug/l to 22 ug/l. No significant inorganic contamination was present in intermediate aquifer samples.

Deep aquifer samples (Table 9) contained three organic compounds at estimated values below the detection limit and below MCLs.

In the FS, the total volume of contaminated groundwater was estimated to be 66.9 million gallons. The estimate was based on the areal extent of contamination indicated in Figure 12. Also, since significant VOC contamination was found in the intermediate wells, the assumed vertical contamination extent was 55 feet, corresponding to the average screen depths of the intermediate wells.

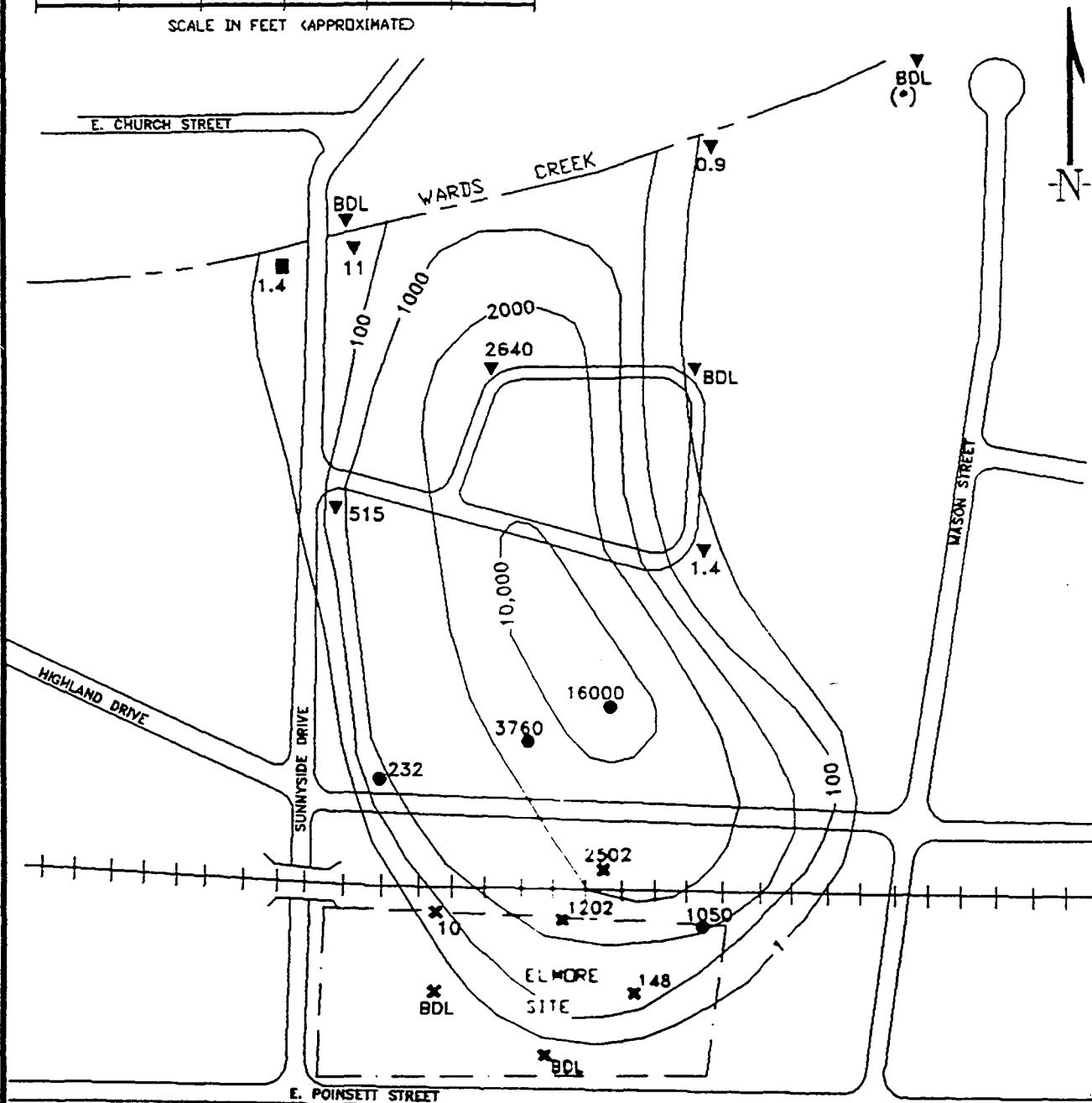
5.2.4 Surface Water

Two sets of samples from Wards Creek contained low levels of two VOCs, trichloroethene (TCE) and tetrachloroethene (PCE), at maximums of 85 and 16 ug/l, respectively (Table 10). Two other VOCs, 1,1-dichloroethane and cis-1,2-dichloroethene, were present at less than 3 ug/l. The TCE maximum value is above the South Carolina Ambient Water Quality Standard (Human Health) for surface waters, which for TCE is 5 ug/l. Despite the presence of a former dump area along and south of Wards Creek, no other types of contaminants were detected in Wards Creek in the second set of samples taken on June 24, 1992. Samples from a groundwater seep near the creek, and from a drainage ditch which runs north along Sunnyside Drive (samples SW-5 and SW-4, respectively; refer to Figure 8), suggest that the surficial aquifer is discharging

(*) Analysis of this sample was for total 1,2-dichloroethene (DCE). The MCL for the cis-isomer, 70 ug/l, may be violated although this cannot be known for certain.

• = IT IS ASSUMED THAT THE
<5 PPB HIT AT THIS LOC-
ATION IS NOT SITE-RELATED.

300 200 100 0 100 200 300
SCALE IN FEET (APPROXIMATED)



TOTAL VOCs

All values in UG/L

LEGEND

● ESD TEMP MONITORING WELL

▼ GEOPROBE SAMPLE LOCATION

BDL BELOW DETECTION LIMIT

■ HAND AUGERED BORING
GROUNDWATER SAMPLING LOCATION

× BWST PERMANENT SHALLOW
WELL (1991 RI DATA)



EXTENT OF SURFICIAL AQUIFER CONTAMINATION

FIGURE

12

TABLE 8
INTERMEDIATE WELLS ANALYTICAL RESULTS

Sample No. Station No. Sample Date	Freq of Detect	Background					Background
		58797 MW1-GW 060491	58790 MW2-GW 060591	58792 MW5-GW 060591	59596 MW6-GW 061891	59591 MW7-GW 061891	58800 MW9-GW 060391
Inorganics		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Aluminum	5/6	380	480	650	990	550 U	930
Barium	3/6	20 U	100 U	190	190	52	120 U
Calcium	2/6	6,800 UJ	3,000 UJ	4,800 UJ	13,000	1,000	2,900 UJ
Chromium	6/6	13	19	24	42	31	15
Iron	6/6	460	770	1,700	1,200	610	860
Magnesium	5/6	870 U	1,400	1,700	3,800	1,200	1,400
Manganese	6/6	94	130	380	340	140	240
Nickel	4/6	20 U	20 UJ	27	25	22	15
Potassium	3/6	2,400 UJ	3,500 U	4,800	6,900	3,000	2,100 U
Sodium	4/6	7,200 U	8,200	15,000 U	19,000	15,000	22,000
Zinc	4/6	7	14	24	30 U	30 U	26
Purgeable Organics		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
1,2-Dichloroethene	3/6	5 U	2 J	74	10 U	32	5 U
Chloroform	3/6	20	5 U	7 U	1 J	1 J	5 U
1,1,1-Trichloroethane	2/6	5 U	5 U	5 U	11	1 J	5 U
Bromodichloromethane	1/6	2 J	5 U	5 U	10 U	10 U	5 U
Trichloroethylene	3/6	5 U	6 U	22	98	7 J	5 U
Benzene	1/6	5 U	5 U	5 U	10 U	5 J	5 U
Tetrachloroethylene	2/6	5 U	9 U	30 U	120	22	10 U
Toluene	3/6	1 J	5 U	3 J	10 U	10 U	1 J
Total Xylenes	1/6	5 U	5 U	5 U	10 U	12	5 U
Miscellaneous Purgeable Organics		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Unidentified Compounds	1/6						10 J
Extractable Organics		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Diethyl Phthalate	1/6	10 U	4 J	10 UR	10 U	10 U	10 U
Miscellaneous Extractable Organics		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Unidentified Compounds	4/6	30 J		30 J	40 J	200 J	
Caprolactam	2/6				10 JN	40 JN	
Diethylmethybenzamide	1/6					3 JN	
Dodecanoic Acid	1/6			20 JN			
Octadecenol	1/6	400 JN					
Butylindenebis(Dimethylethyl)- Methylphenol	2/6		20 JN	6 JN			

U = Material was analyzed for but not detected - Value is minimum quantitation limit;
J = Estimated value; N = Presumptive evidence.

TABLE 9
DEEP WELLS ANALYTICAL RESULTS

	Sample No. Station No. Sample Date	Freq of Detect	Background	
			59597 MW6B-GW 061991	59590 MW8B-GW 061991
Inorganics			ug/l	ug/l
Aluminum		2/2	3,100	1,200
Barium		2/2	34	100
Calcium		2/2	25,000	48,000
Chromium		1/2	20	6 U
Iron		1/2	4,300	370 U
Lead		1/2	4	2 U
Magnesium		2/2	2,500	77
Manganese		1/2	150	5 U
Nickel		1/2	15	21 J
Potassium		2/2	7,500	84,000
Sodium		2/2	12,000	57,000
Vanadium		1/2	4 U	16
Purgeable Organics			ug/L	ug/L
Chloroform		1/2	10 U	8 J
Toluene		1/2	10 U	8 J
Extractable Organics			ug/L	ug/L
Di-n-Octylphthalate		1/2	10 U	3 J
Miscellaneous Extractable Organics			ug/L	ug/L
Unidentified Compounds		1/2	200 J	
Caprolactam		1/2		9 JN

U = Material was analyzed for but not detected –
Value is minimum quantitation limit; J = Estimated
value; N = Presumptive evidence.

TABLE 10
SURFACE WATER ANALYTICAL RESULTS

VOLATILE ORGANIC COMPOUNDS	SW-1	SW-2	SW-3	SW-4	SW-5	SW-6	SW-7	EL-001	ES-002
1,1-Dichloroethane (DCA)	-	-	-	3.0J	-	-	-	0.57J	-
Carbon Disulfide	-	-	-	70	-	-	-	-	-
Cis-1,2-Dichloroethene	2.8J	-	1.1J	12	6.2J	-	-	2.1J	-
Tetrachloroethene (PCE)	16J	0.89	7.2	3.9J	26J	-	-	15	0.86AJ
Trichloroethene (TCE)	85	-	38	6.7	180	-	-	74	0.86AJ
Total Volatiles (2)	103.8	0.89	46.3	95.6	212.2	0	0	91.7	1.7

ALL VALUES IN UG/L.

--- Not detected above quantitation limit.

J Estimated value.

A Average value.

NOTES: (1) Data collected on 4/30/92; 5/28-29/92; and 6/24/92.

(2) EL-001 and ES-002 were also analyzed for metals, cyanide, and extractable organic compounds. Metals concentrations were not elevated and are consistent with expected background conditions. No compounds were detected in the other analyses above quantitation limits.

(3) Sample SW-5 was collected from a hillside seep near Wards Creek, and is believed to be more representative of groundwater than surface water.

contaminated groundwater into Wards Creek. The VOCs detected in surface water are found in both onsite and offsite wells and can be attributed to the Elmore Waste Disposal Site.

6.0 SUMMARY OF SITE RISKS

A Baseline Risk Assessment was conducted to evaluate the risks presented by the Elmore Waste Disposal Site to human health and the environment, under present day conditions and under assumed future use conditions. Currently, there is one family living on the Site and numerous residents residing close to the Site. There are no potable water supply wells on, or within one-half mile of the Site. Information from the Spartanburg County Planning Department suggests that future land use will remain residential, with the potential for resident use of groundwater as a potable water source. The sections which follow correspond to the four major components of the Baseline Risk Assessment.

Under existing conditions, the lifetime carcinogenic risk to onsite residents is estimated to be 1.9×10^{-4} . Under the future use scenario, the lifetime carcinogenic risk estimate is 1.7×10^{-2} . Both current and future use values exceed EPA's allowable range of carcinogenic risk, which is 1×10^{-4} to 1×10^{-6} .

Noncarcinogenic risk presented by current Site conditions is estimated to be Hazard Index (HI) = 0.25 for onsite adults and HQ = 2 for an onsite or offsite child resident. Future risk is estimated as HI = 14 for onsite adults and HI = 16 for onsite or offsite child residents. One current use value (child resident/nonresident) and both future use numbers exceed EPA's noncarcinogenic risk benchmark, HI = 1.

No substantial risk to wildlife or the environment was found to exist under present conditions. In the future, ecological risks could arise in the area along Wards Creek if the levels of contaminants entering the creek via groundwater discharge increased significantly.

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this Record of Decision, may present an imminent and substantial endangerment to public welfare or the environment.

6.1 Contaminants of Concern

Based on RI data, contaminant concentrations to be included and evaluated in the Baseline Risk Assessment were selected. Table 11 presents a summary of these contaminants in all media sampled.

TABLE 11
SUMMARY OF RI CONTAMINANTS OF CONCERN

Chemical of Concern Analyte or Compound	Soil			Groundwater			Surface Water
	Shallow <5 ft	Intermediate 5 to 10 ft	Deep >10 ft	Shallow Wells	Intermediate Wells	Bedrock Wells	
INORGANICS							
Aluminum		X	X	X	X	X	
Arsenic	X	X	X				
Barium				X	X	X	
Beryllium	X			X			
Cadmium	X		X	X			
Chromium	X		X	X	X	X	
Cobalt	X			X			
Copper	X			X			
Lead	X			X		X	
Manganese	X			X	X	X	
Mercury	X						
Nickel	X			X	X	X	
Vanadium	X			X		X	
Zinc	X			X	X		
Cyanide	X			X			
PURGEABLE ORGANICS							
Methylene Chbride				X			
1,1-Dichbroethene				X			
1,1-Dichbroethane				X			X
1,2-Dichbroethene (total)	X			X	X		
Cis-1 2-Dichbroethene				X			X
Chloroform					X	X	
1,1,1-Trichloroethane				X	X		
Carbon Tetrachbride				X			
Bromodichloromethane					X		
1,2-Dichloropropane				X			
Trichbroethene	X			X	X		X
1,1 2-Trichbroethane				X			
Benzene				X	X		
Tetrachloroethene	X			X	X		X
Toluene	X	X		X	X	X	
Ethyl benzene		X					
Total Xylenes		X		X	X		
Carbon Disulfide				X			X
Vinyl Chloride				X			
EXTRACTABLE ORGANICS							
Naphthalene	X	X					
2-Methylnaphthalene	X	X					
2-Nitroaniline				X			
Dimethyl Phthalate				X			
Acenaphthylene	X						
Acenaphthene	X						
Dibenzofuran	X						
Diethyl Phthalate				X	X		
Fluorene	X						
Phenanthrene	X						
Anthracene	X						
Carbazole	X						
Di-N-butylphthalate		X					
Fluoranthene	X	X					
Pyrene	X	X					

TABLE 11 (continued)
SUMMARY OF RI CONTAMINANTS OF CONCERN

Chemical of Concern Analyte or Compound	Soil			Groundwater			Surface Water
	Shallow <5 ft	Intermediate 5 to 10 ft	Deep >10 ft	Shallow Wells	Intermediate Wells	Bedrock Wells	
EXTRACTABLE ORGANICS (cont'd)							
Benzyl Butyl Phthalate	X						
Benzo(A)Anthracene *	X	X					
Chrysene *	X	X					
Di-N-octylphthalate						X	
Benzo(B and/or K) Fluoranthene *	X	X					
Benzo(A)Pyrene *	X	X					
Indeno (1,2,3-C,D) Pyrene *	X	X					
Benzo(G,H,I)Perylene	X						
PESTICIDES							
Delta-BHC	X						
Aldrin	X						
Endosulfan I (Alpha)	X						
4,4'-DDE (P,P'-DDE)	X	X					
Endrin	X						
4,4'-DDD (P,P'-DDD)	X	X					
Endosulfan Sulfate	X			X			
4,4'-DDT (P,P'-DDT)	X	X					
Endrin Aldehyde Chlordane	X						
Gamma-Chlordane	X						
Alpha-Chlordane	X						
DIOXIN/FURANS							
Toxic Equivalent Value (TEQ)	X						

X = Chemical of Concern present

* = Carcinogenic PAH

Contaminants were not included if any of the following criteria applied:

- * The chemical, compound or element was not detected at levels above the minimum quantification limit.
- * If an inorganic compound or element, it was not detected at or above twice the background concentration.
- * If an inorganic compound or element, it was detected at low concentrations, had very low toxicity, and was judged to be naturally occurring.
- * The data included "N" (presumptive evidence) or "R" (not usable).

6.2 Exposure Assessment

Contaminated media at the Site include surface and shallow subsurface soil; shallow and intermediate groundwater; and surface water. Pathways involving air as a medium were not considered due to the extensive grass and vegetative cover at the Site, and the absence of significant VOC concentrations in surface and shallow subsurface soils.

Populations that could potentially be exposed to Site contaminants are child and adult residents living on the Site, and children and adults living near the Site who might visit or play on the Site.

Based on these potential receptors, five general exposure pathways were selected for further numerical risk quantification:

1. Current exposure of adult non-residents to contaminants in shallow soils through incidental ingestion and dermal contact.
2. Current exposure of onsite adult residents to contaminants in shallow soils through incidental ingestion and dermal contact.
3. Current exposure of onsite and offsite child residents to contaminants in shallow soils through incidental ingestion and dermal contact; and to contaminants in surface water through dermal contact and incidental ingestion.
4. Future exposure of onsite adult residents to contaminants in groundwater through ingestion, dermal contact, and inhalation; to contaminants in garden produce through ingestion of contaminated produce; and to contaminants in shallow soils through incidental ingestion and dermal contact.

5. Future exposure of onsite and offsite child residents to contaminants in shallow soils through incidental ingestion and dermal contact; to contaminants in garden produce through ingestion of contaminated produce; to contaminants in groundwater through ingestion, dermal contact, and inhalation; and to contaminants in surface water through dermal contact and incidental ingestion.

In order to quantify the exposure associated with each pathway, various standard assumptions are made for key variables in the exposure calculations. These variables include the contaminant level in the medium, usually referred to as the exposure point concentration; and the amount of the chemical taken into the body, or chronic daily intake, which must be calculated using a number of assumptions. Since EPA policy is that exposure estimates must approximate a Reasonable Maximum Exposure (RME) scenario, each of the variables was selected with the goal of producing the maximum exposure that could reasonably be expected to occur.

Table 12 presents the exposure point concentrations calculated for the contaminants of concern in each medium. For each contaminant, the concentrations represent the upper 95 percent confidence limit of the arithmetic means of all detections (qualified as described in Section 6.1 above).

Calculation of average daily intake requires input of numerous exposure parameters which are usually applicable to a particular exposure pathway. The exposure parameters used are summarized in Table 13.

The result of the exposure assessment is a set of tables showing a calculated average daily intake value for each chemical or compound, as well as a summary value for each exposure pathway. These tables are included in the Baseline Risk Assessment.

6.3 Toxicity Assessment of Contaminants

In this portion of the Baseline Risk Assessment, the toxic effects of contaminants were investigated and evaluated. The critical variables needed to calculate estimates of risk, described below, were obtained from the EPA toxicological database. Critical toxicity values for Elmore Site contaminants are presented in Table 14. Table 15 lists additional critical toxicity values which were derived in order to quantify dermal exposure, for which EPA has not developed reference doses and slope factors.

The reference dose (RfD), used in estimating noncarcinogenic risk, is an estimate of the daily dose of a substance to which

TABLE 12
EXPOSURE POINT CONCENTRATIONS

EXPOSED POPULATION	EXPOSURE MEDIUM	CHEMICAL	EXPOSURE POINT CONCENTRATION *		
			SOIL CONC.(mg/kg)	DATA REFERENCE	SAMPLE DEPTH
Onsite	Onsite	Arsenic	3.6E+01	B	<5'
Adult and	Shallow	Beryllium	1.4E+00	B	<5'
Child Resident	Soil	Cadmium	2.1E+00	B	<5'
Onsite		Chromium (III)	6.8E+01	B	<5'
Nonresident		Cobalt	8.3E+00	B	<5'
		Copper	1.2E+02	A	<5'
		Lead	1.6E+03	B	<5'
		Manganese	3.5E+02	B	<5'
		Mercury	2.0E-01	B	<5'
		Nickel	1.6E+01	B	<5'
		Vanadium	7.9E+01	A	<5'
		Zinc	8.3E+02	A	<5'
		Cyanide	8.8E+00	B	<5'
		1,2-Dichloroethene (total)	6.5E-03	A	<5'
		Trichloroethene	6.5E-03	A	<5'
		Tetrachloroethene	6.5E-03	A	<5'
		Toluene	6.5E-03	A	<5'
		Naphthalene	1.7E+00	B	<5'
		2-Methylnaphthalene	4.5E-01	B	<5'
		Acenaphthylene	1.7E+00	B	<5'
		Acenaphthene	1.7E+00	B	<5'
		Dibenzofuran	1.7E+00	B	<5'
		Fluorene	1.7E+00	B	<5'
		Phenanthrene	1.7E+00	B	<5'
		Anthracene	1.7E+00	B	<5'
		Carbazole	1.8E+00	B	<5'
		Fluoranthene	1.0E+00	A	<5'
		Pyrene	1.2E+00	B	<5'
		Benzyl Butyl Phthalate	1.7E+00	B	<5'
		Benzo(A)pyrene**	1.7E+00	B	<5'
		Benzo(A)anthracene**	1.6E-01	B	<5'
		Chrysene**	1.7E-02	B	<5'
		Benzo(B and/or K)fluoranthene**	2.0E-01	B	<5'
		Indeno(1,2,3-cd)pyrene**	1.7E-01	B	<5'
		Benzo(G,H,I)perylene	1.7E+00	B	<5'
		Delta-BHC	2.6E-03	B	<5'
		Aldrin	1.7E-03	B	<5'
		Endosulfan I (Alpha)	1.1E-03	A	<5'
		4,4'-DDE (P,P'-DDE)	1.2E-02	B	<5'
		Endrin	3.3E-03	B	<5'
		4,4'-DDD (P,P'-DDD)	4.1E-03	B	<5'
		Endosulfan Sulfate	2.7E-03	B	<5'
		4,4'-DDT (P,P'-DDT)	2.6E-02	A	<5'
		Endrin Aldehyde Chlordane	9.3E-03	B	<5'
		Gamma-Chlordane	8.9E-03	B	<5'
		Alpha-Chlordane	2.3E-03	B	<5'
		TEQ	8.4E-05	A	<5'

* - Exposure Point Concentrations assumed to be identical for current and future exposures.

A - Max Hits lower than Confidence Limit (CL).

B - CL lower than max hits.

** - Carcinogenic PAH exposure point concentration adjusted by multiplying by its toxicity equivalency factor relative to benzo(A)pyrene.

For soils, garden area (GA) soil samples were used, in order to obtain a reasonable maximum exposure (RME).

For groundwater, results from the shallow wells were used, in order to obtain the RME.

TABLE 12 (continued)
EXPOSURE POINT CONCENTRATIONS

EXPOSED POPULATION	EXPOSURE MEDIUM	CHEMICAL	EXPOSURE POINT CONCENTRATION *		
			WATER CONC.(mg/l)	DATA REFERENCE	SAMPLE DEPTH
Onsite Adult and Child Resident	Shallow Groundwater	Aluminum	2.0E+02	B	<20'
		Barium	1.2E+00	B	<20'
		Beryllium	4.1E-02	B	<20'
		Cadmium	4.3E-03	B	<20'
		Chromium (III)	2.4E-01	B	<20'
		Cobalt	2.6E-01	B	<20'
		Copper	2.6E-01	B	<20'
		Lead	1.7E-01	B	<20'
		Manganese	7.6E+00	B	<20'
		Nickel	1.9E-01	B	<20'
		Vanadium	6.3E-01	B	<20'
		Zinc	7.5E-01	B	<20'
		Cyanide	5.5E-03	A	<20'
		Methylene Chloride	2.2E-02	B	<20'
		1,1-Dichloroethene	2.8E-02	B	<20'
		1,1-Dichloroethane	7.7E-03	B	<20'
		1,2-Dichloroethene	7.8E-02	B	<20'
		1,1,1-Trichloroethane	2.1E-01	B	<20'
		Carbon Tetrachloride	5.0E-03	A	<20'
		1,2-Dichloropropane	5.0E-03	A	<20'
		Trichloroethene	5.5E+00	B	<20'
		1,1,2-Trichloroethane	4.9E-03	B	<20'
		Benzene	7.5E-03	B	<20'
		Tetrachloroethene	2.1E+00	B	<20'
		Toluene	5.0E-03	A	<20'
		Total Xylenes	7.0E-03	B	<20'
		2-Nitroaniline	2.5E-02	A	<20'
		Dimethyl Phthalate	5.0E-03	A	<20'
		Diethyl Phthalate	5.0E-03	A	<20'
		Endosulfan Sulfate	5.0E-05	A	<20'
		Cis-1,2-Dichloroethane	9.9E-02	A	<20'
		Carbon Disulfide	1.2E-03	A	<20'
		Vinyl Chloride	2.0E-02	A	<20'
Child Resident Offsite	Surface	Carbon Disulfide	5.8E-02	B	
	Water	1,1-Dichloroethane	2.5E-03	B	
		Cis-1,2-Dichloroethene	1.1E-02	B	
		Trichloroethene	1.7E-01	B	
		Tetrachloroethene	2.6E-02	B	

* - Exposure Point Concentrations assumed to be identical for current and future exposures.

A - Max Hits lower than Confidence Limit (CL).

B - CL lower than max hits.

For soils, garden area (GA) soil samples were used, in order to obtain a reasonable maximum exposure (RME).

For groundwater, results from the shallow wells were used, in order to obtain the RME.

TABLE 13
SUMMARY OF EXPOSURE PARAMETERS

<u>Pathway:</u> Incidental soil ingestion						
<u>Exposure Parameter:</u> (See KEY at end)	IR	FI	EF	ED	BW	AT
<u>Population:</u> Onsite non-residents (current use)	100	1.0	260	7	35	2,555 25,550
Onsite adult residents (current + future use)	100	1.0	350	24	70	8,760 25,550
Onsite child residents (current + future use)	200	1.0	350	6	16	2,190 25,550
Onsite adult residents including gardening (future use)	100	1.0	275	24	70	8,760 25,550

<u>Pathway:</u> Dermal soil contact							
<u>Exposure Parameter:</u> (See KEY at end)	SA	AF	AB	EF	E	BW	AT
<u>Population:</u> Onsite non-residents (current use)	4,045	0.6	0.01 0.001	260	7	35	2,555 25,550
Onsite adult residents (current + future use)	4,985	0.6	0.01 0.001	350	24	70	8,760 25,550
Onsite child residents (current + future use)	3,160	0.6	0.01 0.001	350	6	16	2,190 25,550
Onsite adult residents including gardening (future use)	4,985	0.6	0.01 0.001	275	24	70	8,760 25,550

<u>Pathway:</u> Ingestion of groundwater					
<u>Exposure Parameter:</u> (See KEY at end)	IR	EF	ED	BW	AT
<u>Population:</u> Future residents (adults and children)	2.0	350	30	70	10,950 25,550

TABLE 13 (cont'd)
SUMMARY OF EXPOSURE PARAMETERS

Pathway: Dermal contact with groundwater							
Exposure Parameter: (See KEY at end)	SA	PC	ET	EF	ED	BW	AT
Population: Future adult residents	18,150	0.0015	0.2	350	24	70	8,760 25,550
Future child residents	7,195	0.0015	0.2	350	6	16	2,190 25,550

Pathway: Inhalation of VOCs - showering								
Exposure Parameter: (See KEY at end)	L	RS	IHR	ET	EF	ED	BW	AT
Population: Future residents (adults and children)	200	12	0.6	0.2	350	30	70	10,950 25,550

Pathway: Incidental ingestion of surface water - swimming							
Exposure Parameter: (See KEY at end)	CR		ET	EF	ED	BW	AT
Population: Offsite child resident (current land use)	0.05		1.0	24	7	35	2,555 25,550

Pathway: Dermal contact with surface water - swimming							
Exposure Parameter: (See KEY at end)	SA	PC	ET	EF	ED	BW	AT
Population: Offsite child resident (current land use)	1,160	0.0015	1.0	24	7	35	2,555 25,550

TABLE 13 (cont'd)
SUMMARY OF EXPOSURE PARAMETERS

Pathway: Ingestion of contaminated produce grown in contamin. soil						
Exposure Parameter: (See KEY at end)	IR	EF	FI	ED	BW	AT
Future residents (adults and children)	0.122	350	1.0	30	70	10,950 25,550

KEY

References for all variables are detailed in the Baseline Risk Assessment.

IR = Ingestion rate (mg soil/day, or L/day for groundwater).
 FI = Fraction ingested. A value of 1.0 assumes all ingested soil is contaminated.
 EF = Exposure frequency (days or events/yr). 350: daily minus 2 wks annual vacation. 260: daily for 6 mos., alternating days for remaining 6 mos., minus 2 wks. vacation, each year. 275: daily for 9 months per year. 24: twice weekly for 12 weeks (summer).
 ED = Exposure duration (years).
 BW = Body weight (kg). Standard values are 70 kg (adult average), 35 kg (teenager average), 16 kg (children 1-6 yrs, 50th percentile).
 AT = Averaging time (period considered: days). The top value given is the chronic value (ED x 365); the lower is the lifetime period of exposure assuming a 70-year life span.
 SA = Surface area of skin that is exposed (cm²).
 AF = Soil adherence factor (mg/cm²). Represents a fraction of how much of the contacted soil actually adheres to the exposed skin.
 AB = Dermal absorption / soil desorption factor (unitless). The top value, 0.01, is assumed for organic compounds; the lower value, 0.001, is assumed for inorganic compounds/elements.
 ET = Exposure time (hours/day).
 PC = Dermal permeability constant (cm/hr).
 IHR = Inhalation rate (m³/hr). Volume of air inhaled per unit time.
 RS = Room size (m³).
 L = Water Use (liters).
 CR = Contact rate (L/hr).

**TABLE 14
CRITICAL TOXICITY VALUES**

Analyte (Contaminant of Concern)	Carcinogenic Classification	Oral		Inhalation		Reference
		Slope (mg/kg/day) ⁻¹	RfD Chronic (mg/kg/day)	Slope (mg/kg/day) ⁻¹	RfD Chronic (mg/kg/day)	
PURGEABLE ORGANICS						
1,2-Dichloropropane	B2	6.8E-02	--	ND	1.1E-03	HEAST
Cis-1,2-Dichloroethene	--	--	1E-02	--	ND	HEAST
1,1-Dichloroethene	C	6E-01	9E-03	1.2E+00	--	IRIS/HEAST
Benzene	A	2.9E-02	2E-01	2.9E-02	1.6E-01	IRIS
Tetrachloroethene	B2	5.1E-02	1E-02	1.8E-03	ND	IRIS/HEAST
Trichloroethene	B2	1.1E-02	--	1.7E-02	--	IRIS
1,1,2-Trichloroethane	C	5.7E-02	4E-03	5.7E-02	--	IRIS/HEAST
Carbon Tetrachloride	B2	1.3E-01	7E-04	1.3E-01	--	IRIS/HEAST
Methylene Chloride	B2	7.5E-03	6E-02	1.6E-03	8.6E-01	IRIS
Vinyl Chloride	A	1.9E+00	--	3.0E-01	--	HEAST
EXTRACTABLE ORGANICS						
Benzo(a)Pyrene	B2	7.3E+00	--	6.1E+00	--	IRIS
Benzo(b and/or k)Flouranth	B2	7.3E+00*	--	6.1E+00*	--	--
Benzo(a)Anthracene	B2	7.3E+00*	--	6.1E+00*	--	--
Chrysene	B2	7.3E+00*	--	6.1E+00*	--	--
Indeno(1,2,3-cd)Pyrene	B2	7.3E+00*	--	6.1E+00*	--	--
PESTICIDES						
Aldrin	B2	1.7E+01	3E-05	1.7E+01	--	IRIS
Alpha-Chlordane	B2	1.3E+00	6E-05	1.3E+00	--	IRIS
Gamma-Chlordane	B2	1.3E+00	6E-05	1.3E+00	--	IRIS
INORGANICS						
Arsenic	A	1.8E+00	3E-04	5.0E+01	--	IRIS/HEAST
Barium	--	--	7E-02	--	1.4E-04	IRIS/HEAST
Cadmium **	B1	--	1E-3, 5E-04	6.1E+00	--	IRIS/HEAST
Chromium (IV)	--	--	5E-03	4.1E+01	--	IRIS/HEAST
Lead	B2	ND	ND	ND	ND	
Manganese	D	--	1E-01	--	1.1E-04	IRIS
Nickel (Soluble Salts)	--	ND	2E-02	8.4E-01	ND	IRIS/HEAST
Vanadium	--	--	7E-03	--	ND	HEAST
Zinc	D	--	2E-01	--	ND	IRIS
Beryllium	B2	4.3E+00	5E-03	8.4E+00	--	IRIS/HEAST
DIOXIN						
TEQ (Dioxin) ***	B2	1.5E+05	--	1.5E+05	--	HEAST

(1) This table presents the critical toxicity values used in risk calculations, for all contaminants of concern which contribute either noncarcinogenic risk hazard quotient (HQ) > 0.1, or carcinogenic risk > 1 x 10⁻⁶.

ND Not determined

-- Not listed

* Slope factors for these compounds have not been established. Therefore, the EPA interim slope factor for benzo(a)pyrene was assigned since these compounds are also carcinogenic PAHs.

** Cadmium has two RfD values, one for food and a second for water.

*** "TEQ" represents the toxic equivalent factor, calculated according to the procedures specified in the international Toxic Equivalent Factor/89 method.

TABLE 15
DERIVATION OF DERMAL CRITICAL TOXICITY VALUES¹

Analyte (Contaminant of Concern)	Carcinogenic Classification	Oral		Absorbtion Factor (a)	Dermal	
		Slope (mg/kg/day) ⁻¹	RfD Chronic (mg/kg/day)		Slope (b) (mg/kg/day) ⁻¹	RfD (c) (mg/kg/day)
PURGEABLE ORGANICS						
1,2-Dichloropropane	B2	6.8E-02	--	0.8	8.5E-02	--
Cis-1,2-Dichloroethene	--	--	1E-02	0.8	--	8E-03
1,1-Dichloroethene	C	6E-01	9E-03	0.8	7.5E-01	7.2E-03
Benzene	A	2.9E-02	2E-01	0.8	3.6E-02	1.6E-01
Tetrachloroethene	B2	5.1E-02	1E-02	0.8	6.4E-02	8E-03
Trichloroethene	B2	1.1E-02	--	0.8	1.4E-02	--
1,1,2-Trichloroethane	C	5.7E-02	4E-03	0.8	7.1E-02	3.2E-02
Carbon Tetrachloride	B2	1.3E-01	7E-04	0.8	1.6E-01	5.6E-04
Methylene Chloride	B2	7.5E-03	6E-02	0.8	9.4E-03	4.8E-02
Vinyl Chloride	A	1.9E+00	--	0.8	2.4E+00	--
EXTRACTABLE ORGANICS						
Benzo(a)Pyrene	B2	7.3E+00	--	0.85	8.6E+00	--
Benzo(b and/or k)Flouranth	B2	7.3E+00*	--	1.0	7.3E+00	--
Benzo(a)Anthracene	B2	7.3E+00*	--	1.0	7.3E+00	--
Chrysene	B2	7.3E+00*	--	0.41	1.8E+01	--
Indeno(1,2,3-cd)Pyrene	B2	7.3E+00*	--	1.0	7.3E+00	--
PESTICIDES						
Aldrin	B2	1.7E+01	3E-05	0.1	1.7E+02	3E-06
Alpha-Chlordane	B2	1.3E+00	6E-05	0.1	1.3E+01	6E-06
Gamma-Chlordane	B2	1.3E+00	6E-05	0.1	1.3E+01	6E-06
INORGANICS						
Arsenic	A	1.8E+00	3E-04	0.2	9.0E+00	6E-05
Barium	--	--	7E-02	0.2	--	1.4E-02
Cadmium **	B1	--	1E-3, 5E-04	0.2	--	2E-04, 1E-04
Chromium (IV)	--	--	5E-03	0.2	--	1.0E-03
Lead	B2	ND	ND	0.2	--	--
Manganese	D	--	1E-01	0.2	--	2E-03
Nickel (Soluble Salts)	--	ND	2E-02	0.2	--	4E-03
Vanadium	--	--	7E-03	0.2	--	1.4E-03
Zinc	D	--	2E-01	0.2	--	4E-02
Beryllium	B2	4.3E+00	5E-03	0.2	2.2E+01	1E-03
DIOXIN						
TEQ (Dioxin) ***	B2	1.5E+05	--	0.1	1.5E+06	--

(1) This table presents the derivation of dermal critical toxicity values used in risk calculations involving dermal exposure, for all contaminants of concern which contribute either noncarcinogenic risk hazard quotient (HQ) > 0.1, or carcinogenic risk > 1×10^{-6} .

a Based on USEPA HEAs and ATSDR documents (see Baseline Risk Assessment).

b Slope/Absorbtion Factor

c Oral RfD x Absorbtion Factor

ND Not determined

-- Not listed

* Slope factors for these compounds have not been established. Therefore, the EPA interim slope factor for benzo(a)pyrene was assigned since these compounds are also carcinogenic PAHs.

** Cadmium has two RfD values, one for food and a second for water.

*** "TEQ" represents the toxic equivalent factor, calculated according to the procedures specified in the International Toxic Equivalent Factor/89 method.

may be exposed without appreciable risk of health effects. It is expressed as mg/kg/day. RfDs are based on human epidemiological studies or animal studies, and have built-in uncertainty factors that prevent underestimation of potential adverse effects.

In estimating carcinogenic risk, a slope factor (SF) is used to estimate the upper bound excess cancer risk posed by a lifetime of exposure to carcinogens. The SF is an estimate of the dose-response curve at very low doses, and is extrapolated from dose-response data at high doses.

In Table 14, carcinogenic contaminants are classified according to EPA's weight-of-evidence system. This classification scheme is summarized below:

- Group A: Known human carcinogen.
- Group B1: Probable human carcinogen, based on limited human epidemiological evidence.
- Group B2: Probable human carcinogen, based on inadequate human epidemiological evidence but sufficient evidence of carcinogenicity in animals.
- Group C: Possible human carcinogen, limited evidence of carcinogenicity in animals.
- Group D: Not classifiable due to insufficient data.
- Group E: Not a human carcinogen, based on adequate animal studies and/or human epidemiological evidence.

6.4 Risk Characterization

The final step of the Baseline Risk Assessment, generation of numerical estimates of risk, was accomplished by integrating the exposure and toxicity information. Tables 16 and 17 present summaries of the total hazard quotient (noncarcinogenic risk) and total cancer risk, respectively, associated with the Site.

To estimate noncarcinogenic risk, hazard quotients (HQs) are calculated for each contaminant in each exposure pathway. The HQ is the ratio of the daily intake divided by the RfD. An HQ value equal or close to unity (1) indicates the potential for adverse effects. For each pathway, the individual contaminant HQs are added together to give a total hazard index, or HI. Under a reasonable worst-case scenario, a person could be exposed to more than one pathway (for example, both dermal with and incidental ingestion of, shallow soil while gardening). Therefore, the

**TABLE 16
SITE HAZARD INDEX SUMMARY**

POPULATION	EXPOSURE PATHWAY	PATHWAY HAZARD INDEX
Onsite Adult Resident Current Use	Ingestion (onsite shallow soil, garden area)	2.2E-01
	Dermal contact (onsite shallow soil, garden area)	<u>3.4E-02</u>
	Total Hazard Index	2.5E-01
Onsite/Offsite Child Resident Current Use	Ingestion (onsite shallow soil, garden area)	1.9E+00
	Dermal contact (onsite shallow soil, garden area)	9.1E-02
	Incidental Ingestion (surface water)	4.1E-04
	Dermal contact (surface water)	<u>1.8E-05</u>
	Total Hazard Index	2.0E+00
Onsite Non-Resident Current Use	Ingestion (onsite shallow soil, garden area)	3.2E-01
	Dermal contact (onsite shallow soil, garden area)	<u>4.1E-02</u>
	Total Hazard Index	3.6E-01
Onsite Adult Resident Future Use	Ingestion (onsite shallow soil while gardening)	1.8E-01
	Dermal contact (onsite shallow soil while gardening)	2.7E-02
	Ingestion (onsite shallow soil, garden area)	2.2E-01
	Dermal contact (onsite shallow soil, garden area)	3.4E-02
	Ingestion (contaminated produce)*	2.2E-01
	Ingestion (shallow groundwater)*	1.3E+01
	Dermal contact (shallow groundwater)	1.2E-01
	Inhalation (shallow groundwater by showering)*	<u>1.6E-01</u>
	Total Hazard Index	1.4E+01
Onsite/Offsite Child Resident Future Use	Ingestion (onsite shallow soil, garden area)	1.9E+00
	Dermal contact (onsite shallow soil, garden area)	9.2E-02
	Ingestion (onsite contaminated produce)*	2.2E-01
	Ingestion (shallow groundwater)*	1.3E+01
	Dermal contact (shallow groundwater)	2.1E-01
	Inhalation (shallow groundwater by showering)*	1.6E-01
	Incidental Ingestion (surface water)	4.1E-04
	Dermal contact (surface water)	<u>1.8E-05</u>
	Total Hazard Index	1.6E+01

* The exposure assumptions for this pathway are the same for both adult and child residents; therefore, the pathway hazard index is the same for both populations.

**TABLE 17
SITE CANCER RISK SUMMARY**

POPULATION	EXPOSURE PATHWAY	PATHWAY CANCER RISK
Onsite Adult Resident Current Use	Ingestion (onsite shallow soil, garden area)	4.7E-05
	Dermal contact (onsite shallow soil, garden area)	<u>2.5E-05</u>
	Total Cancer Risk	7.2E-05
Onsite/Offsite Child Resident Current Use	Ingestion (onsite shallow soil, garden area)	1.0E-04
	Dermal contact (onsite shallow soil, garden area)	1.7E-05
	Incidental Ingestion (surface water)	3.0E-08
	Dermal contact (surface water)	<u>1.3E-09</u>
	Total Cancer Risk	1.2E-04
Onsite Resident Current Use		Lifetime Risk = 1.9E-04
Onsite Non-Resident Current Use	Ingestion (onsite shallow soil, garden area)	2.0E-05
	Dermal contact (onsite shallow soil, garden area)	<u>8.8E-06</u>
	Total Cancer Risk	2.9E-05
Onsite Adult Resident Future Use	Ingestion (onsite shallow soil while gardening)	3.7E-05
	Dermal contact (onsite shallow soil while gardening)	2.0E-05
	Ingestion (onsite shallow soil, garden area)	4.7E-05
	Dermal contact (onsite shallow soil, garden area)	2.5E-05
	Ingestion (contaminated produce)*	2.0E-03
	Ingestion (shallow groundwater)*	4.8E-03
	Dermal contact (shallow groundwater)	3.0E-05
	Inhalation (shallow groundwater by showering)*	<u>1.7E-03</u>
	Total Cancer Risk	8.7E-03
Onsite/Offsite Child Resident Future Use	Ingestion (onsite shallow soil, garden area)	1.0E-04
	Dermal contact (onsite shallow soil, garden area)	1.7E-05
	Ingestion (contaminated produce)*	2.0E-03
	Ingestion (shallow groundwater)*	4.8E-03
	Dermal contact (shallow groundwater)	1.3E-05
	Inhalation (shallow groundwater by showering)*	1.7E-03
	Incidental Ingestion (surface water)	3.0E-08
	Dermal contact (surface water)	<u>1.3E-09</u>
	Total Cancer Risk	8.6E-03
Onsite Resident Future Use		Lifetime Risk = 1.7E-02

* The exposure assumptions for this pathway are the same for both adult and child residents;
therefore, the pathway cancer risk is the same for both populations.

total HI for each population is a summation of the constituent exposure pathways.

Carcinogenic risk estimates are generated in similar fashion for exposure pathways and populations. EPA has established an excess risk range of 1×10^{-4} to 1×10^{-6} as acceptable and sufficiently protective of human health and the environment.

Lifetime carcinogenic risk to current onsite residents is estimated to be 1.9×10^{-4} . The risk is primarily due to potential ingestion and dermal contact with contaminated soils by adults or children. Under the future use scenario, the lifetime carcinogenic risk estimate is 1.7×10^{-2} . Future risk is due to the same exposure pathways named above, but also from ingestion, inhalation and dermal contact with shallow groundwater, as well as ingestion of contaminated garden produce. Both current and future use values exceed EPA's allowable range of carcinogenic risk, which is 1×10^{-4} to 1×10^{-6} .

Noncarcinogenic risk presented by current Site conditions is estimated to have HI = 0.25 for onsite adults and HI = 2 for an onsite or offsite child resident. Future risk is estimated as HI = 14 for onsite adults and HI = 16 for onsite or offsite child residents. In both cases, exposure through dermal contact and ingestion of contaminated soils are major contributors to the risk, but the future risk estimate also includes significant risk from ingestion and dermal contact with shallow groundwater.

It should be noted that there is some degree of uncertainty associated with the calculated numerical estimates of human health risks generated in the Baseline Risk Assessment. This is due to the considerable number of assumptions required to provide variables in the equations, and the specific selections of each variable from a range of possibilities.

6.5 Environmental (Ecological) Risks

Because land use on the Site and surrounding properties is residential with scattered light industry, the ecological communities surrounding the Elmore Waste Disposal Site have been altered from their natural state. No state or federally designated endangered or threatened species are found at or near the Site. For these reasons, the potential for environmental risks is considered small.

Available habitat for flora and fauna along Wards Creek has been affected by the presence of trash, scrap metal and lumber, and other debris apparently originating from the former dump location. Despite this, there are no obvious signs of ecological problems in Wards Creek or along its banks.

Offsite groundwater sampling results indicate that four VOCs are discharging from the surficial aquifer into Wards Creek at low levels. These levels are not considered ecologically significant. Should these levels increase, which could occur by way of continued northward movement of the groundwater contaminant plume, VOC contamination could pose an ecological threat to the Wards Creek area.

7.0 DESCRIPTION OF REMEDIAL ALTERNATIVES

The Feasibility Study (FS) considered a wide variety of general response actions and technologies for remediating soil and groundwater. Tables 18 and 19 summarize these response actions and technologies, and provide the rationale for why each was retained or rejected for further consideration in the development of remedial alternatives.

Based on the FS, Baseline Risk Assessment, and Applicable or Relevant and Appropriate Requirements (ARARs), the remedial action objectives (RAOs) listed below were established for the Elmore Waste Disposal Superfund Site. Alternatives were developed with the goal of attaining these objectives:

1. Prevent ingestion of any groundwater containing:
 - a. carcinogen concentrations above Federal or State standards, or if there is no standard, above levels that would allow a remaining excess cancer risk of greater than 1×10^{-6} to 1×10^{-5} ; and
 - b. noncarcinogen concentrations above Federal or State standards, or if there is no standard, above levels that would allow an unacceptable remaining noncarcinogenic threat (HI greater than 1).
2. Restore the groundwater aquifer to potential productive use by remediation to an appropriate degree, and by preventing migration of the contaminant plume beyond the existing boundary.
3. Prevent ingestion of, or direct contact with, soil contaminated at levels that pose unacceptable carcinogenic or noncarcinogenic risk.
4. Prevent leaching of contaminants from soil to groundwater that would allow contaminant levels above appropriate standards to remain in groundwater.
5. Reduce or eliminate the contaminant concentrations in Wards Creek, and maintain water quality in accordance with Federal

TABLE 18
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES
FOR CONTAMINATED SOILS (SOURCE CONTROL)

GENERAL RESPONSE ACTIONS	TECHNOLOGY	PROCESS OPTION	PROCESS DESCRIPTION	COMMENTS
No Action	No Action	None	Site is left in its existing state.	RETAINED. Required by the NCP as a baseline alternative.
	Site Access and Use Restrictions	Land Use Restrictions	Land use restrictions would be recorded in the property deeds to prohibit activities that might disturb contaminated soils.	RETAINED. Limited application. Would not reduce or control contaminant migration. Would be used in conjunction with other technologies, such as onsite disposal.
		Fencing	Selected portions of the site may be fenced and warning signs posted during remedial activities. Long-term maintenance and security would be required.	RETAINED. Limited application. Would not reduce or control contaminant migration. Would be used in conjunction with other options, such as onsite disposal or use restriction.
Institutional Controls	Environmental Monitoring	Air, Soil, and Surface Water Monitoring	Site conditions and contaminant levels in these media would be monitored during and after remediation.	RETAINED. Would be used to monitor site conditions and the effectiveness of other remedial technologies.
	Relocation of Residents	Temporary	Move residents to motels or apartments during the remediation. Pay for lodging and other out-of-pocket expenses.	RETAINED. Based on the Risk Assessment (RA) residents are at limited risk from the contaminated soils.
		Permanent	Move residents to new homes. Pay for moving costs, temporary housing and meals, mortgage buydowns, utility connections, and new home closing costs.	REJECTED. Based on the RA residents are only at limited risk from the contaminated soils and may not be cost effective.
Containment	Capping	Native Soil	Placement and compaction of native soil over the contaminated area. Maintenance required.	REJECTED. Ineffective due to inadequate impermeability and lack of erosion and moisture control. Subject to cracking from drying and freeze-thaw action.
		Clay	Placement and compaction of a clay layer over the contaminated area. Maintenance required.	REJECTED. Ineffective due to inadequate impermeability and lack of erosion and moisture control. Subject to cracking from drying and freeze-thaw action.
		Asphalt	Placement of a layer of asphalt over the contaminated area. Maintenance required.	REJECTED. High maintenance due to poor weathering characteristics, such as photosensitivity, susceptibility to cracking, and brittleness from aging.
		Asphaltic Concrete	Placement of a layer of asphaltic concrete over the contaminated area. Maintenance required.	REJECTED. High maintenance due to poor weathering characteristics, such as susceptibility to cracking.
		Concrete	Installation of concrete slabs over the contaminated area. Maintenance required.	REJECTED. Potential for cracking from settling and freeze-thaw action.
		Gravel- or Soil-Clay	Placement of a compacted clay layer followed by a layer of gravel or soil over the contaminated area. Maintenance required.	RETAINED. More self-healing than single-layer caps. Gravel has a cost advantage over loam or other soil cover.
		Soil-Synthetic Membrane	Placement of low-permeability synthetic membrane followed by soil over the contaminated area. Maintenance required.	RETAINED. Long-term reliability of membrane is unknown. Insufficient drainage may cause erosion of the soil cover or damage the membrane.
		RCRA Multilayer	Placement of compacted clay, native soil, or clay mixed with native soil, followed by installation of a synthetic membrane (including associated base and drainage material). A final soil layer is then placed over the membrane. Maintenance required.	RETAINED. Long-term reliability of membrane is unknown. Clay layer provides additional containment.
		Chemical Sealants/Stabilizers	The contaminated soils would be treated with a water-dispersible emulsion or a resin to form a crust that reduces water, wind, and dust erosion. Most are non toxic to plants and animals.	REJECTED. Temporary cover only. Not a permanent solution and there is no current risk from wind-blown materials.
		Soil-Bentonite Slurry Wall	A trench is excavated around the contaminated soils and backfilled with a soil-bentonite slurry mixture. The working face of the trench and a short length of trench behind it are stabilized by a water-bentonite mix until backfilling can occur.	REJECTED. Soil contamination only in shallow soil levels (0-2 feet) and isolated intermediate soil levels (5-10 feet).
Containment (Continued)	Vertical Barriers	Cement-Bentonite Slurry Wall	A trench is excavated around the contaminated soils and backfilled with a cement-bentonite slurry mixture. The working face of the trench and a short length of trench behind it are stabilized by a water-bentonite mix until backfilling can occur.	REJECTED. Soil contamination only in shallow soil levels (0-2 feet) and isolated intermediate soil levels (5-10 feet).
		Grout Curtain	Pressure injection of grout along the boundary of the contaminated soils in a pattern of drilled holes.	REJECTED. Soil contamination only in shallow soil levels (0-2 feet) and isolated intermediate soil levels (5-10 feet).
		Vibrating Beam	A variation of the grout curtain in which a vibrating force is used to advance a steel beam into the soil. A relatively thin wall of cement or bentonite is injected as the beam is withdrawn.	REJECTED. Soil contamination only in shallow soil levels (0-2 feet) and isolated intermediate soil levels (5-10 feet).
		Sheet Piling	Installation of sheet piling along the contaminant boundary. Interlocking piles are placed with a pile driver or drop hammer.	REJECTED. Soil contamination only in shallow soil levels (0-2 feet) and isolated intermediate soil levels (5-10 feet).
		Rock Grouting	Grout would be injected into bedrock to seal fractures, voids, and solution cavities.	REJECTED. Soil contamination only in shallow soil levels (0-2 feet) and isolated intermediate soil levels (5-10 feet).

— Retained Process Option or Technology

— Rejected Process Option or Technology

TABLE 18
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES
FOR CONTAMINATED SOILS (SOURCE CONTROL)
(continued)

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GENERAL RESPONSE ACTIONS	TECHNOLOGY	PROCESS OPTION	PROCESS DESCRIPTION	COMMENTS
Containment (Continued)	Horizontal Barriers	Grout Injection	Pressure injection of grout through drilled holes in a pattern to provide a barrier of low permeability.	REJECTED. Soil contamination only in shallow soil levels (0-2 feet) and isolated intermediate soil levels (5-10 feet).
		Block Displacement	The contaminated area is surrounded by a perimeter barrier, after which grout is pressure-injected into boreholes that have been strategically placed within the contaminated area. The grout then displaces the contaminated earth and forms a seal below it.	REJECTED. Soil contamination only in shallow soil levels (0-2 feet) and isolated intermediate soil levels (5-10 feet).
	Gradient Control	Extraction Wells	Control of the ground water flow by pumping from wells to create new hydraulic gradients.	REJECTED. For this FS, contaminated soils are defined as shallow soils (0-10 feet) in the vadose (unsaturated) zone. Therefore, there is no groundwater to extract.
		Subsurface Drains	Perforated pipe or tile within a gravel-filled trench is used to control the migration of contaminated ground water. May be used at shallow depths in conjunction with a barrier system.	REJECTED. For this FS, contaminated soils are defined as shallow soils (0-10 feet) in the vadose (unsaturated) zone. Therefore, there is no groundwater to extract.
		Well Points	A group of closely spaced wells within the contaminated area is connected to a header pipe and pumped. System is best-suited for shallow aquifers.	REJECTED. For this FS, contaminated soils are defined as shallow soils (0-10 feet) in the vadose (unsaturated) zone. Therefore, there is no groundwater to extract.
	Surface Controls	Soil Stabilization	Chemical stabilizers are sprayed on bare soils or mulched to coat, penetrate, and bind the soil particles together. Chemical stabilizers include latex emulsions, plastic films, oil-in-water emulsions, and resin-in-water emulsions.	REJECTED. Soil erosion not a problem.
		Surface Water Diversion/Collection System	A surface water diversion and collection system would be installed to control storm water and contaminated surface water runoff.	RETAINED. Would be used in conjunction with other remedial technologies.
		Revegetation	A vegetative cover would be reestablished over areas that have been regraded, capped, or remediated to decrease erosion and (if applicable) protect the integrity of the cap.	RETAINED. Would be used in conjunction with other remedial technologies.
	Dust/Vapor Suppression	All Process Options	Various materials are sprayed or spread over the area of concern to prevent dust and/or vapor generation. Process options include: water, membranes or tarps, organic agents/polymers/foams, or hygroscopic agents.	RETAINED. Could be used to control fugitive dust/vapor emissions during extensive earthworking operations.
	Removal	Excavation	Contaminated Soils	Removal of contaminated soils by conventional earth-moving equipment, such as backhoes, bulldozers, and front-end loaders.

On-site Treatment	Biological	Land Farming	Contaminated soils are plowed and spread over a controlled area. Plants are selected and moisture and nutrients are added to encourage microbial destruction of the contaminants. May require seeding with appropriate microorganisms.	REJECTED. Is not effective for treating metals in soils.
		Composting	Contaminated soils are plowed to a depth of 1 to 6 feet high and aerated in a controlled system. May occur in an on-site windrow. Nutrients and moisture are added as necessary. May require seeding with appropriate microorganisms.	REJECTED. Not effective for treatment of metals.
		Slurry Bioremediation	Contaminated soils are mixed with water with sufficient water to create a slurry. The slurry is loaded with microorganisms or seeds and mixed. Nutrients are added as necessary.	REJECTED. Not effective for treatment of metals.
	Chemical	Oxidation	An oxidizing agent (such as hydrogen peroxide, ozone, or hypochlorite) and the contaminated soil are mixed in a reactor. The contaminants are then oxidized to either intermediate compounds or ultimately to carbon dioxide and water.	REJECTED. Not a proven application for the contaminants in the soils. Contaminants may degrade into products more toxic than their precursors.
		Reduction	A reducing agent is added to the material to lower the contaminant's oxidation state and render it less toxic or more treatable.	REJECTED. Effectiveness in treating organics has not been proven.
		Neutralization	Acid or base is added to the contaminated material to adjust the pH of the material to near 7, neutralizing excess base or acid in the material.	REJECTED. Site soil pH is within neutral range (6.0 to 8.5). Therefore, use of this process option is unnecessary.
		Water Leaching	Water would be infiltrated through the subsurface soils to leach out the water-soluble contaminants.	REJECTED. The PAH and metal contaminants at the site have extremely low water leaching properties. Therefore, this process would not be effective.
		Solvent Extraction	Excavated soils would be washed with an organic solvent or solvents to extract target compounds. The soils would be separated from the solvent, dried, and used as backfill. Contaminated solvent would be treated by distillation or other means to concentrate the contaminants. Treated solvent would be reused. The concentrated solvent residuals would require further treatment or disposal.	REJECTED. Not effective for treatment of metals.
		Soil Washing	Similar to solvent extraction except that water and appropriate chemical additives or surfactants would be used to leach out the target contaminants. Process is generally used for volume reduction before further treatment.	RETAINED. This process is effective in removing both organic and inorganic contaminants. Process is very effective in reducing volume of contaminated soil.

-- Retained Process Option or Technology

-- Rejected Process Option or Technology

— Retained Process Option or Technology
 — Rejected Process Option or Technology

TABLE 18
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES
FOR CONTAMINATED SOILS (SOURCE CONTROL)
(continued)

GENERAL RESPONSE ACTIONS	TECHNOLOGY	PROCESS OPTION	PROCESS DESCRIPTION	COMMENTS
Onsite Treatment (Continued)	Thermal	Rotary Kiln Incinerator	Solid waste is fed into the upper end of a kiln, which rotates to mix the waste with combustion air as it passes through the kiln.	REJECTED. Not effective for removing metals from soils.
		Multipled Hearth Furnace	Solid waste is fed into the furnace roof from the top and pushed through drop holes into a series of vertically stacked refractory hearths.	REJECTED. Not recommended for hazardous wastes due to low operating temperature.
		Fluidized Bed Incinerator	Wastes are injected above a preheated granular bed, which is fluidized by bubbling air through a distributor plate located below the bed.	REJECTED. Not effective for removing metals from soils.
		Circulating Bed Incinerator	Similar to fluidized bed incineration, but the fluid moves at much higher velocities. Fluidized material is recirculated through the feed section.	REJECTED. Not effective for removing metals from soils.
		High-Temperature Fluid-Wall Reactor	Waste is destroyed in a reactor consisting of a tubular core of refractory material that emits radiant energy supplied by large electrodes in the jacket of the vessel.	REJECTED. Process has only been tested on a pilot-scale system. Full-scale technology is not yet available. This process has high energy consumption rates and extensive exhaust emission cleanup requirements.
		Infrared Incinerator	Waste is conveyed through two heating modules. In the first, the contaminants are combusted by infrared heat provided by rows of electrically-powered silicon carbide rods. The second module can be infrared or gas heated.	REJECTED. Not effective for removing metals from soils.
		Molten Salt Incinerator	Wastes and air are injected into a bed of molten alkali metal salts, where the contaminants are destroyed by a combination of incineration, absorption, and chemical reaction.	REJECTED. Pilot-scale only. Has been used successfully on highly toxic inorganic or halogenated organic wastes, but no full-scale demonstrations have been completed on PAH-contaminated materials.
		Plasma Arc Torch	Wastes are pyrolyzed by a high-temperature plasma. An electric arc is used to generate the plasma by exciting gas to its ionized state.	REJECTED. Applicable only to liquid organic wastes and finely divided, fluidizable sludges.
Onsite Treatment (Continued)	Physical/Chemical	Low-Temperature Thermal Extraction	Heated air is mixed with excavated soil to physically drive off (evaporate) volatile and some semivolatile contaminants.	REJECTED. Would not be effective in removing the four- and five-ring PAHs.
		Thermal (Continued)		
		Pyrolysis	Contaminated material is thermally destroyed in an oxygen-deficient environment.	REJECTED. Not effective for treating metals.
		Vitrification	Wastes and soil are heated in a container to an extremely high temperature that melts the mix. The resulting mass is then cooled into a glass-like solid.	REJECTED. Experimental process option. Pilot-scale only. Materials handling will be required to size/sort the contaminated soils before pyrolysis.
		Lime-Fly Ash-Pozzolan Stabilization Process	Wastes are mixed with a siliceous- and -aluminous material (pozzolan) and with a lime-fly ash mixture to produce a strong solid with low permeability.	REJECTED. Would be used in conjunction with other treatment technologies.
		Pozzolan-Portland Cement Stabilization Processes	Wastes are mixed with a siliceous- and -aluminous material (pozzolan) and with portland cement to produce a strong solid with low permeability.	RETAINED. Would be used in conjunction with other treatment technologies to ensure that RAOs are achieved.
		Organic Contaminant Solidification/Stabilization Processes	Organic wastes are blended with synthetic binders (many processes use proprietary chemicals), and the waste/binder material is mixed with lime-fly ash or fly ash-cement to produce a strong, low-permeability solid.	REJECTED. Still a relatively new process. Not proven to decrease the mobility of PAHs. Contaminated soils are primarily sand and cobbles with some organic contaminants, and not primarily organic wastes.
		Microencapsulation	Heated dried wastes are mixed with an asphalt bitumen, paraffin, or polyethylene matrix that sets into a solid mass.	REJECTED. Method is only applicable to small quantities of hazardous wastes that are complex and difficult to treat.
Onsite Treatment (Continued)	Physical	Surface Encapsulation	Includes several processes in which wastes are isolated by being sealed in an organic binder or resin.	REJECTED. High cost compared to other solidification techniques. Usually applied to very soluble toxic wastes.
		Solids Separation/Slurry	Separation and sizing of the subsurface soils by conventional materials handling equipment.	REJECTED. Would be used in conjunction with treatment technologies to ensure a homogeneous feed stream.
Onsite Treatment (Continued)	Physical	Decontamination	Cleaning to remove contaminants by use of a steam jenny, mixer/washer, or other decontamination equipment.	REJECTED. Would be used in conjunction with other remedial technologies. Decontamination wash water would have to be treated.

Retained Process Option or Technology

Rejected Process Option or Technology

TABLE 18
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES
FOR CONTAMINATED SOILS (SOURCE CONTROL)
(continued)

GENERAL RESPONSE ACTIONS	TECHNOLOGY	PROCESS OPTION	PROCESS DESCRIPTION	COMMENTS
Offsite Treatment	Thermal	RCRA-Approved Offsite Incinerator	Destruction of contaminants by incineration in an offsite RCRA-approved commercial incinerator.	REJECTED. Proven technology for the destruction of organic contaminants. Not effective for treatment of metals.
		Co-Disposal Processes	Subsurface soils would be mixed with fuel (such as pulverized coal, natural gas, or wood chips) or other wastes and used as a supplemental fuel source to produce steam for a conventional power cycle.	REJECTED. The extremely low fuel value of the contaminated soils and low remediation levels required for the PAH contaminants make this process option ineffective.
	Biological	Land Farming	Land farming (as described earlier) at an appropriate offsite location.	REJECTED. May not be completely effective in treating the carcinogenic PAHs. Not yet commercially available.
In-Situ Treatment	Biological	Bioremediation	Enhancement of indigenous microbial activities by injecting water, oxygen, and nutrients into the contaminated soils.	REJECTED. Site contaminants primarily in shallow soils (0-2 feet) or in isolated areas of intermediate soils (5-10 feet). May not be completely effective in treating four- or five-ring PAHs or metals.
	Chemical	Oxidation	An oxidizing agent is applied to or injected into the contaminated soil. Wastes are subsequently oxidized to less-toxic byproducts.	REJECTED. Not a proven application for PAH contaminated soil. Some contaminants produce degradation products more toxic than their precursors.
		Neutralization	Acid or base is applied or injected into the contaminated soil to adjust the pH to near 7 (neutral).	REJECTED. Site soil pH is within neutral range (6.0 to 8.5). Therefore, use of this process option is unnecessary.
		Reduction	A reducing agent is injected into the contaminated soil to lower the contaminant's oxidation state and render it less toxic or more treatable.	REJECTED. Effectiveness in treating organics has not been proved. Most commonly used in treating heavy metals.
		Precipitation	Substances are applied to the contaminated soil to precipitate metals as sulfides, phosphates, and hydroxides. Suitable soil pH must be maintained to maximize the insolubility of the precipitates.	REJECTED. Not applicable to the organic contaminants in the subsurface soils. Experimental process option for soils. Most commonly used in treating heavy metals.
		Soil Vapor Extraction	Air is pumped from wells screened in the contaminated soil volume. As atmospheric air replaces the removed air and is in turn pumped out, volatile contaminants are stripped from the soil and carried to treatment by the air stream.	REJECTED. Would not be effective in treating the semivolatile organic contaminants in the soils, which have very low vapor pressures.
	Physical/Chemical	Stabilization	Powdered activated carbon or another chemical agent is mixed with the material in place. Contaminant adsorbs onto agent, or reacts with it, thereby restricting migration of the contaminant.	REJECTED. Not proven, especially with regard to long-term effectiveness on organic contaminants. Periodic reapplication of the stabilization agent is required.
In-Situ Treatment (Continued)	Physical/Chemical	Soil Flushing	A flushing solution (solvent or surfactant) is applied to the site or is injected into the contaminated area. Sorbed contaminants are solubilized or emulsified, or they chemically react with the flushing solution and become mobile. The dissolved or reacted contaminants are collected through wells or an underdrain system.	REJECTED. Site contaminants primarily in shallow soils (0-2 feet) and in isolated areas of intermediate soils (5-10 feet). The collected, contaminated material must be treated or disposed of.
	Thermal	Vitrification	An array of electrodes is inserted into the subsurface and electricity is applied between the electrodes. The current heats the soil and causes the soil's silicates to melt. The contaminants are either trapped within the melted mass as it cools or are volatilized and captured by an off-gas treatment system.	RETAINED. Process has worked very well in the Pilot Scale and can potentially treat both organic and inorganic contaminants.
Onsite Disposal	Disposal	Onsite RCRA Landfill	The contaminated soils would be permanently disposed of in an onsite RCRA landfill.	RETAINED. Requires long-term operations, maintenance, and security.
		Temporary Storage	Storage of the contaminated soils as a temporary measure in waste piles, containers, or tanks.	RETAINED. Not a permanent remedial measure, but may be used in conjunction with other technologies, such as slurry biotreatment or offsite thermal treatment.
Offsite Disposal	Disposal	RCRA Solid Waste Landfill	Disposal of treated or decontaminated waste in a solid waste landfill (as a special waste).	RETAINED. Would be used in conjunction with other technologies. Treated material would be required to meet the remedial action objectives before it could be disposed.
		RCRA Hazardous Waste Landfill	Disposal of contaminated waste in a RCRA-approved hazardous waste landfill.	RETAINED. Would not reduce the toxicity of the contaminants or the volume of contaminated soil. Additional remedial action might ultimately be required.

-- Retained Process Option or Technology
 -- Rejected Process Option or Technology

TABLE 19
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES
FOR CONTAMINATED GROUNDWATER

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	PROCESS DESCRIPTION	COMMENTS
No Action	No Action	None	Site is left in its existing state.	RETAINED. The NCP requires the no action alternative to be considered as a baseline.
Institutional Controls	Groundwater Use Restrictions	Absolute Ownership with Deed Restrictions	All property over the contaminated portion of the aquifer would be purchased, and ground water usage would be restricted.	REJECTED. The area of the contaminated plume has not been determined, preventing effective implementation.
		Reasonable Use	Courts place reasonable limits on use and withdrawal of ground water.	REJECTED. Public water supply already utilized by local residents.
		State-Imposed Use Restrictions	SCDHEC restricts use of contaminated ground water. Restrictions are incorporated into property deeds.	REJECTED. Public water supply already utilized by local residents.
		State-Imposed Permit Restrictions	SCDHEC restricts the drilling of new wells into the contaminated portion of the aquifer by requiring drilling permits.	RETAINED. Would not prevent further migration of contaminants, but could be used in conjunction with other technologies.
		Prior Application	Common law and statutory schemes have authority to allocate ground water rights and use.	REJECTED. Public water supply already utilized by local residents.
	Alternative Water Supplies	All Processes	Contaminated water supply is replaced by a noncontaminated water supply. Options include use of surface water, bottled water, home treatment units, hook-up to a public water system, and installation of new wells.	REJECTED. Public water supply already utilized by local residents.
	Relocation	Temporary	Move residents to motels or apartments during the remediation. Pay for lodging and other out-of-pocket expenses.	REJECTED. Public water supply already utilized by local residents.
		Permanent	Move residents to new homes. Pay for moving costs, temporary housing and meals, mortgage buydowns, utility connections, and new home closing costs.	REJECTED. Public water supply already utilized by local residents.
	Environmental Monitoring	Groundwater Monitoring	Long-term monitoring of the contaminated ground water and the treated, discharged water.	RETAINED. Would be used to monitor site conditions and the effectiveness of other remedial technologies.
	Capping	All Processes	Placement of a cap of low-permeability material over the area occupied by the contaminated ground water plume to minimize the infiltration of surface water. Cap types include: native soil, clay, asphalt, asphaltic concrete, concrete, soil-synthetic membrane, RCRA multilayer, and use of chemical sealants/stabilizers.	REJECTED. Capping over the entire area occupied by the plume is not feasible because the contaminated plume extends offsite. The variety of land use in the area, which includes residences, city streets, and businesses would also make capping difficult. It would be nearly impossible to maintain the integrity of the cap over an extended period.
Containment	Vertical Barriers	All Processes	Installation of a vertical barrier of low permeability around the perimeter of the contaminated ground water plume to minimize the migration of contaminated ground water beyond the boundaries of the existing contamination. Barrier types include: soil- and cement-bentonite slurry walls, sheet piling, grout curtains and vibrating boards, and rock grouting.	REJECTED. Installation of a vertical barrier around the entire area occupied by the contaminated ground water plume is not feasible because the contaminated ground water plume extends offsite. The variety of land use in the area, which includes residences, city streets, and businesses would also make installing a vertical barrier difficult. Extensive rerouting of utilities may be required. Also, there is not an effective confining layer at the site which a vertical barrier could be "tied into".
	Horizontal Barriers	Grout Injection	Pressure injection of grout through drilled holes in a pattern to provide a barrier of low permeability.	REJECTED. Not practical due to the depth of the plume. Primarily used for shallow applications.
		Block Displacement	The contaminated area is surrounded by a perimeter barrier after which grout is pressure-injected into bore holes that have been strategically placed within the contaminated area. The grout then displaces the contaminated area upward as a block and forms a seal below the displaced block.	REJECTED. Not practical for the depth that requires contaminant. Experimental process option.
	Gradient Control	Subsurface Drains	Perforated pipe or tile within a gravel-filled trench is used to control migration of the contaminated ground water. May be used at shallow depths in conjunction with a barrier system.	REJECTED. The contamination is too deep for effective use of subsurface drains. In addition, heavy insoluble contaminants such as manganese may clog the drains.
		Extraction Wells	Control of groundwater flow by pumping wells to create new hydraulic gradients.	RETAINED. Could be used in conjunction with injection wells to control hydraulic gradients.
		Injection Wells	Control of groundwater flow by injecting water through wells to create new hydraulic gradients.	RETAINED. Could be used in conjunction with extraction wells to control hydraulic gradients.
		Well Points	A group of closely spaced wells, within the contaminated area are connected to a header pipe and pumped. System is best-suited for shallow aquifers.	REJECTED. Not effective for aquifers deeper than 20 feet. At the Elmore Waste Disposal site, contamination extends to depths of at least 55 feet.

— Retained Process Option or Technology

— Rejected Process Option or Technology

TABLE 19
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES
FOR CONTAMINATED GROUNDWATER
(continued)

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	PROCESS DESCRIPTION	COMMENTS
Containment (Continued)	Surface Controls	Soil Stabilization	Chemical stabilizers are sprayed on bare soils or mulched to coat, penetrate, and bind the soil particles together. The stabilized soil allows less surface water infiltration to the aquifer. Chemical stabilizers include latex emulsions, plastic films, oil-in-water emulsions, and resin-in-water emulsions.	REJECTED. The long-term effectiveness of this option is uncertain.
		Surface Water Diversion/Collection System	Surface water diversion and collection structures are installed to control surface water recharge of the aquifer.	RETAINED. Might be used onsite for surface water collection, in conjunction with other remedial technologies.
		Revegetation	A vegetative cover would be reestablished over areas that have been regraded, capped, or remediated to decrease erosion and decrease surface water infiltration to the aquifer.	RETAINED. Might be used onsite to cover bald spots or remediated areas, in conjunction with other remedial technologies.
Removal	Extraction	Extraction Wells	Removal of groundwater by pumping from wells.	RETAINED. Would be used to recover contaminated groundwater.
		Well Points	A group of closely spaced wells within the contaminated area is connected to a header pipe and pumped by a suction pump. Applicable to shallow aquifers.	REJECTED. Not effective for aquifers deeper than 20 feet. At the Elmore Waste Disposal site, contamination extends to depths of at least 55 feet.
		Subsurface Drains	Perforated pipe or tile within a gravel-filled trench is used to remove or redirect contaminated groundwater. Drains are installed near the bottom of the aquifer.	REJECTED. Subsurface drains are not effective for aquifers deeper than 30 feet. At the Elmore Waste Disposal site, contamination extends to depths of at least 55 feet. Subsurface drains are generally not cost-effective compared with extraction wells. Insoluble contaminants heavier than water may clog the drains.
	Enhanced Removal	Chemically Enhanced Removal	A chemical would be injected into the aquifer to aid in the removal of the contaminants.	REJECTED. Different contaminants may require several different additives. Would be difficult to monitor. Might lead to uncontrolled migration of contaminants.
Onsite Treatment	Biological	Activated Sludge	Organic wastes are metabolized by microorganisms in a mixed aerobic reactor. The solids retention time is controlled by recirculating the biomass from the clarification process back to the aerobic reactor.	REJECTED. Process is not suitable for low biological oxygen demand (BOD < 2 mg/L), nutrient-deficient water.
		Trickling Filter	Liquid wastes are trickled over a bed of rocks or synthetic packing medium on which a biofilm is developed. Organics from the waste stream diffuse into the biofilm and are degraded.	REJECTED. Process is not suitable for low biological oxygen demand (BOD < 2 mg/L), nutrient-deficient water.
		Rotating Biological Contactors	Liquid wastes flow through troughs in which closely spaced, partially submerged discs are rotated. Microorganisms become attached to the surface of the discs and form a biofilm. As the discs rotate waste stream and the atmosphere, contaminants and oxygen alternatively diffuse into the biofilm, allowing the microorganisms to degrade organic wastes.	REJECTED. Process is not suitable for low biological oxygen demand (BOD < 2 mg/L), nutrient-deficient water.
		Fluidized Bed Reactor	Microorganisms are attached to inert particles within a vertical column reactor. The particles are kept in suspension by the upward flow of the liquid waste stream. The organic wastes are then degraded through microbial activity.	REJECTED. Process is not suitable for low biological oxygen demand (BOD < 2 mg/L), nutrient-deficient water.
		Submerged Fixed Film Reactor	A biofilm is developed on a bed of packing or rocks, which is kept submerged and aerated. Organics from the waste stream diffuse into the biofilm and are subsequently degraded.	RETAINED. Effective in treating low biological oxygen demand, nutrient-deficient waste streams.
		Aerated Lagoons	Microbial degradation of wastes in an aerated surface impoundment (oxidation pond).	REJECTED. Process is not suitable for low biological oxygen demand (BOD < 2 mg/L), nutrient-deficient water.
		Anaerobic Lagoons	A surface impoundment with a low surface area-to-volume ratio (narrow and deep) is used to increase degradation action by anaerobic bacteria.	REJECTED. Process is not suitable for low biological oxygen demand (BOD < 2 mg/L), nutrient-deficient water.
		Anaerobic Sludge Digestion	Microorganisms react with high-strength wastes in a closed tank devoid of oxygen. Hydrolysis and fermentation of wastes produce methane and carbon dioxide.	REJECTED. Process is not suitable for low biological oxygen demand (BOD < 2 mg/L), nutrient-deficient water.
		Land Farming	Contaminated groundwater would be mixed with nutrients and tilled into a soil base where microbes would destroy the contaminants. May require seeding with appropriate microbes.	REJECTED. Process is not suitable for low biological oxygen demand (BOD < 2 mg/L), nutrient-deficient water.

— Retained Process Option or Technology

— Rejected Process Option or Technology

TABLE 19
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES
FOR CONTAMINATED GROUNDWATER
(continued)

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	PROCESS DESCRIPTION	COMMENTS
Onsite Treatment (Continued)	Biological (Continued)	Bioleaching	Use of plant or animal species to accumulate contaminants in their tissues. Species are harvested and disposed of in an approved fashion. Most commonly used for heavy metal contamination.	REJECTED. Process is not suitable for low biological demand (BOD < 2 mg/L), nutrient-deficient water.
	Bio/Physical	Activated Sludge with Powdered Activated	This process combines physical treatment with biodegradation. Powdered activated carbon is added to an activated sludge process, achieving greater removal efficiencies than either process alone.	REJECTED. Process is not suitable for low biological demand (BOD < 2 mg/L), nutrient-deficient water.
	Physical Treatment	Phase Separation	Removal of physically distinct phases from the waste stream by flotation, skimming, decanting, coagulation, flocculation, or sedimentation.	RETAINED. May be used in conjunction with other technologies.
		Filtration	Removal of suspended particles by passing the liquid waste stream through a granular or fabric media. Conventional treatment method.	RETAINED. May be used in conjunction with other technologies.
		Air, Gas, or Steam Stripping	Mixing of large volumes of air, gas, or steam with the waste stream in a packed column or through diffused aeration to transfer volatile organics to the air.	RETAINED. Effective in removing volatile organics from groundwater.
		Distillation	Separation of substances by boiling. Groundwater is boiled and condensed to separate out the more volatile components, which are then recovered and treated.	REJECTED. Not effective in inorganics. Hard to implement.
		Ultrafiltration	Removal of medium- to high-molecular-weight solutes from solution by a semipermeable membrane under a low-pressure gradient.	REJECTED. Not efficient for low concentrations of toxic substances.
		Reverse Osmosis	Removal of low- to medium-molecular-weight solutes from solution by a semipermeable membrane under a high-pressure gradient.	REJECTED. Not efficient for low concentrations of toxic substances.
		Carbon Adsorption	Carbon from materials such as wood or coal is generally placed into a fixed-bed reactor. The liquid waste stream is then passed through the bed, and the organic contaminants are removed via adsorption mechanisms.	RETAINED. Effective for removal of all the organic contaminants at the Elmore Waste Disposal site.
		Resin Adsorption	Process is similar to carbon adsorption, with a resin replacing the carbon as the absorbent.	REJECTED. Current data are insufficient to determine the reliability of the process in treating site contaminants.
		Ion Exchange	The liquid waste stream is passed over an ion exchange resin in which ions are bound to the resin are exchanged for ions in the waste stream that have a similar charge. The process is typically used to remove inorganic ions.	RETAINED. Effective in removing metals from the groundwater.
	Physical Treatment (Continued)	Centrifugation	Stable colloidal particles are removed by the centrifugal forces created by high-speed rotation in a cylindrical vessel.	REJECTED. Not applicable to the groundwater contaminants, which are dissolved into the ground-water and are not colloidal suspension.
Onsite Treatment (Continued)	Chemical Treatment	Dissolved Air Flotation	Air is dissolved into a water stream under pressure. The air forms fine bubbles that rise through the water when the stream is released into a separation chamber. The bubbles attach to suspended solids and emulsified oil to the water surface for removal.	REJECTED. Not applicable to the groundwater contaminants, which are not suspended solids or emulsified oils. The contaminants of concern are dissolved volatile organic contaminants and dissolved metals.
		Liquid/Liquid Extraction	Two liquids are separated by the addition of a third liquid that is a solvent for one of the liquids and is insoluble (immiscible) in the other liquid. The final solvent/solute stream is recovered by distillation or chemical means.	REJECTED. The variety of groundwater contaminants may require several solvents. The groundwater may become contaminated due to residuals from the extraction solvent(s).
		Neutralization	A chemical reagent is added to the waste stream to alter the pH.	RETAINED. May be used as a pretreatment step or to treat dissolved metals.
		Oxidation	An oxidizing agent(s) (ozone, hydrogen peroxide, permanganate, etc.) is introduced into a reactor and mixed with the waste stream. The contaminants are then oxidized either to harmless compounds or ultimately to carbon dioxide and water. Most commonly used to remove phenols, cyanides, and heavy metals from the waste stream.	RETAINED. Effective for removal of manganese from groundwater.
		Chemical Reduction	A reducing agent is mixed with the waste stream to lower the oxidation state of the waste and render it less toxic or more treatable. Commonly used for heavy metal removal.	RETAINED. Might be used for removal of metals from groundwater.
		Aeration	Water is saturated with oxygen to remove bicarbonates before hydrolysis. This process is the standard treatment for iron and manganese removal from water.	RETAINED. Effective for removal of manganese from groundwater.
		Chemical Precipitation	A chemical agent is mixed with the waste stream to form an insoluble product that can be removed from the waste stream by settling. Most commonly used to remove heavy metals from the waste stream.	RETAINED. Effective in removing metals from groundwater.

 -- Retained Process Option or Technology
 -- Rejected Process Option or Technology

TABLE 19
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES
FOR CONTAMINATED GROUNDWATER
(continued)

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GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	PROCESS DESCRIPTION	COMMENTS
Onsite Treatment (Continued)	Chemical Treatment (Continued)	Chemical Dehalogenation	A chemical agent such as sodium naphthalide is mixed with the waste stream to strip halogen atoms from chlorinated hydrocarbons.	REJECTED. This process is primarily used to treat PCBs. Not applicable to ground water contaminants of concern.
		Hydrolysis	Waste stream is reacted with water in the presence of chemical agents at high temperatures and pressures to form nonhazardous byproducts.	REJECTED. Not applicable to contaminants of concern.
		Ultraviolet (UV) Photolysis	Contaminants are destroyed by UV irradiation. Contaminant molecules absorb UV energy, changing the molecule's energy state and making it cleave (break up) and oxidize.	REJECTED. Not effective for treating the organic contaminants at Elmore Waste Disposal site.
		Oxidation/UV Photolysis	Hydrogen peroxide, ozone, or some other oxidizing agent is used to oxidize contaminants in conjunction with UV irradiation.	RETAINED. Effective for removal of the volatile organics from groundwater. Metals and any turbidity would have to be removed before this process.
		Electrochemical Precipitation	A direct current across consumable electrodes generates an insoluble ion matrix that adsorbs and precipitates heavy metals and some light metals from the water. The precipitate would then be separated from the water stream.	REJECTED. Not effective for removal of beryllium from groundwater.
	Thermal	Evaporation	The contaminated waste stream is placed in large drying beds. Its volume is then reduced or eliminated through vaporization caused by solar heating.	REJECTED. Not practical due to the volume of ground-water requiring treatment. In addition, precipitation in Greer exceeds mean lake evaporation by 11 inches annually.
		Incineration (All process options)	All processes involving combustion of the waste stream.	REJECTED. Not practical for dilute, aqueous waste streams.
		Wet Air Oxidation	Oxidation of organics in an aerator under high temperature and pressure.	REJECTED. Cost of achieving and maintaining elevated temperatures and pressures for dilute groundwater would be excessive compared to conventional physical treatment.
		Supercritical Water Oxidation	Oxidation of the wastes in a supercritical environment (314 F and 218 atm).	REJECTED. Cost of achieving and maintaining supercritical conditions for dilute groundwater would be excessive compared to conventional physical treatment.
		RCRA Incinerator	Destruction of the contaminants by incineration at an offsite RCRA-licensed incinerator.	REJECTED. Not practical for high volume, dilute aqueous waste streams.
Offsite Treatment	Biological/Physical/Chemical	Approved Offsite Facility	Destruction of the contaminants by biodegradation, physical, or chemical methods at an approved facility.	REJECTED. Not practical for high volume, dilute, aqueous waste streams when onsite treatment is a viable option.
In Situ Treatment	Biological	Bioremediation	Optimization of environmental conditions by injecting oxygen, nutrients, and (if necessary) microorganisms into the subsurface to enhance microbial degradation of the contaminants.	REJECTED. Not practical for the ground water contaminants at the Elmore Waste Disposal site. Typically used for semivolatile organics.
	Physical	Aeration	Air is pumped into the aquifer to strip volatile organics from the ground water.	REJECTED. Depth of contamination would make effective implementation difficult.
	Physical/Chemical	Permeable Treatment Beds	Trenches are filled with a permeable medium that reacts with or traps contaminants as contaminated ground water flows through the trench.	REJECTED. Not practical because of the depth of trench required.
	Chemical	Oxidation	An oxidizing agent is injected into the ground water, where it oxidizes the contaminants to carbon dioxide and water.	REJECTED. Some contaminants produce degradation products more toxic than their precursors. Because of the depth of the contamination, it would be difficult to ensure adequate contact between the oxidation agent and contaminants.
		Acid Neutralization	Acid or base is injected into the ground water to adjust the pH to near 7 (neutral).	REJECTED. Not applicable to the organic contaminants in the ground water. The pH is already at 7, no need to neutralize.
		Reduction	A reducing agent is injected into the aquifer to lower the contaminant's oxidation state and render it less toxic or more treatable.	REJECTED. Effectiveness in treating organics has not been proved. Most commonly used in treating heavy metals.
		Polymerization	A catalyst is injected into the aquifer to convert a monomer of a contaminant into a large chemical molecule (polymer) of itself. The polymer is more stable and less soluble than its monomers.	REJECTED. Not applicable to the organic contaminants in the ground water.
	Discharge	Surface Water	Discharge of treated water to an onsite surface water body.	REJECTED. No onsite surface water body available at the Elmore Waste Disposal site.
		Injection Wells	Discharge of treated water by injection through onsite wells.	RETAINED. Might be used in conjunction with other technologies.
		Recharge Trench	Discharge of treated water by introduction into gravel-filled trenches.	RETAINED. Might be a potential method of discharge, depending on the volume of treated water.

-- Retained Process Option or Technology
 -- Rejected Process Option or Technology

TABLE 19
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES
FOR CONTAMINATED GROUNDWATER
(continued)

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GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	PROCESS DESCRIPTION	COMMENTS
Offsite Disposal	Discharge	Surface Water	Discharge of treated water to an offsite surface water body.	RETAINED. Treated water would be discharged into nearby surface water. Permit required.
		Injection Wells	Discharge of treated water by injection into offsite wells.	REJECTED. Limited availability, transportation requirements, administrative requirements, potential liability, and cost make this option impractical compared to other discharge options.
		Publicly Owned Treatment Works	Discharge of treated ground water to the local publicly owned treatment works (POTW).	RETAINED. City POTW industrial pretreatment requirements must be met.
		RCRA Deep Well Injection	Disposal of the contaminated ground water by injection into an offsite RCRA-licensed deep well facility.	REJECTED. Not practical for dilute aqueous waste streams when onsite treatment is a viable option. Availability of offsite facilities is limited.
	Reuse	Irrigation	Discharge of treated water for irrigation.	REJECTED. Potential liability makes this option impractical compared to other discharge options.
		Water Supply	Piping of the treated ground water to the drinking water supply system.	REJECTED. Potential liability and likely negative public response make this option impractical compared to other discharge options.

-- Retained Process Option, Remedial Technology or General Response Action

-- Rejected Process Option, Remedial Technology or General Response Action

and South Carolina Ambient Water Quality Criteria for surface waters.

Separate remedial alternatives were not developed for surface water. It is anticipated that remediation of the surficial aquifer will eliminate or reduce the concentrations of VOCs entering Wards Creek.

7.1 Source Control Remedial Alternatives

The technologies considered potentially applicable to soil contamination (Table 18) were further evaluated on the effectiveness and implementability criteria. Table 20 lists those which passed this final screening, and outlines the technology components of each of six remedial alternatives proposed for soil remediation.

The six alternatives are:

- Alternative SS1: No Action
- Alternative SS2: Soil-Synthetic Membrane Cap
- Alternative SS3: Soil Stabilization
- Alternative SS4: Soil Washing, Stabilization, and Offsite Disposal
- Alternative SS5: In-Situ Vitrification
- Alternative SS6: Offsite Disposal

Each of the alternatives is discussed below. All source control alternatives except Alternative SS1, No Action, will meet the remediation goals presented in Section 9.1 of this ROD.

"O&M costs" refer to the costs of operating and maintaining the treatment described in the alternative, for an assumed period of 30 years. All of the Alternatives except SS1 (No Action) and SS6 (Offsite Disposal) have anticipated O&M costs. Such costs would include, primarily, periodic inspections of the Site, except in the case of Alternative SS2 (Soil-Synthetic Membrane Cap), for which annual O&M costs will include Site mowing and maintenance of a security fence. O&M costs were calculated using a five percent discount rate per year.

All alternatives except SS1, No Action, and SS2, Soil-Synthetic Membrane Cap, include verification soil sampling to insure that all soil contaminated at concentrations exceeding the remediation goals is removed for treatment or disposal. Additionally, all alternatives except Alternatives SS5 (In-Situ Vitrification) and SS6 (Offsite Disposal) include six Five Year Reviews to be conducted during the assumed 30-year O&M period. The cost, \$41,700, is included with the capital costs but was calculated using the same five percent discount factor as O&M costs.

TABLE 20
COMPONENTS OF SOURCE CONTROL REMEDIAL ALTERNATIVES

General Response Action	Technology	Process Option	Area Impacted	ALTERNATIVES					
				SS1	SS2	SS3	SS4	SS5	SS6
No Action	No Action	None	Entire Site	X					
Institutional Controls	Site Access and Land Use Restrictions	Fencing	Selected Areas		X				
		Land Use Restrictions	Contaminated Soil		X				
	Environmental Monitoring	Air, Soil, and Surface Water Monitoring	Contaminated Soil		X	X	X	X	X
Containment	Capping	Soil-Synthetic Membrane Cap	Contaminated Soil		X				
	Surface Controls	Surface Water Diversion/Collection System	Contaminated Soil		X				
		Revegetation	Contaminated Soil		X	X	X	X	X
			Contaminated Soil			X	X		X
	Dust/Vapor Suppression	Water	Contaminated Soil			X	X		
		Membranes/Tarps	Contaminated Soil			X	X		
Removal	Excavation	Contaminated Soil	Contaminated Soil			X	X		X
Onsite Treatment	Chemical	Soil Washing	Contaminated Soil				X		
	Physical/Chemical	Pozzolan/Portland Cement Soils Stabilization	Contaminated Soil			X	X		
In-Situ Treatment	Thermal	Vitrification	Contaminated Soil					X	
OnSite Disposal	Disposal	Temporary Storage	Contaminated Soil			X	X		
OffSite Disposal	Disposal	Approved RCRA Solid Waste Landfill	Contaminated Soil				X		
	Disposal	Approved RCRA Hazardous Waste Landfill	Contaminated Soil						X

Alternative SS1 = No Action

Alternative SS2 = Soils - Synthetic Membrane Cap

Alternative SS3 = Pozzolan/Portland Cement Soils Stabilization

Alternative SS4 = Soils wash and stabilize onsite, landfill offsite

Alternative SS5 = In-situ vitrification

Alternative SS6 = Excavate, landfill offsite

Certain major ARARs are applicable to each source control alternative. Alternative SS2 would not comply with the Resource Conservation and Recovery Act (RCRA) landfill closure requirements, in 40 CFR Part 264 and in the South Carolina Hazardous Waste Management Regulations (SCHWMR), Reg. 61-79.264, which require removal of contamination "to the maximum extent possible." Alternatives SS3, SS4, SS5 and SS6 would, assuming successful implementation, comply with the following major applicable ARARs. All of these alternatives involve materials handling and potential generation of particulates, and/or VOC emissions from treatment, and thus, must comply with the South Carolina Ambient Air Quality Standards (AAQS) which implement the South Carolina Pollution Control Act, and the National Emission Standards for Hazardous Air Pollutants (NESHAP) under the Clean Air Act. Alternatives SS4 and SS6 include landfill disposal of hazardous wastes and, therefore, could be required to comply with RCRA land disposal restrictions (LDRs, 40 CFR Part 268, SCHWMR 61-79.268) if the soils are shown to be hazardous wastes subject to land disposal requirements (40 CFR Part 261, SCHWMR 61-79.261). Finally, U.S. Department of Transportation (DOT), EPA (40 CFR Part 262), and SCDHEC (SCHWMR 61-79.262) regulations governing the transportation of hazardous materials would also apply to alternatives SS4 and SS6 if the soils prove to be hazardous waste.

As detailed in Section 5.2.1, the estimated volume of contaminated soil requiring remediation is 650 cubic yards. Figure 11 delineates the area of contaminated soil.

7.1.1 Alternative SS1: No Action

CERCLA requires that EPA consider a "No Action" alternative to serve as a basis against which other alternatives can be compared. Under this alternative, no actions are taken and no funds expended for control or cleanup of contamination associated with the contaminated soil. Because contaminants would be left on-site under this alternative, a review is required every five years in accordance with CERCLA. This constitutes the only cost involved and is considered an O&M cost.

Under this alternative, Site conditions would remain unchanged. Thus, no ARARs would be achieved under this alternative. Contaminated soil at the surface would continue to present an unacceptable human health risk now, and in the future.

Total Capital Costs:	0
Total O&M Costs:	<u>\$41,700</u>
Total Present Worth Costs:	\$41,700

7.1.2 Alternative SS2: Soil-Synthetic Membrane Cap

This alternative would include the construction of a soil-synthetic membrane cap over the contaminated area, revegetation, and surface drainage controls. In addition, this alternative would include the use of institutional controls to prevent direct contact and incidental ingestion of contaminated soil by the general public. To reduce the opportunity for exposure, a six-foot security fence would be installed around the contaminated area, and warning signs would be displayed on the fences to alert the public of potential hazards. Future uses of the property would be limited by applying deed restrictions. State and local agencies would be responsible for the implementation and enforcement of these restrictions. Periodic air, soil and surface water monitoring would also be continued onsite to insure compliance with RAOs.

The soil-membrane cap would consist of a synthetic liner installed over the contaminated soil area, a drainage layer, and a geotextile fabric liner placed over the drainage layer to prevent clogging. Finally, the geotextile fabric would be covered by a two-foot soil and topsoil cover. The soil and drainage layers protect the liner layer from heat and other environmental effects. The topsoil layer of the cap would be graded to a gentle slope designed to match current Site topography. Some grading of the contaminated soil may be required to achieve such slopes. A vegetative cover of native grass would be established to minimize cap erosion. Surface drainage channels would be constructed around the perimeter of the cap to collect surface runoff and water from the drainage layer. The collected water would be discharged to an offsite storm water collection point.

Since the contaminated soils would not be treated, judging this alternative's effectiveness would include monitoring Site groundwater. Therefore, the alternative includes periodic groundwater monitoring for an assumed period of 30 years. Periodic maintenance of the soil-membrane cap and surface drainage systems would also be required during the 30-year period.

Design of the cap is estimated to require two to three months. Construction would be complete in approximately 2 months.

Total Capital Costs:	\$135,000
Total O&M Costs:	<u>73,800</u>
Total Present Worth Costs:	\$208,800

7.1.3 Alternative SS3: Soil Stabilization

Soil stabilization is a process involving the addition of Portland cement, chemical binders, and water to the excavated contaminated soil. The soils and binders are then thoroughly mixed with machines typically used for concrete mixing, or they could be mixed in place with backhoe equipment. After mixing is complete, the soils are then backfilled into the original excavation area and allowed to cure and harden. The curing reaction produces a dense, strong, low-permeability block, usually referred to as a "monolith." The monolith would then be covered with one foot of clean native soil. Because the process increases the volume of treated soil, the backfilled area would be graded to provide proper drainage. A vegetative stand would then be established over the treated area. Finally, Site access would be restricted by fencing selected areas.

This alternative, and all of the soil remediation alternatives below, would require that appropriate and carefully planned materials handling procedures be used during the excavation and handling of soil. For this alternative, such measures would likely include the following. First, air monitoring during excavation may necessitate that workers use Occupational Health and Safety Administration (OSHA) Level C protective clothing and masks. Water would be used to minimize dust emissions during soil excavation, transport, and handling. Stockpiled soils and debris would be covered by tarps or plastic sheeting to minimize dust emissions and runoff. Finally, during the curing process, heat generation caused by chemical reactions may cause emission of VOCs to the air. If this occurs, the curing area might require use of a ventilation and carbon adsorption system to capture emissions.

The initial excavation of contaminated soil would include all soil containing contaminants at levels greater than the soil remediation goals. Treated soils would be considered to achieve remedial action objectives if they do not adversely affect groundwater, as determined through testing by the Toxicity Characteristic Leachate Procedure (TCLP). However, using transport modeling, a more appropriate standard than the TCLP may be developed in the remedial design phase.

Bench-scale treatability testing would be necessary at the start of remedial design to verify that the remediation goals could be achieved. During implementation, which would require approximately 9 to 12 months, surface water runoff and air emissions would also be monitored to ensure that the RAOs were being met.

Total Capital Costs:	\$234,600
Total O&M Costs:	<u>7,800</u>
Total Present Worth Costs:	\$242,400

7.1.4 Alternative SS4: Soil Washing, Stabilization, and Offsite Disposal

Alternative SS4 involves excavating the contaminated soils, screening and separation of large debris, soil washing the contaminated soil, stabilizing the remaining highly-contaminated soil fraction, and transporting the stabilized soils to a RCRA solid waste landfill. After soil washing, the treated soil (approximately 90 percent of the original volume) would be backfilled onsite after testing to verify that remediation goals have been met.

Soil washing involves placing screened and sized contaminated soils into a high energy contacting and mixing vessel where the soils are scrubbed with a washing fluid. The sand and coarser material in the soil usually requires only this primary washing step, but can be rewashed, if necessary. The more highly-contaminated clay and silt fractions are hydraulically separated and sent to a special washer module for more intensive washing. The more aggressive washing in this stage removes the highly adsorbed contaminants. After this step, all particles larger than a certain size (approximately 0.074 cm) are rinsed, dewatered, and combined with the coarse material from the initial washing step, stockpiled, tested against the remediation goals, and eventually backfilled. The remaining fines are then dewatered and removed. Depending on the specific soil, this remaining highly-contaminated fraction is generally 10 to 15 percent of the initial volume of contaminated soils. These solids would then be stabilized, by the process described above under Alternative SS3. Stabilization could occur onsite or offsite. After curing/hardening, the stabilized soil would be tested for leachability utilizing TCLP, and then disposed of at a RCRA hazardous waste landfill or RCRA non-hazardous solid waste landfill according to the results.

Prior to being washed, the contaminated soil would be excavated and undergo solids separation and sizing. Techniques could include screens, shredders, and grinders for removal of large stones and debris so that they could be appropriately treated. Such debris could be washed in a separate mixer, or be decontaminated by high-pressure steam washing.

In addition to the activities described above, Site access would be restricted by fencing selected areas until remedial activities were completed. Materials handling procedures would be as described above for Alternative SS3, including the use of soil

moisture to minimize dust emissions during soil excavation, transport, and handling; and tarps or plastic sheeting over stockpiled soil to minimize dust emissions and runoff. Both soil washing and stabilization could potentially generate VOC emissions, so that systems for emissions capture and treatment might be necessary. Surface water runoff and treated debris would also be monitored to ensure that the RAOs were being met.

After treatment activities have been completed, clean native fill material would be placed in the excavation. The entire Site would then be graded to provide proper drainage, and a natural vegetation stand would be established to minimize erosion. Implementation would take approximately 9 to 12 months.

Total Capital Costs:	\$230,200
Total O&M Costs:	<u>7,800</u>
Total Present Worth Costs:	\$238,000

7.1.5 Alternative SS5: In-Situ Vitrification

In-situ vitrification (ISV) is a process whereby contaminated soils are melted in place, binding the contaminants in a glassy, solid matrix. Melting is produced by a high-voltage electric current passed between electrodes placed into the soil. Melt temperatures in the range of 1600° C to 2000° C destroy organic substances in the soil and produce gases which migrate upwards to the surface. The gases would be trapped by use of a hood over the treatment area, and then routed through an air emissions treatment system. Inorganic contaminants remain trapped within the glass matrix formed by the melt. The solid mass created after the melt cools is extremely resistant to leaching and more durable than concrete.

The ISV process would cause a 10 to 20 percent reduction in the soil volume being treated, therefore limited backfilling of clean soil would be needed to fill this void. Regrading to support revegetation would be required to prevent erosion and reduce infiltration. Since this alternative involves a monolith, similar to that described in Alternatives SS3 and SS4, verifying that this alternative meets the remedial action objectives would involve leachability testing using the TCLP, or a more appropriate standard if one is developed in the remedial design phase.

ISV is an innovative technology that has been proven effective in treating both organically-contaminated and inorganically-contaminated soil. Operational-scale units are available, but have not yet been utilized on a full scale basis at a Superfund site. Therefore, before full scale implementation of ISV, samples would be collected for bench scale treatability studies,

to verify that the technology will achieve the remedial action objectives. Implementation of the alternative is estimated to require 9 to 12 months.

Total Capital Costs:	\$808,700
Total O&M Costs:	<u>7,800</u>
Total Present Worth Costs:	\$816,500

7.1.6 Alternative SS6: Offsite Disposal

Alternative SS6 consists of the excavation of all contaminated soil, followed by final disposal, and treatment, if required, at a regulated RCRA hazardous waste landfill.

Contaminated soil in the affected area would be excavated and transported by truck to a Resource Conservation and Recovery Act (RCRA) hazardous waste landfill. Following excavation, clean native fill material would be placed in the excavated area. The entire Site would then be graded to provide proper drainage, and a natural vegetation stand would be established to minimize erosion.

Soil samples from the RI borehole cuttings were tested using the Toxicity Characteristic Leachate Procedure (TCLP). The results of those tests suggest that there are no hazardous wastes, as defined by RCRA, remaining onsite. However, certain of the more highly contaminated soils may test as hazardous by TCLP. Therefore, under this alternative it is assumed that the soils are hazardous and thus, will require treatment at the hazardous waste landfill facility before disposal. Typically, the treatment used for metals-contaminated soils is stabilization.

In addition to the activities described above, Site access would temporarily be restricted by fencing selected areas until remedial activities were completed. Materials handling procedures would, as previously described for Alternatives SS3 and SS4, include the use of soil moisture to minimize dust emissions during soil excavation, transport, and handling; air monitoring during soils handling; and use of the appropriate OSHA personal protection equipment. Excavation work would be staged and coordinated with backfill/grading/seeding activities to minimize dust production and surface runoff.

Total Capital Costs:	\$305,800
Total O&M Costs:	<u>0</u>
Total Present Worth Costs:	\$305,800

7.2 Groundwater Remedial Alternatives

Technologies considered potentially applicable to groundwater contamination (Table 19, Section 7.0 above) were further evaluated on effectiveness and implementability. Table 21 lists those which passed this final screening, and outlines the technology components of each of the five remedial alternatives proposed for groundwater remediation.

The remedial alternatives are listed below. The last three groundwater alternatives are sets ("A" and "B"), indicating choices for specific options, so that, for example, Alternative 4A and 4B may differ only in which option is used for discharging treated groundwater.

Alternative GW1: No Action

Alternative GW2: Groundwater Use Restrictions and Monitoring

Alternatives GW3A and GW3B: Groundwater Containment,
Treatment, Surface Water or POTW Discharge

Alternatives GW4A and GW4B: Groundwater Extraction, Physical
Treatment, Bioremediation, Surface Water or POTW Discharge

Alternatives GW5A and GW5B: Groundwater Extraction, Physical
Treatment, Air/Gas/Steam Stripping, Surface Water or POTW
Discharge

Descriptions of the alternatives are presented in the following subsections. Costs are described in the same manner as above for soil remediation. As with the soil alternatives, a 30-year O&M period is assumed, except as described for alternatives GW3A and GW3B.

The components of Alternative GW2, institutional controls and groundwater monitoring, are implied for all alternatives except GW1, the "no action" alternative. Five Year Review costs are included only in Alternative GW1 (No Action); it is assumed that these would be included in the selected soil remediation alternative.

Certain major ARARs are applicable, or relevant and appropriate, to each of the groundwater remedial alternatives. Site groundwater is classified by South Carolina as Class GB (SC Water Classifications and Standards, Regulation 61-68), and by EPA as Class IIB (Guidelines for Ground Water Use and Classification, EPA Ground Water Protection Strategy, US EPA 1986). Alternatives GW1 and GW2 would not meet the relevant and appropriate ARARs concerning groundwater as a potable water source, the National Primary and Secondary Drinking Water Standards, promulgated in 40 CFR Parts 141-143, and the State of South Carolina Primary Drinking Water Regulations, SC Reg. 61-58, because Site groundwater violates numerous MCLs specified in these

**TABLE 15
COMPONENTS OF GROUNDWATER REMEDIAL ALTERNATIVES**

General Response Action	Technology	Process Option	Area Impacted	ALTERNATIVES							
				GW1	GW2	GW3A	GW3B	GW4A	GW4B	GW5A	GW5B
No Actbn	No Actbn	None	Entire Site	X							
Institutional Controls	Groundwater Use Restrictions	State Imposed Permit Restrictions	Contaminated Groundwater		X	X	X	X	X	X	X
	Environmental Monitoring	Groundwater Monitoring	Contaminated Groundwater		X	X	X	X	X	X	X
Containment	Gradient Control	Extraction Wells	Contaminated Groundwater			X	X				
		Injection Wells	Contaminated Groundwater			X	X				
Removal	Extraction	Extraction Wells	Contaminated Groundwater					X	X	X	X

Alternative GW1 = No Actbn

Alternative GW2 = Groundwater Use Restrictions and Monitoring

Alternative GW3A = Groundwater Containment/Surface Water Discharge

Alternative GW3B = Groundwater Containment/POTW Discharge

Alternative GW4A = Extraction, Neutralization, Aeration, Chemical Reduction, Chemical Precipitation, Phase Separation, Filtration
Aboveground Bioremediation, Surface Water Discharge

Alternative GW4B = Extraction, Neutralization, Aeration, Chemical Reduction, Chemical Precipitation, Phase Separation, Filtration
Aboveground Bioremediation, POTW Discharge

Alternative GW5A = Extraction, Neutralization, Aeration, Chemical Reduction, Chemical Precipitation, Phase Separation, Filtration
Air/Gas/Steam Stripping, Surface Water Discharge

Alternative GW5B = Extraction, Neutralization, Aeration, Chemical Reduction, Chemical Precipitation, Phase Separation, Filtration,
Air/Gas/Steam Stripping, POTW Discharge

TABLE 15 (continued)
COMPONENTS OF GROUNDWATER REMEDIAL ALTERNATIVES

General Response Action	Technology	Process Option	Area Impacted	ALTERNATIVES							
				GW1	GW2	GW3A	GW3B	GW4A	GW4B	GW5A	GW5B
Onsite Treatment	Biological	Submerged Fixed Film Reactor	Contaminated Groundwater					X	X		
	Chemical	Neutralization	Contaminated Groundwater			X	X	X	X	X	X
		Chemical Reduction	Contaminated Groundwater			X	X	X	X	X	X
		Aeration	Contaminated Groundwater			X	X	X	X	X	X
		Chemical Precipitation	Contaminated Groundwater			X	X	X	X	X	X
	Physical	Phase Separation	Contaminated Groundwater			X	X	X	X	X	X
		Filtration	Contaminated Groundwater			X	X	X	X	X	X
		Air/Gas/Steam Stripping	Contaminated Groundwater							X	X
		Carbon Adsorption	Contaminated Groundwater			X	X	X	X	X	X
Offsite Discharge	Discharge	POTW Discharge	Treated Groundwater				X		X		X
		Surface Water Discharge	Treated Groundwater			X		X		X	

Alternative GW1 = No Action

Alternative GW2 = Groundwater Use Restrictions and Monitoring

Alternative GW3A = Groundwater Containment/Surface Water Discharge

Alternative GW3B = Groundwater Containment/POTW Discharge

Alternative GW4A = Extraction, Neutralization, Aeration, Chemical Reduction, Chemical Precipitation, Phase Separation, Filtration
Aboveground Bioremediation, Surface Water Discharge

Alternative GW4B = Extraction, Neutralization, Aeration, Chemical Reduction, Chemical Precipitation, Phase Separation, Filtration
Aboveground Bioremediation, POTW Discharge

Alternative GW5A = Extraction, Neutralization, Aeration, Chemical Reduction, Chemical Precipitation, Phase Separation, Filtration
Air/Gas/Steam Stripping, Surface Water Discharge

Alternative GW5B = Extraction, Neutralization, Aeration, Chemical Reduction, Chemical Precipitation, Phase Separation, Filtration
Air/Gas/Steam Stripping, POTW Discharge

regulations. Also, the CERCLA preference for treatment to reduce toxicity, mobility, or volume of contaminants wherever possible would not be satisfied by these alternatives.

Alternatives GW3A and GW3B would not meet the CERCLA preference for treatment. Assuming successful implementation, however, they would meet the relevant and appropriate drinking water standards specified above, albeit at a very slow rate. The remaining alternatives, GW4A, GW4B, GW5A and GW5B, would achieve these standards, and would also meet the CERCLA preference for treatment. Alternatives GW3A, GW3B, GW4A, GW4B, GW5A, and GW5B would be subject to the following major applicable ARARs: South Carolina Ambient Air Quality Standards (SC Regulation 62.5), National Emissions Standards for Hazardous Air Pollutants (NESHAPs, 40 CFR Part 61), Clean Water Act Discharge Limitations (40 CFR § 403.5), and the Clean Water Act Pretreatment Standards (40 CFR Parts 122, 125, 129, 133, and 136). The treatment system related to these alternatives may produce a sludge that may be subject to the identification (40 CFR Part 261, SCHWMMR 61-79.261), transportation (40 CFR Part 262, SCHWMMR 61-79.262), manifestation (40 CFR Part 263, SCHWMMR 61-79.263), and land disposal restriction (40 CFR Part 268, SCHWMMR 61-79.268) requirements of RCRA, if the resulting sludge is determined to be a RCRA hazardous waste.

Figure 12 on page 37 of this ROD shows the areal extent of groundwater contamination. As noted in Section 5.2.3, the estimated volume of contaminated groundwater is 66.9 million gallons.

7.2.1 Alternative GW1: No Action

Under the no action alternative, the Site is left "as is" and no funds are expended for monitoring, control, or cleanup of the contaminated groundwater. Risks to persons living on and near the Site will remain. Also, contaminants will continue to discharge from the surficial aquifer to Wards Creek, at levels which may exceed Federal and/or State environmental standards. Because hazardous contaminants would remain onsite, a Five Year Review would be required under CERCLA.

Total Capital Costs:	0
Total O&M Costs:	<u>\$41,700</u>
Total Present Worth Costs:	\$41,700

7.2.2 Alternative GW2: Groundwater Use Restrictions and Monitoring

Under this alternative, institutional controls would be implemented to restrict the withdrawal and use of groundwater

from the contaminated plume. A second component of this alternative would be monitoring of Site groundwater conditions.

The institutional controls to be used are deed restrictions and well permit restrictions. Deed restrictions prevent future use of the aquifer for purposes such as potable and industrial water supply, irrigation, and washing. Permit restrictions issued by the State of South Carolina would restrict all well drilling permits issued for new wells on properties that may draw water from the contaminated groundwater plume. These restrictions would be written into the property deeds to inform future property owners of the possibility of contaminated groundwater beneath the property.

Groundwater monitoring would involve collection and analysis of samples from Site monitor wells at regular intervals, to allow tracking of contaminant concentrations and to monitor the speed, direction, and extent of contaminant migration. Institutional controls are estimated to require 9 to 12 months to implement. Groundwater monitoring should take less than one month to initiate.

Total Capital Costs:	\$55,100
Total O&M Costs:	<u>373,500</u>
Total Present Worth Costs:	\$428,600

7.2.3 Alternatives GW3A and GW3B: Groundwater Containment, Treatment, Surface Water or POTW Discharge

Alternatives GW3A and GW3B involve installation of extraction (pumping) wells to capture groundwater at the leading edge of the groundwater contaminant plume to stop its migration offsite. Also, injection wells could possibly be used to change the groundwater flow patterns and effectively "push" the plume into the area influenced by the extraction wells, thereby containing it. The exact well placement and extraction/injection volumes needed to maintain the containment conditions would be developed in the remedial design. In the FS, it was estimated that three wells would be required. A portion of the extracted water would be discharged to Wards Creek; therefore, it would be necessary to meet the appropriate treatment standards for permitted surface water discharge under the Clean Water Act (National Pollutant Discharge Elimination System, NPDES). To achieve this, the extracted groundwater would first be pumped through a treatment system. Because of the necessity for treating the groundwater before any type of final discharge, this alternative is not a true "containment" scheme, which typically would not include a treatment provision.

Groundwater treatment would consist of an aeration pretreatment step, a metals treatment step, and an organic contaminant polishing step. Aeration removes manganese and iron; to remove the other metal contaminants of concern, chemical reduction, chemical precipitation, phase separation, and filtration would be employed. The sludges from these physical processes are generally hazardous wastes because they are contaminated with heavy metals. These sludges would require disposal offsite at a RCRA hazardous waste landfill. Granular activated carbon adsorption would be used as the organic contaminant polishing step. In this step, two similarly sized carbon units would be placed in series. Once the lead unit approaches exhaustion, the backup unit would be switched over to the lead position, while the lead unit is emptied of its spent carbon, refilled with virgin or reactivated carbon, and used as the backup unit. The spent carbon would also be shipped offsite to a RCRA hazardous waste landfill for disposal, or if feasible, reactivated for reuse.

The final disposition of the treated water differs between the two alternatives. Under Alternative GW3A, the portion of the treated water not discharged to Wards Creek would be reinjected, or, if reinjection is not acceptable, to the City of Greer Publicly Owned Treatment Works (POTW).

Under Alternative GW3B, the treated groundwater would be discharged to the City of Greer Publicly Owned Treatment Works (POTW), rather than being discharged to Wards Creek or reinjected. Depending on the industrial pretreatment standards required by the City, this alternative may allow certain treatment steps to be omitted from the onsite treatment system. The system's effluent would be monitored to ensure compliance with the City's industrial pretreatment standards and any other requirements established by SCDHEC.

In addition to the extraction wells and treatment processes described above, Alternatives GW3A and GW3B would include implementation of all of the institutional controls and groundwater monitoring described in Alternative GW2, thereby monitoring the effectiveness of the alternative and limiting the current and future use of groundwater until clean-up goals are achieved. Given the relatively slow horizontal movement of Site groundwater, either alternative would take considerably longer to reach the remediation goals because of the time necessary for the contaminant plume to reach the extraction wells. Therefore, based on estimates of groundwater movement and the area contaminated, an O&M period of 75 years was assumed.

GW3A:	Total Capital Costs:	\$984,500
	Total O&M Costs:	<u>2,225,200</u>
	Total Present Worth Costs:	\$3,209,700
GW3B:	Total Capital Costs:	\$990,600
	Total O&M Costs:	<u>1,985,500</u>
	Total Present Worth Costs:	\$2,976,100

7.2.4 Alternatives GW4A and GW4B: Groundwater Extraction, Physical Treatment, Bioremediation, Surface Water or POTW Discharge

Alternatives GW4A and GW4B involve placing extraction wells throughout the contaminant plume to actively remediate the aquifer. This would also prevent further migration of the contaminant plume. It would involve installing more extraction wells, removing water from the aquifer at a higher rate, and treating more groundwater than Alternatives GW3A and GW3B. The groundwater would be treated to remove inorganic and organic contaminants. In addition to groundwater treatment, institutional controls would be implemented to limit current and future use of groundwater until cleanup goals are achieved, and groundwater monitoring would be performed to monitor the effectiveness of the alternative in achieving the remediation goals.

Preliminary groundwater modeling indicates that six wells would be needed to recover the contaminant plume at a likely total yield of approximately 30 gallons per minute (gpm). Such a scheme would remove one pore volume of water from the affected area every 4.2 years; however, successful remediation would likely take longer. These planning estimates apply to this alternative and to Alternatives GW5A and GW5B.

The primary steps in the groundwater treatment process would be the same as described for Alternatives GW3A and GW3B: an aeration pre-treatment step, a metals treatment step and an organic contaminant polishing step. The organic treatment step would employ bioremediation, a controlled natural process in which microbes (such as bacteria) consume organic substances.

In general, bioremediation is a common treatment method widely used at conventional wastewater treatment plants. In this case, submerged fixed-film reactors (SFFRs) would be used to provide organic contaminant removal. At some sites, systems using SFFRs have been shown to effectively treat low-concentration waste streams, such as the groundwater found at the Elmore Waste Disposal Site. However, pilot scale treatability studies would be required to properly design the treatment facility.

The system consists of vessels or reactors filled with a high-surface-area medium on which bacterial colonies are grown using an artificial stock solution. Once a sufficient film has been established, the stock solution is replaced with the contaminated groundwater. The groundwater does not contain sufficient nutrients and carbon to sustain the volume of film in the reactor, and consequently the film begins to decay. However, in an effort to sustain itself, the film scavenges the groundwater for nutrients and carbon sources. This scavenging action removes and degrades organic contaminants. Eventually, the film decays and the reactor must be removed from service so that new film can be established using the stock solution; in its place, another reactor is then put in line, as the reactors are rotated on-line and off-line. SFFRs generally produce a nonhazardous, organic sludge. This sludge would be initially sampled to confirm that it was, in fact, nonhazardous. The sample results would then be used to determine the proper, offsite disposal method for it. Periodic retesting of the sludge would be necessary.

Alternative GW4A includes discharge of the treated water to Wards Creek. The appropriate NPDES permit pursuant to the Clean Water Act would be required for this discharge. Under Alternative GW4B, the treated groundwater would be discharged to the City of Greer Publicly Owned Treatment Works (POTW), rather than being discharged to Wards Creek. As described above for Alternative GW3B, depending on the industrial pretreatment standards required by the City, this alternative may allow certain treatment steps to be omitted from the onsite treatment system. The system's effluent would be monitored to assure compliance with Greer industrial pretreatment standards and any other requirements established by SCDHEC.

GW4A:	Total Capital Costs:	\$1,122,200
	Total O&M Costs:	<u>1,800,000</u>
	Total Present Worth Costs:	\$2,922,200
GW4B:	Total Capital Costs:	\$1,128,200
	Total O&M Costs:	<u>1,611,000</u>
	Total Present Worth Costs:	\$2,739,200

7.2.5 Alternatives GW5A and GW5B: Groundwater Extraction, Physical Treatment, Air/Gas/Steam Stripping, Surface Water or POTW Discharge

Alternatives GW5A and GW5B would use the same extraction and treatment steps described above for Alternatives GW4A and GW4B. The primary steps in the treatment system would be an aeration pre-treatment step, a metals treatment step, and an organic contaminant treatment step. The organic treatment would consist

of air, gas, or steam stripping. After treatment, the groundwater would be discharged to either Wards Creek via an NPDES permit under Alternative GW5A, or to the Greer POTW via an industrial pretreatment permit under Alternative GW5B. As with the preceding alternatives, institutional controls and groundwater monitoring would also be implemented.

A stripping unit would provide primary organic removal. An air, gas, or steam stripping unit works by fostering a controlled evaporation or "stripping" process. The unit has a "tower" or vertical cylinder, filled with a packing media which provides a large surface area for contact between the water and air. The water to be treated is pumped to the top of the tower and cascades downward through the packing media. Air is blown upwards through the bottom of the tower and exits at the top. The ratio of air to water is 50:1 or higher. The high volume of air passing over the thin film of water on the packing evaporates (strips) the volatile organic contaminants from the water. In the process, contaminants are transferred from water to air. The off-gases produced may have to be treated using gas phase carbon adsorption before they are released to the atmosphere. Steam stripping operates on much the same principal as air stripping, but uses steam instead of air as its vapor-phase carrier.

To be fully effective, the influent water must be as clear as possible. Therefore, filtration to remove turbidity, in addition to the aeration step to remove iron and manganese, would be necessary. Bench-scale testing would be conducted during remedial design to determine which stripping process should be used, as well as to verify that the process can meet the remediation goals for the organic contaminants.

GW5A:	Total Capital Costs:	\$1,017,600
	Total O&M Costs:	<u>1,683,200</u>
	Total Present Worth Costs:	\$2,700,800
GW5B:	Total Capital Costs:	\$1,023,300
	Total O&M Costs:	<u>1,494,200</u>
	Total Present Worth Costs:	\$2,739,200

8.0 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

The alternatives for soil and groundwater remediation were evaluated based on the nine criteria set forth in the NCP (40 CFR § 300.430(e)(9)). In the sections which follow, brief summaries of how the alternatives were judged against these criteria are presented. Additionally, the sections are prefaced by brief descriptions of the criteria.

8.1 Source Control Remedial Alternatives

For ease of reference, the five soil (source control) remedial alternatives considered are listed below in Table 22.

TABLE 22 SOURCE CONTROL REMEDIAL ALTERNATIVES		
Alternative		Cost
SS1	No Action	\$41,700
SS2	Soil-Synthetic Membrane Cap	\$208,800
SS3	Soil Stabilization	\$242,400
SS4	Soil Washing, Stabilization, Offsite Disposal	\$238,000
SS5	In-Situ Vitrification	\$816,500
SS6	Offsite Disposal	\$305,800

8.1.1 Threshold Criteria

Two threshold criteria must be achieved by a remedial alternative before it can be selected.

1. Overall protection of human health and the environment addresses whether the alternative will adequately protect human health and the environment from the risks posed by the Site. Included in judgement by this criterion is an assessment of how and whether the risks will be properly eliminated, reduced, or controlled through treatment, engineering controls, and/or institutional controls.

Among the soil alternatives, SS1 would not achieve protection of human health and the environment. Risks identified in the Baseline Risk Assessment would continue to exist. Alternative SS2 would produce limited protection by preventing human contact with the contaminated soil, and, by reducing infiltration (rainfall) through the vadose zone, the amount of leaching to groundwater would be reduced. Of the remaining alternatives, Alternative SS5 would achieve the highest degree of protection. Alternatives SS3, SS4 and SS6 were all judged even; all should be able to successfully achieve protection.

2. Compliance with applicable or relevant and appropriate requirements (ARARs) addresses whether an alternative will meet all of the requirements of Federal and State environmental laws and regulations, as well as other laws, and/or justifies a waiver from an ARAR. The specific ARARs which will govern the selected remedy are listed and described in Section 9.0, Selected Remedy.

In evaluating compliance with ARARs, it is important to note that TCLP tests of borehole cuttings to date have not indicated that hazardous wastes, as defined under RCRA and the SCHWMR, are present. However, should the contaminated soils fail TCLP, then 40 CFR Parts 261, 262, 263, and the corresponding parts under the SCHWMR, will apply. Also, if the contaminated soils fail TCLP, most likely, the land disposal restrictions in 40 CFR Part 268 and SCHWMR 61-79.268 will apply. However, if EP toxicity tests are performed and the contaminated soils do not exceed EP toxicity limits, then the land disposal restrictions cited above will not apply, even though the contaminated soils fail TCLP.

Alternative SS1 would not comply with the ARARs or the Site-specific RAOs developed for this Site, because groundwater contamination that currently violates ARARs would not be addressed. Alternative SS2 would not comply with the RCRA landfill closure regulations in 40 CFR Parts 264 and SCHWMR 61-79.264 requiring removal of contamination "to the maximum extent possible." Alternatives SS3, SS4, SS5 and SS6 would, assuming successful implementation, comply with ARARs.

8.1.2 Primary Balancing Criteria

Five criteria were used to weigh the strengths and weaknesses among alternatives, and to develop the decision to select one of the alternatives. Assuming satisfaction of the threshold criteria, these are the main considerations in selecting an alternative as the remedy.

1. Long term effectiveness and permanence refers to the ability of the alternative to maintain reliable protection of human health and the environment over time, once the remediation goals have been met.

Alternative SS1 would not meet this criterion. Alternatives SS3, SS4, SS5, and SS6 would achieve and maintain a high degree of effectiveness and permanence, although for SS4, a treatability study would be required to verify this. Alternative SS2 would, if the cap is maintained properly, maintain some degree of effectiveness. If implemented successfully, Alternative SS5 would achieve the highest degree of effectiveness and permanence.

2. Reduction of toxicity, mobility, or volume addresses the anticipated performance of the treatment technologies that an alternative may employ. The 1986 amendment to CERCLA, the Superfund Amendments and Reauthorization Act (SARA), directs that, when possible, EPA should choose a treatment process that permanently reduces the level of toxicity of site contaminants, eliminates or reduces their migration away from the site, and/or reduces their volume on a site.

Alternative SS1 would not meet this criterion since no treatment would occur. Alternative SS2 would achieve some reduction in the mobility of contaminants, but would not reduce either the toxicity or volume. The remaining alternatives, SS3, SS4, SS5, and SS6, achieve varying degrees of toxicity/mobility/volume reduction, and were rated essentially equivalent on this criterion.

Alternatives SS3, SS4, and SS5 would reduce the mobility and volume of contamination, although in the case of SS3, the volume of contamination reduced would be offset by the overall larger size of the monolith created, as compared to the original volume of contaminated soil. However, the inherent toxicity of the contaminants is not eliminated through the immobilization achieved by stabilization (Alternatives SS3 and SS4) or vitrification (Alternative SS5).

Alternative SS6 would reduce the mobility, and may reduce the toxicity or volume, of the contaminants through treatment of the contaminated soil at a RCRA hazardous waste disposal facility since treatment may be required to comply with LDRs. The reduction achieved will depend on the specific treatment used at the RCRA hazardous waste disposal facility.

3. Short-term effectiveness refers to the length of time needed to achieve protection, and the potential for adverse effects to human health or the environment posed by implementation of the remedy, until the remediation goals are achieved.

Excluding Alternative SS1, which achieves no protection, the alternatives were rated evenly on this criterion. All alternatives can be completed within 3 to 12 months. Alternatives SS3, SS4, and SS6 have some potential for short-term impacts on nearby residents and the community, due to the necessary soil excavation and soil handling procedures. However, the excavation phase of work is very brief and is followed immediately by treatment (SS3, SS4) or offsite transport (SS6). Alternatives SS3 and SS4 could involve some very short-term stockpiling of soils onsite. Alternatives SS4, and SS5 include the use of air emissions controls to capture VOCs if they are produced. For Alternatives SS4 and SS6, remediation includes

truck transport of contaminated material offsite. However, these concerns can be successfully addressed through careful and well-planned abatement measures during implementation.

4. Implementability considers the technical and administrative feasibility of an alternative, including the availability of materials and services necessary for implementation.

Implementation is not a concern for Alternative SS1, since no actions would be implemented. Alternatives SS3 and SS6 were judged to be the most easily implemented, followed closely by Alternative SS2.

Between Alternatives SS3 and SS6, Alternative SS6 was judged by EPA to be superior. Given the relatively small volume of contaminated soil (650 cubic yards), it is the most feasible option. Excavation, soil testing, and transport of contaminated soil to a RCRA hazardous waste landfill is a fairly straightforward and routine operation. Unlike Alternative SS3, treatability testing would not be necessary, and long-term monitoring would not be required since no treated wastes would remain onsite.

The remaining alternatives were rated slightly lower than Alternative SS2 on this criterion. Alternative SS4 employs two technologies and would require two treatability studies, and Alternative SS5 has not been used full-scale at a Superfund site and would also require treatability testing.

Cost includes both the capital (investment) costs to implement an alternative, plus the long-term O&M expenditures applied over a projected period of operation. The total present worth cost for each of the six alternatives is presented in Table 22.

8.1.3 Modifying Criteria

State acceptance and community acceptance are two additional criteria that are considered in selecting a remedy, once public comment has been received on the Proposed Plan.

1. State acceptance: The State of South Carolina concurs with this remedy. South Carolina's letter of concurrence is provided in Appendix B to this ROD.

2. Community acceptance was indicated by the verbal comments received at the Elmore Waste Disposal Site Proposed Plan public meeting, held on January 14, 1993. The public comment period opened on December 30, 1992, and was to close on January 28, 1993. However, a request for extension was received on January 28, 1993, and the period was extended through February 27, 1993.

Written comments received concerning the Elmore Waste Disposal Site, and those comments expressed at the public meeting, are addressed in the Responsiveness Summary attached as Appendix A to this ROD.

8.2 Groundwater Remedial Alternatives

For ease of reference, the eight groundwater remedial alternatives are listed below in Table 23. The subsections under Section 8.1 above provide brief descriptions of each of the NCP nine criteria used to judge remedial alternatives.

TABLE 23 GROUNDWATER REMEDIAL ALTERNATIVES		
Alternative		Cost
GW1	No Action	\$41,700
GW2	Groundwater Use Restrictions and Monitoring	\$428,600
GW3A	Groundwater Containment, Treatment, Surface Water Discharge	\$3,209,700
GW3B	Groundwater Containment, Treatment, POTW Discharge	\$2,976,100
GW4A	Groundwater Extraction, Treatment (Bioremediation), Surface Water Discharge	\$2,922,200
GW4B	Groundwater Extraction, Treatment (Bioremediation), POTW Discharge	\$2,739,200
GW5A	Groundwater Extraction, Treatment (Air/Gas/Steam Stripping), Surface Water Discharge	\$2,700,800
GW5B	Groundwater Extraction, Treatment (Air/Gas/Steam Stripping), POTW Discharge	\$2,517,500

8.2.1 Threshold Criteria

1. Overall protection of human health and the environment:

Alternative GW1 fails this criterion since it does not address any of the risks posed by the Elmore Waste Disposal Site.

Alternative GW2 would provide some limited protection to human

health by restricting aquifer usage; however, the potential threat to Wards Creek from the surficial aquifer VOCs would remain.

Alternatives GW4A, GW4B, GW5A and GW5B provide the greatest protection to human health and the environment. Each of these alternatives is designed to actively remediate the surface and intermediate zones of the aquifer through capture and treatment of the contaminated groundwater plume.

Alternatives GW3A and GW3B would achieve a moderate degree of protection. Further migration of the groundwater contaminants would be prevented, and groundwater extracted at the leading plume edge would be treated prior to reinjection or surface water/POTW discharge. Institutional controls would also restrict aquifer usage.

2. Compliance with ARARs: Alternatives GW1 and GW2 would not comply with ARARs concerning groundwater as a drinking water source, because no actions would be taken to remediate the groundwater. Because of the passive nature of the proposed groundwater extraction scheme (from the leading plume edge only), Alternatives GW3A and GW3B would achieve these ARARs only at a very slow rate. Therefore, they were rated poorly on this criterion.

Alternatives GW4A, GW4B, GW5A and GW5B would, assuming successful implementation, achieve the highest degree of compliance with ARARs. Each of these alternatives involves a more aggressive extraction scheme which would recover and treat more groundwater faster. Thus these alternatives were rated as best satisfying the ARARs.

8.2.2 Primary Balancing Criteria

1. Long-term effectiveness and permanence: Alternative GW1 does not meet this criterion, since no actions would be taken to mitigate the human health risks identified in the Baseline Risk Assessment. Alternative GW2 relies on institutional controls to restrict aquifer usage. The reliability of such controls is uncertain, since it is difficult to project how well they will be implemented, thus the long-term effectiveness of Alternative GW2 is questionable.

All remaining alternatives would achieve a higher degree of long-term effectiveness than the two described above. However, Alternatives GW3A and GW3B require longer to achieve the remediation goals; the potential for problems affecting performance to occur would be higher, since the alternative would

be in operation longer. Therefore, Alternatives GW4A, GW4B, GW5A and GW5B were rated highest on this criterion.

2. Reduction of toxicity, mobility or volume: Alternatives GW1 and GW2 would have no effect on the toxicity or mobility of the Site contaminants. However, implementing either alternative would allow the volume of contaminated groundwater to increase.

The remaining alternatives would successfully achieve this criterion by capturing the contaminated groundwater and treating it to remove or reduce contamination. However, Alternatives GW3A and GW3B will achieve these reductions at a slower rate than Alternatives GW4A, GW4B, GW5A and GW5B.

3. Short-term effectiveness: Alternative GW1 cannot be evaluated on this criterion since no protection of human health or the environment would be achieved. Alternative GW2 would require only a short period to initiate the monitoring portion of the action, but the length of time needed to assign the deed restrictions for limiting aquifer usage is uncertain.

Each of the remaining alternatives could be employed without undue risk of adverse effects to the community or environment. Since Alternatives GW3A and GW3B require longer to achieve the remediation goals, the period of time until protection is achieved would be longer. Other than this difference, all of the remaining alternatives were rated evenly on this criterion.

4. Implementability: Implementation is not a concern for Alternative GW1, since no actions would be implemented. Groundwater monitoring under Alternative GW2 would be straightforward and easily implemented, but as noted above, the deed restrictions could prove more difficult.

All of the remaining alternatives are implementable, but Alternatives GW5A and GW5B were judged less difficult to implement than Alternatives GW4A and GW4B. This judgement was based on Agency experience with both air/gas/steam stripping and bioremediation, the two technologies considered for organic contaminant removal.

5. Cost includes both the capital (investment) costs to implement an alternative, plus the long-term O&M expenditures applied over a projected period of operation. The total present worth cost for each of the five alternatives is presented in Table 23.

8.2.3 Modifying Criteria

1. State acceptance: As noted above under section 8.1.3, the State of South Carolina concurs with this remedy. The State of South Carolina's letter of concurrence is provided in Appendix B of this ROD.

2. Community acceptance: As noted above, the community has provided comments on the Elmore Waste Disposal Site Proposed Plan. These comments, and EPA's response to them, are contained in the Responsiveness Summary, Appendix A to this ROD.

9.0 THE SELECTED REMEDY

Based upon consideration of the requirements of CERCLA, the NCP, the detailed analysis of alternatives and public and state comments, EPA has selected a remedy that addresses soil and groundwater contamination at this Site. At the completion of this remedy, the risk remaining at this Site will be within EPA's acceptable risk range of 1×10^{-4} to 1×10^{-6} , which is considered protective of human health and the environment.

The selected remedy for this Site is:

Source Control:	Alternative SS6, Offsite Disposal
Groundwater Remediation:	Alternative GW5B, Groundwater Extraction, Physical Treatment, Air/Gas/Steam Stripping, POTW Discharge

The estimated total present worth cost of the remedy is \$2,823,300.

9.1 Source Control

This remedy component consists of excavation of contaminated soil, verification sampling, and transport of the soil to a permitted RCRA hazardous waste landfill. The following subsections describe this remedy component in detail, provide the criteria (ARARs and TBC material) which shall apply, and establish the performance standards for implementation.

For purposes of describing this portion of the remedy and specifying the requirements which shall apply to it, it is assumed that some or all of the contaminated soils to be addressed will be shown by laboratory analysis to be RCRA hazardous wastes. TCLP tests of cuttings to date have not indicated that hazardous wastes, as defined under RCRA, are present.

9.1.1 Description

Onsite work shall be performed in accordance with the OSHA health and safety standards applicable to remedial activities. Proper materials handling procedures shall be used during the excavation and handling of soil. Such measures may include the use of water to minimize dust emissions during soil excavation, transport, and handling; and the use of tarps or plastic sheeting placed over temporary soil stockpiles to minimize dust emissions and runoff.

Soil in the area of soil contamination (Figure 11) shall be excavated until the remaining soil achieves the concentrations established as performance standards as described in Section 9.3 of this ROD. Subsurface soils which violate the performance standards at and below 2 feet below land surface shall be excavated until the remaining soil achieves the performance standards or the water table is encountered.

Prior to excavation, soil sampling sufficient to confirm the areal extent of soil which exceeds these criteria, shall be conducted, at the southern and western boundaries of the area shown in Figure 11, page 29 of this ROD. Verification sampling shall be employed to ensure that all soil that is contaminated at levels exceeding the performance standards is removed.

The excavated soil shall be transported to a permitted RCRA hazardous waste (RCRA Subtitle C) landfill facility for disposal, preceded by treatment, if required. A RCRA Subtitle C facility is deemed appropriate because of the health risks posed by direct contact with the soils.

Transport shall be accomplished in compliance with DOT regulations governing transportation of hazardous materials.

Excavation work shall be staged and coordinated with backfill/grading/seeding activities to minimize dust production and surface water runoff. The onsite excavation shall be backfilled with clean soil, properly recompact, and the land surface regraded to the preexisting natural slope. A vegetative cover will be established to minimize undue surface water runoff and minimize erosion.

9.1.2 Applicable or Relevant and Appropriate Requirements (ARARs)

ARARs originate from applicable requirements, intended to definitely and specifically apply to a remedial action; or relevant and appropriate requirements, which, while not intended to apply to the specific situation in question, EPA judges to be applicable to a remedial action. In addition, when establishing

criteria for ensuring the proper implementation of a remedial action, EPA may develop requirements from other guidance documents or criteria, sources often referred to as "To Be Considered" material (TBCs).

Applicable Requirements. Soil remediation shall comply with all applicable portions of the following Federal and State of South Carolina regulations:

49 CFR Parts 107, 171-179, promulgated under the authority of the Hazardous Materials Transportation Act. Regulates the labelling, packaging, placarding, and transport of hazardous materials offsite.

40 CFR Parts 261, 262 (Subparts A-D), 263, and 268, promulgated under the authority of the Resource Conservation and Recovery Act. These regulations govern the identification, transportation, manifestation, and land disposal restriction requirements of hazardous wastes. If the contaminated soils fail TCLP, most likely, the land disposal restrictions in 40 CFR Part 268 will apply. However, if EP toxicity tests are performed and the contaminated soils do not exceed EP toxicity limits, then the land disposal restrictions in 40 CFR Part 268 will not apply, even though the contaminated soils fail TCLP. In the event that the Site soils requiring remediation do not test hazardous (i.e., do not fail TCLP), the regulations listed here will be considered relevant and appropriate rather than applicable.

SCHWMR 61-79.124, .261, .262, .263 and .268, South Carolina Hazardous Waste Management Regulations, promulgated pursuant to the Hazardous Waste Management Act, SC Code of Laws, 1976, as amended. Establishes criteria for identifying and handling hazardous wastes, as well as land disposal restrictions. These regulations will also become relevant and appropriate in the event that the soils requiring remediation do not prove to be hazardous, as described in the above paragraph.

Relevant and Appropriate Requirements. The following regulations are "relevant and appropriate" to source control actions (soil remediation) at the Elmore Waste Disposal Site. Applicability of these air quality control regulations is due to the potential for release of harmful particulates (metals) or VOCs during soil excavation and handling activities.

40 CFR Parts 60 and 61, promulgated under the authority of the Clean Air Act. Included are the National Emissions Standards for Hazardous Air Pollutants (NESHAPs). Ambient air quality standards and standards for emissions to the atmosphere fall under these regulations.

SC Reg. 61-62, South Carolina Air Pollution Control Regulations and Standards, promulgated pursuant to the S.C. Pollution Control Act, SC Code of Laws, 1976, as amended. Establishes limits for emissions of hazardous air pollutants and particulate matter, and establishes acceptable ambient air quality standards within South Carolina.

"To Be Considered" and Other Guidance.

Revised Procedures for Planning and Implementing Off-site Response Actions, OSWER Directive 9834.11, November 1987. This directive, often referred to as "the off-site policy," requires EPA personnel to take certain measures before CERCLA wastes are sent to any facility for treatment, storage, or disposal. EPA personnel must verify that the facility to be used is operating in compliance with § 3004 and § 3005 of RCRA, as well as all other federal and state regulations and requirements. Also, the permit under which the facility operates must be checked to ensure that it authorizes (1) the acceptance of the type of wastes to be sent, and (2) the type of treatment to be performed on the wastes.

40 CFR Part 50, promulgated under the authority of the Clean Air Act. This regulation includes the National Ambient Air Quality Standards (NAAQS), and establishes a national baseline of ambient air quality levels. The state regulation which implements this regulation, South Carolina Reg. 62-61, is applicable to the source control portion of the remedy.

Various TBC materials were utilized in the Baseline Risk Assessment and in the Feasibility Study. Because cleanup standards were established based on these documents, they are considered TBC.

In the Baseline Risk Assessment, TBC material included information concerning toxicity of, and exposure to, Site contaminants. TBC material included the Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), and other EPA guidance as specified in the Baseline Risk Assessment.

In the FS, soil concentrations protective of human health and the environment were calculated based on the Site-specific risk calculations from the Baseline Risk Assessment, using TBC information as described above. These levels are established as performance standards in the following section. There are no established federal or state standards for acceptable levels of Elmore Waste Disposal Site contaminants in surface or subsurface soils.

The protective levels for surface/shallow subsurface soils (0-2 feet) were established for two of the contaminants, arsenic and beryllium, based on Baseline Risk Assessment calculations. For both of these the 10^{-5} risk value was used. The protective level for lead (Pb) is equivalent to the EPA Region IV Level of Concern of 500 mg/kg for surface soils (0-2 feet). This criterion is also designated TBC.

Subsurface soil protective levels for the remaining seven contaminants were based on the results of a leaching model using Site-specific information, conducted in the FS. No RI subsurface soil samples violated these standards; however, they were established as a contingency to allow the remedial action to proceed in the event subsurface contaminant concentrations exceeding these standards are encountered.

Other requirements. Remedial design often includes the discovery and use of unforeseeable, but necessary, requirements, which result from the planning and investigation inherent in the design process itself. Therefore, during design of the source control component of the selected remedy, EPA may, through a formal ROD modification process such as an Explanation of Significant Differences or a ROD Amendment, elect to designate further ARARs which apply, or are relevant and appropriate, to this portion of the remedy.

9.1.3 Performance Standards

The standards outlined in this section comprise the performance standards defining successful implementation of this portion of the remedy.

Excavation. The following soil remediation goals (Table 24) are established as performance standards. The performance standards shall control the excavation procedure described above in Section 9.1.1. Additionally, all onsite excavation work shall comply with 29 CFR § 1910.120, the OSHA health and safety requirements applicable to remedial activities.

TABLE 24 SOURCE CONTROL PERFORMANCE STANDARDS

Contaminant	Maximum Concentration Detected (mg/kg)	Remediation Goal (mg/kg)	Source
<u>Surface Contact (0-2 ft):</u>			
Arsenic	37	10	A
Beryllium	4.1	4.0	A
Lead	1900	500	B
<u>Subsurface (Leaching):</u>			
Arsenic	37	300	C
Beryllium	4.1	9	C
Cadmium	2.3	4	C
Chromium	81	800	C
Nickel	39	400	C
Manganese	870	10000	C
Vanadium	140	600	C
SOURCES OF REMEDIATION GOALS A - Health-Based Remediation Goal B - EPA Region IV Health-Based Level of Concern C - Leachability-Based Remediation Goal			

Transport of contaminated soil. Transportation shall be accomplished in compliance with the Hazardous Materials Transportation Act (49 CFR § 107, 171-179).

Disposal of contaminated soil. Disposal of contaminated Site soil shall comply with the applicable, or relevant and appropriate, RCRA regulations (40 CFR Parts 261, 262 (Subparts A-D), 263, and 268). The determination of applicability, versus relevant and appropriate, is described on page 93, Section 9.1.2, under "applicable requirements," where the above regulations are cited. In any circumstance, the disposal of contaminated soils shall be done at a RCRA Subtitle C treatment, storage, and disposal facility.

9.2 Groundwater Remediation

The groundwater component of the remedy includes extraction of contaminated groundwater from the surface shallow and

intermediate portions of the aquifer; physical treatment to remove inorganic contaminants; air/gas/steam stripping to remove organic contaminants; and discharge of the treated water to a local Publicly-Owned Treatment Works (POTW).

9.2.1 Description

This remedy component consists of the design, construction and operation of a groundwater extraction and treatment system, and development and implementation of a Site monitoring plan to monitor the system's performance. The groundwater treatment specified below shall be continued until the performance standards listed in Section 9.2.3 are achieved at all of the extraction and monitoring wells on or associated with the Site. The point of compliance for this action shall be the entire Site.

Extraction wells shall be used for hydraulic capture of contaminated groundwater from the surface and intermediate aquifers, following confirmation of the extent of contamination (Section 9.3 below). Preliminary modelling in the FS anticipated the need for six extraction wells. Actual numbers and placement of extraction wells shall be determined in the remedial design.

The extracted groundwater will be treated using physical and chemical processes to remove inorganic contaminants. Aeration, chemical reduction, and chemical precipitation in combination with phase separation and filtration will be used to remove metals from groundwater. Aeration would be used to remove manganese from the groundwater, by oxidizing manganese from Mn^{+2} to its more easily precipitable form, Mn^{+4} . The next process, chemical reduction, utilizes reducing agents to reduce the valence state of the metal contaminants to more easily precipitable forms. Chemical precipitation, the next step, is achieved by adjusting the pH of the groundwater to the optimum value for precipitation: metal contaminants become less soluble and are precipitated out of the groundwater as solid particles.

Metal removal is then completed using phase separation and filtration. Phase separation processes typically add polymer to the water to force metal precipitates to clump together or form a floc. Then, a sedimentation process is used to settle out the large floc particles. Finally, the supernatant is filtered to remove any other suspended particles not removed by the sedimentation process. The settled floc particles and the particles removed by the filter are typically transferred to a solids holding tank. Solids from the holding tank are then dewatered via filter press; the liquids are usually pumped back to the head of the treatment system. Dewatered solids will be collected and stored onsite until disposal. These solids will require management as a hazardous waste, and disposal in a

RCRA-regulated landfill. These actions shall comply with the ARARs described in the following section (Section 9.2.2).

After metals removal, the groundwater will be passed through an air-, gas-, or steam stripping unit to remove or reduce the concentrations of VOCs. The final treatment step shall route the water through an activated carbon "polishing" unit, to remove any VOCs not stripped out and to provide secondary, back-up capability to the stripping unit. Operation of the stripping unit shall comply with the ARARs described in Section 9.2.2.

Following treatment, the groundwater shall be discharged to an industrial sewer or other appurtenance of the local Publicly-Owned Treatment Works, owned and operated by the City of Greer, South Carolina. Discharge to this system shall comply with all applicable City of Greer industrial pretreatment requirements, as well as any other effluent limits established by EPA.

Remedial design shall include the design of the treatment system described above, as well as the necessary pipelines, electrical lines, pump systems, treatment equipment, treatment facility, and other appurtenances as required.

The goal of this remedial action is to restore groundwater to its beneficial use as a drinking water source. Based on the information collected during the RI and on a careful analysis of all remedial alternatives, EPA and the State of South Carolina believe that the selected groundwater remedy will achieve this goal. However, the remedy's ability to achieve the remediation goals at all points throughout the area of the plume cannot be determined until the extraction system has been implemented, modified as necessary, and plume response monitored over time.

If the selected remedy cannot meet the specified remediation goals, at any or all of the monitoring points during implementation, the contingency measures and goals described in this section may replace the selected remedy and goals for certain portions of the plume. Such contingency measures will, as a minimum, prevent further migration of the plume and include a combination of containment technologies and institutional controls. These measures are considered to be protective of human health and the environment, and are technically practicable under the corresponding circumstances.

The selected remedy will include groundwater extraction for an estimated period, during which the system's performance will be carefully monitored on a regular basis and adjusted as warranted by the performance data collected during operation. Modification may include any or all of the following:

- * at individual wells where cleanup goals have been attained, pumping may be discontinued;
- * alternating pumping at wells to eliminate stagnation points;
- * pulse pumping to allow aquifer equilibration and encourage adsorbed contaminants to partition into groundwater; and
- * installation of additional extraction wells to facilitate or accelerate cleanup of the contaminant plume.

To insure that cleanup goals continue to be maintained, the aquifer will be monitored at those wells where pumping has ceased on a regular periodic basis, following discontinuation of groundwater extraction. The intervals between groundwater sampling/analysis events will be established in the Remedial Action Work Plan.

If it is determined, on the basis of the preceding criteria and the system performance data, that certain portions of the aquifer cannot be restored to their beneficial use, all of the following measures involving long-term management may occur, for an indefinite period of time, as a modification of the existing system:

- * engineering controls such as physical barriers, or long-term gradient control provided by low level pumping, as containment measures;
- * chemical-specific ARARs will be waived for the cleanup of those portions of the aquifer based on the technical impracticability of achieving further contaminant reduction;
- * institutional controls will be provided/maintained to restrict access to those portions of the aquifer that remain above remediation goals;
- * continued monitoring of specified wells; and
- * periodic re-evaluation of remedial technologies for groundwater restoration.

The decision to invoke any or all of these measures may be made during a periodic review of the remedial action (Five Year Review), which will occur at five year intervals in accordance with CERCLA Section 121(c), 42 U.S.C. § 9621(c).

9.2.2 Applicable or Relevant and Appropriate Requirements
(ARARs)

Applicable Requirements. Groundwater remediation shall comply with all applicable portions of the following federal and State of South Carolina regulations:

40 CFR Parts 261, 262 (Subparts A-D), 263, and 268, promulgated under the authority of the Resource Conservation and Recovery Act. These regulations govern the identification, transportation, manifestation, and land disposal restriction requirements of hazardous wastes, and would be applicable to the sludges which may be produced as a result of chemical treatment of groundwater, and to spent carbon generated by the carbon polishing unit. For either of these materials, if the material fails TCLP, most likely, the land disposal restrictions in 40 CFR Part 268 will apply. However, if EP toxicity tests are performed and the material does not exceed EP toxicity limits, then the land disposal restrictions in 40 CFR Part 268 will not apply, even though the material fails TCLP. In the event that either material does not test hazardous (i.e., does not fail TCLP), the regulations listed here will be considered relevant and appropriate rather than applicable, for that material.

SC Reg. 61-79.124, .261, .262, .263 and .268, South Carolina Hazardous Waste Management Regulations, promulgated pursuant to the Hazardous Waste Management Act, SC Code of Laws, 1976, as amended. Establishes criteria for identifying and handling hazardous wastes, as well as land disposal restrictions. Applicable as described above.

49 CFR Part 107, 171-179, promulgated under the authority of the Hazardous Materials Transportation Act. Regulates the labelling, packaging, placarding, and transport of hazardous materials offsite.

40 CFR Parts 60 and 61, promulgated under the authority of the Clean Air Act. Included are the National Emissions Standards for Hazardous Air Pollutants (NESHAPs). Standards for emissions to the atmosphere fall under these regulations. Applicable to the air, gas or steam stripping unit to be used for groundwater treatment.

SC Reg. 61-62, South Carolina Air Pollution Control Regulations and Standards, promulgated pursuant to the Pollution Control Act, SC Code of Laws, 1976, as amended. Establishes limits for emissions of hazardous air pollutants and particulate matter, and establishes acceptable ambient air quality standards within South Carolina. This regulation is applicable in the same manner as the federal regulation cited above.

40 CFR Part 122, 125, 129, 133 and 136, CWA Discharge Limitations (CWA § 301), promulgated under the authority of the Clean Water Act. Applicable to any point discharges of wastewaters to waters of the United States. Applicable to discharge of treated waters.

40 CFR § 403.5, CWA Pretreatment Standards (CWA § 307), promulgated under the authority of the Clean Water Act. Regulates discharges of water to POTWs.

SC Reg. 61-68, South Carolina Water Classifications and Standards, promulgated pursuant to the Pollution Control Act, SC Code of Laws, 1976, as amended. These regulations establish classifications for water use, and set numerical standards for protecting state waters.

SC Reg. 61-71, South Carolina Well Standards and Regulations, promulgated under the Safe Drinking Water Act, SC Code of Laws, 1976, as amended. Standards for well construction, location and abandonment are established for remedial work at environmental or hazardous waste sites.

Relevant and Appropriate Requirements. The following regulations are relevant to groundwater remediation at the Elmore Waste Disposal Site.

40 CFR Part 131, Ambient Water Quality Criteria (CWA § 304), promulgated under the authority of the Clean Water Act. Sets numerical criteria for ambient water quality based on toxicity to aquatic organisms and human health.

40 CFR Parts 141-143, National Primary and Secondary Drinking Water Standards, promulgated under the authority of the Clean Water Act. These regulations establish acceptable maximum levels of numerous substances in public drinking water supplies, whether publicly owned or from other sources such as groundwater. Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs) are specifically identified in the NCP as remedial action objectives for ground waters that are current or potential sources of drinking water supply (NCP 40 CFR § 300.430(a)(1)(ii) (F)). Therefore, MCLs and MCLGs are relevant and appropriate as criteria for groundwater remediation at this Site.

SC Reg. 61-58, South Carolina Primary Drinking Water Regulations, promulgated pursuant to the Safe Drinking Water Act, SC Code of Laws, 1976, as amended. These regulations are similar to the federal regulations described above, and are relevant and appropriate as remediation criteria for the same reasons set forth above.

"To Be Considered" and Other Guidance. As noted above in Section 9.1.2, TBC criteria were utilized and/or established in the Baseline Risk Assessment and in the Feasibility Study. Groundwater cleanup standards were established based on these documents and both are thus considered TBC.

In the Baseline Risk Assessment, TBC material used included information concerning toxicity of, and exposure to, Site contaminants. Sources of such data included the Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), and EPA guidance as specified in the Risk Assessment.

In the FS, groundwater concentrations protective of human health and the environment were calculated based on the Site-specific risk calculations from the Baseline Risk Assessment. Certain of these levels were established as remediation goals in cases where there is no MCL for a particular contaminant. Specific contaminants for which health-based goals were established were vanadium and manganese. The groundwater remediation goals are established as performance standards in the Section 9.2.3.

Groundwater remediation goals were established for carbon tetrachloride and 1,1,2-trichloroethane although no RI samples violated these standards. They were established as a contingency since they were detected and could be present at levels above the remediation goals.

Other TBC material includes the following:

Guidelines for Ground Water Use and Classification, EPA Ground Water Protection Strategy, U.S. EPA, 1986. This document outlines EPA's policy of considering a site's groundwater classification in evaluating possible remedial response actions. As described under Section 1.4, the groundwater at the Site is classified by EPA as Class IIB and by South Carolina as Class GB groundwater, indicating its potential as a source of drinking water.

National Oceanic and Atmospheric Administration (NOAA) ER-L/ER-M Values. These guidelines were developed as screening criteria for sediment contamination in surface water bodies, and are based on toxicity to aquatic life.

40 CFR Part 50, National Ambient Air Quality Standards (NAAQS), promulgated under the authority of the Clean Air Act. This regulation includes the National Ambient Air Quality Standards (NAAQS), and establishes a national baseline of ambient air quality levels. The state regulation which implements this

regulation, South Carolina Reg. 62-61, is applicable to the groundwater portion of the remedy.

Clean Air Act, § 501 and 502, 1990 CAA Amendments, 42 U.S.C. § 7661 and § 7661(a). The amendments will require that all "major sources" and certain other sources regulated under the CAA to obtain operating permits. Although CERCLA § 121(e) exempts this remedy from requiring such a permit, air/gas/steam stripping at this Site may have to comply with any substantive standards associated with such permits. Regulations have been proposed, but not promulgated, for the operating permit program.

Other requirements. As described above in Section 9.1.2, remedial design often includes the discovery and use of unforeseeable but necessary requirements. Therefore, during design of the groundwater component of the selected remedy, EPA may, through a formal ROD modification process such as an Explanation of Significant Differences or a ROD Amendment, elect to designate further ARARs which apply, or are relevant and appropriate, to groundwater remediation at this Site.

9.2.3 Performance Standards

The standards outlined in this section comprise the performance standards defining successful implementation of this portion of the remedy.

Groundwater treatment. The groundwater remediation goals in Table 25 below shall be the performance standards for groundwater treatment.

The Proposed Plan incorrectly identified two MCLs, those for beryllium and cis-1,2-dichloroethene (DCE). The correct MCL for beryllium is 4 ug/l and for cis-1,2-DCE, 70 ug/l.

TABLE 25 GROUNDWATER REMEDIATION PERFORMANCE STANDARDS			
Contaminant	Maximum Concentration Detected (ug/l)	Remediation Goal (ug/l)	Source
<u>Volatile Organic Compounds</u>			
Benzene	48	5	A
Carbon Tetrachloride	2	5	A
Cis-1,2-Dichloroethene	140	70	A
Methylene Chloride	32	5	B
Tetrachloroethylene	4,000	5	A
Trichloroethylene	12,000	5	A
1,1,1-Trichloroethane	310	200	A
1,1,2-Trichloroethane	2	5	A
Vinyl Chloride	69	2	A
<u>Inorganic Contaminants</u>			
Beryllium	51	4	A
Cadmium	6	5	A
Lead	270	15	C
Manganese	9100	3000	D
Chromium	300	100	A
Nickel	230	100	A
Vanadium	810	200	D
SOURCES OF REMEDIATION GOALS A - MCL B - Proposed State of South Carolina MCL C - EPA Action Level D - Health-Based Remediation Goal (HI < 1.0)			

Discharge. Discharge of treated groundwater to the POTW shall comply with all applicable City of Greer industrial pretreatment standards, as well as any other effluent standards or limits established by EPA.

9.3 Confirm Extent of Groundwater Contamination

Upon initiation of the remedial design, sufficient additional groundwater and surface water data shall be collected to achieve the following objectives:

- A. Verify the presence or absence of a contributing source of VOCs east of the Elmore Site.
- B. Confirm the absence of a contributing source of VOCs and/or other contaminants in the groundwater underlying the former dump area (primarily Sunnyside Circle subdivision).
- C. Confirm the areal extent of groundwater contamination in the surface aquifer, and the areal (horizontal) and the vertical extent of contamination in the intermediate aquifer offsite (north of the Elmore Waste Disposal Site).

Attainment of these objectives must be accomplished during the first portion of remedial design, so that design of the extraction and treatment system has, as its basis, an accurate conceptual model of Site conditions. Confirmation of the extent of contamination will also require collection of further information and data for characterizing the specific hydrogeology of the Site, and will include aquifer testing and modelling as appropriate.

9.4 Monitor Site Groundwater and Surface Water

Beginning with initiation of the remedial design, groundwater and surface water samples shall be collected and analyzed on a regular quarterly schedule. Analytical parameters for groundwater and surface water samples will include the known Elmore Waste Disposal Site contaminants of concern: VOCs and metals. The specific wells to be sampled and methodology for offsite sample collection will be determined during design. Surface water samples will be collected, as a minimum, from Wards Creek at one upstream location and one downstream location as necessary to monitor the contamination. The analytical data generated from the quarterly sampling events will be used to track the concentrations and movement of groundwater contaminants until a long-term Site monitoring plan is implemented in the remedial action phase.

10.0 STATUTORY DETERMINATIONS

The selected remedy for this Site meets the statutory requirements set forth at Section 121(b)(1) of CERCLA, 42 U.S.C. § 9621(b)(1). This section states that the remedy must protect human health and the environment; meet ARARs (unless waived); be cost-effective; use permanent solutions, and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and finally, wherever feasible, employ treatment to reduce the toxicity, mobility or volume of

the contaminants. The following sections discuss how the remedy fulfills these requirements.

Protection of human health and the environment: The selected soil remedy will remove the human health risks from dermal contact, incidental ingestion, or ingestion from gardening of contaminated Site soils. The groundwater remediation system will extract and treat contaminated groundwater, thereby reducing and eventually removing the future risks to human health which could result from ingestion of or contact with groundwater, and the environmental risks which could result from continued discharge of contaminants to Wards Creek.

Compliance with ARARs: The selected remedy will meet ARARs, which are listed in Sections 9.1.2 and 9.2.2 of this ROD.

Cost effectiveness: The selected soil remedy component is cost effective: while the cost is greater than three of the four other alternatives (excluding no action), a greater benefit is achieved by the elimination of the O&M costs and the uncertainties associated with projecting such O&M costs.

Among the groundwater alternatives that are protective of human health and the environment and comply with all ARARs, the selected alternative is the most cost-effective choice because it uses a well proven widely-used treatment method for which costs can be reliably predicted (air/gas/steam stripping), and because the use of the POTW option is the most cost-effective means to dispose of the treated groundwater.

Utilization of permanent solutions, and alternative treatment technologies or resource recovery technologies to the maximum extent practicable: The selected remedy represents the maximum extent to which permanent solutions and treatment can practicably be used for this action. Both of the selected remedy components are considered permanent solutions.

Among the alternatives that are protective of human health and the environment and comply with all ARARs, EPA and the State of South Carolina have determined that the selected remedy achieves the best balance of trade-offs in terms of long-term effectiveness and permanence, reduction of toxicity/mobility/volume, short-term effectiveness, implementability, and cost. The selected groundwater action is more readily implementable than the other alternatives considered, and utilizes the most cost-effective option for disposal of treated water. The selected soil remedial action is the most practical and easily implemented alternative, given the relatively small volume of soil requiring remediation (approximately 650 cubic yards).

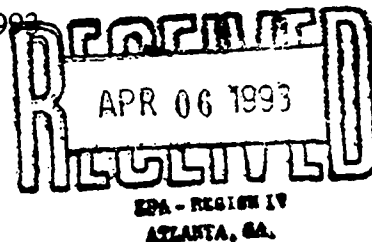
Preference for treatment as a principal remedy element: The proposed groundwater remediation system will fulfill the preference for treatment as a principal element, through extraction and treatment of contaminated groundwater until the remedial goals are achieved.

The soil remedial action will not satisfy the preference, because it was determined that treatment of the small volume of soil requiring remediation is not practical. Additionally, offsite disposal is more feasible in that it does not result in creation of an onsite waste cell that must be monitored for an extended period of time. If the contaminated soils are treated prior to disposal at a RCRA facility, then the preference will be satisfied.

APPENDIX B

**STATE OF SOUTH CAROLINA CONCURRENCE LETTER
ELMORE WASTE DISPOSAL SUPERFUND SITE**

March 31, 1993



Mr. Patrick Tobin
Acting Regional Administrator
US EPA, Region IV
345 Courtland St., N.E.
Atlanta, Georgia 30365

RE: Final Draft Record of Decision (ROD)
Elmore Waste Disposal Site
Spartanburg County

Dear Mr. Tobin:

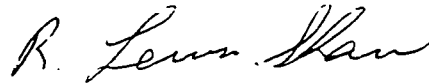
The Department has reviewed, commented on, and concurs with The Record of Decision (ROD) for the Elmore Waste Disposal site. The ROD is for the remedial actions to be undertaken at this Site. The EPA recommended alternative for source control includes excavation and transportation to an approved hazardous waste disposal facility of contaminated soils. The groundwater related remedial activities include extraction filtration, treatment through chemical precipitation and discharge to a local POTW.

Should the proposed discharge alternative require an upgrade of the local POTW, the ROD should be reopened and all alternatives for discharge from the groundwater pump and treat system re-evaluated. In concurring with this ROD, the South Carolina Department of Health and Environmental Control (SCDHEC) does not waive any right or authority it may have to require corrective action in accordance with the South Carolina Hazardous Waste Management Act and the South Carolina Pollution Control Act. These rights include, but are not limited to, the right to ensure that all necessary permits are obtained, all clean-up goals and criteria are met, and to take a separate action in the event clean-up goals and criteria are not met. Nothing in the concurrence shall preclude SCDHEC from exercising any administrative, legal and equitable remedies available to require additional response actions in the event that: (1)(a) previously unknown or undetected conditions arise at the site, or (b) SCDHEC receives additional information not previously available concerning the premises upon which SCDHEC relied in concurring with the selected remedial alternative; and (2) the implementation of the remedial alternative selected in the ROD is no longer protective of public health and the environment.

March 31, 1993
Page 2

This concurrence with the selected remedy for the Elmore Waste Disposal Site is contingent upon the State's above-mentioned reservation of rights. If you have any questions, please feel free to contact Mr. Lewis Bedenbaugh at (803)734-5211.

Sincerely,

A handwritten signature in cursive script, appearing to read "R. Lewis Shaw".

R. Lewis Shaw, P. E.
Deputy Commissioner
Environmental Quality Control

RLS/LRB/ehr

cc: Hartsill Truesdale
Lewis Bedenbaugh
Keith Lindler
Rebecca Dotterer
Harry Mathis
Charles Gorman
Barney Harmon