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NAWC WARMINSTER
5090.3a

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
841 Chestnut Building
Philadelphia, Pennsylvania 19107-4431

SEP 30 1993

Mr. Orlando Monaco
Naval Facilities Engineering Command
Northern Division
Environmental Restoration Branch
10 Industrial Highway
Lester, Pennsylvania 19113

Re: Naval Air Warfare Center (NAWC) - Warminster, PA

Dear Mr. Monaco:

Please find enclosed a copy of a signed Record of Decision (ROD) documenting the selected interim remedy for Operable Unit One at NAWC. This ROD was signed by the Navy on September 21, 1993 and signed by the EPA on September 29, 1993. As a result, the effective date of the ROD is September 29, 1993. At this time, the EPA shall retain the original, signed copy of the ROD.

Also enclosed is a disc with the subject ROD.

Terri White, EPA Community Relations Coordinator for NAWC, will be contacting the Navy to discuss the issuance of news release to announce the signature of the ROD.

I understand this is the first ROD signed by the EPA and the Navy in EPA Region III. Thank you for your efforts in this regard. Should you have any questions or comments, please give me a call.

Sincerely,

Darius Ostrauskas
Remedial Project Manager

Enclosures (2)

cc: David Kennedy (w/Enclosure (1))
Joe Cody, NAWC (w/Enclosure (1))

RECORD OF DECISION
NAVAL AIR DEVELOPMENT CENTER

DECLARATION

SITE NAME AND LOCATION

Naval Air Development Center
Warminster Township
Bucks County, Pennsylvania

STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD) presents a selected interim remedial action for Operable Unit One (OU-1) at the Naval Air Development Center in Warminster Township, Bucks County, Pennsylvania (the "Site"), chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended, 42 U.S.C. § 9601 et seq. and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 C.F.R. Part 300. This decision is based on the Administrative Record for this Site. In January 1993, the facility was renamed Naval Air Warfare Center (NAWC) Aircraft Division Warminster.

The Commonwealth of Pennsylvania concurs with the selected interim remedy for OU-1 at this Site.

ASSESSMENT OF THE SITE

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

DESCRIPTION OF THE SELECTED REMEDY

The selected interim remedy for OU-1 is the first remedial action addressing the Site. OU-1 consists of contaminated groundwater attributable to Area A and Area B at the Site in overburden and shallow bedrock aquifers. The objective of the selected interim remedy is to minimize the migration of the contaminated groundwater. A final remedial action for OU-1 will be selected in a final Record of Decision for OU-1 to be issued after the full nature and extent of contaminated groundwater attributable to Area A and Area B in overburden and shallow bedrock aquifers are identified. The selection of the final remedial action will consider the information generated during the implementation of the interim remedial action. Future actions at the Site will address groundwater in overburden and shallow bedrock in other areas, groundwater in deep bedrock, waste, soils, surface water, and sediment as necessary.

The selected interim remedy for OU-1 includes the following major components:

- Installation, operation and maintenance of groundwater extraction wells
- Installation, operation and maintenance of an onsite groundwater treatment system which includes precipitation, filtration, air stripping and carbon adsorption, and/or other necessary means of treatment
- Periodic sampling of treated water to ensure the effectiveness of the treatment system

- Discharge of treated water to an unnamed tributary of Little Neshaminy Creek or an unnamed tributary of Southampton Creek
- Installation, operation and maintenance of vapor phase carbon adsorption units as necessary
- Offsite treatment and/or disposal of solid residuals generated during water treatment
- Monitoring of groundwater in monitoring wells and residential wells
- Installation and periodic sampling of observation wells to ensure the effectiveness of the groundwater extraction wells
- Periodic evaluation of hydrogeologic data and the effectiveness of the groundwater extraction wells
- Modification of the groundwater extraction well system and/or groundwater treatment system as necessary based on periodic evaluations

STATUTORY DETERMINATIONS

Pursuant to duly delegated authority, we hereby determine, pursuant to Section 106 of CERCLA, 42 U.S.C. § 9606 that this interim action is protective of human health and the environment, complies with Federal and State applicable or relevant and appropriate requirements directly associated with this action, and is cost-effective. Although this action is not intended to fully address the statutory mandate for permanence and treatment to the maximum extent practicable, this interim action utilizes treatment and thus is in furtherance of that statutory mandate. Because this action does not constitute the final remedy for Operable Unit One, the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element, although partially addressed by this remedy, will be addressed by the final response action. Subsequent actions are planned to address fully the threats posed by the conditions at the Site.

Because the interim remedy addressing groundwater is likely to result in hazardous substances remaining onsite above health-based levels, a review will be conducted within five years of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment. Because this is an interim action ROD, review of this Site and of this remedy will be continuing as the Navy and EPA continue to develop final remedial alternatives for Operable Unit One.

William L. McCracken
Captain, U.S. Navy
Commanding Officer
Naval Air Warfare Center, Warminster

9/21/93
Date

Stanley L. Laskowski
for Acting Regional Administrator
EPA Region III

9/29/93
Date

RECORD OF DECISION

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RECORD OF DECISION

NAVAL AIR DEVELOPMENT CENTER

DECISION SUMMARY

I. SITE NAME, LOCATION, AND DESCRIPTION

The Naval Air Development Center is a 734-acre Naval facility located in Warminster Township, Bucks County, Pennsylvania ("the Site") (see Figure 1 for Site Location Map). In January 1993, the Naval facility was renamed Naval Air Warfare Center (NAWC) Aircraft Division Warminster. The Site lies in a populated suburban area surrounded by private homes, various commercial and industrial activities, and a golf course. On-site areas include various buildings and other complexes connected by paved roads, the runway and ramp area, mowed fields, and a small wooded area.

The longest runway, which is currently the only active runway, is generally located along the topographically highest area at the Site. Many of the primary NAWC buildings are located west of the airstrip, along Jacksonville Road, a public road which traverses the Site north to south. A housing development for military enlisted personnel is within the southeastern portion of the Site. A wastewater treatment plant (WWTP) owned and operated by NAWC is located in the northwestern corner of the Site.

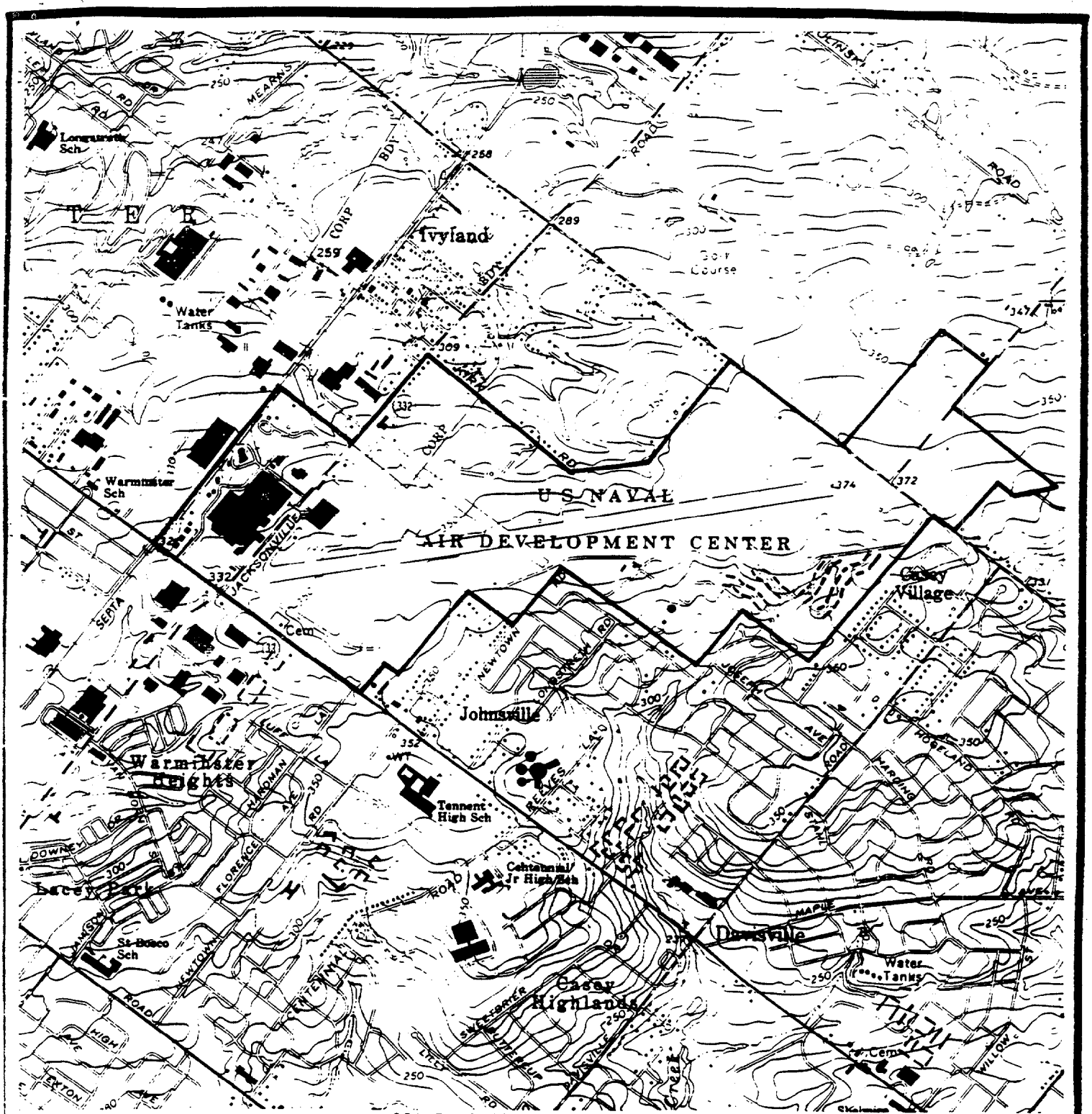
Commissioned in 1944, NAWC's main function is research, development, testing, and evaluation for Naval aircraft systems. NAWC also conducts studies in anti-submarine warfare systems and software development.

NAWC has approximately 3,000 employees, and 1,000 people reside at the Site year round. The residents living at the Site are the nearest population center. The closest off-base home is about 200 feet away from the NAWC property line. Residential development is located along the length of the southern property line of NAWC, and to a lesser extent, along the northern property line. Industrial development is located along the west and northwest perimeter of NAWC property. Groundwater is used extensively as a source of water by both residents and industry in the immediate vicinity of the Site. The Site is located on a ridge, generally oriented east-west, with elevations ranging from 297 feet at the northwestern property boundary to 377 feet at the eastern boundary. Onsite slopes are gentle and average three to five percent.

The northern portion of the Site (about 65 percent) drains into small, unnamed tributaries of Little Neshaminy Creek. The remaining portion (about 35 percent) drains into unnamed tributaries of Southampton Creek. These streams are used for recreation and industrial purposes. An unnamed tributary of Little Neshaminy Creek which flows immediately adjacent to the NAWC property line may be used for recreational purposes by children approximately 3000 feet downgradient of the Site. There are no known endangered species or critical habitats within the immediate vicinity of the Site.

II. SITE HISTORY

This section describes the history of waste disposal, and CERCLA investigations and response actions at the Site.



ADAPTED FROM THE U.S.G.S HATBORO 7.5 INCH QUADRANGLE

FIGURE 1

NAWC WARMINSTER
SITE LOCATION MAP

A. HISTORY OF WASTE DISPOSAL

Historically, wastes containing hazardous substances have been generated by NAWC during aircraft maintenance and repair, pest control, fire-fighting training, machine and plating shop operations, spray painting, and various materials research and testing activities in laboratories. The wastes generated have included paints, solvents, sludges from industrial wastewater treatment, and waste oils. From 1940 to 1980, these wastes were disposed in pits, trenches, and landfills located on current NAWC property. In addition, wastes generated by NAWC were burned in a fire training area until 1988.

To date, eight (8) areas on current NAWC property have been identified as areas used for the disposal of wastes containing hazardous substances. A brief summary of these eight areas is provided on Table 1-1. Figure 2 provides the locations of these eight waste disposal areas, which cover approximately seven acres. None of these areas are currently used for waste disposal. For investigative purposes, sites 1, 2 and 3 have been grouped into Area A, while sites 5, 6 and 7 have been grouped into Area B.

1. Area A

Site 1 is located on a portion of the NAWC property facility lying northwest of Jacksonville Road and is adjacent to the NAWC wastewater treatment plant. Site 1 is within 1,000 feet of an off-site food processing facility located outside of NAWC property and within 300 feet of an unnamed tributary of Little Neshaminy Creek. Site 1 was operated as a burn pit within an eroded ravine from 1940 to 1955. Various wastes such as paints, oils, asphalt, roofing material, solvents, scrap metals, and unspecified chemicals were burned within this pit. The quantity of wastes deposited or burned is unknown. The estimated area of site 1 is approximately 2,500 square feet.

Site 2, located about 300 feet southeast of site 1, received wastewater sludges from 1965 to 1970. Site 2 consisted of two disposal trenches; each trench was approximately 12 feet wide by 200 feet long by eight feet deep. The total area of site 2 may be 20,600 square feet.

Site 3 is immediately southeast of site 2. Site 3 was used from 1955 to 1965 as a burn pit for solvents, paints, roofing materials, and other unspecified chemicals. The pit was approximately 20 feet wide by 30 feet long by 10 feet deep. Residue from the pit was occasionally removed and deposited at an unknown area of the NAWC property.

2. Area B

Site 5 is located adjacent to and under several housing units in NAWC's enlisted men's housing area. Site 5 operated from 1955 to 1970 and was unearthed during construction for the foundation of a housing unit. Site 5 reportedly consists of six to eight disposal trenches in which paints, solvents, scrap metal, demolition debris, and 30 drums of asphalt were disposed. Each trench was reportedly about 12 feet wide by 70 feet long and eight feet deep.

Site 6 reportedly consists of an unknown number of disposal pits or trenches on the south side of the main runway. This site received paint, solvents, demolition waste, waste oils, flammable waste, and grease trap waste from 1960 to 1980. The site covers an area of about 70,000 square feet. Little information is available regarding waste disposal operations for site 6.

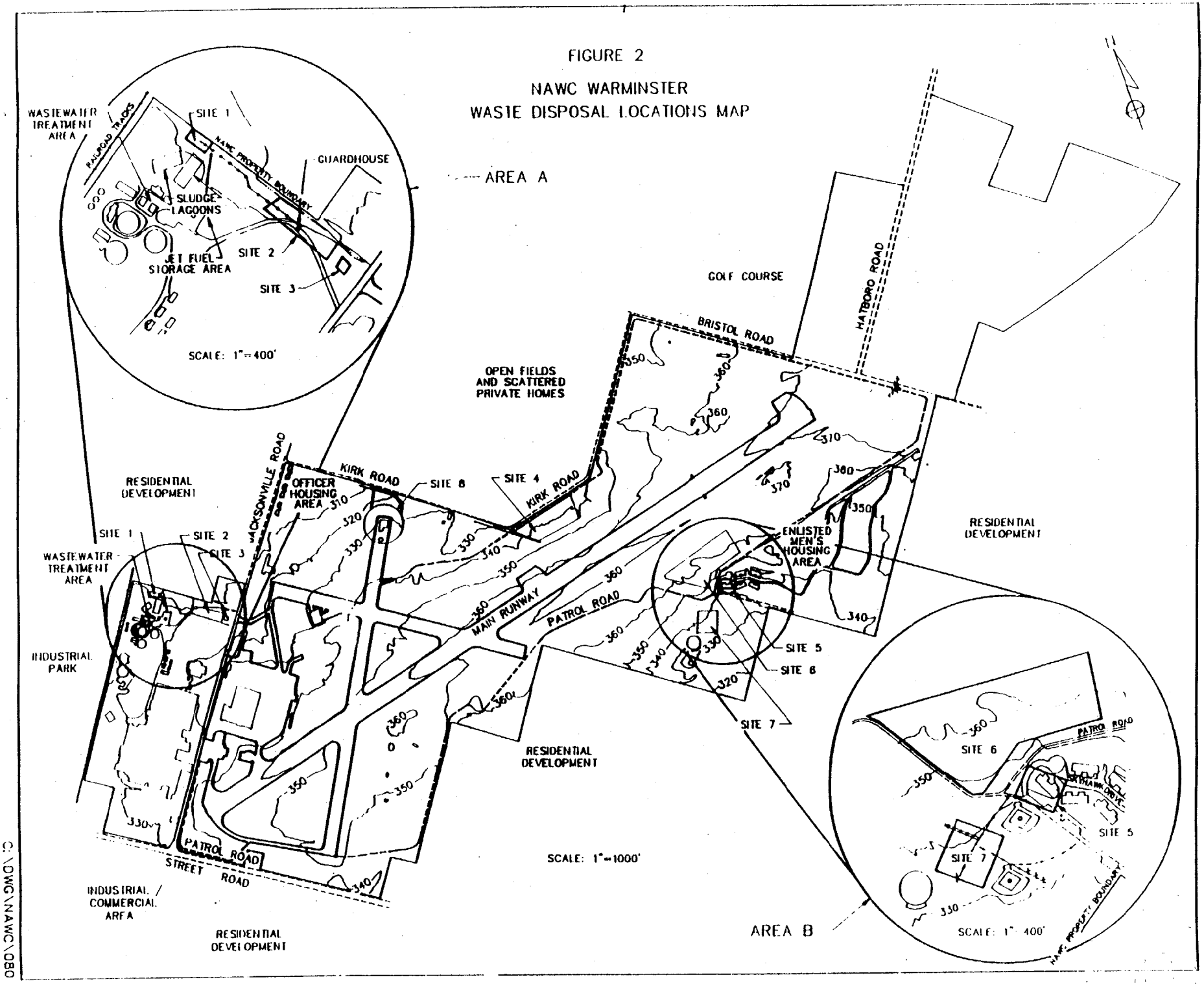
TABLE 1
SUMMARY OF WASTE MANAGEMENT AND SITE OPERATIONS
NAWC WARMINSTER, PENNSYLVANIA

SITE NO.	DATES OF OPERATION	TYPES OF WASTES	METHOD OF OPERATION	POTENTIAL HAZARDS
1	1940 to 1955	Paints, oils, asphalt, roofing material, unspecified chemicals, firing range wastes	Burn pit within an eroded ravine	Various solvents, driers, pigments, PAHs, creosote, phenols, asbestos, binders, lead
2	1965 to 1970	Industrial wastewater sludges	2 disposal trenches	Biological wastes, heavy metals
3	1955 to 1965	Solvents, paints, roofing materials, and unspecified chemicals	Burn pit	Various solvents, driers, pigments, asbestos, binders
4	1966 to 1970	Non-industrial solid wastes, paints, waste oils, waste metals, construction debris, solvents, and sewage treatment sludge	7 disposal trenches	Various solvents, driers, pigments, lead, PAHs, biological wastes, heavy metals
5	1955 to 1970	Paints, solvents, scrap metal, and 30 drums of asphalt	6 to 8 disposal trenches	Various solvents, driers, pigments, creosote, phenols, PAHs
6	1960 to 1980	Paints, solvents, demolition wastes, waste oils, other flammable wastes, and grease trap wastes	Unknown number of disposal pits or trenches	Various solvents, driers, pigments, lead, PAHs
7	1950 to 1955	Industrial wastewater sludge	2 disposal trenches	Biological wastes, heavy metals
8	1961 to 1988	Aviation fuel, lubricants, coolants	Firefighting training area	PAHs, PCBs

ADAPTED FROM SMC MARTIN 1991 (TABLES 1-1 AND 4.3-4)

FIGURE 2

NAWC WARMINSTER
WASTE DISPOSAL LOCATIONS MAP



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Site 7 is located west of sites 5 and 6 and east of the inertial reference building. Site 7 reportedly consists of two disposal trenches that were used from 1950 to 1955 to receive sludge from the wastewater treatment plant. The trenches were reportedly 100 feet long by 12 feet wide and eight feet deep. The potential capacity of each trench is 356 cubic yards. The trenches were reportedly backfilled with fill after each dumping episode.

B. CERCLA INVESTIGATIONS AND RESPONSES

The EPA completed CERCLA Preliminary Assessment (PA) and PA/Site Inspection (SI) Reports in 1979 and 1985 respectively. In 1986, the Site was proposed for inclusion on the National Priorities List (NPL). On October 4, 1989, the Site was placed on the final NPL. On September 20, 1990, the Navy and EPA signed an Interagency Agreement (IAG) which established a procedural framework for developing and implementing investigative and response actions at the Site in accordance with CERCLA and the NCP.

In response to the inclusion of the Site on the NPL and in accordance with the IAG, the Navy has investigated hazardous substance releases at the Site in two phases to date. A Phase I Remedial Investigation (RI) was initiated in late 1988 and was completed on September 11, 1990 with the release of the Phase I RI Report. Phase I initiated the investigation of sites 1 through 8 by screening these sites for volatile organic compounds (VOCs) via soil gas analysis and detecting any buried materials through electromagnetic surveys. The sites were also investigated through soil borings and the installation and sampling of shallow monitoring wells installed to monitor overburden and shallow bedrock aquifers. In addition, test pits were excavated, nearby wells were inventoried, and a bedrock fracture-trace analysis was conducted.

The Phase II RI was initiated in late 1991. Phase II work included the installation of additional overburden and shallow bedrock monitoring wells, sampling and analyzing groundwater, and an evaluation of aquifer characteristics through water-level monitoring, slug and step-drawdown tests and a pumping test. Four off-site wells were sampled during the Phase II RI.

Both the Phase I and Phase II RI investigated the nature and extent of shallow groundwater contamination within Areas A and B. The Phase II RI also investigated the potential for groundwater in the shallow bedrock aquifer underlying Area A to migrate to offsite locations, including deeper aquifers. The findings of the Phase II RI and a summary of the Phase I RI were included in the Phase II RI Report for OU-1 released on April 19, 1993.

On April 21, 1993, the Navy released a Focused Feasibility Study (FFS) Report for OU-1 at the Site. The FFS for OU-1 developed several remedial alternatives for minimizing the migration of contaminated groundwater in overburden and shallow bedrock attributable to NAWC.

During the week of April 28, 1993, the Navy initiated the sampling of offsite wells to assess the impact of contaminated groundwater attributable to NAWC on offsite groundwater users. Through July 30, 1993, the Navy had sampled over 200 wells. Seven (7) residential wells sampled exceeded EPA Removal Action Levels, while an additional thirity (30) residential wells exceeded Maximum Contaminant Levels (MCLs) (developed pursuant to the Safe Drinking Water Act). At least part of this contamination is potentially attributable to the Site. In response, the Navy has conducted a CERCLA removal action, installing a water treatment system in each residence where either EPA Removal Action Levels or MCLs have been exceeded.

The EPA determined this offsite groundwater contamination constitutes an imminent threat to human health. In response, the EPA and the Navy are conducting additional CERCLA removal action work which shall provide residences exceeding EPA Removal Action Levels and MCLs as well as residences in the immediate path of the groundwater contamination with connections to public water supply systems.

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

Since 1988, the plans and results of CERCLA investigations and actions have been presented to a Technical Review Committee (TRC) for the Site. The TRC includes representatives of Bucks County Health Department, Warminster Township, Warminster Township Municipal Authority, Upper Southampton Township, Upper Southampton Water and Sewer Authority, Northampton Township and Northampton Municipal Authority.

In accordance with Sections 113 and 117 of CERCLA, 42 U.S.C. Sections 9613 and 9617, the Navy, in conjunction with EPA, issued a Proposed Plan on April 29, 1993, presenting the preferred interim remedy for OU-1. The Proposed Plan and RI and FFS reports for OU-1 were among those documents included in the Administrative Record on April 29, 1993. The Administrative Record is available for review by the public at the following information repositories:

- NAWC Public Affairs Office
  Jacksonville Road (Building 3)
  Warminster, Pennsylvania 18974

- Bucks County Library
  150 South Pine Street
  Doylestown, Pennsylvania 18901

An announcement of the public meeting, the comment period, and the availability of the Administrative Record for the interim remedy for OU-1 was published in the Philadelphia Inquirer, Intelligencer, Public Spirit, and Courier Times on April 29 and 30, 1993. Minor corrections to this announcement were published in the Philadelphia Inquirer, Intelligencer, and Courier Times on May 10, 1993. Additionally, the Proposed Plan and the Notice of Availability were mailed to local municipal and government agencies in the vicinity of the Site.

The public comment period for the Proposed Plan was from April 29, 1993 to May 28, 1993. A public meeting was held at William Tennant High School, Centennial Road, Warminster, Pennsylvania on May 10, 1993 to present the RI, FFS and Proposed Plan, answer questions, and accept both oral and written comments.

A transcript of the meeting was maintained in accordance with Section 117 (a) (2) of CERCLA, 42 U.S.C. §9617(a)(2). As a result, responses to many oral comments during the public meeting are in the transcript of the meeting, which is now part of the Administrative Record. Responses to written comments received during the public comment period are included in the Responsiveness Summary section of this ROD.

This Record of Decision presents the selected interim remedial action for OU-1 at the Site chosen in accordance with CERCLA and, to the extent practicable, the National Contingency Plan (NCP).

All documents considered or relied upon in reaching the remedy selection decision contained in this ROD are included in the Administrative Record for the Site and can be reviewed at the information repositories.

IV. SCOPE AND ROLE OF THIS REMEDIAL ACTION

Section 300.430 (a)(1)(ii)(A) of the NCP, 40 C.F.R. Section 430(a)(1)(ii)(A) provides that CERCLA NPL Sites "should generally be remediated in operable units when early actions are necessary or appropriate to achieve significant risk reduction quickly, when phased analysis or response is necessary or appropriate given the size or complexity of the Site, or to expedite the completion of a total cleanup." OU-1 at the Site has been identified to facilitate these objectives.

This ROD selects an interim remedial action for contaminated groundwater attributable to Area A and Area B at the Site in overburden and shallow bedrock aquifers. Contaminated groundwater attributable to Area A and Area B at the Site in overburden and shallow bedrock aquifers has been designated as OU-1. This groundwater presents unacceptable risks to human health and sufficient information is available to select an interim remedy at this time.

The objective of the interim remedy in this case is to minimize the migration of contaminated groundwater attributable to Areas A and B at the Site in overburden and shallow bedrock aquifers while additional RI work is performed to determine the full nature and extent of contamination in these aquifers both on and off current NAWC property. The additional RI work to be conducted by the Navy will include additional monitoring well installation, groundwater sampling, long-term water-level monitoring, and aquifer testing as necessary.

The final remedy for OU-1 will be selected after the full nature and extent of the problem are identified and will consider the information generated during implementation of the interim remedy. In the Preamble to the publication of the revised NCP, it is noted that operable units "may include interim actions (e.g., pumping and treating of groundwater to retard plume migration) that must be followed by subsequent actions which fully address the scope of the problem (e.g., final groundwater operable unit that defines the remediation level and restoration timeframe)." (55 Fed.Reg. at 8705 (March 8, 1990)). Therefore, a final ROD for OU-1 will be issued after the implementation of the interim action. The interim action will be consistent with planned future actions to the extent possible.

Other media associated with the Site, including groundwater in deep bedrock aquifers, wastes, soils, sediment and surface water will be further investigated under the RI/FS process. Additional remedial actions will be proposed and selected as soon as adequate information exists to support the selection of a remedy for a particular medium or group of media. Any such medium (or group of media) will be designated as an Operable Unit by the Navy and EPA. At this time, only OU-1 has been designated by the Navy and EPA.

V. SUMMARY OF SITE CHARACTERISTICS AND EXTENT OF CONTAMINATION

Summarized below are the relevant findings of the RI to date with regard to groundwater in overburden and shallow bedrock at the Site.

A. SITE CHARACTERISTICS

1. Geology

The Site is located in the Piedmont Physiographic Province, Triassic Lowlands Section, of southeastern Pennsylvania. The land forms have been modified by erosion to form moderate slopes and gently rounded hills with a dendritic drainage pattern.

Surface soils in the vicinity of the Site are generally fine-textured, predominantly silty loams, with moderate to low permeabilities. The soils are commonly underlain by saprolite (extensively weathered bedrock) at an approximate depth of four to 10 feet. Available information indicates saprolite on NAWC property varies from eight (8) and twenty-five (25) feet in thickness.

The bedrock underlying the saprolite belongs to the late Triassic age middle arkose member of the Stockton Formation. These rocks consist of fine- to medium-grained arkosic sandstone interbedded with red shale, siltstone and conglomerate. Units of varying lithology are irregularly interbedded with coarse-grained units commonly overlying fine-grained units. Individual beds commonly pinch out or form gradational contacts with overlying or underlying beds over lateral distances greater than several hundred feet.

The beds of the Stockton Formation strike to the northeast and dip from seven to 16 degrees to the northwest with an average dip of 12 degrees. The thickness of the middle arkose member of the Stockton Formation is estimated to be approximately 500 feet near the southeastern property boundary of NAWC, increasing to between 1,500 and 2,000 feet near the northwestern boundary. The Stockton Formation is extensively faulted and is cut by a well-developed joint or fracture system.

2. Hydrogeology

The Stockton Formation forms a multi-aquifer system of relatively discrete water-bearing zones separated by thicker, less permeable zones. Transmissivity and groundwater movement within water-bearing zones are greater parallel to bedding than across bedding. Vertical or nearly vertical fractures cutting across bedding and the weathering of various beds are expected to permit varying degrees of leakage between the main water-bearing zones, particularly near the surface. Groundwater in the Stockton Formation occurs locally under both confined and unconfined conditions.

Within water-bearing zones in the fine- and medium-grained sandstone of the Stockton Formation, groundwater is transmitted through primary intergranular porosity, as well as along fractures, joints, and bedding planes (secondary porosity). The shale and siltstone beds are commonly too fine-grained to transmit large amounts of groundwater through primary porosity, and fractures and joints are typically not well developed in these fine-grained beds. Consequently, the shale and siltstone beds often act as confining layers to groundwater. Fracture permeability is generally better developed in the sandstone layers compared to the shale and siltstone layers of the formation. This, along with greater primary permeability, allows the sandstone layers to function as the most productive water-bearing units of the Stockton Formation.

The regional hydrogeology for the Stockton Formation in the area around the Site is that of a complex multi-aquifer system. The individual water-bearing zones of the Stockton Formation may belong to either of three different aquifer types based on their storage coefficients, leakage factors, and spatial relationships. In descending order, these aquifer types include:

- Overburden aquifers
- Shallow bedrock aquifers
- Deeper bedrock aquifers

With the exception of the overburden, these aquifer types are not interpreted to necessarily represent physically distinct units but to represent transitional zones that occur within the individual water-bearing units encountered at increasing depths.

The overburden aquifers consist of saturated soils and saprolite derived from erosion of the truncated edges of the inclined bedrock layers. They extend to depths of 15 to 35 feet, with an average depth of 20 feet. The overburden controls the rate at which water percolates to the water table. Saturated conditions do not exist within the overburden at all locations throughout the Site. Interpretation of overburden water-table elevations indicates that an unnamed tributary of Little Neshaminy Creek acts as a groundwater divide for the overburden aquifer in the vicinity of Area A. Based on available information, it is unknown whether a tributary to Southampton Creek acts as a divide for groundwater in overburden south of NAWC property in the vicinity of Area B.

The shallow bedrock aquifers underlie the overburden aquifers have been considered to extend to a depth of 100 feet below the ground surface. The shallow bedrock aquifers are recharged by vertical percolation from the overburden aquifers and are the primary reservoir for groundwater storage in the Stockton Formation. The shallow bedrock aquifers are generally under water-table conditions and may consist of numerous discrete water-bearing zones. The hydraulic characteristics of the shallow aquifers are primarily controlled by the physical properties of the bedrock. Horizontal groundwater migration in response to regional gradients (controlled by topography or long-term well pumping) is probably significant in the shallow bedrock aquifers.

The deeper bedrock aquifers underlie the shallow bedrock aquifers and have been considered to occur at depths of greater than 100 feet below the ground surface. Pumping water from the deeper aquifers induces leakage from the shallow bedrock aquifers. This is the manner in which water stored in the water table provides recharge to the deeper portions of the Stockton Formation.

The transition in the water-bearing zones from unconfined to confined conditions varies between particular areas and occurs at different depths within bedrock. Leakage of water from the shallow bedrock aquifers to deeper bedrock aquifers also varies with location and depth. In general, the Stockton Formation is a complex multiple aquifer system with beds of varying permeability and fracturing. Most deep wells in the Stockton Formation penetrate several major water-bearing zones and, if allowed to remain open through these zones, are multi-aquifer wells. The individual water-bearing zones of a given well generally have different hydraulic properties and different hydraulic heads. Therefore, the hydraulic head of a multi-aquifer well is a composite head of all the water-bearing zones in which it is completed. In unused supply wells and monitoring wells that are completed in more than one major water-bearing zone, groundwater is free to flow from water-bearing zones of higher hydraulic head to those of lower hydraulic head.

3. Hydrology

This Site is located in an upland area lying between two local drainage basins. The northern 65 percent of the Site (including Area A) drains toward the north through several swales and storm sewers into small unnamed tributaries of Little Neshaminy Creek. The southern 35 percent of the Site (including Area B) drains toward the south to the headwaters of Southampton Creek, a tributary of Pennypack Creek. Both local drainage basins lie within the regional drainage basin of the Delaware River. Various studies conducted on the Site have revealed that no areas within the Site are included in the 100-year or 500-year floodplains.

Much of the natural drainage pattern has been altered by development, and drainage within developed areas of the NAWC property is controlled primarily through constructed drainage systems. A significant portion of precipitation runoff is directed by surface grading and paving to constructed ditches, culverts, and storm sewers. Several of the tributaries of Little Neshaminy and Southampton Creeks originate at, or near, the outfall points of these culverts adjacent to the NAWC boundary. Springs and seeps contributing to surface water flow have been reported or observed near the facility boundary in the vicinity of Areas A and B. An underground tile drainage system was used to drain the eastern portion of NAWC when it was farmed in the 1940s. The present conditions of the tile drains and their influence on surface or near-surface drainage are unknown.

4. Meteorology

The climate of the area is humid continental and is modified by the Atlantic Ocean. Temperatures average 76°F (24.4°C) in July and 32°F (0°C) in January. The average daily temperature for the NAWC location is 53.3 °F (11.8°C). Precipitation averages 42.5 inches per year (106.25 cm per year), and snowfall averages 22 inches per year (55 cm per year). The distribution of precipitation is fairly even throughout the year. The relative humidity for the Site averages 70 percent. The mean wind speed for this area is 9.6 mph, with a prevailing direction of west-southwest.

5. Ecology

Open land, woodland, and wetland habitats are all found within or near the Site. These include mowed fields and lawns, nonforested overgrown land, wooded areas, forested wetlands, scrub/shrub wetlands, and streams with associated riparian areas.

There are no permanent threatened or endangered species on or near the Site; however, some transient species do traverse the area. No areas have been designated as wetlands on NAWC property according to Army Corps of Engineers criteria. A wetlands assessment must still be completed for off-base areas.

Mourning doves, pheasants, and various songbirds such as sparrows, red-winged black birds, gold finches, cardinals, blue jays, and robins are present throughout the Site. Canada geese and ducks have been observed in the streams south of Area B and north of Area A. Snakes, leopard frogs, and muskrats have also been observed in or near the stream north of this area. Snails, earthworms, amphipods, and larval insects have also been observed. Small fish or minnows tentatively identified as creek chubs are present in each of the streams from which surface water and sediment samples were obtained. White-tailed deer, groundhogs, rabbits, and squirrels are common throughout the facility. Raccoon tracks have been observed in several adjacent streams.

6. Soils

The Site is underlain by soils of the Lansdale-Lawrenceville Association. This unit consists of nearly level to sloping, moderately well-drained soils and well-drained soils on uplands. The soils are deep and have a medium-textured surface layer and a medium-textured or moderately coarse-textured subsoil. They formed in material weathered from shale and sandstone and in silty, windblown deposits. They consist primarily of silt loam, shaly silt loam, silty clay loam, and some sandy loam. Some of the soils in this association have a seasonal high water table and restricted permeability.

Large portions of the Site are urban land areas where the original soils have been graded, disturbed, filled over, or otherwise altered prior to construction of the base facilities. Various types of fill material, including the contents of the known waste areas at the Site, are included in the urban land areas. Much of the area is covered by paved surfaces, buildings, or other engineered structures.

7. Groundwater Use

Groundwater is the primary source of residential, industrial and commercial water supplies in the immediate vicinity of the Site. The groundwater is provided either through individual, privately owned wells or by larger supply systems which have their own wells. The systems of concern include those owned by the Warminster Municipal Township Authority, Upper Southampton Municipal Authority, Northampton Municipal Authority and the Warminster Heights Development Corporation. From April to July 1993, the Navy identified and sampled over 200 private residential wells within an approximately 3,000 foot radius of Area A and Area B. In addition, 3 commercial wells are known to be located within 1,000 feet of Area A. Finally, NAWC is supplied by its own system and associated wells. Based on available information, the location of known municipal, residential and commercial supply wells in the vicinity of the Site is provided in Figure 3. The dotted line in Figure 3 depicts the area where residential wells were identified and sampled through July 1993. The area of residential wells sampled in the vicinity of Area A was designated as Area 1, while the area of residential wells sampled in the vicinity of Area B was designated Area 2.

B. NATURE AND EXTENT OF CONTAMINATION

The findings of the RI to date with respect to groundwater in overburden and shallow bedrock aquifers are provided in detail within the Phase II RI report. A summary of the major findings for Area A, Area B, and offsite locations respectively is presented below. Representative (or "average") concentrations of groundwater contaminants for Areas A and B were calculated as part of the RI.

1. Area A

All monitoring wells in the vicinity of Area A are depicted in Figure 4. All of these wells are located on NAWC property and monitor groundwater in either overburden or shallow bedrock with the exception of Well SMC-2, which monitors the deeper bedrock aquifer. Table 2 summarizes the occurrence and distribution of organics in wells downgradient of Area A, while Tables 3 and 4 summarize the occurrence and distribution of inorganics (metals) in unfiltered and filtered samples, respectively, from the same wells.

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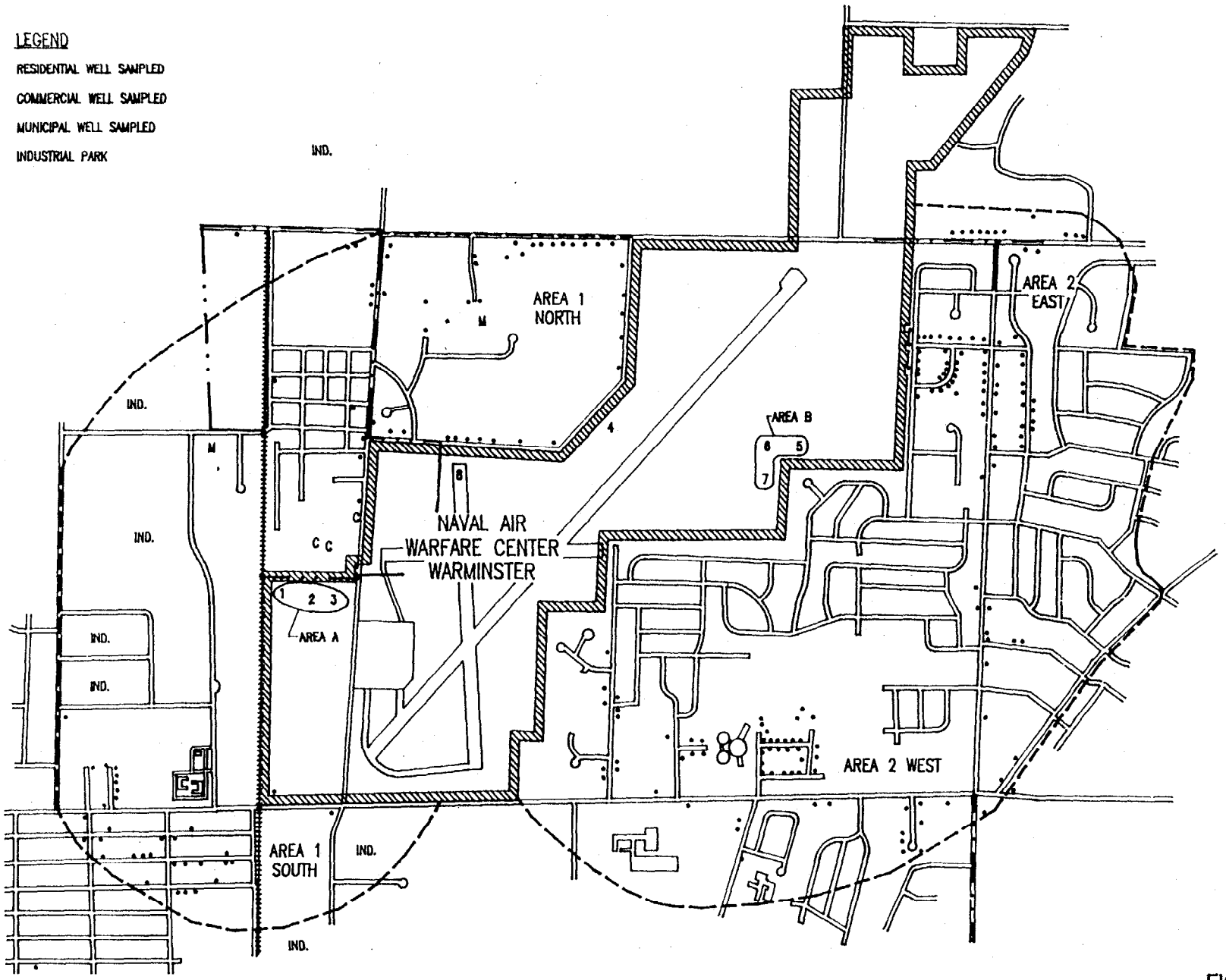


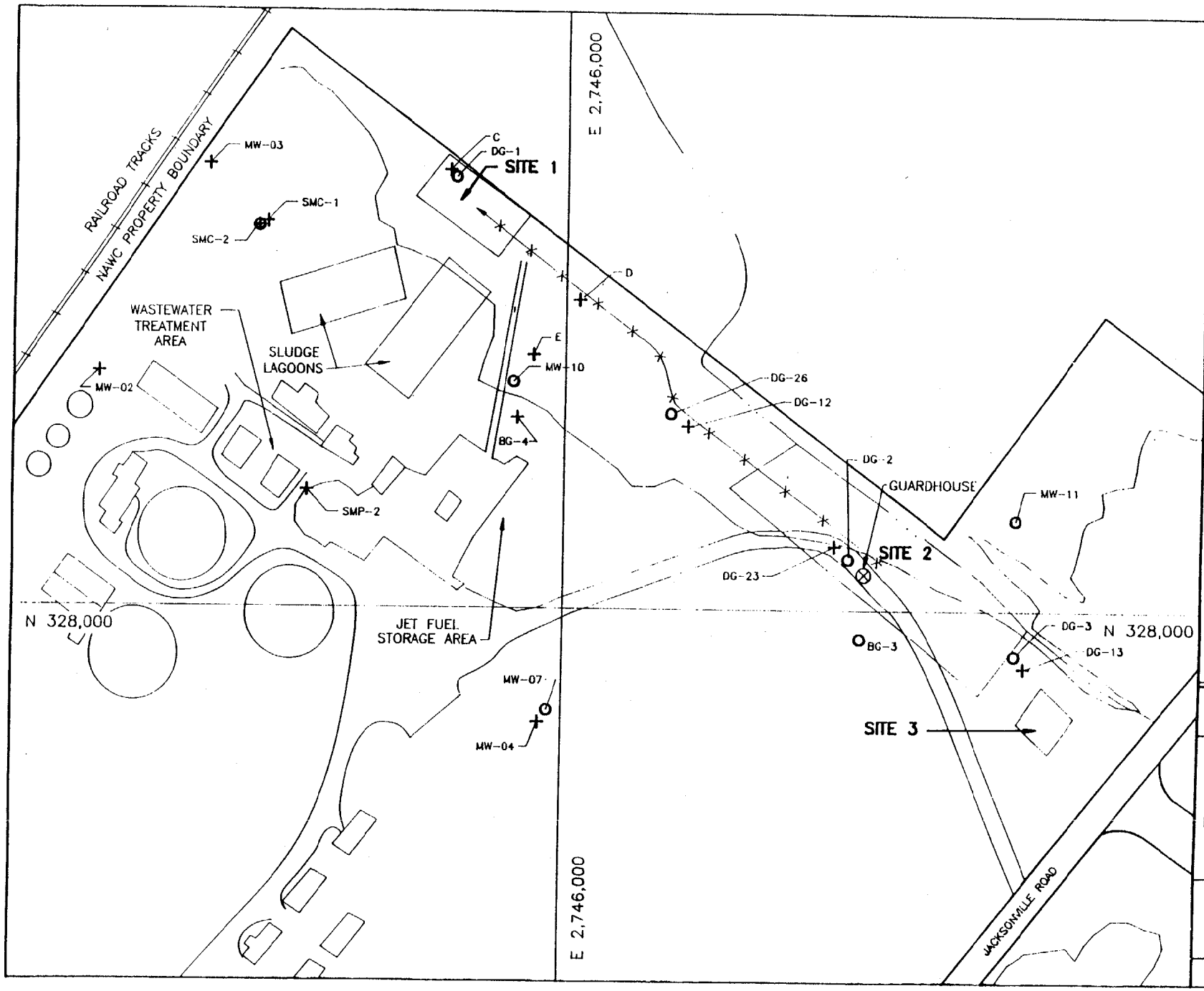
0 2000 4000
SCALE IN FEET

FIGURE 3

MUNICIPAL, RESIDENTIAL AND COMMERCIAL WELL LOCATION MAP
NAVAL AIR WARFARE CENTER, WARMINSTER, PENNSYLVANIA

Halliburton NUS CORPORATION

8/19/93



LEGEND

- DG-1 — OVERBURDEN MONITOI WELL
- BG-4 — SHALLOW BEDROCK MONITORING WELL
- SMC-2 — DEEP BEDROCK MONITORING WELL
- SITE 1 — ESTIMATED SITE BOUN PRIOR TO RI
- STREAM
- TOPOGRAPHIC CONTOUR LINE
- X X — APPROX. FENCE LOCATION

N

SCALE:
0 50 100 200 (FI

NAWC
WARMINSTER, PA

FIGURE 4

MONITORING WELLS INSTALLE THROUGH AND INCLUDING PHASE II REMEDIAL INVESTIGATIO SITES 1,2 AND 3

(CONTOUR INTERVAL 10 FEET)

Halliburton NUS CORPORATION

Adapted From SMC Environmental Services Group, 1991

DATE: 2/3/93

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TABLE 2
OCCURRENCE AND DISTRIBUTION OF MONITORING WELL ORGANICS - SITES 1, 2, and 3
NAWC, WARMINSTER, PENNSYLVANIA
(ug/L)

Compound	CRQL	Frequency of Positive Detection	Range of Positive Detection	Rep Conc
Vinyl chloride	1/10	1/24	1.5	1.5
1,1-Dichloroethene	1/5	13/24	0.175-3	3.0
1,1-Dichloroethane	1/5	14/24	1-8	8.0
1,2-Dichloroethene	5	6/11	1-62	27.0
Cis-1,2-Dichloroethene	1/5	5/13	2-510	138
1,2-Dichloroethane	1/5	4/24	3-3.5	3.5
Trichloroethene	1/5	19/24	0.75-2100	469
Tetrachloroethene	1/5	11/24	3-440	128
1,1,1-Trichloroethane	1/5	9/24	2-10	10.0
Chloroform	1/5	5/24	6-25	13.8
Carbon tetrachloride	1/5	6/24	10-44	16.8
Benzene	1/5	3/24	0.95-2	2.0
Trichlorofluoromethane	5	3/11	10-91	29.8
Toluene	1/5	2/24	3-4	4.0
Ethylbenzene	1/5	1/24	0.2	0.2
Xylenes	1/5	1/24	2	2.0
1,2-Dichlorobenzene	1/10	3/24	0.4-0.7	0.7
1,2-Dichloropropane	1/5	1/24	1	1.0
2-Butanone	5/10	1/13	24	24.0
Di-n-octylphthlate	10	5/12	0.3-3	3.0
Diethylphthalate	10	3/12	0.2-0.375	0.375
Phenanthrene	10	1/12	0.3	0.3
Fluoranthene	10	1/12	0.6	0.6
Pyrene	10	1/12	0.6	0.6
TICs	-	3	+	-

TICs = Tentatively identified compounds
CRQL = Contract Required Quantitation Limit

Adopted from - Halliburton NUS Corporation Phase II Remedial Investigation Report, April 1993

TABLE 3
OCCURRENCE AND DISTRIBUTION OF UNFILTERED MONITORING WELL INORGANICS
SITES 1, 2, and 3
NAWC, WARMINSTER, PENNSYLVANIA
(ug/L)

Element	CRDL	Frequency of Positive Detection	Range of Positive Detection	Representative Concentration
Aluminum	200	15/24	854-158000	25820
Arsenic	10	7/24	2-67.5	10.6
Barium	200	13/24	47-4620	873
Cadmium	5	4/24	6-33	9.6
Calcium	5000	13/24	30900-158400	63520
Chromium	10	13/24	2.5-220	49.4
Cobalt	50	10/24	2-118	22.8
Copper	25	7/24	30.5-1660	236
Iron	100	21/24	4330-126280	42010
Lead	3	16/24	1.2-325	85.5
Magnesium	5000	13/24	9080-68500	24120
Manganese	15	22/24	53-32100	5410
Mercury	0.2	3/21	0.3-0.67	0.22
Nickel	40	9/24	10-121	43.6
Potassium	5000	12/24	1030-9110	2850
Silver	10	2/24	4-20	5.58
Sodium	5000	13/24	10900-42500	21230
Thallium	10	1/24	2	1.14
Vanadium	50	6/24	14-101	24.5
Zinc	20	10/24	22-1660	400

CRDL = Contract Required Detection Limit

Adopted from - Halliburton NUS Corporation Phase II Remedial Investigation Report, April 1993

TABLE 4
OCCURRENCE AND DISTRIBUTION OF FILTERED MONITORING WELL INORGANICS
SITES 1, 2, and 3
NAWC, WARMINSTER, PENNSYLVANIA
(ug/L)

Element	CRDL	Frequency of Positive Detection	Range of Positive Detection	Rep Conc
Barium	200	13/13	29-343	210
Calcium	5000	13/13	30600-60700	51230
Chromium	10	1/13	31	9.6
Iron	100	6/13	37-4840	1860
Lead	3	3/13	1.6-5	1.86
Magnesium	5000	13/13	8750-21950	19150
Manganese	15	13/13	26-4190	1310
Potassium	5000	9/13	723-3360	2080
Sodium	5000	13/13	10400-40300	28140
Vanadium	50	1/13	6	3.39
Zinc	20	5/13	6-174	48.9

CRDL = Contract Required Detection Limit

Adopted from - Halliburton NUS Corporation Phase II Remedial Investigation Report, April 1993

The most frequently detected organics within Area A, in order of descending frequency, included trichloroethene, 1,1-dichloroethane, 1,2-dichloroethene, cis-1,2-dichloroethene, 1,1-dichloroethene, and tetrachloroethene. The highest representative concentrations were trichloroethene (440 micrograms per liter (ug/l)), cis-1,2-dichloroethene (138 ug/l) and tetrachloroethene (128 ug/l). The maximum concentrations detected were trichloroethene (2,100 ug/l), cis-1,2-dichloroethene (510 ug/l) and tetrachloroethene (440 ug/l).

Toxic or carcinogenic metals with significant representative concentrations in filtered and/or unfiltered samples included lead, iron, copper, arsenic, manganese, thallium, barium, cadmium and nickel.

The inferred groundwater flow direction in both overburden and shallow bedrock under Area A is to the north. A water-level study, combined with groundwater analytical data, suggest that contaminated groundwater in the shallow bedrock underlying Area A has migrated to deeper portions of the aquifer north of NAWC property. The Phase II RI Report concluded that the full nature and extent of overburden and shallow bedrock groundwater contamination attributable to Area A have not been determined at this time.

As noted previously (see Groundwater Use Section), a significant number of residential wells are located within a 3,000 foot radius of Area A. Based on a review of available information, these wells could be potentially affected by groundwater contamination attributable to Area A in overburden and shallow bedrock.

2. Area B

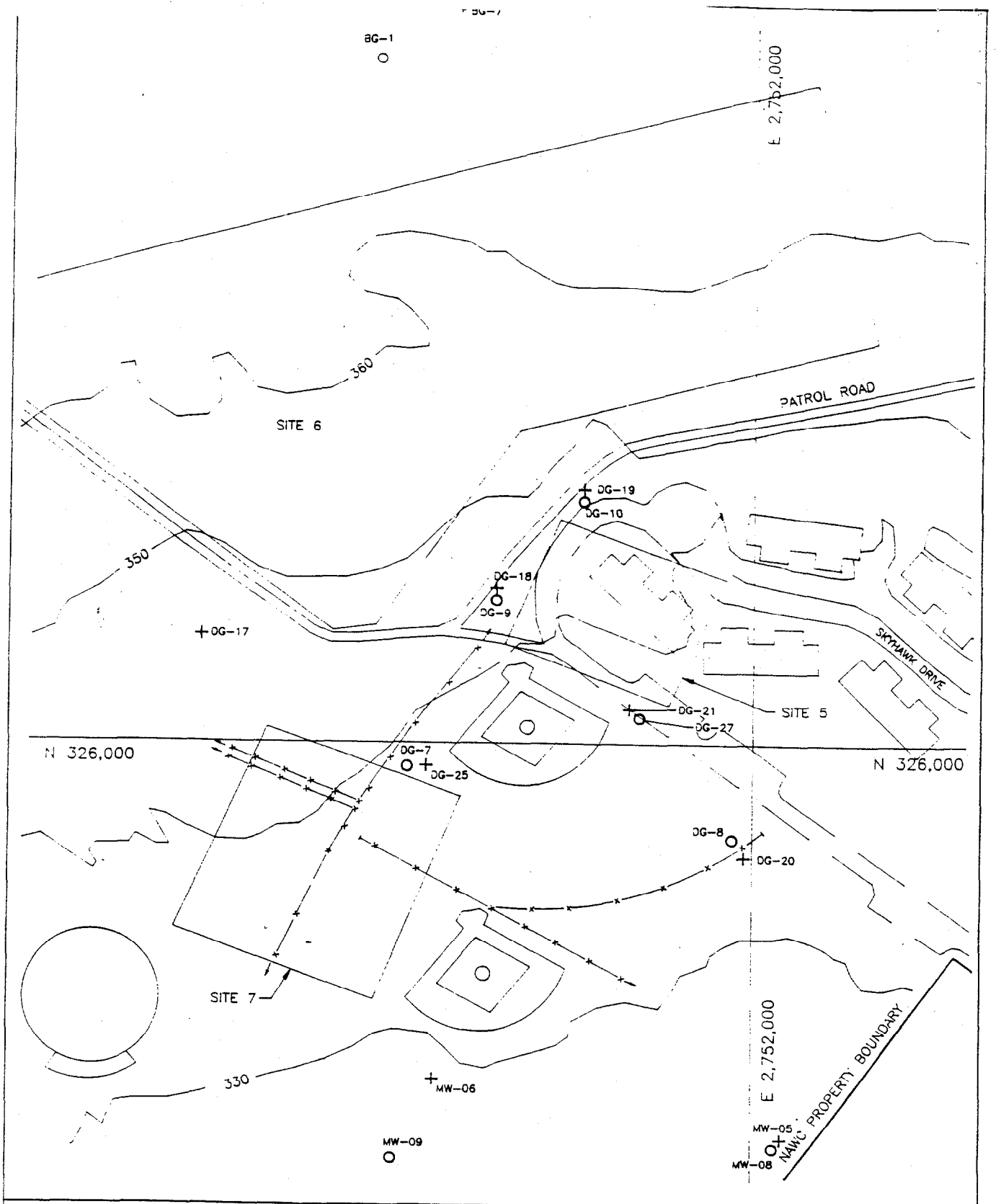
Monitoring wells installed in the vicinity of Area B are depicted in Figure 5. As noted, all of the wells are located on NAWC property and monitor groundwater in overburden or shallow bedrock. Table 5 summarizes the occurrence and distribution of organics in wells within Area B, while Tables 6 and 7 summarize the occurrence and distribution of inorganics (metals) in unfiltered and filtered samples, respectively, from these wells.

The most frequently detected organics within Area B, in order of decreasing frequency, included 1,2-dichloroethene, trichloroethene, cis-1,2-dichloroethene, toluene and carbon tetrachloride. The highest representative (mean) concentrations were for trichloroethene (4.4 ug/l), 1,2-dichloroethene (3.8 ug/l) and cis-1,2-dichloroethene (2.6 ug/l). The maximum concentrations detected were trichloroethene (13 ug/l) and cis-1,2-dichloroethene (8 ug/l).

Toxic or carcinogenic metals with significant representative concentrations in unfiltered and/or filtered well samples included arsenic, barium, cadmium and manganese.

Based on water level measurements conducted during the RI, the inferred flow of groundwater in both overburden and shallow bedrock under NAWC property in the vicinity of Area B is to the south. The Phase II RI Report concluded that the full nature and extent of overburden, shallow bedrock and deep bedrock groundwater contamination attributable to Area B have not been determined at this time.

As noted previously (see Groundwater Use Section), a significant number of residential wells are located within a 3,000 foot radius of Area B. Based on a review of available information, these wells could be potentially affected by groundwater contamination attributable to Area B in overburden and shallow bedrock.



LEGEND

O DG-7	OVERBURDEN MONITORING WELL
+ DG-25	SHALLOW BEDROCK MONITORING WELL
—330—	TOPOGRAPHIC CONTOUR LINE

N

SCALE:

0 50 100 200 (FT)

NAWC
WARMINSTER, PA

FIGURE 5
MONITORING WELLS INSTALLED THROUGH AND INCLUDING PHASE II REMEDIAL INVESTIGATION SITES 5,6 AND 7
(CONTOUR INTERVAL 10 FEET)

HALLIBURTON NUS
Environmental Corporation

Adapted From SMC Environmental Services Group, 1991

DATE: 2/3/93

TABLE 5
OCCURRENCE AND DISTRIBUTION OF MONITORING WELL ORGANICS - SITES 5, 6, and 7
NAWC, WARMINSTER, PENNSYLVANIA
(ug/L)

Compound	CRQL	Frequency of Positive Detection	Range of Positive Detection	Rep Conc
1,2-Dichloroethene	5	5/11	2-7	3.8
Trichloroethene	1/5	8/24	1-13	4.4
Tetrachloroethene	1/5	1/24	3	1.8
Carbon tetrachloride	1/5	4/24	0.3-2	1.6
Cis-1,2-Dichloroethene	1/5	3/13	2-8	2.6
Chloromethane	1/10	1/24	2	2.0
Chloroform	1/5	2/24	0.75-2	1.4
Toluene	1/5	5/24	1-6	2.4
1,1,1-Trichloroethane	1/5	1/24	1	1.0
Di-n-octylphthalate	10	4/12	0.2-0.9	0.9
Diethylphthalate	10	4/12	0.2-2	2.0
TICs	-	3	+	-

TICs = Tentatively identified compounds
CRQL = Contract Required Quantitation Limit

Adopted from - Halliburton NUS Corporation Phase II Remedial Investigation Report, April 1993

TABLE 6
OCCURRENCE AND DISTRIBUTION OF UNFILTERED MONITORING WELL INORGANICS
SITES 5, 6, and 7
NAWC, WARMINSTER, PENNSYLVANIA
(ug/L)

Element	CRDL	Frequency of Positive Detection	Range of Positive Detection	Rep Conc
Aluminum	200	18/24	659-42000	9660
Arsenic	10	9/24	2-12	3.4
Barium	200	13/24	75-969	388
Cadmium	5	1/24	2	2.0
Calcium	5000	13/24	11200-70800	33680
Chromium	10	8/24	4-67	19.6
Cobalt	50	9/24	2-120	23.2
Copper	25	3/24	40-166	34.1
Iron	100	21/24	224-97000	29120
Lead	3	5/24	7.5-29.2	7.1
Magnesium	5000	13/24	4000-23500	13500
Manganese	15	22/24	68-9565	2000
Nickel	40	12/24	10-98	32.3
Potassium	5000	12/24	817.5-23200	5780
Sodium	5000	12/24	7660-28900	12670
Vanadium	50	7/24	4.25-79	16.3
Zinc	20	12/24	12-1300	228
Cyanide	10	1/24	92	26.3

CRDL = Contract Required Detection Limit

Adopted from - Halliburton NUS Corporation Phase II Remedial Investigation Report, April 1993

TABLE 7
OCCURRENCE AND DISTRIBUTION OF FILTERED MONITORING WELL INORGANICS
SITES 5, 6, and 7
NAWC, WARMINSTER, PENNSYLVANIA
(ug/L)

Element	CRDL	Frequency of Positive Detection	Range of Positive Detection	Rep Conc
Barium	200	13/13	22-484.5	214
Calcium	5000	13/13	12800-64700	41670
Cobalt	50	1/13	6	3.7
Iron	100	4/13	1460-6630	2600
Magnesium	5000	13/13	4060-19800	14580
Manganese	15	11/13	17-753	335
Nickel	40	1/13	25	12.0
Potassium	5000	13/13	429-18100	6020
Sodium	5000	13/13	7070-31800	17060
Thallium	10	1/13	2	1.2
Zinc	20	3/13	32-73	31.0

CRDL = Contract Required Detection Limit

Adopted from - Halliburton NUS Corporation Phase II Remedial Investigation Report, April 1993

3. Offsite Locations

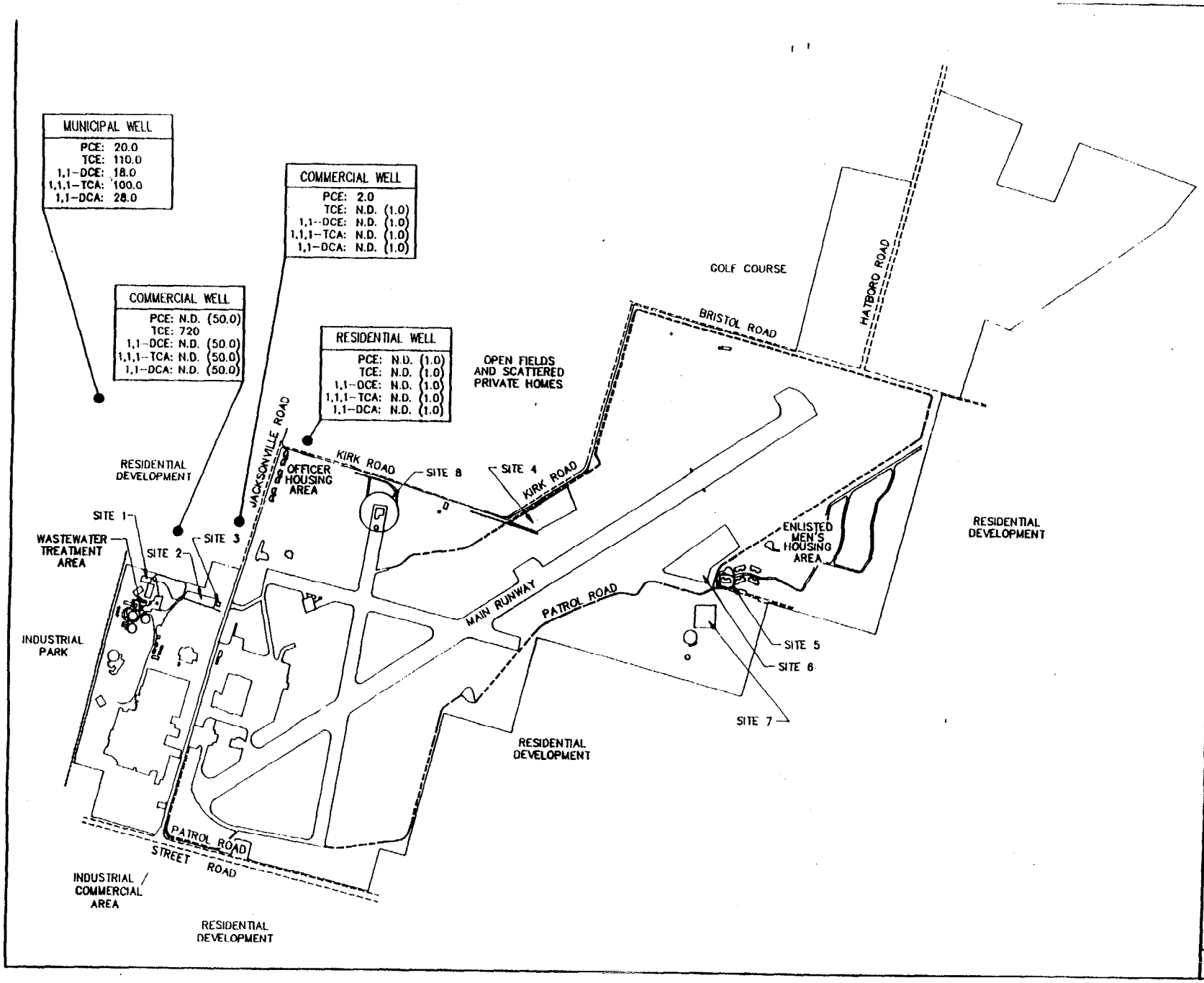
Offsite wells sampled during the Phase II RI included the following locations relative to Area A: a municipal well 0.4 miles north, a commercial well 400 feet northeast, a second commercial well 1,200 feet east and one residential well 2,200 feet southeast (see Figure 6).

The municipal supply well, which is cased down to 70 feet and is 250 feet deep, was found to contain several volatile organic compounds (VOCs) which have been detected in overburden or shallow bedrock underlying Area A. Based on hydrogeologic data presented in the Phase II RI Report, it is unknown whether VOCs in overburden and shallow bedrock underlying Area A have migrated to this municipal well. However, this hydrogeologic data suggests that contaminated groundwater in overburden and shallow bedrock under Area A could potentially migrate to the municipal well of concern.

Phase II RI sampling found that the commercial well located 400 feet northeast of Area A contained 720 ug/l of trichloroethene (TCE). (This water is currently being treated by the commercial facility of concern.) This information combined with Phase II RI water level study data, other available hydrogeologic data and the detection of TCE in shallow bedrock underlying Area A suggests that contaminated groundwater in the shallow bedrock underlying Area A has migrated to this commercial well, which draws from an unknown depth north of NAWC property. The commercial well 1,200 feet east of Area A was found to contain 2 ug/l of tetrachloroethene (PCE). The source of this trace contamination is unknown at this time. Finally, no contamination was detected in the one residential well sampled during the Phase II RI.

As noted previously (see Groundwater Use Section), a significant number of additional residential, commercial and industrial wells are located in the vicinity of Area A. Based on available hydrogeologic data, many of these wells could potentially be affected by contaminated groundwater in overburden and shallow bedrock attributable to Area A. To initiate an assessment of the potential offsite impacts of Area A, the Navy sampled all known residential wells within Area 1 (see Groundwater Use section). A summary of the results of this sampling effort within Area 1 is presented in Table 8. VOCs have been detected in a number of these wells. Based on available information, the full nature and extent of offsite overburden, shallow bedrock and deeper bedrock groundwater contamination attributable to Area A cannot be determined.

The quality of surface water in an offsite, unnamed tributary of Little Neshaminy Creek downgradient of Area A has not been fully characterized at this time. To date, only two samples of surface water downgradient of site 3 (but upgradient of site 1 and possibly site 2) have been collected. The analytical results for inorganics and organics in these samples, as well as upgradient background samples, are summarized in Tables 9 and 10. These preliminary results indicate elevated levels of iron, cadmium, copper and lead in surface water downgradient of site 3. Based on available data, it is uncertain whether these elevated levels are due to groundwater recharge of the stream.



NAWC
WARMINSTER, PA

FIGURE 6

LOCATION OF SAMPLED OFF SITE WELLS AND SUMMARY OF VOC SAMPLE RESULTS (ug/L)

Halliburton NUS CORPORATION

Adapted From SMC Environmental Services Group, 1991

DATE: 2/9/93

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TABLE 8
OCCURRENCE AND DISTRIBUTION OF VOLATILE ORGANIC CONTAMINATION IN AREA 1

Chemical	CRQL (ug/l)	Frequency of Positive Detection	Range of Positive Detection (ug/l)
Trichloroethene (TCE)	1 or 2	6	0.1 J - 46.0*
Tetrachloroethene (PCE)	1 or 2	17	0.2 J - 31.0
1,1-Dichloroethene (1,1-DCE)	1 or 2	1	6.0
1,1-Dichloroethane (1,1-DCA)	1 or 2	---	
1,1,1-Trichloroethane (1,1,1-TCA)	1 or 2	11	0.1 J - 16.0
1,1,2-Trichloroethane (1,1,2-TCA)	1 or 2	---	
cis-1,2-Dichloroethene (cis-1,2-DCE)	1 or 2	3	0.4 J - 6.0
trans-1,2-Dichloroethene (trans-1,2-DCE)	1 or 2	---	
1,2-Dichloroethane (1,2-DCA)	1 or 2	---	
Carbon Tetrachloride (CCl_4)	1 or 2	---	
2-Butanone	2 or 5	1	10.0 L(c)
TOTAL NUMBER OF WELLS SAMPLED IN AREA 1		85 Wells	

J = Value is estimated because positive result is reported that is less than the contract required quantitation limit.

L(c) = Positive result is considered biased very low due to initial and continuing calibration response factors less than 0.050.

* = Result taken from dilution analysis.

CRQL = Contract Required Quantitation Limit

Adopted from - Halliburton NUS Corporation Off-Base Well Inventory and Sampling Analysis Report, September 1993

Private wells off of NAWC property in the vicinity of Area B were not sampled during the Phase I RI or Phase II RI. Available hydrogeologic data suggest that contaminated groundwater attributable to Area B at the Site in overburden and shallow bedrock could potentially impact offsite wells. In response, the Navy initiated an assessment of potential offsite impacts of groundwater associated with Area B and surrounding NAWC property by sampling residential wells within Area 1 (see Groundwater Use section) from April to July 1993. A summary of the results of this sampling effort for Area 2 appears in Table 11. Significant VOC concentrations have been detected in the many of the wells sampled in the area of Casey Village. Based on available information, the full nature and extent of offsite overburden, shallow bedrock and deep bedrock groundwater contamination attributable to Area B cannot be determined.

The quality of surface water in an offsite, unnamed tributary of Southampton Creek downgradient of Area B has not been fully characterized at this time. To date, only two samples of surface water downgradient of Area B have been collected. The analytical results for inorganics and organics in these samples, as well as upgradient background samples, are summarized in Tables 12 and 13. These preliminary results do not indicate elevated levels of metals in the tributary of concern.

VI. SUMMARY OF SITE RISKS

This section summarizes available assessments of risk posed by contaminated groundwater attributable to the Site in overburden and shallow bedrock aquifers to human health and the environment. These assessments are based on RI information generated to date.

A final assessment of risk presented by OU-1 will be included in the final Record of Decision for OU-1 to be issued after the full nature and extent of the groundwater contamination are identified.

Removal Actions by the Navy and EPA are addressing risks posed by residential well contamination discussed in Section V.B.3. As a result, these risks are not being assessed as part of this ROD.

A. HUMAN HEALTH

As part of the RI, a risk assessment was conducted with available data to estimate the potential risks to human health posed by the contaminated groundwater in overburden and shallow bedrock underlying Areas A and B.

The following exposure pathways were determined to present a potential risk to human health:

- Ingestion of the groundwater as a drinking water source.
- Dermal exposure to the groundwater (e.g., through handwashing, showering, and bathing).
- Inhalation of contaminants in groundwater (i.e., volatile compounds emitted during showering).

Potential human health risks were categorized as carcinogenic or noncarcinogenic. A hypothetical carcinogenic risk increase from exposure should ideally fall within a range of 1×10^{-6} (an increase of one case of cancer for one million people exposed) to 1×10^{-4} (one additional case per 10,000 people exposed). Noncarcinogenic risks were estimated utilizing Hazard Indices (HI), where an HI exceeding one is considered an unacceptable health risk. Federal Maximum Contaminant Levels (MCLs) for public drinking water supplies were also utilized to assess potential risks posed by exposure to groundwater.

TABLE 9
OCCURRENCE AND DISTRIBUTION OF SURFACE WATER INORGANICS NEAR SITES 1, 2, and 3
NAWC, WARMINSTER, PENNSYLVANIA
(ug/L)

Element	CRDL	Upstream				Downstream			
		Frequency of Positive Detection (unfiltered)	Range of Positive Detection (unfiltered)	RC* (unfiltered)	RC* (filtered)	Frequency of Positive Detection (unfiltered)	Range of Positive Detection (unfiltered)	RC* (unfiltered)	RC* (filtered)
Barium	200	1/2	80	80	76	1/2	121	121	134
Calcium	5	1/2	21,200	21,200	20,700	1/2	37,150	37,150	43,050
Chromium	10	1/2	3	3	-	-	-	-	-
Copper	25	-	-	-	-	1/2	106	106	-
Iron	100	1/2	69	69	-	2/2	2,300	1,320-2,300	-
Lead	3	-	-	-	-	2/2	17	15.3-17	-
Magnesium	5,000	1/2	8,520	8,520	8,350	1/2	14,700	14,700	16,950
Manganese	15	1/2	39	39	39	2/2	230-254.5	254	272
Nickel	40	1/2	12	12	-	1/2	20	20	13.8
Sodium	5,000	1/2	8,020	8,020	7,990	1/2	19150	19,150	22,430
Thallium	10	1/2	2	2	-	-	-	-	-
Zinc	20	1/2	32	32	-	1/2	99	99	74

*RC = Representative concentration (for sample sets <5 RC = maximum positive concentration)

CRDL = Contract Required Detection Limit

Adopted from - Halliburton NUS Corporation Rough Draft Phase II Remedial Investigation Report, November 1992

TABLE 10
OCCURRENCE AND DISTRIBUTION SURFACE WATER ORGANICS NEAR SITES 1, 2, and 3
NAWC, WARMINSTER, PENNSYLVANIA
(ug/L)

Compound	CRQL	Upstream			Downstream		
	(ug/l)	Frequency of Positive Detection	Range of Positive Detection	Representative Concentration	Frequency of Positive Detection	Range of Positive Detection	Representativ Concentration
Bromomethane	10	1/2	0.4	0.4	-	-	-
1,1-Dichloroethane	5/10	1/2	1	1	-	-	-
Benzene	5/10	1/2	0.2	0.2	-	-	-
Diethylphthalae	10	-	-	-	1/2	0.2	0.2
Di-n-octylphthalate	10	1/2	0.2	0.2	1/2	0.1	0.1
Phenanthrene	10	-	-	-	1/2	0.1	0.1
Fluoranthene	10	-	-	-	1/2	0.3	0.3
Pyrene	10	-	-	-	1/2	0.3	0.3
Benz(a)anthracene	10	-	-	-	1/2	0.1	0.1
Chrysene	10	-	-	-	1/2	0.2	0.2
Benzo(b)fluoranthene	10	-	-	-	1/2	0.2	0.2
TICs	-	1/2	+	-	1/2	+	-

TICs = Tentatively identified compounds

CRQL = Contact Required Quantitation Limit

Adopted from - Halliburton NUS Corporation Rough Draft Phase II Remedial Investigation Report, November 1992

TABLE 11
OCCURRENCE AND DISTRIBUTION OF VOLATILE ORGANIC CONTAMINATION IN AREA 2

Chemical	CRQL (ug/l)	Frequency of Positive Detection	Range of Positive Detection (ug/l)
Trichloroethene (TCE)	1 or 2	37	0.1 - 1200.0*
Tetrachloroethene (PCE)	1 or 2	30	0.1 - 480.0*J (c)
1,1-Dichloroethene (1,1-DCE)	1 or 2	20	0.1 J - 19.0
1,1-Dichloroethane (1,1-DCA)	1 or 2	8	0.2 J - 2.0
1,1,1-Trichloroethane (1,1,1-TCA)	1 or 2	29	0.2 J - 35.0
1,1,2-Trichloroethane (1,1,2-TCA)	1 or 2	2	0.2 J - 0.4 J
cis-1,2-Dichloroethene (cis-1,2-DCE)	1 or 2	21	0.4 J - 530.0*
trans-1,2-Dichloroethene (trans-1,2-DCE)	1 or 2	6	0.2 J - 3.0
1,2-Dichloroethane (1,2-DCA)	1 or 2	---	
Carbon Tetrachloride (CCl_4)	1 or 2	2	6.9 - 8.7
2-Butanone	2 or 5	1	0.7 L(c)
TOTAL NUMBER OF WELLS SAMPLED IN AREA 2		141 Wells	

J = Value is estimated because positive result is reported that is less than the contract required quantitation limit.
L(c) = Positive result is considered biased very low due to initial and continuing calibration response factors less than 0.050.
* = Result taken from dilution analysis.
CRQL = Contract Required Quantitation Limit

Adopted from - Halliburton NUS Corporation Off-Base Well Inventory and Sampling Analysis, September 1992

TABLE 12
OCCURRENCE AND DISTRIBUTION OF SURFACE WATER INORGANICS NEAR SITES 5, 6, AND 7
NAWC, WARMINSTER, PENNSYLVANIA
(ug/L)

Element	CRDL	Midstream				Downstream			
		Frequency of Positive Detection (unfiltered)	Range of Positive Detection (unfiltered)	RC* (unfiltered)	RC* (filtered)	Frequency of Positive Detection (unfiltered)	Range of Positive Detection (unfiltered)	RC* (unfiltered)	RC* (filtered)
Barium	200	1/2	92	92	90	1/2	92	92	83.5
Calcium	5,000	1/2	22,600	22,600	23,000	1/2	27,950	27,950	26,800
Iron	100	1/2	388	388	-	1/2	389	389	-
Magnesium	5,000	1/2	9,030	9,030	8,550	1/2	11,150	11,150	9,845
Manganese	15	2/2	55-100	100	49	1/2	44	44	24
Nickel	40	1/2	20	20	-	-	-	-	-
Potassium	5,000	1/2	1,180	1,180	-	1/2	1,545	1,545	-
Sodium	5,000	1/2	13,600	13,600	12,100	1/2	16,150	16,150	7,680

RC* = Representative Concentration (for sample sets <5, RC = maximum positive concentration).

CRDL = Contract Required Detection Limit

Adopted from - Halliburton NUS Corporation Rough Draft Phase II Remedial Investigation Report, November 1992

TABLE 13
OCCURRENCE AND DISTRIBUTION OF SURFACE WATER ORGANICS NEAR SITES 5, 6, AND 7
NAWC, WARMINSTER, PENNSYLVANIA
(ug/L)

Element	CRDL	Midstream			Downstream		
		Frequency of Positive Detection	Range of Positive Detection	RC*	Frequency of Positive Detection	Range of Positive Detection	RC*
Bis(2-ethylhexyl)phthalate	10	1/2	1	1	-	-	-
Chloroform	10/25	-	-	-	1/2	12	12
Diethylphthalate	10	-	-	-	1/2	0.2	0.2

RC* = Representative Concentration (for sample sets <5, RC = maximum positive concentration).

CRDL = Contract Required Detection Limit

Adopted from - Halliburton NUS Corporation Rough Draft Phase II Remedial Investigation Report, November 1992

Carcinogenic and noncarcinogenic risks posed by hypothetical exposure to contaminated groundwater in overburden and shallow bedrock were estimated for adult residents, child residents and adult employees. To assess these carcinogenic and noncarcinogenic risks, primary organic and inorganic contaminants of concern were selected based on their occurrence and distribution, mobility, persistence and toxicity.

An important component of the risk assessment process is the relationship between the intake of a contaminant and the potential for adverse health effects resulting from that exposure. Dose-response relationships provide a means by which potential human health impacts may be quantified. The dose-response relationships for carcinogenic and noncarcinogenic effects are reference doses (RfDs) and cancer slope factors (CSFs), respectively. The RfD is developed by EPA for chronic and/or subchronic human exposure to hazardous chemicals and is usually expressed as a dose per unit body weight per unit time (mg/kg/day). CSFs are applicable for estimating the lifetime probability of developing cancer as a result of exposure to known or potential carcinogens, are generally reported in units of 1/(mg/kg/day), and are derived through an assumed low-dosage linear relationship of extrapolation from high to low dose-responses determined form animal studies. RfDs and CSFs used to calculate estimated risks in this case are identified in the RI.

The Phase II RI Report contains a detailed risk assessment for contaminated groundwater attributable to Area A and Area B at the Site in overburden and shallow bedrock. The assumptions utilized in conducting this assessment are identified therein. These assumptions include exposure input parameters which estimate the exposure of an individual to a contaminant over time. Exposure to the representative contaminant concentrations identified in Tables 2, 3, and 4 in Section V.B. of this ROD was assumed.

In conducting this risk assessment, it is acknowledged that there are uncertainties associated with the evaluation of chemical toxicity and potential exposures. For example, uncertainties arise in the derivation of RfDs and CSFs and estimation of exposure point concentrations.

Summarized below are the results of the risk assessment for contaminated groundwater in overburden and shallow bedrock attributable to Area A and Area B.

1. Area A

Cumulative, total estimated risks to human health due to potential exposure to noncarcinogenic and carcinogenic groundwater contaminants attributable to Area A at the Site in overburden and shallow bedrock are summarized in Tables 14 and 15, respectively.

The total HI and carcinogenic risk for hypothetical exposure to this groundwater exceeds values of one and 1×10^{-4}, respectively. Primary contributors to the unacceptable noncarcinogenic risk are arsenic, trichlorothene (TCE), tetrachloroethene (PCE), carbon tetrachloride, manganese, cis-1,2-dichloroethene, thallium and barium. Primary contributors to unacceptable carcinogenic risk are vinyl chloride, TCE, PCE, arsenic (unfiltered water only), 1,1-dichloroethene, 1,2-dichloroethane, carbon tetrachloride, and chloroform.

In addition, the average concentrations of TCE and PCE in wells within Area A are 469 ug/l and 128 ug/l, respectively, in excess of the MCL of 5 ug/l for both of these substances. MCLs have also been exceeded for carbon tetrachloride, vinyl chloride, 1,2-dichloroethene, cadmium, manganese, nickel, arsenic and barium in individual groundwater samples collected within Area A.

TABLE 14
SUMMARY OF NONCARCINOGENIC RISKS - SITES 1, 2, AND 3
NAWC WARMINSTER - GROUNDWATER (CURRENT)

Exposure Route	Receptor		
	Adult Resident	Child Resident	Adult Employee
Ingestion	3.6E1	8.4E1	1.3E1
Dermal Contact	6.1E0	8.7E0	2.0E-1
Inhalation	3.7E-2	- - -	- - -
Total Risk	4.2E1	9.3E1	1.3E1

Adopted from Halliburton NUS Corporation, Phase II Remedial Investigation Report, April 1993

TABLE 15
SUMMARY OF CARCINOGENIC RISKS - SITES 1, 2, AND 3
NAWC WARMINSTER - GROUNDWATER (CURRENT)

Exposure Route	Receptor		
	Adult Resident	Child Resident	Adult Employee
Ingestion	4.4E-4	2.1E-4	1.3E-4
Dermal Contact	4.6E-4	1.3E-4	1.3E-5
Inhalation	8.6E-5	---	---
Total Risk	9.9E-4	3.4E-4	1.4E-4

Adopted from Halliburton NUS Corporation, Phase II Remedial Investigation Report, April 1993

2. Area B

Cumulative, total estimated risks to human health due to potential exposure to contaminated groundwater attributable to Area B at the Site in overburden and shallow bedrock are summarized in Tables 16 and 17.

The HI for hypothetical exposure to unfiltered groundwater in this case exceeds one due to elevated levels of arsenic, barium, cadmium, and manganese, while the hypothetical carcinogenic risk associated with this water exceeds 1×10^{-5} due to TCE, PCE, carbon tetrachloride, and arsenic.

In addition, concentrations of TCE in three shallow bedrock wells in Area B exceeded the MCL of 5 ug/l in groundwater samples collected during both the Phase I and II RIs.

B. ENVIRONMENT

Available RI data are inadequate to fully assess risk to the environment (e.g., risk to aquatic life in surface water) posed by groundwater in overburden and shallow bedrock at Areas A and B.

A brief, preliminary assessment of environmental risk based on available RI data follows below.

1. Area A

Surface water samples to date are limited to two sets of filtered and unfiltered samples from an unnamed tributary of Little Neshaminy Creek. Maximum concentrations of iron, lead and copper in the unfiltered samples exceeded Ambient Water Quality Criteria (AWQC) developed pursuant to the Federal Clean Water Act for the protection of aquatic life (see 40 C.F.R. Part 131). The specific nature of aquatic life in this tributary is unknown at this time. Available RI data indicate this tributary acts as a groundwater divide for the overburden aquifer in the vicinity of Area A (see Tables 9 and 10 for sample analytical summary). These data suggest contaminated groundwater in overburden of Area A could migrate to this tributary and potentially present an unacceptable risk to the aquatic life. (A preliminary assessment of hypothetical human health risk posed by this surface water using the subject data does not indicate a potential noncarcinogenic or carcinogenic risk of concern to children or adults.)

2. Area B

Two sets of filtered and unfiltered samples of surface water collected to date in the vicinity of Area B detected no contaminant levels of environmental (or human health) concern. The extent of groundwater discharge from Area B to surface water in this area, if any, is unknown (see Tables 12 and 13 for sample analytical summary).

C. CONCLUSIONS

Contaminated groundwater attributable to Areas A and B at the Site in overburden and shallow bedrock has been determined to present an unacceptable risk to human health and/or the environment. As indicated in Section V., this contaminated groundwater may migrate to offsite drinking water supplies and/or surface water.

TABLE 16

CURRENT GROUNDWATER NONCARCINOGENIC INGESTION RISKS TO ADULT RESIDENTS - SITES 1, 2, and 3 - MODIFIED WITH FILTERED INORGANICS (POTENTIAL CURRENT EXPOSURE) NAWC, WARMINSTER, PENNSYLVANIA

Exposure Route	Receptor		
	Adult Resident	Child Resident	Adult Employee
Ingestion	1.2E1	2.8E1	4.2EO
Dermal Contact	1.1E-1	3.3E-2	3.0E-3
Inhalation	9.4E-4	NA	NA
Total Risk	1.2E1	2.8E1	4.E0

Adopted from - Halliburton NUS Corporation Phase II Remedial Investigation Report, April 1993

TABLE 17

SUMMARY OF CARCINOGENIC RISKS - CURRENT GROUNDWATER
NAWC WARMINSTER - GROUNDWATER SITES 5, 6, AND 7

Exposure Route	Receptor		
	Adult Resident	Child Resident	Adult Employee
Ingestion	7.4E-5	3.5E-5	2.2E-5
Dermal Contact	6.6E-6	4.0E-7	1.8E-7
Inhalation	3.1E-6	NA	NA
Total Risk	8.4E-5	3.5E-5	2.2E-5

Adopted from - Halliburton NUS Corporation Phase II Remedial Investigation Report, April 1993

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

VII. DESCRIPTION OF ALTERNATIVES

An FFS was conducted by the Navy to identify and evaluate remedial alternatives for contaminated groundwater attributable to the Site in overburden and shallow bedrock aquifers. Applicable engineering technologies for achieving the interim remedy objective of minimizing contaminant migration were initially screened in the FFS based on effectiveness, implementability, and cost. The alternatives meeting these criteria were then evaluated and compared to nine criteria required by CERCLA. Three interim remedy alternatives were developed for OU-1. Costs and implementation times were estimated for each alternative described in this section.

A. ALTERNATIVE 1: NO ACTION WITH GROUNDWATER MONITORING

The NCP requires that the "no action" alternative be evaluated at every Site to establish a baseline for comparison with action alternatives. Under this alternative, no remedial action would be undertaken to address contaminated groundwater attributable to the Site in overburden and shallow bedrock aquifers. Instead, additional studies necessary to identify the full nature and extent of contaminated groundwater in overburden and shallow bedrock aquifers would be conducted as part of continuing RIs addressing the Site. In addition to these studies, monitoring of groundwater in overburden and shallow bedrock aquifers would be conducted for an estimated 30 years.

For cost estimation purposes, a total of 20 overburden and shallow bedrock wells would be sampled quarterly for an estimated 30-year period. The frequency of sampling may be reduced after a reliable trend has been established. An estimated four additional wells would be installed in the downgradient areas. Because this alternative would result in contaminated groundwater remaining at the facility, five-year reviews would be required to monitor the effectiveness of this alternative. The present worth of this alternative is estimated to be $2,871,000 over a 30-year period, with a capital cost of $72,000 and an annual operation and maintenance (O&M) cost of $182,000.

The additional monitoring wells could be installed approximately three weeks after a field crew and equipment are mobilized.

B. ALTERNATIVE 2: GROUNDWATER EXTRACTION, ON-SITE TREATMENT, AND DISCHARGE TO SURFACE WATER

Under this alternative, contaminated groundwater in overburden and shallow bedrock aquifers attributable to the Site would be extracted using a series of extraction wells. The extraction well network would be located as necessary to maximize the effectiveness of the system. The extracted groundwater would be pumped to an on-site treatment system constructed specifically to treat groundwater. Water treatment would include air stripping to remove VOCs and carbon adsorption to remove semivolatile organics (or other means, if necessary). Emissions from the air stripper would be treated by vapor phase carbon adsorption as required by PA Code Chapter 127 and the National Ambient Air Quality Standards for Hazardous Air Pollutants (NAAQS) and National Emissions Standards for Hazardous Air Pollutants (NESHAPS) under the Federal Clean Air Act. Metals in the water would be treated by precipitation and filtration (or other means, if necessary). Organic and inorganic treatment residuals would be disposed offsite as required by treatment, storage and disposal regulations under the Federal Resource Conservation and Recovery Act (RCRA), including Land Disposal Restrictions (LDRs) under 40 C.F.R. Parts 262 and 268, Pennsylvania Hazardous Waste Management (25 PA Code, Article VII) and Residual Waste Regulation (25 PA Code, Article IX). Upon meeting effluent limits consistent with National Pollution Discharge Elimination System (NPDES)

requirements under the Federal Clean Water Act and Pennsylvania Clean Streams Law, the treated water would be discharged to an unnamed tributary of Little Neshaminy Creek or an unnamed tributary of Southampton Creek. Treatability studies would be performed to confirm that effluent levels meet NPDES requirements.

Concurrent with the design, construction, and operation of the initial extraction well network and treatment system, investigations would be conducted both on and off NAWC property as necessary to fully identify the nature and extent of contamination in overburden and shallow bedrock aquifers attributable to Areas A and B. If additional contamination is identified, the extraction well network and treatment system would be modified as necessary during the interim action for OU-1 to minimize migration of contaminants and to maximize the effectiveness of the extraction well network.

This alternative would also incorporate the sampling of existing on-site and off-site wells. Monitoring of groundwater in overburden and shallow bedrock aquifers would be conducted for an estimated 30 years.

To estimate the cost of this alternative, the following assumptions were made: a total of 25 extraction wells would be installed (16 within Area A and 9 within Area B); a total flow of 56 gallons per minute (gpm) would be pumped to a plant constructed near Area A for treatment; and on-site and off-site wells would be constructed and monitored on a quarterly basis for an estimated 30 years. (Additional costs would be incurred if additional groundwater from overburden and shallow bedrock aquifers were extracted and treated.) Based on these assumptions, the present worth of this alternative was estimated at $13,172,000, with a capital cost of $3,515,000 and an operation and maintenance cost of $628,000 annually. This alternative could be constructed in 12 months or less.

C. ALTERNATIVE 3: GROUNDWATER EXTRACTION, ON-SITE PRETREATMENT, AND DISCHARGE TO NAWC WARMINSTER WASTEWATER TREATMENT PLANT OR PUBLICLY OWNED TREATMENT WORKS

Under this alternative, contaminated groundwater in overburden and shallow bedrock aquifers attributable to NAWC Warminster would be extracted using a series of extraction wells. The extraction well network would be located as necessary to maximize the effectiveness of the system. The extracted groundwater would be pumped to an on-site treatment system constructed specifically to pretreat groundwater prior to discharge to the NAWC Warminster Wastewater Treatment Plant (WWTP). In the event that the NAWC Warminster WWTP ceases operation as part of Base Realignment and Closure, the pretreated groundwater would then be discharged to a publicly owned treatment works (POTW) such as the Warminster Municipal Authority (WMA) WWTP. The discharge of pretreated water to the POTW would comply with Federal Clean Water Act (33 U.S.C. Section 1251 et seq.) pretreatment regulations as set forth at 40 C.F.R. Part 403 and the pretreatment requirements of the receiving POTW. Pretreatment may include air stripping to remove volatile organics, precipitation/filtration (or other means, if necessary) to remove metals, and/or carbon adsorption to treat semivolatile organics. Emissions from the air stripper would be treated by vapor phase carbon adsorption as required by PA Code 127, NAAQS and NESHAPS. Organic and inorganic treatment residuals would be disposed offsite and handled as required by treatment, storage and disposal regulations of RCRA, including LDRs under 40 C.F.R. Parts 262 and 268, 25 PA Code, Article VII and 25 PA Code, Article IX. After pretreatment, the groundwater would be discharged to the NAWC Warminster or POTW WWTP. Treatability studies would be conducted as necessary to confirm that the pretreatment meets the requirements of the receiving WWTP.

Concurrent with the design, construction, and operation of the initial extraction well network and treatment system, investigations would be conducted both on and off current NAWC property as necessary to fully identify the nature and extent of contamination in overburden and shallow bedrock aquifers attributable to the Site. If additional contamination of concern attributable to NAWC is identified, the extraction well network and treatment system would be modified as necessary during the interim action for OU-1 to minimize migration of contaminants and to maximize the effectiveness of the extraction well network.

This alternative would also incorporate the sampling of existing on-site and off-site wells. Monitoring of groundwater in overburden and shallow bedrock aquifers would be conducted for an estimated 30 years.

For cost estimation purposes, the potential cost of connecting to a POTW such as the WMA WWTP is not included. The present worth of this alternative was estimated at $13,172,000 with a capital cost of $3,515,000 and an operation and maintenance cost of $628,000 annually. This alternative could be constructed in 12 months or less.

VIII. COMPARATIVE ANALYSIS OF ALTERNATIVES

To help select a remedial action, CERCLA requires that remedial alternatives be evaluated under the nine criteria discussed below.

A. OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Alternatives 2 and 3 would protect both human health and the environment by minimizing the migration of contaminated groundwater in overburden and shallow bedrock aquifers. Additional studies to determine the full nature and extent of groundwater contamination attributable to the Site would be conducted concurrently with the design, construction, and operation of the groundwater extraction and treatment system.

Alternative 1 would not meet the objective of minimizing the migration of groundwater contamination attributable to the Site in overburden and shallow bedrock aquifers. Therefore, this alternative is not considered protective of human health and the environment.

B. COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

ARARs for both Alternatives 2 and 3 are identified in detail within Sections IX. and X. These alternatives would be equally effective in meeting these ARARs. Since no remedial action would be taken under Alternative 1, there are no ARARs associated with remedial activity under this alternative. Only ARARs associated with groundwater monitoring would apply and be met in this case.

C. LONG-TERM EFFECTIVENESS AND PERMANENCE

By initiating an interim action at this time, Alternatives 2 and 3 may reduce the time necessary to restore affected aquifers relative to Alternative 1.

Alternatives 2 and 3 require groundwater monitoring to evaluate their effectiveness. Operation and maintenance of the treatment plant and monitoring of the treated discharges would be required for both of these alternatives.

D. REDUCTION OF TOXICITY, MOBILITY, OR VOLUME

Alternatives 2 and 3 would reduce the volume and toxicity of contaminated groundwater. Further migration of groundwater in the overburden and shallow bedrock aquifers would be contained by the extraction systems. The treatment systems for these alternatives would generate residuals that would require further treatment or disposal.

Alternative 1 would not use treatment to reduce the toxicity, mobility, or volume of contaminated groundwater in overburden and shallow bedrock aquifers.

E. SHORT-TERM EFFECTIVENESS

Under Alternative 1, groundwater contaminants would continue to migrate and would present potential unacceptable risks to human health. There would be no additional risks to the public or the environment under Alternatives 2 and 3. In the case of these alternatives, workers would be required to wear protective equipment during activities where they may be exposed to hazardous materials.

F. IMPLEMENTABILITY

No remedial action is included under Alternative 1.

For Alternatives 2 and 3, the remedial technologies and process options proposed for groundwater extraction and treatment all have been proven to be implementable and commercially available. Treatability studies would be required for both alternatives to ensure that treatment requirements can be met. In each case, if extraction wells were required off of NAWC property, access to the property of concern would be required.

Under Alternative 2, it is reasonable to assume that extracted groundwater could be treated on site to meet Federal and State NPDES requirements for discharge to a tributary of Little Neshaminy Creek or Southampton Creek.

Under Alternative 3, it is reasonable to assume that extracted groundwater could be treated on site as necessary to meet the pretreatment requirements of the NAWC Warminster WWTP. However, the NAWC Warminster WWTP may cease operating within the next five years. The Warminster Municipal Authority (WMA) is the only POTW within a reasonable distance of the NAWC. WMA has indicated that the capacity of the WMA WWTP is not designed to handle the flow of pretreated water projected in this case. As a result, the discharge of pretreated water to the WMA WWTP does not appear to be implementable.

G. COST

The present worth of Alternative 1 is $2,871,000. The present worth of Alternative 2 is $13,172,000. The present worth of Alternative 3 is also $13,172,000.

H. STATE ACCEPTANCE

The Commonwealth of Pennsylvania concurs with the selected interim remedy for OU-1 at this Site, Alternative 2.

I. COMMUNITY ACCEPTANCE

A public meeting on the Proposed Plan was held on May 10, 1993 in Warminster, Pennsylvania. Comments received orally at the public meeting and in writing during the public comment period are referenced in the Responsiveness Summary (Section VIII.of this ROD). Comments from the local community reflect a preference for Alternative 2: Groundwater Extraction, On-Site Treatment, and Discharge to Surface Water.

IX. SELECTED REMEDY

A. GENERAL DESCRIPTION

The Navy and EPA have selected Alternative 2: Groundwater Extraction, On-Site Treatment, and Discharge to Surface Water as the interim remedy for remediation of contaminated groundwater attributable to Areas A and B at the Site in overburden and shallow bedrock aquifers. This alternative includes the design and implementation of an interim remedial action to protect human health and the environment. More specifically, this alternative meets the objective of minimizing the migration of contaminated groundwater attributable to the Site in overburden and shallow bedrock aquifers while further Remedial Investigations are performed to determine the full nature and extent of contamination in these aquifers. The final remedy for OU-1 will be selected after the full nature and extent of the contamination are identified and will utilize information generated during the implementation of the interim remedy. The final remedial action may incorporate elements of the interim remedial action.

The selected interim remedy is believed to provide the best balance of trade-offs among the alternatives with respect to the response criteria. Based on available information, the Navy and EPA believe the selected interim remedy would be cost effective and would comply with applicable or relevant and appropriate requirements. Although this interim action is not intended to fully address the statutory mandate for permanence and treatment to the maximum extent practicable, this interim action utilizes treatment to reduce volume and toxicity and thus is in furtherance of that statutory mandate.

The selected interim remedy for OU-1 includes the following major components:

- Installation, operation and maintenance of groundwater extraction wells to minimize migration of contaminated groundwater attributable to Areas A and B at the Site in overburden and shallow bedrock aquifers
- Installation, operation and maintenance of an onsite groundwater treatment system which includes precipitation, filtration, air stripping and carbon adsorption and/or other necessary means of treatment
- Periodic sampling of treated water to ensure the effectiveness of the treatment system
- Discharge of treated water to an unnamed tributary of Little Neshaminy Creek or an unnamed tributary of Southampton Creek
- Installation, operation and maintenance of vapor phase carbon adsorption units as necessary

- Offsite treatment and/or disposal of solid residuals generated during water treatment

- Monitoring of groundwater in monitoring wells and residential wells

- Installation and periodic sampling of observation wells to ensure effectiveness of the groundwater extraction wells

- Periodic evaluation of hydrogeologic data and the effectiveness of the groundwater extraction system in minimizing the migration of contaminated groundwater attributable to Areas A and B at the Site in overburden and shallow bedrock aquifers

- Modification of the groundwater extraction well system and/or groundwater treatment system as necessary based on periodic evaluations

The FFS estimated the present worth of this remedy at $13,172,000 over a 30-year period, with a capital cost of $3,515,000 and an annual O&M cost of $628,000.

Performance standards associated with the components above are described below.

B. PERFORMANCE STANDARDS

1. Groundwater Extraction Wells

The extraction well network will include extraction wells in the vicinity of Area A and Area B. These extraction wells will be installed on and off current NAWC property, as necessary, to minimize the migration of contaminated groundwater in overburden and shallow bedrock underlying these areas, where shallow bedrock is currently defined to extend to a depth of 100 feet below the ground surface. The migration of the contaminated groundwater will be minimized by achieving and maintaining an inward and upward hydraulic gradient about the extraction wells installed for each area. The FFS projected that 16 extraction wells pumping at a depth of 87 feet and at a rate of 36 gpm would minimize the migration of contaminated groundwater in the overburden and shallow bedrock in the vicinity of Area A. The FFS projected that 9 extraction wells pumping at a depth of 77 feet and a rate of 20 gpm would minimize the migration of the contaminated groundwater of concern in the vicinity of Area B.

Observation wells will be located and constructed to gather data to confirm these gradients and to characterize the response of the aquifer to pumping. This information, in conjunction with additional hydrogeologic and contaminant distribution data generated during concurrent RI work will be used to modify and optimize the extraction well system for minimizing migration of contaminated groundwater in the overburden and shallow bedrock as necessary during this interim remedial action. All of the resultant data, including information regarding the deeper bedrock aquifers, will be used to confirm the vertical and horizontal extent of the shallow bedrock and determine the final extraction well configuration, the appropriate depths and pumping rates for the system, the performance monitoring program and the cleanup goals and timeframes anticipated for the final remedial action ROD for OU-1.

The groundwater from each extraction well will be raised by a submersible pump. An underground header piping system will collect the extracted groundwater and convey the groundwater to a treatment system located on current NAWC property. A booster pump station(s) will be used to help convey the groundwater from the extraction wells to the treatment system as necessary.

As part of additional RI work, monitoring wells will be installed on and off current NAWC property as necessary to determine the full nature and extent of contaminated groundwater attributable to Areas A and B in overburden and shallow bedrock. In any case where additional contaminated groundwater attributable to Areas A and B is identified in overburden and/or shallow bedrock, the extraction well network shall be modified as necessary to minimize the migration of the contaminated groundwater of concern.

2. Groundwater Treatment System

The treatment system for extracted groundwater will meet effluent limits developed in accordance with National Pollution Discharge Elimination System (NPDES) requirements under the Federal Clean Water Act, NPDES requirements under the Pennsylvania Clean Streams Law (25 PA Code, Chapter 92) and Pennsylvania Wastewater Treatment Requirements (25 PA Code, Chapter 95). The receiving stream(s) for the treated groundwater will be either an unnamed tributary of Little Neshaminy Creek and/or an unnamed tributary of Southamption Creek. Where the seven-day, 10-year low flow of these projected receiving streams is zero (due to intermittent flow), the effluent limits will be the Pennsylvania Water Quality Standards (25 PA Code, Chapters 16 and 93) for the stream of concern since no dilution will be provided by the receiving stream under low-flow conditions.

The treatment system will include precipitation, sedimentation and filtration as necessary to remove metals, with air stripping and carbon adsorption as necessary to remove volatile and semivolatile organics. Air stripping will remove volatile organics prior to carbon absorption to reduce carbon usage. Ion exchange or reverse osmosis will be used if necessary to meet the effluent limits for metals. Alternative treatment methods such as UV/oxidation may be required to remove organics if air stripping and carbon adsorption are inadequate to meet organic effluent limits. Treatability studies will be conducted as necessary. The initial groundwater treatment system will be designed to handle significant additional capacity beyond that required for the initial extraction well network to accommodate additional potential flow in the future (see Groundwater Extraction Wells). The treated groundwater shall be monitored as necessary to assure that prescribed effluent limits are being met prior to discharge. An Operation and Maintenance plan shall be developed and implemented to assure the continued effective operation of the Groundwater Treatment System.

3. Treatment of Air Emissions

Volatile organic compound emissions from the air stripper will be treated by vapor-phase carbon adsorption as required by 25 PA Code, Chapter 127, Subchapter A, as well as the National Emissions Standards for Hazardous Air Pollutants (NESHAPs) and the National Ambient Air Quality Standards for Criteria Pollutants (NAAQS) under the Federal Clean Air Act. EPA Directive 9355.0-28, which covers emissions from air strippers at CERCLA sites, is a standard to be considered.

4. Waste Treatment Residuals

Spent carbon from the carbon adsorption unit, spent carbon from the vapor-phase carbon adsorption unit and sludge generated during the treatment of metals will be handled in accordance with treatment, storage and disposal requirements under RCRA, including RCRA LDRs in 40 C.F.R. Parts 262 and 268, Pennsylvania Hazardous Waste Management Regulations (25 PA Code, Article VII) and Residual Waste Regulations (25 PA Code, Article IX).

5. Groundwater Monitoring

An Operation and Maintenance Plan for Groundwater Monitoring for groundwater in overburden and shallow bedrock shall be developed and implemented. The Plan will be approved by the EPA in consultation with PADER. Under the Plan, wells shall be monitored at locations on and off current NAWC property. Monitoring shall include residential and other privately owned wells as necessary. Monitoring wells shall be installed off of current NAWC property as necessary. Monitoring will be conducted through the selection and implementation of the final remedy for OU-1 and for at least thirty years.

6. Five Year Reviews

Because contaminated groundwater will likely remain at the facility after five years, a five year review will be required. A Five-Year Review Work Plan will be developed and approved by EPA in consultation with PADER.

7. Worker Safety

All work shall comply with Occupational Safety and Health Administration (OSHA) standards governing worker safety in 29 C.F.R. Parts 1910, 1926 and 1904.

X. STATUTORY DETERMINATIONS

A. PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

This interim action is protective of human health or the environment by minimizing the migration of groundwater contamination attributable to Area A and Area B at the Site in overburden and shallow bedrock aquifers. The selected interim remedy will not pose unacceptable short-term risks to human health and the environment during implementation.

B. COMPLIANCE WITH ARARS

The selected interim remedy will comply with all applicable or relevant and appropriate requirements specific to this interim action. These ARARs include those identified in Section IX. and those listed below:

1. Location-Specific ARARs

The substantive requirements of the Delaware River Basin Commission (18 C.F.R. Part 430) are applicable. These regulations establish requirements for the extraction of groundwater within the Delaware River Basin.

2. Action-Specific ARARs

Federal Clean Air Act requirements, 42 U.S.C. §§7401 et seq., are applicable and must be met for the discharge of contaminants to the air. Pennsylvania's Air Pollution Control Act is also applicable, as are Pennsylvania's Air Pollution Control Regulations (25 PA Code, Chapters 121-142).

The requirements of Subpart AA (Air Emission Standards for Process Vents) of the Federal RCRA regulations set forth at 40 C.F.R. Part 264 are relevant and appropriate and, (depending upon the levels of organics in the extracted groundwater and treatment residuals) may be applicable to the air stripping operations conducted as part of the selected interim remedy. These regulations require that total organic emissions from the air stripping process vents must be less than 1.4 kg/hr (3 lb/hr) and 2800 kg/yr (3.1 tons/yr).

25 PA Code, Section 123.31 is applicable to the selected remedial alternative and prohibits malodors detectable beyond the NAWC property line.

25 PA Code, Section 127.12(a)(5) will apply to new point source air emissions that result from implementation of the selected interim remedy. These Commonwealth of Pennsylvania regulations require that emissions be reduced to the minimum obtainable levels through the use of best available technology ("BAT") as defined in 25 PA Code, Section 121.1.

The substantive requirements of 25 PA Code, Section 127.11 will apply to the selected interim remedy. These Commonwealth of Pennsylvania regulations require a plan for approval for most air stripping and soil venting/decontamination projects designed to remove volatile contaminants from soil, water, and other materials.

Regulations concerning well drilling as set forth in 25 PA Code, Chapter 107 are applicable. These regulations are established pursuant to the Water Well Drillers License Act, 32 P.S.§ 645.1 et seq. Only substantive requirements of these regulations need be followed for onsite actions.

The groundwater collection and treatment operations will constitute treatment of hazardous waste (i.e., the groundwater containing hazardous waste), and will result in the generation of hazardous wastes derived from the treatment of the contaminated groundwater (i.e., spent carbon filters from carbon adsorption treatment of water and from vapor-phase carbon adsorption treatment of air emissions from air stripping operations). The interim remedy will be implemented in a manner consistent with the requirements of 25 PA Code, Chapter 262, Subparts A (relating to hazardous waste determination and identification numbers), B (relating to manifesting requirements for off-site shipments of spent carbon or other hazardous wastes), and C (relating to pretransport requirements); 25 PA Code, Chapter 263 (relating to transporters of hazardous wastes); and with respect to the operations at the Site generally, with the substantive requirements of 25 PA Code, Chapter 264, Subparts B-D, I (in the event that hazardous waste generated as part of the interim remedy is managed in containers) and 25 PA Code, Chapter 264, Subpart J (in the event that hazardous waste is managed, treated or stored in tanks). The interim remedy will be also be implemented in a manner consistent with 40 C.F.R. Part 264, Subpart AA (relating to air emissions from process vents), 40 C.F.R. Part 268, Subpart C, Section 268.30 and Subpart E (regarding prohibitions on land disposal and prohibitions on storage of hazardous waste) and 40 C.F.R. Part 264, Subpart AA (relating to air emission standards for process

vents).

25 PA Code, Chapter 264, Subchapter F, regarding groundwater monitoring is applicable to the selected interim remedy.

Any surface water discharge of treated effluent will comply with the substantive requirements of the Section 402 of the Clean Water Act, 33 U.S.C. §1342, and the National Pollutant Discharge Elimination System ("NPDES") discharge regulations set forth at 40 C.F.R. Parts 122-124, the Pennsylvania NPDES regulations (25 PA Code, Section 92.31), and the Pennsylvania Water Quality Standards (25 PA Code, Sections 93.1-93.9).

The Occupational Safety and Health Act ("OSHA") regulations codified at 29 C.F.R. Section 1910.170 are applicable for all activities conducted during this interim remedial action.

25 PA Code, Sections 261.24 and 273.421 are applicable regulations for the handling of residual and other waste and for the determination of hazardous waste by the Toxic Characteristic Leaching Procedure ("TCLP").

Transportation of any hazardous wastes off-site shall also comply with the Department of Transportation ("DOT") Rules for Hazardous Materials Transport (49 C.F.R. Parts 107 and 171-179).

3. Standards To Be Considered

Pennsylvania's Ground Water Quality Protection Strategy, dated February 1992.

EPA Directive 9355.0-28, which covers emissions from air strippers at Superfund groundwater remediation sites.

Pennsylvania Bureau of Air Quality Memorandum, "Air Quality Permitting Criteria for Remediation Projects Involving Air Strippers and Soil Decontamination Units".

EPA's Ground Water Protection Strategy, dated July 1991.

EPA OSWER Directive 9834.11 which prohibits the disposal of Superfund Site waste at a facility not in compliance with §3004 and §3005 of RCRA and all applicable State requirements.

C. COST-EFFECTIVENESS

The selected remedy is cost-effective in providing overall protection in proportion to cost.

D. UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES OR RESOURCE RECOVERY TECHNOLOGIES TO THE MAXIMUM EXTENT PRACTICABLE

Although this action is not intended to fully address the statutory mandate for permanence and treatment to the maximum extent practicable, this interim action utilizes treatment and thus is in furtherance of that statutory mandate.

E. PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

Because this action does not constitute the final remedy for Operable Unit One, the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element, although partially addressed by this remedy, will be addressed by the final response action.

XI. DOCUMENTATION OF SIGNIFICANT CHANGES

The preferred alternative presented in the Proposed Plan was Alternative 3: Groundwater Extraction, On-Site Pretreatment, and Discharge to NAWC Warminster Wastewater Treatment Plant or Publicly Owned Treatment Works. Based on public comments, the selected remedy is Alternative 2: Groundwater Extraction, On-Site Treatment and Discharge to Surface Water. The selected interim remedy for OU-1 is as described in the FSS and the Proposed Plan with one exception. Rather than address all contaminated groundwater attributable to the entire Site in overburden and shallow bedrock aquifers as described in the FSS and Proposed Plan, the interim remedy for OU-1 shall only address contaminated groundwater attributable to Areas A and B at the Site. Should additional RI work determine a remedial action is necessary to address groundwater in overburden and shallow bedrock attributable to another area at the Site, a Proposed Plan for that action shall be released to the public for comment prior to selecting a remedy.

XII. RESPONSIVENESS SUMMARY

A. OVERVIEW

In a Proposed Plan released for public comment on April 29, 1993, the Navy, with the support of EPA, identified Alternative 3 as the preferred interim remedial alternative for OU-1 at the Site. Alternative 3 in the Proposed Plan was as described in Section VIII. of this ROD.

The majority of written and oral comments received during the public comment period were in support of Alternative 2 as described in the Proposed Plan and Section VIII. of this ROD. Alternative 2 was preferred by Warminster Township, the Warminster Municipal Authority, Congresswoman Marjorie Margolies-Mezvinsky, the Bucks County NAWC Economic Adjustment Committee and the Northampton Municipal Authority. Based on these and other comments received during the public comment period, the Navy and EPA have selected Alternative 2 as the interim remedy for OU-1. Other comments and the associated responses of the Navy and EPA are described below after a brief discussion of community involvement to date.

B. COMMUNITY INVOLVEMENT TO DATE

In July 1989, NAWC Warminster prepared a draft Community Relations Plan for RI/FS activities. Community relations activities to date have been conducted in accordance with this plan. These activities have included regular Technical Review Committee meetings with local officials, communications with the media and the establishment of information repositories.

The Navy and EPA established a public comment period from April 29, 1993 to May 28, 1993 for interested parties to comment on the Proposed Plan, the RI Report, the FFS Report and other documents pertaining to OU-1. These and all other documents considered or relied upon during the interim remedy selection process for OU-1 are included in the Administrative Record, which has been

in two information repositories accessible to the public since the beginning of the public comment period for OU-1. A public meeting was held at William Tennant High School, Centennial Road, Warminster, Pennsylvania on May 10, 1993 to present the RI/FFS Reports and Proposed Plan, answer questions, and accept both oral and written comments for the OU-1 interim remedy. Approximately 165 people attended this meeting.

This Responsiveness Summary, required by CERCLA, provides a summary of citizens' comments identified and received during the public comment period and the responses of the Navy and EPA to those comments. All comments received by the Navy and EPA during the public comment period were considered by the Navy and EPA in selecting the interim remedy for OU-1. Responses to these comments are included in the section below.

C. SUMMARY OF COMMENTS RECEIVED DURING PUBLIC COMMENT PERIOD AND COMMENT RESPONSES

Comments received during the public comment period regarding the interim remedy for OU-1 have been summarized below with the responses of the Navy and EPA to these comments. The comments and associated responses have been organized by subject category.

Remedial Alternative Preferences

Comment 1: A petition with 25 signatures, along with many written and verbal responses, expressed a preference for Alternative 2. Warminster Township, the Warminster Municipal Authority, Congresswoman Marjorie Margolies-Mezvinsky, the Bucks County NAWC Economic Adjustment Committee and the Northampton Municipal Authority all expressed a preference for Alternative 2. Several authorities/officials indicated Alternative 3 should not be selected because existing local POTWs (e.g., the POTW owned by the Warminster Municipal Authority) did not have the capacity to handle the volume of water expected to be generated by the OU-1 interim remedy.

Response: The Navy and EPA have selected Alternative 2 based on this and other comments received during the public comment period.

Comment 2: One commenter expressed concern that discharge to the NAWC WWTP will not be feasible if the NAWC WWTP is not in compliance with an existing NPDES permit. This commenter also expressed concern that cost estimates in the FSS did not account for the cost of modifications to the NAWC WWTP which might be necessary prior to accepting pretreated water.

Response: The selected remedy does not include discharge to the NAWC WWTP. Therefore, compliance of the NAWC WWTP with NPDES requirements is not required to implement the selected remedy. While the FFS did not estimate the cost of any modifications to the NAWC WWTP as part of the evaluation of Alternative 3, this had no bearing on the interim remedy selection process for OU-1.

Comment 3: Some citizens expressed their preference for Alternative 3 because of their concerns about the release of toxins to surface water. A petition with 11 signatures opposing any discharge to surface water was filed by residents from the Twin Streams development. One commenter expressed a preference for land application of pre-treated groundwater as an alternative to stream discharge to protect stream users.

Response: Prior to any discharge of treated water to surface water, the quality of the water must meet the requirements of the Federal Clean Water Act and the Pennsylvania Clean Streams Law. According to these statutes, these requirements must be protective of the uses of the receiving stream. Only water which meets these requirements and thus is protective of all stream users, including children, will be released to surface water. In addition, the location of the discharge shall be as necessary to be protective. Discharges will be monitored on a regular basis as necessary to assure that the treated water is meeting the requirements.

Comment 4: Thirty-five residents of the Casey Village development submitted a petition stating that the three alternatives discussed in the Proposed Plan were not acceptable because they are, according to the petitioners, a threat to the health and welfare of the community. The residents requested that an alternate clean-up solution be devised under the supervision of EPA.

Response: The selected remedy will protect both human health and the environment by meeting the objective of minimizing migration of contaminated groundwater in overburden and shallow bedrock aquifers while studies continue to identify the full nature and extent of contamination of these aquifers and other media. The EPA believes the migration of concern should be minimized at this time and that there are no other viable alternatives for minimizing this migration.

Remedial Design and Implementation

Comment 5: Several commenters were concerned about the possible quality of discharges to surface water. The comments centered around the following issues:

- What are the discharge limits and how would the discharge limits be set?
- Who would enforce these limits and how would the limits be enforced?
- How would a treatment process meet the limits?

Response: The discharge limits will be set per NPDES requirements consistent with the Pennsylvania Clean Streams Law and the Federal Clean Water Act. The Pennsylvania Department of Environmental Resources, in cooperation with the EPA, will establish the discharge limits and subsequently enforce the discharge limits. These limits will be established during the design of the treatment plant as necessary technical data are generated. Compliance with the discharge limits will be monitored by periodic sampling consistent with NPDES requirements. In any case where the discharge limits are exceeded, the discharge would be halted and the treatment would be modified so

that any further discharge of effluent would meet the discharge limits. Technologies likely to be used for treatment of extracted groundwater include air stripping and carbon adsorption for organics and precipitation for metals. If necessary, alternative technologies such as UV/oxidation (for organics) and ion-exchange (for metals) may be utilized. These technologies have been proven effective.

Comment 6: A number of commenters stated that the treatment process should incorporate destructive technologies to destroy the contaminants. A concern was expressed regarding the fate of carbon used in treatment and sludge generated during treatment.

Response: Organic contaminants in the extracted groundwater will adsorb to carbon during the air stripping and water treatment process. The carbon will periodically be recycled by transporting the "used" carbon to an offsite facility, where the adsorbed organic contaminants will be destroyed by thermal treatment (or other means of treatment). If utilized, UV/oxidation could also destroy the organic contaminants. No technology exists to destroy metals, which will be accumulated in a sludge during treatment and subsequently disposed at a permitted offsite facility.

Comment 7: A concern was expressed regarding the quality of air emissions from the air stripper.

Response: Emissions from air strippers are regulated under both Pennsylvania and Federal law. Section IX.B.3. and Section X.B. of this ROD identify the specific requirements of concern.

Comment 8: During the public meeting, some local residents expressed concern that the extraction well network would dry out their wells.

Response: As part of remedial design, the groundwater recovery well network will be engineered to avoid such impacts.

Comment 9: One commenter asked why only Areas A and B were being addressed by investigations and the interim remedy for OU-1. Another commenter requested that additional studies of groundwater in overburden and shallow bedrock continue while the interim remedy is implemented.

Response: Preliminary groundwater investigations have been conducted at all eight known disposal Sites as part of RI activity to date. At this time, adequate information exists to select an interim remedy for Areas A and B (OU-1). RI/FS work will continue to address other areas of the Site. Additional remedial actions will be proposed and selected as soon as adequate information exists to support the selection of a remedy. With regard to OU-1, further RI work is being performed to determine the full nature and extent of contaminated groundwater in overburden and shallow bedrock attributable to Areas A and B (OU-1). If additional groundwater contamination is identified in overburden and shallow bedrock in these areas, the groundwater pump and treat system will be modified as necessary to minimize the additional contamination. A final Record of Decision for OU-1 will be prepared when the RI/FS work for OU-1 is completed. Per Section 18.6 of the Federal Facility Agreement for NAWC between the EPA and the Navy, the RI/FS for OU-1 is not considered complete

until a final remedy is selected.

Additional Studies

Comment 10: Several residents expressed concern over the high incidence of cancer among local residents.

Response: This concern has been referred by the EPA to the Agency for Toxic Substances and Disease Registry (ATSDR) for investigation.

Comment 11: Numerous residents felt that public water should be supplied to neighboring communities near NAWC.

Response: Connections to public water systems are being provided by the EPA and the Navy to residences in areas affected by groundwater contamination in the vicinity of NAWC.

Comment 12: Several commenters expressed an objection to the lack of studies and a remedy for the deep bedrock aquifer.

Response: At this time, there is insufficient information to select a remedial alternative for groundwater in the deep bedrock aquifer. The next phase of the RI/FS will study the deep bedrock aquifer (as well as other media such as surface water, sediment, and soils) to determine where additional remedial actions are necessary.

Comment 13: Several residents, including 11 that signed a petition, expressed concern over their property values. One resident wanted the Navy to purchase their home.

Response: While property values may be impacted in certain cases at this time, these values should be restored upon implementing the necessary response actions.

Comment 14: A number of local residents questioned whether areas known to be used for waste disposal in the past (sites 1 through 8) were still releasing contamination or whether ongoing practices at NAWC were contributing to groundwater contamination.

Response: Current data does not indicate any significant ongoing contaminant releases to groundwater from wastes disposed at sites 1 through 8. In the event future RI work identifies a release of concern from a disposal area, response actions shall be taken as necessary. The handling of waste generated at this time is strictly regulated by the Federal Resource Conservation and Recovery Act (RCRA) and Pennsylvania regulations.

Comment 15: Several residents expressed concern about stormwater or groundwater potentially contaminated by the Site being discharged by culvert or storm sewer to their properties.

Response: Additional RI work will investigate all potential water discharges of concern from NAWC to neighboring properties. Should contaminated groundwater in overburden and shallow bedrock attributable to the Site be determined to be discharging to the surface of a neighboring property, the interim remedy for OU-1 shall include minimizing the migration of the contaminated groundwater of concern. Should additional RI work determine the quality of stormwater from NAWC is impacting (or could potentially impact) neighboring property, an appropriate response action shall be performed.

Comment 16: One resident expressed concern regarding the "orange seeps" observed during RI work to be discharging to an unnamed tributary of Little Neshaminy Creek adjacent to Area A.

Response: Available data on the quality of this stream suggest that contaminated groundwater in overburden under Area A may be discharging to this stream. The interim remedy for OU-1 shall be designed as necessary to minimize any contaminant migration to this stream. In addition, the water and sediment in this stream shall be investigated further as necessary as part of continuing RI/FS work.