United States
Environmental Protection
Agency

Office of
Emergency and
Remedial Response

EPA/ROD/R04-92/112
September 1992

EPA

Superfund Record of Decision:

Carrier Air Conditioning, TN

NOTICE

The appendices listed in the index that are not found in this document have been removed at the request of the issuing agency. They contain material which supplement, but adds no further applicable information to the content of the document. All supplemental material is, however, contained in the administrative record for this site.

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. EPA/ROD/R04-92/112	2.	3. Recipient's Accession No.

4. Title and Subtitle
SUPERFUND RECORD OF DECISION
Carrier Air Conditioning, TN
First Remedial Action - Final

5. Report Date
09/03/92

6.

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401 M Street, S.W.
Washington, D.C. 20460

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800/000

14.

15. Supplementary Notes
PB93-964019

16. Abstract (Limit: 200 words)

The 135-acre Carrier Air Conditioning site is an active manufacturing facility in the Town of Collierville, Shelby County, Tennessee. Land use in the area is predominantly industrial, with the nearest residential area approximately 100 feet north of the site boundary. Two aquifer units have been identified at the site: a shallow class IIIa aquifer, which is not used as a drinking water source; and the Memphis Sand, a class IIa aquifer, which lies below the shallow aquifer and is currently used as a drinking water source. The Town of Collierville purchased the site property and installed a well field for potable water on the northwest corner of the site, known as Water Plant 2, which currently provides up to 1.4 million gallons per day of potable water to the Town of Collierville. In 1967, Collierville leased the site property, buildings, and equipment to Carrier to manufacture residential heating and air-conditioning units. During the manufacturing process, aluminum sheeting is stamped and assembled with copper tubing to form air heat exchangers. Stamping and forming oils and dirt are removed prior to assembly. Until recently, trichloroethylene (TCE) was used onsite as

(See Attached Page)

17. Document Analysis a. Descriptors
Record of Decision - Carrier Air Conditioning, TN
First Remedial Action - Final
Contaminated Media: soil, sludge, gw
Key Contaminants: VOCs (PCE, TCE), metals (lead, zinc)

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report) None	21. No. of Pages 62
	20. Security Class (This Page) None	22. Price

(See ANSI-Z39.18) *See Instructions on Reverse*

OPTIONAL FORM 272 (4-77)
(Formerly NTIS-35)
Department of Commerce

Abstract (Continued)

the primary solvent for degreasing and cleaning parts. In 1979, a TCE release from a storage area resulted in the removal of asphalt pavement and underlying soil from the parking area, which was affected by the spill. It also was discovered that an onsite wastewater lagoon had accepted waste contaminated with TCE and zinc. In response to a second release in 1985, both a massive soil excavation and disposal action were conducted to remove TCE contamination. Monitoring wells also were installed at the facility. In 1986, one of the wells from Water Plant 2 was found to be contaminated with low levels of TCE. In 1987, Carrier purchased the site property, except for the municipal well area. In 1990, Carrier installed air strippers at Water Plant 2 to remove TCE and its degradation products. This ROD addresses a final remedy for the contaminated soil, sludge, and ground water at the Carrier facility and is the only ROD planned for the site. The primary contaminants of concern affecting the soil, sludge, and ground water are VOCs, including TCE and PCE; and metals, including lead and zinc.

The selected remedial action for this site includes treating an estimated 76,500 cubic yards of contaminated soil/sludge and shallow ground water in the old lagoon and main plant source areas using soil vapor extraction (SVE); extracting and containing ground water from the Memphis Sand aquifer using the existing and supplemental extraction wells with treatment using the air strippers at Water Plant 2, followed by discharge of the treated ground water to the municipal water supply, a local POTW, surface water, or reinjecting it to the Memphis Sand aquifer; treating any air emissions from the SVE or the air stripping processes using granular activated carbon, thermal treatment, or photolytic oxidation, if necessary; implementing institutional controls deed restrictions to limit well construction and water use near the site; and conducting periodic monitoring. The estimated present worth cost for this remedial action ranges from $5,700,000 to $7,900,000, which includes a total O&M cost of $5,489,334 for 30 years.

PERFORMANCE STANDARDS OR GOALS: The chemical-specific soil clean-up level is 533 ug/kg for TCE, based on fate and transport modeling for TCE leachate, which would not contaminate the ground water above the maximum concentration level for TCE established under the SDWA. The ability to achieve 533 ug/kg cannot be determined until after the extraction system has been implemented. EPA may set an alternate clean-up level when it is determined that contaminant levels have ceased to decline over time and are remaining constant at some statistically significant level above remediation levels, as verified by soil sampling. The chemical-specific ground water clean-up levels are based on SDWA MCLs, MCLGs, and UIC regulations; CWA Discharge Limitations and Pretreatment standards; and/or the Tennessee Water Quality Act. These levels include TCE 5 ug/l; cis-DCE 70 ug/l; trans-DCE 100 ug/l; PCE 5 ug/l; vinyl chloride 2 ug/l; zinc 5,000 ug/l; and lead 15 ug/l or background levels.

CARRIER AIR CONDITIONING SUPERFUND SITE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

RECORD OF DECISION

RECORD OF DECISION
CARRIER A.C. SITE

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DECLARATION FOR THE RECORD OF DECISION

SITE NAME AND LOCATION

Carrier Air Conditioning Site
97 Byhalia Road
Collierville, Tennessee 38017

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial action for the Carrier Air Conditioning Site, in Collierville, Tennessee, which was chosen in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision document is based on the Administrative Record for this Site.

The Tennessee Department of Environment and Conservation concurs with the selected remedy.

ASSESSMENT OF THE SITE

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

DESCRIPTION OF THE REMEDY

This final remedy addresses remediation of soils and groundwater contamination by eliminating or reducing the risks posed by the Site, through treatment, engineering and institutional controls.

The major components of the selected remedy include:

> Contaminated soils and shallow groundwater in the old lagoon and main plant source areas will be remediated using soil vapor extraction.
>
> Contaminated groundwater will be removed from the Memphis Sands aquifer using the existing extraction wells (at the City of Collierville Water Plant 2) and with supplemental wells. The contaminated groundwater will be treated by air stripping.
>
> Extracted groundwater after treatment will be (1) utilized in the municipal water supply; (2) discharged to a local publicly owned treatment works (POTW); (3) discharged to surface water; or (4) reinjected to the Memphis Sands aquifer.

Periodic monitoring will be conducted to assess the effectiveness of the remedy for a period up to 30 years.

Institutional controls will be placed on well construction and water use in the general area of the Site.

STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial action and is cost-effective. This remedy utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable and satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element. Because this remedy will result in hazardous substances remaining onsite above health-based levels, a review will be conducted at least every five years beginning no later than five years from commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment. Reviews may be conducted on a more frequent basis as EPA deems necessary.

9/3/92
Date

Greer C. Tidwell
Regional Administrator

DECISION SUMMARY

1.0 SITE NAME, LOCATION, AND DESCRIPTION

1.1 Site Location

The Carrier Air Conditioning Site (also referred to as the Collierville Site) is located on the western side of the Town of Collierville, Shelby County, Tennessee. Shelby County, TN is located in the southwest portion of the State. The Site is located near the intersection of Poplar Avenue (U.S. Highway 72) and Byhalia Road. The address is 97 South Byhalia Road, Collierville, TN 38017. Collierville is located approximately 21 miles east of downtown Memphis, TN. Figure 1-1 is a location map showing the Carrier A.C. Site and vicinity. Figure 1-2 shows the Site itself and relevant features.

1.2 Site Topography

Currently the Site slopes gently to the South and West. The Site has been graded and filled in various locations in order to change drainage patterns and adapt the land for manufacturing use. In general the western portion of the property has been graded and leveled, with excess dirt moved to the areas under Buildings A and F. A pond located at the western edge of the Main Plant has been filled. A drainage ditch running east/west on the western side of the property was removed and an intermittent stream was rerouted around the area which became the Main Plant.

1.3 Geologic/Hydrogeologic Setting

The Memphis/Shelby County area is situated in two major physiographic subdivisions: the Mississippi Alluvial Plain and the Gulf Coastal Plain. The Carrier A.C. Site is located in the Gulf Coastal Plain which is distinguished by gently rolling topography and a characteristic thick layer of loess deposited during Pleistocene glaciation. Anomalous areas of loess deposition are associated with alluvial plains of Mississippi River tributaries that cross the area. These rivers include the Wolf River, the Loosahatchie River, and Nonconnah Creek. Nonconnah Creek runs through the Site boundaries.

Unconsolidated deposits, up to 3000 feet, overlie bedrock in the Memphis/Shelby County area. The sediments consist primarily of sand, clay, gravel, silt, and some lignite. The principal freshwater aquifers in the designated area are 1) the alluvium, 2) fluvial (terrace) deposits, 3) the Memphis Sand, and 4) the Fort Pillow Sand. The alluvium and fluvial deposits are separated in most areas from the Memphis Sands by the Jackson-upper Claiborne confining layer (locally referred to as the Jackson Clay). The Memphis Sands and the Fort Pillow Sands are separated by the Flour Island confining layer.

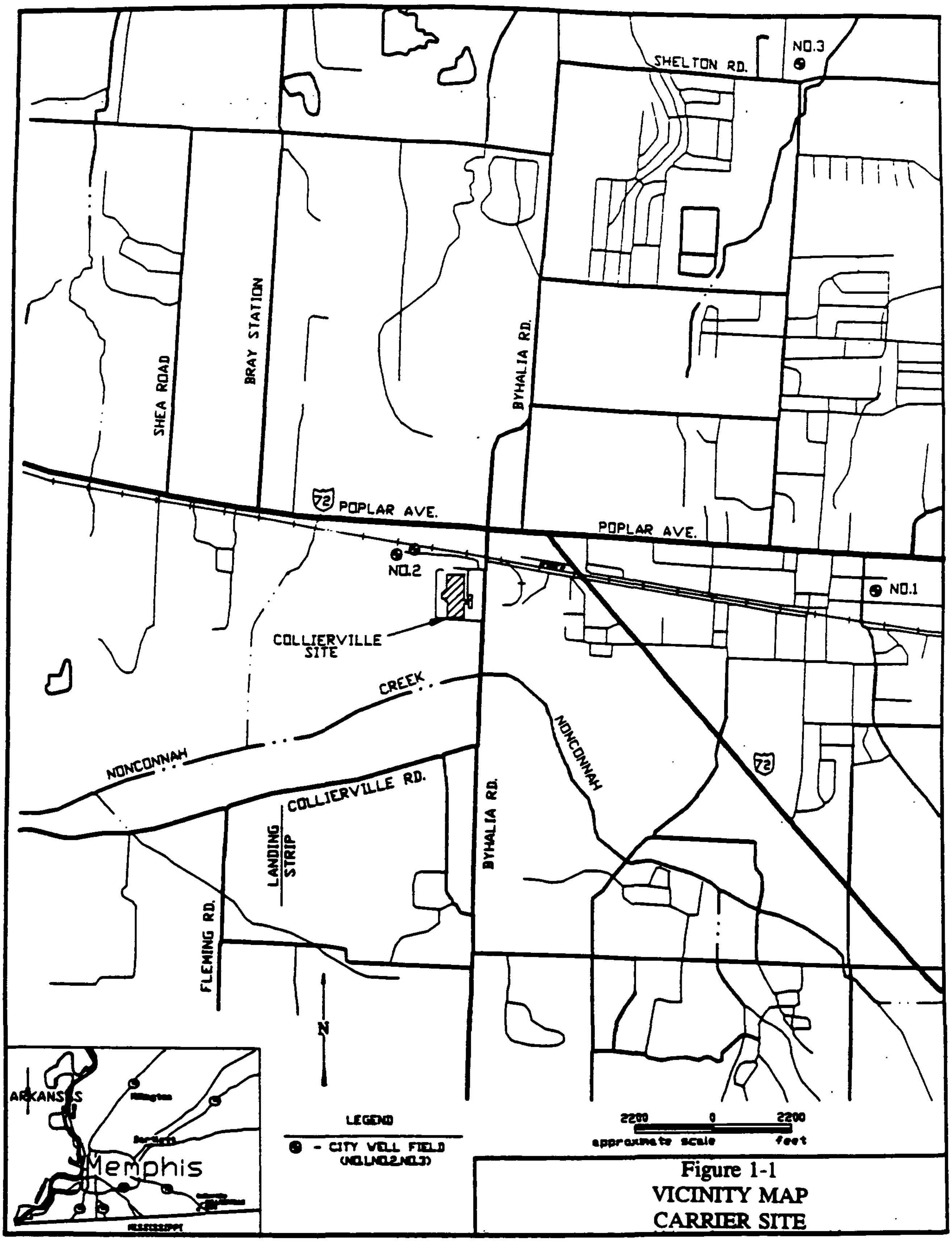


Figure 1-1
VICINITY MAP
CARRIER SITE

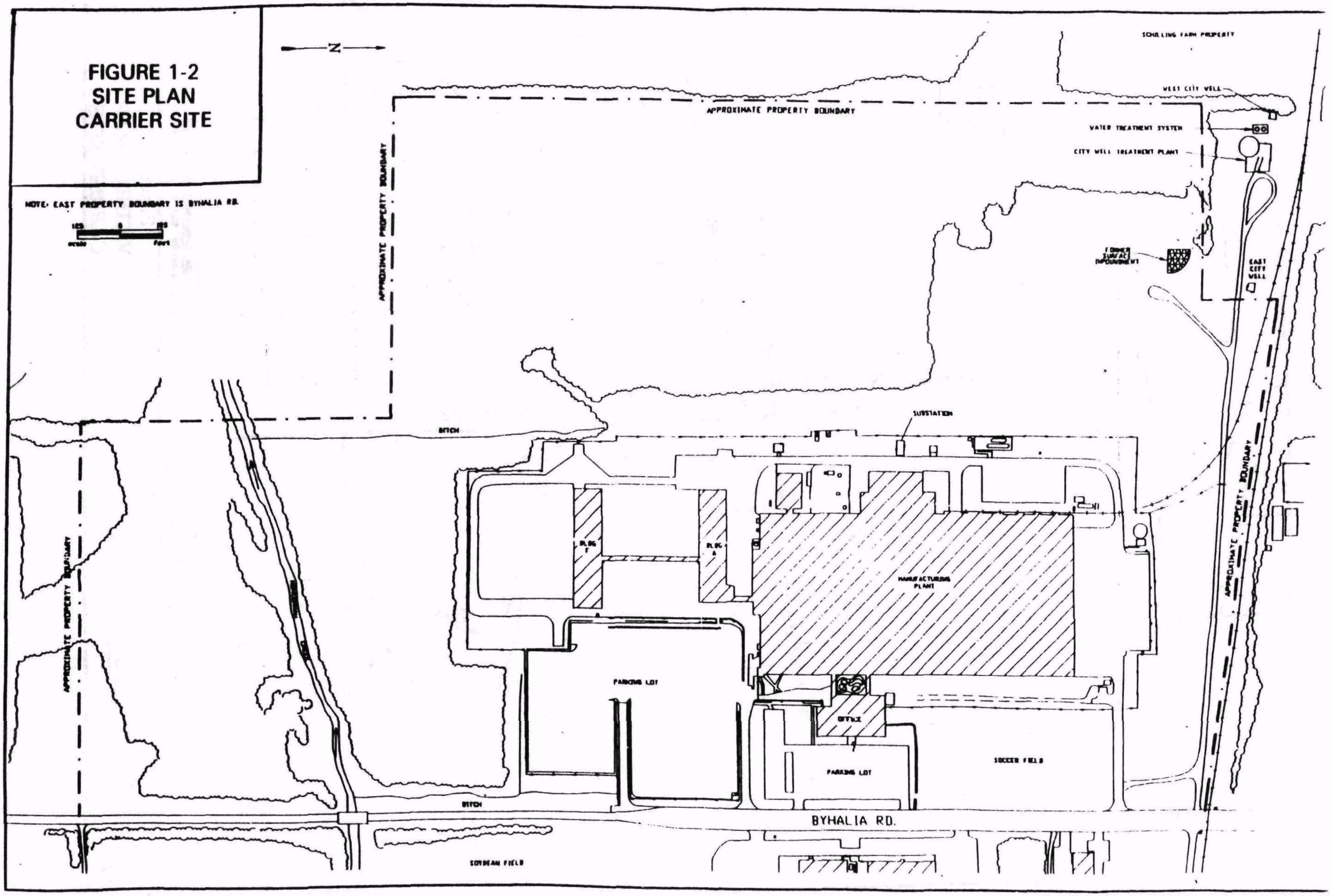


FIGURE 1-2
SITE PLAN
CARRIER SITE

Two aquifer units have been identified at the Site: (1) intermittent shallow water in the alluvial and fluvial deposits overlying a semi-confining clay unit, and (2) the Memphis Sand aquifer. The alluvium and fluvial deposits show inconsistencies throughout the region. The intermittent characteristic of shallow groundwater is due to undulations in the surface of the clay layer. These undulations capture and direct percolating groundwater along the top of the clay layer. The clay layer thins to non-existence between the Carrier plant building and Nonconnah Creek, resulting in a direct exchange between the shallow aquifer, where present, and the deeper Memphis Sand aquifer. The Memphis Sand consists of massive beds of fine to coarse grained well-rounded to sub-angular sand and gravels intercalated with thin lenses and beds of silt, clay and argillaceous, micaceous and lignitic materials. The Memphis Sand is confined throughout most of the Memphis area, except in the eastern and southeastern portions of Shelby County. The Fort Pillow Sand is artesian throughout the Memphis area and including the Carrier Site. Vertical interaquifer exchange between the Memphis Sand and the Fort Pillow Sand is restricted by the low hydraulic conductivity associated with the Flour Island confining layer.

The shallow aquifer is classified as a IIIA aquifer - groundwater not used as a drinking water source and has limited beneficial use. Also, this aquifer is highly to intermediately interconnected to adjacent groundwater units of a higher class and/or surface waters. The Memphis Sand is a Class IIA aquifer - groundwater that is currently used as a drinking water source and having other beneficial uses.

1.4 Meteorology

Collierville's climate is typical of the Memphis region which is humid with summer temperatures ranging from the low 80°s F to 100° F; and winter temperatures in the 40°s F. Average humidity is 50 to 60 percent. Average rainfall is 56 inches per year. Evapotranspiration averages 40 inches, most of which occurs between May and October. Average wind speed is 10 miles per hour in winter and 7 miles per hour in summer. Predominant wind direction is to the north-northeast.

2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

2.1 Facility Operations and History

The Site consists of approximately 135 acres owned principally by Carrier Corporation (Carrier) which operates a manufacturing facility on the property. In 1967, the Town of Collierville purchased the Site property from Robert and Grace Snowden. That same year, the Town of Collierville constructed industrial buildings and purchased industrial equipment for the Site. The property, buildings and equipment were leased to Carrier on March 1, 1967. In 1982, the lease was amended to exclude the northwest portion of the property where the Town of Collierville municipal wells are located. On December 14, 1987, Carrier purchased all the property included in the lease with the Town of Collierville.

In 1967 the Town of Collierville installed a well field for potable water on the northwest corner of the Site. The operation consists of two extraction wells, described as the West Well and the East Well, a treatment (aeration and chlorination) plant, and a storage tank. This operation is identified as Water Plant 2 and provides up to 1.4 million gallons per day of potable water to the Town of Collierville.

Carrier began manufacturing residential heating and air conditioning units in the late 1960s. Carrier's use consists primarily of four buildings: the main plant which is an assembly plant for air conditioning units, buildings A and F which contain storage and supporting operations, and an office building. In the process of assembling air conditioning units, aluminum sheeting is stamped and assembled with copper tubing to form air heat exchangers. Stamping and forming oils and dirt are removed from these parts prior to final assembly. Trichloroethylene (TCE) was, until recently, the primary solvent used to degrease and clean these parts. Two discrete releases (in 1979 and 1985) of TCE occurred from solvent storage systems to an area just south of the main manufacturing building. In addition, a wastewater lagoon, operated from about 1972 to 1979, apparently accepted waste contaminated with TCE and zinc.

Removal actions were conducted at the former lagoon in 1979 and both near-plant spill areas in 1979 and 1985. At the lagoon, approximately one foot of sludge was removed. Asphalt pavement and underlying soils were removed from the parking area affected by the 1979 spill of TCE from a degreaser vent pipe. In 1985, about 500 gallons of TCE from a nearby aboveground storage tank pipe were released. A massive soil excavation and disposal action was conducted to remove the affected soils. As a result of the spill, monitoring wells were installed at the facility.

Since the 1985 spill, the Tennessee Department of Environment and Conservation (TDEC) continued groundwater monitoring at the Site on a regular basis. In July 1986, one of the extraction wells in the Town of Collierville's Water Plant 2 was found to be contaminated with low levels of TCE. Although low levels of TCE were found in both wells of Water Plant 2, no TCE was found in any of the other City municipal water plants. Operation of the wells and the existing plants has continued under frequent monitoring. In 1990, packed aeration towers, also called air strippers, were installed by Carrier at Water Plant 2 to to remove TCE and its degradation products from raw water prior to entry into the chlorination system. The treatment system was designed to handle incoming TCE concentrations of up to 200 $\mu g/\ell$. Design, construction, and operation of this system was coordinated with and approved by the Tennessee Department of Water Supply (which permits water treatment systems), the Memphis Shelby County Health Department, Bureau of Pollution Control (which has delegated authority for air emissions permitting), the State of Tennessee Division of Superfund, and the Town of Collierville. EPA Region IV was kept informed of the action.

In 1987 and 1988, Carrier conducted an extensive Site investigation under an agreement with the TDEC. Sampling indicated measurable amounts of TCE in the soils and smaller amounts in the groundwater at the Site. The Site investigation also confirmed the earlier finding of low TCE concentrations in the groundwater from Water Plant #2.

2.2 Enforcement Activities

In March 1987, the Site was placed on the TDEC's List of Hazardous Substance Sites. In June 1988, it was proposed for inclusion on EPA's National Priorities List (NPL), and became final in 1990.

On November 7th and 10th, 1988, EPA sent general notice letters to the following entities:

1. Town of Collierville
2. Carrier Corporation

The letters notified the potentially responsible parties (PRPs) of their potential responsibility for the release of hazardous substances at the Carrier Air Conditioning Site in Collierville, Tennessee. A special notice letter sent to Carrier requested that they conduct a Remedial Investigation and Feasibility Study (RI/FS) for the Site. On September 28, 1989, the Carrier Corporation and EPA entered into a Consent Order under which Carrier agreed to conduct the RI/FS.

3.0 COMMUNITY PARTICIPATION HIGHLIGHTS

Public participation requirements in CERCLA §§ 113(k)(2)(B)(i-v) and 117 were met in the remedy selection process. The Community Relations Plan was finalized April 25, 1990 for the Carrier Air Conditioning Superfund Site. This document lists contacts and interested parties throughout the government and the local community. The Plan also establishes communication pathways to assure timely dissemination of pertinent information.

On May 8, 1990, EPA held a public information session to announce the Carrier Site RI/FS start.

The RI/FS Reports and Proposed Plan for the Carrier Air Conditioning Site were released to the public on April 18, 1992. These two documents were made available to the public in both the Administrative Record and the information repository maintained at the Memphis/Shelby County Public Library, Collierville Tennessee and the EPA Region IV Records Center. The notice of the availability of these two documents was published in *The Collierville Herald* and *The Independent* on April 16, 1992. A public comment period was held from April 21, 1992 through May 21, 1992. An extension to the public comment period was not requested. In addition, a public meeting was held on April 30, 1992. At this meeting, representatives from EPA, TDEC, and the Town of Collierville answered questions about problems at the Site and the remedial alternatives under consideration. A transcript of the public meeting and response to the comments received during the public comment period are included in the Responsiveness Summary, which is part of this Record of Decision. This decision document presents the selected remedial action for the Carrier Air Conditioning Superfund Site, chosen in accordance with CERCLA, as amended by SARA, and, to the extent practicable, the National Contingency Plan. The decision for this Site is based on the Administrative Record.

4.0 SCOPE AND ROLE OF RESPONSE ACTION

The selected remedy for the Site is intended to address the threats to human health and the environment. This remedial action will remove the threat posed by contaminated groundwater and soil at the Site. Remediating the soils will prevent the contaminants from adversely impacting the groundwater. Remediating groundwater will prevent ingestion or inhalation of contaminated groundwater at or above the Maximum Contaminant Levels (MCLs) and will restore groundwater to contamination levels below MCLs. This is the only ROD contemplated for the Site.

5.0 SUMMARY OF SITE CHARACTERISTICS

5.1 Nature and Extent of Contamination

Results of the Carrier Site Remedial Investigation (RI) show varying levels of TCE contamination on the property. Results from soil and groundwater sample analyses, and soil-vapor screening data confirm that the two spill areas and the former lagoon area are the sources of contamination of Site soils and groundwater. Tables 5-1, 5-2, and 5-3 summarize groundwater and soil analytical data collected during the RI. Figure 5-1 shows the location of the three source areas.

On July 15, 1986, the Town of Collierville's west well in Water Plant 2 adjacent to the Site was sampled by TDEC and found to contain TCE. Subsequent analyses conducted on a bimonthly basis have shown values of TCE in the untreated water from the west well ranging from 45 to 290 $\mu g/\ell$. Values in the east well have ranged from 5 to 34 $\mu g/\ell$ for the untreated waters. Values in treated water, prior to chlorination, averaged 4 $\mu g/\ell$, prior to the installation of a treatment system to remove TCE and have since been consistently less than 2 $\mu g/\ell$.

In addition to the Town of Collierville's Water Plant 2, 15 private wells have been identified by TDEC within three miles of the Site. Analyses of these wells by TDEC in September and October 1986 were negative for TCE to a detection limit of 0.1 $\mu g/\ell$. Private wells were again sampled in the RI with no TCE detected at a detection limit of 5 $\mu g/\ell$.

As part of the RI, soil samples collected within areas suspected to be impacted by the spills indicate a wide range of levels of contamination. Samples from these areas ranged in concentration from < 0.5 μg/kg to 1,550,000 μg/kg TCE. The greatest concentrations (B-4,

TABLE 5-1
Summary of Groundwater Results

Parameter	Sampling Period/ Phase	No. Samples	No. Hits	Range, µg/l	Mean, µg/l
TRICHLOROETHENE	12/89	15	10	38-4400	1230
	4/90	17	10	9-14000	2800
	8/90	20	12	20-24000	3850
	11/90	25	13	23-7300	1840
	2/91	23	9	59-8700	2350
	4/91	23	11	8-12500	4400
	8/91	25	15	5-37000	3800
1,2-DICHLOROETHENE	12/89	15	7	7-5300	1530
	4/90	17	6	50-5400	2720
	8/90	20	8	5-3900	830
	11/90	25	9	8-12000	1480
	2/91	23	9	11-12000	1560
	4/91	23	7	7.2-6900	1200
	8/91	25	7	3-370	125
1,1-DICHLOROETHENE	11/90	25	2	9-14	12
	2/91	23	1		7.9
	4/91	23	1		4.75
	8/91	25	1		9
1,1,1-TRICHLOROETHANE	12/89	15	1		44
	4/90	17	0		
	8/90	20	0		
	11/90	25	1		120
	2/91	23	1		32
	4/91	23	2	135.2-824	480
	8/91	25	1		69
TETRACHLOROETHENE	12/89	15	0		
	4/90	17	0		

TABLE 5-1
Summary of Groundwater Results

Parameter	Sampling Period/ Phase	No. Samples	No. Hits	Range, µg/l	Mean, µg/l
TETRACHLOROETHENE	8/90	20	0		
	11/90	25	0		
	2/91	23	1		27
METHYLENE CHLORIDE	12/89	15	0		
	4/90	17	2	7-160	85
	8/90	20	0		
	11/90	25	1		7
	2/91	23	2	27-35	31
	4/91	23	6	8-997	210
	8/91	25	7	3-11	6
ACETONE	12/89	15	2	200-320	260
	4/90	17	6	12-860	450
	8/90	20	0		
	11/90	25	1		6
	2/91	23	8	7.2-156	45
	4/91	23	4	3.2-790	250
	8/91	25	5	9.1-50	24
CARBON DISULFIDE	12/89	15	0		
	4/90	17	3	9-75	34
	8/90	20	0		
	11/90	25	3	7.58	24
	2/91	23	2	11-78	45
	4/91	23	1		17.1
	8/91	25	1		11
VINYL CHLORIDE	11/90	25	2	1-5	3
	2/91	23	1		3.4
	4/91	23	2	2.27-8.51	5.5
	8/91	25	0		

TABLE 5-1
Summary of Groundwater Results

Parameter	Sampling Period/ Phase	No. Samples	No. Hits	Range, µg/l	Mean, µg/l
TOLUENE	11/90	25	1		5
	4/91	23	0		
	8/91	25	1		7
1,2-DICHLOROETHANE	2/91	23	1		43
trans 1,3-DICHLOROPROPENE	2/91	23	1		46
	4/91	23	0		
	8/91	25	1		7.4
BROMODICHLOROMETHANE	2/91	23	1		42
DIBROMOCHLOROMETHANE	4/91	23	1		824
cis 1,3-DICHLOROPROPENE	2/91	23	1		37
BROMOCHLOROMETHANE	2/91	23	1		48
LEAD	12/89	15	3	4-106	42
	4/90	16	9	2.4-152	43
	8/90	20	20	1.4-54.2	19
	11/90	25	21	1.1-278	30
	2/91	26	11	4.9-198	50
	4/91	19	12	3.9-454	134
	8/91	25	17	1-246	80
ZINC	12/89	15	14	2.2-21900	4010
	4/90	16	15	20.6-30300	6800
	8/90	20	19	11-19800	4840
	11/90	25	21	12-146000	11650
	2/91	26	24	10-30500	5600

TABLE 5-2
Summary of Town Well Raw Water Samples

Parameter	Sampling Period/ Phase	No. Samples	No. Hits	Range, μg/ℓ	Mean μg/ℓ	Standard Deviation, μg/ℓ
TRICHLOROETHENE	8/90	6	3	2-27	12	13
	11/90	6	2	34-45	40	8
	4/91	2	2	20-103	61.5	41.5
	8/91	2	2	5-290	147.5	142.5
	11/91	2	2	11-79	45	34
1,2-DICHLOROETHENE	8/90	6	0			
	11/90	6	0			
	4/91	2	0			
	8/91	2	0			
	11/91	2	0			
VINYL CHLORIDE	8/90	6	0			
	11/90	6	0			
	4/91	2	0			
	8/91	2	0			
	11/91	2	0			
LEAD	8/90	6	6	1.2-7.6	4	2
	11/90	6	1		3	
	4/91	2	2	28.2-42	35.1	6.9
	8/91	2	2	27-45	36	9
	11/91	2	0			
ZINC	8/90	6	6	10-272	57	96
	11/90	6	5	11-115	56	40
	4/91	2	2	1390-3350	2370	980
	8/91	2	2	1290-6680	3985	2695
	11/91	2	0			

TABLE 5-3
Summary of Soils Results

Parameter	Sampling Period/ Phase	No. Samples	No. Hits	Range, µg/kg	Mean, µg/kg	Standard Deviation, µg/kg
TRICHLOROETHENE		56	8	8-1,200,000	152000	420000
1,2-DICHLOROETHENE		56	3	14-200	78	110
TETRACHLOROETHENE		56	1		11	
1,1,2-TRICHLOROETHANE		56	1		26	
TOLUENE		56	4	6-87	40	60
2-BUTANONE		56	1		190	
ACETONE		56	3	12-35	26	13
LEAD (mg/kg)		39	33	0.67-21.4	7	4
ZINC (mg/kg)		39	26	3.3-77.8	33	15

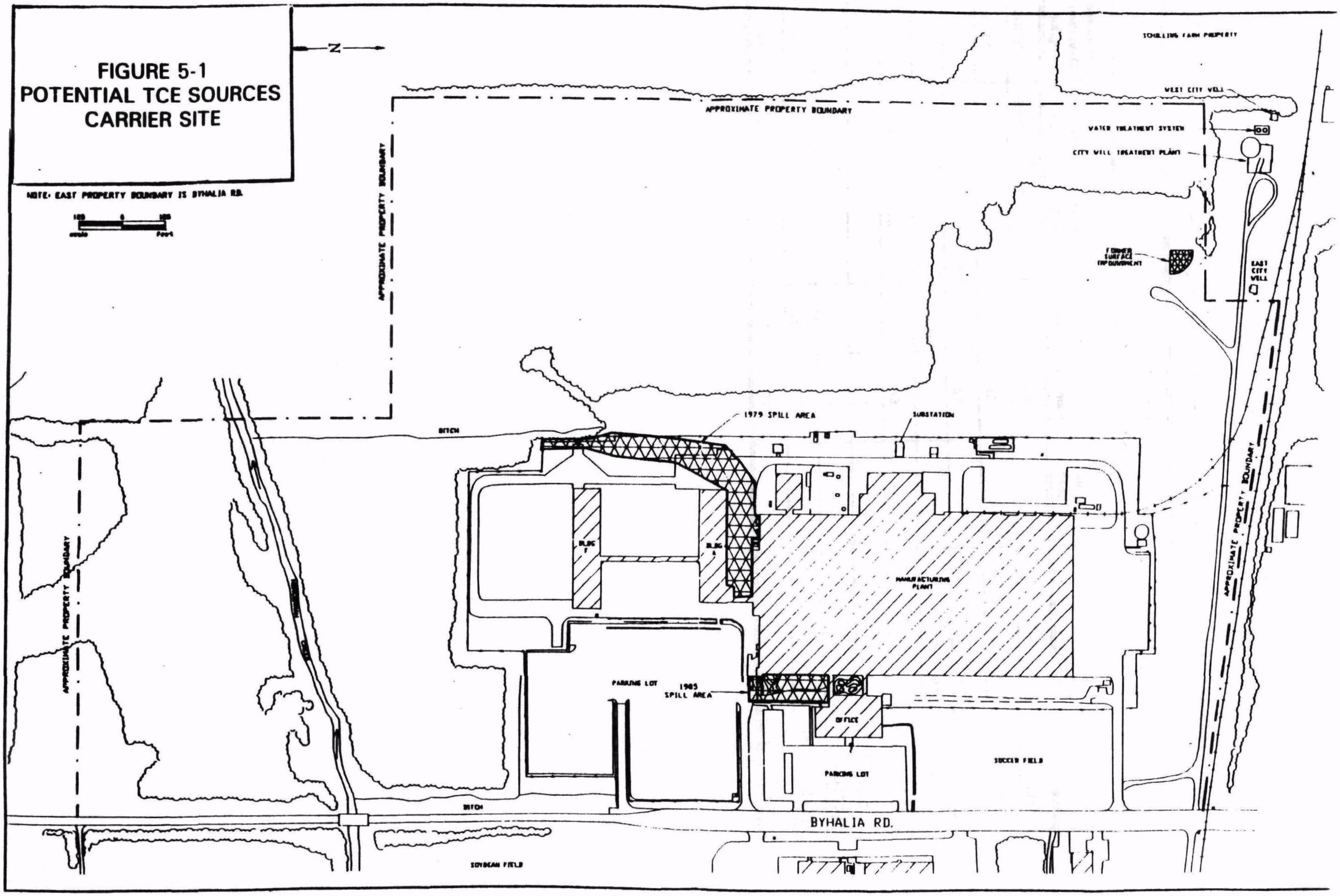


FIGURE 5-1
POTENTIAL TCE SOURCES
CARRIER SITE

B-9, B-21, and B-38) were from those areas more directly associated with the 1979 degreaser spill. The vertical extent of TCE contamination is variable throughout the Site. Soil screening methods indicate that many of the sample's concentration levels decrease with depth. However, there are samples which indicate an increase in concentrations as the zone of saturation in the shallow aquifer is approached. Soil samples collected from the former lagoon area (borings B-17, B-18, B19, and B-40) confirm the presence of TCE. Figures 5-2 and 5-3 are isocon maps which graphically display the TCE soil testing results in the plant and lagoon areas.

Upon completion of the RI, 37 groundwater monitoring wells (identified generally in this ROD as MWs) were present at the Site.

Concentrations of chlorinated hydrocarbons consisting primarily of TCE and *cis* and *trans* isomers of 1,2-dichloroethene (DCE) were found in samples collected from most of the monitoring wells screened in the upper aquifer.

The latter compound and vinyl chloride are natural degradation products of TCE. Total chlorinated hydrocarbon (TCH) concentrations in these wells range from 70 $\mu g/\ell$ at MW-23 to 19,900 $\mu g/\ell$ at MW-19 during the last RI sampling period in February 1991. Figures 5-4 and 5-5 are facility layouts that identify all onsite and offsite monitoring wells.

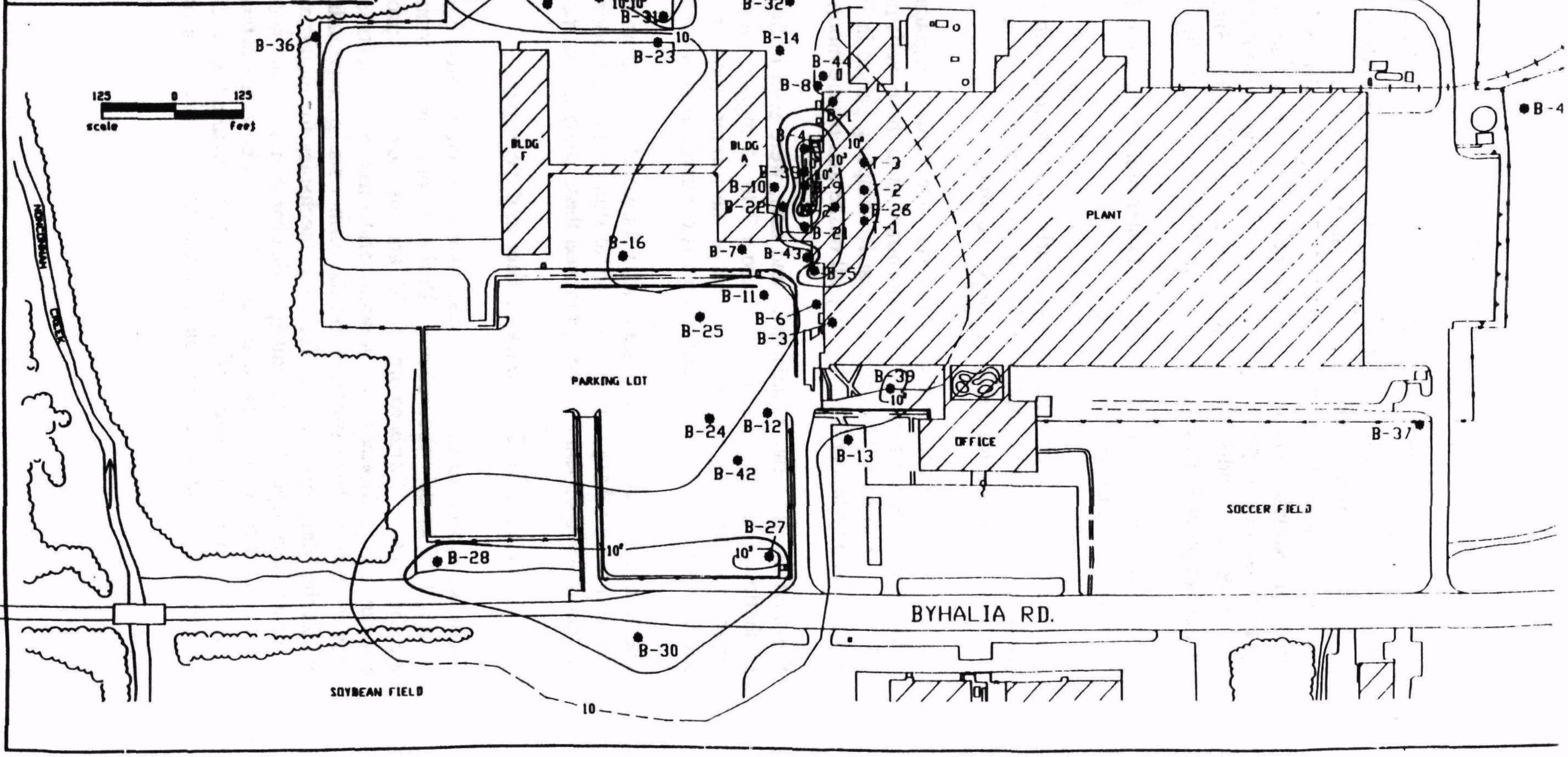
Elevated levels of two metals, lead and zinc, were seen in Site shallow groundwater samples. In shallow soils, lead values range from 7 to 15 mg/kg. Average lead values decrease with depth in virtually all Site soils, except at the former lagoon area. Zinc values show a similar pattern. Otherwise, no pattern of metals contamination or a source area has been defined.

The former lagoon area may serve as a source of zinc due to the use of zinc phosphate on the Site and the discharge of zinc phosphate sludges to the lagoon. However, the closure of the lagoon in 1980 appears to have removed these sludges and residual concentrations are low.

5.2 Contaminant Distribution, Fate and Transport

There have been three documented sources of chlorinated hydrocarbon contamination at the Carrier Site as described above. Residual contaminants from these source areas are still in specific areas. Furthermore, TCE and its degradation products have been identified in groundwater. Groundwater contamination has been identified at the Carrier Site in close proximity to the 1979 spill site and the former sludge impoundment in the shallow aquifer, and within the Memphis Sand aquifer. The mechanics for migration of TCE from the source areas to the aquifers depend on solvent-specific characteristics, site-specific geology and hydrogeology. With respect to solvent characteristics, TCE has been characterized as an immiscible fluid with a density greater than that of water, and is classified as a dense non-aqueous-phase liquid. Figure 5-6 illustrates the possible mechanisms for movement of TCE in both soils and

FIGURE 5-2
ISOCONS OF MAXIMUM TCE VALUES FOR SOIL BORINGS IN MAIN PLANT AREA CARRIER SITE



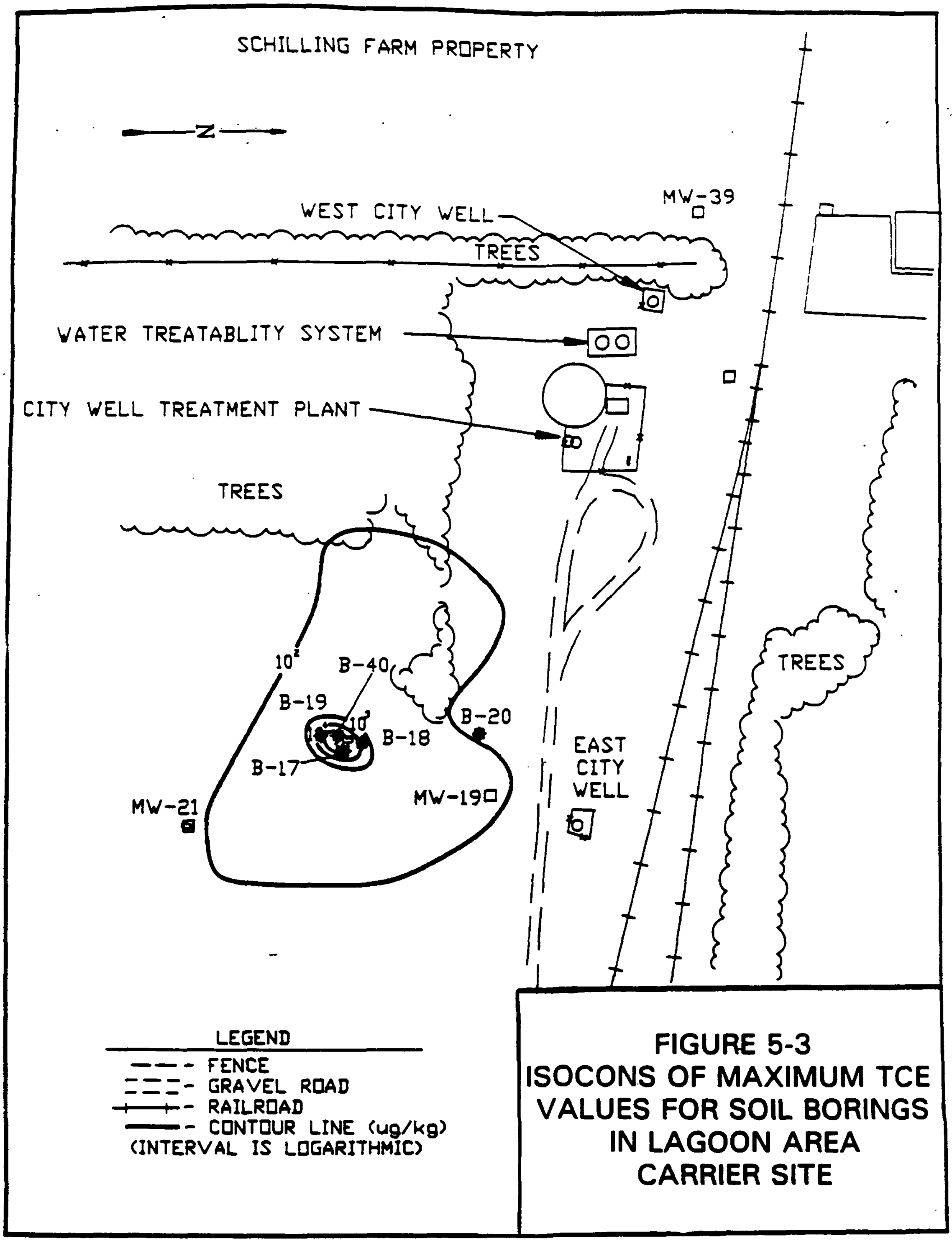


FIGURE 5-3
ISOCONS OF MAXIMUM TCE VALUES FOR SOIL BORINGS IN LAGOON AREA CARRIER SITE

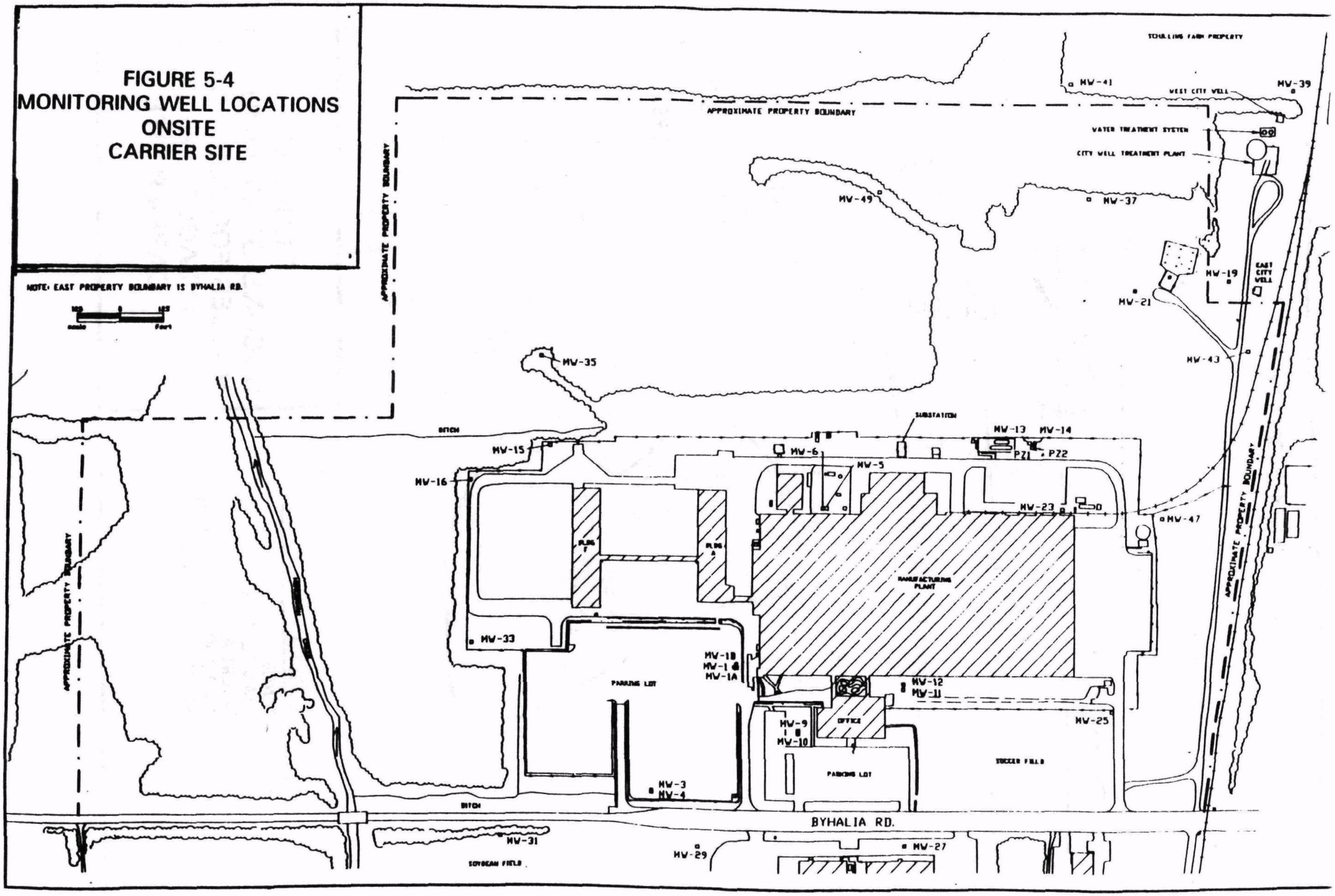


FIGURE 5-4
MONITORING WELL LOCATIONS
ONSITE
CARRIER SITE

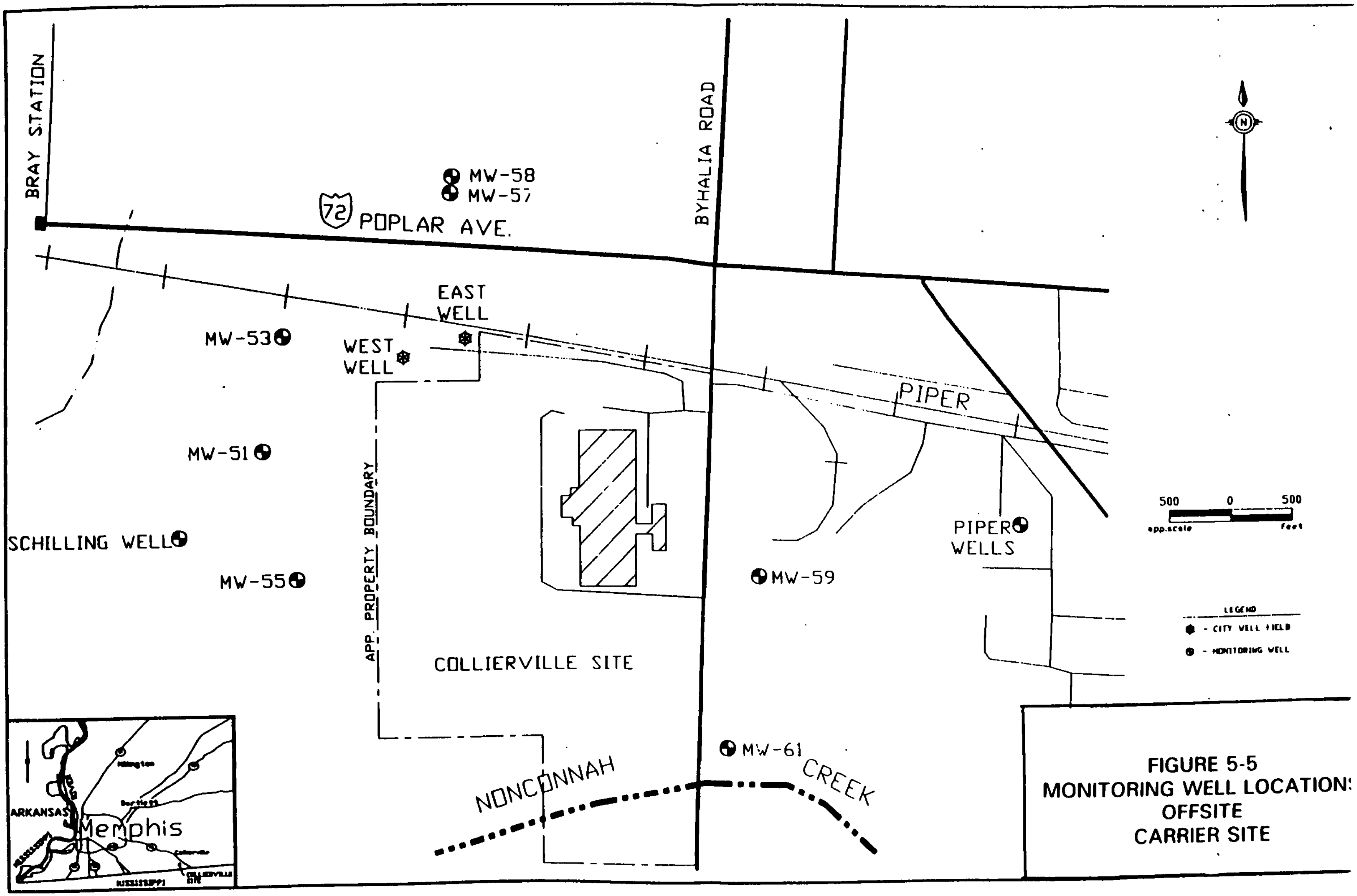


FIGURE 5-5
MONITORING WELL LOCATION:
OFFSITE
CARRIER SITE

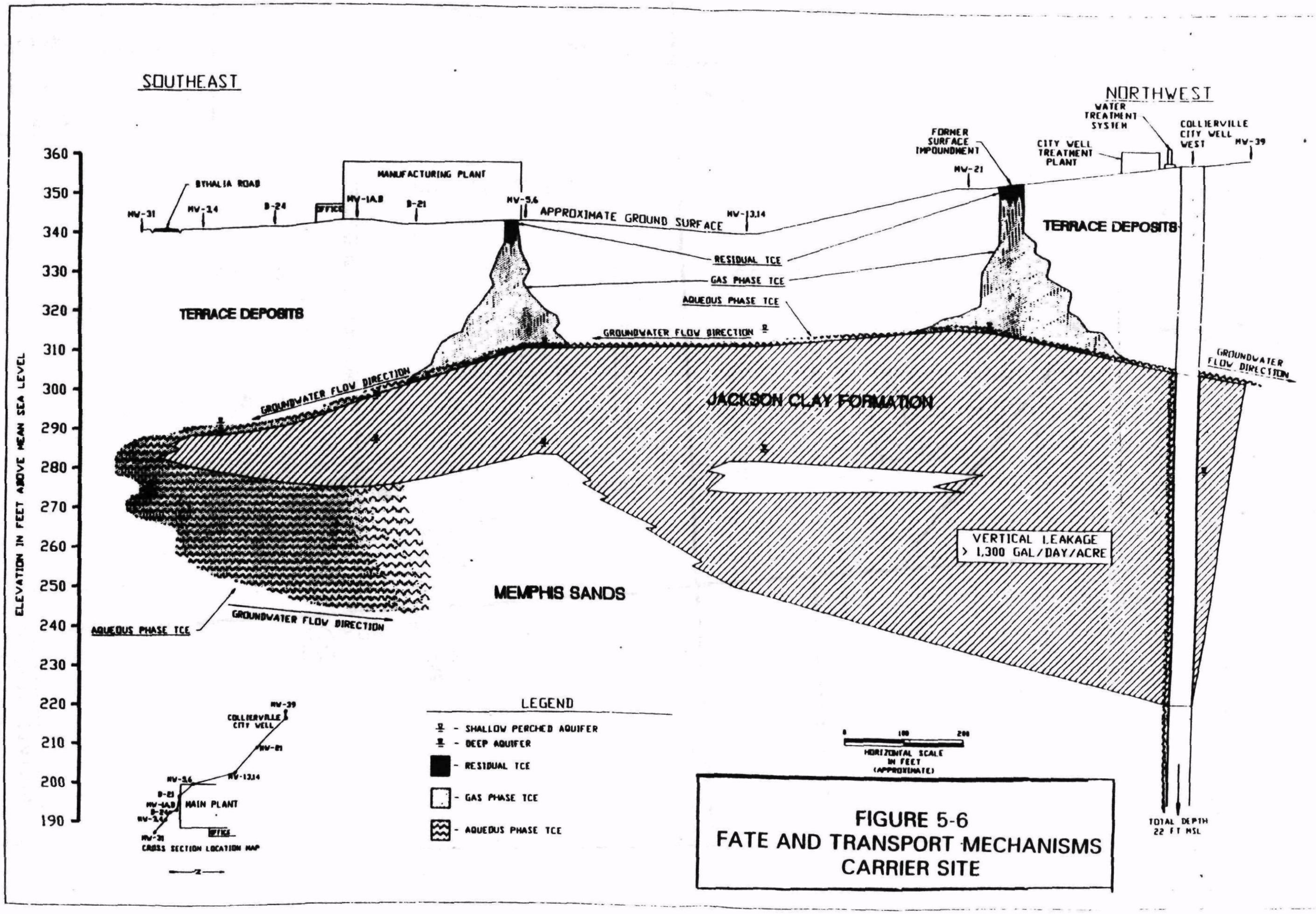


FIGURE 5-6
FATE AND TRANSPORT MECHANISMS
CARRIER SITE

groundwater as seen in results of the RI. Due to the immediate response and removal of soils impacted from the 1985 spill, the spill area has not been included in the figure.

Vadose Zone

Soil boring demonstrates that TCE is migrating through the vadose zone. Residual solvent remains adsorbed within the pore space of the soil particles as TCE migrates through the soil. TCE migrates from soils through diffusion in the vapor phase and in the dissolved aqueous phase from the infiltration and percolation of rainwater through soils.

Shallow Aquifer

Upon reaching groundwater, the further movement of TCE in the shallow aquifer correlates closely with the structure of the underlying aquitard. Groundwater in the shallow aquifer moves radially from a "structural high" in the Jackson Clay in the proximity of the former lagoon. The Jackson Clay formation grades from this "high" to the south toward Nonconnah Creek, to the southeast towards Byhalia Road, and generally to the west, along the western extent of the Carrier property. There is some evidence of a slight grade to the north as well, in the vicinity of the town wells and further north.

Advective transport of contaminants in the aqueous phase, from source areas around the main plant and the former lagoon, follow natural shallow groundwater flow directions at the Site. There is some evidence that groundwater in the upper aquifer flows only intermittently. This is substantiated by the poor recharge to some of the shallow monitoring wells. Significant amounts of groundwater may be present in localized depressions with very little lateral movement except during high recharge periods. However, around contaminant source areas this movement is generally to the southeast, along the top of the Jackson Formation.

The stratigraphic investigation clearly indicates that shallow groundwater movement to the south and east will eventually migrate to an area in which the Memphis Sand aquifer and the shallow aquifer unit are hydraulically connected.

Memphis Sand Aquifer

Flow direction in the Memphis Sand is to the northwest, as seen from potentiometric measurements made during periods when the town wells were not pumping. TCE contamination has been identified in the Memphis Sand in the southeast portion of the Site (MW-1, MW-1B, and MW-4) and at the municipal wells.

The density of TCE in water at maximum water solubilities of less than 2 $\mu g/\ell$ is not likely to be sufficient to cause sinking of the plume. Therefore, movement of the contaminants to the well field will be more directly dependent upon the pumping rates of the city well system and resulting drawdown effects on the Memphis Sand aquifer.

The results of the Site investigation suggest that other pathways also exist. Regional geologic data suggest that recharge through the Jackson Clay is relatively low because of low clay permeability across the unit. However, the aquifer pumping test conducted at the Site indicated a potential for vertical leakage through this confining clay layer. The vertical leakage or recharge rates range from 0.9 to 18.8 gallons per minute per acre. As determined in that aquifer test, these rates suggest that leakage through the aquitard may be a potential pathway for TCE to enter the Memphis Sand aquifer.

5.3 Treatability Study

As part of the RI a treatability study was conducted at the lagoon area to determine how effective soil vapor extraction (SVE) would be for removing TCE and its degradation products from onsite soils and shallow groundwater. The treatability study, also referred to as the North Remediation System (NRS), has indicated that this technology is effective in removing contamination in soils and shallow groundwater.

6.0 SUMMARY OF SITE RISKS

A baseline risk assessment (BRA) has been conducted for the Carrier Site, and the results are presented in Section 8 of the RI report. The BRA was based on contaminated environmental Site media as identified in the RI. It was conducted in order to provide an assessment of the resulting impact to human health and environment if contaminated soils and groundwater at the Site were not remediated.

The Carrier BRA concluded that the primary health risk posed by the Site is through ingestion and inhalation of TCE and lead from untreated groundwater.

6.1 Contaminants of Concern

The selected contaminants of concern for Site soils and groundwater are shown in Table 6-1. Seven major hazardous contaminants were considered. Of these, trichloroethylene (TCE) and dichloroethylene (DCE) were the most frequently detected and generally found at the highest concentrations. Although TCE and DCE are the primary contaminants of concern, lead, zinc, 1,2-dichloroethane (DCA), tetrachloroethylene (PCE) and vinyl chloride were also included due to their presence in one or more sample wells at an average concentration which equalled or exceeded the current or proposed MCLs.

DCA, PCE and vinyl chloride have not been identified at a significant frequency in either groundwater or soils. DCA and PCE are commonly associated with TCE because solvents are rarely pure products and often contain a small residual amount of other chlorinated hydrocarbons. Vinyl chloride is a common degradation product of TCE.

No pattern of lead or zinc in groundwater was established in Site soils or groundwater. Lead was not historically used onsite. The old lagoon area may be a potential source of zinc due to the use of zinc phosphate on the Site and the discharge of zinc phosphate sludges to the lagoon. However, the closure of the lagoon in 1980 appears to have removed these sludges and residual concentrations are low. The high level of metals may be caused from a secondary effect of the TCE contamination/degradation, except perhaps beneath the former lagoon. Degradation of TCE may be lowering the pH causing the insoluble metal complexes to leach into groundwater. Lead and zinc may also be attributed to naturally occurring levels and/or non Site-related anthropogenic sources.

Contamination was not indicated in any surface water samples; therefore, this medium was not further evaluated. Lead and zinc were detected in sediment samples and are included as contaminants of concerns in Table 6-1.

6.2 Exposure Assessment

The objectives of the exposure assessment are to identify actual or potential exposure pathways; characterize the potentially exposed populations; and to determine the extent of the exposure. The results of the exposure assessment are combined with the chemical-specific toxicity information to characterize the potential risks.

The Site is located near a state road in a developed community setting. The site exists in the small and growing community of Collierville, Tennessee (pop. ~ 13000). With the current strict zoning, the long-term future use of this Site would be for continued industrial use. The Site is an operating facility and will continue to be so for the foreseeable future. Therefore, it seems prudent to assume that direct and frequent contact by adults in an industrial setting will continue to occur. The Site is fenced and secured. The occurrence of infrequent trespassers would pose a likely current exposure scenario with direct exposure to the southern and western portions of the Site. The nearest residential area is approximately 100' north of the Site boundary adjacent to the Collierville municipal well field.

None of the nonpaved areas appear to receive heavy foot traffic or constitute obvious pathways for routine exposure[1]. However, direct soil or dust contact could result in exposure to trespassers and the workers onsite.

Irrigation from the shallow water bearing zone (thin, low yielding zone lying above the Jackson Clay) is not feasible due to the poor production of this unit. Irrigation from the deeper aquifer

[1]Approximately 20% of the 190-acre Site is paved or covered by buildings. Approximately 50 to 60% of the contaminant source areas are beneath paved or covered areas.

TABLE 6-1 Contaminants of Concern by Environmental Media Carrier Site
SOIL/SEDIMENT
TCE
DCE
Vinyl Chloride*
PCE
DCA
Lead
Zinc
GROUNDWATER
TCE
DCE
Vinyl Chloride*
PCE
DCA
Lead
Zinc

*Vinyl chloride was not detected on-site in any media at a significant frequency, but is considered a common degradation product of TCE.

system (the Memphis Sands) would be possible, but would not significantly contribute to overall risk due to the following factors:

- The site is an operating industrial facility.
- The organic contaminants of concern have low bioconcentration factors (<50) and high Henry's Law constants. The uptake by crops is expected to be minimal.
- The primary metals of concern are zinc and lead. Zinc is a trace element, and both are not available to plants for uptake until soil levels reach >50 ppm.
- Groundwater metals concentrations are not significantly above background concentrations.

Surface waters do not exist onsite or adjacent to the Site with the exception of Nonconnah Creek in which no water sample contamination was detected.

No significant direct inhalation exposure onsite is expected as a large portion of the contaminated area is paved/covered. The unpaved areas of the Site are far less contaminated and are covered by maintained vegetation (grasses and trees/shrubs). Soil contamination exists at the highest levels at depths from one to five feet (subsurface vs. surface, 0-1'). These factors along with the mild southeast inland climate (average wind speeds of 5-10 mph) contribute to insignificant passive volatilization of Site contaminants. Also, the facility has an operating air permit which allows approximately 200 tons of total VOCs per year to be emitted. The maximum combined air stripper output annually has been estimated at <500 lbs/year. Passive volatilization from the Site would not contribute significantly to VOC air emissions or risk. Active volatilization (such as soil gas vapor extractions) will be addressed in the Description of Alternatives and Compliance with ARARs sections.

Shallow groundwater is not currently used for domestic purposes in the immediate area. The shallow aquifer is classified as a Class IIIA aquifer. The nearest known municipal well is located adjacent to the northwest corner of the Site. The deep groundwater flow is best described as to the northwest (influenced by pumping). The Memphis Sand aquifer is classified as a Class IIA aquifer. Groundwater contaminant exposure was computed for current and future use of water produced by the Memphis Sand aquifer. Current groundwater pathways exist for local residents supplied by the Collierville municipal well system. Future exposure was assessed via a hypothetical pathway involving residential wells screened in the Memphis Sands. Groundwater contaminant ingestion and inhalation of volatilized groundwater contaminants were considered to determine total exposure through the groundwater pathway. The maximum concentration of each parameter observed in the untreated municipal well water was used to compute current risk (conservative assumption). Future resident reasonable maximum exposure (RME) concentrations were established by computing the 95% upper confidence limit mean for each constituent of concern from wells screened in the Memphis Sand aquifer.

The highest groundwater concentrations onsite were generally observed in monitoring wells located in the shallow water bearing zone (which is not used as a potable water source in the Site vicinity). Actual current exposure to groundwater contaminants (through the municipal system) is minimized (or eliminated) by engineering controls (i.e. air stripping of municipal well water prior to distribution). Volatile contaminant concentrations subsequent to the air stripping unit are below MCLs. Use of the shallow water bearing zone and the Memphis Sand aquifer as a potable water source is restricted by city and county ordinances. Both these ordinances control and regulate the location and construction of wells in Collierville and Shelby County.

Current and future exposure pathways to hazardous substances associated with the Site include direct soil contact via ingestion and dermal contact; and groundwater expsoure via inhalation/bathing and ingestion (Table 6-2).

6.3 Toxicity Assessment

Seven contaminants have been positively identified and quantified at the Site. They are TCE, DCE, PCE, DCA, vinyl chloride, lead and zinc. DCE exists in two isomeric forms, *cis* and *trans*. Isolation of the two isomers in routine analytical determinations is difficult and subject to error. Therefore DCE is usually reported as the total of all isomers. DCE is considered an equivocal carcinogen. However, the two isomers do exhibit somewhat different toxicities. Therefore, as a conservative approach, the more toxic of the two isomers is used in risk assessment. In general, the *cis*-1,2-DCE isomer is considered the more toxic. A secondary degradation product of TCE, vinyl chloride, has not been identified at the Site in any media at significant frequencies or concentrations (four hits ranging from 1 to 8.51 ppb). Over a long period of time, however, degradation of DCE to vinyl chloride has been known to occur. Zinc and lead are the metals of concern at the Site, however, observed concentrations do not vary significantly from background, and no Site-related source of lead has been established.

In addition to the potential toxicity of TCE and vinyl chloride, most of these substances can produce systemic toxic responses at doses greater than an experimentally-determined threshold level. The USEPA has derived Slope Factor[2] and/or Reference Dose (RfD)[3] values for these substances for use in determining the upper bound level of cancer risk and noncancer hazard from exposure to a given level of contamination (Table 6-3).

Drinking water standards (MCLs) have been established for some contaminants detected in groundwater impacted by Site activities (Table 6-3). These contaminants include hazardous substances identified as carcinogens and systemic toxicants in published research studies.

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[2]Slope Factor. A plausible upper-bound estimate of the probability of an individual developing cancer as a result of a lifetime of exposure to a particular level of a potential carcinogen.

[3]Reference Dose. EPA's preferred toxicity value for evaluating noncarcinogenic effects resulting from exposures at Superfund sites. *See specific entries for chronic RfD, subchronic RfD, and developmental RfD. The acronym RfD, when used without other modifiers, either refers generically to all types of RfDs or specifically to chronic RfDs. It never refers specifically to subchronic or developmental RfDs.

TABLE 6-2 Potential Complete Exposure Pathways for Risk Assessment Considerations Carrier Site
• Ingestion of and dermal contact with contaminated soil by on-site workers, trespassers (e.g., children), and hypothetical, future, onsite residents.[a]
• Ingestion of contaminated groundwater by current municipal water system users (before treatment) and hypothetical, future residents obtaining their water from an on-site well screened in the Memphis Sand aquifer.[b]
• Inhalation of chemical vapors emanating from contaminated groundwater during showering by current municipal water system users (before treatment) and hypothetical, future residents obtaining their water from an on-site well screened in the Memphis Sand aquifer.[b]

[a] Exposure rates (CDI) for ingestion and dermal contact with contaminated soils by future child residents were calculated to be (mg/kg-day) TCE = 4.8×10^{-6}, DCE = 1.2×10^{-6}, Pb = 1.9×10^{-4}, Zn = 8.2×10^{-4}, and PCE = 1.8×10^{-7} (1.5×10^{-8} for carcinogenic effects). Appendix P of the RI contains calculations used to derive exposure concentrations (RMEs).

[b] Exposure concentrations for chemical intakes for chemical intakes (ingestion and inhalation) related to groundwater were determined as follows:

Current Resident- maximum concentration detected (before treatment) in the Collierville municipal well system water

Future Resident- 95% upper confidence limit mean contaminant concentration detected in monitoring wells screened in the Memphis Sand aquifer

Current after treatment exposure/risk levels were not computed as contaminant concentrations in treated municipal well system water are below analytical detection limits.

TABLE 6-3
Health-Based Values for Carcinogens (SF) and Noncarcinogens (RfD) and ARARs for Oral Exposure to Contaminants of Concern
Carrier Site

Contaminant	SF_{oral} $(mg/kg\text{-}day)^{-1}$	$SF_{inhalation}$[g] $(mg/kg\text{-}day)^{-1}$	RfD (mg/kg-day)	Cancer Weight of Evidence	ARAR (mg/ℓ)
Trichloroethylene (TCE)	1.1×10^{-2}[a]	0.017	NA	B_2	0.005
1,2-Dichloroethene (DCE)	NA	NA	0.01[g]	D	0.07[b]
1,2-Dichloroethane (DCA)	9.1×10^{-2}	0.091	NA	B_2	0.005
Tetrachloroethene (PCE)	5.1×10^{-2}	1.1×10^{-10}[h]	0.01	B_2/C[f]	0.005
Vinyl Chloride	1.9[c]	1.8×10^{-8}[h]	NA	A	0.002
Lead	NA	NA	0.0004[d]	B_2/C[f]	0.015
Zinc	NA	NA	0.21[e]	D	5[e]

[a] Not on IRIS 4/91, based on USEPA, 54 & 1-86-046.
[b] Based on unit risk for drinking water (est. from CPF/RfD)
[c] Not on IRIS 4/91, based on USEPA, ECAO-CIN-P155
[d] Calculated unit risk based on 0.015mg/l action level (hazard index = 1) and ingestion rate of 2 liters/day and 70 kg average body weight
[e] Not on IRIS 4/91, based on USEPA, AWQCD, 440/5-80-079 (2° MCL)
[f] Not yet determined or being reconsidered
[g] HEAST, 1/91
[h] Inhalation Unit Risk assuming IR_a = $15m^3$/day; BW=70 kg.

NA = Not applicable or not determined (pending)

Cancer Weight of Evidence
- A = Human Carcinogen
- B2 = Probable Human Carcinogen- sufficient evidence in animals and inadequate or no evidence in humans.
- C = Possible Human Carcinogen
- D = Not Classifiable as to Human Carcinogenicity

Critical studies used in their toxicity classification by the USEPA are shown in the Integrated Risk Information System (IRIS) data base. These standards are considered as ARARs for the surface and groundwater at the Site. They are considered as "Relevant and Appropriate" since the Memphis Sands aquifer is currently used as a domestic water supply. A copy of the IRIS database outputs for each parameter are included as Appendix Q of the RI.

6.4 Risk Characterization

Site soil contaminants are not uniformly distributed over the surface, but exist in areas of varying concentrations. This pattern of contaminant distribution was managed for risk assessment purposes by considering the risk from exposure to the unpaved/uncovered portions of the Site which have shown soil contamination in the upper five feet of soil. Conservative estimates based on the total area of the Site which has surface contamination were used to assess current adult worker exposure to volatile contaminants of concern. The entire unpaved/uncovered area of the Site was used to assess the risk to adult workers posed by lead and zinc in the Site surface soils. In both instances, the workers were assumed to contact the Site uniformly. To assess the risk posed by the Site to future child residents, it was assumed that the entire Site will be unpaved and uncovered, and that all potential ingestion and dermal contact exposures would occur within the contaminated surface soil zones. The mean concentration of a contaminant found in samples collected in the upper five feet of soil was considered as the exposure level (for both ingestion and dermal contact scenarios).

The result of the risk calculation for the major soil contaminants, using the above stated assumptions, are shown in Tables 6-4 and 6-5. In Table 6-4, the risk to workers from the major contaminants of concern is shown. In Table 6-5, the risk to future child residents is shown. Since the risk values represent a fraction of time exposed uniquely to a contaminant in the contaminated areas, the sum of these risk values ($5.2x10^{-7}$) approximates the child's upper bound risk. This value does not represent the total risk from the Site since neither 100% of a future child resident's onsite time nor exposure to all Site contaminants is accounted. However, the remaining unaccounted risk is presumed to represent an insignificant additional risk. Vinyl chloride has been determined to pose little or no current risk to human health due to the infrequency of detection and low concentrations identified.

These data indicate that exposure to contaminated surface soils does not pose an upper bound risk level greater than the 10^{-6} point of departure for current Site workers or future children onsite.

The Hazard Index values as shown (Tables 6-4 and 6-5) indicate that onsite exposures would not result in noncancer toxicity to the current adult workers or future child residents onsite. As a result, lead and zinc are not considered to pose a significant health risk from the standpoint of soil ingestion or dermal contact.

TABLE 6-4 Summary of Risks for Adult Workers from Oral and Dermal Exposure to Contaminants in Soil Carrier Site		
Soil Contaminant Level (mg/kg)[a]	**Contaminant**	**Upper Bound Risk Level[b] (or Hazard Index)**
35	TCE	$1.0x10^{-7}$
0.077	1,2-DCE	HI=$7.2x10^{-6}$
0	Vinyl Chloride	0[c]
0	DCA	0
0.011	PCE	$1.5x10^{-10}$ HI=$1.0x10^{-6}$
12[e]	Lead	HI=$2.8x10^{-2}$
51[e]	Zinc	HI=$2.3x10^{-4}$
Upper bound Sum cancer risk = $1.0x10^{-7}$		
Upper bound Sum hazard indices = 0.028		

[a] X concentration in all soils within surface contaminated areas (90-95% C.L. was not calculated as the data are not normally distributed); for metals X concentration assumed to be in all unpaved/uncovered site soils. TCE and 1,2-DCE concentrations are the means for all samples collected at depths of 0 to 5 feet, including screening data from Phase I (see Appendix P).

[b] HI (Hazard Index) of >1 are 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] Approximately 89 ppm of vinyl chloride in soil at this site with these assumptions would equal $1x10^{-6}$ risk level.

[d] Tetrachloroethene (PCE) was identified in one soil sample.

[e] Lead and zinc concentrations for all samples collected from within five (5) feet of ground surface were used to compute mean values.

TABLE 6-5 Summary of Risks for Potential Future Child Residents from Oral and Dermal Exposure to Contaminants in Soil Carrier Site		
Soil Contaminant Level (mg/kg)[a]	**Contaminant**	**Upper Bound Risk Level[b] (or Hazard Index)**
35[e]	TCE	5.2×10^{-7}
0.077[e]	1,2-DCE	HI = 6.1×10^{-5}
0	Vinyl Chloride	0[c]
12[f]	Lead	HI = 1.9×10^{-1}
0	DCA	0
0.011	PCE	HI = 1.7×10^{-5}
51[f]	Zinc	HI = 3.9×10^{-3}
Upper bound Σ cancer risk = 5.2×10^{-7}[g]		

[a]X concentration in all site soils within five (5) feet of ground surface where TCE and/or DCE has been identified; assume 100% of Future Child Resident soil exposure is in contaminated area on-site

[b]HI (Hazard Index) of >1 are 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]1×10^{-6} risk (with these assumptions) in soil ~150 ppb vinyl chloride

[d]Lead is not bioavailable to humans below approximately 200 ppm in soils. The USEPA has recommended a soil lead level of 500 to 1,000 ppm at NPL sites (to protect from direct contact and ingestion). A site-specific lead exposure model is currently being tested by the USEPA (USEPA/ECAO 6/91, personal conversation with Dr. Harlal Choudhury)

[e]TCE and 1,2-DCE data from samples collected prior to the initiation of the Remedial Investigation were included. Below detection limit results were not used in the calculation of means.

[f]Lead and zinc concentrations for all samples collected from within five (5) feet of ground surface were used to compute mean values.

[g]Example calc. are the same as Figure 8-2b except child assumptions (Figure 8-3) were used.

NOTE: It was assumed that in the future the entire site will be unpaved and uncovered.
The shallow water bearing zone is not currently used as a source or potable water nor is it anticipated to be used as a potable source in the future. Therefore, it was not considered a viable future exposure pathway.

Table 6-6 shows that, assuming worst-case conditions, Site groundwater may pose a significant carcinogenic and non-carcinogenic risk to current and future residents. The upper bound cancer risk to current residents posed by the groundwater exposure pathway is $2.5x10^{-4}$. The Hazard Indices for lead and zinc are 3.2 and 0.87, respectively, under the current resident scenario. The lead value indicate that a non-carcinogen risk may be posed to current residents. Maximum contaminant concentrations in untreated Collierville municipal well system water were used to compute current risk (and hazard indices).

The upper bound cancer risk to future Site residents from the groundwater exposure pathway is $4.7x10^{-4}$. The hazard indices for DCE, lead and zinc are 0.33, 4.1, and 0.82, respectively, under the future resident scenario. The contaminant concentrations (Reasonable Maximum Esposure (RME)) used to compute risk (and Hazard Indices) to future Site residents were the 95% upper confidence limit mean values for all deep monitoring wells computed over three quarterly sampling periods. As a result, the risk levels computed are highly conservative estimates.

It is worthy of mention that lead concentrations (which pose the primary non-carcinogenic risk) observed in the Memphis Sand monitoring wells are not significantly different than those observed in background wells. The 95% upper confidence limit mean for lead in wells CMW-001 and CMW-002 (background wells) over the same monitoring period was 0.061 mg/L (versus 0.060 mg/L in the Memphis Sand wells). The maximum concentration of lead observed in untreated municipal well system water was 0.045 mg/L (over the same sampling period). As a result, the Hazard Indices computed for lead (under current and future exposure scenarios) may not be directly attributable to the Site, and may result from natural lead content of the aquifer material or non Site-related anthropogenic sources. Appendix P of the RI provides data tables and statistics used to establish RMEs as well as background well 95% upper confidence limit determinations. Although metal concentrations are variable and sometimes high in background wells, the range of concentrations are higher onsite. The higher concentrations may be a secondary effect of the TCE contamination/degradation which may be lowering the pH,leaching otherwise insoluble metal complexes into groundwater.

The shallow water bearing zone is not currently used as a source of potable water nor is it anticipated to be used as a potable source in the future. Therefore, it was not considered a viable future exposure pathway.

The Memphis Sand aquifer which lies below the shallow water bearing zone (separated by the Jackson Clay unit) is used as a potable water source for the Town of Collierville. Engineering controls (i.e. air stripper) are currently in place on the Collierville municipal well system to remove contaminants prior to distribution. As a result, actual current resident exposure to groundwater contaminants is negligible.

In light of the current and potential future groundwater uses, efforts should be made to preclude the migration of volatile contaminants from the shallow water bearing zone to the Memphis

TABLE 6-6
Current and Future Resident
Direct Ingestion and Inhalation Groundwater Pathway Risk
Carrier Site

Compound	SF_{oral} $(mg/kg\text{-}day)^{-1}$	$SF_{inhalation}$ $(mg/kg\text{-}day)^{-1}$	RfD (mg/kg-day)	Current Resident RME (ppm)	Future Resident RME (ppm)	Current Risk (Hazard Index)	Future Risk (Hazard Index)
TCE	0.011	0.017	NA	0.29	0.53	4.7×10^{-4}	2.5×10^{-4}
DCE	NA	NA	0.01	0[A]	0.117	NA	HI=0.33
DCA	0.091	0.091	NA	0[A]	0[A]	NA	NA
PCE	0.051	1.1×10^{-10}	0.01	0[A]	0[A]	NA	NA
Vinyl Chloride	1.9	$1.8x^{8}$	NA	0[A]	0[A]	NA	NA
Lead	NA	NA	0.0004	0.045[B]	0.060[B]	HI=3.2	HI=4.1
Zinc	NA	NA	0.21	6.68	6.3	0.87	0.82
Upper Bound Sum of cancer risk: Current Residents = 2.5×10^{-4}; Future Residents = 4.7×10^{-4}							
Upper Bound Sum of hazard indices Current Residents = 4.07; Future Residents = 5.3							

__Notes__:

NA = Not Applicable
RME = The highest exposure that is reasonable expected to occur at a Site.

[A] indicates that the compound was not identified in samples collected from the subject wells.

[B] not significantly elevated above background well concentrations (see Appendix P)

Cancer Risk Formula:

$$\text{Risk} = \frac{[\text{contaminant}] \times EF \times ED \times [(SF_i \times K \times IR_a) + (SF_o \times IR_w)]}{BW \times AT \times 365\ \text{days/year}}$$

Non-Carcinogenic Risk (Hazard Index) Formula:

$$\text{Hazard Index} = \frac{[\text{contaminant}] \times IR_w \times EF \times ED}{RfD_o \times BW \times AT \times 365\ \text{days/year}} + \frac{[\text{contaminant}] \times K \times IR_a \times EF \times ED}{RfD_i \times BW \times AT \times 365\ \text{days/year}}$$

Where:

BW = Body Weight = 70 kg; AT = Averaging Time = 70 years
EF = Exposure Frequency = 350 days/year; ED = Exposure Duration = 30 years
SF_i = Inhalation slope factor = chemical-specific; SF_o = Oral slope factor = chemical-specific
K = volatilization factor = 0.0005 x 1000 L/m^3; IR_a = daily indoor inhalation rate = 15 m^3/day
IR_w = daily water ingestion rate = 2 L/day; RfD_o = oral reference dose = chemical-specific
RfD_i = inhalation reference dose = chemical-specific
Risk (hazard index) formulae were obtained from USEPA's Risk Assessment Guidance for Superfund, Volume I, Parts A & B.

Sands in order to maintain (and over time enhance) the quality of the Memphis Sand aquifer.

6.5 Soil Cleanup Goals for Groundwater Protection

USEPA's Center for Environmental Assessment Modeling (CEAM) provided their Exposure Assessment Multimedia Model (MultiMed) for application at the Carrier A.C. Site. The model was used in conjunction with traditional contaminant mass partitioning formulae to determine the soil cleanup goals necessary for protection of Memphis Sands aquifer quality.[4] Based on Site-specific soil and hydrogeologic conditions, a soil cleanup goal of 533 $\mu g/kg$ TCE was determined to be protective of the Memphis Sand aquifer. The goal is applicable to the contaminant source areas ("hot spots") previously discussed. Remedial efforts need only focus on a limited portion of the Site as soil contaminants are restricted to approximately 20% of the total Site area.

All discussions regarding MultiMed input variable selection, model outputs and soil cleanup goal calculations are provided in Appendix R of the RI.

6.6 Ecological Considerations

No U.S. Dept. of Interior or State of TDEC lands or federally listed endangered species of wildlife were identified at the Site. The nature of the Site is such that avian or terrestrial wildlife would not be drawn to the Site. A surface water quality assessment and a biological impact assessment were conducted. The assessments included a quantitative study of benthic species diversity in Nonconnah Creek, and a qualitative review of sensitive and endangered species typical of southeastern Shelby County. Data to date indicate no significant adverse ecological impacts from the present soil or groundwater contamination. This preliminary survey does not rule out ecological impacts to aquatic and terrestrial species through contaminated food chain mechanisms. However, TCE is not biocumulative and as a result, it is not expected to cause deleterious food chain effects based on currently available data.

6.7 Risk Uncertainty

There is a generally recognized uncertainty in human risk values developed from experimental data. This is primarily due to the uncertainty of data extrapolation in the areas of (1) high to low dose exposure, (2) modeling of dose response effects observed, (3) route to route extrapolation, and (4) animal data to human experience. The Site-specific uncertainty is mainly in the degree of accuracy of the exposure assumptions.

In the presence of such uncertainty, the USEPA and the risk assessor have the obligation to

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[4]Contaminant partitioning equations from USEPA's *Determining Soil Response Action Levels Based on Potential Contaminant Migration to Groundwater: A Compendium of Examples*, USEPA, OERR, EPA/540/2/89/057, October 1989.

make conservative assumptions such that the chance is very small for the actual health risk to be greater than that determined through the risk process. On the other hand, the process is not to yield absurdly conservative risk values that have no basis in reality. That balance was kept in mind in the development of exposure assumptions and pathways and in the interpretation of data and guidance for this baseline risk assessment.

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

7.0 DESCRIPTION OF REMEDIAL ALTERNATIVES

The following remedial alternatives were selected for evaluation:

- Alternative 1: No-Action
- Alternative 2: North Remediation System (NRS); Groundwater Containment/Treatment at Water Plant 2
- Alternative 3: NRS and Plant Area Soil Vapor Extraction (SVE); Groundwater Containment/Treatment at Water Plant 2
- Alternative 4: NRS and Plant Area SVE; Groundwater Containment/Treatment at Water Plant 2, and Supplemental Extraction Well(s) via (a) Air Stripping, or (b) UV/Oxidation
- Alternative 5: Plant Area Soil Excavation/Low Temperature Thermal Desorption (LTTD), NRS and Plant Area SVE; Groundwater Containment/Treatment at Water Plant 2
- Alternative 6: Plant Area Soil Excavation/LTTD, NRS and Plant Area SVE; Groundwater Containment/Treatment at Water Plant 2, and Supplemental Extraction Well(s) via (a) Air Stripping, or (b) UV/Oxidation

Common Features of the Alternatives

Institutional Controls

All alternatives, except No Action, include institutional controls such as deed restrictions, local ordinances or record notices applied as appropriate for long-term management and prevention of exposure to contaminants.

Groundwater Residuals

Excluding No Action, all the alternatives generate a groundwater stream which must be discharged. The route of discharge may be release to the local POTW, surface water, the Town of Collierville water supply, or back to Site groundwater by reinjection. EPA will select the discharge route. The selection is subject to the ability of each alternative to meet ARARs, and is discussed in text describing each alternative.

Soils Residuals

Alternatives 5 and 6 require that soils be excavated prior to treatment. EPA will select the disposal route for the treated soils. Disposal may be offsite, or onsite, and subject to RCRA land disposal restrictions if the soils are hazardous waste. Delisting may be required if the soils are deemed RCRA-listed wastes, and onsite use as fill is chosen as the ultimate disposition. If offsite disposal is chosen, the waste must meet treatment standards prior to disposal in a permitted RCRA facility.

Site Monitoring

While wastes remain at the Carrier A.C. Site, CERCLA requires that monitoring data collected from the Site be evaluated every five years. This evaluation would include spatial and temporal analysis of existing data to determine increasing, decreasing, or stationary trends in contaminant concentrations. The results of this evaluation would be used to reassess the need to maintain, increase or decrease the number and types of samples and analysis required for monitoring, and the need to change the remedial response at the Site.

Existing Controls

The Town of Collierville's Water Plant No. 2 essentially contains groundwater contaminants in the Memphis Sand, and controls exposure to contaminants through treatment. The plant includes two extraction wells with 5-foot diameter air strippers (treatment capacity is 1.4 MGD) to remove TCE and other VOCs from groundwater to a level below 1 $\mu g/\ell$. In order for this treatment system to contain groundwater contaminants, the Town of Collierville wells must pump without interruption.

In addition to the Memphis Sand groundwater containment and treatment afforded by continued operation of Water Plant 2, a remediation system is in place, as a result of the treatability study, at the former lagoon, referred to as the North Remediation System (NRS). This equipment was installed to dewater and extract Site contaminants from soils impacted by the former lagoon by soil vapor extraction (SVE).

In the following alternative descriptions, although all constituents of concern must be considered, TCE will drive remedial efforts. Lead in Memphis Sand groundwater poses significant potential acute health risk in the worst-case scenarios presented in the Baseline Risk Assessment.

Elevated lead levels have not been observed routinely in the Memphis Sand groundwater at Water Plant 2, nor anywhere in the Collierville drinking water system. For this reason the following proposed remedial alternatives do not explicitly include lead removal actions. This in no way changes the need for alternatives to comply with ARARs, including chemical-specific requirements for metals.

7.1 Alternative 1: No Action

CERCLA requires that the "No Action" alternative be considered at every site against which the other alternatives are evaluated. Under this alternative no action would be taken. Operation of the two air strippers at Water Plant 2 and the NRS would be discontinued.

The only reduction of contaminant levels in Site soils and groundwater would occur through natural processes. The time for groundwater levels to drop below SDWA regulations is on the order of 2000 years. This alternative leaves the volume of hazardous substances unchanged, and the potential increase in volume of impacted environmental media - groundwater. Without treatment or containment, residual upper-bound risk associated with groundwater exposure is in the range 2.5×10^{-4} to 4.7×10^{-4}.

Selected Site groundwater monitoring wells and soil spaces would be sampled for volatile organic compounds and metals. Because contaminated soils and groundwater would remain in place, untreated, at the Site, CERCLA requires that data be collected and evaluated at least every five years to assure that a selected remedy continues to be protective of human health and the environment. Based upon the findings of the review, EPA may determine other studies and/or actions should be taken.

This alternative would not comply with the Safe Drinking Water Act (SDWA) regulations or EPA's Groundwater Protection Strategy.

This alternative has no capital costs. The approximate costs for the monitoring program is $410,000 per five year sampling event, and $50,000 annually for quarterly groundwater sampling and analysis, yielding an approximate present worth from $1,437,223 to $2,180,152. The present worth analysis is based upon a 30-year life and a 5 percent discount rate.

7.2 Alternative 2: North Remediation System (NRS); Groundwater Containment/Treatment at Water Plant 2

The major features of this alternative include soil vapor extraction in the former lagoon area, also referred to as the North Remediation System (NRS). Approximately 8500 cubic yards of TCE and its degradation products would be addressed by the NRS. Also, the town wells at Water Plant 2 would continue to operate to provide containment and treatment (air stripping) of Memphis Sands groundwater contaminated with TCE and its degradation products.

Modeling runs and indications from RI data point toward the conclusion that operation of the town well field has essentially contained the plume. This information is not conclusive and thus makes any assessment of overall protection somewhat uncertain, until additional Memphis Sands aquifer testing is performed duirng Remedial Design (RD). Also, contamination will continue to enter the Memphis Sand aquifer at the southern end of the Site and will remain in the Sand for some years until extracted at Water Plant 2.

The amount of contaminated soils that would be treated in the lagoon area was determined using fate and transport modeling to estimate the potential groundwater contamination. Transport modeling calculations indicate that at an average concentration of about 533 $\mu g/kg$ TCE at the existing source areas would no longer yield leachate which would contaminate Memphis Sand groundwater above 5 $\mu g/\ell$ for TCE. Approximately 68,000 cubic yards of contaminated soils which are a significant source of current and potential future contamination of the Memphis Sand aquifer would be left untreated. Although some native microbial degradation has occurred, it is not likely that natural attenuation will reduce residual TCE contamination to the level estimated to be protective of the Memphis Sand in a timely manner (over a period on the order of 2000 years).

The treated water from the air strippers would remain a significant supply for the Town of Collierville. Both air stripping and SVE volatilize contaminants to an air stream. Due to the low volumes of air emissions, no off-gas controls would be necessary.

The Memphis Sands groundwater would eventually be treated to levels below SDWA regulations, but would not comply with the EPA's Groundwater Protection Strategy. This alternative would comply with federal and state Clean Air Act (CAA) standards.

Selected Site groundwater monitoring wells and soil would be sampled for volatile organic compounds and metals. A review of data collected at the Site would be evaluated at least every five years during the remedial action or until contaminant concentrations in groundwater no longer exceed SDWA regulations or soil cleanup levels. The evaluation would continue until completion of the groundwater remedial action and would serve to indicate whether cleanup levels have been or will be attained. Based upon the findings of the review, EPA may determine other studies and/or actions should be taken.

The estimated capital cost of Alternative 2 is in the range of $1,052,935 to $1,133,199 while the associated Operations & Maintenance (O&M) and monitoring costs is $2,931,647. The estimated present worth cost is in the range $2,968,754 to $4,064,847. The estimated present worth analysis is based upon a 30-year life and a 5% discount rate.

7.3 Alternative 3: NRS and Plant Area Soil Vapor Extraction (SVE); Groundwater Containment/Treatment at Water Plant 2

This alternative treats TCE contaminated soil by soil vapor extraction at both the former lagoon area and the plant spill areas (volumes of approximately 8,500 cubic yards, and 68,000 cubic yards, respectively) and continued operation of Water Plant 2 affords containment and treatment (air stripping) of the Memphis Sand groundwater.

Modeling runs and indications from RI data point toward the conclusion that operation of the Town well field has essentially contained the TCE plume. This information is not conclusive and thus makes any assessment of overall protection somewhat uncertain, until additional Memphis Sands aquifer testing is performed during RD. Also, TCE will continue to enter the Memphis Sand aquifer at the southern end of the Site until the Plant Area SVE is implemented, and will remain in the Memphis Sand until extracted at Water Plant 2. Containment at Water Plant 2 would be continued up to 30 years.

The locations and number of SVE wells in the main plant area depends upon the areal extent of contamination, area of influence produced by each well, and the variability in pneumatic permeability around the plant area. Some pilot-scale treatability work would likely be needed to complete the design of SVE implementation near the manufacturing plant.

The amount of contaminated soils that would be treated in the lagoon and main plant areas was determined using fate and transport modeling to estimate the potential groundwater contamination. Transport modeling calculations indicate that an average concentration of 533 μg/kg TCE at the existing source areas will no longer yield leachate which would contaminate Memphis Sand groundwater above 5 $\mu g/\ell$ for TCE. Long-term benefits of this alternative would include permanent reduction in toxicity and volume of soil contamination. The estimated time for SVE to remediate the lagoon and main plant areas is three to five years.

The treated water from the air strippers would remain a significant supply for the Town of Collierville. Both air stripping and SVE volatilize contaminants to an air stream. Vapor-phase Granular Activated Carbon (GAC), thermal treatment, or photolytic oxidation would be used to control off-gas emissions if during Remedial Design/Remedial Action (RD/RA) it is determined necessary. Photolytic oxidation, although promising, is a relatively new technology and would require a pilot-scale treatability study.

The Memphis Sands groundwater would be treated to levels below SDWA regulations. This alternative would comply with federal and state CAA standards. All activities would comply with Occupational Safety and Health Act (OSHA) health and safety requirements. A small portion of the Site is situated in a 100-year floodplain and wetlands area. Any remedial activity or construction in the floodplain and wetland areas would comply with the Clean Water Act (CWA) Wetlands Regulations and the Wetlands Protection and Floodplain Management Policies. Also, Resource Conservation and Recovery Act (RCRA) Subtitle C and Department of Transportation (DOT) requirements for hazardous waste generation, transportation, storage, and disposal of hazardous waste would be applicable for this alternative. Hazardous waste soils from drilling, and spent GAC, if used, would be stored and transported to approved disposal facilities in accordance with RCRA Subtitle C and DOT requirements.

Selected Site groundwater monitoring wells and soil would be sampled for volatile organic compounds and metals. A review of data collected at the Site would be evaluated at least every five years during the remedial action or until contaminant concentrations in groundwater no longer exceed SDWA regulations or soil cleanup levels. The evaluation would continue until completion of the groundwater remedial action and would serve to indicate whether cleanup levels have been or would be attained. Based upon the findings of the review, EPA may determine other studies and/or actions should be taken.

The estimated capital cost for this alternative is in the range of $1,742,400 to $2,102,512 while the associated costs for O&M and monitoring are $5,349,263. The estimated present worth costs are in the range $5,468,140 to $7,451,775. The estimated present-worth analysis is based upon a 30-year life and a 5% discount rate.

7.4 Alternative 4: NRS and Plant Area SVE; Groundwater Containment/Treatment at Water Plant 2, and Supplemental Extraction Well(s)/Treatment via (A) Air Stripping, or (B) UV/Oxidation

This alternative includes remediation of TCE contaminated soil by SVE in the former lagoon (NRS) and plant spill areas. Approximately 76,500 cubic yards of contaminated soils would be treated. Also included would be groundwater containment, treatment (air stripping), and disposal. The groundwater containment currently provided by the operation of Water Plant 2 extraction wells would be supplemented by additional extraction well(s).

Alternative 4 differs from alternative 3 in the manner that groundwater containment will have greater assurance. Groundwater in the Memphis Sand would continue to receive TCE contamination until the SVE could be implemented. The supplemental groundwater extractions included with this alternative would minimize the extent of Memphis Sand degradation that occurs in this interim period. Groundwater actions are expected to be effective, although additional information must be obtained during Remedial Design (RD) to determine the configuration and number of supplemental extraction wells required to meet effectiveness levels.

The fact that additionally-extracted groundwater will require treatment opens the following two treatment options: (A) air stripping and (B) innovative UV/oxidation. Operation of the air stripping system at Water Plant 2 will continue. An additional treatment unit will be required under this scenario to handle the added water from the supplemental extraction.

The locations and number of SVE wells in the main plant area depends upon the areal extent of contamination, area of influence produced by each well, and the variability in pneumatic permeability around the plant area. Some pilot-scale treatability work would be needed to complete the design of SVE implementation near the manufacturing plant.

The amount of contaminated soils that would be treated in the lagoon and main plant areas was determined using fate and transport modeling to estimate the potential groundwater contamination. Transport modeling calculations indicate that an average soil concentration of 533 μg/kg TCE at the existing source areas will no longer yield leachate which would contaminate Memphis Sand groundwater above 5 $\mu g/\ell$ for TCE. Long-term benefits of this alternative would include permanent reduction in toxicity and volume of soil contamination. The estimated time for SVE to remediate the lagoon and main plant areas is three to five years.

The treated water from the supplemental extraction well(s) will be released to surface water, reinjected to the Memphis Sand, or distributed to the Town of Collierville drinking water supply as with Water Plant 2. The Town of Collierville Public Works has stated a preference for the use of treated water as an additional drinking water supply, because Collierville's water demand is increasing along with its population.

Both air stripping and SVE volatilize contaminants to an air stream. Vapor-phase Granular Activated Carbon (GAC), thermal treatment, or photolytic oxidation would be used to control off-gas emissions if during Remedial Design/Remedial Action (RD/RA) it is determined necessary. Photolytic oxidation, although promising, is a relatively new technology and would require a pilot-scale treatability study. UV/oxidation does not require air pollution control equipment or associated testing. Bench-scale testing would be required prior to UV/oxidation design to determine optimum operating parameters.

The Memphis Sands groundwater would be treated to levels below SDWA regulations, CWA Discharge Limitations and Pretreatment Standards, CWA Wetlands Regulations, SDWA Underground Injection Control Program, and/or the Tennessee Water Quality Act. This alternative would comply with federal and state CAA standards. All activities would comply with OSHA health and safety requirements. A small portion of the site is situated in a 100-year floodplain and wetlands area. Any remedial activity or construction in the floodplain and wetland areas would comply with the CWA Wetlands Regulations and the Wetlands Protection and Floodplain Management Policies. Also, RCRA Subtitle C and DOT requirements for hazardous waste generation, transportation, storage, and disposal of hazardous waste would be applicable for this alternative. Hazardous waste soils from drilling, and spent GAC, if used, would be stored and transported to approved disposal facilities in accordance with RCRA Subtitle C and DOT requirements.

Selected Site groundwater monitoring wells and soil would be sampled for volatile organic compounds and metals. A review of data collected at the Site would be evaluated at least every five years during the remedial action or until contaminant concentrations in groundwater no longer exceed SDWA regulations or soil cleanup levels. The evaluation would continue until completion of the groundwater remedial action and would serve to indicate whether cleanup levels have been or would be attained. Based upon the findings of the review, EPA may determine that other studies and/or actions should be taken.

The estimated capital cost for Alternative 4(A) is in the range of $1,900,260 to $2,443,431 while the associated costs for O&M and monitoring are $5,489,334. The estimated present worth costs are in the range $5,717,755 to $7,932,765.

The estimated capital cost for Alternative 4(B) is in the range of $2,007,540 to $2,578,163 while the associated costs for O&M and monitoring are $5,839,513. The estimated present worth costs are in the range $6,054,423 to $8,417,675.

The estimated present-worth analyses is based upon a 30-year life and a 5% discount rate.

7.5 Alternative 5: Plant Area Soil Excavation/Low Temperature Thermal Desorption (LTTD), NRS and Plant Area SVE; Groundwater Containment/Treatment at Water Plant 2

Alternative 5 includes excavation, low temperature thermal desorption (LTTD) and SVE for source remediation. Shallow source area soils (approximately 52,000 cubic yards contaminated with TCE at greater than the 533 μg/kg threshold for protection of Memphis Sand groundwater) would be excavated and backfilled with clean native soil. SVE would then be used to remediate deeper contamination where excavation of about 16,300 cubic yards is less readily implemented, and permeability is expected to be greater than in the lagoon area. The NRS would also be operated to reach soil remedial levels at the former lagoon source area, involving about 8500 cubic yards, the top 15 feet of which may be excavated and processed by LTTD, if needed.

Water Plant 2 operation would continue to contain and treat (air stripping) contaminated groundwater. Modeling runs and indications from RI data point toward the conclusion that operation of the Town well field has essentially contained the TCE plume. This information is not conclusive and thus makes any assessment of overall protection somewhat uncertain, until additional Memphis Sands aquifer testing is performed. Also, TCE will continue to enter the Memphis Sand aquifer at the southern end of the Site until the Plant Area SVE is implemented, and will remain in the Memphis Sand until extracted at Water Plant 2. Containment at Water Plant 2 would be continued for up to 30 years.

All soil contaminated above 533 μg/kg TCE would be excavated to a depth of approximately 15 feet, sampled, analyzed and stockpiled for LTTD processing. After soil excavation is completed and the cells are backfilled with clean native soil, SVE will be implemented to remediate soils which exceed the soil cleanup level at depths greater than 15 feet.

Effectiveness of excavation and LTTD is expected to be very high for the source soils. LTTD off-gas would be treated with a cyclone separator, a baghouse, and an afterburner. The afterburner would be located either upstream or downstream of the baghouse.

The locations and number of SVE wells in the lagoon and main plant areas depend upon the areal extent of contamination, area of influence produced by each well, and the variability in pneumatic permeability around the plant area. Some pilot-scale treatability work would likely be needed to complete the design of SVE implementation near the manufacturing plant.

The amount of contaminated soils that would be treated in the lagoon and main plant areas was determined using fate and transport modeling to estimate the potential groundwater contamination. Transport modeling calculations indicate that an average concentration of

533 $\mu g/kg$ TCE at the existing source areas would no longer yield leachate which would contaminate Memphis Sand groundwater above 5 $\mu g/\ell$ for TCE. Long-term benefits of this alternative would include permanent reduction in toxicity and volume of soil contamination. The estimated time for LTTD and SVE to remediate the lagoon and main plant areas is two to three years.

The treated water from the air strippers would remain a significant supply for the Town of Collierville. Both air stripping and SVE volatilize contaminants to an air stream. Vapor-phase Granular Activated Carbon (GAC), thermal treatment, or photolytic oxidation would be used to control off-gas emissions if during RD/RA it is determined necessary. Photolytic oxidation, although promising, is a relatively new technology and would require a pilot-scale treatability study.

The Memphis Sands groundwater would be treated to levels below SDWA regulations. This alternative would comply with federal and state CAA standards. All activities would comply with OSHA health and safety requirements. A small portion of the site is situated in a 100-year floodplain and wetlands area. Any remedial activity or construction in the floodplain and wetland areas would comply with the CWA Wetlands Regulations and the Wetlands Protection and Floodplain Management Policies. Also, RCRA Subtitle C and DOT requirements for hazardous waste generation, transportation, storage, and disposal of hazardous waste would be applicable for this alternative. Hazardous waste soils from drilling, and if used, spent GAC, would be stored and transported to approved disposal facilities in accordance with RCRA Subtitle C and DOT requirements.

Selected Site groundwater monitoring wells and soil spaces would be sampled for volatile organic compounds and metals. A review of data collected at the Site would be evaluated at least every five years during the remedial action or until contaminant concentrations in groundwater no longer exceed SDWA MCLs and/or MCLGs or soil cleanup levels. The evaluation would continue until completion of the groundwater remedial action and would serve to indicate whether cleanup levels have been or will be attained. Based upon the findings of the review, EPA may determine that other studies and/or actions should be taken.

The estimated capital cost for this alternative is in the range of $5,688,540 to $8,579,136 while the associated costs for O&M and monitoring are $5,437,347. The estimated present worth costs are in the range $9,467,667 to $13,956,482. The estimated present-worth analysis is based upon a 30-year life and a 5% discount rate.

7.6 Alternative 6: Plant Area Soil Excavation/LTTD, NRS and Plant Area SVE; Groundwater Containment/Treatment at Water Plant 2, and Supplemental Extraction Well(s)/Treatment via (A) Air Stripping, or (B) UV/Oxidation

Alternative 6 includes excavation and low temperature thermal desorption (LTTD) and SVE for source remediation. Shallow source area soils (approximately 52,000 cubic yards contaminated with TCE at greater than the 533 $\mu g/kg$ threshold for protection of Memphis Sand groundwater) would be excavated and backfilled with clean native soil. SVE would then be used to remediate deeper contamination where excavation of about 16,300 cubic yards is less readily implemented, and permeability is expected to be greater than in the lagoon area. The NRS would also be operated to reach soil remediation levels at the former lagoon source area, involving about 8500 cubic yards, the top 15 feet of which may be excavated and processed by LTTD, if needed.

All soil contaminated above 533 μg/kg TCE would be excavated to a depth of approximately 15 feet, sampled, analyzed and stockpiled for LTTD processing. After soil excavation is completed and the cells are backfilled with clean native soil, SVE will be implemented to remediate soils which exceed the soil cleanup level at depths greater than 15 feet.

Effectiveness of excavation and LTTD is expected to be very high for the source soils. Off-gas would be treated with a cyclone separator, a baghouse, and an afterburner. The afterburner would be located either upstream or downstream of the baghouse.

The locations and number of SVE wells in the lagoon and main plant areas depend upon the areal extent of contamination, the area of influence produced by each well, and the variability in pneumatic permeability around the plant area. Some pilot-scale treatability work would likely be needed to complete the design of SVE implementation near the manufacturing plant.

The amount of contaminated soils that would be treated in the lagoon and main plant areas was determined using fate and transport modeling to estimate the potential groundwater contamination. Transport modeling calculations indicate that an average concentration of 533 μg/kg TCE at the existing source areas would no longer yield leachate which would contaminate Memphis Sand groundwater above 5 μg/ℓ for TCE. Long-term benefits of this alternative would include permanent reduction in toxicity and volume of soil contamination. The estimated time for LTTD SVE to remediate the lagoon and main plant areas is two to three years.

Alternative 6 differs from Alternative 5 in the manner that groundwater containment will have greater assurance. Groundwater in the Memphis Sand would continue to receive TCE contamination until the SVE could be implemented. The supplemental groundwater extraction wells included with this alternative would minimize the extent of Memphis Sand degradation that occurs in this interim period. Groundwater actions are expected to be effective, although additional information must be obtained during RD to determine the configuration and number of supplemental extraction wells required to meet effectiveness levels.

The fact that additionally-extracted groundwater will require treatment opens the following two treatment options: (A) air stripping and (B) innovative UV/oxidation. Operation of the air stripping system at Water Plant 2 would continue. An additional treatment unit would be required under this scenario to handle the added water from the supplemental extraction.

The treated water from the supplemental extraction well(s) would be released to surface water, reinjected to the Memphis Sand, or distributed to the Town of Collierville drinking water supply as with Water Plant 2. The Town of Collierville Public Works has stated a preference for the use of treated water as an additional drinking water supply, because Collierville's water demand is increasing along with its population.

Both air stripping and SVE volatilize contaminants to an air stream. Vapor-phase Granular Activated Carbon (GAC), thermal treatment, or photolytic oxidation would be used to control off-gas emissions if during Remedial Design/Remedial Action (RD/RA) it is determined necessary. Photolytic oxidation, although promising, is a relatively new technology and would require a pilot-scale treatability study. UV/oxidation does not require air pollution control equipment or associated testing. Bench-scale testing would be required prior to UV/oxidation design to determine optimum operating parameters.

The Memphis Sands groundwater would be treated to levels below SDWA regulations, CWA Discharge Limitations and Pretreatment Standards, CWA Wetlands Regulations, SDWA Underground Injection Control Program, and/or the Tennessee Water Quality Act. This alternative would comply with federal and state CAA standards. All activities would comply with OSHA health and safety requirements. A small portion of the site is situated in a 100-year floodplain and wetlands area. Any remedial activity or construction in the floodplain and wetland areas would comply with the CWA Wetlands Regulations and the Wetlands Protection and Floodplain Management Policies. Also, RCRA Subtitle C and DOT requirements for hazardous waste generation, transportation, storage, and disposal of hazardous would be applicable for this alternative. Hazardous waste soils from drilling, and if used, spent GAC, would be stored and transported to approved disposal facilities in accordance with RCRA Subtitle C and DOT requirements.

Selected Site groundwater monitoring wells and soil would be sampled for volatile organic compounds and metals. A review of data collected at the Site would be evaluated at least every five years during the remedial action or until contaminant concentrations in groundwater no longer exceed SDWA regulations or soil cleanup levels. The evaluation would continue until completion of the groundwater remedial action and would serve to indicate whether cleanup levels have been or will be attained. Based upon the findings of the review, EPA may determine that other studies and/or actions should be taken.

The estimated capital cost for Alternative 6(A) is in the range of $5,917,734 to $8,931,088 while the associated costs for O&M and monitoring are $5,577,418. The estimated present worth costs are in the range $9,788,616 to $14,508,506.

The estimated capital cost for Alternative 6(B) is in the range of $5,913,909 to $8,923,438 while the associated costs for O&M and monitoring are $5,927,597. The estimated present worth costs are in the range $10,014,179 to $14,851,035.

The estimated present-worth analyses is based upon a 30-year life and a 5% discount rate.

8.0 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

A detailed comparative analysis was performed on the six remedial alternatives developed during the FS and the modifications submitted during the public comment period using the nine evaluation criteria set forth in the NCP. The advantages and disadvantages were compared to identify the alternative with the best balance among these nine criteria.

Overall Protection of Human Health and the Environment addresses whether or not a remedy provides adequate protection and describes how risks are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls. Criteria used to evaluate the protectiveness of an alternative included the following: (1) no cancer risks from exposure to groundwater of less than $1x10^{-6}$; (2) no significant risks of threshold toxic effect (HI less than 1) under reasonable maximum exposure; and (3) no significant risk or adverse effects on the environment.

All alternatives except for "No Action", would be protective of human health. The "No Action" alternative is not protective because it would not prevent unacceptable risk from ingestion or inhalation of groundwater.

"No Action" and Alternative 2 are not protective of the environment because they allow for contamination to continue to enter the Memphis Sands. The effectiveness of the existing Water Plant 2 well system in containing the entire plume is the key factor which differentiates alternatives 3 and 5 from 4 and 6. If the southwestern extent of the plume of TCE (concentrations greater than MCLs) which arises from the plant area spills is outside the capture zone of Plant 2 wells, protectiveness is not assured. Thus, Alternatives 3 and 5 would not fully protect the environment. Alternatives 4 and 6 would provide additional certainty that existing groundwater contamination would be contained.

Since the "No-Action" alternative does not eliminate, reduce or control any of the exposure pathways, it is therefore not protective of human health or the environment and will not be considered further in this analysis. Alternative 2 will not be discussed further because it is not protective of the environment. This alternative only addresses the soils in the vicinity of the former lagoon area and without response directed toward source soils near the main plant, these sources will be remediated only by natural attenuation over a period on the order of 2000 years, not accounting for biological degradation. Without more rapid source control, restoration of the Memphis Sand cannot be accomplished in a timely manner.

Compliance with Applicable or Relevant and Appropriate Requirements (ARARs) addresses whether or not a remedy will meet all of the applicable or relevant and appropriate requirements of other Federal and state environmental statutes and/or provide grounds for a waiver. The identified ARARs for this site are listed in Section 10.2.

Alternatives 3,4,5, and 6 would comply with Federal and state ARARs.

Long-Term Effectiveness and Permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk and the adequacy and reliability of controls.

Alternatives 4 and 6 afford the highest degree of long-term effectiveness because all contaminated soils would be reduced to levels protective of the Memphis Sand aquifer; the remedial action objective of preventing further contamination to the Memphis Sands is quickly achieved through implementation of additional extraction well(s); and the additional well(s) will provide assurance that containment of the entire contaminant plume is adequate. Although Alternatives 3 and 5 reduce contaminated soil to levels protective of the Memphis Sands, these alternatives do not assure quick prevention of further contamination of the Memphis Sands or containment of the entire plume.

Reduction of Toxicity, Mobility, or Volume Through Treatment refers to the anticipated performance of the treatment technologies a remedy may employ.

Alternatives 3,4,5, and 6 would accomplish a reduction in toxicity, mobility, and volume. The alternatives would reduce toxicity by volatilization of TCE from soil and groundwater. Mobility would be reduced as residual TCE is extracted (all alternatives) and/or excavated (5 and 6) from soils. As soon as treatment of vadose zone soils is complete, migration of toxic concentration levels of TCE in groundwater would cease. The volume of TCE in groundwater and some contaminated soils would be reduced as the treatment progresses. Essentially the entire volume of contaminated site soils would be treated by SVE (Alternatives 3,4,5, and 6) and/or LTTD (5 and 6) —— totalling over 76,000 cubic yards. Alternatives 3,4,5, and 6 provide for destruction of air emission residuals through properly selected, designed and operated emission controls.

Alternative 4 and 6 would extract and treat all affected Memphis Sand groundwater. Alternatives 3 and 5 would capture most of the contaminated groundwater plume at Water Plant 2.

Short-Term Effectiveness refers to the period of time needed to complete the remedy and any adverse impacts on human health and the environment that may be posed during the construction and implementation of the remedy until cleanup levels are achieved.

Short-term risk from Alternatives 5 and 6 are higher than those associated with Alternatives 3 and 4 because excavation activities would increase VOCs and fugitive dust emissions. A water or foam spray would reduce emissions enough to substantially mimimize the risk to the community.

Alternatives 5 and 6 would require approximately two to three years to remediate Site soils to levels protective of the Memphis Sands. Alternatives 3 and 4 would require three to five years to remediate Site soils to levels protective of the Memphis Sands. All the alternatives would require approximately 30 years to remediate groundwater to ARARs.

For all alternatives, risk to onsite workers would be minimized by providing personal protection equipment as outlined by OSHA. The alternatives protect the community and workers by reducing the contaminants in soil, groundwater, and air (through the use of emission controls on discharge pipes at the SVE, and air stripper systems). UV/oxidation generates no air emissions. No additional adverse impact to the environment would occur from the implementation of these alternatives.

Implementability is the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement the chosen solution.

Groundwater containment/air stripping (3, 4A, 5, and 6A) measures are extremely common and widely available. Monitoring groundwater and its restoration should not pose extraordinary problems.

SVE (all alternatives) and LTTD (5 and 6) are relatively new, yet widely available technologies for the treatment of volatile organic contaminated soils. A treatability study for SVE at the main plant area would be required to effectively address what are expected to be heterogeneous spaces in terms of both contamination and air permeability. The ability to monitor effectiveness of SVE is not technically infeasible, but would require carefully designed and implemented sampling efforts to assure effectiveness in reaching soil cleanup levels.

UV/oxidation (4A and 6A) is less common at hazardous waste sites, but is a demonstrated process for streams with low contaminant concentrations, and low total solids content. Supplementally-extracted groundwater may pose operation problems, such as fouling, or high oxidant consumption, due to the presence of trace metals and hardness. UV/oxidation treatability work would be required before design to avoid or manage potential operational problems.

Cost

The total Present Worth Costs for each of the alternatives evaluated are as follows:

Alternative 3: $5.5 to $7.5 million
Alternative 4A: $5.7 to $7.9 million
Alternative 4B: $6.1 to $8.4 million
Alternative 5: $9.5 to $14 million
Alternative 6A: $9.8 to $14.5 million
Alternative 6B: $10 to $14.9 million

State Acceptance

EPA and the Tennessee Department of Environment and Conservation (TDEC) have cooperated throughout the RI/FS process. The State has participated in the development of the RI/FS through comment on each of the planning and decision documents developed by EPA, and the

Draft ROD and through frequent contact between the EPA and TDEC site project managers. EPA and TDEC are in agreement on the selected alternative. Please refer to the Responsiveness Summary which contains a letter of concurrence from TDEC.

Community Acceptance

EPA received two letters from residents in the Town of Collierville. During the public meeting held on April 30, 1992, town residents in attendance expressed interest and support for the selected remedy present by EPA. Please see the Responsiveness Summary which contains these letters and a transcript of the public meeting.

9.0 THE SELECTED REMEDY

Based upon consideration of the CERCLA requirements, the detailed analysis of the alternatives using the nine criteria, and public comments, both EPA and TDEC have determined that Alternative 4A is the most appropriate remedy for the Carrier A.C. Superfund Site in Collierville, Tennessee.

The selected remedy shall include the following: (1) the North Remediation System (NRS) and plant area soil vapor extraction (SVE); (2) groundwater containment/treatment at Water Plant 2, and supplemental extraction well(s)/treatment via air stripping; and (3) institutional controls placed on well construction and water use in the general area of the Site.

It is estimated that the present worth cost of the selected remedy will be approximately $5.7 to $7.9 million. The present worth cost analysis is based upon a 30-year life and a 5% discount rate.

Alternative 4A will permanently reduce the risk of exposure to contaminants in soil and groundwater and will also prevent further contamination to the environment.

9.1 Performance Standards

(1) North Remediation System (NRS) and Plant Area Soil Vapor Extraction (SVE)

The NRS shall continue to remediate the contaminated soils in the area of the former lagoon via SVE. A SVE system in the area of the main plant source area shall be constructed to remediate contaminated soils. SVE in the former lagoon and main plant area will continue to operate until remediation to cleanup levels are reached throughout the area of soil contamination. The cleanup level for the TCE-contaminated soil will be approximately 533 μg/kg or until in EPA's determination, it is demonstrated that contaminant levels have ceased to decline over time, and are remaining constant at some statistically significant level above remediation levels in the area of remediation, as verified by soil sampling. The ability to achieve 533 μg/kg cannot be determined until after the extraction system has been implemented, modified as necessary, and soil response monitored over time. A monitoring system will be instituted to measure progress and operating efficiencies of SVE in achieving the cleanup level.

EPA will determine the locations and number of vapor extraction wells in the main plant area. The decisions will be based upon the areal extent of contamination, area of influence produced by each well, and the variability in pneumatic permeability around the plant area. Some pilot-scale treatability work will be needed to complete the design of SVE implementation near the manufacturing plant.

All air emissions shall be in compliance with the Federal and State CAA standards. Off-gas emissions, if determined necessary during RD, will be controlled by Granular Activated Carbon (GAC), thermal treatment, or photolytic oxidation.

(2) Groundwater Containment/Treatment at Water Plant 2, and Supplemental Extraction Well(s)/Treatment via Air Stripping

Groundwater Containment/Treatment shall be conducted at Water Plant 2 and with supplemental well(s). EPA will determine the final number and location of supplemental wells for the Site. The existing air strippers at Water Plant 2 shall continue to be used to treat extracted groundwater. If EPA deems necessary, additional air strippers and/or monitoring wells will be installed as part of the remedial action to ensure compliance with the cleanup levels of the selected remedy.

The groundwater extraction system will continue to operate until cleanup levels for the contaminants of concern are reached throughout the area of attainment. The area of attainment shall encompass the area up to the contaminant plume boundary.

The Memphis Sand aquifer will be treated until the cleanup levels for the contaminants, as listed below, are attained.

Trichloroethylene (TCE)	5 $\mu g/\ell$	(SDWA MCL)
cis-1,2-Dichloroethylene (DCE)	70 $\mu g/\ell$	(SDWA MCLG)
trans-1,2-Dichloroethylene (DCE)	100 $\mu g/\ell$	(SDWA MCLG)
Tetrachloroethene (PCE)	5 $\mu g/\ell$	(SDWA MCL)
Vinyl Chloride	2 $\mu g/\ell$	(SDWA MCL)
Zinc	5000 $\mu g/\ell$	(SDWA SMCL)

The Memphis Sand aquifer will be treated until (1) background levels of lead or (2) cleanup levels for lead of 15 $\mu g/\ell$ (SDWA Treatment Technique Action Level) is attained. The determination of which level will be achieved will be based upon whether lead is elevated above background levels and this condition is due to Site-related conditions; or whether a significant statistical difference between background levels and onsite levels of lead exists.

The accepted EPA methods are documented in the "USEPA Contract Lab Program Statement of Work for Inorganic Analysis, Document #ILM02.0"; the "Contract Lab Program Statement of Work for Organic Analysis, Document # OLM01.0," dated August 1991; and the "Superfund Analytical Methods for Low Concentration Water for Organic Analysis," dated June 1991, and any amendments made thereto during the course of the implementation of RD/RA. Monitoring wells shall be sampled for up to 30 years.

The sampling frequency, number, and location of the monitoring wells and background monitoring wells will be designated by EPA during the RD, and if deemed necessary, additional monitoring wells will be installed.

The goal of this remedial action is to restore the Memphis Sands groundwater to its beneficial use, which is, at this Site, a drinking water aquifer. Based on information obtained during the RI and on a careful analysis of all remedial alternatives, EPA and TDEC believe that the selected remedy will achieve this goal. It may become apparent, during implementation or operation of the groundwater extraction systems, that contaminant levels have ceased to decline and are remaining constant at levels higher than the remediation levels. In such a case, the system performance standards and/or remedy will be reevaluated.

The selected remedy will include groundwater extraction for an estimated period of 30 years, during which the system's performance will be carefully monitored on a regular basis and adjusted as warranted by the performance data collected during operation. The operating system may include:

a) discontinuing operation of extraction wells in areas where cleanup levels have been attained;

b) alternating pumping at wells to eliminate stagnation points; and

c) pulse pumping to allow aquifer equilibration and encourage adsorbed contaminants to partition into groundwater.

To ensure that cleanup levels continue to be maintained, the aquifer will be monitored at those wells where pumping has ceased on an occurrence of at least every 5 years following discontinuation of groundwater extraction.

All extracted groundwater shall be treated to levels which allow for discharge to (1) the municipal water supply; (2) a local POTW; (3) surface water; or (4) reinjected to the Memphis Sands aquifer. All groundwater discharge actions shall comply with Federal and State discharge requirements.

All air emissions from the air stripper(s) shall be in compliance with Federal and State CAA standards. Off-gas emissions, if determined necessary during RD, will be controlled by Granular Activated Carbon (GAC), thermal treatment, or photolytic oxidation.

(3) Institutional Controls Placed on Well Construction and Water Use in the General Area of the Site

If EPA deems necessary, institutional controls will be placed on well construction in the general area of the Site. No well will be located, constructed or operated which results in the diminution of the extraction wells at Carrier A.C. Superfund Site or in the degradation of the Memphis Sands. Institutional controls will also restrict the use of groundwater containing, or potentially containing, levels of contamination in excess of MCLs, SMCLs and non-zero MCLGs. Institutional controls may include local ordinances, deed restrictions, record notice, or some other appropriate measures. The controls shall remain in effect until EPA through monitoring determines that the cleanup levels have been attained.

10.0 STATUTORY DETERMINATIONS

Under CERCLA Section 121, EPA must select remedies that are protective of human health and the environment, comply with applicable or relevant and appropriate requirements (unless a statutory waiver is justified), are cost-effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduce the volume, toxicity, or mobility or hazardous wastes as their principal element. The following sections discuss how the remedy meets these statutory requirements.

10.1 Protection of Human Health and the Environment

The selected remedy protects human health and the environment through the North Remediation System (NRS) and plant area soil vapor extraction (SVE); groundwater containment/treatment at Water Plant 2, and supplemental extraction well(s)/treatment via air stripping; and institutional controls placed on well construction and water use in the general area of the Site. Air stripping will irreversibly remove organic compounds from groundwater. SVE will irreversibly remove VOCs from soils to levels at or below soil cleanup levels. Residuals in air emissions will be controlled through properly selected, designed and operated emission controls. Institutional controls will assure that the public is not affected by Site-related contaminants at a current or future time.

Air stripping of contaminated groundwater will eliminate the threat of exposure to the contaminants of concern via ingestion or inhalation of groundwater. The current cancer risk associated with this exposure pathway is 2.5×10^{-4}. The future cancer risk from the groundwater pathway is 4.7×10^{-4}. By extracting and air stripping the groundwater, the cancer risk will be reduced to 1×10^{-6}. This level falls within the EPA's acceptable risk range of 10^{-4} to 10^{-6}. No short-term threats are associated with the selected remedy that cannot be readily controlled. In addition, no adverse cross-media impacts are expected from the remedy.

Exposure to contaminated surface soils does not pose a current or future risk greater than the

10^{-6} point of departure. However, in light of the current and potential future groundwater uses, soil vapor extraction will be used to effectively to remediate the contaminated soils to levels protective of the Memphis Sands. No short-term threats are associated with the selected remedy cannot be readily controlled. In addition, no adverse cross-media impacts are expected from the remedy.

10.2 Compliance with Applicable or Relevant and Appropriate Requirements

The selected remedy of the North Remediation System (NRS) and plant area soil vapor extraction (SVE); groundwater containment/treatment at Water Plant 2, and supplemental extraction/treatment via air stripping; and institutional controls placed on well construction and water use in the general area of the Site will comply with applicable or relevant and appropriate chemical, action, and location-specific requirements (ARARs). The ARARs are presented below:

Chemical-Specific ARARs:

Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs) (42 U.S.C. § 1412 (§ 300g-1); 40 C.F.R. 141.61 and 141.80) have been set for toxic compounds as enforceable standards for public drinking water systems.

SDWA Secondary Maximum Contaminant Levels (SMCLs) (42 U.S.C. § 1412 (§ 300g-1); 40 C.F.R. 143.3) are unenforceable goals regulating the aesthetic quality of drinking water.

SDWA Maximum Contaminant Levels Goals (MCLGs) (42 U.S.C. § 1412 (§ 300g-1); 40 C.F.R. 141.50) are unenforceable health goals.

Clean Water Act (CWA) Federal Water Quality Criteria (33 U.S.C. § 1314(a)(1)(§ 304(a)(1)) are effluent limitations that must meet Best Available Technology (BAT).

Clean Air Act (CAA) National Ambient Air Quality Standards (42 U.S.C. § 7409 (§ 109); 40 C.F.R. Part 50) establishes emissions standards, monitoring and testing requirements, and reporting requirements for eight pollutants in air emissions.

Tennessee Water Quality Control Act (69-3-101) controls and regulates drinking water and discharges to POTW and also to waters of the State.

Location-Specific ARARs

Resource Conservation Recovery Act (RCRA) (42 U.S.C. §§ 6921-39 (§§ 3001-19); 40 C.F.R. Parts 260-70) regulates the treatment, storage, and disposal of hazardous waste from generation through ultimate disposal. Remedial action at the Site may require the handling of materials that constitute RCRA hazardous waste, for example, soil and groundwater residuals or spent carbon (if carbon adsorption is chosen). Any such materials will be handled in compliance with applicable RCRA requirements.

Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.) requires actions to protect fish and wildlife from actions modifying streams or areas affecting streams.

CAA National Ambient Air Quality Standards (42 U.S.C. § 7409 (§ 109); 40 C.F.R. Part 50) establishes emission standards to protect public health and public welfare. These standards are national limitations on ambient air intended to protect health and welfare.

Action-Specific ARARs

RCRA (42 U.S.C. §§ 6921-39 (§§ 3001-19); 40 C.F.R. Parts 260-70) regulates the treatment, storage, and disposal of hazardous waste from generation through ultimate disposal. Remedial action at the Site may require the handling of materials that constitute RCRA hazardous waste, for example, soil and groundwater residuals or spent carbon (if carbon adsorption is chosen). Any such materials will be handled in compliance with applicable RCRA requirements.

CWA Discharge Limitations (33 U.S.C. § 1311 (§ 301); 40 C.F.R. Parts 122, 125, 129, 133, and 136) prohibits unpermitted discharge of any pollutant or combination of pollutants or combinations of pollutants to waters of the U.S. from any point source. Standards and limitations are established for these discharges to a POTW.

SDWA Undergound Injection Control (UIC) (42 U.S.C. §§ 300h-300h-7 (§§ 1421-8); 40 C.F.R. Parts 144-7) is a permit program designed to prevent contamination of underground sources of drinking water.

CWA Pretreatment Standards (33 U.S.C. § 1317 (§ 307); 40 C.F.R. 403.5) prohibits unpermitted discharge of any pollutant or combination of pollutants or combinations of pollutants to waters of the U.S. from any point source. Standards and limitations are established for these discharges to a POTW.

CWA Dredge and Fill Material Permits - Wetlands (33 U.S.C. § 1344 (§ 404); 40 C.F.R. Part 230) controls the discharge of dredged or fill materials into water of the U.S. such that the physical and biological integrity is maintained.

CAA New Source Performance Standards (42 U.S.C. § 7411 (§ 111); 40 C.F.R. 60) establishes standards of performance for new air emission sources.

CAA National Emission Standards for Hazardous Air Pollutants (42 U.S.C. § 7412 (§ 112); 40 C.F.R. Part 61) establishes emissions standards, monitoring and testing requirements, and reporting requirements for eight pollutants in air emissions.

Occupations Safety and Health Standards Act (29 U.S.C. § 651 et seq.; 29 C.F.R. Part 1910) sets limits on exposure to workers on hazardous site or emergency responses, sets forth minimum health and safety requirements such as personal protection and training, and reporting requirements.

To Be Considered Materials (TBCs)

EPA Groundwater Protection Strategy (EPA, 1984) is a policy to restore groundwater to its beneficial uses within a time frame that is reasonable. Groundwater beneath and adjacent to the Carrier A.C. Site are Class IIA and IIIA aquifers.

Town of Collierville Municipal Code of Ordinances (10-230) is a promulgated local deed restriction prohibiting installation of wells without a permit.

Shelby County Well Construction Codes (Section 4 and 5) are promulgated local rules and regulations to control and regulate the location, construction, and modification of all types of wells in Shelby County.

Executive Order 11990 Wetlands Protection Policy sets forth policy for the protection of wetlands.

Executive Order 11988 Floodplain Management Policy sets forth policy for the protection of floodplains.

10.3 Cost Effectiveness

The selected remedy, Alternative 4A was chosen because it provides the best balance among criteria used to evaluate the alternatives considered in the Detailed Analysis. This alternative was found to achieve both adequate protection of human health and the environment and to meet the statutory requirements of Section 121 of CERCLA. The present worth cost of Alternative 4A is in the range of $5,717,755 to $7,932,765.

10.4 Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable

EPA and TDEC have determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost-effective manner for the final ROD at the Carrier A.C. Site. Of those alternatives that are protective of human health and the environment and comply with ARARs, EPA and TDEC have determined that the selected remedy provides the best balance of trade-offs in terms of long-term effectiveness and permanence, reduction in toxicity, mobility, or volume achieved through treatment, short-term effectiveness, implementability, cost, while also considering the statutory preference for treatment as a principal element and considering State and community acceptance.

The selected remedy treats the principal threats posed by groundwater and soils, achieving significant contaminant reductions. This remedy provides the most effective treatment of any of the alternatives considered, and will cost less than excavation. The selection of treatment for the contaminated soils and groundwater is consistent with program expectations that highly toxic and mobile wastes are a priority for treatment to ensure the long-term effectiveness of a remedy.

10.5 Preference for Treatment as a Principal Element

By treating the contaminated groundwater and soils by air stripping and soil vapor extractions, the selected remedy addresses the principal threats posed by the Site through the use of treatment technologies. By utilizing treatment as a significant portion of the remedy, the statutory preference for remedies that employ treatment as a principal element is satisfied.