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Superfund Record of Decision:

Helena Chemical Landfill, SC

50272-101

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16. Abstract (Limit: 200 words)

The 4-acre Helena Chemical Landfill site is located on the northern portion of the 13.5-acre Helena Chemical Company property in Fairfax, Allendale County, South Carolina. Land use in the area is mixed commercial, industrial, agricultural, and residential. A water supply well to the city of Fairfax supplies water to 2,300 residents, and is located 200 feet west of the property. Surface water at the facility drains into a small ditch which subsequently drains into Duck Creek, a tributary located northwest of the property that flows into the Cooswatchie River located to the west of the property. In addition, several wetland areas occur in the northern portion of the facility in close proximity to the former landfill. Prior to the 1960s, and until 1978, the Helena Chemical Company and two previous owners manufactured liquid and powdered insecticides onsite. The facility consists of three buildings: the north warehouse, which was used to formulate liquid insecticides; the south warehouse, which was used to formulate powdered insecticides; and the office. The former landfill is located north of the north warehouse and was reportedly used for disposal of chemical wastes. Several above-ground solvent tanks, which have since been removed, were used to store solvents transported to the site by rail. Types of chemicals formulated or stored onsite included pesticides, solvents, diesel fuels, and clays. In 1980, State

(See Attached Page)

17. Document Analysis a. Descriptors

Record of Decision - Helena Chemical Landfill, SC
First Remedial Action - Final
Contaminated Media: soil, sediment, gw, sw
Key Contaminants: VOCs (benzene), other organics (pesticides), metals (chromium, lead)

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report) None	21. No. of Pages 100
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(See ANSI-Z39.18) *See Instructions on Reverse* OPTIONAL FORM 272 (4-77) (Formerly NTIS-35) Department of Commerce

Abstract (Continued)

investigations regarding an onsite waste dump indicated high levels of various pesticides at the site. In 1981, the State required Helena Chemical to provide additional information regarding site activities. The State, EPA, and Helena Chemical conducted additional site investigations from 1981 through 1992. These investigations confirmed the presence of site-related pesticides in the soil and indicated the presence of pesticides in sediment, debris, ground water, and surface water in the vicinity of the former landfill. Two removal actions were conducted at the site during 1984 and 1992, and 500 and 1,000 yds^3 of contaminated soil, respectively, were removed to a permitted hazardous waste landfill. This ROD addresses a first and final remedy for the remaining onsite contamination in the soil, sediment, ground water, and surface water. The primary contaminants of concern affecting the soil, sediment, ground water, and surface water are VOCs, including benzene; other organics, including pesticides; and metals, including chromium and lead.

The selected remedial action for this site includes excavating approximately 20,000 yd^3 of contaminated soil and debris from the former landfill and areas adjacent to the northern warehouse; treating the soil an debris using hydrolytic/photolytic dechlorination (HPD), followed by ex-situ biodegradation; returning the treated soil and debris to the original excavated areas; covering the treated soil with at least one foot of clean fill; providing for a contingent remedy including low temperature thermal desorption, if treatability studies indicate that the HPD/biological treatment cannot attain the soil remediation goals; demolishing the former formulation buildings, if necessary, to allow for removal and treatment of all contaminated soil; testing the demolished buildings to determine appropriate handling and disposal options; mitigating any impact to wetlands; extracting and treating contaminated ground water onsite to POTW pre-treatment requirements, with discharge to the local POTW; and monitoring excavated and treated soil and ground water (in-situ, as well as, extracted and treated) to ensure compliance with all performance standards. The estimated present worth cost for this remedial action is $3,900,000.

PERFORMANCE STANDARDS OR GOALS:

The soil excavation standard is based on protection of human health and the environment and is equal to 50 mg/kg total pesticides. Soil treatment standards are based on RCRA LDRs and range from 66 ug/kg to 1,300 ug/kg. Chemical-specific ground water treatment goals are based on SDWA MCLs, and include benzene 5 ug/l; chromium 100 ug/l; lead 15 ug/l; and pesticides 0.002-3 ug/l.

RECORD OF DECISION

SUMMARY OF REMEDIAL ALTERNATIVE SELECTION

HELENA CHEMICAL SUPERFUND SITE

FAIRFAX, ALLENDALE COUNTY
SOUTH CAROLINA

PREPARED BY:

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

DECLARATION FOR THE RECORD OF DECISION

SITE NAME AND LOCATION

Helena Chemical
Fairfax, Allendale County, South Carolina

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial action for the Helena Chemical Superfund Site (the Site) in Fairfax, 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. Appendix B contains the letter indicating their concurrence.

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 subsurface soil, with verification sampling;
- Treatment of the contaminated soils by means of hydrolytic/photolytic dechlorination and biological degradation;
- Placement of the treated soils into on-Site excavations.
- Site re-grading to prevent uncontrolled storm-water run off into waters of the State or the United States.

GROUNDWATER

- Extraction of contaminated groundwater from the surface (shallow) aquifer;
- Treatment and discharge of the treated groundwater to a local Publicly-Owned Treatment Works (POTW).

MITIGATION FOR ADVERSE IMPACTS TO WETLANDS

- Mitigation for adverse impacts to environmental receptors in accordance with regulatory guidelines established under the authority of Section 404 of the Clean Water Act.

SITE MONITORING

- Quarterly sampling of groundwater and nearby public water supply to monitor the concentrations and movement of contaminants in affected and potentially affected aquifers.

CONTINGENCY REMEDY

- Low temperature thermal desorption (LTTD) is a contingency remedy for soil treatment, to be implemented should the chosen soil treatment technology prove incapable of achieving performance standards.

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 and/or innovative treatment technology to the maximum extent practicable for this Site. The selected groundwater remedy component satisfies the preference for treatment. The selected remedy for source control and soil treatment also 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

9-8-93

Date

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1.0 SITE LOCATION AND DESCRIPTION

1.1 SITE LOCATION

Helena Chemical Company, Fairfax, South Carolina is located on 13.5 acres adjacent to Highway 321 in Allendale County, South Carolina. Figure 1.1 is a vicinity map. Located at the facility is a former landfill which contains pesticide residues and other waste materials generated on-Site. The former landfill occupies approximately four (4) acres on the northeast portion of the Fairfax property. Figure 1.2 is an approximately scaled survey of the facility showing the location of the landfill. The site is encircled by a chain link security fence topped with barbed wire. A city water well that is utilized by a population of approximately 2,300 is located 200 feet west of the property.

1.2 SITE DESCRIPTION

Three buildings exist on the Fairfax property; the north warehouse, the office, and the south warehouse. The north warehouse, which was once utilized to house the liquid insecticide formulation operation, is currently used to store various pesticides, herbicides, and fertilizers which are sold to farmers. There are several significant features of the liquid formulation building which were focal points of the investigation. Two 22,000 gallon above ground solvent tanks were once located near the north entrance to the "kettle room" in the former liquid formulation building. These tanks were present prior to Helena's occupancy of the property. Solvents used in the formulation process were delivered to the site by rail car via a rail spur which was used to serve the facility. The solvents were offloaded by pressurizing the tanker cars and pumping the solvents through product lines which ran under the formulation building to the storage tanks. The storage tanks were located in the area identified as the "tank farm" on Figure 2. The solvents were then gravity fed to the kettle as needed. The solvent tanks are no longer present; however, the concrete slab on which the tank saddles rested still exists. The remains of a tank farm which was used to store the technical grade pesticide compounds are located on the east side of the liquid formulation building. Only the concrete pads on which the tanks rested and a retaining wall remain. During the Remedial Investigation (RI) a drain pipe which originates inside the warehouse was observed and is suspected to have been used to discharge effluent onto the ground surface in an area northwest of the structure. The south warehouse where powdered insecticides were formulated is no longer in use. A septic tank system which serviced the property is located between the north liquid formulation building and the office.

Figure 1; Helena Location Map

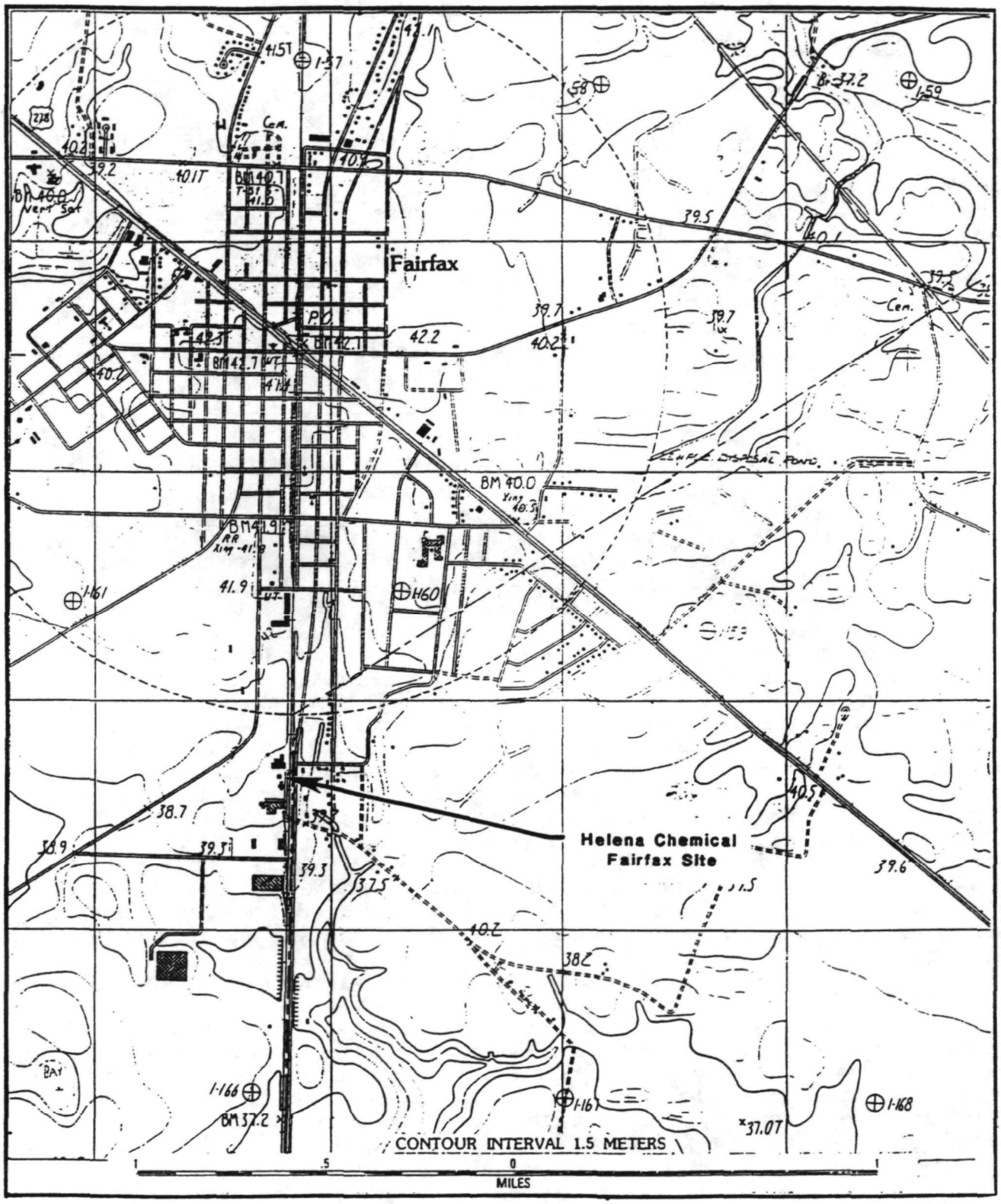
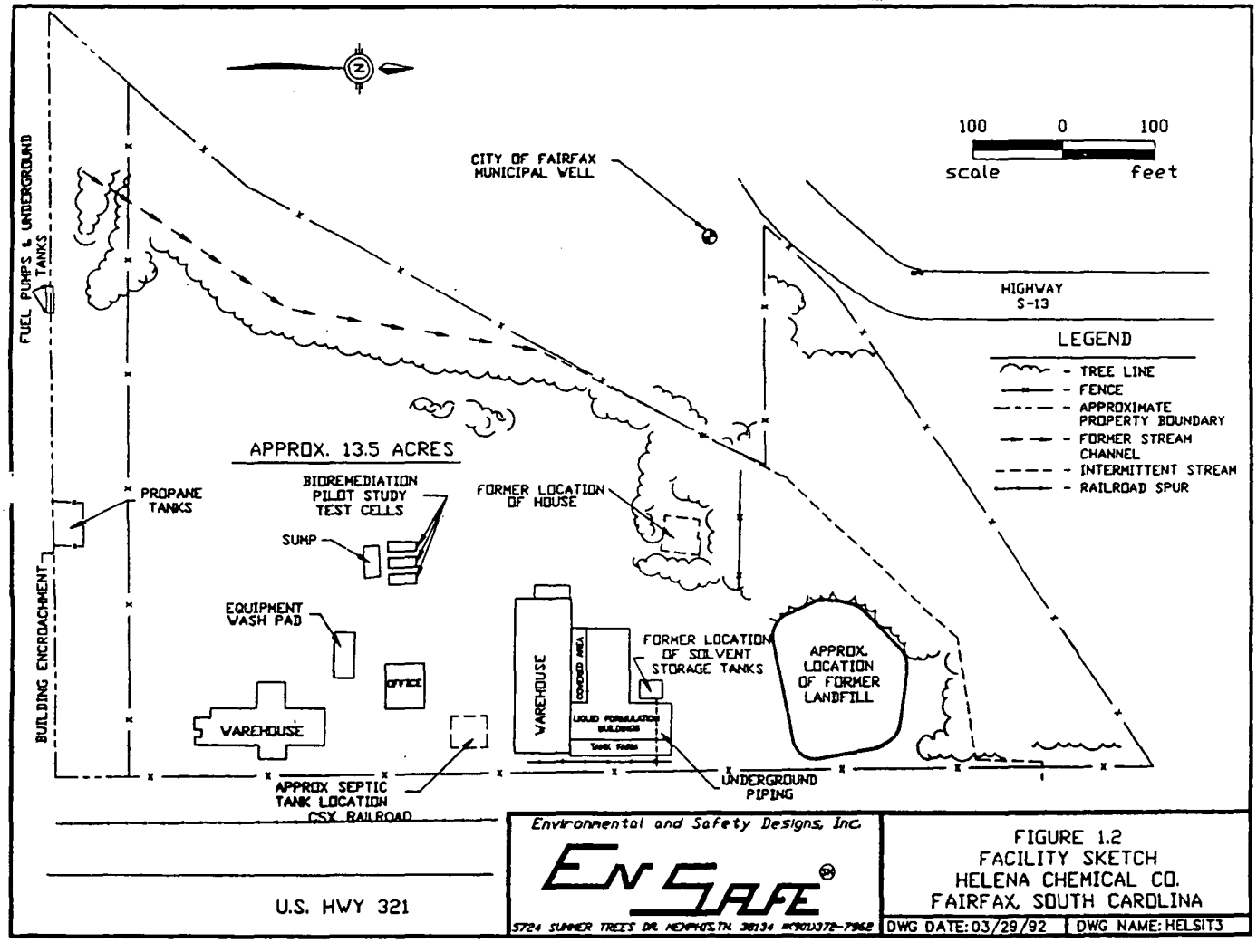


Figure 2; Helena Site Map



Located northwest of the north warehouse are the remains of a house that burned sometime prior to 1988. The house belonged to the previous property owner, Charles Blue.

According to City of Fairfax Water Department records, a 12" water main constructed of cast iron extends across the site between the north warehouse and the former landfill. The water line trends in a general east-west direction and is reported to have been installed approximately ten years ago.

Between the years of 1971 and 1978, Helena used the Fairfax facility for the formulation of liquid, and some dry, agricultural insecticides. Prior to the ownership by Helena Chemical Company (beginning in 1971), two other chemical companies operated at the Fairfax facility: Atlas Chemical Company, owned by Billy Mitchell (prior to the mid 60's), and then Blue Chemical Company, owned by Charles Blue (mid 60's through 1971). Both Atlas Chemical Company and Blue Chemical Company utilized the Fairfax facility for the formulation of insecticides. Chemicals formulated and/or stored at the facility prior to Helena's ownership include: DDT, aldrin, toxaphene, disulfoton, dieldrin, chlordane, BHC (benzene hexachloride), and ethoprop (Mocap). The Fairfax facility is presently being operated as a retail sales outlet and warehouse for agricultural chemicals. Chemicals used in the previous formulation of insecticides by Helena at the Fairfax facility include: toxaphene, methyl parathion, EPN (ethyl p-nitrophenyl thionobenzene-phosphonate), and disulfoton. In producing the insecticides, the chemicals were formulated as mixtures with other ingredients including diesel fuel, aromatic solvents, and clays.

1.3 SITE TOPOGRAPHY AND DRAINAGE

The local topography of the Fairfax area exhibits little relief. The Helena Chemical property slopes slightly to the north. North of the property is a topographically low area that collects surface water during period of high rainfall. Additionally, surface water from the facility drains into a small ditch that parallels the property to the northwest. This ditch carries the water to Duck Creek, a tributary located northwest of the property, which in turn flows into the Coosawatchie River located to the west of the Fairfax property. The creek and the river are located within a three (3) mile radius of the Site.

1.4 CLIMATE

The relatively temperate climate of Fairfax is typical of the South Carolina coastal plains region. This is largely due to the close proximity of the Atlantic Ocean and its warm Gulf Stream current flowing northward near the southeastern border of the state creating a warming effect on the region.

Data provided by the South Carolina State Climatology office indicated the annual mean temperature in the vicinity of Fairfax is 65.1°F. The mean annual precipitation of Fairfax is approximately 47.95 inches. These figures are based on data gathered at Hampton, S.C. which is the closest reporting station to Fairfax (a reporting station has recently been established in Allendale, S.C.; however, at the present time insufficient data has been gathered to calculate the annual means).

Prevailing winds in the Fairfax area exhibit seasonal variations. In the spring, southwest winds are predominate; summer, south and southwest winds prevail; autumn, prevailing winds are from the northeast; and in winter, northeast and southwest winds have close to the same frequency. Average wind speeds throughout the year range from 6 to 10 miles per hour (Climate Report No. G5, S.C. State Climatology Office, May 1990).

1.5 GEOLOGY AND HYDROGEOLOGIC SETTING

Site specific geological and stratigraphic data were developed during the installation of test borings and monitoring wells. Three distinct stratigraphic units were observed in the upper 145 feet of unconsolidated sediments encountered at the site, and a fourth may be present.

The lowermost stratigraphic unit identified during the investigation was a gray to green, fine grained clayey sand interbedded with clay laminae and numerous shell fragments. The unit was moist, but did not exhibit the saturated properties as seen in the overlying sands. Based on lithology, this unit is presumed to be the upper portion of the McBean/Santee Limestone Formation. The observed thickness of this unit was approximately 45 feet. The maximum thickness of this formation was not determined during the investigation.

Overlying what is presumed to be the McBean Formation is a predominantly yellow to gold, fine to coarse sand. This unit is also characterized by numerous shell fragments interspersed among the sand grains. These sands are thought to be a member of the Barnwell Group. The Barnwell Group is comprised of the Tobacco Road Sand and the Dry Branch Formation. Recent investigations have indicated that the contact between the formations is a one to three foot thick layer of coarse sand and gravel. This gravel layer was not positively identified in any of the borings; therefore, distinct facies changes were not stratigraphically identified during the RI.

Overlying the sands of the Barnwell Group is a light gray and green medium sand which in some locations graded to a coarse tan sand with some pebbles and shell fragments. The lower contact between the formations was distinguished by a silicified shell hash in other locations. The sands graded in a fining upward sequence to a

very fine to medium grained sand intermingled with a dense red, orange, and gray mottled clay. These sediments are characteristic of what is thought to be the Duplin Formation.

Based on the boring logs from MW-12, MW-14, MW-19 and MW-20, there appears to be a lateral facies change to the north of the landfill. Surface soils north of the landfill consist of a dark gray, dense clay. Due to limited information, it is unclear whether the detrital sand underlying this area is a continuation of the Duplin or if a portion of the Duplin has been eroded and the sand a product of more recent depositional processes.

The highest yielding aquifer in the area surrounding Fairfax is found within the sands of the Cape Fear, Middendorf, and Black Creek Formations. These regional aquifers are some of the most permeable units in the stratigraphic column, providing large quantities of water for both municipal and private use.

The high clay content of the Black Mingo Formation results in relatively low permeability. This has led to the designation of the formation as an aquitard or aquiclude. Some small domestic wells, however, may be utilizing water from more permeable portions of the Black Mingo.

Although previous studies have indicated the McBean was not thought to be important as a public or commercial source, member beds within this formation produce sufficient water for use. The Town of Fairfax south municipal well is screened within the McBean/Santee Formation. A pumping test on the municipal well conducted by the city engineers indicated a transmissivity of 500 $ft.^2$/day at a pumping rate of approximately 298 gpm. The overlying sands of the Barnwell Group have been described as a relatively low permeability, low yielding aquifer that is used primarily for domestic water supply. The Barnwell underlying the site, however, is recognized as a highly permeable, saturated sand.

Previous investigations tentatively identified the presence of the Cooper Marl at the Site. Recent investigations, however, have indicated that the surficial sediments are characteristic of the Duplin Formation of Miocene age. The upper portion of the Duplin Formation appears to be acting as an aquitard at the Site.

2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

Several companies have operated pesticide formulation facilities on the Site currently owned by Helena. Prior to the mid-60's, the Site was owned by Atlas Chemical Company, and from the mid-60's until 1971 by Blue Chemical Company. Between the years 1971-1978, Helena Chemical company used the Site for the formulation of both liquid and dry agricultural insecticides. Chemicals that have been stored and/or formulated at the facility during its active life

include DDT, aldrin, toxaphene, disulfoton, dieldrin, chlordane, benzene hexachloride (BHC), ethoprop, methyl parathion and ethyl p-nitrophenyl thionobenzene-phosphonate (EPN). During the formulation process these chemicals were mixed with carrying agents including diesel fuel, volatile organic chemicals and adsorbent materials.

The first regulatory actions taken with respect to the Helena Site occurred in November, 1980, as a result of reports by a former employee of Helena and a newspaper reporter that a waste dump was being operated on the Site. The Site was investigated at that time by the South Carolina Department of Health and Environmental Control (SCDHEC). Numerous soil samples were collected and analyzed in December, 1980. High levels of various pesticides, including aldrin, BHC isomers, chlordane, dieldrin, disulfoton, endrin and toxaphene were detected in these samples. As a result of these findings, SCDHEC requested that Helena provide further information regarding activities at the Site, including chemicals handled as part of the operation, waste disposal practices and other pertinent information with respect to past and present Site activities.

SCDHEC issued a Notice of Violation to Helena in July, 1981, for the operation of a waste disposal facility in violation of applicable South Carolina regulations. Negotiations between SCDHEC and Helena resulted in the issuance of Administrative Consent Order No. 81-05-SW on October 1, 1981. In compliance with the terms of this Consent Order, Helena conducted investigations at the Site lasting from October, 1981, to July, 1982. The results of these studies indicated that surficial soils were heavily contaminated with pesticides, including those identified in the earlier sampling described above. The results of analyses of ground-water samples obtained as part of this investigation were contradictory; the positive results reported from the first sampling event were not confirmed in samples taken at that time or in subsequent sampling events. Surface water samples, taken from water standing in the wetland areas in the northern portion of the Site, were found to be heavily contaminated with site-related pesticides.

Helena prepared a plan for site remediation which was submitted to SCDHEC for review, and, under the terms of an amendment to Administrative Consent Order No. 81-05-SW, dated March 12, 1984, remediation efforts were conducted that consisted mainly of the removal of contaminated soils to a permitted hazardous waste landfill.

In 1985, EPA, in conjunction with SCDHEC, conducted a Site Screening Investigation at the Helena Chemical Site in order to prepare a Hazard Ranking System (HRS) package for the Site in order to determine whether the Site should be included on the National Priorities List (NPL). The HRS ranking was completed in June, 1987, and the Helena Site was proposed for listing in June, 1988.

The Site was listed on the NPL in February, 1990.

In April, 1989, an Administrative Order by Consent (AOC) was jointly developed, negotiated and agreed to by EPA and Helena Chemical Company. Under the terms of this AOC, Helena agreed to conduct a Remedial Investigation (RI) and Feasibility Study (FS) at the Site under the oversight of EPA. The purpose of the RI/FS process was to develop an appropriate remedy for the Site as required by the National Contingency Plan (NCP). Helena retained the services of Environmental Safety and Designs, Inc. (ENSAFE), of Memphis, Tennessee as their contractor to conduct the RI/FS. RI field activities began in May, 1989, and were completed in April, 1992.

Two removal actions for contaminated soils have taken place at the Site. In addition to the removal of approximately 500 cubic yards of contaminated material conducted by Helena in March, 1984, as discussed above, in April, 1992, approximately 1000 cubic yards of contaminated soils were also removed by Helena under the oversight of EPA and likewise transported to a secure hazardous waste landfill.

3.0 HIGHLIGHTS OF COMMUNITY PARTICIPATION

Initial community relations activities at the Helena Chemical NPL Site included development and finalization of the Community Relations Plan in December 1989. An information repository was established at the Fairfax City Hall in January 1990.

A "kickoff" fact sheet announcing the start of the RI/FS was issued in April 1990. On April 19, 1990, EPA held a public meeting at the Fairfax Community Center to present the Agency's plans for the RI/FS. The meeting was attended by several local citizens, representatives of Helena Chemical, elected local officials and was covered by local newspapers. EPA's presentation to the public included information on how to participate in the investigation and remedy selection process under Superfund. At the meeting, several questions were asked and a fair amount of interest was expressed by the community.

Following completion of the FS, a second public meeting was held on May 27, 1993, to update the public on the RI findings to date, and to present the proposed plan for the remedial actions at the Site. The meeting was attended by only a few members of the public, with no press coverage. At this meeting, the primary concerns expressed by the public involved the threat posed by contaminated ground water to the nearby public supply well.

Proposed Plan fact sheets were distributed on May 18, 1993. An advertisement was published in two of the local newspapers on the same date. Both the advertisement and the fact sheet highlighted

the Public Comment period extending from May 18, 1993, until June 17, 1993.

At the Proposed Plan public meeting on May 27, 1993, EPA presented the Agency's selection of Preferred Alternatives for addressing soil, sediment, surface water and groundwater contamination at the Site. Public comments and questions are documented in the Responsiveness Summary, Appendix A.

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 serve to remove the threat to surface water by reducing the concentrations of surficial aquifer contaminants reaching nearby surface water systems. Wetlands mitigation will address the unacceptable levels of environmental risk posed by contamination of sediments and surface waters in on-site and adjacent jurisdictional wetlands. This is the only ROD contemplated for this Site.

5.0 SUMMARY OF SITE CHARACTERISTICS

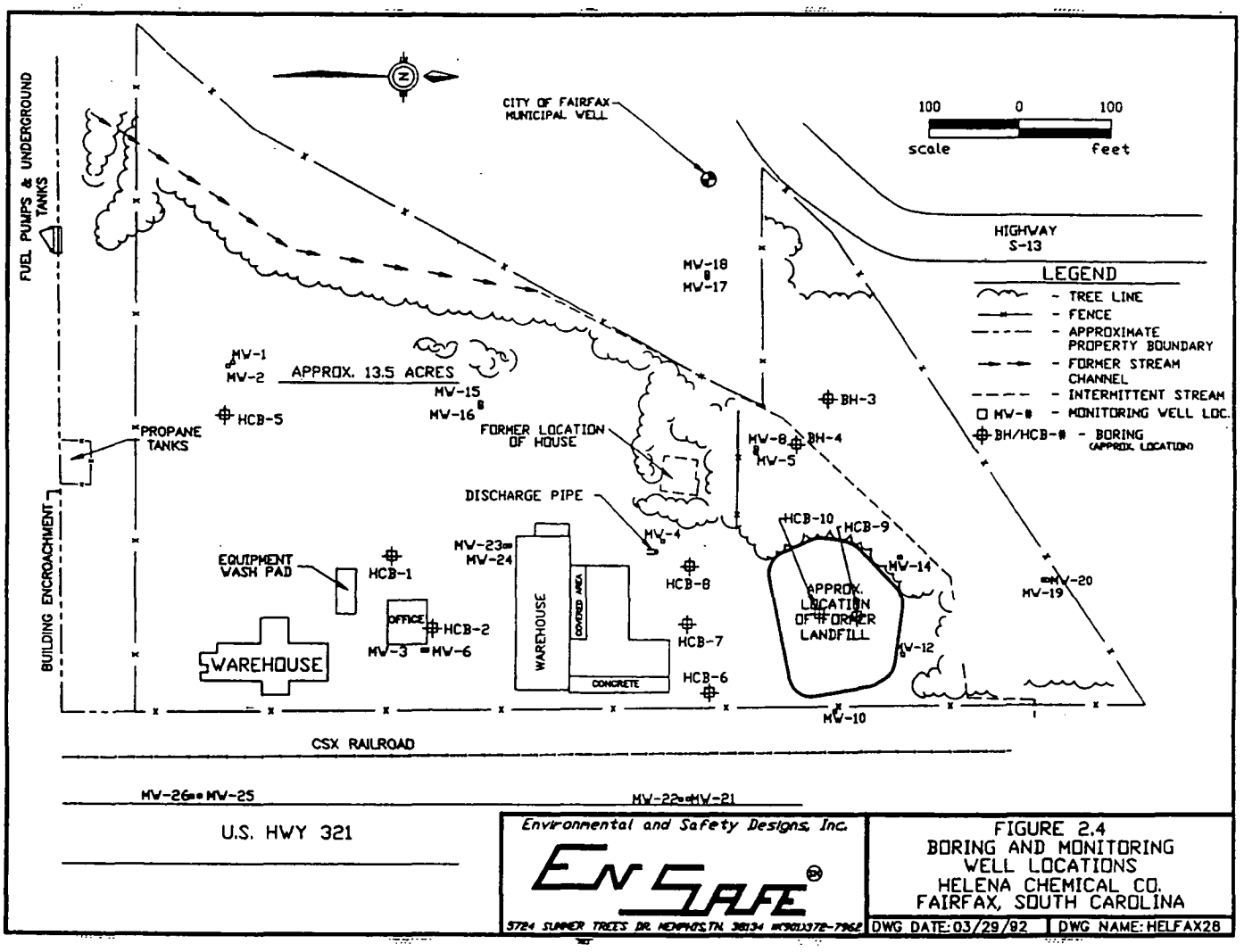
The RI investigated the nature and extent of contamination on and near the Site, and defined the potential risks to human health and the environment posed by the Site. A supporting RI objective was to characterize the Site-specific geology and hydrogeology. The main portion of the RI was conducted from May 1989 through April 1992. Onsite locations of soil borings, soil samples, and monitor wells are shown in Figure 3.

5.1 SITE SPECIFIC GEOLOGY AND HYDROGEOLOGY

The local hydrogeologic characterization discussed below was derived from RI data, including falling head permeability tests, grain size analyses, slug tests, piezometric surface maps, and numerous boring logs. In addition, the Barnwell Group aquifer system was monitored to determine if the City of Fairfax Municipal well affected the aquifer during pumping and non-pumping events as described below.

For the purpose of the RI, the hydrogeologic assessment concentrated primarily on the uppermost aquifer at the Site. The

Figure 3; Monitoring Wells and Soil Borings



uppermost aquifer occurs within sands of the Barnwell Group and the lower portion of the Duplin Formation. Member beds within these formations may exhibit minor facies changes; however, they are considered to be hydraulically connected.

Beneath the site, the upper portion of the Duplin Formation at times demonstrates the hydrogeologic characteristics of an aquitard. High clay content and corresponding low permeability are two characteristics that limit vertical groundwater flow in this unit. Grain size analyses and boring logs indicate that the Upper Duplin has a high silt and clay content. The average silt and clay fraction from nine (9) soil samples was 33 percent. The samples averaged 90 percent finer than the upper limit designation for fine sand. These analyses suggest that the Upper Duplin is a silty, clayey very fine sand with the capability to retard groundwater flow.

Estimates of permeability were determined with Shelby tube samples collected from the Upper Duplin. Eight undisturbed soil samples were obtained from MW-4, MW-8, MW-10, MW-14, MW-20, MW-22, MW-24, and MW-26 by pushing a thin walled Shelby tube 12-24 inches into the soil. Rigid wall falling head permeability tests were conducted on these samples in accordance with the Corp of Engineers method EM 110-2-1906. The resulting permeability values were indicative of an aquitard, and they highlight the capability of this unit to restrict near surface groundwater movement. Two additional thin wall Shelby tubes were collected from the clay cap overlying the closed landfill, and these soil samples also exhibit low permeabilities.

The upper aquifer system appears to be comprised of, in descending order, the lower sands of the Duplin Formation, the Tobacco Road Sand Formation, and the Dry Branch Formation. These units exhibit saturated conditions and appear hydraulically connected in the study area. Although there are a few thin clay/silt laminae present in the upper 30 feet of the unit the limited thickness and lateral extent of these laminae suggest that they do not impede vertical groundwater flow. Well logs indicate these sands to be vertically uninterrupted from an average depth of approximately 12 feet to a depth of at least 90 feet below ground surface. The overall thickness of the uppermost aquifer is estimated to be approximately 80 feet.

The Fairfax municipal well log included in the RI describes a yellow and gray clay from 90 to 103 feet. During the installation of soil boring HCB-5 on the north end of the Helena property a dark gray to green, fine grained clayey sand interbedded with clay laminae and numerous shell fragments was identified from approximately 95 to 145 feet below ground surface. The unit was moist, but did not exhibit the saturated properties as seen in the upper Eocene sands and appeared relatively impermeable. Based on the aforementioned lithological descriptions, this unit is thought

to be representative of the upper section of the McBean Formation. Defining the lateral and vertical extent of this unit was beyond the scope of this investigation. The drillers log from the City of Fairfax municipal well, however, indicates the presence of limestone at depths of 260 to 347 below ground surface. The limestone may be representative of the Santee which varies considerably in the area and may signify actual lateral facies changes between the downdip Santee and the updip McBean.

Water level measurements conducted during the RI indicate that groundwater flow directions in both the shallow and deep portions of the upper aquifer exhibit seasonal variation. Summer water levels indicate that shallow flow is directed to the south-southwest. The piezometric diagram of water levels taken in April 1991, however, reveals directional components to the south, east and southeast. Similarly, but to a lesser extent, groundwater flowing in the deeper portions of the aquifer exhibits variation in direction throughout the year. Although deep well control is limited, flow direction in the summer is directed to the southwest. This corresponds with shallow flow directions. The data for April and September, 1991, indicate that the deeper groundwater flow was toward the south-southeast.

The lack of vertical groundwater flow is apparent from the minimal differences in water level between wells in the nine (9) deep/shallow well clusters at the site. From the eight (8) water level measuring events that have been conducted, the maximum downward vertical gradient was 0.018 feet per foot between MW-1 and MW-2 for July, 1990. The minimum was 0.0001 feet per foot between MW-19 and MW-20 for October, 1991. The average downward gradient of the nine (9) well clusters for the eight (8) measurement events was 0.002 feet per foot.

Interestingly, the upper aquifer appears to change from unconfined to confined conditions at different times throughout the year. The July, 1990 water levels for most of the wells on site were from 2 to 2.5 feet below the top of the confining portion of the Duplin formation. This suggests unconfined conditions may exist for at least a portion of the year. Conversely, confined conditions were encountered in the spring of 1991 when water levels were well above the contact between the more permeable sands of the upper aquifer system and the overlying less permeable clayey sands. This artesian condition was further supported by groundwater flowing out the top of MW-14 in March, 1991. One simple explanation for this phenomenon is associated with changing water levels in the upper aquifer.

During the dryer portion of the year (July and August), water levels fall below the base of the clayey sands of the Duplin Formation. This effectively dewaters the upper portion of the aquifer. Dewatering is a characteristic behavior of unconfined aquifers. During wet periods when water levels rise above the

contact between the permeable sands and the low permeability clayey sand within the Duplin, the aquifer exhibits confined conditions.

To obtain estimates of groundwater velocity, several slug tests were conducted at the site on March 4 and 5, 1991. Testing consisted of rising and/or falling head slug tests for MW-2, MW-4, MW-6, MW-8, and MW-10.

Rising and falling head slug tests were performed to characterize the hydraulic conductivity (K) of aquifer materials. Slug tests were initiated during Phase II-B and Phase III of the RI. Before each slug test was initiated, the static water level in the well was measured using an electronic water level indicator. A stainless steel cylinder of known volume was then introduced "instantaneously" into the well, at which time, the water level and the time were recorded. Periodically, water level/elapsed time measurements were made as the head fell back to the original level. Similarly, rising head slug tests were preformed by removing the slug and recording water level/elapsed time measurements as the head rose back to normal. For slug tests, the time required for the water level to return to normal is a function of the hydraulic conductivity (K) of the aquifer.

For this investigation, an In-Situ, HERMIT 1000B data logger and a 50 psi pressure transducer were used to record water level/elapsed time measurements during each slug test. For purposes of graphing data, the instrument was programmed to record measurements on a logarithmic time scale. The slug consisted of a five-foot (5) long, 1.66-inch diameter stainless steel cylinder with a stainless steel ring welded on one end. A teflon coated stainless steel cord tethered to the ring served to suspend the slug in the well just above or below the water level. At the beginning of each test, the data logger was activated the instant the slug was either lowered into or removed from the water.

The hydraulic conductivity (K) calculated from each slug test is presented in Table 1 below. The methods used to arrive at these values are discussed below. Rising and falling head slug test data from each well were graphed as time (elapsed) versus Log(H/Ho) in order to create a straight line. Log(H/Ho) is the Log base ten of the change in head divided by the initial head. Hydraulic conductivity (K) was computed from these plots using a method developed by Hvorslev.

This method utilizes a variable known as the basic time lag in an equation that calculates the hydraulic conductivity. Hvorslev contends that the basic time lag is the time at which the head ratio (H/Ho) equals 0.37. Log (H/H_0) was plotted against time on standard graph paper. A corresponding basic time lag was taken from the time scale at the bottom of each diagram, and then calculated using an equation for hydraulic conductivity.

Table 1 Hydraulic Conductivity K (ft/day) Estimated from Rising and Falling Head Slug Tests			
Well #	Method	K	
MW2	Falling	2.5	
MW4	Falling	1.23	kmax = 9.5 ft/day
MW6	Falling	9.2	kmin = 1.23 ft/day
MW6	Rising	4.6	kave = 5.3 ft/day
MW8	Rising	9.5	
MW10	Falling	4.2	
MW10	Rising	5.6	

The Hvorslev equation used in these calculations was developed for confined conditions with the assumption that the test well is screened in the upper portion of a permeable unit that is overlain by an impermeable unit. This scenario approximately describes Fairfax site conditions.

To estimate groundwater velocity, the hydraulic gradient was derived from the piezometric data generated during the RI. The maximum and minimum slopes between contour lines were measured directly from the isocon maps developed from this data, and these values are shown in Table 2.

Table 2 Hydraulic Gradient i (ft/ft) Estimated Maximum and Minimum		
Shallow Wells	Max	0.0026
	Min	0.00033
Deep Wells	Max	0.0035
	Min	0.0007

Estimates of the shallow horizontal groundwater velocity (V) were calculated from the following formula:

$$V = Ki/n$$

Where:

V = groundwater velocity
K = hydraulic conductivity
i = hydraulic gradient
n = porosity

A porosity (n) of 25 percent was chosen based on estimates for medium-to coarse-grained, poorly sorted sand aquifers. The maximum and minimum estimated velocities were calculated using the maximum and minimum hydraulic conductivities and corresponding hydraulic gradients in the formula.

Estimated Shallow Groundwater Velocity V (ft/day)

Vmax = (Kmax * imax)/n = 0.1 ft/day
Vmin = (Kmin * imin)/n = 0.0016 ft/day

Additional slug tests were completed upon completion of Phase III field activities. With the following exceptions, Phase III slug tests were conducted in a manner similar to the Phase II-B slug tests:

- Phase III tests incorporated a different type of slug than Phase II-B. Instead of using the stainless steel cylinder, one gallon of deionized water was "instantaneously" introduced in the well.

- Only falling head tests were conducted as water was not "instantaneously" removed from the well.

For the Phase III investigation, an In-Situ HERMIT 2000 data logger and a 20 psi pressure transducer were used to record water level/elapsed time measurements during each slug test. A one gallon jug of deionized water was used to slug each well. At the beginning of each test, the data logger was activated the instant that water was poured into the well.

Data reduction and compilation were conducted using the same equations and calculations described for the Phase II-B slug tests. The Phase III slug test graphs are presented in Appendix C and Table 3 summarizes the hydraulic conductivity values derived from the graphs.

To determine if the aquifer supplying the Fairfax municipal well is separate from the shallow aquifer beneath the site, two aquifer communication tests were conducted the week of November 11, 1991. The City of Fairfax public works department provided full cooperation during the tests.

Table 3 Hydraulic Conductivity K (ft/day) Estimated from Falling Head Slug Tests		
Well #	Method	K
MW5	Falling	10.04
MW15	Falling	3.23
MW17	Falling	3.15

The first test involved pumping the city well for three 1-hour long intervals separated by nonpumping periods of approximately 1-hour in length. This test was designed to approximate the normal operating conditions of the city pump system. During the test, water levels were monitored in three observation wells (MW-5, MW-15, and MW-17). Data from this test were inconclusive because identifiable trends did not develop from short duration pumping.

The second test was conducted to investigate what effects might result from pumping the city well for longer than one hour. Pumping duration for the second test lasted approximately 5.5 hours and MW-5, MW-15, and MW-17 served as observation wells again. With a pumping duration of 5.5 hours, this test was never designed or intended to be a constant rate aquifer test.

A Hermit 2000 data logger with three pressure transducers and a barometric pressure probe were used during each test. Each observation well had one of the pressure transducers monitoring water level fluctuations. The barometric probe was placed on the ground to measure changes in barometric pressure during the tests. The data logger recorded measurements from the four transducer inputs simultaneously and on five-minute intervals during pumping and nonpumping events.

For the second test, the data logger was activated approximately 17.5 hours before the city well pump was started to investigate local water level trends. The static water level in each monitoring well at the time the data logger was activated became the zero reference level for that well. Throughout the recording period, the data logger recorded water level changes from this original reference level.

Prior to the test, the city water tank was allowed to drain to approximately 1/3 capacity. Because some water had to remain in the tank to maintain water pressure, this was the lowest water tank level that Fairfax water supply officials would permit. Pumping at 390 gallons per minute (gpm), it took the city water supply well approximately 5.5 hours to refill the water tank during the test.

Drawdown values from each well were plotted against time to investigate water level trends. Drawdown is represented as a positive deflection from the original zero reference level in the data. Water levels recorded above the original reference level were recorded as negative drawdowns. Similarly, a rise in water level is represented by a negative deflection. In all three monitoring wells there was a general downward trend in water levels with time. This may be the result of increasing barometric pressure at the site. When the water level graphs were compared to the barometric pressure graph, however, the graphs show a definite change in water level with respect to pressure along the time axis. The difference in drawdown changes may be due to the difference in water level elevation.

Interestingly, water levels in each observation well rose abruptly when the pump was turned on. Although immediate, the maximum rise in any of the wells was slightly above 0.1 feet. While the pump was running, water levels fluctuated greatly. When the pump stopped, water levels dropped to levels corresponding to prepumping trends.

This phenomenon of abrupt rise and fall of water levels induced by pumping is common in confined and semiconfined aquifers. The occurrence is attributed to the elastic properties of aquifer materials (Lohman, 1972). When the hydraulic pressure in an artesian aquifer is reduced from pumping, the aquifer matrix compresses to compensate. This matrix compression is physically manifested as a slight net reduction in the thickness of the aquifer. When pumping is halted, the aquifer matrix elastically rebounds and the original aquifer thickness is recovered.

Ultimately, what appears to be a rise and fall in water levels may actually be a decrease and increase in the thickness of the aquifer. During the test, as aquifer thickness changed, the ground surface, well casings, and the transducers attached to the casings were lifted or lowered with respect to the nearly static water level. These reactions were recorded by the transducers as changes in water level.

With regard to communication between the deep city water supply aquifer and the shallow aquifer beneath the site, the results of this test are inconclusive. No large scale effects (obvious drawdown) from pumping were observed in any of the monitoring wells over the relatively short pumping duration used in this test. A much longer pumping duration (24-hours or more) may be necessary to investigate whether the observed phenomenon is the result of a hydraulic connection between the two aquifers.

While evaluating the results of this pump test, however, consideration should be given to the actual city pump system configuration. According to Fairfax water supply officials, the city pump rarely runs longer than 1/2 an hour at a time.

Therefore, the pump test duration of 5.5 hours created much more stress on the aquifer than normal pumping conditions would create. Even though greater stress occurred during this test, no excessive drawdowns were observed in the monitoring wells.

Given the uncertainty associated with the pump test already conducted and the possibility of communication between the shallow aquifer and the production zone of the City well, EPA believes that further pump tests are warranted. The details by which additional pump tests will be conducted will be determined during the Remedial Design review process.

5.2 NATURE AND EXTENT OF CONTAMINATION

Environmental contamination at the Site can be summarized as follows:

1) Organic and inorganic constituents of concern have been identified in the various media. The primary constituents of concern at the Site include: aldrin, alpha-BHC, beta-BHC, delta-BHC, gamma-BHC, DDT, DDD, DDE, dieldrin, endosulfan, endrin, endrin ketone, toxaphene, endosulfan sulfate, disulfoton, benzene, lead and chromium. Table 4, reproduced from the **RI**, identifies the preliminary contaminants of concern for the Site.

2) Surface and subsurface soils throughout the Site have been affected by past waste disposal activities. The highest levels of contamination are found in the vicinity of the former liquid formulation building now used as a warehouse, in the vicinity of the old landfill, and near the southernmost building on the Site in an area where transhipments of materials from railroad cars occurred.

3) Ground waters in the aquifers immediately underlying the Site have been affected by waste disposal activities at the Site. The ground waters underlying the Site are considered to be Class IIB ground waters under the draft EPA Guidelines for Ground-Water Classification, indicating that they are a potential source of public water supply. These ground waters are also classified as Class GB ground waters under South Carolina regulations. The ground water has been contaminated to levels that render it a threat to public health should it ever be used for potable water supply and which exceed state ambient standards for Class GB ground waters. Ongoing sampling has to date revealed no site-specific contamination in the nearby municipal water supply well.

4) High levels of contamination remain in soils and waste materials in the old landfill located in the northern

portion of the Site. These soils and waste materials are likely to be a continuing source of ground-water contamination.

5) Surface water and sediments in on-site wetlands and drainage pathways have been affected by past waste disposal activities. Pesticide concentrations in samples taken from on-site surface waters exceeded criteria that

TABLE 4
Contaminants of Concern by Environmental Media for the Helena Chemical Company Fairfax, South Carolina

SOIL/SEDIMENTS	
Dieldrin Endosulfan Endrin Ketone 4,4'-DDT Disulfoton** Tributylphosphorotrithioate (TBPT)** Toxaphene	Aldrin Endosulfan Sulfate Endrin Methoxychlor 4,4'-DDE 4,4'-DDD BHC (α, ß, Δ and gamma)
GROUNDWATER	
Benzene Aldrin Endosulfan II Toxaphene DDT (plus DDE & DDD) BHC (α, ß, Δ and gamma) Dieldrin Endrin Endrin Ketone Heptachlor Epoxide Disulfoton TBPT Lead Chromium	
SURFACE WATER	
BHC (ß, Δ) Dieldrin Endrin Ketone	

are protective of aquatic life. Sediments in the on-site wetland areas were found to be contaminated with site-related pesticides at levels that are likewise likely to

have an adverse impact on indigenous aquatic life.

6) Background and on-site air sampling indicates that local ambient air has not been affected by past waste disposal activities.

5.2.1 Surface and Subsurface Soils

The results of the field investigation identified varying concentrations of polychlorinated pesticide compounds and minor quantities of volatile organics in shallow surface soils (0 to 3 feet). Soils from the 1 to 3 foot interval would normally be considered shallow subsurface soils; however, for purposes of this discussion soils from 0 to 3 feet will be referred to as surface soils. Surface soils were collected employing hand augering techniques as previously described. Figure 4 is an isocon displaying the relative distribution of total pesticides in surface soils at the Fairfax site.

In addition to surface soil samples, ten soil borings were completed utilizing hollow stem auger techniques. Soil samples were collected for analysis from the surface, and from just below the interface of the vadose and saturated zones. Analytical results from some deep soil boring samples have indicated elevated levels of chlorinated pesticides.

5.2.1.1 VOCs in Soils

Soil samples collected throughout the RI have identified relatively low levels of various volatile organic chemicals (VOCs). The most commonly detected were acetone and methylene chloride; however, the data validation review suggests that these and some other contaminants may be laboratory artifacts. Two other chlorinated solvents were identified in soil samples, tetrachloroethylene (PCE), and trichloroethylene (TCE), although the TCE detected in two samples is believed to be a laboratory artifact. In addition, the aromatic solvents, benzene, toluene, ethylbenzene, and xylene were identified. Xylene is considered to be directly related to the formulation process. The VOCs found during the RI are discussed below.

Acetone

Acetone is a clear, colorless liquid with a fragrant mint-like odor. Acetone is a common organic solvent which is highly soluble in water. It is also one of the most common laboratory contaminants found in environmental samples. Acetone was

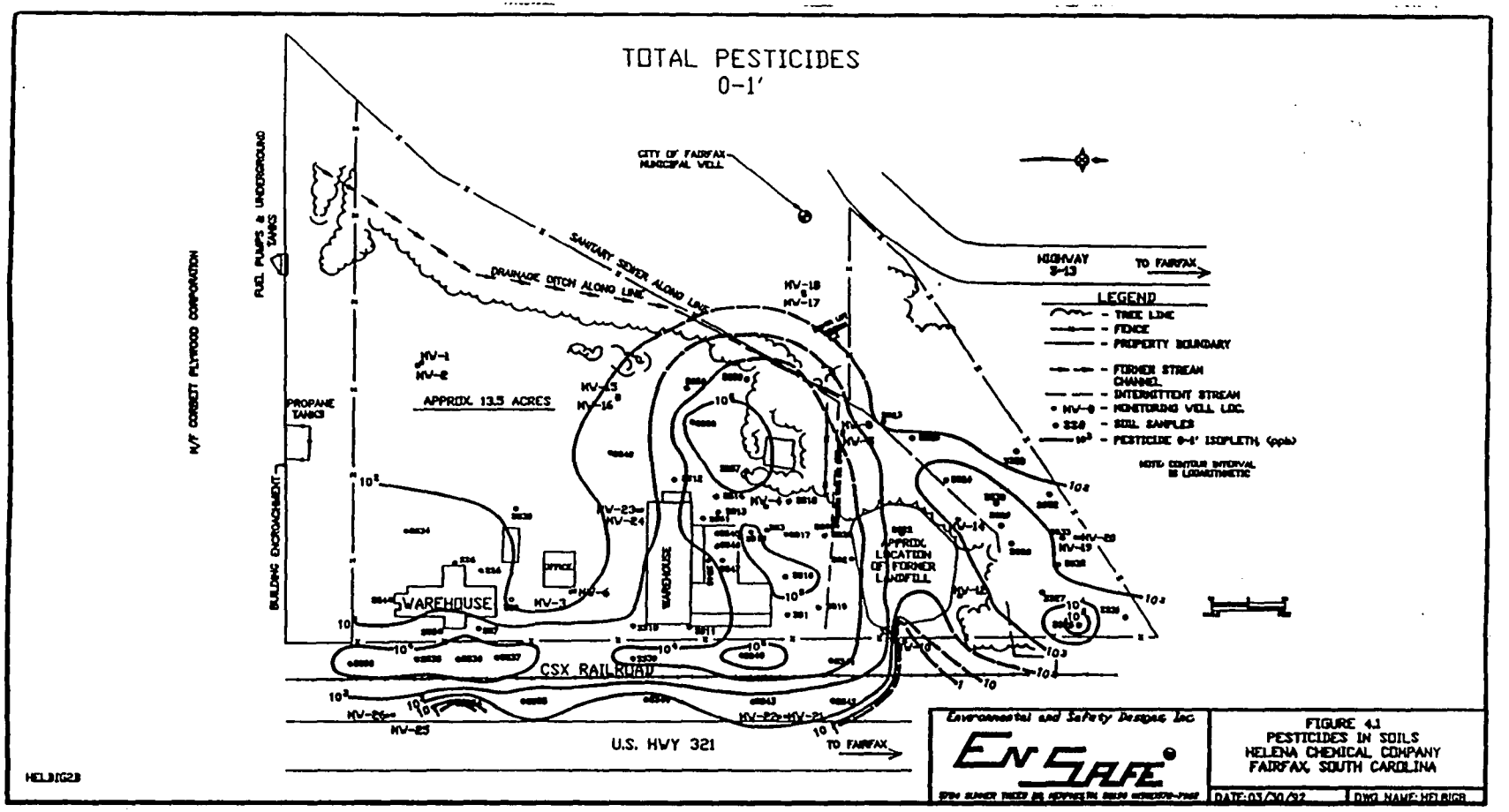


Figure 4
Pesticides in
Surficial Soils

identified in approximately 57 percent of the soil samples collected. Concentrations range from 2 µg/kg (ppb) - 13,000 µg/kg (ppb).

Methylene Chloride

Methylene chloride is a clear, colorless, highly volatile liquid. It is used as a degreaser, photographic film processing chemical, solvent, raw material for organic synthesis, and a fumigant. It is soluble in water to 20,000 mg/l. Methylene chloride is a common laboratory contaminant found in environmental samples.

Approximately 38 percent of the surface soil samples analyzed indicated variable levels of methylene chloride. Concentrations range from 2 ppb - 140 ppb.

Tetrachloroethylene

Tetrachloroethylene (PCE) is a colorless liquid with a chloroform-like odor, and is slightly soluble in water (150 mg/l). It is used for dry cleaning, metals degreasing and heat exchange fluid. PCE was formerly used in mixtures with grain protectants and certain liquid grain fumigants (vermifuge).

Tetrachloroethylene was identified in less than one percent of the soil samples. Concentrations ranged from 11 ppb - 240 ppb.

Trichloroethylene

Trichloroethylene (TCE) is a colorless, mobile, volatile liquid with a chloroform-like odor. It is used as a degreaser, dry cleaning solvent, gas purification agent, and a raw material in organic chemical manufacturing.

Trichloroethylene was identified in two soil samples, SS-10-1 and SS-19-2. The concentrations were 24 and 210 ppb, respectively. TCE was also detected at 19 ppb in the trip blank submitted with these samples on 02/26/91. The samples were run consecutively indicating the values may be laboratory artifacts or lab error.

Benzene

Benzene is a clear, colorless, volatile liquid which is very slightly water soluble. Benzene is a component of gasoline and an organic solvent which was formerly used (on a limited basis) in pesticide formulation.

Benzene was identified in approximately three percent of the samples. Concentrations ranged from 3 to 1,300 ppb.

Toluene

Toluene is a colorless liquid with a benzol-like odor. It is used as a solvent, and in dye manufacturing, artificial leather production, asphalt and naphtha constituents, fuel blending and extraction of organic soluble plant materials.

Approximately eight percent of the soil samples identified low levels of Toluene. Samples range from a low of 1 ppb to a high of 210 ppb.

Ethylbenzene

Ethylbenzene is a colorless liquid with an aromatic odor and limited water solubility (140 mg/l). It is used in synthetic rubber manufacturing, as a solvent, and is component of gasoline. Ethylbenzene was detected in approximately three percent of the soil samples. Concentrations range from 3 ppb - 4100 ppb.

Xylene

Xylene is a clear liquid which consists of a mixture of three (3) isomers: ortho-, meta-, and para-. Xylene is used in the manufacture of a number of consumer products, and is also a component of gasoline and a raw material for synthesis of organic chemicals.

Xylene was detected in four percent of the soil samples. The highest concentrations were found in the soils beneath the cap of the former landfill. The values range from 3 µg/kg to 27,000 µg/kg.

5.2.1.2. Semi-Volatiles in Soils

Although no semi-volatile compounds were confirmed in soils during the Data Validation report three tentatively identified compounds (TIC's) were recognized: disulfoton, chlorobenzilate, and butylphosphorotrithioate. Levels of disulfoton ranged from 60 ppb - 430,000 ppb and were identified in four percent of the soil samples collected. Butylphosphorotrithioate was detected in three samples at a concentrations ranging from 750 to 7900 ppb. Chlorobenzilate was not detected in samples collected by ENSAFE, but was identified in one split sample collected by the EPA oversight contractor. Disulfotone sulfone was identified in one sample at 51 ppb. Disulfoton sulfone is a degradation product of disulfoton.

Disulfoton (a.k.a. Di-syston) is a colorless, oily liquid (in the pure state), and the technical grade is brown in color. It is generally insoluble in most organic solvents. Disulfoton was

produced as an insecticide for mites and aphids on small grains, corn, sorghum, cotton, and other field crops.

Butylphosphorotrithioate is a colorless to pale yellow clear liquid which is insoluble in water. It was produced as a pesticide and cotton defoliant.

Chlorobenzilate (a.k.a. 4,4'-Dichlorobenzilic acid ethyl ester) is a viscous liquid sometimes yellow in color, and is slightly water soluble. It was manufactured as an acaricide. It was approved for use in the USA in 1969 for application on 11 crops which were primarily fruits and vegetables.

5.2.1.3 Pesticides in Soil

Soil samples collected during the RI have indicated a varied distribution of individual pesticide components. Concentrations for total pesticides range from below detection limits to 7170 mg/kg in surface and shallow subsurface soils. For the purpose of total pesticides, the values indicated represent the summation of all pesticide components identified during the RI. The primary pesticide constituents identified were DDT (and its degradation products), toxaphene, and BHC (including isomers). Contaminant distribution data have been generated for the primary constituents identified on the property. Those components comprising a less significant fraction of the total pesticides identified include aldrin, chlordane (including isomers), dieldrin, endrin, endrin ketone, total endosulfans, heptachlor, heptachlor epoxide, and methoxychlor.

The most significant levels of pesticides identified on the site were found immediately north, northwest, and/or east of the north warehouse. The overall levels of contamination generally show a decrease in concentration with depth from the surface to three feet below grade. Isolated "hot spots" however, show an increase in concentrations at the one to two foot interval with subsequent decrease in concentration again with depth. Individual pesticides are further detailed below.

Toxaphene

Toxaphene (a.k.a. chlorinated camphene) is produced as a yellow, waxy solid with a pleasant piney odor. Toxaphene is nearly insoluble in water. It was used as an insecticide for cotton, early stages of vegetables (peas, soybeans, and peanuts), and wheat and other small grains. Current uses are limited to cattle and sheep dipping (under certain provisions), disinfecting buildings, and termite, insect, rodent and other pest control (limited application). Toxaphene has not been produced commercially in the U.S. since 1982.

Toxaphene is generally present at the highest concentration in the pesticide fractions identified at the Site. Toxaphene was identified in 40 percent of the samples collected and concentrations ranged in value from 42 µg/kg (ppb) to 2700 mg/kg (ppm). Toxaphene data from the RI indicate contamination with the highest concentrations is found immediately northwest of the north warehouse, and elevated concentrations were also identified east of the building.

DDT, DDE, and DDD

DDT (a.k.a. 4,4'-Dichlorodiphenyltrichloroethane) was produced as colorless crystals or white/off-white powder. It is odorless or has a slight aromatic odor. DDE and DDD are found as contaminants (minor fraction) in DDT, and may also be produced through degradation of DDT. These compounds are non-systemic contact and stomach insecticides. DDT was used primarily to control insects capable of spreading malaria, typhus, and other insect transmitted diseases. Use of these products has been banned in the U.S.

DDT was detected in approximately 61 percent of the soil samples collected during the RI. The reported concentration of DDT and its degradation products in soils ranged from 2.3 ppb to 2,800 ppm. Contaminant distribution data generated during the RI indicate contamination from DDT is greatest at the surface and decreases with depth.

BHC (Lindane) and Isomers

Lindane is produced as a white crystalline powder, and is only slightly soluble in water (varies between isomers). Lindane is a organochlorine pesticide. Lindane is the gamma isomer of benzene hexachloride (BHC).

All four BHC isomers (alpha, beta, gamma, and delta) were identified in soil samples collected during the investigation. The most frequently detected isomer was beta-BHC which was found in approximately 38 percent of the soil samples. Concentrations of BHC range from 0.1 ppb - 390 ppm. Again, data indicate a decrease in concentration levels with increased depth.

Aldrin

Aldrin is produced as tan to dark brown crystals which are essentially insoluble in water. It was formerly used as an insecticide, and has been registered as a termaticide in the USA. The manufacture and use of aldrin have been banned in the USA.

Aldrin was detected in approximately 17 percent of the soil samples. Values ranged from 1.2 ppb - 800,000 ppb. Predominant soil contamination from aldrin was identified west and northwest of the north warehouse.

Chlordane

Chlordane (pure form) exists as a colorless to amber, odorless, viscous liquid which is insoluble in water. Chlordane was also produced in emulsifiable concentrates, granules, dusts and wettable powders (for termite control). It was formerly used as a fumigant and acaricide, and also as a home and garden pesticide/insecticide. As of 1983, the only approved use of chlordane in the USA is for termite control.

Chlordane (alpha and gamma isomers) was identified in approximately four percent of the soil samples. Chlordane concentrations range from 15 ppb - 58,694 ppb.

Dieldrin

Dieldrin was produced as white crystals or light tan flakes which are odorless and insoluble in water. Dieldrin was formerly used to control soil insects, insects of public health concern and termites. Its use as a broad spectrum insecticide ceased in 1974 when EPA restricted its use to direct soil injection for termite control and non-food seed/plant treatment.

Dieldrin was identified in approximately 36 percent of the soil samples collected during the RI. Dieldrin concentrations range from 4.6 ppb - 96,000 ppb. Soil contamination was identified between the warehouse and the former house and in the low lying areas north and west of the former landfill. Concentrations decrease with depth.

Total Endosulfans

Endosulfan (two (2) isomers) was produced as brown crystals essentially insoluble in water. Its primary application was as an insecticide for vegetables. Endosulfan sulfate is a degradation product of endosulfan.

Endosulfan was detected in approximately 5 percent of the soil samples collected. Endosulfan sulfate was detected in approximately 13 percent of the samples analyzed. Concentrations ranged from 2.1 ppb - 22,000 ppb. The most significant concentrations were identified immediately northwest of the warehouse. Less significant contamination was identified in the low lying area northwest of the landfill. Analytical data indicates that Endosulfan concentrations have decreased with depth.

Endrin

Endrin was produced as water insoluble white crystals dissolved in a liquid carrier (organic solvent). The only uses currently registered in the US are for cotton and bird perches. It is a persistent insecticide used on field crops to control army cutworm,

meadow voles, and grasshoppers under strict adherence to Federal regulations on application. Endrin ketone is an impurity in and degradation product of endrin.

Endrin and Endrin Ketone were identified in soil samples west of the warehouse and west-northwest of the landfill. Concentrations ranged from 0.74 ppb - 9,200 ppb. Approximately 12 percent of the samples collected contained endrin and 16 percent its degradation product endrin ketone. Concentrations appear to decrease with depth with the exception of one anomaly from sample SS-3-3.

Heptachlor

Heptachlor was produced as white to tan, waxy-looking solid crystals which are nearly insoluble in water. It has been used as an insecticide for termite control, and was also formerly used in fieldcrops (including corn, citrus, pineapples, cereal, vegetables sugar beets, nuts and cotton) for pest control (fire ants, boll weevils). Heptachlor epoxide is a degradation product of heptachlor.

Heptachlor was identified in approximately 25 percent of the soil samples. The concentration of heptachlor and its degradation products ranged from 1.0 ppb to 68,000 ppb. The predominant area of contamination was in the low lying area north and west of the landfill with some minor levels of contaminant identified north of the warehouse.

Methoxychlor

Methoxychlor was produced as a white, crystalline solid dissolved in an organic liquid carrier. It is essentially insoluble in water. Methoxychlor has been used as an insecticide for livestock and poultry, alfalfa, citrus, vegetables, soybeans, deciduous fruits and nuts, and other crops as well as home use, garden and ornamental plants, and forests. A common formulation is Methoxychlor with Diazinon (1:2 mix).

Four percent of the soil samples collected contained methoxychlor. Concentrations ranged from 24 ppb - 12,000 ppb. Methoxychlor was identified in the low lying area north of the landfill and northwest of the warehouse.

5.2.2 Ground Water

A total of 22 monitoring wells were installed at the Fairfax site during the RI. Thirteen wells were completed as shallow monitoring wells and nine wells were completed as deep monitoring wells. All wells were completed within the upper Eocene aquifer system. The installation and subsequent sampling of wells during Phase III of

the RI corresponded with the third quarter sampling event of 1991 for the wells installed during Phase II-A.

Chlorinated pesticides and volatile organics were identified in samples collected from on-site shallow monitoring wells. One deep well (MW-3) also indicated low levels of pesticides in ground water. Endosulfan sulfate was detected in MW-5; however, the quantity was "j" flagged. Four metals were detected in various wells at concentrations above their respective MCLs and are discussed below.

The City of Fairfax municipal well (south well) was sampled during Phases II-A and III of the field investigation. Samples were collected both before and after treatment by a chlorination process. No Site-related contaminants were identified in any of the samples collected from the municipal well samples. The north well field, which is located approximately one mile north of the Site, was not sampled.

5.2.2.1 Volatile Organics in Groundwater

Groundwater samples collected throughout the RI have identified low levels of various fractions of the volatile compound list. The most commonly detected were acetone and carbon disulfide; however, data validation suggests that these and other minor constituents are laboratory artifacts. Other constituents identified include benzene, chlorobenzene, chloroform, 1,2-dichloropropane, ethylbenzene, methylene chloride, and xylene were identified.

Acetone

Acetone was identified in groundwater samples from all site monitoring wells except for MW-1, MW-10, 20, 21, 22, 23, and 24. Additionally, acetone was identified in the raw (before chlorination) and finished (after chlorination) water samples collected from the Fairfax municipal well. As mentioned previously acetone is considered to be a lab artifact. Concentrations range from 3 µg/l (ppb) - 150 µg/l (ppb) identified in numerous groundwater samples.

Carbon Disulfide

Groundwater samples from all site monitoring wells except for MW-1 and MW-3 identified varying levels of carbon disulfide. The untreated city water was also positive for carbon disulfide. Concentrations range from 3 ppb - 130 ppb. Carbon disulfide was only detected in eight samples collected during all sampling events subsequent to Phase II-A. Many of the reported concentrations were "j" flagged (estimated values). In addition to the Phase II-A wells, carbon disulfide was identified in monitoring wells MW-18, MW-20 and MW-22 installed during Phase III of the RI.

Methylene Chloride

Methylene chloride was detected in groundwater samples collected from monitoring wells MW-1, MW-2, MW-4, MW-5, MW-8, MW-10, MW-12, MW-14, MW-19 and the finished city water during the investigation. Concentrations range from 1 ppb - 7 ppb. Once again, many of the reported concentrations were "j" flagged.

Benzene

Benzene was identified in groundwater samples collected from MW-12 during Phase II-A, the first quarterly sampling event under Phase II-B, and the December sampling event. Concentrations of benzene varied from 34 ppb to 52 ppb in the three respective sampling events. Benzene was detected in MW-4 during two sampling events at concentrations of 5 and 6 ppb. During Phase III benzene was detected in MW-14 at 37 ppb.

Chlorobenzene

Chlorobenzene was detected in groundwater samples collected from monitoring wells MW-4, MW-6, MW-8, MW-12 and MW-14. Concentrations ranged from 2 ppb - 17 ppb.

Chloroform

The finished water sample collected from the City of Fairfax municipal water well detected chloroform at 2 ppb. This occurrence probably results from the City's water chlorination process. No Chloroform was detected in the municipal well system during Phase III sampling.

1,2-Dichloropropane

1,2-Dichloropropane was detected in samples collected from monitoring wells MW-8, MW-12, and MW-14 in the quarterly sampling events. Concentrations range from 6 ppb to 28 ppb.

Ethylbenzene

Ethylbenzene was detected in samples collected from monitoring wells MW-4, MW-8, MW-12, MW-14, MW-19, MW-22, and MW-24 during sampling events completed to date. Concentrations range from 2 ppb - 190 ppb.

Xylene

Groundwater samples collected from monitoring wells MW-4, MW-6, MW-8, MW-12, MW-14, MW-19, MW-22 and MW-24 exhibited elevated levels of xylenes. Concentrations ranged from 5 ppb - 2000 ppb. Monitoring well MW-4 contained the highest concentration.

5.2.2.2 Semi-Volatiles in Ground Water

Disulfoton was identified in monitoring wells MW-4 and MW-12 during two of the groundwater sampling events. Concentrations of 78 ppb and 110 ppb were reported in MW-4 while concentrations of 3 ppb and 4 ppb were reported for MW-12. Both of the concentration values for MW-12 were reported as estimated concentrations (i.e., "j" flagged). Butyl phosphorotrithioate was identified in MW-15 during Phase III at a concentration of 49 ppb, and was likewise "j" flagged.

5.2.2.3 Pesticides in Groundwater

Monitoring well samples indicate that elevated levels of pesticides exist in shallow groundwater. Contaminants identified appear to consist primarily of toxaphene, DDT (and its degradation products), BHC (including isomers) and dieldrin. Those components comprising a less significant fraction of the total pesticides identified include aldrin, chlordane (including isomers), endrin and endrin ketone, total endosulfans, and heptachlor and heptachlor epoxide. Methoxychlor, which was identified in soil samples, was not identified in groundwater.

Toxaphene

Toxaphene contamination comprises the most significant concentrations of the pesticides fraction identified in groundwater at the Site. Toxaphene was identified in groundwater samples from monitoring wells MW-4, MW-6, MW-8, and MW-10 collected during the Remedial Investigation. Concentrations ranged in value from 9.9 ppb - 120.0 ppb. The laboratory did not identify toxaphene in groundwater samples collected during the March 1991 sampling event; however, toxaphene is believed to be present in MW-4, MW-6, and MW-10. Internal validation and assessment of chromatagrams indicates the probable presence of toxaphene in these wells. Due to severe matrix interferences in these samples, however, toxaphene quantification was not possible. The maximum concentration of toxaphene was detected in MW-8.

The Maximum Contaminant Level (MCL) for toxaphene in groundwater were established at 3.0 ppb.

DDT, DDE, and DDD

DDT, DDE, and DDD were detected in groundwater samples collected from monitoring wells MW-4, MW-6, MW-12, MW-14, and MW-22 during the RI and ranged in value from 0.045 ppb to 2 ppb. An MCL has not been established for DDT, or its metabolites DDE and DDD.

BHC (Lindane)

Lindane and its BHC isomers (alpha, beta, and delta) were identified in groundwater samples collected from monitoring wells MW-3, MW-4, MW-6, MW-8, MW-10, MW-12, MW-14, MW-16, MW-18, MW-22, and MW-24. Concentrations of BHC range from 0.024 ppb - 42.0 ppb. The MCL for lindane has been established at 0.2 ppb.

Dieldrin

Dieldrin was identified in groundwater samples from monitoring wells MW-4, MW-6, MW-8, MW-10, MW-12, and MW-14 in the first quarterly sampling event. Subsequent quarterly sampling events identified dieldrin in monitoring wells MW-6, MW-8, MW-10, MW-12, MW-14, MW-16, MW-18, MW-22, and MW-24. Concentrations range from 0.024 ppb - 5.5 ppb.

An MCL has not been established for dieldrin.

Aldrin

Aldrin was detected in groundwater samples collected from monitoring wells MW-4, MW-6, MW-8, and MW-12. Values ranged from 0.22 ppb - 7.9 ppb. The maximum concentration was detected in MW-4.

An MCL has not been established for aldrin.

Chlordane

Chlordane (alpha and gamma isomers) was identified in groundwater samples collected from monitoring wells MW-4 and MW-12. Chlordane was detected in MW-4 during the Phase II-A sampling events at 1.2 ppb. Chlordane was identified in MW-12 during Phase II-A, and both Phase II-B sampling events at concentrations ranging from 0.31 ppb - 1.3 ppb. The MCL established for chlordane is 2.0 ppb.

Total Endosulfans

Endosulfans were detected in monitoring wells MW-4 and MW-6 during the Phase II-A at concentrations of 1.8 ppb and .021 ppb respectively. Phase III groundwater sampling indicated elevated concentrations of endosulfans from monitoring wells MW-2, MW-5, MW-14, and MW-24. Concentrations ranged from 0.054 ppb to 0.62 ppb.

Endrin

Endrin and endrin ketone were identified in groundwater samples collected from monitoring wells MW-4, MW-6, MW-8, MW-10, MW-12, MW-18, MW-22, and MW-24. Concentrations ranged from 0.3 ppb - 2.1 ppb for endrin, and from 0.064 ppb - 18 ppb for endrin ketone. The MCL for endrin is 2.0 ppb.

Heptachlor

Heptachlor and heptachlor epoxide were identified in monitoring wells MW-6 and MW-12. The concentrations identified were 0.12 ppb for heptachlor and 0.57 ppb for heptachlor epoxide. Groundwater samples collected during Phase III of the RI did not show detectable quantities of heptachlor or heptachlor epoxide.

MCLs have been established at 0.4 ppb and 0.2 ppb, respectively.

5.2.2.4 Metals in Groundwater

The metals analyses conducted during the Phase II-A sampling event did not provide conclusive evidence that metals contamination of ground waters was a result of releases from the Site. Most metals in groundwater were detected at concentrations below detection limits or at levels comparable to background concentrations. During subsequent Phase II-B and Phase III groundwater sampling events beryllium, chromium, cadmium, and lead were detected in samples at levels which exceeded their respective MCLs.

Beryllium

Beryllium was identified in monitoring wells MW-4, MW-8, and MW-20 at concentrations of 6 ppb, 9 ppb, and 5 ppb respectively. The MCL for beryllium is 4 ppb. The detection of beryllium at concentrations above MCLs was a one time occurrence in each of the wells; therefore its presence does not appear to be significant.

Chromium

The presence of chromium was detected in monitoring wells MW-4, MW-6, MW-20, MW-23, and MW-24 at levels which exceeded the MCL of 100 ppb. The maximum concentration reported was 415 ppb which was detected in MW-20.

Cadmium

Cadmium was identified in MW-20 during both the September/October 1991 and December 1991 sampling at a concentration of 10 ppb. The MCL for cadmium is 5 ppb.

Lead

Lead was detected above the action level of 15 ppb in samples collected from monitoring wells MW-12, MW-20, MW-23, and MW-26. Lead was most frequently identified above the action level in MW-12.

Table 5

Table 4-22
Pesticides (Surface Water/Sediment
Phase II-A, II-B, III

PARAMETER	MATRIX	NUMBER OF SAMPLES	NUMBER OF HITS	RANGE(ppb)	MEAN(ppb)
alpha - BHC	Surface Water	2	0	—	—
	Sediment	10	2	0.1-60	30.5
beta - BHC	Surface Water	2	2	0.57-1.2	1
	Sediment	10	3	0.1-500	171.7
gamma - BHC	Surface Water	2	0	—	—
	Sediment	10	2	0.1-67	33.6
delta - BHC	Surface Water	2	1	—	0.28
	Sediment	10	0	—	—
Aldrin	Surface Water	2	0	—	—
	Sediment	10	1	—	990
Dieldrin	Surface Water	2	2	0.41-6.2	3.5
	Sediment	10	1	—	3200
4,4' DDD	Surface Water	2	2	0.045-0.23	0.2
	Sediment	10	9	18-3400	437
4,4' DDT	Surface Water	2	1	—	1.2
	Sediment	10	7	5.3-5700	862.9
4,4' DDE	Surface Water	2	0	—	—
	Sediment	10	8	9.8-280	80
Endrin Ketone	Surface Water	2	2	0.35-1.4	1
	Sediment	10	0	—	—
Heptachlor	Surface Water	2	0	—	—
	Sediment	10	2	2.1-25	13.6
Toxaphene	Surface Water	2	1	—	NOT QUANTIFIED
	Sediment	10	2	78-42000	21039
Gamma Chlordane	Surface Water	2	0	—	—
	Sediment	10	2	18-900.7	459.4
Alpha Chlordane	Surface Water	2	0	—	—
	Sediment	10	1	—	443
Endrin	Surface Water	2	0	—	—
	Sediment	10	1	—	1.6

5.2.3 Surface Water and Sediments

Sediments in the wetland areas located in the northern portion of the Site were found to be contaminated with semivolatile chemicals and pesticides. Table 5 summarizes the findings of the RI with respect to contaminated sediments. There are no chemical-specific ARARs for sediments, but the levels of contamination found in the RI exceed concentrations that have been shown through toxicological research to have an adverse impact to aquatic life due to toxic effects of these contaminants. This research is summarized in the National Oceanographic and Atmospheric Administration (NOAA) publication entitled The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program, NOAA Technical Memorandum NOS OMA 52, August, 1991. The pattern and distribution of contamination in the sediments indicate that the primary source of contamination is the landfill that was placed partially in the jurisdictional wetlands. Sediment contamination also extends into off-site drainage pathways for surface waters. The sediment contamination found in both on-site and off-site locations poses an unacceptable risk to environmental receptors.

On-site surface waters were found to have been contaminated with pesticides at levels which exceed Ambient Water Quality Criteria (AWQC) for the protection of aquatic life. Federal AWQC have been established under the authority of Section 303 of the Clean Water Act for the purpose of establishing protective guidelines for ambient water quality. AWQC as developed by EPA are identified in Section 121 of CERCLA as amended by SARA as chemical-specific ARARs for NPL sites. In addition, the AWQC have been adopted by the State of South Carolina as ambient surface water quality standards, and are therefore ARARs for the Site. Table 5 also summarizes the findings of the RI with respect to surface water contamination at the Helena Chemical Site. The surface water contamination identified as part of the RI also poses an unacceptable risk to environmental receptors in the on-site wetland areas and in drainage pathways leading off-site.

6.0 SUMMARY OF SITE RISKS

A Baseline Risk Assessment was conducted to evaluate the risks presented by the Helena Chemical Superfund Site to human health and the environment, under present day conditions and under assumed future use conditions. Currently, there are no residents living on the Site and only a few residents residing close to the Site. There are no potable water supply wells on the Site, although there is a municipal water supply well located less than one-quarter mile away. Information gathered from census data regarding population trends in Allendale County and surrounding areas suggests that future land use will remain commercial and industrial, with little potential for residential use of groundwater as a potable water

source. The Site was evaluated, however, under residential exposure scenarios, including exposure pathways involving the use of shallow ground water as a potable water supply source. These exposure scenarios correspond to potential future use of the Site for residential development.

Under the current land use scenario, potential human receptors at the Site include residents in the vicinity of the Site who may be occasional Site trespassers, and workers on the Site. The Site is surrounded by residential, agricultural and light industrial areas. Beyond these areas immediately surrounding the Site (including the City of Fairfax), the local area is not densely populated, and consists primarily of agricultural land and forests. The most likely potential human receptors under the current land use scenario are workers and occasional trespassers. No private drinking water wells were identified either on-Site or immediately downgradient from the Site, and no users of surface water for potable water supplies were identified downgradient from the Site. Under current land use, the Reasonable Maximum Exposure (RME) is represented by the individual worker or Site trespasser who may be exposed by direct contact and incidental ingestion of surface soil and stream sediments.

Potential environmental receptors under the current land use scenario include the plants and animals at the Site. Site features, including the small unnamed stream and wetlands adjacent to the Site, and nearby wooded areas and open fields, provide a variety of habitats. No unique or critical habitats have been identified at the Site, and no vegetative stress is evident based upon site visits by regulatory personnel. No threatened or endangered species have been observed at the Site or in adjacent areas.

Future land use for the Site was considered to include potential development of the area as residential property. This potential land use scenario is considered to be that which would result in the greatest degree of risk to human health should the Site remain unremediated. The RME under a residential land use scenario is assumed to be an adult person or child living on the Site property and drinking potable water obtained from a private well drilled into the Barnwell Formation. Under the future land use scenario, environmental receptors would likely be more limited than at present, since residential development of the property would in all likelihood involve the elimination of the wetland and forested areas on and adjacent to the Site.

EPA has determined that the elevated levels of pesticides in the soils and ground waters at the Site pose the primary hazard to human health at the Site. In addition, the elevated levels of pesticides in the sediments and soils located in the wetland areas adjacent to and downstream of the Site pose a hazard to environmental receptors inhabiting those areas. Primary exposure

pathways for humans are incidental dermal contact with and ingestion of contaminated soils, and ingestion of contaminated ground water. Air transport of particulate matter contaminated with Site-related constituents of concern is not considered to be a significant risk to human health because the contaminated soils are generally in vegetated areas and the most heavily contaminated soils have been removed prior to this time. Air sampling results conducted during the Remedial Investigation indicated that airborne contamination was not present above levels that would pose a significant risk to human health.

EPA has established in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR Part 300, a range of 1×10^{-4} to 1×10^{-6} as acceptable limits for excess lifetime carcinogenic risks. Excess risk within EPA's acceptable limits means that any individuals exposed to Site conditions under the assumed exposure scenarios will run a one in ten thousand (1×10^{-4}) to a one in one million (1×10^{-6}) increased chance of developing cancer. Under the "No Action" scenario, (assuming the Helena Chemical Site is left as it is now) the estimated carcinogenic risk for current land use is 8.0×10^{-5}. The estimated excess cancer risk calculated for the future land use scenarios at the Site is 2.6×10^{-4}. These calculated risks for the future land use scenario exceed the acceptable risk levels established by EPA and are based on the assumption that no cleanup activities will have occurred.

EPA has also established acceptable exposure limits based upon non-carcinogenic health effects. A Hazard Index (HI) of 1.0 or greater has been established by EPA as the criterion defining unacceptable levels of exposure for non-carcinogenic health effects. The HI is the ratio of exposure levels resulting from site conditions to acceptable exposure levels (ie., exposure levels that result in no adverse health affects) for any given contaminant. The HI for potential non-carcinogenic effects under the current land use exposure scenario is 0.3. The associated Hazard Index for non-carcinogenic effects under the future land use exposure scenario is 8.6.

Actual or threatened releases of hazardous substances from this Site, if not addressed by the preferred alternative or one of the other active measures considered, may present a current or potential future threat to the public health, welfare, or the environment.

6.1 CONTAMINANTS OF CONCERN

Numerous chemical contaminants were identified in site media during RI Phases II-A, II-B, and III. Tables 6, 7, 8, 9, and 10 provide a summary of those contaminants which were evaluated or considered for evaluation during the Baseline Risk Assessment process. In Tables 6-10 the term "hit" or "hits" refers to positive results of

Table 6

Table 7-1 Summary of Soil Pesticide Concentrations HCFSC Site					
Parameter	Soil Class	Number of Samples	Number of Hits	Range (ppb)	Mean (ppb)
Aldrin	Total	261	35	1.2 - 800000	27100
	Surface	152	6	1.4 - 8100	1590
alpha-BHC	Total	261	32	2.1 - 390000	12300
	Surface	152	6	4.4 - 1800	530
beta-BHC	Total	261	52	4.9 - 270000	9900
	Surface	152	15	4.9 - 6200	750
delta-BHC	Total	261	22	4.1 - 210000	19000
	Surface	152	4	5 - 1500	380
gamma-BHC	Total	261	19	4.2 - 220000	11700
	Surface	152	4	5 - 67	34
4,4'-DDT	Total	261	124	5.1 - 2800000	31000
	Surface	152	41	8.5 - 220000	19200
4,4'-DDE	Total	261	66	0.74 - 21000	1100
	Surface	152	31	4.5 - 15000	910
4,4'-DDD	Total	261	72	2.3 - 750000	16800
	Surface	152	22	4.0 - 60000	6400
Dieldrin	Total	261	79	3.7 - 96000	3500
	Surface	152	21	4.6 - 44000	2700
Endosulfan II	Total	261	13	23 - 7100	660
	Surface	152	4	23 - 7100	1820
Endosulfan Sulfate	Total	261	33	2.1 - 22000	1040
	Surface	152	16	2.5 - 22000	1920
Endrin	Total	261	26	5.8 - 1600	390
	Surface	152	11	9.1 - 1500	550
Endrin Ketone	Total	261	35	2.1 - 9200	530
	Surface	152	12	5.3 - 1200	220

Table 6 (continued)

Table 7-1
Summary of Soil Pesticide Concentrations
HCFSC Site

Parameter	Soil Class	Number of Samples	Number of Hits	Range (ppb)	Mean (ppb)
Heptachlor	Total	261	11	6.1 - 68000	9300
	Surface	152	3	19 - 35	26
Heptachlor Epoxide	Total	261	9	2.4 - 29	15
	Surface	152	4	6 - 29	20
Methoxychlor	Total	261	10	24 - 12000	2050
	Surface	152	6	24 - 12000	3300
Toxaphene	Total	261	62	78 - 2700000	66000
	Surface	152	22	78 - 350000	43300
alpha-Chlordane	Total	261	4	15 - 9600	2500
	Surface	152	1	—	15
gamma-Chlordane	Total	261	6	16 - 14000	2600
	Surface	152	4	16 - 66	39

Table 7

Table 7-2 Summary of Soil Semivolatile Concentrations HCFSC Site					
Parameter	Soil Class	Number of Samples	Number of Hits	Range	Mean (ppb)
Disulfoton[a,b]	Total	261	12	60 - 430000	59400
	Surface	152	1	—	97
Tributylphoshoro-trithioate[b]	Total	261	3	750 - 7900	3200
	Surface	152	0	—	—
Chlorobenzilate[b]	Total	261	0	—	—
	Surface	152	0	—	—

Notes: Only disulfoton of the semivolatile SAS compounds (originally Tentatively Identified Compounds) were detected in site surface soils.

a One disulfoton sulfone hit (51 ppb) was identified during Phase II-A. This hit occurred as a Tentatively Identified Compound with estimated ("J" flag) concentration. This hit was not used to compute the average disulfoton concentration.

b Compound identified in a limited area in immediate vicinity of landfill.

Table 8

Table 7-3
Summary of Soil Volatiles Concentrations
HCFSC Site

Parameter	Soil Class	Number of Samples	Number of Hits	Range	Mean (ppb)
Benzene	Total	210	6	3 - 1300	223
	Surface	151	0	—	—
Chloroform	Total	210	5	1 - 11	4
	Surface	151	2	2 - 11	7
Ethylbenzene	Total	210	7	3 - 4100	1260
	Surface	151	0	—	—
Methylene Chloride	Total	210	80	2 - 140	20
	Surface	151	39	2 - 140	30
Toluene	Total	210	17	1 - 120	32
	Surface	151	4	1 - 89	35
Acetone	Total	210	118	2 - 13000	320
	Surface	151	69	2 - 13000	600
2-Butanone	Total	210	31	1 - 36	12
	Surface	151	13	3 - 32	13
Xylenes	Total	210	9	3 - 27000	4250
	Surface	151	1	—	3
Carbon Disulfide	Total	210	4	12 - 48	30
	Surface	151	3	19 - 48	35
Trichloroethylene	Total	210	2	24 - 210	117
	Surface	151	0	—	—
Styrene	Total	210	2	—	2
	Surface	151	0	—	—
1,2-Dichloroethene	Total	210	2	2 - 12	7
	Surface	151	1	—	12
Tetrachloroethene	Total	210	2	11 - 240	130
	Surface	151	2	11 - 240	130
1,2-Dichloropropane	Total	210	2	15 - 75	45
	Surface	151	0	—	—
Chlorobenzene	Total	210	4	5 - 8000	2300
	Surface	151	0	—	—

Table 9

Table 7-4
Summary of Groundwater Contaminants
HCFSC Site

Parameter	CRQL	Sampling Date	Number of Hits	Range (ppb) of Hits	Mean (ppb) of Hits	95% Upper Confidence Limit Mean (ppb)*
Aldrin	0.05	October 91	2	0.88 - 2.3	1.59	0.266
		December 91	2	0.66 - 1.2	0.93	
alpha-BHC	0.05	October 91	9	0.11 - 18	2.78	3.44
		December 91	8	0.17 - 31	6.72	
beta-BHC	0.05	October 91	8	0.26 - 26	5.42	3.74
		December 91	7	0.19 - 26	4.70	
delta-BHC	0.05	October 91	7	0.024 - 5.7	1.25	1.06
		December 91	5	0.094 - 1.2	0.62	
gamma-BHC	0.05	October 91	7	0.12 - 6.6	1.47	0.69
		December 91	6	0.23 - 2.2	0.91	
4,4'-DDT	0.1	October 91	1	—	0.45	0.175
		December 91	1	—	1.2	
4,4'-DDD	0.1	October 91	3	0.045 - 0.65	0.26	0.24
		December 91	1	—	2.10	
4,4'-DDE	0.1	October 91	2	0.051 - 2.0	1.03	0.21
		December 91	0	—	—	
Dieldrin	0.1	October 91	9	0.024 - 3.4	0.99	1.11
		December 91	7	0.23 - 5.5	2.70	
Endosulfan II	0.1	October 91	1	—	0.62	0.13
		December 91	0	—	—	
Toxaphene[b]	1.0	October 91	0	—	—	8.29
		December 91	1	—	36.0	
Endrin	0.1	October 91	0	—	—	0.081
		December 91	1	—	0.3	
Endrin Ketone	0.1	October 91	7	0.064 - 18	6.15	2.98
		December 91	6	0.17 - 11	4.15	

Table 9 (continued)

Table 7-4
Summary of Groundwater Contaminants
HCFSC Site

Parameter	CRQL	Sampling Date	Number of Hits	Range (ppb) of Hits	Mean (ppb) of Hits		95% Upper Confidence Limit Mean (ppb)[a]
Endosulfan Sulfate	0.1	October 91	3	0.054 - 0.12	0.08		0.091
		December 91	0	—	—		
Benzene	5.0	October 91	2	5 - 37	21		5.85
		December 91	1	—	35		
Disulfoton	5	October 91	0	—	—		9.12
		December 91	2	3 - 110	57		
TBPT	10	October 91	0	—	—		10.7
		December 91	1	—	49		
Chromium		October 91	21	3.9 - 415	52.4		69.75
		December 91	14	10.0 - 298	51.9		
Lead		October 91	24	0.7 - 44	8.0		11.5
		December 91	16	1.0 - 38.2	10.8		

Notes: "—" means no applicable value

All data used in developing this table were derived from groundwater results from the 3rd and 4th Quarter 1991 groundwater sampling events.

Heptachlor epoxide was identified in one well during Phase II-A of the RI. It was not identified in subsequent sampling phases and was attributed to a drilling artifact. As a result, heptachlor epoxide is not evaluated further in the BRA for the groundwater pathway.

a 95% UCL means were computed using the average concentration of each parameter from each well. If the compound or element was not detected in the sample, one-half of the sample quantitation limit was used to establish the average in the well for the parameter (per USEPA, RAGS, Volume I, Part A)

b Toxaphene was not originally reported on Form I's for the 3rd Quarter 1991 but was manually computed by the laboratory quality assurance director. Toxaphene was quantitated from relative intensities of characteristic chromatogram peaks (multiple peak pattern). The toxaphene chromatograms did not match the standard peaks with respect to the characteristic peaks generally used for quantitation. As a result, secondary characteristic peaks were chosen in order to quantify toxaphene.

Table 10

Table 7-5 Pesticides (Surface Water/Sediment) Phase II-A, II-B, III					
PARAMETER	MATRIX	NUMBER OF SAMPLES	NUMBER OF HITS	RANGE(ppb)	MEAN(ppb)
alpha - BHC	Surface Water	2	0	—	—
	Sediment	9	1	—	60
beta - BHC	Surface Water	2	2	0.57-1.2	1
	Sediment	9	2	15-500	257.5
gamma - BHC	Surface Water	2	0	—	—
	Sediment	9	1	—	67
delta - BHC	Surface Water	2	1	—	0.28
	Sediment	9	0	—	—
Aldrin	Surface Water	2	0	—	—
	Sediment	9	1	—	990
Dieldrin	Surface Water	2	2	0.41-6.2	3.5
	Sediment	9	1	—	3200
4,4' DDD	Surface Water	2	2	0.045-0.23	0.2
	Sediment	9	9	18-3400	437
4,4' DDT	Surface Water	2	1	—	1.2
	Sediment	9	5	14-5700	1207
4,4' DDE	Surface Water	2	0	—	—
	Sediment	9	8	9.8-280	80
Endrin Ketone	Surface Water	2	2	0.35-1.4	1
	Sediment	9	0	—	—
Heptachlor	Surface Water	2	0	—	—
	Sediment	9	1	—	25
Toxaphene	Surface Water	2	1	—	NOT QUANTIFIED
	Sediment	9	2	78-42000	21039
Gamma Chlordane	Surface Water	2	0	—	—
	Sediment	9	2	18-67	42.5

analyses. Many of the contaminants identified during the RI occurred at low frequency and/or in very low concentrations relative to the practical quantification limit for each compound.

The selection of contaminants that would be fully evaluated during the Baseline Risk Assessment in order to quantify Site risks were selected in accordance with guidance as contained in the document Risk Assessment Guidance for Superfund (RAGS), EPA/540/1-89/002, 12/89. The selection process included the following criteria: (1) the chemical has demonstrated significant toxicity to animal life in published reports, (2) USEPA health-based numbers can be obtained for the chemical, (3) whether its occurrence is significant, based on frequency, concentration and exposure potential, in regard to the total risk posed by the Site. The rationale used for selection of the evaluated contaminants and for eliminating the other contaminants is provided in the following discussions.

The selected contaminants of concern for the baseline risk assessment are shown in Table 4. Pesticides were the primary hazardous contaminants detected. In addition, a limited number of semi-volatile, volatile, and inorganic parameters were identified and will be carried through the baseline risk assessment process as explained below. Only Contract Laboratory Program (CLP) data were used for the evaluation of baseline risk at the Helena Chemical NPL Site.

In soils, DDT (plus DDE and DDD), BHC (all isomers), toxaphene and dieldrin were the most frequently detected and generally were found in the higher concentrations. Aldrin, endosulfan sulfate, endrin and endrin ketone were the next most frequently detected pesticides. Endosulfan, heptachlor, heptachlor epoxide, methoxychlor, and chlordane were the least frequently detected. Disulfoton and tributylphosphoro-trithioate (TBPT, butylphosphorotrithioate) were also detected infrequently, but were nonetheless evaluated as part of the BRA. Due to the low frequency of detection and the relatively low concentrations of heptachlor, heptachlor epoxide and chlordane (both isomers) found in site soils, these compounds were not evaluated as part of the BRA as it was determined that they would not contribute significantly to the overall risk posed by the site. This approach is consistent with the process for eliminating compounds from further consideration as outlined in RAGS. Endosulfan sulfate and endrin ketone are not listed in EPA databases which contain Agency reviewed toxicity data, and as a result the reference doses (RfD's) of their parent compounds (endosulfan and endrin, respectively) were used to compute the risk posed by these compounds. This procedure provided a conservative estimate of risk (or hazard index).

A large number of inorganic parameters were detected in soil samples. No inorganic contamination associated with site activities was found, however, in soils at a frequency and/or

concentration sufficient to warrant consideration as a contaminant of concern.

Site-related contamination was identified in the surface water samples gathered during the RI. An evaluation of this data indicates that pesticides are the only hazardous substances detected at significant concentration and frequency in this medium to warrant further consideration. Due to the intermittent nature of the surface water on-site, this medium was not considered a significant pathway for direct human exposure.

In groundwater, aldrin, BHC (all isomers), DDT (plus DDE & DDD), dieldrin, and endrin ketone were detected in the highest concentration or frequency, and represent the contaminants of concern from the groundwater perspective. Other detected chlorinated pesticide compounds included endosulfan II, endrin, toxaphene, endosulfan sulfate, and heptachlor epoxide. With the exception of heptachlor epoxide, these compounds were also evaluated in the Baseline Risk Assessment (BRA). Heptachlor epoxide was detected in one groundwater sample during Phase II-A. It has not been detected in any other sample during subsequent groundwater sampling events. As a result, heptachlor epoxide was not considered a contaminant of concern for the groundwater pathway. Heptachlor epoxide was therefore not evaluated as part of the BRA process. TBPT was also detected in one groundwater sample during the 3rd Quarter 1991 groundwater sampling event. Disulfoton was detected in two groundwater samples from the 4th Quarter 1991 sampling event and was evaluated as a contaminant of concern in groundwater. Benzene, lead, and chromium were also detected in groundwater samples. The frequency of detection and concentration for these parameters was generally higher than for the pesticide compounds and they were evaluated due to their potential contributions to overall risk (or hazard index).

Carbon disulfide was not consistently detected between RI phases. As a result, carbon disulfide results were attributed to laboratory artifacts, and were not evaluated further. Although bis(2-ethylhexyl)phthalate (BEHP), acetone, methylene chloride, and 2-butanone were identified in a significant number of samples, they were not evaluated as contaminants of concern. These compounds are common exogenous contaminants attributable to sampling methods and/or laboratory artifacts, and are not related to current or former site operations.

Numerous polynuclear aromatic hydrocarbons (PAHs) and phenolic compounds were identified in soil and groundwater during RI Phase II-A. These compounds were detected at low frequencies and at concentrations at or near their respective practical quantitation limits. Subsequent to Phase II-A, the semi-volatile contaminants of concern were limited to tentatively identified compounds (TICs) identified during Phase II-A. The TICs were disulfoton, TBPT, and chlorobenzilate. As a result, the BRA focused on the TICs and

Figure 5

Figure 7.3
Equations for Calculating Oral and Dermal Chronic Exposure Levels from HCFSC Site Soils
Future Site Residents and Current Site Workers

FUTURE SITE RESIDENTS

SOIL INGESTION PATHWAY

Age-adjusted Ingestion Factor ($IF_{soil/adj}$)

$$IF_{soil/adj}\ (\text{mg-yr/kg-day}) = \frac{IR_{soil/age1\text{-}6} \times ED_{age1\text{-}6}}{BW_{age1\text{-}6}} + \frac{IR_{soil/age7\text{-}31} \times ED_{age7\text{-}31}}{BW_{age7\text{-}31}}$$

where:

		Default Values
$IF_{soil/adj}$	age-adjusted soil ingestion factor (mg-yr/kg-day)	109 mg-yr/kg-day
$BW_{age1\text{-}6}$	average body weight from ages 1-6 (kg)	16 kg
$BW_{age7\text{-}31}$	average body weight from ages 7-31 (kg)	70 kg
$ED_{age1\text{-}6}$	exposure duration during ages 1-6 (yr)	6 years
$ED_{age7\text{-}31}$	exposure duration during ages 7-31 (yr)	24 years
$IR_{soil/age1\text{-}6}$	ingestion rate of soil age 1 -6 (mg/day)	200 mg/day
$IR_{soil/age7\text{-}31}$	ingestion rate of soil age 7-31 (mg/day)	100 mg/day
$IF_{soil/adj}$	age-adjusted ingestion factor (mg-yr/kg-day)	109 mg-yr/kg-day

DERMAL CONTACT PATHWAY
Age-adjusted Contact Factor ($CF_{soil/adj}$)

$$CF_{soil/adj}\ (\text{mg-yr/kg-day}) = \frac{SA_{age1\text{-}6} \times AF \times ED_{age1\text{-}6}}{BW_{age1\text{-}6}} + \frac{SA_{age7\text{-}31} \times AF \times ED_{age7\text{-}31}}{BW_{age7\text{-}31}}$$

where:

$CF_{soil/adj}$	age-adjusted contact factor (mg-yr-event/kg-day)	3400 mg-yr-event/kg-day
$SA_{age1\text{-}6}$	skin surface area available for contact (cm^2/event)	2430 cm^2/event
$SA_{age7\text{-}31}$	skin surface area available for contact (cm^2/event)	2300 cm^2/event
AF	soil to skin adherence factor (mg/cm^2)	2 mg/cm^2
$ED_{age1\text{-}6}$	exposure duration during age 1-6 (yr)	6 yr
$ED_{age7\text{-}31}$	exposure duration during age 7-31 (yr)	24 yr

COMBINED DAILY ABSORBED DOSE

Non-Carcinogens
Daily Absorbed Dose =
$((IF_{soil/adj} x C_s x 10^{-6} kg/mg x EF_R)/AT_{NC}) + ((CF_{soil/adj} x C_s x 10^{-6} kg/mg \times EF_R \times ABS)/AT_{NC})$

Carcinogens
Daily Absorbed Dose =
$((IF_{soil/adj} x C_s x 10^{-6} kg/mg x EF_R)/AT_C) + ((CF_{soil/adj} x C_s x 10^{-6} kg/mg \times EF_R \times ABS)/AT_C)$

Figure 5 (continued)

Figure 7.3
Equations for Calculating Oral and Dermal Chronic Exposure Levels from HCFSC Site Soils
Future Site Residents and Current Site Workers

where:		Default Values
C_s	Chemical concentration in soil	chemical-specific
EF_R	Residential exposure frequency	350 days/year
AT_{NC}	Averaging time (non-carcinogen)	10,950 days
AT_C	Averaging time (carcinogen)	25,550 days
ABS	Absorption factor (unitless)	0.01

CURRENT SITE WORKERS

COMBINED SOIL INGESTION AND DERMAL CONTACT PATHWAYS DAILY ABSORBED DOSE

Non-Carcinogens
Combined Chronic Absorbed Dose =
$((IR_{soil\text{-}worker} \times C_s \times 10^{-6}\ kg/mg \times EF_w \times ED_w)/(BW_w \times AT_{NC\text{-}worker})) +$

$((C_s \times 10^{-6}\ kg/mg \times ABS \times AF \times SA_w \times EF_w \times ED_w)/(BW_w \times AT_{NC\text{-}worker}))$

Carcinogens
Combined Chronic Absorbed Dose =
$((IR_{soil\text{-}worker} \times C_s \times 10^{-6}\ kg/mg \times EF_w \times ED_w)/(BW_w \times AT_{C\text{-}worker})) +$

$((C_s \times 10^{-6}\ kg/mg \times ABS \times AF \times SA_w \times EF_w \times ED_w)/(BW_w \times AT_{C\text{-}worker}))$

where:		Default Values
$IR_{soil\text{-}worker}$	Worker soil ingestion rate (mg/day)	100 mg/day
C_s	Soil contaminant concentration (mg/kg)	Chemical-specific
EF_w	Worker exposure frequency (days/year)	250 days/year
ED_w	Worker exposure duration (years)	30 years
BW_w	Worker body weight (kg)	70 kg
$AT_{NC\text{-}worker}$	Worker averaging time-non-carcinogen (days)	10,950 days
$AT_{C\text{-}worker}$	Worker averaging time-carcinogen (days)	25,550 days
ABS	Absorption factor (unitless)	0.01**
AF	Soil to skin adherence factor (mg/cm^2)	2 mg/cm^2
SA_w	Skin surface area available for contact (cm^2/event)	2300 cm^2/event

Figure 6

Figure 7.2
Equations For Calcualtion Of Chronic Exposure For The Groundwater Pathway[a]

FUTURE SITE RESIDENTS

Non-Carcinogenic

Chronic Absorbed Dose from Groundwater =

$$C_w \times IR_{water} \times EF \times ED/(BW \times AT_{NC})$$

Carcinogenic

Chronic Absorbed Dose from Groundwater =

$$C_w \times IR_{water} \times EF \times ED/(BW \times AT_C)$$

Where:		Default Values
C_w	Groundwater contaminant concentration (mg/liter)	Chemical-specific
IR_{water}	Groundwater ingestion rate (1/day)	2 liter/day
EF	Groundwater exposure frequency (days/year)	350 days/year
ED	Residential exposure duration (years)	30 years
BW	Body weight (kg)	70 kg
AT_{NC}	Averaging time for non-carcinogens (days)	30 years x 365 d/yr = 10,950 days
AT_C	Averaging time for carcinogens (days)	70 years x 365 d/yr = 25,550 days

a - Default exposure assumptions values referenced from USEPA, RAGS, 12/89 and OSWER Directive #9285.6-03.

Note: Assume absorbed dose is equivalent to intake/ingested dose.

Cancer Risk = Carcinogenic Chronic Absorbed Dose x Slope Factor

Hazard Index = Non-Carcinogenic Chronic Absorbed Dose/RfD

eliminated PAHs and phenolic compounds from further consideration on the basis of low detection frequency and low concentration.

6.2 EXPOSURE ASSESSMENT

Contaminated media at the Site include surface and subsurface soil; shallow groundwater; and surface water and sediments in on-Site and adjacent wetlands. Pathways involving air as a medium were not considered due to the extensive grass and vegetative cover at the Site, and the lack of positive results from air monitoring for Site-specific contaminants.

Populations that could potentially be exposed to Site contaminants under current exposure conditions are on-Site workers and occasional trespassers. Potential future land use exposure scenarios include 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, three general exposure pathways were selected for numerical risk quantification:

1. Current exposure of adult non-residents (Site workers and trespassers) to contaminants in surface soils through incidental ingestion and dermal contact.

2. Future exposure of on-site adult and child residents to contaminants in shallow soils through incidental ingestion and dermal contact.

3. Future exposure of onsite adult and child residents to contaminants in groundwater through ingestion.

In order to quantify the exposure associated with each pathway, various standard procedures were used to determine 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. Tables 13 and 14 present the exposure point concentrations calculated for the contaminants of concern in soils and ground water. It should be noted that the mean concentrations for each contaminant detected in the "hot spots" were used as the exposure point concentrations in the RME evaluation.

Calculation of average daily intake requires input of numerous exposure parameters which are usually applicable to a particular

Table 11

Table 7-13
Groundwater Contaminant Levels (ug/L) Yielding 10^{-4} to 10^{-6} Upper Bound Risk Levels for Future Site Residents
Exposure Scenario
HCFSC Site

Parameter	Current 95% UCL Mean (ppm)	Current Upper Bound Cancer Risk	Current Hazard Indices	Concentration (ppb) Required to Obtain		
				10^{-4} Risk	10^{-5} Risk	10^{-6} Risk
Aldrin	0.00027	5.4E-5	0.24	—	0.049	0.0049
alpha-BHC	0.0034	2.54E-4	NA	1.35	0.135	0.0135
beta-BHC	0.0037	7.90E-5	NA	—	0.47	0.047
delta-BHC	0.0011	NA	NA	—	—	—
gamma-BHC	0.00069	1.05E-5	0.063	—	0.66	0.066
DDT	0.00017	7.00E-7	0.0096	—	—	—
DDD	0.00024	6.75E-7	NA	—	—	—
DDE	0.00021	8.31E-7	NA	—	—	—
Dieldrin	0.0011	2.08E-4	0.61	0.53	0.053	0.0053
Endosulfan II	0.00013	NA	0.073	—	—	—
Endrin	0.000081	NA	0.0073	—	—	0.0073
Endrin Ketone	0.0030	NA	0.27	—	—	—
Toxaphene	0.0083	1.07E-4	NA	7.75	0.775	0.078
Endosulfan Sulfate	0.000091	NA	0.050	—	—	—
Disulfoton	0.0091	NA	6.25	—	—	1.5 (HI = 1)
Benzene	0.0059	1.99E-6	NA	—	—	2.94
Lead	0.0115	NA	0.23	—	—	—
Chromium	0.0697	—	8.19E-4	—	—	—

Notes:

The ensuing reduction in contaminant levels would also reduce the Σ Hazard Indices to below unity (1).

Groundwater cleanup goals may be calculated by solving the following:

$$\text{Groundwater Cleanup Goal (ppb)} = \frac{\text{Risk Level Goal} \times \text{Current Groundwater Concentration}}{\text{Current Risk Level}}$$

Table 12

Table 7-12 Soil Contaminant Levels (mg/kg) Yielding 10^{-4} to 10^{-6} Upper Bound Risk Levels for Future Resident Exposure Scenarios at the HCFSC Site					
Potential Future Site Resident					
Contaminant	Current Mean Concentration (mg/kg)	Current Upper Bound Risk Level	10^{-4}	10^{-5}	10^{-6}
Aldrin	1.59	5.3E-5	—	0.3	0.03
alpha-BHC	0.53	6.5E-6	—	—	0.08
beta-BHC	0.75	2.65E-6	—	—	0.28
delta-BHC	0.38	NA	NA	NA	NA
gamma-BHC	0.034	8.68E-8	—	—	—
DDT	19.2	1.28E-5	—	15	1.5
DDD	6.45	3.04E-6	—	—	2.1
DDE	0.91	6.07E-7	—	—	—
Dieldrin	2.69	8.45E-5	—	0.32	0.032
Disulfoton	0.097	NA	NA	NA	NA
Endosulfan	1.82	NA	NA	NA	NA
Endosulfan Sulfate	1.92	NA	NA	NA	NA
Endrin	0.55	NA	NA	NA	NA
Endrin Ketone	0.22	NA	NA	NA	NA
Methoxychlor	3.3	NA	NA	NA	NA
TBPT	0.0	NA	NA	NA	NA
Toxaphene	43.3	9.35E-5	—	4.63	0.463

Notes: No compound presented a hazard index in excess of 1; a linear relationship exists between soil concentration and associated risk levels, therefore the cleanup objectives for each risk level may be computed by determining the following:

X (Soil Cleanup Goal) = Risk Level Goal x Current Soil Concentration/Current Risk Level

NA No Slope Factor for the compound.

— Current contaminant levels in soil do not present a risk in excess of the respective risk levels.

exposure pathway. The exposure parameters used for soils aresummarized in Figure 5. The same parameters for ground-water exposure are shown on Figure 6.

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. Tables 13 and 14 contain these data and summaries.

6.3 TOXICITY ASSESSMENT

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 were obtained from the EPA toxicological databases. Critical toxicity values for Helena Chemical Site contaminants are presented in Table 15.

Slope factors (SFs) have been developed by EPA's Carcinogenic Assessment Group for estimating lifetime cancer risks associated with exposure to potentiall carcinogenic contaminants of concern. SFs, which are expressed in terms of $(mg/kg\text{-}day)^{-1}$, are multiplied by the estimated intake of a potential carcinogen in order to provide an upper-bound extimate of the excess lifetime cancer risk associated with exposure at that intake level. The term "upper bound" reflects the conservative estimate of the risks calculated from the SF. Use of this approach makes under-estimation of the actual cancer risk highly unlikely. Slope factors are derived from the results of human epidemiological studies or chronic animal bioassays; if animal bioassays are used, animal-to-human extrapolation and uncertainty factors are applied to account for the use of animal data to predict effects on humans. The SFs for the carcinogenic contaminants of concern are contained in Table 15.

Reference doses (RfDs) have been developed by EPA for use in indicating the potential for adverse health effects from exposure to contaminants exhibiting noncarcinogenic effects. RfDs, which are expressed in units of mg/kg-day, are estimates of lifetime daily exposure levels for humans, including sensitive individuals or subpopulations. Estimates intakes of contaminants of concern ingested from environmental media can be compared to the RfD. RfDs are derived from human epidemiological studies or animal studies to which uncertainty factors have been applied, to account for the use of animal data to predict effects on humans. The RfDs for the noncarcinogenic contaminants of concern are also contained in Table 15.

Carcinogenic contaminants are classified according to EPA's weight-of-evidence system. This classification scheme is summarized below:

Group A: Known human carcinogen.

Table 13

Table 7-9
Summary of Risks for Future Site Resident Direct Ingestion of Groundwater[a]
HCFSC Site

Parameter	95% UCL[b] (ppb)	Slope Factor (SF)[c]	Reference Dose (RfD)[c]	Upper Bound Cancer Risk[d]	Hazard Index[f]
Aldrin	0.266	17	0.00003	5.32E-5	0.24
alpha-BHC	3.44	6.3	NA	2.54E-4	NA
beta-BHC	3.74	1.8	NA	7.90E-5	NA
delta-BHC	1.06	NA	NA	NA	NA
gamma-BHC	0.69	1.3	.0003	1.05E-5	0.063
DDT	0.175	0.34	0.0005	7.00E-7	0.0096
DDD	0.24	0.24	NA	6.75E-7	NA
DDE	0.21	0.34	NA	8.31E-7	NA
Dieldrin	1.11	16	0.00005	2.08E-4	0.61
Endosulfan II	0.13	NA	0.00005	NA	0.073
Endrin	0.081	NA	0.0003	NA	0.0073
Endrin Ketone	2.98	NA	0.0003[d]	NA	0.27
Toxaphene	8.29	1.1	NA	1.07E-4	NA
Endosulfan Sulfate	0.091	NA	0.00005[d]	NA	0.050
Disulfoton	9.12	NA	0.00004	NA	6.25
TBPT	10.7	NA	NA	NA	NA
Benzene	5.85	0.029	NA	1.99E-6	NA
Lead	11.5	NA	0.0014[e]	NA	0.23
Chromium	69.75	NA	1.0	NA	8.19E-4
Sum of Cancer Risks and Hazard Indices[f]				Σ Risk = 7.1E-4	Σ HI = 7.80

a - assumes consumption of 2 liters/day of contaminated groundwater (at 95% UCL for each parameter) over a 70 year period for carcinogens and a 30 year period for non-carcinogens.

b - Figure 7-2 provides the equations used to compute chronic daily intake for establishing risk levels and hazard indices.

c - 95% Upper Confidence Limits means calculated using detected values for hits and one-half the sample quantitation limit for non-hits. Data used was derived from the 3rd and 4th Quarter 1991 Groundwater Sampling Events.

d - RfD for endrin applied to endrin ketone; RfD for endosulfan applied to endosulfan sulfate.

e - The unit risk for lead is calculated from a treatment technology based MCL of 0.015 mg/l. A USEPA approved RfD for lead has not been established.

f - Hazard Indices have been summed as a conservative estimate of non-carcinogenic risk; generally summation of Hazard Indices is appropriate only for contaminants having the same target organ effect (for non-carcinogens).

Table 14

Table 7-10 Summary of Risks for Current Adult Workers and Future Site Residents from Oral and Dermal Exposure to Contaminants in Soil/Sediments HCFSC Site			
Concentration of Contaminant (mg/kg)[a]	Contaminant	Future Resident Upper Bound Risk Level[b] (or Hazard Index)	Adult Worker Upper Bound Risk Level[b] (or Hazard Index)
1.59	Aldrin	5.3E-5 (HI=0.0243)	1.56E-5 (HI=0.076)
0.53	alpha-BHC	6.5E-6	2.0E-6
0.75	beta-BHC	2.65E-6	8.3E-7
0.38	delta-BHC	NA	NA
0.034	gamma-BHC	8.68E-8 (HI=0.00052)	2.7E-8 (HI=1.6E-4)
19.2	DDT	1.28E-5 (HI=0.176)	4.0E-6 (HI=0.055)
6.45	DDD	3.04E-6	9.5E-7
0.91	DDE	6.07E-7	1.9E-7
2.69	Dieldrin	8.45E-5 (HI=0.246)	2.6E-5 (HI=0.077)
1.82	Endosulfan	(HI=0.167)	(HI=0.052)
1.92	Endosulfan Sulfate	(HI=0.176)	(HI=0.055)
0.55	Endrin	(HI=0.0084)	(HI=2.6E-3)
0.22	Endrin Ketone	(HI=0.0034)	(HI=1.1E-3)
3.3	Methoxychlor	(HI=0.003)	(HI=9.4E-4)
43.3	Toxaphene	9.35E-5	2.92E-5
0.097	Disulfoton	(HI=0.011)	(HI=0.0035)
0.0	TBPT[c]	NA	NA
Sum of Upper Bound Cancer Risk		2.57E-4	8.0E-5
Sum of Hazard Indices		Sum of HI=.82	Sum of HI=0.32

Notes:

a Mean concentration in soil (95% C.L. was not calculated as the data are not normally distributed). The mean contaminant concentrations in the "hot spots" onsite were assumed to be present over the entire site area. Uniform exposure to all areas onsite was assumed to provide a conservative estimate of exposure. This approach is consistent with USEPA, Region IV guidance for establishing RME levels.

b HI (Hazard Index) of >1 is a cause for concern. Upper bound risk levels of 10^{-4} to 10^{-6} are considered on a case-by-case basis as to their acceptability by the USEPA.

c TBPT was not identified in surface soils onsite.

NA Not applicable

Table 15

Table 7-8
Health-Based Values for Carcinogens (CPF) and Noncarcinogens (RfD) and ARARs for Oral Exposure to Contaminants of Concern at the HCFSC Site

Contaminant	Slope Factor (SF) $(mg/kg/day)^{-1}$	RfD (mg/kg/day)	ARAR (MCL as mg/ℓ)
Chlordane	1.3	0.00006	0.002
Endrin	NA	0.0003	0.002[a]
Heptachlor	4.5	0.0005	0.0004
Heptachlor Epoxide	9.1	0.000013	0.0002
Disulfoton	NA	0.00004	NA
Benzene	0.029	NA	0.005
Aldrin	17	0.00003	NA
α-BHC	6.3	NA	NA
ß-BHC	1.8	NA	NA
gamma-BHC (Lindane)	1.3	0.0003	0.0002
delta-BHC	NA	NA	NA
Dieldrin	16	0.00005	NA
Endosulfan	NA	0.00005	NA
DDD	0.24	NA	NA
DDE	0.34	NA	NA
DDT	0.34	0.0005	NA
Toxaphene	1.1	NA	0.003
TBPT[b]	NA	NA	NA
Methoxychlor	NA	0.005	0.04
Chlorobenzilate	NA	0.02	—
Chromium[d]	NA	1.0	0.1
Lead	NA	0.0014[e]	0.015[c]

a A proposed MCL of 0.002 mg/ℓ
b No verified risk based criteria exist for TBPT.
c The unit risk for lead is calculated from a treatment technology based MCL of 0.015 mg/l. A USEPA approved RfD for lead has not been established.
d based on assumption that all chromium is present in the (III) valence state.
e unit risk computed from MCL
NA Not available or not determined
Slope Factor synonymous to Cancer Potency Factor (CPF)

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

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. The potential risk associated with soils and groundwater exposure was quantified through the standard risk assessment scenarios (Tables 13 and 14).

6.4.1 Ground Water

Ground-water risk based upon residential drinking water exposure was evaluated as a potential future risk. Samples from several monitoring wells had at least one contaminant that exceeded the current MCL.

Table 13 presents the individual risks associated with each parameter found in ground water along with total carcinogenic and non-carcinogenic values. The total groundwater risk for future residents consuming water from the surficial aquifer was calculated at 7.1×10^{-4}. The summation of the Hazard Indices for the future groundwater exposure scenario was calculated at 7.8. Toxaphene, dieldrin and alpha-BHC account for 80 percent of the carcinogenic risk. Disulfoton accounts for 80 percent of the non-carcinogenic risk. These values indicate that significant carcinogenic and noncarcinogenic risk may be posed by consumption of contaminated groundwater from a potable water well located onsite. The assumptions upon which these risk levels were based are conservative.

The groundwater risk levels were computed using the 95 percent Upper Confidence Limit of the mean from each well for each parameter. The 95 percent Upper Confidence Limit was computed

using detected values for hits and one-half the sample quantitation limit for non-detects. The mean value for each groundwater monitoring well (for the 3rd and 4th Quarter 1991 sampling events) was used. This more rigorous statistical approach for computing the Reasonable Maximum Exposure (RME) was used due to the greater uncertainty associated with the distribution of contaminants in the groundwater medium.

Under current circumstances, contaminants attributable to the site pose no imminent carcinogenic or non-carcinogenic risk to site workers or area residents through the groundwater exposure pathway. The adjacent municipal potable water well is screened in a deeper saturated zone separated by a possible aquitard from the contaminated aquifer. The municipal well has been tested, and no site constituents have been detected in the potable source. Residences within the groundwater contaminant plume area are connected to the municipal water system rendering private wells unnecessary.

In light of these factors, future resident exposure through the groundwater pathway may be minimized through control of the limited shallow aquifer contamination. Control would serve to reduce contaminant levels in the shallow aquifer (with concurrent reductions in the future resident groundwater onsite exposure risk potential), and would prevent migration of contaminants to the unaffected deep aquifer supplying the nearby municipal well. Surface water is not considered a significant pathway for direct human exposure.

6.4.2 Soils

Direct soil exposure poses a pathway of significant reasonable potential risk (current and future). Upper bound cancer risk and toxicity hazard index values were calculated for the contaminants of concern. A summary of these calculated values is shown in Table 14.

The soil samples indicated that soils had a wide range of contaminant levels with rather defined areas of greater contaminant concentration (north and northeast portions of the Site). The vast majority of Site contamination exists within an area from the north warehouse building onsite to 300 feet north and northwest of this warehouse building. Careful perusal of the data gathered during the RI reveal approximately 30% of the Site's total soil area is contaminated with total pesticide levels greater than 100 ppb.

Volatiles in soils tend to be in these same areas (warehouse and old landfill) but only constituted 20-25% of the total area. Soil contaminant mean concentrations were computed using the 'hot spot' method where only those samples with detectable contaminant concentrations were included in the calculations. The total area

of the 'hot spots' encompasses approximately 30 percent of the entire site area. In order to provide a conservative exposure estimate, the computed mean concentration of each contaminant (from 'hot spots') was assumed to exist over 100 percent of the site. This approach is consistent with EPA guidance for establishing reasonable maximum exposure (RME) levels.

Throughout most of the year, site sediments are not submerged, and as a result, present the same exposure pathways as site soils. Sediment contaminant concentrations were within the range observed in site soils. Therefore, no differentiation was made between soil and sediment for risk computation purposes for the ingestion and dermal contact pathways.

In order to provide a conservative estimate of the potential risk posed by the direct ingestion and dermal contact soil exposure pathways, the following exposure scenario assumptions were applied.

The potential for direct soil ingestion or dermal contact with soils is greatest for those soils closest to ground surface. As a result, the arithmetic mean was computed for each constituent of concern using soil concentrations from samples collected within one foot of ground surface. The distribution of pesticide contaminants indicated that higher concentrations for an area are generally present at the surface. Only positive results were used for the calculation of mean contaminant concentrations in soil. As a result, the mean values calculated (and used for calculation of chronic daily intakes) were biased toward the higher range of all values observed for soils. This approach is consistent with the 'hotspot' approach discussed in USEPA, RAGS, 12/89.

In addition for purposes of calculating carcinogenic risk (or hazard index), it was assumed that the computed average contaminant concentrations were present over 100 percent of the site. It was also assumed that current site workers and future site residents would have uniform exposure to all areas onsite. This assumption is conservative in that current site operations are restricted to approximately 25 percent of the site area. Highly contaminated soils are concentrated north and northeast of the north warehouse. The current operations area is restricted to the southern portion of the north warehouse. Current site workers do not enter other highly contaminated areas over the course of everyday operations.

The relevant current and potential future soil exposure scenarios for this site are considered to be adult workers and future site residents exposed through the combined pathway of ingestion and dermal adsorption of contaminated soil. Trespassers would be expected to spend a minimal amount of time on-site compared to adult workers and therefore should be more than adequately protected based on the occupational risk calculations.

Table 14 summarizes computed risk values (and hazard indices) for

the soil direct ingestion and dermal contact exposure pathway. The combined carcinogenic risk from surface soil contaminants is 8.0 x 10^{-5} for current adult workers and 2.57 x 10^{-4} for future site residents. Aldrin, toxaphene, and dieldrin account for the majority (approximately 85 percent) of the total upper bound cancer risk for onsite surface soils for both current adult workers and future site residents. The sum of hazard indices is less than unity (1) for current adult workers and 1.0 for future site residents, using only soil exposure pathways. It is worth noting, however, that the sum of hazard indices is generally relevant only in instances where the target organ for each contaminant is the same. As a result, the computed sum of hazard indices yields a more conservative assessment of non-carcinogenic risk.

The areas directly north and northwest of the northernmost warehouse represent the area of concern for most surface soil contaminants. It should be noted that each individual surface soil contaminant was assumed to be present over 100 percent of site surface soils (at the mean concentration). In reality, each contaminant is present in a much smaller area. The contamination distribution assumptions and the occupational exposure duration assumptions used in calculating risk are conservative. It should also be noted that occupational exposures are intermittent and not continuous. Again, the conservative assumption of continuous exposure was used.

6.4.3 Surface Water

The surface water identified on-site is intermittent in nature, and only exists after rainfall associated with storm events. Standing water is generally isolated to the densely vegetated area along the north property line. This area is not subject to recreational use, and site workers do not have occasion to enter this area during normal site operations. As a result, surface water is not considered a viable exposure pathway.

6.5 ENVIRONMENTAL (ECOLOGICAL) RISKS

Surface water and sediment samples were gathered during the RI from on-Site areas and in drainage pathways leading from the Site into local surface water streams. These samples were shown to be contaminated with Site-specific pesticides at levels which present an unacceptable level of risk to environmental receptors.
Surface water samples were contaminated with pesticides at concentrations which exceed ARARs, namely Federal Ambient Water Quality Criteria (AWQC) and State of South Carolina ambient standards for surface waters. The AWQC and state standards have been established based upon protection of aquatic life from adverse effects of exposure to toxics, and it is presumable that concentrations which exceed these criteria and standards will have

an unacceptable adverse impact on environmental receptors.

Sediment samples were also found to be contaminated with Site-specific pesticides. There are no promulgated standards or criteria for sediment quality at either the State or Federal level, so no ARARs exist for sediment quality. Considerable research has been conducted, however, on the environmental effects of exposure to contaminated sediments. This research has been compiled by the National Oceanographic and Atmospheric Administration (NOAA), in the document entitled The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program, NOAA Technical Memorandum NOS OMA 52, August, 1991. The levels of sediment contamination found at this Site exceed the levels cited in this document as being likely to contribute to adverse impacts to biological receptors.

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. 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 Site. Alternatives were developed with the goal of attaining these objectives:

Groundwater - EPA believes that active remediation of groundwater (such as a groundwater pump and treat system) in the Barnwell formation underlying the Site is a practicable and appropriate response. The Barnwell Formation is classified under the EPA Guidelines for Ground-Water Classification as a Class IIB ground water, ie., a potential source of potable water supply. These ground waters also are classified as Class GB waters of the State. The contamination at the Site has resulted in impairment of the ground-water resource as a potential drinking water source due to unacceptable risks to human health. In addition, the likelihood of a hydraulic connection between the Barnwell Formation and the underlying McBean/Santee Formation exists; the nearby municipal supply well draws water from the McBean/Santee Formation. In order to prevent migration from the existing contaminant plume into the underlying drinking water supply aquifer, ground-water extraction is warranted.

The remedial action objective for contaminated ground water is to restore the affected aquifer to a condition that renders it suitable for use as a potable water supply. Criteria based upon protection of human health via drinking water exposure for site-specific contaminants of concern are listed in Table 6. These criteria constitute the remedial goals for ground water at the Helena Site.

Given the likelihood of a hydraulic connection between the Barnwell and the McBean/Santee formations, and the inconclusive nature of the pump test conducted as part of the RI, EPA anticipates that effective implementation of the ground-water remediation at this Site will include another pump test. The purpose of such a pump test will be to determine the degree of interconnection between the formations mentioned above. The exact means by which this pump test will be conducted will be determined during remedial design activities.

Surface and Subsurface Soils - Soils on the Site, both at the ground surface and at depths grater than one foot, are contaminated at levels which exceed criteria protective of human health under an exposure scenario which assumes unrestricted land use, including residential development, and which exceed concentrations that are likely to continue to leach contaminants to ground water. The overall remedial action objective for the surface and subsurface soils is to remove and remediate contaminated soils to such a degree that both ground-water quality (in conjunction with ground-water extraction and treatment) and human health are protected. The RI identified soil remediation goals for both of these purposes. Table 7 presents a comparison of these remedial goals as developed in the RI. EPA review of the remedial goals developed in the RI for the protection of ground water revealed, however, that the technical basis for these goals was inadequate. EPA therefore conducted an independent analysis of soil contamination levels and has determined that a soil remediation goal of 50 ppm total pesticides is protective of human health and the environment, and will result in the removal of 90% of the total pesticide mass that exists at the site.

The evaluation performed by EPA was based upon contaminant distribution data provided in the RI. EPA used this contaminant distribution data to calculate the contaminant mass associated with the soils at the Site as it is related to contaminant concentrations. Contaminants migrating from a relatively concentrated source area via soils or ground water tend to be logarithmically distributed. By determining the concentration at which the bulk of contaminant mass will be removed and optimizing this concentration with relation to the volume of soil requiring treatment (i.e., by avoiding a situation whereby the law of diminishing returns is created), the appropriate soil remediation goal can be estimated.

The proposed remedial action would then consist of treating the soils by a combination of bioremediation and hydrolytic/photolytic dechlorination (HPD), and replacement of the treated soils in the on-site excavations, followed by covering the backfilled material with one foot of clean soils. The performance standards for treatment of the soils would satisfy the Land Disposal Restrictions (LDRs) found in 40 CFR Part 268, promulgated under the authority of the Resource Conservation and Recovery Act (RCRA). This proposal

is based partly upon the concept that ground-water quality can be protected by treatment of soils in these source areas in combination with extraction and treatment of contaminated ground water. The removal and treatment of soils in the source areas is also protective of human health via direct contact and incidental ingestion.

Wetlands and Contaminated Sediments - The placement of fill material in jurisdictional wetlands, and the contamination of the sediments in the wetlands that resulted from this placement, have resulted in an unacceptable level of risk to environmental receptors. The remedial action objective for the fill and the contaminated sediments is to mitigate for the impacts that have resulted in these unacceptable levels of risk to environmental receptors. Mitigation will comply with the requirements of Section 404 of the Clean Water Act, and specific mitigative measures will be determined in accordance with the criteria and guidelines established under Section 404(b)(1) of that Act. These regulations are relevant and appropriate to the circumstances of the release of contaminants from the landfill placed in jurisdictional wetlands.

The following section provides a summary of the six (6) alternatives developed in the FS Report to address the contamination of soils, sediments and ground water at the Helena Chemical NPL Site. The primary objective of the FS was to determine and evaluate alternatives for the appropriate extent of remedial action to prevent or mitigate the migration or the release or threatened release of hazardous substances from the Site. With the exception of the No-Action alternative, all alternatives include the same provision for extraction, treatment and proper disposal of contaminated ground water. Likewise, all alternatives with the exception of No Action have the same provision for mitigation of the adverse effects associated with pesticide contamination in the wetlands adjacent to the Site. While wetlands mitigation is not discussed in the FS as a component of any of the alternatives, EPA has determined that unacceptable levels of risk to environmental receptors have resulted from the release of site-specific contaminants into jurisdictional wetlands. Mitigation for these releases has been determined to be relevant and appropriate to the circumstances of the release under the criteria for such determinations contained in the NCP. Alternatives 2 through 6 (Alternative 1 being the No-Action alternative) differ only in the technologies to be applied for the remediation of contaminated soils.

The following descriptions of remedial alternatives are summaries of more complete descriptions found in the FS report. The FS report contains a more detailed evaluation of each alternative and is available for review in the Administrative Record for the Site. All costs are based upon capital costs plus the present worth of annual operation and maintenance costs.

7.1 ALTERNATIVE 1 - NO ACTION

By statute, EPA is required to evaluate a "No Action" alternative to serve as a basis against which other alternatives can be compared. Under the No Action Alternative, no remedial response would be performed on any of the media of concern (surface soil, ground water or sediments) at the Site. This alternative does not reduce the risk calculated by the Baseline Risk Assessment. The No Action Alternative results in an excess cancer risk of 8.0×10^{-5} and a Hazard Index for non-carcinogenic effects of 0.3 for current land use exposure scenarios, and an excess cancer risk of 2.6×10^{-4} and a Hazard Index for non-carcinogenic effects of 8.6 for potential future land use scenarios.

The estimated present worth cost for the no-action alternative is $480,000. This cost is for monitoring of ground water and soils for thirty years.

7.2 ALTERNATIVE 2 - DEMOLISH FORMULATION BUILDINGS; CONSOLIDATE CONTAMINATED SOILS AND DEBRIS IN ONSITE LANDFILL; GROUND-WATER EXTRACTION, TREATMENT AND DISPOSAL; AND WETLANDS MITIGATION

All alternatives, excluding No Action, include ground-water containment by means of extraction, treatment and appropriate disposal. The installation of ground-water extraction wells will prevent the migration of contaminants beyond the present extent of the contaminant plume, and will over time remove contaminants from the ground water lying beneath the Site. At present, the extent of contaminated ground water is confined to the shallow aquifer (the Barnwell Formation) and does not appear to extend laterally to off-site areas.

Extracted ground water will be treated to criteria appropriate for the final means of disposal. At present, it is planned that the extracted ground water will be treated and discharged to the local sanitary sewer system, also known as a POTW. Pretreatment requirements will be set by the owner/operator of that sanitary sewer system in order to insure that the discharge permit for the system will not be violated. It is possible, based upon initial estimates of ground-water quality, that no pretreatment will be necessary; for the purposes of preliminary cost estimates, however, it is assumed that some degree of pretreatment for extracted ground water will be required. The actual technologies to be employed will be based upon the pretreatment criteria established by the owner/operator of the POTW.

Extraction of contaminated ground water will continue until the ground-water remediation goals are met throughout the extent of the plume. Should it prove to be technically impracticable to achieve these remedial goals, EPA will amend the ROD to reflect any changes in remediation criteria.

All alternatives, with the exception of No-Action, also include the demolition of on-site buildings as necessary to remove contaminated soil for treatment. Testing of the demolished buildings will be conducted during remedial design in order to determine the appropriate methods of disposal for demolition debris. It is likely that the demolition debris will not be significantly contaminated, so that no special handling will be required, allowing disposal of the demolition debris as non-hazardous solid waste.

All alternatives, with the exception of the No-Action Alternative, also include mitigation for contaminated soils and sediments in the wetland areas adjacent to the Site and downstream can be accomplished in a number of ways under the regulations, guidelines and criteria established under Section 404(b)(1) of the Clean Water Act, which is an ARAR for the remedial action at this Site. The exact form of mitigation that will satisfy the requirements of this ROD will also conform with the Memorandum of Agreement (MOA) between the Corps of Engineers and EPA which took effect on February 7, 1990. This MOA is a criterion "to be considered" in the determination of remedial actions for the Site. Removal of the fill placed in the affected wetlands, accompanied by removal of the contamination that has resulted from transport of toxic materials from that fill, is one potential method. Another would be the restoration of degraded wetlands at some off-site location. Another possibility is the acquisition of unaffected wetlands that are currently threatened by development or other destructive activities and placing those wetland areas in a protected status. A number of factors will be used to determine the most cost-effective and environmentally sound manner in which compliance with the mitigation guidelines will be achieved.

Alternative 2 calls for the demolition of the former formulation buildings on the Site, excavation of contaminated soils and disposal of contaminated soil in an on-site landfill constructed especially for this purpose. All soils exceeding 50 ppm total pesticides would be placed in the landfill. The landfill would be constructed to meet all applicable technical requirements regarding design of such landfills, including top and bottom liners to prevent infiltration of rainfall and also to prevent any further contamination of ground water. Long-term maintenance of the landfill would be required as part of the implementation of this alternative.

The estimated cost for this alternative is $5.5 million.

7.3 ALTERNATIVE 3 - DEMOLISH FORMULATION BUILDINGS, EXCAVATION AND ON-SITE BIOLOGICAL TREATMENT OF CONTAMINATED SOILS, GROUND-WATER EXTRACTION, TREATMENT AND DISPOSAL, AND WETLANDS MITIGATION

The ground water and wetlands portions of this alternative are

identical to those described under Alternative 2. They will consist of ground-water extraction, treatment and disposal (preferably in the local sanitary sewer), and mitigation of wetlands impacts. Demolition of Site buildings will also be as described under Alternative 2.

Under this alternative, contaminated soils containing greater than 50 ppm total pesticides would be treated on-site by means of biological degradation. Biological degradation would take place in treatment cells constructed on-site that would be lined to prevent any leaching of contaminants to ground waters underlying the Site.

Biological treatment cells would consist of lined pits into which the contaminated soils would be placed. Once placed into the cells, moisture content, temperature and nutrient levels would be adjusted and maintained to maximize the rate of biological activity. Both aerobic and anaerobic conditions are envisioned in order to maximize the effect of biological degradation. Anticipated treatment would consist of anaerobic treatment, particularly for soils contaminated with DDT, followed by aerobic treatment. Some of the Site soils may require aerobic treatment alone.

Treatability studies would be conducted to determine if this alternative can achieve the remedial goals, but preliminary data indicate that significant reductions in concentration of many site-specific contaminants can be achieved by biological degradation. Once soils are treated to the remedial goals, they would be replaced in the on-site excavations from which they were removed. The performance standard for treatment would be based upon the LDRs for site-specific contaminants.

The estimated cost for this alternative is $8.0 million

7.4 ALTERNATIVE 4 - DEMOLITION OF FORMULATION BUILDINGS, EXCAVATION AND HYDROLYTIC/PHOTOLYTIC DECHLORINATION OF CONTAMINATED SOILS, GROUND-WATER EXTRACTION, TREATMENT & DISPOSAL, AND WETLANDS MITIGATION

The ground water and wetlands portions of this alternative are identical to those described under Alternative 2. They will consist of ground-water extraction, treatment and disposal (preferably in the local sanitary sewer), and mitigation of wetlands impacts. Demolition of Site buildings will also be as described under Alternative 2.

Under this alternative, contaminated soils containing greater than 50 ppm total pesticides from the Site would be treated by means of hydrolytic/photolytic dechlorination (HPD) of the pesticide contaminants. This process would be implemented at Helena Chemical by mixing contaminated soils with chemical reagents and exposing

them to heat and ultraviolet (UV) radiation. The mixing process is necessary to distribute the reagents (usually hydrated lime, possibly supplemented by sodium hydroxide) throughout the mass of contaminated material. The mixed material/reagent mass is then placed in thin layers in cells similar to those proposed for biological treatment in order for the soils to be exposed to heat and UV energy from the sun. The soil mass would also be kept moist in order to enhance biodegradation of any organic end products resulting from the hydrolytic/photolytic dechlorination process. Soils would be periodically "turned over" to maximize contaminant exposure to UV radiation. The performance standard for the treatment process would be the LDRs for site-specific contaminants.

Treatability studies would also be required to determine if this technology would be capable of achieving the required performance standards.

The estimated cost for this alternative is $7.2 million.

7.5 ALTERNATIVE 5 - DEMOLISH FORMULATION BUILDINGS, EXCAVATION, HYDROLYTIC/PHOTOLYTIC DECHLORINATION AND BIOLOGICAL TREATMENT OF SOILS ON-SITE, GROUND-WATER EXTRACTION, TREATMENT AND DISPOSAL, AND WETLANDS MITIGATION

This is the preferred alternative for remediation of the Helena Site.

The ground water and wetlands portions of this alternative are identical to those described under Alternative 2. They will consist of ground-water extraction, treatment and disposal (preferably in the local sanitary sewer), and mitigation of wetlands impacts. Demolition of Site buildings will also be as described under Alternative 2.

Under this alternative, the two technologies discussed under Alternatives 3 and 4 above would be combined in order to take advantage of the particular benefits of each. Past studies and experience with biological treatment have indicated that biological treatment alone is effective for many of the site-related soil contaminants at Helena (notably DDT and its metabolites). Biological treatment alone, however, is less effective for toxaphene, which is another Site contaminant found in significant concentrations, likewise contributing significantly to the risk associated with Site exposure. HPD, on the other hand, has been shown in pilot-scale studies to be effective in the destruction of toxaphene. The two technologies would be combined in a treatment-train mode, with HPD treatment followed by biological treatment. In addition to biological treatment of site-specific contaminants other than toxaphene, the second step of the treatment train would also serve to further degrade the breakdown products produced by the initial HPD step.

Otherwise, the treatment processes would be as described under Alternatives 3 and 4, above. The soil remediation goal would remain at 50 ppm total pesticides, and the treatment performance standard would be based upon the LDRs for site-specific contaminants. The estimated cost for this alternative is $3.9 million.

7.6 ALTERNATIVE 6 - DEMOLISH FORMULATION BUILDINGS, EXCAVATION AND LOW TEMPERATURE THERMAL DESORPTION OF SOILS ON-SITE, GROUND-WATER EXTRACTION, TREATMENT AND DISPOSAL, AND WETLANDS MITIGATION

The ground water and wetlands portions of this alternative are identical to those described under Alternative 2. They will consist of ground-water extraction, treatment and disposal (preferably in the local sanitary sewer), and mitigation of wetlands impacts. Demolition of Site buildings will also be as described under Alternative 2.

Under this alternative, contaminated soils exceeding 50 ppm total pesticides from the Site would be treated on-site by means of low temperature thermal desorption (LTTD). This process involves processing contaminated soils through a rotary dryer or kiln. The soil mass is heated to a temperature level that is sufficient to drive the contaminants off of the soil matrix, but not high enough to actually incinerate or destroy the contaminants. Soil contaminants are volatilized from the solids and purged from the kiln or dryer by means of an inert purge gas. After the purge gas leaves the desorption unit, it is treated by an off-gas treatment system that prevents the soil contaminants from being released into the environment. Typical air pollution control equipment (such as cyclonic precipitators and baghouses) are also used to protect air quality during operation of desorption units.

LTTD typically concentrates the Site contaminants into a low-volume, highly concentrated waste stream that must in turn be disposed of in a manner that complies with all environmental regulations. This residual waste stream would be disposed of either by incineration or by transport to an approved waste disposal facility.

Numerous vendors for this type of treatment system exist, and EPA has experienced good success with its use on soils contaminated with pesticides at other Superfund sites. Treatability studies would likewise be necessary in order to assess the suitability of this technology for application at the Helena Chemical Site. The performance standard for this treatment system would likewise be the LDRs for site specific contaminants.

The estimated cost for this alternative is $4.4 million.

8.0 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

The alternatives for Site 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.

8.1 CRITERIA FOR COMPARATIVE ANALYSIS

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.

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.

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.

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.

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.

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

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.

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.

2. Community acceptance was indicated by the verbal comments received at the Helena Chemical NPL Site Proposed Plan public meeting, held on May 27, 1993. The public comment period opened on May 18, 1993, and closed on June 17, 1993.

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

8.2 COMPARISON OF ALTERNATIVES

All alternatives, except Alternative 1, provide adequate protection of human health and the environment. All alternatives, again with the exception of Alternative 1, achieve all identified ARARs. With respect to short-term effectiveness and implementability, Alternatives 2-6 are all are comparable. Treatment Alternatives 3 through 6 achieve overall protectiveness and risk reduction by permanently treating the waste and using the treated materials to prevent contact with less affected soils beneath the treatment areas. Landfill Alternative 2 achieves similar risk reductions, but does not satisfy the statutory preference for reducing the toxicity and volume of the waste, although the mobility of Site contaminants would be greatly reduced. Therefore, Alternatives 3-6 are preferable to Alternative 2.

Neither Alternative 3 nor Alternative 4 (biological treatment alone or HPD alone) has been shown to be fully effective for the entire range of pesticide contaminants found at the Site. The long-term

effectiveness of Alternatives 3 and 4 is therefore less assured than that for Alternatives 5 and 6. Alternative 6, treatment of soils by LTTD, would make use of a proven treatment technology that could reasonably be expected to achieve the remedial goals specified in this ROD. Preliminary studies regarding the proposed technology described under Alternative 5 (combining biological treatment with HPD) indicate that remedial goals for all Site contaminants are likely to be achievable.

Alternatives 5 and 6, therefore, are those that best meet the statutory preference for permanent solutions that reduce the toxicity, mobility and volume of waste materials while using technologies that can reasonably be expected to achieve the remedial goals determined to be protective of human health and the environment, and to achieve ARARs. They also fulfill the other criteria regarding long- and short-term effectiveness and implementability. The projected cost for Alternative 5 is significantly less than that for Alternative 6. Given that Alternative 5 can be implemented at significantly less cost than could Alternative 6, Alternative 5 is the preferred alternative.

EPA recognizes, however, that the preferred remedy includes a soil treatment technology (HPD/biological treatment) that is an innovative technology that has not been demonstrated capable of achieving performance standards specified in Section 9, below. EPA therefore will retain Alternative 6 as a contingency remedy to be implemented should treatability studies of HPD/biological treatment prove that this technology is incapable of achieving the performance standards for this Site. The only difference between Alternative 5 and Alternative 6 is the soil treatment technology to be employed. Alternative 6 contains low temperature thermal desorption (LTTD) as the soil treatment technology.

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 includes source control, ground-water remediation, and mitigation for wetlands impacts for this Site. At the completion of this remedy, the residual risk associated with this Site will fall within the acceptable range mandated by CERCLA and the NCP of 10^{-6} to 10^{-4} which is determined to be protective of human health. The unacceptable level of risk posed to environmental receptors will also be adequately addressed. The total present worth cost of the selected remedy, Alternative 5, is estimated at $3.9 million.

9.1 DESCRIPTION OF SELECTED REMEDY

9.1.1. Source Control

Source control will address the contaminated soils and waste materials at the Site. Source control shall include excavation of contaminated soils and waste materials, on-Site treatment by means of combined hydrolytic/photolytic dechlorination (HPD) and biological degradation, and placement of the treated soils and waste materials back into on-Site excavations. The treated soils will then be covered by a minimum of one foot of clean backfill.

The major components of source control to be implemented include:

9.1.1.1. Excavation

Excavation of materials contaminated with greater than 50 ppm of total pesticides at the Site. Excavation will be limited to the uppermost three feet of soils at the Site in order to prevent creation of a preferential flow path for infiltration of rain water into the shallow aquifer.

9.1.1.2. Treatment of Excavated Soils

Treatment of all excavated materials by means of a combination of hydrolytic/photolytic dechlorination and biological degradation.

Contaminated soils and waste materials containing greater than 50 ppm total pesticides from the Site would be treated by means of hydrolytic/photolytic dechlorination (HPD) of the pesticide contaminants. This process would be implemented at Helena Chemical by mixing contaminated soils with chemical reagents and exposing them to heat and ultraviolet (UV) radiation. The mixing process is necessary to distribute the reagents (usually hydrated lime, possibly supplemented by sodium hydroxide) throughout the mass of contaminated material. The mixed material/reagent mass is then placed in thin layers in cells similar to those proposed for biological treatment in order for the soils to be exposed to heat and UV energy from the sun. The soil mass would also be kept moist in order to enhance biodegradation of any organic end products resulting from the hydrolytic/photolytic dechlorination process. Soils would be periodically "turned over" to maximize contaminant exposure to UV radiation.

Contaminated soils containing greater than 50 ppm total pesticides would also be treated on-site by means of biological degradation subsequent to the HPD process steps. Biological degradation would take place in treatment cells constructed on-site that would be lined to prevent any leaching of contaminants to ground waters underlying the Site. Treatability studies would be conducted to determine if this alternative can achieve the remedial goals, but

preliminary data indicate that significant reductions in concentration of many site-specific contaminants can be achieved by biological degradation. Once soils are treated to the remedial goals, they would be replaced in the on-site excavations from which they were removed, and covered by a minimum of one foot of clean fill. The performance standard for the combined treatment process would be based upon the LDRs for site-specific contaminants.

Biological treatment cells would consist of lined pits into which the contaminated soils would be placed. Once placed into the cells, moisture content, temperature and nutrient levels would be adjusted and maintained to maximize the rate of biological activity. Both aerobic and anaerobic conditions are envisioned in order to maximize the effect of biological degradation. Anticipated treatment would consist of anaerobic treatment, particularly for soils contaminated with DDT, followed by aerobic treatment. Some of the Site soils may require aerobic treatment alone.

The final element of the source control portion of the overall remedy will be to grade the Site and construct any structures or appurtenances necessary so that the Site complies with all regulations regarding storm water run off from industrial facilities. This will prevent any further non-point source contribution from future Site activities to contamination in adjacent waters of the United States.

9.1.2. Ground Water Remediation

Groundwater remediation will address the contaminated groundwater at the Site. Groundwater remediation will include extraction of contaminated groundwater, treatment, and discharge to the local Publicly Owned Treatment Works (POTW).

The major components of groundwater remediation to be implemented include:

Extraction from the surficial aquifer by means of pumping wells and treatment by standard treatment technologies generally available to achieve pre-treatment requirements imposed by the POTW; and

Discharge of treated water to the nearest access point into the sanitary sewer collection system serving the local POTW.

The installation of ground-water extraction wells will prevent the migration of contaminants beyond the present extent of the contaminant plume, and will over time remove contaminants from the ground water lying beneath the Site. At present, the extent of contaminated ground water is confined to the shallow aquifer (the Barnwell Formation) and does not appear to extend to any significant degree laterally to off-site areas, although one well

located off the Site property (MW-18) was contaminated during the RI.

Extracted ground water will be treated to criteria appropriate for the final means of disposal. At present, it is planned that the extracted ground water will be treated and discharged to the local sanitary sewer system, also known as a POTW. Pretreatment requirements will be set by the owner/operator of that sanitary sewer system in order to insure that the discharge permit for the system will not be violated. It is possible, based upon initial estimates of ground-water quality, that no pretreatment will be necessary; for the purposes of preliminary cost estimates, however, it is assumed that some degree of pretreatment for extracted ground water will be required. The actual technologies to be employed will be based upon the pretreatment criteria established by the owner/operator of the POTW.

Extraction of contaminated ground water will continue until the ground-water remediation goals are met throughout the extent of the plume. Should it prove to be technically impracticable to achieve these remedial goals, EPA will amend the ROD to reflect any changes in remediation criteria.

9.1.3 Wetlands Mitigation

Mitigation for contaminated soils and sediments in the wetland areas adjacent to the Site and downstream can be accomplished in a number of ways under the regulations, guidelines and criteria established under Section 404(b)(1) of the Clean Water Act, which is an ARAR for the remedial action at this Site. These guidelines and criteria include the MOA between EPA and the Corps of Engineers, effective date February 7, 1990, concerning the determination of mitigation. Removal of the fill placed in the affected wetlands, accompanied by removal of the contamination that has resulted from transport of toxic materials from that fill, is one potential method. Another would be the restoration of degraded wetlands at some off-site location. Another possibility is the acquisition of unaffected wetlands that are currently threatened by development or other destructive activities and placing those wetland areas in a protected status. A number of factors will be used to determine the most cost-effective and environmentally sound manner in which compliance with the mitigation guidelines will be achieved.

The exact form of mitigation for the effects of contaminated sediments will be based in part upon the consideration that, although the sediments are contaminated to a level that is expected to adversely impact flora and fauna normally found in such a habitat, and that therefore pose an unacceptable level of risk to environmental receptors, the habitat function has not been completely destroyed. In addition, other valuable wetland

functions remain intact and could conceivably be physically destroyed by an active removal of contaminated sediments. Physical reconstruction of wetland areas damaged by such physical disruptions is theoretically possible, but EPA's experience with reconstructed wetlands as part of regulatory actions taken under the authority of Section 404 of the Clean Water Act has been that limited success can be expected from such projects. Also, reasonable estimates of the time required to achieve full restoration of the existing wetlands under this approach may be similar to that required for natural attenuation and biodegradation of site-related contamination to insignificant concentrations. Finally, it is possible that other sources of pesticide contamination exist that will not be addressed as part of the remedy for the Helena Chemical Site, since those sources are not related to the Site or activities that took place at the Site. Even should a successful reconstruction of contaminated wetlands be achieved, it is possible that these other sources would re-contaminate the wetland areas adjacent to the Helena Site, rendering the reconstruction ineffective in the long term.

Executive Order 11990, and regulations related to that Order found at 40 CFR Part 6, will also be considered in determining the most effective means by which the mitigation will be accomplished. These regulations require EPA to avoid, to the extent possible, the adverse impacts associated with the destruction or loss of wetlands and to avoid direct or indirect support of new construction in wetlands if a practicable alternative exists. Mitigative measures consistent with these requirements will therefore be given preference in determining specific actions to be required as part of the remedial action.

By insuring that adequate habitat for indigenous species potentially found in the wetlands associated with the Site will be made available by the mitigative measures proposed, the adverse impacts to the habitat function of the Helena wetlands can be remedied. While individuals of these species may under some mitigative options continue to be impacted by toxic effects of contaminants in the sediments at the Site, the viability of the various species populations in the area will be protected and enhanced by the long-term stability and availability of suitable habitat provided for by mitigation as part of the remedy.

9.1.4. Compliance Testing

Monitoring of groundwater (both in situ and after extraction and treatment), excavated soils, and treated soils shall be conducted as part of this remedial action. After demonstration of compliance with Performance Standards, Site ground water shall be monitored for five years. If monitoring indicates that the Performance Standards set forth below are being exceeded at any time after pumping has been discontinued, extraction and treatment of the

ground water will recommence until the Performance Standards are once again achieved.

Compliance testing of the residual soils that have been subjected to treatment will also be performed, to insure compliance with the LDR requirements established as performance standards for the soil treatment technology.

9.1.5 Contingency Remedy

Should treatability studies demonstrate that the selected remedy described above, HPD/biological treatment, cannot achieve performance standards established for the Site, the treatment technology used for soil remediation at the Site will be low temperature thermal desorption (LTTD) in lieu of HPD/biological treatment. LTTD has been successfully used at other NPL sites with similar soil contaminants and levels of contamination, and therefore can be expected to satisfactorily achieve performance standards at this Site.

Using this technology, contaminated soils exceeding 50 ppm total pesticides from the Site would be treated on-site by means of low temperature thermal desorption (LTTD). This process involves processing contaminated soils through a rotary dryer or kiln. The soil mass is heated to a temperature level that is sufficient to drive the contaminants off of the soil matrix, but not high enough to actually incinerate or destroy the contaminants. Soil contaminants are volatilized from the solids and purged from the kiln or dryer by means of an inert purge gas. After the purge gas leaves the desorption unit, it is treated by an off-gas treatment system that prevents the soil contaminants from being released into the environment. Typical air pollution control equipment (such as cyclonic precipitators and baghouses) are also used to protect air quality during operation of desorption units.

Numerous vendors for this type of treatment system exist, and EPA has experienced good success with its use on soils contaminated with pesticides at other Superfund sites. Treatability studies would likewise be necessary in order to assess the suitability of this technology for application at the Helena Chemical Site. The performance standard for this treatment system would likewise be the LDRs for site specific contaminants.

9.2. APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

9.2.1. Applicable Requirements

The remedy will comply with all applicable portions of the following Federal and State regulations:

40 CFR Part 6, Subpart C, promulgated under the authority of the National Environmental Policy Act. Specifically:

Section 6.302(a), governing protection of wetlands, including referenced Appendix A to 40 CFR Part 6. These regulations incorporate Federal Executive Order 11990 into Federal regulation.

40 CFR Part 122, promulgated under the authority of the Clean Water Act. Specifically:

Section 122.26, governing storm water discharges from industrial sites.

Section 122.50, governing discharges to publicly owned treatment works (POTWs).

40 Part 136, promulgated under the authority of the Clean Water Act. These regulations govern the water quality testing of discharges associated with NPDES-related activities. For this Site they are applicable to testing of waters discharged to a POTW and to the testing of storm water discharges.

South Carolina Code of Regulations (SCCR) Chapter 61-72, governing the discharge of storm waters from industrial sites. Specifically:

Section 72.307, containing design criteria for storm water discharge facilities.

SCCR Chapter 61-69, governing ambient water quality standards for surface and ground waters. Specifically:

Section 61-68(C), establishing applicability of state water quality standards.

Section 61-68(E), establishing minimum criteria for all state waters.

Section 61-68(F), establishing ambient standards for surface waters.

Section 61-68(G), establishing ambient standards for ground waters.

9.2.2. Relevant and Appropriate Requirements

40 CFR Part 141, promulgated under the authority of the Safe Drinking Water Act. Specifically:

Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs) promulgated under the authority of the

Safe Drinking Water Act are specifically identified in the National Contingency Plan (NCP) as remedial action objectives for ground waters that are current or potential sources of drinking water supply. The ground waters underlying this Site are classified as Class IIA ground waters under the EPA Guidelines for Ground-Water Classification. Ground-water extraction and treatment is included in this remedy in order to satisfy EPA's stated goal of returning usable ground waters to their beneficial uses within a reasonable time frame (see FR Vol. 53, no. 245, p 51433, and Section 300.430(a)(1)(ii)(F) of the NCP). MCLs and MCLGs are therefore relative and appropriate for use as remedial action objectives for the remedial action at this Site.

Maximum Contaminant Level Goals (MCLGs) are found in 40 CFR Part 141, Subpart F.

Maximum Contaminant Levels (MCLs) are found in 40 CFR Part 141, Subparts B and G.

40 CFR Part 230, Subparts B and H, promulgated under the authority of the Clean Water Act. These regulations govern the mitigation of impacts to jurisdictional wetlands associated with the placement of fill material in waters of the United States and any secondary adverse impacts resulting from that placement.

Since the solid waste on-Site is not hazardous waste, but contains hazardous constituents, the following regulations established under the authority of RCRA are relevant and appropriate to the circumstances of the release, but are not directly applicable. This includes regulations found at 40 CFR Parts 261-268 cited below.

40 CFR Part 261, Subpart B. These regulations establish methods for the testing of hazardous materials at RCRA-regulated facilities. They will be used to guide testing procedures established as part of the compliance monitoring portion of this remedy.

40 CFR Part 264, Subpart B, established under the authority of RCRA. Specifically:

Section 264.14, establishing criteria for Site security.

Section 264.15, establishing criteria for inspection of the Site by the owner/operator.

Section 264.16, establishing criteria for training of personnel who will be involved in Site remediation.

40 CFR Part 264, Subpart D, which requires the development of a contingency and emergency procedures plan for the Site.

40 CFR Part 264, Subpart F, which governs releases from solid waste management units. Specifically:

Section 264.95, which requires the establishment of a point of compliance for ground-water protection standards. The performance standards established in this ROD for ground-water remediation will serve as the ground-water protection standards. A point of compliance will be established at the downgradient boundary of the final disposal site for treated soils and waste materials.

Section 264.97, which establishes requirements for a ground-water monitoring program. These requirements will be used to establish a ground-water monitoring program for the purpose of evaluating releases from the final disposal site for treated soils and waste materials.

Section 264.98, which established requirements for a detection monitoring program. This detection monitoring program will be used to evaluate potential releases from the final disposal site for treated soils and waste materials.

40 CFR Part 264, Subpart G, which governs closure of solid waste management units. Specifically:

Section 264.111, which sets forth closure performance standards.

Section 264.112, which requires the submission of a closure plan for review and approval.

40 CFR Part 268, Subpart D, which establishes treatment standards which must be achieved prior to land disposal of hazardous wastes. These regulations will establish the performance standards for treatment of contaminated soil and waste materials excavated from the Site.

Federal Ambient Water Quality Criteria (AWQC) established under the authority of Section 304(a) of the Clean Water Act.

These criteria are specifically identified in Section 121(d)(2)(A) of CERCLA as amended by SARA to be ARARs for CERCLA remedial actions. AWQC are developed as guidance for the States to develop ambient surface water quality standards that will be fully protective of human health and the environment. As such, AWQC are relevant and appropriate to the selected remedial action. Discharge of the treated effluent from this site must not result in ambient surface water concentrations that exceed chemical-specific AWQC.

SCCR Chapter 61-79, which contain the State of South Carolina regulations governing the management, treatment, storage and

disposal of hazardous wastes. These regulations are, in a manner analogous to Federal RCRA regulations, relevant and appropriate to the circumstances of the releases from this Site without being directly applicable. In addition, since the South Carolina regulations simply incorporate verbatim the Federal RCRA regulations, the sections of SCCR Chapter 61-79 corresponding to the Federal RCRA sections cited above are hereby incorporated into this ROD as relevant and appropriate requirements.

9.2.3 Criteria "To Be Considered"

CERCLA guidance recommends the identification of criteria that may be relevant and appropriate to the circumstances of the release at a site, but which do not meet the statutory definition of an ARAR. To be defined as an ARAR, a standard or criterion must be a requirement or regulation promulgated under Federal or state authority, and must be of general applicability. Other standards or criteria, known as criteria to be considered or TBCs, may be necessary in order for the remedy to be fully protective of human health and the environment. These TBCs may include EPA reference doses, cancer potency factors, drinking water health advisories or other health-based criteria.

A number of TBC criteria have been identified for ground-water remediation at the Helena Chemical NPL Site. They are based upon protection of human health via drinking water exposure, using data contained in EPA data bases regarding toxicity and/or carcinogenicity of these compounds, and also using standard assumptions regarding intake and exposure via drinking water.

The following TBC criteria have been developed based upon an incremental carcinogenic risk of 1×10^{-6}:

Aldrin	0.002 parts per billion (ppb)
alpha-BHC	0.006 ppb
beta-BHC	0.020 ppb
delta-BHC	0.006 ppb
Dieldrin	0.002 ppb
DDT	0.100 ppb
DDD	0.100 ppb
DDE	0.100 ppb

The following TBC criteria are based upon non-carcinogenic toxicity (hazard index less than 1):

Disulfoton	1.400 ppb
Endrin Ketone	2.000 ppb
Lead	15.000 ppb

In addition, the Memorandum of Agreement between EPA and the U.S. Army Corps of Engineers concerning the determination of mitigation

under the Clean Water Act Section 404(b)(1) guidelines ia also a TBC criterion for remedial actions related to wetlands mitigation at this Site.

9.3. PERFORMANCE STANDARDS

The Performance Standards for this component of the selected remedy include the following:

9.3.1. Excavation Standards

Excavation shall continue until the remaining soil and materials are contaminated at a concentration of no more than 50 parts per million (ppm) total pesticides. Total pesticides shall be determined by summing the concentrations of all pesticides found in any soil sample analyzed for the pesticides fraction of the Hazardous Substances List (HSL). Testing methods approved by EPA shall be used to determine if the allowable pesticide concentration levels have been achieved.

9.3.2. Treatment Standards

Since the remedy also specifies land disposal of the treated waste, the LDR-based ARARs are also performance standards for the residue left after treatment of the soils and waste. These performance standards are found in 40 CFR Part 268, Subpart D, Section 268.43. They are:

From Table CCW[1]:

Aldrin	66 parts per billion (ppb)
BHC, all isomers, total	660 ppb
Chlordane, total	130 ppb
Dieldrin	130 ppb
Disulfoton	100 ppb
DDT, DDE, DDD, total	87 ppb
Endrin	130 ppb
Endosulfan, all isomers, total	66 ppb
Endosulfan sulfate	130 ppb
Heptachlor	66 ppb
Heptachlor epoxide	66 ppb
Methoxychlor	180 ppb
Toxaphene	1300 ppb

Note 1: Compliance to be determined by grab samples of treatment residue.

9.3.3. Ground-Water Remediation Standards

Groundwater shall be extracted until the following Maximum Concentration Levels (MCLs) are attained at the wells designated during remedial design by EPA as compliance points.

Aldrin	0.002	parts per billion (ppb)
Benzene	5.0	ppb
alpha-BHC	0.006	ppb
beta-BHC	0.02	ppb
delta-BHC	0.006	ppb
Chlordane	2.0	ppb
Chromium	100.0	ppb
Dieldrin	0.002	ppb
DDT	0.1	ppb
DDD	0.1	ppb
DDE	0.1	ppb
Endrin	2.0	ppb
Lead	15.0	ppb
Lindane	0.2	ppb
Toxaphene	3.0	ppb
Heptachlor	0.4	ppb

9.3.4 Storm Water Discharges

Final Site grading and drainage shall comply with the substantive design criteria contained in SCCR Chapter 61-72, Section 72.307.

9.3.5 Wetlands Mitigation

Wetlands mitigation actions taken as part of this remedy shall comply with the substantive requirements of 40 CFR Part 230, Subparts B and H, promulgated under the authority of the Clean Water Act. These regulations govern the mitigation of impacts to jurisdictional wetlands associated with the placement of fill material in waters of the United States and any secondary adverse impacts resulting from that placement. Quantitative performance standards shall be established as part of remedial design activities.

Mitigation activities shall also comply with the requirements of 40 CFR Part 6, Subpart C, promulgated under the authority of the National Environmental Policy Act. Specifically:

> Section 6.302(a), governing protection of wetlands, including referenced Appendix A to 40 CFR Part 6. These regulations incorporate Federal Executive Order 11990 into Federal regulation.

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 and incidental ingestion 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 adjacent jurisdictional waters.

In addition, the remedy selected to address the contamination of surface waters and sediments in the on-Site and adjacent wetlands (mitigation as per CWA Section 404 guidelines) will be protective of the environment.

Compliance with ARARs: The selected remedy will meet ARARs, which are listed in Section 9.2 of this ROD.

Cost effectiveness: The selected soil remedy component is the most cost effective of the alternatives considered. Among the 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 treatment method for which costs can be reliably predicted 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. All 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 achieves the best compliance with the five balancing criteria described in the NCP.

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 also satisfy the preference, due to the treatment of soils by the selected technology, HPD/biodegradation. Likewise, the contingency remedy fully satisfies this preference.