Superfund Proposed Remedial Action Plan

Greenwood Chemical Site
Operable Unit Two and Four
Albemarle County, Virginia

June 2005

I. INTRODUCTION

The United States Environmental Protection Agency Region III ("EPA") has identified its Preferred Alternative for addressing hazardous contamination in subsurface soil and **ground water** at the Greenwood Chemical Site ("Site") located in Newtown, Albemarle County, Virginia (Figure 1). The major components of EPA's Preferred Alternative include a permeable soil cover, upgrading the existing ground water pump and treat system, long term monitoring, and institutional controls.

This Proposed Plan is organized into the following sections:

- *Section I* (Introduction)
- *Section II* (Site Background and History)
- *Section III* (Scope and Role of Remedial Response Actions)
- *Section IV* (Site Characteristics)
- *Section V* (Summary of Site Risks)
- *Section VI* (Remedial Action Objectives)
- *Section VII* (Summary of Remedial Alternatives)
- *Section VIII* (Evaluation of Remedial Alternatives)
- *Section IX* (Preferred Alternative)
- *Section X* (Community Role in Selection Process)

This Proposed Plan is based on Site-related documents contained in the **Administrative Record** for the Site including the **Operable Unit 4 ("OU-4")** Final Feasibility Study Report and the Ground Water Remedial Investigation and Focused Feasibility Study Report (OU-2). The Administrative Record file can be reviewed electronically at http://www.epa.gov/arweb or at the following locations:

Jefferson-Madison Regional Library P.O. Box 423, Route 240 Crozet, VA 22932-0430 (434) 823-4050	U.S. EPA Region III - 6th Floor Docket Room Ms. Anna Butch 1650 Arch Street Philadelphia, PA 19103 (215) 814-3157

EPA, which is the lead agency for Site activities, will select a final remedial alternative for the Greenwood Chemical Site in consultation with the Virginia Department of Environmental Quality ("VDEQ"), the support agency for this response action, only after careful consideration of any information submitted by the public during the public comment period. EPA is issuing this Proposed Plan as part of its public participation responsibilities under Sections 113(k)(2)(B) and 117(a) and 121(f)(1)(G) of the **Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended ("CERCLA"),** 42 U.S.C. §§ 9613(k)(2)(B), 9617(a)

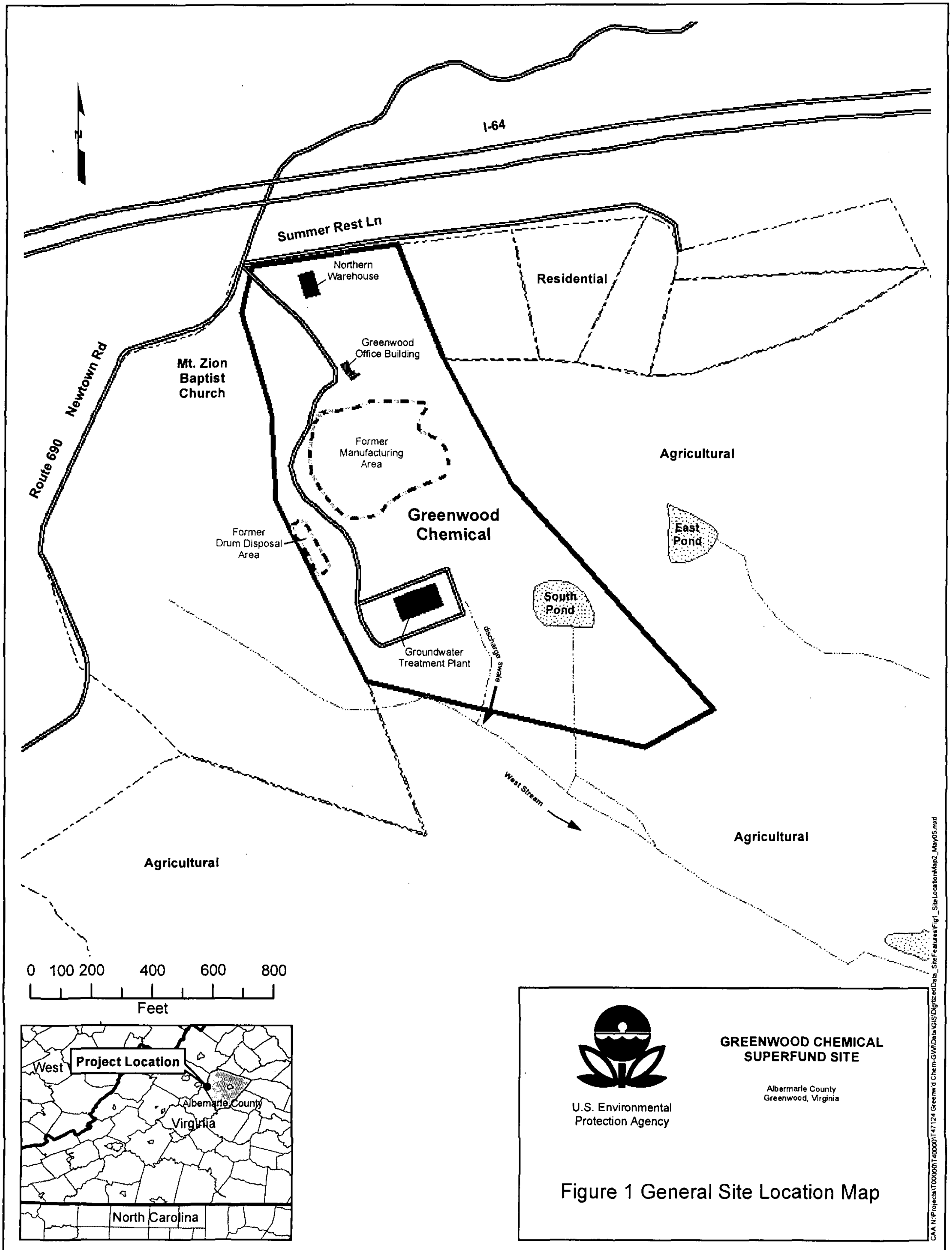

Figure 1 General Site Location Map

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and 9621(f)(1)(G).

EPA and VDEQ encourage the public to review and comment on each of the clean up options evaluated in this Proposed Plan and other documents in the Administrative Record file during the public comment period which begins on June 23, 2005 and closes on July 22, 2005. On July 6, 2005 at 7:00 p.m., EPA will hold a public meeting to discuss this Proposed Plan at the Emmanuel Episcopal Church, in Greenwood, Virginia. Written comments, postmarked no later than July 22, 2005 should be sent to:

Eric Newman (3HS23)
Remedial Project Manager
U.S. EPA - Region III
1650 Arch Street
Philadelphia, PA 19103

Although EPA has identified a preferred alternative, no final decision has been made. EPA may modify the Preferred Alternative, select another response action or develop another alternative, if public comment warrants or if new material is presented. EPA in consultation with VDEQ will make its final selection of a remedy for the contamination at the Site in a **Record of Decision ("ROD").**

A glossary explaining terms that may be unfamiliar to the general public is provided in Exhibit 2 at the end of this Proposed Plan. Glossary terms are noted by bold print the first time they appear in the text.

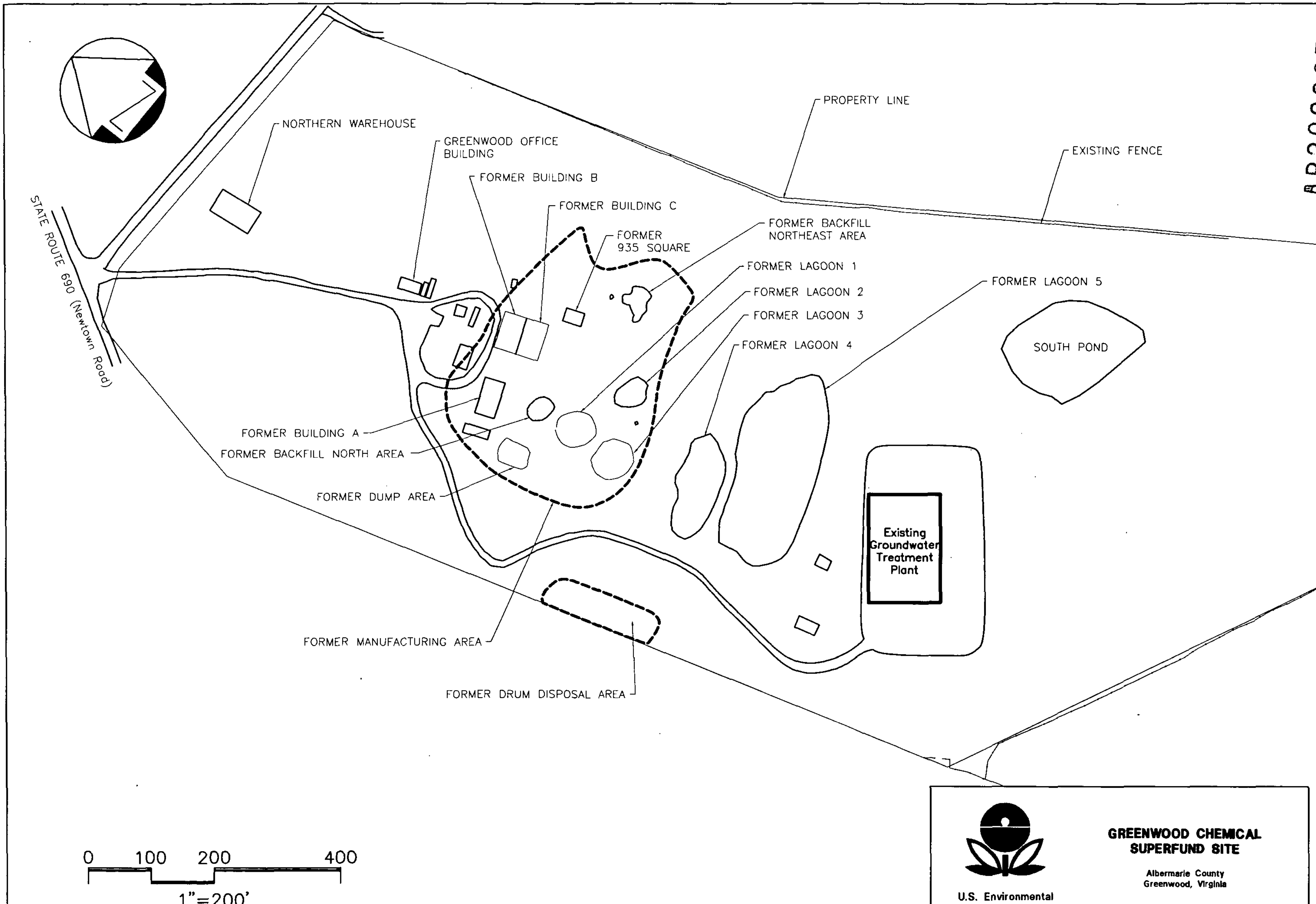
II. SITE BACKGROUND AND HISTORY

The Greenwood Chemical Site is located in the village of Newtown, Albemarle County, Virginia between the cities of Waynesboro and Charlottesville. The Site encompasses an area of approximately 34 acres, of which 18 acres were used for chemical manufacturing and waste disposal activities. The two main areas of the Site are known as the "manufacturing area" and the "drum disposal area." A Site location map is presented in Figure 1.

The Greenwood Chemical Company manufactured a variety of chemicals used in industrial, agricultural, photographic and pharmaceutical processes. Chemical manufacturing operations began in approximately 1947, and terminated in 1985 when a chemical vapor fire destroyed the main processing building and resulted in the death of four workers. Former operations at the Site have led to the release of hazardous substances into the environment.

Former Site features within the manufacturing area included chemical processing buildings, offices and laboratory space, storage trailers and sheds, a pump house, a concrete bunker, seven treatment lagoons and several abandoned structures. The former drum disposal area is located approximately 500 feet southwest of the manufacturing area, comprising a drum disposal trench along the western Site boundary. Approximately 400 crushed and intact drums were removed from the trench by EPA during a 1987 response action. Historic Site features are shown in Figure 2.

The manufacture of specialty chemicals at the Site began in approximately 1947 under the name of Cockerille Chemical Company. The facility was sold to the Greenwood Chemical Company ("GCC") in 1968 and continued to operate under that name until its closure. The primary compounds produced at the Site included naphthalene acetic acid, 1- naphthaldehyde, and



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U.S. Environmental Protection Agency

GREENWOOD CHEMICAL SUPERFUND SITE

Albemarle County
Greenwood, Virginia

Figure 2
Historic Site Features

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naphthoic acid. In addition, arsenic salts were used as catalysts in producing chloromethylnaphthalene, an intermediary in the production of naphthalene acetic acid. Production processes used toluene, naphthalene derivatives, sodium cyanide and inorganic arsenic salts. The GCC reported using between one and ten tons of cyanide per year to the Virginia Department of Toxic Substances, from 1972 to 1974.

Manufacturing activities at the Site involved the handling of large numbers of drums containing various chemicals, comprising waste, feedstock, intermediate, and final products. A series of interconnected wastewater "treatment/disposal" lagoons were associated with chemical processing activities. Wastewater was discharged from the process buildings through a series of floor drains, interconnected piping and open ditches to one or more of the lagoons.

In July 1987, the Greenwood Chemical Site was placed on the **National Priorities List ("NPL")** of Superfund Sites.

EPA response activities were initiated in 1987 with an emergency removal action to address the immediate threats posed by the Site. The scope of this action included removal of buried and surface drums and smaller containers of chemicals, and removal of sludge associated with former lagoons 1, 2 and 3 and construction of a temporary cap over those areas. This action was completed in 1988. In November 1989, EPA determined that further removal action was necessary to repair the temporary cap over the former drum disposal area and to construct several drainage swales around the waste lagoons to prevent further erosion.

Since the initiation of EPA involvement with this Site, the Superfund has been used to finance all investigation and remediation activity. A total of 30 Potentially Responsible Parties ("PRPs") were ultimately identified, including several former owners and operators of the facility and various entities which did business with Greenwood Chemical. EPA issued a unilateral administrative order in 1993 to several of the PRPs to conduct the OU-1 remedial action ("RA"), but the PRPs declined to perform the RA. Thereafter, EPA made the decision to proceed with cleanup utilizing the Superfund. All subsequent removal and remedial activities have been accomplished with Superfund financing. EPA has recovered a portion of its response costs from 15 PRPs pursuant to several judicial settlements.

From the late 1980's through the 1990's, the GCC remained an active corporation and maintained an inventory of laboratory chemicals. In recent years the GCC has not conducted any business operations on-Site, and abandoned scores of small containers of hazardous substances within trailers overgrown with vegetation and degraded laboratory and office facilities. In 2004 EPA completed an additional removal action to address these remaining abandoned chemicals.

A **Remedial Investigation and Feasibility Study ("RI/FS")** for the entire Greenwood Chemical Site was completed in August 1990. The report characterized the nature and extent of soil, surface water, sediment and ground water contamination. The 1990 RI/FS process, including several preliminary reports, provided the basis for Records of Decision for OU-1, OU-2, the 1991 **Explanation of Significant Differences ("ESD")** which defined OU-3, and the 1994 ESD. See Section III (Scope and Role of Remedial Response Actions) for a summary of these decision documents.

EPA's understanding of the nature and extent of remaining contamination at the Site has been supplemented by additional investigative studies performed as part of the OU-1 and OU-2 **Remedial Designs**, additional soil characterization in areas of concern, and on-going ground water monitoring. This information has been used to better define the extent of contamination in the deep soil and to determine the likelihood that these contaminants would migrate. EPA completed a Focused Feasibility Study ("FFS") for OU-4 describing the remedial action objectives and comparing cleanup alternatives for deep soil contamination. In June 2005, EPA completed the Ground Water Investigation and Focused Feasibility Study ("GWI/FFS") to develop ground water cleanup levels necessary to meet the remedial action objectives established in the 1990 Interim ROD. The findings of these reports are summarized in Section IV (Site Characteristics).

III. SCOPE AND ROLE OF REMEDIAL RESPONSE ACTIONS

The problems at the Greenwood Chemical Site are complex. As a result, EPA has divided the work into four components called **Operable Units ("OU's")**, in addition to the Removal Actions it has undertaken. An operable unit is a portion of a Superfund Site that is addressed separately from the rest of the Site, to allow for easier project management. The OU's at the Greenwood Site and the actions EPA has taken to address them are as follows:

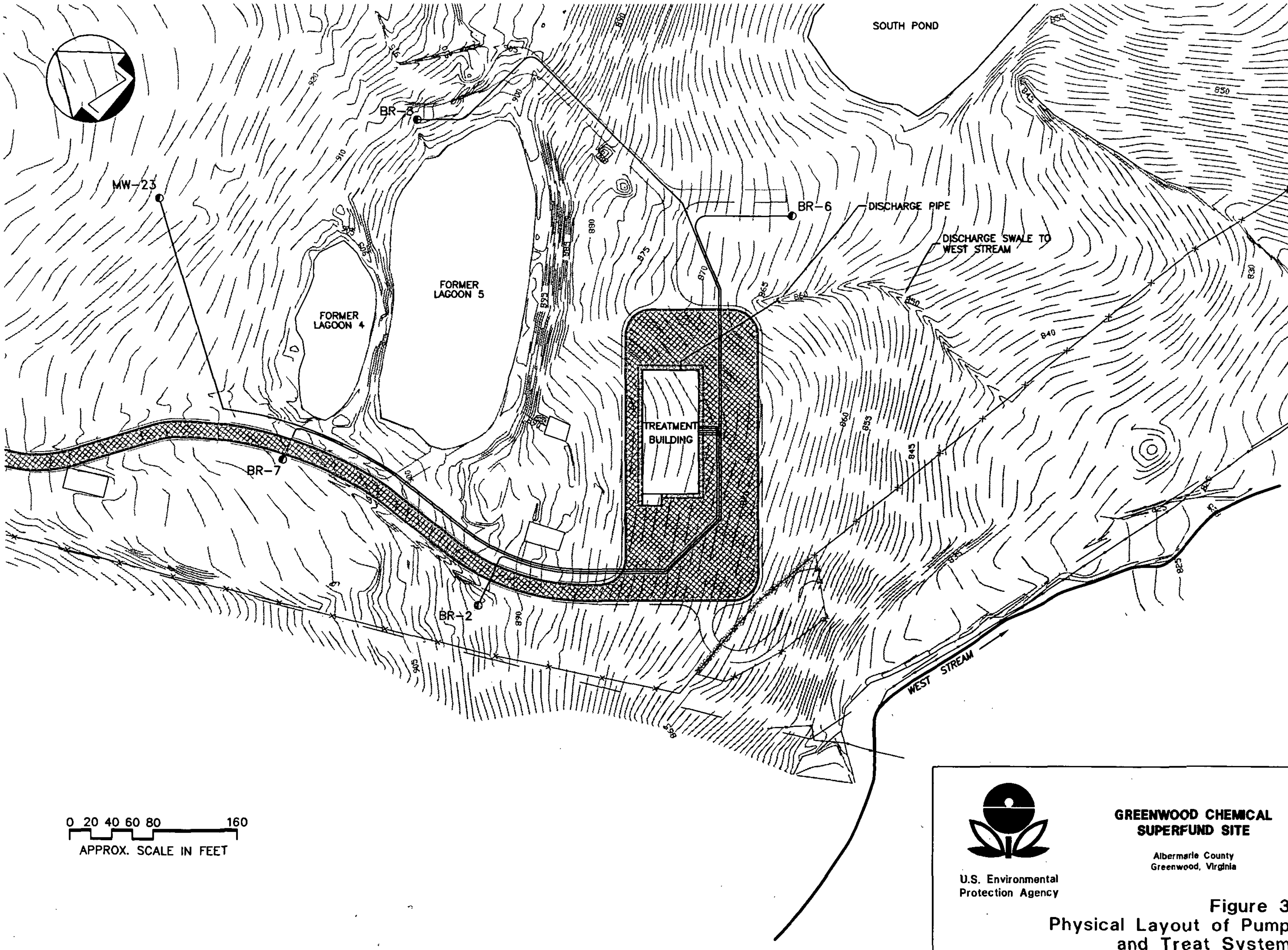
- OU-1 (shallow soil): EPA issued a ROD in December, 1989 which selected a remedy comprised of excavation, off-site incineration, stabilization and/or disposal of contaminated soil and sludge associated with Lagoons 1, 2 and 3, and off-site disposal of abandoned containers of chemicals left in the process buildings. The OU-1 remedial action was completed in fall 1996.

- OU-2 (ground water): EPA issued an interim ROD in December 1990 in which it determined that preliminary action was necessary to initiate the reduction in the toxicity, mobility and volume of ground water contaminants and to eliminate elevated risks presented by surface water in lagoons 4 and 5. The interim remedy selected in this ROD was extraction and treatment of ground water and lagoon water in an on-Site water treatment plant. The interim ROD deferred the final decision for ground water cleanup until final ground water cleanup goals could be developed. The water treatment system began operation in March 2001. The system currently consists of five extraction wells which convey contaminated ground water to a treatment plant located in the southern portion of the Site, downgradient of the manufacturing and drum disposal source areas. The physical layout of the system is shown in Figure 3.

  This Proposed Plan includes EPA's final ground water cleanup goals and identifies the Agency's preferred final alternative for ground water at the Site.

- OU-3 (manufacturing buildings): The ESD EPA issued in July 1991 required removal of former manufacturing buildings A, B and C and their contents. One purpose of this activity was to access and further characterize underlying contaminated soil. EPA completed the removal and proper disposal of the buildings and contents in 1993. This soil was excavated during the OU-1 remedial action. (The location of the former manufacturing buildings is shown in Figure 2.)

- OU-4 (deep soil source areas): Addresses the deeper contaminated soil occurring beneath the vertical limits of the OU-1 soil excavation activities. This operable unit is described in the March 1994 ESD for OU-1, which provided that "EPA will establish a separate operable unit to address the deeper contaminated soils that are below the excavation depths specified in the OU-1 Remedial Design ("RD")." Deep contamination is located beneath the former manufacturing and drum disposal areas, and has migrated into the



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U.S. Environmental Protection Agency

GREENWOOD CHEMICAL SUPERFUND SITE

Albermarle County
Greenwood, Virginia

Figure 3
Physical Layout of Pump and Treat System

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shallow zone of underlying fractured bedrock.

- Removal Actions: In addition to the removal action conducted between 1987 and 1989 (described above), on June 22, 2004 EPA issued an **Action Memorandum ("Action Memo")** which required removal and proper off-site disposal of the remaining chemicals abandoned by Greenwood Chemical, properly closing out lagoons 4 and 5, and excavation and off-site disposal of remaining arsenic-contaminated surface soil. The arsenic cleanup level selected by EPA was 27 milligrams per kilogram ("mg/kg"). This cleanup level makes it safe to reuse the Site for industrial or recreational purposes. The Action Memo also required excavating and transporting contaminated lagoon sludge to an appropriately permitted disposal facility and backfilling with clean soil. A soil cover (minimum of 2-feet-thick) was installed over the entire excavation area. This removal action was completed in May 2005.

This Proposed Plan presents EPA's preferred alternative for addressing OU-2 (ground water) and OU-4 (deep soil source areas). The selection of an interim response action for contaminated ground water was documented in the OU-2 ROD dated December 1990. The preferred alternative described in this Proposed Plan is intended to be the final response action for the Site.

IV. SITE CHARACTERISTICS

Geologic/Hydrogeologic Setting

The topography of the Site slopes predominantly to the southeast and levels off at the southern end. Total relief across the Site is approximately 196 feet with an average grade of 10 percent. The majority of the Site is covered with soil ranging in thickness from 0 - 15 feet. Beneath the soil is a relatively thick layer of saprolite formed from the chemical weathering of the bedrock. The composition of the saprolite is predominantly silty clay. The soil has a relatively high clay content of approximately 30% by weight. Consolidated rock is generally encountered below the water table. Shallow bedrock, however, was encountered in several locations at depths above the water table.

Ground water at the Site is present in both the soil and underlying fractured bedrock. Two distinct water bearing units (aquifers) have been identified in the soil (overburden) and bedrock. Aquifer testing indicates that the two water bearing units exhibit a high degree of hydraulic interconnection sufficient to consider the two units to be part of a single aquifer system. Significant movement within the bedrock is limited to its uppermost 50 feet. The water table at the Site is encountered in the soil at depths ranging from 5 feet to 35 feet below ground surface ("bgs").

The water table generally follows surface topography. Ground water in the soil layer flows in a southeasterly direction toward West Stream, a tributary of Stockton Creek into which it discharges. The bedrock ground water flow system is controlled by the nature and extent of bedrock fracturing. The direction of ground water flow in the bedrock is also in a southeasterly direction. Ground water located in the sloped areas of the Site generally has a downward vertical gradient (water moves downward from the overburden to the shallow bedrock). Topography at the southern end of the Site levels off and the vertical gradient of the ground water is upward. The water table is generally located at or above the top of the bedrock.

In the southern portion of the Site, the ground water elevations are at, or slightly above, ground surface elevations. Since the ground water is found close to the surface in the southern portion of the Site, this indicates that the area serves as a ground water discharge area. The West Stream and associated features at the southern periphery of the Site are probably ground water discharge features.

Since completion of the remedial investigation in 1990, the surface features of the Site have changed significantly due to response actions taken by EPA. There has also been significant alteration and regrading associated with removal of soils in the manufacturing area. Buildings have been removed, the former lagoons and the drum disposal area were excavated and backfilled with clean soil and the Site was graded.

Subsurface Soil Contamination

Deep soil sampling identified elevated levels of 12 Site-related contaminants of potential concern ("COPCs") remaining in subsurface soil. The list of COPCs includes the following **organic compounds** and metals: 4-chloroanaline (up to 48 mg/kg), arsenic (up to 7,120 mg/kg), benzene (up to 4.3 mg/kg), bis(2-ethylhexyl)phthalate (up to 0.91 mg/kg), chlorobenzene (up to 23 mg/kg), cyanide (up to 1,000 mg/kg), methylene chloride (up to 61 mg/kg), naphthalene (up to 1,780 mg/kg), tetrachloroethylene (up to 8.2 mg/kg), tetrahydrofuran (up to 9,000 mg/kg), toluene (up to 5,900 mg/kg) and trichloroethylene (up to 50 mg/kg). Contaminants in the deep soil zone are concentrated beneath the former manufacturing and drum disposal areas. These contaminated subsurface soils do not present a direct contact risk since they are generally more than 15 feet below the ground surface but they do constitute a source of ongoing contamination to the ground water.

The areal extent of organic and inorganic contamination in subsurface soil was estimated by entering sample results into a mathematical computer model which predicted the volume of contaminated soil present. Figure 4 shows the estimated limits of contaminated soil based on the model rather than actual samples collected at the boundaries. The vertical extent of contamination is based on the conservative assumption that the entire vertical thickness of the subsurface soil is uniformly contaminated with COPCs.

Site-specific **Preliminary Remediation Goals ("PRGs")** were initially developed for subsurface contaminated soil during the FFS. EPA's objective was to determine the extent to which subsurface soil would need to be addressed, by excavation or in-situ treatment, such that the ground water could be safe to drink at the property boundary in the absence of any ground water containment (i.e., ground water recovery well system). The subsurface soil PRGs are only directly relevant to the cleanup alternatives which include excavating these materials as part of the remedy. For each of the twelve contaminants identified above, EPA used a theoretical model to calculate the highest concentration that could remain on Site and still meet a safe drinking water level (including MCLs where available) for each of those contaminants. More details on the development of subsurface soil PRGs are provided in Exhibit 1 (How Did EPA Develop Deep Soil Preliminary Remediation Goals and Estimate the Volume of Soils To Be Excavated?) at the end of this Proposed Plan.

Ground Water Contamination

A total of 56 ground water monitoring wells (shallow and deep) have been installed at the Site to characterize ground water contamination (See Figure 5). Seven (7) of the wells are located upgradient of the two deep soil source areas. Ground water in these seven upgradient wells is not contaminated with Site-related contaminants. Thirty three (33) wells have been placed within the

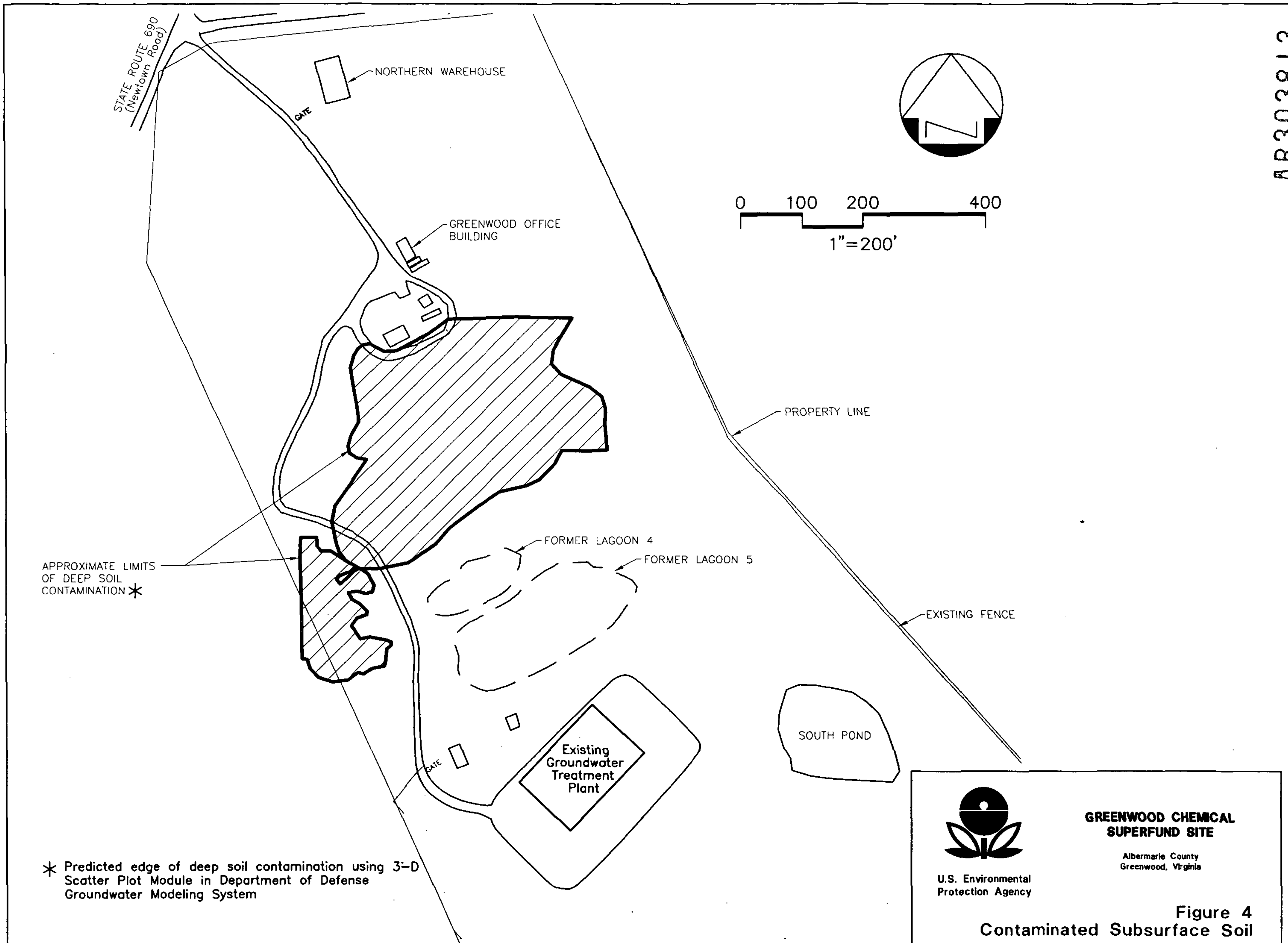

Figure 4
Contaminated Subsurface Soil

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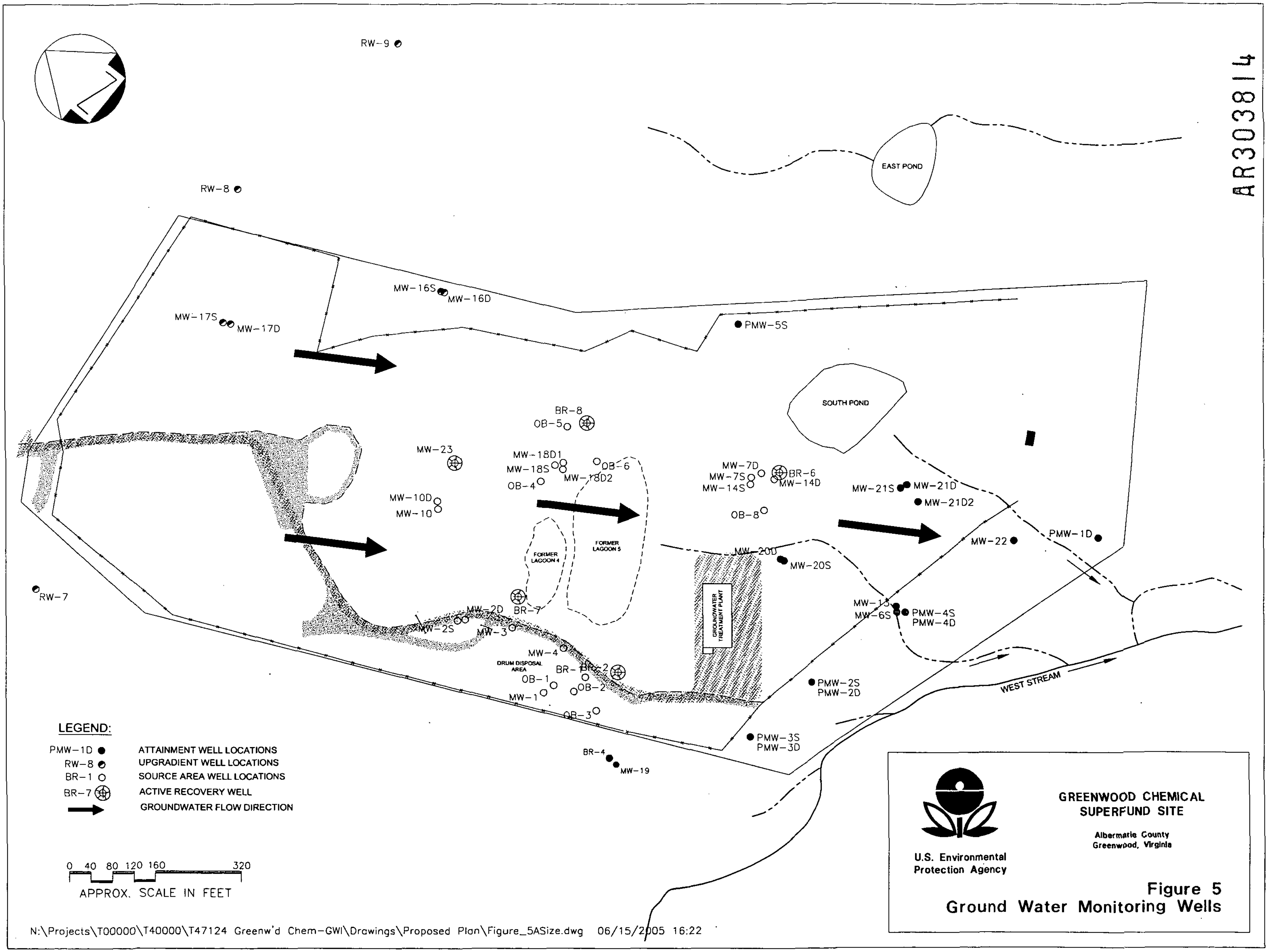


Figure 5
Ground Water Monitoring Wells

current **waste management area**, the area comprised of deep soil source areas extending to the former Lagoon 5. The remaining 16 wells are located downgradient from the waste management area.

Elevated concentrations of hazardous substances are present in the ground water beneath and downgradient of the primary source areas (manufacturing area and drum disposal area) extending to the former Lagoon 5, referred to as the waste management area. Ground water within the waste management area has the highest concentrations of contaminants, including some contaminants which are not migrating from that area due to low mobility.

- The primary contaminants detected in the ground water within the waste management area include benzene (up to 260 ug/l), bis(2-chloroethyl)ether (up to 76 ug/l), bromodichloromethane (up to 4.1 ug/l), carbon tetrachloride (up to 1,200 ug/l), 4-chloroaniline (up to 39 ug/l), chlorobenzene (up to 790 ug/l), chloroform (up to 390 ug/l), 2-chlorophenol (up to 4.3 ug/l), dibromochloromethane (up to 3.6 ug/l), 1,2-dibromoethane (up to 3.7 ug/l), 1,2-dichlorobenzene (up to 280 ug/l), 1,4-dichlorobenzene (up to 7.8 ug/l), cis-1,2-dichloroethane (up to 330 ug/l), 1,2-dichloroethane (up to 580 ug/l), 1,2-dichloropropane (up to 4.1 ug/l), cis-1,3-dichloropropene (up to 330 ug/l), 4,6-dinitro-2-methylphenol (up to 0.75 ug/l), 4-methylphenol (up to 18 ug/l), naphthalene (up to 400 ug/l), 4-nitroaniline (up to 4.6 ug/l), N-nitroso-di-n-propylamine (up to 1.0 ug/l), trichloroethene (up to 1,500 ug/l), tetrachloroethene (up to 87 ug/l), toluene (up to 120 ug/l), trans-1,3-dichloropropene (up to 4.0 ug/l), 1,1,2-trichloroethane (up to 4.1 ug/l) and vinyl chloride (up to 83 ug/l).

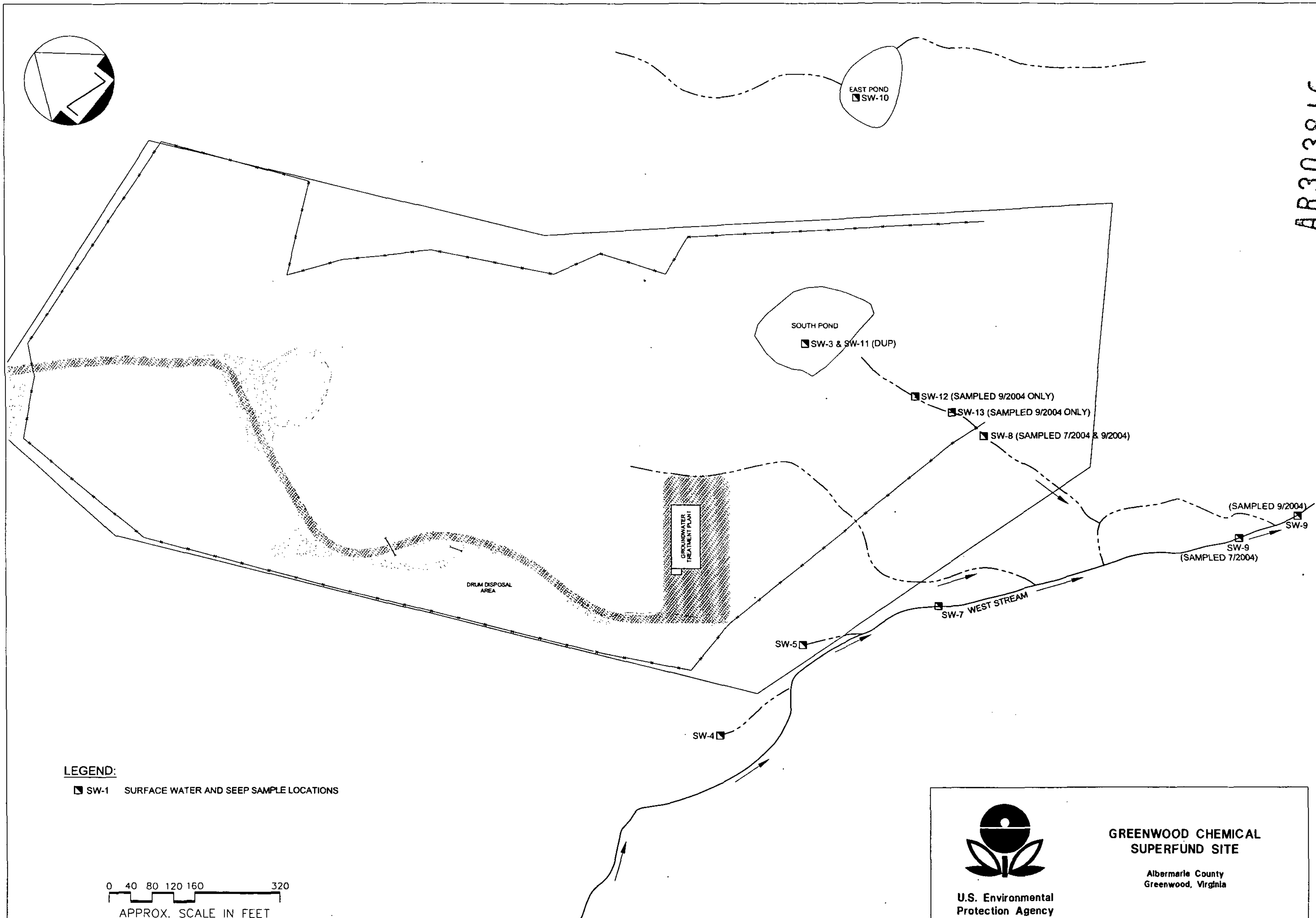
Ground water in the **area of attainment**, beyond the waste management area, has elevated concentrations of contamination; however, the list of contaminants in this area is limited to the six compounds that EPA has determined are migrating from the deep soil source area via ground water. Those contaminants which have been detected in the wells within the area of attainment are present at much lower concentrations when compared to ground water within the waste management area.

- The contaminants of concern ("COC") detected in the ground water at one or more of the wells outside the waste management area are bis(2-chloroethyl)ether (up to 1.4 ug/l), carbon tetrachloride (up to 19 ug/l), 1,2-dichloroethane (up to 20 ug/l), tetrachloroethene (up to 25 ug/l), trichloroethene (up to 120 ug/l) and vinyl chloride (up to 4.8 ug/l). In addition, arsenic was detected in one perimeter well at 6.0 ug/l.

The remedy selected in the OU-2 Interim ROD called for the installation of a system of ground water recovery wells and the construction and operation of a water treatment plant. The ground water pump and treat system began operation in March 2001. The current ground water recovery system consists of five bedrock extraction wells at or just downgradient of the deep soil source area. The treatment plant utilizes a combination of chemical precipitation and ultraviolet/oxidation and carbon filtration technologies to treat the contaminated ground water.

<u>**Surface Water and Seep Assessment**</u>

In 2004, EPA collected surface water samples from the small intermittent streams which are tributaries to West Stream, the West Stream, the South Pond, and the East Pond (see Figure 6). Low concentrations of VOCs, including TCE and carbon tetrachoride, were detected in a short stretch (SW-13 and SW-08) of an intermittent stream located at the southernmost portion of the Site. This is the topographic low elevation, where the ground water table is very close to the



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GREENWOOD CHEMICAL SUPERFUND SITE

Albermarle County
Greenwood, Virginia

Figure 6
Surface Water Sampling

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surface, indicating likely discharge of contaminated ground water into the shallow stream bed. Nonetheless, the contaminants were detected at concentrations so low that the surface water meets the Virginia surface water quality standards, and does not present elevated risk to human health or the environment. The water quality was even higher at sampling points downstream, indicating clean ground water is also discharging to the stream. Analysis of samples from the West Stream, the South Pond and the East Pond do not indicate the presence of Site-related contamination.

Off-Site (Residential) Ground Water Quality Assessment

Residential wells have been sampled and analyzed for Site-related contamination periodically since the late 1980's with the most recent round of sampling conducted in June 2004. Nine residential wells were tested within a one-half mile radius of the Site. Water samples were collected from wells that were either hydraulically downgradient or side gradient of the Site. No Site-related contaminants were detected above EPA Maximum Contaminant Levels ("MCLs") or above any other risk-based action levels.

Site-Wide Ground Water Assessment

Most of the contamination identified at the Site appears to be limited to the overburden and the shallow bedrock aquifer in the immediate vicinity of the deep soil source areas extending to Lagoon 5. Minimal contamination was detected in the deep bedrock. Two possible explanations for this observation are: 1) there is a lack of interconnection between the shallow and deep bedrock fracture zones; and 2) there is a general upward vertical gradient of ground water from the deep to the shallow fracture zones, which reduces downward contaminant migration.

The most concentrated portion of the "plume" extending from the former manufacturing area is located at the center of the Site along the following array of wells: MW-23 (recovery well), OB-5, MW-18D1/D2, BR-8 (recovery well), OB-7, BR-6 (recovery well). The branch of the plume extending toward PMW-5 follows a localized dip in the topography. A second "plume" appears to exist close to the former drum disposal area along the following array of wells: MW-2D, OB-1, BR-2 (recovery well). The highest concentrations of contaminants are located mostly north and east of the ground water treatment plant, though high concentrations are also located south of the drum disposal area. The most contaminated well on the Site consistently has been MW-23. (See Figure 7)

A capture zone analysis was performed to 1) determine if the existing recovery wells are containing the contaminated ground water on Site and, 2) identify additional ground water recovery well locations which may be necessary to achieve containment.

The capture zone analysis identified a significant gap in the area between recovery wells BR-2 and BR-6, which may be resulting in contaminant migration to unaffected portions of the aquifer. This is substantiated by the monitoring well data. The capture zone analysis concluded that a minimum of three new recovery wells are required in this vicinity to contain the plume, each pumping at a rate of 3 gpm (See Figure 8).

The other area that EPA determined requires installation of additional recovery wells to contain the contaminated ground water is the area near PMW-5 at the eastern boundary of the Site. Sample results indicate VOC concentrations over 146 ug/l at PMW-5. This perimeter well monitors ground water following a local eastward dip in the topography and appears not to be affected by the existing recovery well network. The capture zone analysis concluded that a minimum of two new recovery wells are required in the vicinity of BR-5 and PMW-5 to contain

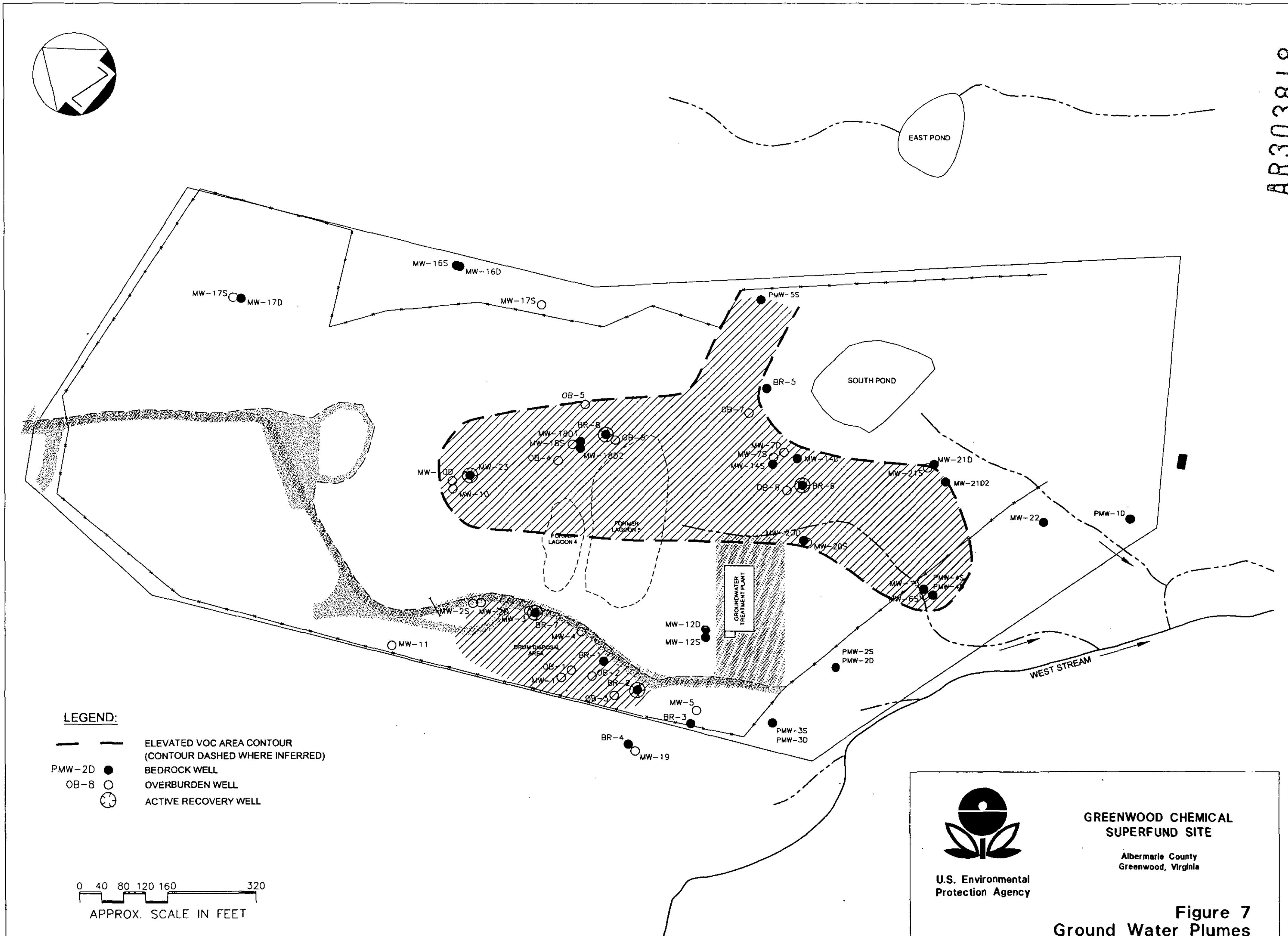

Figure 7
Ground Water Plumes

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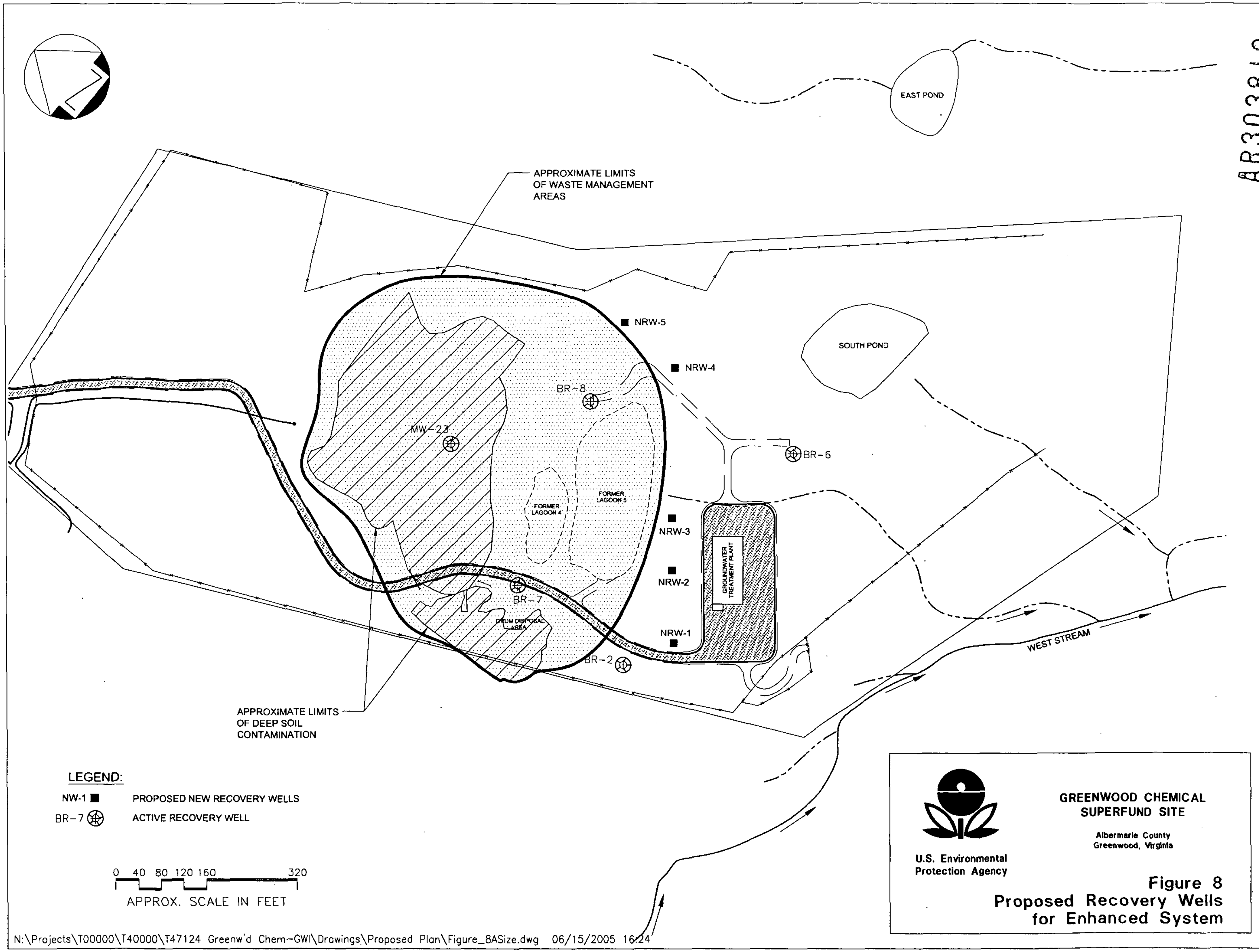

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U.S. Environmental Protection Agency

GREENWOOD CHEMICAL SUPERFUND SITE

Albermarie County
Greenwood, Virginia

Figure 8
Proposed Recovery Wells for Enhanced System

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the plume, each pumping at a rate of 2 gpm.

The capture zone analysis and associated ground water sampling confirmed that recovery wells BR-2 and BR-7 are successfully containing contaminated ground water from the former Drum Disposal Area.

V. SUMMARY OF SITE RISKS

Baseline Human Health Risk Assessment Summary

The 1990 Remedial Investigation included a baseline **risk assessment** to estimate the human health hazards that could result if contamination at the Site was not addressed. This assessment was conducted to identify existing and future risks that the Site would present if conditions at the Site did not change. **The Baseline Human Health Risk Assessment ("BLRA")** evaluated human health risks

What are EPA's Risk Reduction Goals?

The BLRA assessed the toxicity, or degree of hazard, posed by contaminants related to the Site, and involved describing the routes by which people could come into contact with these substances. Separate calculations were made for those substances that can cause cancer (carcinogens) and for those that can cause non-carcinogenic, but adverse, health effects.

The **NCP, 40 C.F.R. Part 300,** established acceptable levels of **carcinogenic** risk for Superfund Sites ranging from one excess cancer case per 10,000 people exposed to one excess cancer case per 1 million people exposed, if no action is taken at a site. This translates to a risk range of between one in 10,000 and one in one million additional cancer cases. Expressed in **scientific notation,** this translates to a risk range of between 1.0 E-04 and 1.0 E-06 over a defined period of exposure to contaminants at the Site. Remedial Action is warranted at a site when the calculated cancer risk level exceeds 1.0E-04. EPA's initial cleanup goal is to reduce the risk to 1.0E-06. When multiple contaminants make reducing the aggregate risk to one in one million impracticable, EPA will establish cleanup goals which reduce the risk presented by the Site to within the acceptable risk range (between 1.0E-04 and 1.0E-06).

The NCP also states that sites should not pose a health threat due to a non-carcinogenic, but otherwise hazardous, chemical. Chemical contaminants that are ingested (eaten), inhaled (breathed) or dermally absorbed (skin contact) may present non-carcinogenic risks to different organs of the human body. EPA defines a non-carcinogenic threat by the ratio of the contaminant concentration at the Site that a person may encounter to the established safe concentration. If the ratio, called the **Hazard Index ("HI"),** exceeds one (1.0) there may be concern for the potential non-carcinogenic health effects associated with exposure to the chemical. The HI identifies the potential for the most sensitive individuals to be adversely affected by the non-carcinogenic effects of chemicals. As a rule, the greater the value of the HI above 1.0, the greater the level of concern.

considering the residential[1] and trespasser land use scenarios and was subsequently updated to consider industrial and recreational land use scenarios. The BLRA documented that hazardous substances in soil, ground water, and surface water and sludge in the lagoons presented unacceptably high risks to human health and the environment and warranted response actions to mitigate those risks.

As summarized in Section II (Site Background and History) and Section III (Scope and Role of Remedial Response Actions), EPA has conducted significant response actions addressing the unacceptable risks presented by hazardous substances previously located in the former chemical manufacturing plant, including the former lagoons and the surface soil.

The updated BLRA does establish that action to mitigate risks presented by remaining contaminants of concern in ground water is warranted. Ground water is the only contaminated media at the Greenwood Chemical Site which continues to present an unacceptable risk to human health and the environment (assuming a future use scenario). Off-Site residential well sampling indicates that no unacceptable risk is currently presented to private well users.

The primary contaminants associated with potential human health risk at the Site include:

- Multiple Volatile Organic Compounds **("VOCs")**, Semi-Volatile Organic Compounds ("SVOCs") and arsenic in subsurface soil and ground water within the waste management area; and,
- The five VOCs, (carbon tetrachloride, 1,2-dichloroethane, tetrachloroethene, trichloroethene and vinyl chloride) and one SVOC [bis(2-chloroethyl)ether] present at one or more wells outside the waste management area at a level of concern.

There is no current on-Site use of ground water at the Greenwood Chemical Site. The updated BLRA considered potential risks posed to future residents using ground water beneath or downgradient of the Site as a source of drinking or showering/bathing water. The exposure routes evaluated include drinking, inhalation of contaminants while showering, and direct skin contact with ground water. Table 1 summarizes the respective risk levels calculated for children and adults exposed to ground water. Each of these risk levels exceed EPA's expectations for acceptable risk.

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[1] EPA has determined that recreational or industrial land use is the reasonably anticipated future land use for this former chemical plant property. Residential use of ground water outside the "waste management area" of the Site is the basis for ground water cleanup standards.

Table 1 Human Health Risks at the Site		
Risk From Ground Water	**Cancer Risk**	**Hazard Index**
Future Use: Resident exposed to ground water within the waste management area	2.0E-03	6.0
Future Use: Child Resident exposed to ground water outside the waste management area	3.45E-04	17
Future Use: Adult Resident exposed to ground water outside the waste management area	3.1E-04	5.8

For the future use scenario, carcinogenic risk exceeded 1.0E-04 for ground water for both adults and children. Trichloroethene and vinyl chloride were the primary contributors to the total excess cancer risk. The carcinogenic risk associated with drinking ground water at the Site boundary has been estimated at 3.45E-04. (This risk corresponds to one additional case of cancer for every 2,900 persons exposed). Ground water with a carcinogenic risk over 1.0E-04 is considered to be unacceptable. The non-carcinogenic HI exceeded 1.0 for the ground water ingestion and bathing (residential) exposure scenarios. The HI is driven by trichloroethene and carbon tetrachloride. Ground water with a HI of over 1.0 is considered to be unacceptable for human consumption over the long term due to potential adverse effects.

For the reasons given above, it is EPA's current judgement that the Preferred Alternative identified in this Proposed Plan, or one of the other active measures considered in the Proposed Plan, is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

VI. REMEDIAL ACTION OBJECTIVES

The Remedial Action Objectives ("RAOs") for risks associated with the ground water at this Site include:

- Preventing exposure to contaminated ground water in the future (both on-Site and off-Site);
- Preventing discharge of contaminated ground water to surface water at concentrations that exceed water quality or human health criteria;
- Containing the contaminant plume to prevent migration off-Site to ensure that downgradient private water supplies are not impacted;
- Restoring ground water quality in the area of attainment (entire ground water plume beginning at the boundary of the waste management area) to levels that do not pose unacceptable risk to human health or the environment.

Development of Cleanup Goals for Ground Water

This subsection summarizes how Ground Water Cleanup Goals for ground water were developed.

Maximum Contaminant Levels ("MCLs") and non-zero Maximum Contaminant Level Goals ("MCLGs") have been established under the Safe Drinking Water Act and are considered relevant and appropriate standards for ground water. However, meeting the chemical-specific MCLs and non-zero MCLGs at the property boundary would still result in a cumulative risk in excess of 10E-4 due to the fact that there are multiple contaminants associated with the Site. In accordance with the NCP, use of lower, risk-based target concentrations are necessary to set a protective remediation level. Risk-based target concentrations are concentration levels that result in a cumulative carcinogenic risk within EPA's target risk range of 10E-4 to 10E-6 and a HI equal to or less than 1.0.

In accordance with NCP, cleanup options that include leaving the deep soils contamination in place require establishment of an area of attainment beyond the waste management area. Accordingly, EPA has developed chemical-specific cleanup goals for ground water which meet the regulatory standards for drinking water and consider the cumulative risk presented by multiple contaminants beyond the waste management area, or within the "area of attainment," which is shown in Figure 8.

Table 2
Risk-Based Remedial Goals ("RBRG") for Ground Water - Area of Attainment

Chemical of Potential Concern	PQL (ug/l)*	MCL (ug/l)	Final RBRG (ug/l)
1,2-Dichloroethane	0.5	5.0	5.0
Bis(2-Chloroethyl)Ether	0.01	no MCL	0.5
Carbon Tetrachloride	0.5	5.0	4.0
Tetrachloroethene	0.5	5.0	0.8
Trichloroethene	0.5	5.0	1.0
Vinyl Chloride	0.5	2.0	0.5

* The RBRG of 0.5 ug/L selected for vinyl chloride is the **practical quantitation limit ("PQL")** and represents an approximate risk level of 4E-05. The final RBRG for each of the other five contaminants was set at a level equivalent to a 1E-05 risk.

The ground water risk-based remediation goals ("RBRGs") set forth in Table 2 fall within the acceptable risk range of a cancer risk of 1E-04 to 1E-10-6 and a HI of 1.0, and assume that all six contaminants are present in a single well. In fact, the contamination at the Site varies by location, and no more than two contaminants above RBRGs were found in any one monitoring well. The contaminant-specific cleanup goals were established at levels which: 1) comply with ARARs; 2) are detectable in a laboratory; and, 3) would achieve a cumulative risk within EPA's target risk range.

VII. SUMMARY OF REMEDIAL ALTERNATIVES

The OU-4 FFS, dated January 2002, and the GWI/FFS, dated June 2005, discuss the range of alternatives EPA evaluated to address risks presented by the Site, and together with the Administrative Record provide supporting information relating to alternatives in this Proposed Plan. The Proposed Plan discusses alternatives and concludes by presenting the preferred alternative based on the analysis to date. Based on the potential impacts to human health and the environment, ground water at the Site warrants additional action to minimize potential exposure to hazardous substances. Since the deep soil contamination in the former manufacturing and drum disposal areas is a continuing source to ground water, additional action to address the deep soils was considered in some of the alternatives.

This Proposed Plan includes a "No Action" alternative, as required by the NCP, and several cleanup options for each of the above areas and media. EPA believes that the recommended option presented is protective of human health and the environment, achieves state and federal regulatory requirements, and would best achieve the cleanup goals for the Site. The alternatives EPA considered are based on those presented in the FFS and GWI/FFS. Reviewers are encouraged to comment on the additional alternatives presented in the FFS and GWI/FFS as well as those included in this Proposed Plan.

Alternative 1: No Action (Existing Permeable Soil Cover and Pump and Treat System)

Capital Cost:	$ 0
Annual **O&M** Cost:	$ 454,000[2]
Present Worth Cost:	$5,634,000
Time to Implement:	Immediate

The NCP requires that EPA consider a "No Action" alternative for every Superfund site to establish a baseline or reference point, against which each of the Remedial Action alternatives are compared. In the event that the other identified alternatives do not offer substantial benefits in the protection of human health and the environment, the No Action alternative may be considered a feasible approach. This alternative leaves the Site in its current state and all current and potential future risks would remain. Since the pump and treat system is currently being operated on the Site, and significant response actions have already been implemented above and downgradient of the subject subsurface soil, the "no action" alternative for subsurface soil and ground water at the Greenwood Chemical Site is better described as "no further action."

The "No Action" alternative involves leaving the clean, permeable soil cover that was backfilled over the former drum disposal and manufacturing areas in place as the final cover. The existing clean soil cover is a minimum of 2-feet-thick. Previous response actions addressed contaminated surface soil such that the property can be safely reused for recreational or industrial purposes. The clean soil cover was constructed as part of the OU-1 remedial action and the subsequent surface soil removal activities. The existing soil cover has been graded and vegetated to minimize erosion. This alternative is based on Alternative 2 for the Manufacturing and Drum Disposal Areas (Permeable Cap & Institutional Controls) in the FFS, as modified by EPA, with

[2] This is the annual operation and maintenance cost for the existing pump and treatment system being implemented in accordance with Interim Record of Decision for Operable Unit 2.

the permeable soil cover recognized as already being in place.

Alternative 1 would allow the continued infiltration of rain water through the contaminated subsurface soils which are at an elevation higher than the ground water table, because the existing soil cover is permeable. The infiltration of rain water leaches contaminants into the aquifer and incrementally contributes to the migration of contaminants to the ground water.

The No Action alternative for ground water would maintain the existing pump and treat system selected and implemented in accordance with the Interim ROD for OU-2. The existing five-extraction-well configuration would not be modified and the volume of ground water extracted would not be increased. Most of the contaminated ground water would continue to be captured and contaminants would be removed prior to the treated water being discharged to the unnamed tributary to West Stream. This alternative would continue to allow some contaminated ground water to flow around or between the existing recovery wells. The ground water quality would not meet applicable or relevant and appropriate regulatory standards for drinking water and would continue to be unsafe to drink beyond the waste management area. The long-term human health and environmental risks remaining at the Site would not change.

Alternative 2: Existing Permeable Soil Cover with Enhanced Pump and Treat System

Capital Cost:	$ 365,000
Annual O&M Cost:	$ 463,000
Present Worth Cost:	$6,110,000
Time to Implement:	5 months

This alternative is based on Alternative 2 for the Manufacturing and Drum Disposal Areas (Permeable Cap & Institutional Controls) in the FFS, combined with Alternative #2 in the GWI/FFS, as modified by EPA. This alternative augments the existing permeable soil cover included in Alternative 1 with an enhanced ground water pump and treat system described below.

Alternative 2 would augment the existing five-well ground water pumping network with additional wells necessary to prevent the continued migration of Site-related contaminants to West Stream and off-Site locations (See Figure 8). The GWI/FFS estimates that an additional five wells screened to withdraw ground water in the upper 50 feet of bedrock would be required. All recovered ground water would be managed through the continued operation of the water treatment plant installed pursuant to the 1990 Interim ROD for OU-2. The enhanced pump and treat system would capture contaminated ground water, thereby preventing contaminant migration from the Site. The series of ground water extraction wells would be operated in concert to achieve the final Site-specific risk-based ground water cleanup goals (Table 2) beyond the waste management area. Periodic evaluation of the performance and effectiveness of the ground water extraction system would be performed. The ground water extraction system would be modified as necessary to achieve the performance standards beyond the waste management area.

The existing water treatment plant has a design flow rate of 45 gpm. The present contribution from the five recovery wells varies between 20-25 gpm. Analysis of ground water data and the design influent concentrations at the existing treatment plant indicate that the additional volume of ground water can likely be processed without modification to the treatment system. The ground water treatment plant would meet regulatory discharge standards.

Operation and maintenance activities for this alternative would include: maintaining the extraction wells, operating the treatment plant, and performing periodic ground water level and chemical measurements to confirm that Site ground water is being captured. Routine chemical analyses of plant effluent would be conducted with quarterly bioassay tests to confirm that the discharge meets State requirements. The net present worth estimate was based on a 30-year operation period.

Institutional controls would be implemented to ensure that prospective users of the Site are aware that deep soil contamination is present, to prevent the extraction of ground water from the aquifer beneath the Site for use as a **potable water** source, and to prevent removal of the soil cover or any interference with the ground water extractions wells, treatment system, and related equipment. No institutional controls would be required for off-Site properties. Specific institutional controls would consist of both of the following:

1. a deed notice identifying the Site as a Superfund Site and prohibiting (1) residential use of the property, (2) on-Site potable use of ground water, (3) any activity that would adversely impact the operation of the pump and treat system, and (4) deep excavation without a site-specific health and safety plan. Any soil excavated from the former Manufacturing or Drum Disposal Areas would need to be sampled and managed in an appropriate manner; and,

2. the granting of easements for Site access to the Commonwealth of Virginia (and their designees) to monitor the constructed remedy, operate and maintain the ground water treatment system, and ensure that restrictions on land use are being maintained.

Alternative 2A: Existing Permeable Soil Cover, In-Situ Chemical Oxidation with Enhanced Pump and Treat System

Capital Cost:	$ 5,664,000
Annual O&M Cost	$ 463,000
Total Present Worth Cost:	$11,409,000
Time to Implement:	18 months

This alternative is based on Alternative 2 for the Manufacturing and Drum Disposal Areas (Permeable Cap & Institutional Controls) in the FFS, combined with Alternative #4 in the GWI/FFS, as modified by EPA. This alternative includes all of Alternative 2 activities described above, and adds the in-situ chemical oxidation of contaminants in ground water described below.

In addition to the actions described under Alternative 2, Alternative 2A involves in-situ treatment of organic contaminants in the saturated subsurface with a chemical oxidant such as potassium permanganate (KMnO4). Chemical oxidation works when the oxidant comes into direct contact with the contaminant and destroys it by converting the contaminant to innocuous compounds, such as carbon dioxide and water. The chemical reagent is typically injected directly into the subsurface and allowed to flow with the ground water into contaminated areas.

Most of the organic contaminants found at the Site have been successfully cleaned from the environment at other sites using in-situ chemical oxidation, including 1,2-dichloroethene, trichloroethene, and tetrachloroethene. Unfortunately, chemical oxidation would not likely be effective for other Site-related contaminants, such as carbon tetrachloride and bis(2-chloroethyl)ether. Little or no decrease in carbon tetrachloride or bis(2-chloroethyl)ether would be expected with the use of relatively stable oxidants such as KMnO4. Stronger oxidants which may be capable of destroying the carbon tetrachloride or bis(2-chlorothyl)ether are less stable, meaning that the oxidant does not maintain its ability to oxidize contaminants for very long once injected into the subsurface.

Alternative 2A would address some organic contaminants in the fractured bedrock beneath the deep soils source areas as well as the contaminants dissolved in the ground water constituting the "plumes." For cost estimation purposes, the conceptual design includes fabrication and installation of approximately 40 injectors, each with a radius of influence of 50-feet that collectively covers an area approximately 850 feet x 400 feet. The aquifer was estimated to be 50 feet thick and predominantly a combination of overburden and bedrock aquifer. In addition, the natural oxidant demand, due to Site unknowns such as aquifer heterogeneity and geochemistry, is estimated to be 1g/kg.

During the construction of the ground water treatment plant and associated recovery wells as part of the OU-2 interim remedy, it was observed that the overburden (saprolite) yielded minimal quantities of ground water. Attempts were made to install recovery wells in the overburden, but these wells frequently clogged with sediments and ran dry within a few days after installation. Therefore, this alternative would address the bedrock aquifer and associated contamination only. It should be noted that although this alternative has the potential to clean up most of the contaminants in the bedrock aquifer, several significant contaminants would not likely be destroyed by in-situ chemical oxidation. In addition, since the oxidant would only be applied to the fractured bedrock, there would still be a potential for the bedrock aquifer to be "re-contaminated" by contaminants remaining in the soil above the bedrock. This would require treating the bedrock aquifer with additional doses of the chemical oxidant.

For estimation purposes, it is assumed that three applications of the chemical oxidant, 3 to 6 months apart, would be required to affect a major reduction in the total contaminant mass in the ground water.

There are no additional institutional controls or long-term operation and maintenance costs associated with the chemical oxidation component of this alternative.

Since some contaminants would not likely be destroyed via chemical oxidation, the ground water would not meet drinking water standards and would remain unsafe to drink. The enhanced pump and treat system would be implemented as described in Alternative 2 to capture contaminated ground water and achieve remedial action objectives. Institutional controls identical to those described in Alternative 2 would have to be implemented to prevent the extraction of ground water from the aquifer within the waste management area for use as a potable water supply.

Alternative 3: Impermeable Cap with Enhanced Pump and Treat System

Capital Cost:	$ 4,290,000
Annual O&M Cost:	$ 510,000
Total Present Worth Cost:	$10,614,000
Time to Implement:	24 months

This alternative is based on Alternative 3 for the Manufacturing and Drum Disposal Areas (Impermeable Cap & Institutional Controls) in the FFS, combined with Alternative #2 in the GWI/FFS, as modified by EPA.

This alternative includes all the actions described under Alternative 2 described above, except that an impermeable cap would be constructed on top of the existing permeable soil cover.

This alternative involves the construction of a multi-layer impermeable cap over both the Manufacturing and Drum Disposal Areas. For performance and cost estimation purposes, design criteria for **Resource Conservation and Recovery Act ("RCRA")** Subtitle C caps were assumed. The actual cap profile (materials and thickness of respective layers) would be developed in the Remedial Design. A 7-acre impermeable cap would cover the areas with contaminated subsurface soil (Figure 4). The cap would reduce the amount of precipitation that infiltrates through contaminated soil above the water table and presently leaches contaminants into the ground water. However, most of the mass of hazardous substances located in the subsurface are in the saturated zone. The impermeable cap would not have any impact on ground water moving through the contaminated subsurface soil below the ground water table and down the slope of the hill.

The actual size and location of the capped area would be determined during the Remedial Design phase of the project. The cap would be a multi-layer composite barrier system that minimizes the long-term migration of liquids into the capped area. The various components of a generic multi-layered cap are described from the ground surface down to the top of contaminated soil as follows:

- Vegetative Topsoil Layer: A 6-inch topsoil layer and low-maintenance vegetative cover would be provided to stabilize the cap system and reduce the potential for erosion.

- Select Fill Layer: A compacted layer of fill material, 18 inches in thickness.

- Drainage Layer: A drainage layer would minimize the hydraulic gradient above the impermeable layer (permeability equal to 12 inches of sand at 1E–02 cm/sec or a geonet with transmissivity equal to or greater than 3E-05 m^2/sec).

- Low Permeability Barrier: A barrier which, when constructed, would have a sufficiently low permeability such that it prevents infiltration. (This layer would provide a hydraulic barrier to minimize infiltration of precipitation into the contaminated soil thus reducing leaching of COCs in the soil to ground water). The low permeability barrier would be comprised of two major components. The synthetic (upper) layer is designed to prevent infiltration of liquids into the soil. The underlying low permeability (1E-07 cm/sec) layer provides added assurance that liquids entering the soil will be minimized should a breach of the synthetic layer occur.

- Bedding Layer: The first layer over the area would utilize the existing 24-inch thick clean soil cover constructed over the former drum disposal area and manufacturing area. The area would be compacted to provide a workable graded surface on which the remaining layers of the cover system would be constructed.

An engineered surface water runoff and erosion control system would be designed in accordance with Virginia Storm Water Management and Erosion and Sedimentation Control Regulations and installed to control surface runoff. The system would include surface grading and storm water retention basins and outfall structures as necessary.

Operation and Maintenance would be performed to ensure the integrity of the cap. The landfill cap maintenance plan would require removal of deep-rooted plants to protect the liner.

Maintenance activities would also include the repair of sedimentation controls and erosion damage.

The enhanced ground water pump and treat system would be installed and maintained as described in Alternative 2.

Institutional controls would be implemented to ensure that the integrity of the impermeable cap would be maintained and the Site would not be used in a manner inconsistent with the remedy. Any construction on the capped portion of the property would need to be designed to avoid damage to the cap. No institutional controls would be required for off-Site properties. Specific institutional controls would consist of both of the following:

1. a deed notice identifying the Site as a Superfund site and prohibiting (1) residential use of the property, (2) on-Site potable use of ground water, (3) any activity that would adversely impact the integrity of the impermeable cap or operation of the pump and treat system; and,

2. the granting of easements for Site access to the Commonwealth of Virginia (and their designees) to monitor the constructed remedy, operate and maintain the ground water treatment system, and ensure that restrictions on land use are being maintained.

Alternative 4: Soil Excavation, Off-Site Treatment and Disposal with Enhanced Pump and Treat System

Capital Cost:	$106,018,000
Annual O&M Cost:	$ 463,000
Total Present Worth Cost:	$111,763,000
Time to Implement:	42 months

This alternative is based on Alternative 1 for the Manufacturing and Drum Disposal Areas (Excavation & Institutional Controls) in the FFS, combined with Alternative #2 in the GWI/FFS Report, as modified by EPA.

Under Alternative 4, all clean soil over the deep contaminated soil would be excavated and stockpiled for subsequent use as clean backfill. The underlying soil determined to exceed PRGs (See Exhibit 1 at the end of this Proposed Plan) would be excavated and segregated from clean soil. The soil excavation would continue until all soils exceeding the deep soil PRGs were removed or bedrock was encountered. The estimated volume of soil exceeding PRGs in the manufacturing and drum disposal areas is 116,555 yds^3.

For cost estimation purposes, it was assumed that all contaminated soil would need to be transported to a RCRA Subtitle C hazardous waste **treatment, storage and disposal facility ("TSDF")**. The soil excavated during the OU-1 remedial action conducted in 1996 required thermal destruction (incineration) to comply with applicable regulations. Based on project history and past contaminated soil excavation activities conducted at the Site, it was assumed that all soil removed would be RCRA-listed waste which would require treatment prior to land disposal.

Dust and vapors occurring during excavation, temporary storage and transportation to the TSDF would be managed with standard engineering controls such as wetting with water, tarping and/or use of specialty foam. The excavated areas would be backfilled with clean soil to replace the contaminated soil that was disposed of off-site. A layer of topsoil would be placed over the backfill material and the surface would be re-vegetated.

A significant mass of hazardous substances have migrated into the fractured bedrock beneath the contaminated subsurface soil and beyond practical excavations limits. The enhanced ground water pump and treat system would be installed and maintained as described in Alternative 2, above, to achieve remedial action objectives.

Institutional controls would be implemented to prevent residential use or the extraction of ground water from the aquifer beneath the Site for use as a potable water source. Specific institutional controls would consist of both of the following:

1. a deed notice identifying the Site as a Superfund site and prohibiting (1) residential use of the property, (2) on-Site potable use of ground water, and (3) any activity that would adversely impact the operation of the pump and treat system; and,

2. the granting of easements for Site access to the Commonwealth of Virginia (and their designees) to operate and maintain the ground water treatment system, and to ensure that restrictions on residential land use are being maintained.

Alternative 4A: Soil Excavation, Off-Site Treatment and Disposal of Contaminated Soil, In-Situ Chemical Oxidation with Enhanced Pump and Treat System

Capital Cost:	$111,317,000
Annual O&M Cost:	$ 463,000
Total Present Worth Cost:	$117,062,000
Time to Implement:	60 months

Alternative 4A includes the remedial actions described in Alternative 4 augmented by the in-situ chemical oxidation remedial action described under Alternative 2A.

After the excavation and off-site disposal of the contaminated soil above the bedrock, a chemical oxidant would be injected into fractured bedrock to destroy the contaminants which are amenable to oxidation. As discussed in Alternative 2A above, contaminants such as carbon tetrachloride and bis(2-chloroethyl)ether will not likely be removed by oxidation. The enhanced pump and treat system would be implemented as described in Alternative 2 to capture contaminated ground water and achieve remedial action objectives beyond the waste management area.

Institutional controls identical to those described in Alternative 4 would be implemented. There are no additional institutional controls or long-term operation and maintenance costs associated with the chemical oxidation component of this alternative.

VIII. EVALUATION OF REMEDIAL ALTERNATIVES

In selecting EPA's Preferred Alternative, EPA evaluates each proposed remedy against the nine criteria specified in the **National Contingency Plan ("NCP").** The alternative selected must first satisfy the threshold criteria. Next, the primary balancing criteria are used to weigh the tradeoffs or advantages and disadvantages of each of the alternatives. Finally, after public comment has been obtained, the modifying criteria are considered. Below is a summary of the nine criteria used to evaluate the remedial alternatives.

Threshold Criteria:

1. Overall Protection of Human Health and the Environment addresses whether the remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

2. Compliance with Applicable or Relevant and Appropriate Requirements (**"ARARs"**) addresses whether or not a remedy will meet all applicable or relevant and appropriate requirements of Federal and State environmental statutes and/or whether there are grounds for invoking a waiver.

Primary Balancing Criteria:

3. Long-Term Effectiveness refers to the ability of the remedy to maintain reliable protection of human health and the environment over time once cleanup goals are achieved.

4. Reduction of Toxicity, Mobility or Volume through Treatment addresses the degree to which treatment will be used to reduce the toxicity, mobility, or volume of the contaminants causing Site risks.

5. Short Term Effectiveness addresses the time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation period until cleanup goals are achieved.

6. Implementability addresses the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular option.

7. Cost includes estimated capital (construction), operation and maintenance ("O&M"), and net present worth costs. (The present worth analysis is used to evaluate expenditures that occur over different time periods by discounting all future costs to a common base year, usually the current year. This analysis allows the cost of the remedial action alternatives to be compared on the basis of a single figure representing the amount of money that, if invested in the basis year and disbursed as needed, would be sufficient to cover all costs associated with the remedial action over its planned life.)

Modifying Criteria:

The modifying criteria are used in the final evaluation of remedial alternatives, generally after the EPA has received public comments on the Proposed Plan

8. State Acceptance indicates whether the Commonwealth, based on its review of supporting documents and the Proposed Plan, concurs with, opposes, or has no comment on the preferred remedial alternative.

9. Community Acceptance considers whether the community agrees with the remedy. This criteria is assessed in the ROD following a review of the public comments received on the Proposed Plan and supporting documents included in the Administrative Record.

The following discussion summarizes how each alternative considered in this Proposed Plan compares against each other with respect to these evaluation criteria.

1. Overall Protection of Human Health and Environment

A primary requirement of CERCLA is that the selected remedial alternative be protective of human health and the environment. A remedy is protective if it reduces current and potential risks to acceptable levels within the established risk range posed by each exposure pathway at the Site.

Alternative 1 (No Action - Existing Permeable Soil Cover and Pump and Treat System) would not effectively reduce risk to human health and the environment. The only unacceptable risk remaining at the Site is presented by contaminated ground water, assuming a future use scenario. Some contaminants in ground water are by-passing the existing ground water recovery well network and moving off the Site. If Alternative 1 were selected ground water at the Site would continue to be unsafe to drink. Since Alternative 1 does not meet the threshold criteria of protection of human health and the environment it will not be considered further in this analysis.

All of the remaining remedial alternatives (Alternatives 2, 2A, 3, 4, and 4A) received an overall positive rating for protection of human health and the environment, primarily due to the enhanced pump and treat component. Each of the remaining alternatives would upgrade the existing recovery well network to capture contaminated ground water before it migrates off-Site. Each remaining alternative considered also includes institutional controls to prevent the installation of drinking water wells on the Site and long-term monitoring of ground water.

Alternative 2 (Permeable Soil Cover with Enhanced Pump and Treat) would not implement any additional engineering controls or treatment technology to reduce the mass of contaminants in the deep soil or fractured bedrock. As is the case with each of the other alternatives, Alternative 2 achieves protectiveness by collecting contaminated ground water before it migrates off-Site.

Alternative 2A (Permeable Soil Cover, Enhanced Pump and Treat with In-Situ Chemical Oxidation) would include in-situ chemical oxidation to destroy some of the contaminant mass in the fractured bedrock but would not be effective for all of the contaminants found on the Site.

Alternative 3 (Impermeable Soil Cap and Enhanced Pump and Treat) would use an impermeable cap constructed over the former manufacturing and drum disposal areas to reduce infiltration of precipitation through contaminants in subsurface soil. The reduced infiltration would marginally reduce migration of contaminants from unsaturated soil to the underlying ground water. However, neither the treatment included in Alternatives 2A nor the engineering controls included in Alternative 3 would result in a remedy that would be protective of human health and the environment without the pump and treat component of the respective remedies.

Alternative 4 (Excavation with Enhanced Pump and Treat) would excavate contaminated soil above the bedrock for off-site treatment and disposal. Alternative 4A (Excavation, Enhanced Pump and Treat with In-situ Chemical Oxidation) would use in-situ chemical oxidation to further destroy some contaminant mass in the fractured bedrock after the contaminated soil was excavated. However, even Alternatives 4 and 4A require its respective ground water treatment components to achieve protectiveness because significant contamination is located in the fractured bedrock and beyond the practical limits of excavation, and the oxidation would not be effective for all of the contaminants

2. Compliance with Applicable or Relevant and Appropriate Requirements ("ARARs")

Any cleanup alternative selected by EPA must comply with all applicable or relevant and appropriate federal and state environmental requirements. Applicable requirements are those substantive environmental standards, requirements, criteria, or limitations promulgated under federal or state law that are legally applicable to the Remedial Action to be implemented at the Site. Relevant and appropriate requirements, while not directly applicable, address problems or situations sufficiently similar to those encountered at the Site such that their use is well-suited to the particular Site, and which EPA has decided must be met. Additionally, To Be Considered ("TBC") requirements are those which, while not required at this Site because they are not ARARs, EPA considers, and may follow.

Each of the remaining Alternatives (2, 2A, 3, 4, and 4A) would include the continued operation of the on-Site water treatment plant. The treatment plant would continue to meet the effluent discharge standards and monitoring requirements established under the Virginia Pollutant Discharge Eliminations System ("VPDES").

EPA understands that GCC's manufacturing operations may have generated F002 and F005 listed hazardous wastes that may have been discharged into the on-Site lagoon system as late as April, 1985, when production ceased. For purposes of this remedial action, EPA has assumed that the RCRA Regulatory Requirements, including **Land Disposal Regulations** (40 **CFR** Part 268, as adopted in 9VAC20-60-268, "LDRs"), and Minimum Technology Requirements (40 CFR 265, as adopted in 9 VAC20-60-265, "MTRs"), are applicable to the excavation and off-site disposal Alternatives 4 and 4A, which involve off-site transportation of contaminated soil. Virginia has an approved RCRA program and Virginia's Waste Management Regulations will generally govern instead of federal RCRA regulations. (Note that Virginia's Waste Management Regulations are similar to the federal RCRA regulations.). However, Virginia is not yet authorized to implement the LDR program and is therefore subject to federal LDR requirements.

Finally, as noted above, Maximum Contanimant Levels ("MCLs") under the Safe Drinking Water Act are relevant and appropriate with respect to each of the alternatives which involve continuation of the ground water pump and treatment system, and all non-zero MCLs are expected to be achieved beyond the waste management area.

All of the substantive federal and state ARARs which EPA has identified for the remedial alternatives in this Proposed Plan, as well as the TBCs, are summarized in Table 3. Alternatives 2, 2A, 3, 4, and 4A would comply with ARARs.

3. Long-Term Effectiveness and Permanence

Alternatives 2, 2A, 3, 4 and 4A would each be effective in maintaining reliable protection of human health and the environment over time once cleanup goals are achieved. The ground water pump-and-treat component of each of the remaining remedial alternatives has a high degree of long-term effectiveness and permanence. The treatment technologies utilized in the water treatment plant are well understood and easy to implement. However, there is considerable uncertainty as to whether the ground water beneath the Site can be successfully restored to levels acceptable for drinking water within 30 years, if ever. The ground water extraction system is expected, however, to contain the contaminated ground water within the waste management area, and the ground water pump-and-treat component would gradually remove contaminant mass from the ground water. Moreover, as noted above, all non-zero MCLs are expected to be achieved outside the waste management area. Thus, the long-term effectiveness of the ground water alternative depends on an effective recovery well network to prevent any potential for exposure off-Site and the institutional controls to prevent exposure on-site.

Alternatives 2 and 3 would rank well on long-term effectiveness and permanence. The permeable soil cover (Alternative 2) would support natural vegetation and would not require any special maintenance activities. The engineered impermeable cap (Alternative 3) would have some marginal reduction to the leaching of contaminants from the unsaturated zone to the ground water, thereby reducing the mass loading to the water treatment plant. The impermeable cap would have a design-life of 50-100 years and support a vegetated cover limited to grasses and shallow-rooted shrubs. Alternatives 2A, 4 and 4A rate better with respect to permanence because some of the contaminants, which are the source of ground water contamination, would be excavated and removed from the Site and/or be treated to destroy some contaminant mass. Alternative 4A ranks the best on permanence because the excavated soil would be treated in conformance with RCRA LDRs and disposed of at an off-site TSDF, and contaminants amenable to oxidation would be destroyed in the fractured bedrock. Nevertheless, the ground water pump and treat component would still be required to maintain the effectiveness of this Alternative.

Alternative 3 would require institutional controls to prevent future use activities from affecting the integrity of the engineered low-permeability cap. Each of the remaining alternatives would require institutional controls to prevent the installation of potable water wells on the Site until the quality of underlying ground water is restored to safe levels[3]. Since all institutional controls would require permanent monitoring, the different types of institutional controls had little effect on the alternatives analysis with respect to long term effectiveness.

[3] It is anticipated that even if the contaminated soil that presents a continuing source of contaminants to the ground water is removed, the quality of ground water beneath the Site would not return to acceptable levels for a great number of years.

TABLE 3
KEY ARARS FOR GREENWOOD CHEMICAL REMEDIATION ALTERNATIVES

Except where noted, the following are ARARs for all alternatives except No-Action.

<table>
<tr><th>ARAR OR TBC</th><th>LEGAL CITATION</th><th>CLASSIFICATION</th><th>SUMMARY OF REQUIREMENT</th><th>FURTHER SPECIFICATION AND/OR DETAILS REGARDING ARARS IN THE CONTEXT OF REMEDIATION</th></tr>
<tr><td>Safe Drinking Water Act: Maximum Contaminant Levels and Maximum Contaminant Level Goals</td><td>42 U.S.C. § 300(f); 40 C.F.R. §§ 141.11-16; 40 C.F. R. §§ 141.50-52</td><td>Relevant and Appropriate</td><td rowspan="2">MCLs are enforceable standards for public drinking water supply systems which have at least 15 service connections or are used by at least 25 persons. MCLGs are non-enforceable health-based goals for similar systems. These requirements are not directly applicable since ground water in the vicinity of the Site is used as a private drinking water supply. However, under the circumstances of this Site, MCLs and MCLGs are relevant and appropriate requirements which were considered in establishing ground water cleanup levels.</td><td rowspan="2">EPA regulation establishes that, where relevant and appropriate, MCLGs set at levels above zero will be attained at CERCLA sites and that, where the MCLG is set at zero, the MCL will be attained.

The MCLs/non-zero MCLGs will be met in ground water within the "area of attainment." The more stringent of the Federal or State MCLGs/MCLs will be attained.</td></tr>
<tr><td>Virginia Waterworks Regulation</td><td>12 VAC 5-590-440, Tables 2.2 and 2.3</td><td>Relevant and Appropriate</td></tr>
<tr><td>Clean Water Act: Federal Ambient Water Quality Criteria</td><td>33 U.S.C. § 1314</td><td>Relevant and Appropriate</td><td>These are non-enforceable guidelines published pursuant to Section 304 of the Clean Water Act that set the concentrations of pollutants which are considered adequate to protect human health and aquatic life.</td><td rowspan="2">All Commonwealth waters are designated for recreational uses, propagation and growth of aquatic life, wildlife, and the production of edible and marketable natural resources. The standards for freshwater aquatic life and non-public water supplies set forth in the Commonwealth's water quality standards will be attained. Those Federal Water Quality Criteria which deal with these designated uses will be attained where a state standard does not exist.</td></tr>
<tr><td>Virginia Water Quality Standards</td><td>9 VAC 25-260-5 to 550</td><td>Relevant and Appropriate</td><td>These are criteria to maintain surface water quality.</td></tr>
</table>

ARAR OR TBC	LEGAL CITATION	CLASSIFICATION	SUMMARY OF REQUIREMENT	FURTHER SPECIFICATION AND/OR DETAILS REGARDING ARARS IN THE CONTEXT OF REMEDIATION
Virginia Surface Water Antidegradation Policy	9 VAC 25-260-30	TBC	Provides that, at a minimum, the level of water quality necessary to protect existing uses shall be maintained and protected. Where water quality exceeds water quality standards, that quality must be maintained and protected, with certain exceptions.	These standards will be attained. The surface waters at issue have not been designated as providing "exceptional environmental settings and exceptional aquatic communities or exceptional recreational opportunities" within the meaning of 9 VAC 25-260-30(A)(3).
Virginia Anti-Degradation Policy for Groundwater	9 VAC 25-280-30	TBC	Provides that if the concentration of any constituent in groundwater is less than the limit set forth in Virginia's groundwater standards, the "natural quality" for the constituent shall be maintained. Further requires that "natural quality" shall be maintained for constituents for which Virginia has not set standards. Variances are permissible under certain circumstances.	With respect to each contaminant of concern for which no Virginia groundwater standard exists (e.g. vinyl chloride), the remedial action will attain "natural quality," provided that this level is above detection level and attaining such level is not technologically impracticable.
Clean Water Act: National Discharge Elimination System Requirements	40 C.F.R. Part 122	Applicable	These are enforceable standards for direct discharge of pollutants to surface waters of the United States.	The more stringent of the Federal and State substantive requirements will be attained. No permits shall be required for on-site discharges.
Virginia Pollutant Discharge Elimination System	9 VAC 25-31-10 to 940	Applicable	These are standards for discharging pollutants into surface waters of the State	
Virginia Hazardous Waste Regulations Identification Generation Transportation	9 VAC20-60-12 to 1505 9 VAC 20-60-261 9 VAC 20-60-262 9 VAC 20-60-263	 Applicable Applicable Applicable	These regulations establish standards for the identification, generation, transportation and disposal of hazardous waste.	The substantive requirements of these regulations will be attained in the event RCRA hazardous waste is identified.

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ARAR OR TBC	LEGAL CITATION	CLASSIFICATION	SUMMARY OF REQUIREMENT	FURTHER SPECIFICATION AND/OR DETAILS REGARDING ARARS IN THE CONTEXT OF REMEDIATION
Virginia Regulations Governing the Transportation of Hazardous Materials	9 VAC 20-110-10 to 130	Applicable	These regulations establish standards for the transportation of hazardous materials	The substantive requirements of these regulations will be attained.
Virginia Solid Waste Management Regulations:	9 VAC 20-80-10 to 790	Applicable	These regulations govern the handling, storage, treatment, and disposal of solid waste	The substantive requirements of these regulations will be attained.
Virginia Erosion and Sediment Control Regulations	4 VAC 50-30-10 to 110	Applicable	Requires preparation of an erosion and sediment control plan for activities involving land clearing, grading and other earth disturbances and establishes erosion and sediment control criteria	Alternatives 3, 4 and 4A would require significant earth disturbances. The substantive requirements of these regulations will be attained. No permits are required.
Virginia Stormwater Management Regulations	4 VAC 3-20-10; 60(A)-(G), (J)-(L); 71; 81(A); and 85(A), (B), and (D).	Applicable	These regulations establish criteria for management of storm water within the Commonwealth.	The substantive requirements of these regulations will be attained. No permits are required.
Virginia Ambient Air Quality Standards: Particulate Matter	9 VAC 5-30-60	Applicable	These regulations establish standards for particulate matter in ambient air.	The substantive requirements of these regulations will be attained during construction activities. No permits are required.
Virginia Air Regulations: New and Modified Stationary Sources: Compliance and Standards of Performance for Visible Emissions and Fugitive Dust/Emissions	9 VAC 5-50-20; 60 to 120	Applicable	These regulations establish standards for visible and fugitive dust emissions from new/modified stationary sources.	The substantive requirements of these regulations will be attained during construction activities. No permits are required.

4. Reduction of Toxicity, Mobility, and Volume through Treatment

Section 121(b) of CERCLA, 42 U.S.C. § 9621(b), established a preference for Remedial Actions that include treatment that permanently and significantly reduces the toxicity, mobility, or volume of contaminants.

Alternatives 2, 2A, 3, 4, and 4A each involve the collection and treatment of contaminants in ground water. In each of these scenarios, the contaminant mass from the ground water would continue to be removed from the environment and conveyed to the water treatment plant. The water treatment plant employs chemical precipitation, ultraviolet light oxidation (UV oxidation), and carbon filtration. The UV oxidation step destroys organic contaminants and is a non-reversible process.

The permeable soil cover included in Alternative 2 would provide limited reduction in vertical infiltration of rain water through the unsaturated contaminated subsurface soils. Through proper grading and support of a healthy stand of vegetation, the reduced infiltration would marginally reduce the migration of contaminants to the ground water for subsequent collection and treatment in the water treatment plant. Alternative 3 would incorporate an engineered multi-layered cap that would nearly eliminate vertical infiltration of rain water and reduce the mass of contaminants migrating from the unsaturated soil to the ground water.

Alternatives 4 and 4A would involve excavation of subsurface soil where concentrations of hazardous substances exceed cleanup standards. The excavated soil would be transported to an off-site RCRA TSDF. All material received by the TSDF would likely be subject to RCRA LDRs, and would be treated as appropriate prior to disposal. Alternatives 2A and 4A would reduce toxicity of many of the contaminants in the saturated soils and ground water. Under these alternatives, a chemical oxidant, such as potassium permanganate ($KMnO_4$), would be injected into the fractured bedrock aquifer. The oxidant could come into direct contact with degradable contaminants and react to break those hazardous substances into harmless compounds. Not all of the contaminants in subsurface soil and ground water at the Site are degradable with a stable oxidant, however. Of the alternatives considered, Alternative 4A would provide the best reduction of toxicity, mobility, and volume through treatment as subsurface soil exceeding cleanup criteria would be excavated and sent to a TSDF for treatment and some of the contaminants remaining in ground water would be treated in situ.

5. Short-term Effectiveness

All the alternatives achieve good short-term effectiveness. The permeable soil cover (Alternative 2) and impermeable cap (Alternative 3) alternatives, however, are expected to have the greatest short-term effectiveness. These alternatives are superior to Alternatives 4 and 4A because they minimize the exposure risk to the community, workers and the environment during implementation. Alternatives 4 and 4A would offer the least short-term effectiveness given the large scale of the excavation and the increased time required to complete this work. Alternative 3, 4 and 4A would introduce a statistically small incremental risk due to potential traffic accidents caused by the number of trucks needed to haul materials for the impermeable cap (Alternative 3) or the excavation and backfill alternatives (Alternatives 4 and 4A).

Alternatives 4 and 4A would require controls to minimize risks presented to site workers and the community by airborne dust, exposure to contaminated soil, and vaporization of contaminants of concern during construction. These risks can be readily controlled using established construction methods. Alternatives 2A and 4A present some additional occupational hazards to site workers handling chemical oxidants. Alternatives 3, 4 and 4A would require controls in order to minimize impacts associated with storm water runoff during construction. Standard erosion and sedimentation control methods would be employed to control storm water runoff.

The ground water component of the remaining Alternatives achieves good short-term effectiveness. There would be little potential for exposure to Site contaminants during installation of additional recovery wells. Construction of the enhanced ground water pump-and-treat system would take approximately 5 months. The potential for significant exposure to Site-related contaminants during the operation of the pump-and-treat system is minimal.

6. Implementability

This evaluation criterion addresses the difficulties and unknowns associated with implementing the cleanup technologies associated with each alternative, including the ability and time necessary to obtain required permits and approvals, the availability of services and materials, and the reliability and effectiveness of monitoring.

Alternatives 2, 3 and 4 can reasonably be implemented using commonly employed engineering and construction methods, equipment, materials, and personnel. Relative to other alternatives, the impermeable capping and permeable soil cover alternatives are administratively easier to implement because no excavation and removal of impacted soil from the Site is required.

The chemical oxidation included in Alternatives 2A and 4A is difficult to effectively implement in the field. The chemical reaction between the oxidant and the target contaminant only occurs when the respective molecules physically come into contact. While injection of the water-born oxidant into the ground is not difficult, the further delivery of the oxidant into the fractured bedrock system, within the specific fissures containing contaminants, is difficult to accomplish successfully. A strong oxidant that is capable of degrading a wider variety of contaminants, including carbon tetrachloride, would lose its potency too quickly to be effective in the field. A more stable chemical oxidant such as $KMnO4$ would not likely be effective degrading some of the contaminants such as carbon tetrachloride or bis(2-chloroethyl)ether.

Alternatives 4 and 4A involving the excavation of contaminated soil would require coordination with other state and local agencies in order to transport contaminated material off-site for treatment and disposal. Alternatives 2A and 4A would require coordination with the federal and state water protection programs to establish and meet requirements for injection of the chemical oxidant into the ground water. The construction of each of these alternatives would employ methods, equipment and specialists that are readily available from more than one vendor and are sufficiently demonstrated.

Expansion of the existing ground water pump-and-treat system can be readily implemented. Ground water modeling has already been performed to select the most appropriate locations for additional recovery wells. Materials and services are readily available for installation of extraction wells and modification of the treatment system, as appropriate.

7. Cost

Evaluation of costs for each alternative generally includes calculation of direct and indirect capital costs, and annual O&M costs, both calculated on a present worth basis. An estimated capital, annual O&M, and total present worth cost for each of the alternatives has been calculated for comparative purposes, and is presented in Table 4.

Direct capital costs include costs of construction, equipment, building and services, and waste disposal. Indirect capital costs include engineering expenses, start-up and shutdown, and contingency allowances. Annual O&M costs include labor and material, chemicals, energy, and fuel; administrative costs and purchased services; monitoring costs; and insurance, taxes, and license costs. For cost estimation purposes, a period of 30 years has been used for O&M. In reality, maintenance of a site with waste left in place would be expected to continue beyond this period. Similarly, the actual duration of operation for the ground water extraction and treatment system would depend on its ability to successfully limit migration of Site-related contaminants, and to achieve acceptable water quality on Site. The actual cost for each alternative is expected to be in a range from 50 percent higher than the costs estimated to 30 percent lower than the costs estimated. The evaluation was based on the Focused Feasibility Study cost estimates, as modified by EPA. The present worth is based on both the capital and O&M costs, and provides the means of comparing the cost of different alternatives. The present worth cost includes costs for the long-term operation of the ground water pump-and-treat system.

Table 4
Summary of Estimated Costs

	Capital Cost	Annual O&M Cost	Present Worth
Alternative 1	$0	$454,000	$5,634,000
Alternative 2	$365,000	$463,000	$6,110,000
Alternative 2A	$5,664,000	$463,000	$11,409,000
Alternative 3	$4,290,000	$510,000	$10,614,000
Alternative 4	$106,018,000	$463,000	$111,763,000
Alternative 4A	$111,317,000	$463,000	$117,062,000

8. State Acceptance

The VDEQ has reviewed and commented on this Proposed Plan and all documents supporting this Proposed Plan. VDEQ's acceptance of the Preferred Alternative will be evaluated after the public comment period and will be described in the ROD.

9. Community Acceptance

Community acceptance of the Preferred Alternative will be evaluated after the public comment period ends, and will be described in the Responsiveness Summary contained in the ROD for the

Site.

IX. PREFERRED ALTERNATIVE

Based on the comparison of the evaluation criteria summarized previously for each of the alternatives in this Proposed Plan, EPA's preferred alternative is Alternative 2: Permeable Soil Cover with Enhanced Pump and Treatment System. The preferred alternative meets the threshold criteria of overall protection of human health and the environment and compliance with ARARs. In considering the balancing criteria, EPA believes this Alternative can be readily implemented, achieves long-term effectiveness and permanence at a reasonable cost, minimizes the short-term impacts, and effectively reduces the mobility of Site contaminants through engineering controls.

The cumulative estimated cost of implementing EPA's preferred alternative is:

Capital Cost:	$ 365,000
Annual O&M Cost:	$ 463,000
Total Present Worth Cost:	$ 6,110,000
Time to Implement:	5 months

X. COMMUNITY ROLE IN SELECTION PROCESS

This Proposed Plan is being distributed to solicit public comment regarding the proposed remedial alternative for cleaning up the Site. EPA relies on public input so that the remedy selected for each Superfund Site meets the needs and concerns of the local community. To assure that the community's concerns are being addressed, a public comment period lasting thirty (30) calendar days, beginning on June 23, 2005 and ending on July 22, 2005, to encourage public participation in the selection process will follow this public notice. EPA will conduct a public meeting during the comment period in order to present the Proposed Plan and supporting information, answer questions, and accept both oral and written comments from the public. The public meeting will be held on July 6, 2005 at 7:00 pm at the Emmanuel Episcopal Church in Greenwood, Virginia.

EPA will summarize and respond to comments received at the public meeting and written comments post marked by July 22, 2005 in the Responsiveness Summary section of the ROD, which documents EPA's final selection for cleanup. To obtain additional information relating to this Proposed Plan, please contact either of the following EPA representatives:

Patricia Taylor (3HS43)
Community Involvement Coordinator
U.S. EPA Region - Region III
1650 Arch Street
Philadelphia, PA 19103
Phone: (215) 814-3063

Eric Newman (3HS23)
Remedial Project Manager
U.S. EPA - Region III
1650 Arch Street
Philadelphia, PA 19103
Phone: (215) 814-3237

EXHIBIT 1

How Did EPA Develop Deep Soil Preliminary Remediation Goals ("PRGs") and Estimate the Volume of Soils To Be Excavated?

Recognizing that hazardous substances in deep subsurface soil represents a continuing source of contamination to ground water, the 2002 FFS considered the possibility of a cleanup option which would remove enough contaminated deep soil such that ground water could be restored to safe drinking water standards without the need to operate the ground water pump and treatment system (Alternatives 4 and 4A in this Proposed Plan). The following discussion summarizes the process EPA used to estimate the amount of contaminated soil which would need to be removed to eliminate the continued leaching of unacceptably high concentrations of hazardous substances to the ground water.

Development of Deep Soil Preliminary Remediation Goals

Site-specific cleanup goals for subsurface soil were initially developed so that ground water would not be adversely impacted by hazardous substances leaching from those soils. For the purposes of establishing these goals, it was assumed that a drinking water well could be installed and safely operated at the Site boundary, and that no other ground water containment system (i.e., the existing pump and treat system, or a subsurface cut off wall) would be operated. Beginning with chemical-specific cleanup levels[1] that would need to be met in the ground water at the Site boundary, EPA used a model to calculate a chemical-specific soil cleanup level for each contaminant in deep soil. These chemical-specific soil cleanup levels were calculated using a combination of leach testing and a dilution/attenuation factor ("DAF"). The leach testing method utilized – the Synthetic Precipitation Leaching Procedure ("SPLP") – was designed to determine the mobility of both organic compounds and metals present in solids, such as soils. In this case, the primary concern was movement of hazardous substances from the contaminated subsurface soil to the ground water. A DAF of 20 was used to account for the reduction in contaminant concentrations in the ground water that would occur naturally as the ground water flows from the contaminated soils to the property boundary.

The PRGs shown in Table 1 represent the cleanup levels for deep soil which would theoretically lead to ground water safe to drink at the property boundary of the Site without the need for a ground water containment system.

Development of Deep Soil Volumetric Estimates

The deep soil PRGs were used to generate the soil volume estimate presented in Table 2. The 2002 FFS utilized a mathematical computer model[2] along with site-specific information – such as deep soil sampling results – and the deep soil PRGs discussed above to estimate the area of deep soils which have elevated levels of contamination and constitute an unacceptable source to the ground water (See Figure 4). Volume estimates for deep contaminated soils were calculated based on the following factors:

1. Manufacturing Area: The areal extent was calculated by combining the perimeter of the overlapping areas of organic and inorganic soil contamination (approximately 3.0 acres). An average combined depth of 20 feet was selected for estimating the soil volume.

2. Drum Disposal Area: The areal extent was calculated by combining the perimeter of the overlapping areas of organic and inorganic soil contamination (approximately 0.5 acres). An average depth of 30 feet was selected for estimating the soil volume.

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[1] The chemical-specific cleanup levels utilized at the property boundary were MCLs, where available, or health-based limits listed in EPA's Soil Screening Level User's Guide (1996).

[2] The 3-D Scatter Point module in "The Department of Defense Ground Water Modeling System" (2001)

The volumes of deep soil exceeding PRGs estimated in this fashion are conservative given the assumption that the entire vertical thickness of the deep soil is uniformly contaminated.

Table 1
Subsurface Soil Preliminary Remediation Goals (mg/kg)

Contaminant of Concern	**Deep Soils PRG to Protect Ground Water (mg/kg)**	**Maximum Concentration Detected (mg/kg)**	
		Drum Disposal Area	**Manufacturing Area**
4-Choroanaline	2	32	48
Arsenic	400	1050	7120
Benzene	2.2	4.3	3.5
Bis(2-ethylhexyl) phthalate	0.3	0.9	0.9
Chlorobenzene	16.6	17	23
Free Cyanide[a]	14.6	80.3	1,000
Naphthalene	400	1780	130
Tetrachloroethylene	2.4	8.2	4.5
Tetrahydrofuran	0.4	Not Detected	9,000
Toluene	600	5,900	620
Trichloroethylene	10	Not Detected	50

[a] Free Cyanide was measured as total cyanide

Table 2
Volume Estimates for Areas of COC Contamination Above Ground Water PRG[1]

Area (Name)	Area (Acres)	Volume (yds^3)
Manufacturing Area	3.0	92,907
Drum Disposal Area	0.5	23,648
Total (entire Site)	3.50	116,555

Note: The estimated soil volumes do not include the approximately 11,000 yds^3 clean fill which was used to replace contaminated soils previously excavated during the OU-1 remedial action and otherwise grade the former manufacturing area.

EXHIBIT 2

GLOSSARY

Administrative Record - EPA's official compilation of documents, data, reports, and other information that is considered important to the status of, and decisions made, relative to a Superfund site. The record is placed in the information repositories to allow public access to the material.

Action Memorandum (Action Memo) - A legal decision document that identifies short-term threats presented by a contaminated property and describes the removal actions selected to mitigate those threats.

ARARs - Applicable, or Relevant and Appropriate Requirements

Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA Site.

Relevant and Appropriate requirements are those same standards mentioned above that while not "applicable" at the CERCLA site, address problems or situations sufficiently similar to those encountered at the site that their use is well suited to the particular site.

Area of Attainment - The area of attainment is where the ground water performance standards will be met. The area encompasses the entire ground water plume beginning at the boundary of the waste management area.

BLRA - or Baseline Human Health Risk Assessment. A process to characterize the current and potential threats to human health that may be posed by contaminants at a Superfund site.

Capping - Construction of a protective cover over areas containing wastes or contamination. Caps prevent surface exposure of the wastes and reduce or eliminate infiltration of rain water or other precipitation into the waste. This minimizes the movement of contaminants from the site through ground water, surface water, or leachate.

Carcinogenic - Cancer-causing agent.

CERCLA - **Comprehensive Environmental Response, Compensation and Liability Act (commonly called Superfund,** name of the Federal law passed in 1980 and modified in 1986 by the Superfund Amendments and Reuthorization Act codified at 42 U.S.C. §§ 9601 et. seq. The Act created a Trust Fund known as Superfund, which is available to EPA to investigate and clean up abandoned or uncontrolled hazardous waste sites.

CFR - The Code of Federal Regulations. For example, the citation 40 CFR 260 means Title 40 of the Code of Federal Regulations, Part 260.

ESD - or Explanation of Significant Differences. Where necessary, an ESD describes to the public the nature of significant changes to the remedy selected in the Record of Decision

Ground Water - Water found beneath the earth's surface that fills pores between soil, sand, and gravel particles to the point of saturation. Ground water often flows more slowly than surface water. When it occurs in sufficient quantity, ground water can be used as a water supply.

Hazard Index - The sum of more than one hazard quotient for multiple substances and/or multiple exposure pathways. It is a means of measuring potential non-carcinogenic affects chemicals may have on a person.

Information Repository - A location where documents and data related to the Superfund project are placed by EPA to allow the public access to the material.

Land Disposal Restrictions - Specific provisions requiring treatment of RCRA hazardous wastes prior to land disposal.

Leachate -The contaminated liquid resulting from water percolating through a landfill or other waste disposal facility.

MCLs - or Maximum Contaminant Levels are primary drinking water standards developed by EPA to protect human health. These standards are enforceable and apply to specific contaminants that EPA has determined have an adverse effect on human health.

National Contingency Plan (NCP) - The Federal regulation at 40 CFR, Part 300 that guides the determination and manner in which sites will be cleaned up under the Superfund program.

National Priorities List (NPL) - EPA's list of the nation's top priority hazardous waste sites that are eligible to receive federal money for response action under Superfund.

NPDES or VPDES - National Pollutant Discharge Elimination System program is the national program for issuing, monitoring, and enforcing permits for direct discharges. The NPDES permits contain applicable effluent standards, monitoring requirements, and standard and special conditions for discharge. In Virginia, the water discharge program is administered by the Commonwealth's VPDES program which is equivalent to the Federal NPDES program.

Operable Unit (OU) - Operable Unit. Superfund sites may be divided into smaller, more manageable units called operable units.

O & M - Operation and Maintenance.

Organic Compounds - Chemicals containing carbon are classified as organic. Many hundreds of thousands are known. Some organic compounds can cause cancer.

Plume - The three dimensional area of contamination in a particular media, such as ground water. A plume can expand due to ground water movement.

Potable Water - Water that is safe for drinking and showering.

Practical Quantitation Limits (PQLs) - The lowest concentration of a specific chemical that can be routinely quantified and reported by a laboratory.

PRG - Preliminary Remediation Goal. Site specific chemical concentration protective of human health and ecosystems based on exposure scenarios in the baseline risk assessment.

RCRA (Resource Conservation and Recovery Act) - A statute at 42 U.S.C. §§ 6901 et. seq. under which EPA regulates the management of hazardous waste.

Record of Decision (ROD) - A legal decision document that describes the remedial actions selected for a Superfund site, why certain remedial actions were chosen as opposed to others, how much they will cost, how the public responded and how the public's comments about the Proposed Plan were incorporated into the final decision.

Remedial Design (RD) - Planning phase where the engineering reports, technical specifications, and drawings that detail the steps to be taken are prepared.

Remedial Investigation and Feasibility Study (RI/FS) - A report composed of two scientific studies, the RI and the FS. The RI is the study to determine the nature and extent of contaminants present at a site and the problems caused by their release. The FS is conducted to develop and evaluate options for the cleanup of a site.

Risk Assessment (RA) - The RA is an essential component of the Remedial Investigation Report. This portion of the RI evaluates the carcinogenic and non-carcinogenic risks presented by the contaminants at the site. Risk is calculated both for current uses and potential future uses of the property by a defined population, i.e., on and off-site residents, trespassers, etc.

Scientific Notation - In dealing with particularly large or small numbers, scientists and engineers have developed a "short hand" means of expressing these numeric values based on their value in a base 10 system. For example, 1,000,000 can be written as 1E06 and 1/1,000,000 can be written as 1E-06 .

Treatment Storage and Disposal Facility (TSDF) - Facility specifically designed and constructed for the treatment, storage and disposal of RCRA hazardous wate.

Volatile Organic Compounds (VOCs) - Chemical compounds containing carbon that readily volatilize or evaporate when exposed to the air. These compounds are commonly used as solvents.

Waste Management Area - The geographical area which includes the primary continuing sources of contamination to ground water (the deep soil source areas) and any residual soil contamination underlying the excavated limits of former Lagoons 4 and 5.