N62269.AR.000091
NAWC WARMINSTER
5090.3a

Phase II
Remedial Investigation Report
Volume I

for

Operable Unit 1
Naval Air Warfare Center

Warminster, Pennsylvania

Northern Division
Naval Facilities Engineering Command

Contract No. N62472-90-D-1298
Contract Task Order 0022

April 1993

Halliburton NUS
CORPORATION

R-51-2-3-7

PHASE II
REMEDIAL INVESTIGATION REPORT
VOLUME I

OPERABLE UNIT 1
NAVAL AIR WARFARE CENTER (NAWC)
WARMINSTER, PENNSYLVANIA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Northern Division
Environmental Branch, Code 18
Naval Facilities Engineering Command
10 Industrial Highway, Mail Stop No. 82
Lester, Pennsylvania 19113-2090

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EXECUTIVE SUMMARY

INTRODUCTION AND PURPOSE

In response to Contract Task Order No. 22 under Contract N62472-90-D-1298, Halliburton NUS Corporation is submitting this Remedial Investigation (RI) report for the Naval Air Warfare Center (NAWC) (formerly the Naval Air Development Center), Warminster, Pennsylvania. This work is part of the Navy's Installation Restoration Program (IRP), which is designed to identify contamination of Navy and Marine Corps facilities resulting from past operations and to institute corrective measures as needed.

In addition to meeting the objectives of the Navy's IRP, the purpose of the RI is to meet the requirements of CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act of 1980), as amended by SARA (Superfund Amendments and Reauthorization Act of 1986). As such, the RI should investigate the nature and extent of contamination associated with all hazardous substance releases at the facility that are not regulated and are not being investigated under the authority of the Clean Air Act, Clean Water Act, the Resource Conservation and Recovery Act (RCRA), and other Federal laws.

This report presents results of the RI work conducted at NAWC Warminster. Data from these investigations are used to conduct baseline risk assessments, which are also included in the report. The risk assessments determine where unacceptable risks to human health have been identified. The report also identifies where additional investigations are needed to complete risk assessments and where Feasibility Studies (FSs) should be performed to evaluate remedial alternatives for identified contamination.

SCOPE AND OBJECTIVES

NAWC Warminster is listed on the National Priorities List, EPA's list of hazardous waste facilities that appear to pose the most serious risk to public health or the environment. The areas of concern identified to date at NAWC Warminster are eight inactive waste sites covering more than seven acres:

- Three waste burn and disposal pits (Sites 1, 3, and 6)
- Two sludge disposal pit areas (Sites 2 and 7)
- Two landfills (Sites 4 and 5)
- One fire training area (Site 8)

Two investigations, Phases I and II, were conducted at these sites between October 1989 and September 1992. Phase I was performed between October 1989 and April 1991 by SMC Environmental Services Group. Phase II was performed between May and September 1992 by Halliburton NUS. To the extent practicable, the results of both Phases I and II have been incorporated into this report.

This report focuses on on-site groundwater contamination in the overburden and shallow bedrock aquifers at Sites 1, 2, and 3 (Area A) and Sites 5, 6, and 7 (Area B). These areas comprise a portion of Operable Unit 1 (OU-1), which has been defined as any groundwater in overburden and shallow bedrock contaminated by NAWC Warminster property. For NAWC Warminster, remedial actions are being implemented in phases as appropriate using OUs to manage problems and expedite the reduction of risks posed by the facility.

The objectives of the RI for Areas A and B were to characterize the nature and extent of potential overburden and shallow bedrock groundwater contamination, to better understand the physical parameters affecting groundwater contaminant fate and transport, and to assess groundwater risks to human health and the environment. In addition, information on local hydrogeology was collected and evaluated. The main focus of the overall RI for NAWC Warminster to date has been to determine groundwater impacts from the eight inactive waste sites identified above, particularly the location and concentration of potential groundwater contamination by volatile organic compounds (VOCs) and metals.

Additional remedial investigations are planned by the Navy to fully identify the nature and extent of contamination at OU-1 and for the rest of the facility. This includes studies to address the full nature and extent of groundwater contamination, both on and off site, in the shallow and deep bedrock aquifers, as well as contamination in other media.

FACILITY HISTORY AND DESCRIPTION

NAWC Warminster is located in the township of Warminster, Bucks County, Pennsylvania. The total area of the facility is approximately 734 acres. The facility lies in a populated suburban area surrounded by private homes, various commercial/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.

Commissioned in 1944, NAWC Warminster's main function is research, development, testing, and evaluation for naval aircraft systems. NAWC Warminster also conducts studies in anti-submarine warfare systems and software development. Historically, wastes were generated 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. These wastes included paints, solvents, sludges from industrial wastewater treatment, and waste oils.

NAWC Warminster has approximately 3,000 employees, and 1,000 people reside at the facility year round. The residents living at the facility are the nearest population center. The closest off-base home is about 200 feet away. Any hazardous substance releases from the eight sites identified to date and from other unidentified sites at NAWC Warminster potentially affect the Stockton Formation aquifer, which provides water for more than 100,000 people within the vicinity of the facility. Local surface water bodies are used for recreation and industrial purposes.

GEOLOGY, HYDROGEOLOGY, AND HYDROLOGY

Surface soils in the vicinity of the facility 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. The soils and saprolite are underlain by the middle arkose member of the late Triassic age Stockton Formation. The Stockton Formation is underlain by Ordovician to Precambrian age basement rocks.

The middle member of the Stockton Formation consists of fine- to medium-grained arkosic sandstone interbedded with red shale, siltstone, and conglomerate. Bedding layers strike from southwest to northeast and dip to the northwest at an average rate of 12 degrees. The Stockton Formation is extensively faulted and is cut by a well-developed joint system.

Groundwater within the Stockton Formation is transmitted through primary porosity and along bedding planes and fractures. Shales and siltstone units commonly restrict vertical movement of groundwater due to their low primary porosity and poorly developed secondary porosity. The well-sorted, fine- to medium-grained sandstone units form the best aquifers within the formation. Groundwater in the unconsolidated overburden and shallow bedrock layers typically occurs under water-table (unconfined) conditions. Groundwater within the deeper bedrock layers can occur under both unconfined and confined conditions.

NAWC Warminster is located in an upland area lying between two local drainage basins. The majority of the facility drains toward the north into an unnamed tributary of Little Neshaminy Creek, and the remaining drainage flows southward to Southampton Creek. Both local drainage basins lie within the regional drainage basin of the Delaware River. Local drainage is controlled primarily through natural flow to ephemeral streams and constructed drainage; runoff is influenced locally by surface grading, pavement, constructed ditches, and storm sewer lines.

GENERAL FIELD ACTIVITIES

To date, NAWC Warminster has been addressed in two long-term remedial phases. The study for the first phase began near the end of 1989 and was completed in April 1991. Phase I involved mapping VOCs in soil gas and detecting any conductivity anomalies through electromagnetic surveys. Approximate site boundaries were identified and confirmation of site contamination was made through soil borings, installation of new overburden and shallow bedrock monitoring wells, and groundwater sampling and analysis. In addition, test pits were excavated, local wells were inventoried, and a fracture-trace analysis was conducted.

The second phase began at the end of 1991. Phase II involved installing overburden and shallow bedrock monitoring wells, sampling and analyzing groundwater, and evaluating aquifer characteristics by performing long-term water-level monitoring and slug and step-drawdown tests along with a pumping test. Four off-site wells were also sampled. Both phases explored the nature and extent of groundwater contamination within Areas A and B and were designed to help pinpoint the most effective strategies for cleanup.

A total of 57 groundwater samples were collected and analyzed during both phases for Areas A and B: 24 samples during Phase I and 33 samples during Phase II. Field and laboratory Quality Assurance/Quality Control (QA/QC) samples were also included in the laboratory analysis. Samples were analyzed for volatile organics, semivolatile organics, pesticides, polychlorinated biphenyl (PCBs), inorganics, cyanide, and various engineering parameters (e.g., hardness, alkalinity, chemical oxygen demand, chlorides, sulfates, total organic carbon).

SITES 1, 2, AND 3 (AREA A)

Sites 1, 2, and 3 were combined into one general area (Area A) for purposes of this report. Site 1 is located on a portion of the facility lying northwest of Jacksonville Road and is adjacent to the wastewater treatment plant. The site is within 1,000 feet of an off-site food processing facility and within 300 feet of an unnamed tributary that flows to 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 is located southeast of Site 1 and received wastewater sludges from 1965 to 1970. The site consisted of two disposal trenches; each trench was approximately 12 feet wide by 200 feet long by eight feet deep. The total area of the site may be 20,600 square feet.

Site 3 is adjacent to Site 2. The site 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 at NAWC Warminster.

Field Activities - Area A

EM conductivity and soil gas surveys were performed at Area A during Phase I. Soil gas readings were taken from 80 stations at Sites 1 and 2 and from 26 stations at Site 3. Soil confirmation borings were drilled at 30 locations near Sites 1 and 2 and seven borings were drilled at Site 3 to further delineate site boundaries.

Four shallow bedrock monitoring wells and one overburden well were installed during Phase I; three shallow bedrock and three overburden wells were installed during Phase II. Six overburden wells, 12 shallow bedrock wells, and one deep bedrock well were sampled during Phase II.

Hydrogeologic investigations near Area A included estimates of yields from new monitoring wells, calculations of horizontal groundwater flow velocities and vertical hydraulic gradients, construction of groundwater elevation maps, and estimates of flow rates for the surface water near the site. During Phase II, slug tests were performed on several new monitoring wells, step-drawdown tests were done for selected wells, and an aquifer pumping test was conducted. A two-week water-level study was also performed. A biological characterization was completed for this area during Phase I.

Physical Characteristics - Area A

Area A is in the northwestern corner of the fenced facility bordering an industrial/commercial area. The sites are located on a generally flat-lying area. An unnamed tributary of Little Neshaminy Creek is located north of this area, and the NAWC Warminster wastewater treatment facility, jet fuel storage area, and parking lots are immediately to the south.

Orange-colored seeps were observed at several points along the creek bank north of Sites 2 and 3 during both phases of the RI. The average soil thickness at Area A ranges from 6.5 to 16 feet. The soil cover is thinnest in the area north of the wastewater sludge lagoons. The current location of the stream channel, adjacent to the sites, may partially be a result of filling operations. The pattern of waste and fill indicates that burning of waste may have occurred at the same time as filling and grading with imported clean fill.

The buried, gray, wet, clay-like material represents the eastern extent of the 200-foot-long trenches. Seeps found along the stream bank adjacent to Site 2 represent a potential contaminant migration path from groundwater to the stream. The wide distribution of burned cinders found at Site 3 represents the regraded contents of this former burn pit.

The bedrock of the area is generally composed of micaceous siltstones interbedded with arkosic and quartzitic sandstones. The bedrock layers strike towards the northeast with an eight to 12 degree strike towards the northwest. Overburden and shallow bedrock aquifer flow was observed to be toward the north and the adjacent creek. Vertical groundwater gradients between the overburden and shallow bedrock were both upward and downward and varied with time and location.

The long-term water-level study indicates that the shallow and deeper bedrock aquifers in the northern portion of this area are influenced by the pumping of a nearby well, inferred to be the Wagner & Sons commercial well. Both the shallow bedrock and overburden aquifers in the southwestern part of the area, as well as the deep bedrock aquifer, are influenced by another unidentified pumping well, possibly one of the NAWC Warminster supply wells. A recharge mound and corresponding variations in local horizontal gradients and flow directions are evident near Well SMC-1.

Nature and Extent of Contamination - Area A

The EM survey at Site 1 delineated an area with low conductivity. The EM survey over Site 2 delineated a second conductivity low that closely corresponds with the area suspected to have received fill based on the review of historical aerial photographs. The EM survey at Site 3 showed an anomalous area of approximately 30 by 40 feet.

Soil gas readings at Area A yielded VOC concentrations ranging from not detected to 1.5 ppm. Confirmation borings delineated the extent of Sites 1 and 2, except on the eastern side. The eastern edge of Site 2 may extend to Site 3 where a gray, clay-like fill is found. The detection of cinders in Sites 1 and 2 in an area approximately twice as large as the original burn pit and the finding of natural soil above and below fill material indicate that considerable regrading of soil around the Site 1 burn pit was done. The thickness of surficial and subsurface fill material at Sites 1 and 2 averages between four and five feet. The average thickness of waste-containing material is between five and six feet. Waste material includes fill, cinders, glass, ceramic fragments, wood, bricks, and metal fragments.

The thickness of fill and waste material over the northeastern part of Site 3 is 10 feet or greater. Waste and fill material at Site 3 average approximately six and seven feet in thickness, respectively. Organic vapors were detected at one boring in Site 3 that contained a gray, clay-like material. Cinders, wood, metal, brick, and glass fragments are also found at Site 3.

Concentrations of arsenic, cadmium, lead, manganese, and thallium were detected in unfiltered monitoring well samples downgradient of Area A. The metals concentrations were higher in shallow bedrock rather than overburden wells. Most unfiltered downgradient metal concentrations exceed upgradient concentrations. Chlorinated ethanes, chlorinated ethenes, benzene, alkylbenzenes, and phthalates were detected in wells downgradient of Area A at concentrations greater than those in upgradient wells. The highest concentrations of chlorinated ethenes and ethanes were found in shallow bedrock wells located north of the jet fuel storage area.

Contaminant Fate and Transport - Area A

The major contaminant transport pathways for Area A include leaching from subsurface soil to groundwater, runoff of soil to surface water, discharge of groundwater to surface water, migration of groundwater contaminants to off-site groundwater, and fugitive dust emissions.

Potential human and environmental exposure pathways identified under current or future land-use scenarios for Area A include ingestion, dermal, and inhalation exposures to chemicals in groundwater, dermal and incidental ingestion exposure to stream surface water and sediment, and dermal exposure, incidental ingestion, and fugitive dust inhalation of soil contaminants. The primary focus of this report is the investigation of on-site shallow groundwater and the potential migration of this groundwater to off-site locations.

Risk Assessment - Area A

Groundwater chemicals of concern were selected based on exceeding background or upgradient concentrations, exceeding Applicable or Relevant and Appropriate Requirements (ARARs) or dose-response parameters, and carcinogenic status. Three receptors were chosen for the shallow groundwater exposure pathway: adult residents, child residents, and adult employees.

The shallow groundwater underlying Area A presents several noncarginogenic and carcinogenic risks to human receptors. Noncarcinogenic risks were estimated by use of Hazard Quotients (HQs) and Hazard Indices (HIs). When HQs exceed 1.0, potential adverse effects can no longer be ruled out. Carcinogenic risks were estimated using cancer slope factors. Cancer risk increases should ideally be below 1E-6, although sometimes risks up to 1E-4 may be considered acceptable.

HIs for hypothetical ingestion of current groundwater at Area A exceeded 1.0 for all receptors. The primary contributors to noncarcinogenic risk were arsenic, trichloroethene (TCE), tetrachloroethene (PCE), carbon tetrachloride, manganese, cis-1,2-dichloroethene (cis-1,2-DCE), thallium, and barium. For residential receptors, individual HQs of manganese would exceed 1.0. HIs for hypothetical dermal exposure to groundwater exceeded 1.0 for residential receptors because the individual HQs of TCE and PCE exceeded 1.0. Without PCE and TCE, the dermal HIs would be less than 1.0.

Estimated cancer risk increases for hypothetical ingestion of groundwater would exceed 1E-4 for all receptors. The major contributors to ingestion risk were vinyl chloride, TCE, PCE, arsenic (unfiltered water only), 1,1-DCE, 1,2-dichloroethane (1,2-DCEA), and carbon tetrachloride. Estimated cancer risks for hypothetical dermal exposure to groundwater would exceed 1E-4 for residential receptors and 1E-5 for employee receptors because of TCE and PCE, and to a lesser extent, vinyl chloride, 1,1-DCE, chloroform, and carbon tetrachloride.

Estimated cancer risk increases for hypothetical inhalation exposure to groundwater would exceed 1E-5 for adult residents because of TCE, vinyl chloride, 1,1-DCE, chloroform, and carbon tetrachloride.

Currently, the only enforceable standards for exposure to groundwater contaminants are the Maximum Contaminant Levels (MCLs) promulgated under the Safe Drinking Water Act. These standards are designed for the protection of human health. MCLs were exceeded for several VOCs (i.e., TCE, PCE, carbon tetrachloride, vinyl chloride, and 1,2-DCE) and inorganics (i.e., cadmium, manganese, nickel, arsenic, and barium) in the groundwater samples collected from wells located in the vicinity of Area A. For manganese, the secondary MCL of 50 ppb was exceeded by all Area A monitoring wells during Phase II. Among the VOCs, MCLs for TCE (5 ppb) and PCE (5 ppb) were exceeded most frequently in these wells.

Conclusions - Area A

Additional investigation should be performed to better define the nature and extent of groundwater, surface water, and sediment contamination in this area. At a minimum, these tasks should include

- Additional monitoring wells as needed to define the upgradient and downgradient extent of site-related groundwater contamination due to releases from Area A to the overburden, shallow bedrock, and deeper bedrock aquifers.

- Additional surface water and sediment sampling within the unnamed tributary downstream of Area A. Biota sampling may also be warranted to explore food chain impacts, if necessary.

- Additional surface and subsurface soil sampling as necessary within Area A to assess the nature and extent of contamination and associated risks.

- Research and generation of production information and construction details for off-site wells, including the Wagner & Sons, Warminster Township Municipal Authority No. 26, and Aztec wells.

- Generation and analysis of water-level and production data for all on-site wells, including both monitoring and NAWC Warminster production wells.

- Review historical data for off-site or other sources of VOC contamination in the vicinity of the western portion of NAWC Warminster.

- Hydrogeologic investigation as necessary to determine deep bedrock aquifer characteristics and the effect of nearby supply wells on groundwater flow directions in the vicinity of Area A.

- Modelling to estimate bioaccumulation of contaminants in the unnamed tributary near Area A.

- Modelling to estimate future groundwater concentrations in the shallow bedrock aquifer using analytical data to be generated by additional soil sampling.

- Additional well survey work as needed to identify groundwater receptors potentially at risk. Off-site well sampling should be performed as needed based on the results on this survey. The survey should be extended to at least one mile north of Area A.

Groundwater in overburden and shallow bedrock contaminated by NAWC Warminster beneath Area A has been found to present an unacceptable risk to human health because some HQs (e.g., manganese) and HIs based on total risks of organic compounds (e.g., TCE) that act on similar target organs exceeded unity (1.0), and potential noncarcinogenic impacts could not be ruled out if groundwater were used by employees or residents. Estimated dermal and ingestion cancer risk increases would exceed 1E-4 because of chlorinated VOCs and possibly arsenic. The absence of arsenic in filtered groundwater samples suggests that its presence in unfiltered samples was due to suspended materials.

Based on information generated during the RI, adequate data exist to proceed with the evaluation of remedial alternatives for overburden and shallow bedrock contaminated groundwater through the FS process. Additional sampling and investigation are needed for other media associated with Area A, including groundwater in deep bedrock aquifers.

SITES 5, 6, AND 7 (AREA B)

Sites 5, 6, and 7 were combined into one general area (Area B) for purposes of this report. Site 5 is located under Housing Unit 401 in NAWC Warminster's enlisted men's housing area. Site 6 is south of the main runway and north of the patrol road near the eastern end of the facility. Site 7 is located west of Sites 5 and 6 and east of the inertial reference building.

Site 5 is located south of the main runway and adjacent to a baseball field at NAWC Warminster. The site operated from 1955 to 1970 and was rediscovered during construction for the foundation of a housing unit. Site 5 consisted of six to eight disposal trenches in which paints, solvents, scrap metal, demolition debris, and 30 drums of asphalt were disposed. Each trench was 12 feet wide by 70 feet long and eight feet deep.

Site 6 consists of an unknown number of disposal pits or trenches on the northern side of the patrol road and 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. Information regarding waste disposal operations for Site 6 is poor.

Site 7 reportedly consisted of two disposal trenches that were used from 1950 to 1955 to receive sludge from the wastewater treatment plant. The site is located south of the main runway and adjacent to the western side of Site 5. 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.

Field Activities - Area B

Electromagnetic conductivity surveys were performed at Sites 6 and 7 during Phase I. Soil gas surveys were performed at all sites during Phase I. Ten confirmation soil borings were drilled at Site 5, and 14 borings were drilled at Site 7. Six test pits at Site 6 and three pits at Site 7 were excavated near the perimeter of anomalous EM areas and adjacent to soil gas anomalies.

Seventeen monitoring wells are present in the area of Area B. Three shallow bedrock wells and one overburden well were installed during Phase II. Groundwater samples were obtained from seven shallow bedrock and five overburden wells during Phase I and from nine shallow bedrock and five overburden wells during Phase II.

Physical Characteristics - Area B

Site 5 has been reworked and filled with waste and imported natural clean soils used as backfill. The complete extent of the waste has not been determined, but waste was found north, east, and west of Building 401. Waste material encountered included wood, glass, and waste metal fragments in a matrix of fill material.

Site 6 contains a heterogeneous mixture of building demolition materials, such as concrete, bricks, macadam, and metal. Some materials are not buried. The current surface of this site contains several mounds of waste material covered with some or no soil.

The exact locations of the two disposal trenches at Site 7 were not identified during the RI.

Several fracture traces are located south and southwest of the sites. One spring was found south of the baseball field adjacent to Site 5 near Wells DG-8 and DG-20. Review of historical aerial photos revealed the presence of a stream in the area where the spring was found.

The bedrock lithology consists mainly of brownish-red micaceous siltstone interbedded with gray, red, and light to dark brown, fine- to coarse-grained arkosic sandstone and gray to brown, medium-grained quartzitic sandstone. These rock units were observed to strike northeast and dip six to 10 degrees to the northwest. The thicknesses of the lithologic units range from five to 20 feet. The sandstone encountered during drilling in one well appeared to be extensively fractured.

Vertical hydraulic gradients were consistently downward in all well couplets in this area. Shallow bedrock and overburden groundwater flows generally toward the south and Southampton Creek. Horizontal groundwater velocities for the shallow bedrock aquifer ranged from 455 to 2,850 ft/yr; velocities for the overburden ranged from two to six ft/yr. In general, the depth to groundwater increases from south to north throughout the area.

Storm water is piped underground from the south-central NAWC Warminster property boundary to a point approximately 500 feet to the south, where it flows through a residential area in a concrete channel. The channel travels through a road culvert before flowing into a streambed, which forms the headwaters of Southampton Creek.

Nature and Extent of Contamination - Area B

Two EM anomalies were delineated at Sites 6 and 7. Low concentrations of VOCs were detected during the soil gas survey at Site 5. VOC readings from not detected to 52 ppm were reported at Site 6; the positive readings were detected in the western part of the site. Low concentrations of VOCs (0.4 to 1.5 ppm) were detected at Site 7.

The content of Site 5 included wood, glass, and metal fragments. Clean fill and construction debris were found in five of the six test pits. Building demolition debris (asphalt, concrete, and brick) was scattered around the eastern part of Site 6. Construction debris, including cement, glass, wires, electrical parts, scrap metal, asphalt, and one empty paint drum, was found in Site 6 test pits. No waste or significant fill material was found in the confirmation borings or test pits at Site 7.

Cyanide was detected in one monitoring well north of Site 5, but the result may be suspect. Concentrations of arsenic, lead, and manganese were detected in unfiltered monitoring wells downgradient of the site. No pattern of contaminated metals in groundwater was identified. Toluene and phthalates were detected in monitoring wells in no identified pattern by well location. Patterns of VOC contamination were found between wells in the shallow bedrock aquifer but not between wells in the overburden aquifer. Several recognizable groundwater contaminant patterns (i.e., TCE and 1,2-DCE) originate in an area upgradient of Sites 5 and 7 and downgradient of the background wells in this area.

The extent of these patterns suggests that contaminants enter the shallow bedrock aquifer from a relatively discrete area within Site 6 and that both patterns may originate from the same source. The potential for contaminated groundwater to migrate from the shallow bedrock to deeper bedrock aquifers cannot be determined with available information.

Contaminant Fate and Transport - Area B

The major contaminant transport pathways for Area B include leaching of subsoil contaminants to groundwater, soil runoff into surface water, discharge of groundwater to surface water, fugitive dust emissions from soil, and migration of contaminants in groundwater to off-site areas.

Potential human and environmental exposure pathways identified under current or future land-use scenarios for Area B include ingestion, dermal, and inhalation exposures to chemicals in groundwater, dermal and incidental ingestion exposure to stream surface water and sediment, and dermal exposure, incidental ingestion, and fugitive dust inhalation of soil contaminants. The primary focus of this report is the investigation of on-site shallow groundwater and the potential migration of this groundwater to off-site locations.

Risk Assessment - Area B

Groundwater chemicals of concern were selected based on exceeding background or upgradient concentrations, exceeding ARARs or dose-response parameters, and carcinogenic status. Three receptors were chosen for the shallow groundwater exposure pathway: adult residents, child residents, and adult employees.

The shallow groundwater underlying Area B presents several noncarcinogenic and carcinogenic risks to human receptors. Noncarcinogenic risks were estimated by use of HQs and HIs. When HQs exceed 1.0, potential adverse effects can no longer be ruled out. Carcinogenic risks were estimated using cancer slope factors. Cancer risk increases should ideally be below 1E-6, although sometimes risks up to 1E-4 may be considered acceptable.

The HIs for hypothetical ingestion of current groundwater at Area B by residents would exceed 1.0 because of arsenic, barium, cadmium, and manganese. If filtered groundwater were used instead, the child resident's HI would exceed 1.0 because of thallium. Estimated cancer risk increases for the hypothetical ingestion of current groundwater by all receptors would exceed 1E-5 because of arsenic, PCE, and carbon tetrachloride. The estimated cancer risk increases for dermal exposure to adult residents would exceed 1E-6 due to TCE and PCE.

Estimated blood-lead concentrations from exposure to lead in groundwater, would not be expected to pose a significant detectable risk. However, some potential (currently unquantifiable) carcinogenic risk would occur, according to the no-threshold theory of carcinogenicity.

Currently, the only enforceable standards for exposure to groundwater contaminants are the MCLs. MCLs were exceeded for TCE in the groundwater samples collected from monitoring wells located in the vicinity of Area B. These exceedances were detected in three shallow bedrock wells during both phases of the RI.

Conclusions - Area B

Additional investigation should be performed as necessary to characterize the nature and extent of groundwater and soil contamination in this area. At a minimum, these tasks should include

- Additional monitoring wells as needed to define the upgradient extent of shallow bedrock aquifer contamination and the extent of any deeper bedrock aquifer contamination.

- Additional soil borings and test pits to better define the possible source area of groundwater contamination within Site 6.

- Additional soil samples to determine the potential impacts from uncovered waste at Site 6. Surface debris at Site 6 may be the source of surface water and sediment contamination via overland runoff. The surface debris should be located, characterized, sampled, and mapped.

- Additional surface and subsurface sampling within Area B to determine the extent of soil contamination and to assess potential risks from direct contact with any contaminated soils.

- Additional sediment sampling to determine the extent of stream contamination due to the sites located within Area B.

- Additional groundwater investigation to characterize flow in the shallow bedrock aquifer beneath Area B, hydraulic interconnections between the shallow and deeper bedrock aquifers, and the potential for contaminated groundwater to discharge to Southampton Creek.

- Evaluate the need for additional air monitoring to assess risks in areas of potential concern identified through aerial photointerpretation.

- An additional well survey to determine whether nearby groundwater receptors (e.g., residential wells) are potentially at risk due to releases from Area B. Off-site groundwater sampling should be performed as necessary based on this survey.

No conclusive evidence was collected during the RI to confirm the location of Site 7 or to determine if hazardous materials are present at this site.

It is recommended that further investigation be explored for metals in groundwater near Area B. Suspended materials may be responsible for significant concentrations of arsenic, barium, cadmium, and manganese, but thallium was the only contaminant detected at significant concentrations in filtered groundwater samples (one well only). Resampling of both filtered and unfiltered water may be warranted to confirm the presence of thallium.

Groundwater in overburden and shallow bedrock contaminated by NAWC Warminster beneath Area B has been found to present an unacceptable risk to human health. Based on information generated during the RI, adequate data exist to proceed with the evaluation of remedial alternatives for overburden and shallow bedrock contaminated groundwater through the FS process. Additional sampling and investigation are needed for other media associated with Area B, including groundwater in deep bedrock aquifers.

ADDITIONAL GROUNDWATER INVESTIGATIONS

Since 1979, a number of wells within Warminster Township and other nearby townships have been sampled for VOCs, and contamination by VOCs has made some groundwater unsuitable for public supply. Between September 1979 and April 1980, five nearby municipal authorities (along with NAWC Warminster) removed a total of 18 public wells from service due to VOC contamination, primarily TCE and PCE. Some of these wells have been returned to service following the installation of air-stripper treatment facilities. TCE has been found in NAWC Warminster supply wells SW-1 and SW-2 at 147 and 293 ppb, respectively; PCE has been found in supply wells SW-5 and SW-2 at 36 and 33 ppb, respectively.

Off-Site Groundwater Investigation

During Phase I, a local well inventory was performed to determine the number of residential and municipal wells that were near the facility. During Phase II, four off-site wells were sampled. All samples were analyzed for TCL volatile organics, TAL metals (both total and dissolved), and cyanide. One groundwater sample was also tested for TCL semivolatile organics and pesticides/PCBs.

Off-Site Groundwater Use

Groundwater in much of the Warminster area is used as a source of drinking water. Nearby residents rely primarily on groundwater sources for water supply. The majority of these people are served by municipal water authorities, and the remainder utilize private domestic or commercial wells. The main NAWC Warminster supply system obtains water from three deep wells located at the facility. Some local municipal water authorities supplement their groundwater withdrawals with water from the Philadelphia Suburban Water Company.

Within the immediate vicinity of NAWC Warminster (less than one mile) are supply wells for the Warminster Municipal Township Authority (WMTA), Upper Southampton Municipal Authority, Warminster Heights Development Corporation, and other commercial facilities. Municipal supply wells and other wells in the area pump several hundred million gallons of groundwater per year, mainly from deeper bedrock zones of the Stockton Formation. Several public and commercial water-supply wells near NAWC Warminster have encountered significant levels of VOC groundwater contamination.

Eight municipal water-supply wells were identified within the 0.75-mile radius of the facility; however, WMTA Well-26 (WTMA-26) is located 0.4 mile from the facility. The three commercial wells are operated by Aztec Corporation, Wagner & Sons, and a local golf course. Between 47 and 91 residences and businesses within 0.25 mile of the facility property boundary have private supply wells. For confirmed residential wells, well depths range from 30 to 145 feet below grade. Therefore, some nearby residential wells are assumed to be drawing from the shallow bedrock aquifer that also underlies the facility.

Residences served by wells are concentrated in three principal areas. One area is between Davisville Road and the facility. Another area is on Newtown Road, north of Street Road, and the third is on Maple and Memorial Streets, southwest of NAWC Warminster. None of these areas are directly downgradient of any of the Areas A and B with respect to the shallow bedrock aquifer.

Several residential wells were reported to contain TCE and/or PCE during the well survey. Independent sampling to confirm this has not been performed as a part of the RI.

Nature and Extent of Off-Site Groundwater Contamination

Off-site wells sampled during Phase II included the Wagner & Sons well, WTMA-26, the Lewis well, and the Aztec Corporation well. The Wagner well is used for industrial purposes, including food processing. WTMA-26 supplies potable water to local homes and businesses. The Lewis well is a residential well, and the uses of the Aztec well are unknown.

The Wagner well is treated with carbon filtration and UV treatment but was sampled prior to treatment. TCE was found in this well at 720 ug/l. Filtered and unfiltered results were comparable, except for lead, which was much lower in the filtered sample. The notable inorganic results include arsenic and lead (carcinogens).

WTMA-26 is treated with an air stripper but was sampled prior to treatment. Both chlorinated ethenes and chlorinated ethanes were detected. Filtered and unfiltered inorganic results were comparable, and arsenic, a Group A human carcinogen, was detected in this well. Groundwater from the Lewis well is reportedly not treated. No organic compounds were positively detected in this well. Filtered and unfiltered inorganic results were comparable.

PCE was detected at the Aztec well at a low concentration (2 ug/L). Filtered and unfiltered inorganic results were similar; arsenic (a Group A human carcinogen) was notable.

Transport of Contaminated Groundwater Off Site

Contaminated groundwater within the water-table (or overburden) aquifers may move laterally within these aquifers to off-site locations or surface water discharge points or may move vertically into deeper bedrock aquifers. Contaminated groundwater in bedrock may move off site along bedding planes or within fractures and may be under confined or unconfined conditions. Migration of groundwater in bedrock is influenced by on-site and off-site pumping wells.

Risk Assessment for Off-Site Groundwater

For employees exposed to untreated water from the Wagner well, the cancer risk via ingestion would exceed 1E-6 but not 1E-4 because of TCE and arsenic. The dermal risk would exceed 1E-6 but not 1E-4 because of TCE.

Ingestion by child residents of untreated water from WTMA-26 may pose some noncarcinogenic risk, although the chemicals that would combine to produce such a risk actually affect different organ systems (arsenic, skin; barium, cardiovascular system; PCE and 1,1-DCE, liver). Dermal cancer risks for all receptors would exceed 1E-6 but not 1E-4 due to PCE, TCE, and 1,1-DCE. The ingestion risk for adult employees would exceed 1E-6 and for residents would exceed 1E-4 because of arsenic, PCE, TCE, and 1,1-DCE. The inhalation risk for adult residents would exceed 1E-6 but not 1E-4 due to 1,1-DCE and TCE.

Because public water supplies must comply with National Primary Drinking Water Regulations, these estimated risks are not expected to reflect exposures to actual current consumers of this water. Rather, they indicate anticipated risks for consumption of this water in an untreated state.

Neither significant noncarcinogenic nor carcinogenic impacts were indicated for residential receptors of water from the Lewis well.

Because of arsenic, the total cancer risk via the ingestion route would exceed 1E-6 but not 1E-4 for employees consuming untreated water from the Aztec well. Significant noncarcinogenic hazards are not indicated.

Prior to treatment, MCLs were exceeded for TCE in both the Wagner and WTMA-26 wells and for lead and manganese in the Wagner well. For WTMA-26, MCLs were also exceeded for PCE and 1,1-DCE prior to treatment.

Conclusions for Off-Site Groundwater

Based on the results of Phase I and II, additional investigation should be performed to evaluate the number of off-site residential wells near NAWC Warminster and the specific groundwater uses (e.g., drinking water) of these wells. Survey recipients who were suspected to have wells and did not respond to the survey should be contacted again. The local county health department should also be contacted. More specifically, the residences along Kirk and Newtown Roads are of particular interest. It is recommended that all the residents along these two roads should be canvassed.

While off-site deeper groundwater in the vicinity of the Wagner well presents a potential unacceptable risk, current information is inadequate to evaluate remedial alternatives. Additional sampling and investigation should be performed, including

- Installation of additional monitoring wells as needed to define the upgradient and downgradient extent of groundwater contamination due to releases from Area A to the overburden, shallow bedrock, and deeper bedrock aquifer.

- Review of historical data for off-site or other sources of groundwater contamination in the vicinity of the western portion of NAWC Warminster.

- Research and generation of production information and construction details for off-site wells, including the Wagner and Sons, WTMA-26, and Aztec wells.

- Generation and analysis of water-level and production data for all on-site wells, including both monitoring and NAWC Warminster production wells.

- Hydrogeologic investigation as necessary to determine deeper bedrock aquifer characteristics and the effect of nearby supply wells on groundwater flow directions in the vicinity of the western portion of NAWC Warminster.

1.0 INTRODUCTION

In response to Contract Task Order No. 22 under Contract N62472-90-D-1298, Halliburton NUS Corporation (HNUS) is submitting this Remedial Investigation (RI) report for the Naval Air Warfare Center (NAWC) (formerly the Naval Air Development Center), Warminster, Pennsylvania. This work is part of the Navy's Installation Restoration Program (IRP), which is designed to identify contamination of Navy and Marine Corps facilities resulting from past operations and to institute corrective measures as appropriate. IRP activities are typically performed in four distinct phases. The first phase consists of a Preliminary Assessment (PA) followed by a Site Inspection (SI). The third phase is a Remedial Investigation/Feasibility Study (RI/FS), which is intended to characterize physical and chemical parameters and risks associated with the facility. The last phase consists of remedial action designed to control and mitigate contamination. This report is prepared under Phase III IRP activities.

In addition to meeting the objectives of the Navy's IRP, the purpose of the RI is to meet the requirements of CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act of 1980), as amended by SARA (Superfund Amendments and Reauthorization Act of 1986). As such, the RI should investigate the nature and extent of contamination associated with all hazardous substance releases at the facility that are not regulated and are not being investigated under the authority of the Clean Air Act, Clean Water Act, the Resource Conservation and Recovery Act (RCRA), and other Federal laws.

1.1 PURPOSE OF REPORT

The purpose of this report is to present results of the remedial investigations conducted at NAWC Warminster. Data from these investigations are used to conduct baseline risk assessments, which are also included in the report. The risk assessments determine where unacceptable risks to human health have been identified. The report also identifies where additional investigations are needed to complete risk assessments and where FSs should be performed to evaluate remedial alternatives for identified contamination.

1.2 SCOPE AND OBJECTIVES

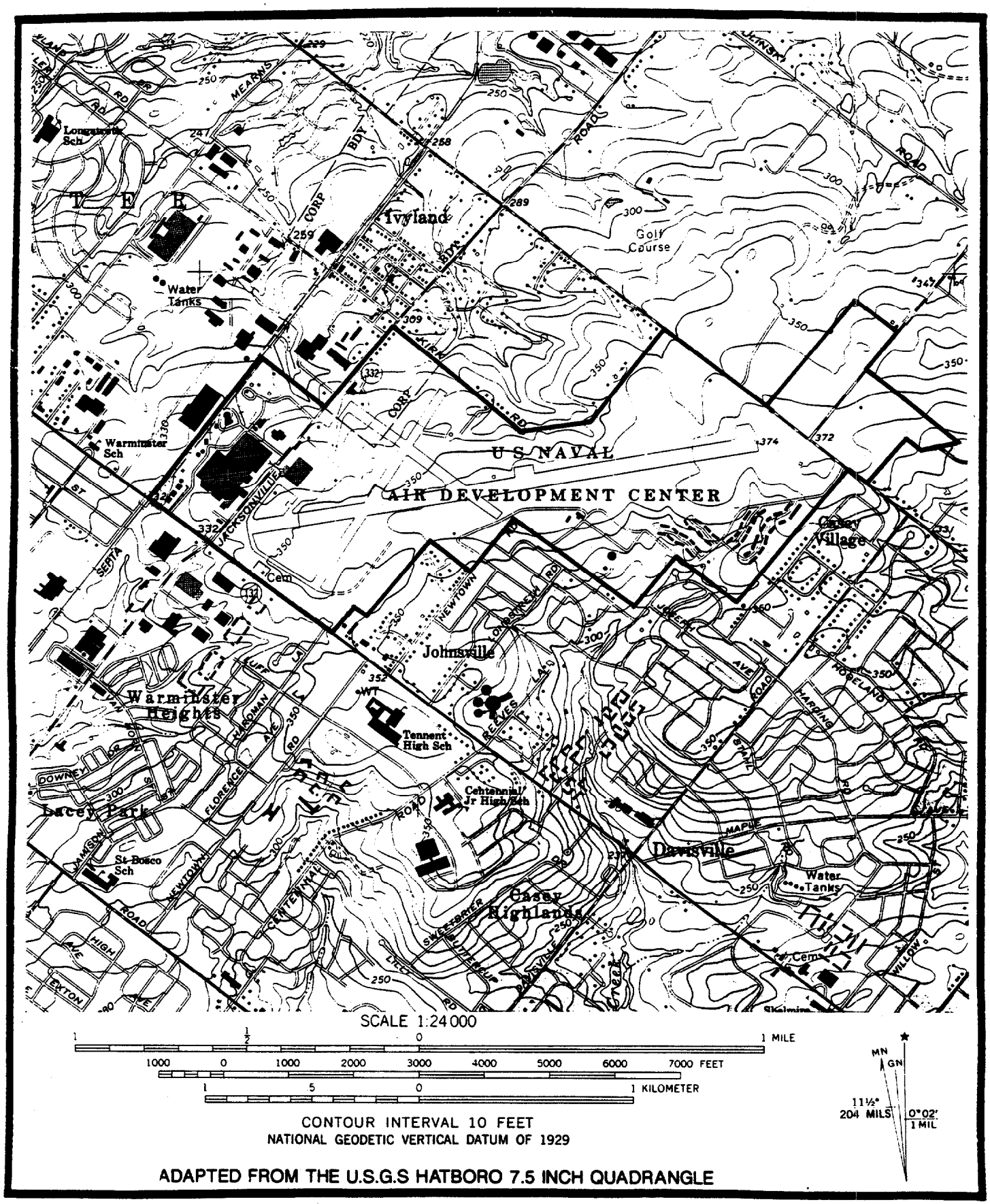
The areas of concern identified to date at NAWC Warminster are eight sites covering more than seven acres (Figure 1-1). All sites are located within the NAWC Warminster property, including

- Three waste burn and disposal pits (Sites 1, 3, and 6)
- Two sludge disposal pit area (Sites 2 and 7)
- Two landfills (Sites 4 and 5)
- One fire training area (Site 8)

Table 1-1 summarizes the disposal history and types of waste deposited at these sites. None of the sites are currently used for waste disposal.

Although each site was investigated as part of the RI, this report focuses on on-site groundwater contamination in the overburden and shallow bedrock aquifers at Sites 1, 2, and 3 (Area A) and Sites 5, 6, and 7 (Area B). These areas comprise a portion of Operable Unit 1 (OU-1), which has been defined as any groundwater in overburden and shallow bedrock contaminated by NAWC Warminster property. For NAWC Warminster, remedial actions are being implemented in phases as appropriate using OUs to manage problems and expedite the reduction of risks posed by the facility.

The objectives of the RI for Areas A and B were to characterize the nature and extent of potential overburden and shallow bedrock groundwater contamination at these areas, to better understand the physical parameters affecting contaminant fate and transport, and to assess risks to human health and the environment. In addition, information on local hydrogeology was collected and evaluated. The main focus of the overall RI for NAWC Warminster to date has been to determine groundwater impacts from eight inactive wastes sites identified above, particularly the location and concentration of potential groundwater contamination by volatile organic compounds (VOCs) and metals. A more detailed description of each site in Areas A and B can be found in Sections 4 and 5 of this report. Data collected during the RI will be used to evaluate potential remedial options and to support the FS.



SITE LOCATION MAP

NAWC AND SURROUNDING AREA

FIGURE: 1-1

HALLIBURTON NUS
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TABLE 1-1
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)

Additional remedial investigations are planned by the Navy to fully identify the nature and extent of contamination at OU-1 and for the rest of the facility. This includes studies to address the full extent of groundwater contamination, both on and off site, in the shallow and deep bedrock aquifers, as well as contamination in other media.

NAWC Warminster is listed on the National Priorities List (NPL). The NPL includes those sites that appear to pose the most serious risks to public health or the environment. Two remedial investigations (Phases I and II) were conducted at these sites between October 1989 and August 1992. Phase I was performed between October 1989 and January 1991 by SMC Environmental Services Group. Phase II was performed between May and August 1992 by HNUS. A Technical Review Committee, which consisted of representatives of the Navy, the United States Environmental Protection Agency (EPA), the Pennsylvania Department of Environmental Resources (PA DER), the Bucks County Health Department, the Northampton Township Municipal Authority, the Warminster Township Municipal Authority, and Upper Southampton Township assisted in the planning and review of these activities.

To the extent practicable, the results of both the Phase I and II RIs have been incorporated into this report.

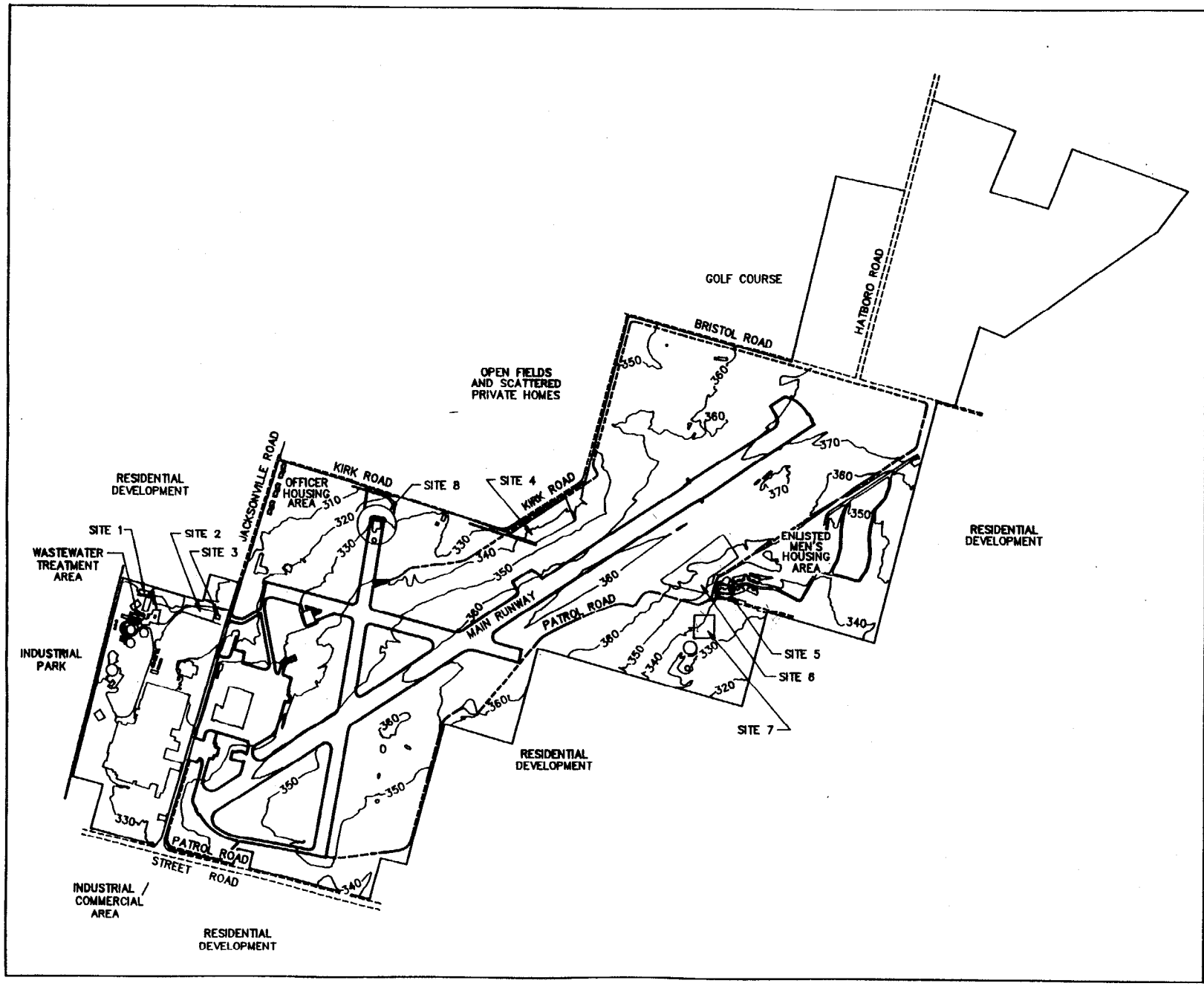
1.3 SITE BACKGROUND AND HISTORY

This section describes NAWC Warminster and provides a brief synopsis of the facility's background and history. More detailed discussion is provided in the RI work plans.

1.3.1 Site Description

NAWC Warminster is located in the Township of Warminster, Bucks County, Pennsylvania. The facility can be found on the United States Geological Survey (U.S.G.S.) Hatboro 7.5-minute topographic quadrangle map, a portion of which is reproduced as Figure 1-2. The total area of NAWC Warminster is approximately 734 acres. The facility lies in a populated suburban area surrounded by private homes, various commercial/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 facility. Many of the primary facility buildings are located west of the airstrip, along Jacksonville Road. A housing development for military enlisted personnel is within the southeastern portion of NAWC Warminster. The on-site wastewater treatment plant in the northwestern corner of the facility.



LEGEND

SITE 6 — SITE

360 — TOPOGRAPHIC CONTOUR MAP

RAILROAD TRACKS

NAWC
WARMINSTER, PA

FIGURE 1-2

LOCATION OF EIGHT NAWC WASTE SITES

HALLIBURTON NUS
Environmental Corporation

Adapted From SMC Environmental Services Group, 1991

SCALE: 1"=1000' | DATE: 10/12/92

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NAWC Warminster has approximately 3,000 employees, and 1,000 people reside at the facility year round. The residents living at the facility are the nearest population center. The closest off-base home is about 200 feet away. The facility 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. Slopes are gentle and average three to five percent. The northern portion of the facility (about 65 percent) drains into small, unnamed tributaries of Little Neshaminy Creek. The remaining portion drains into unnamed tributaries of Pennypack Creek.

Any hazardous substance releases from eight sites identified to date and from other unidentified sites at NAWC Warminster potentially affect the Stockton Formation aquifer, which provides water for more than 100,000 people within the vicinity of the facility. Local surface water bodies are used for recreation and industrial purposes.

1.3.2 Site History

Commissioned in 1944, NAWC Warminster's main mission is research, development, testing, and evaluation for naval aircraft systems. NAWC Warminster also conducts studies in anti-submarine warfare systems and software development. Historically, wastes were generated during aircraft maintenance and repair, pest control, firefighting training, machine and plating shop operations, spray painting, and various materials research and testing activities in laboratories. These wastes included paints, solvents, sludges from industrial wastewater treatment, and waste oils.

EPA officially recognized the NAWC Warminster sites as possibly needing investigation in September 1979. In November 1979, EPA completed a PA. In 1980, the Department of the Navy began its environmental investigative work at NAWC Warminster. The first study, known as the Clay/Law Report, inventoried disposal activities at each of the eight sites. Since 1980, a variety of environmental consultants under Navy contracts have studied these sites. The first of these reports, prepared by JRB Associates in 1983, concluded that on-site contamination existed but probably was not affecting off-site water supply wells.

In 1985, EPA completed a PA/SI Report. In 1986, NAWC Warminster was proposed for inclusion on the NPL based on a Hazard Ranking System (HRS) score greater then 28.50. EPA used the HRS to assess the relative threat from releases of hazardous substances from the eight NAWC Warminster sites to surrounding groundwater and surface water. The facility score was based on the likelihood that a hazardous substance would be released from the sites, the toxicity and amount of hazardous substances at the sites, and the people and sensitive environments potentially affected by contamination at the sites. From 1988 to 1991, SMC Environmental Services Group performed a comprehensive multi-stage Phase I RI of the eight NAWC sites.

On October 4, 1989, NAWC Warminster was placed on the final NPL. That same year, EPA submitted a draft Interagency Agreement to the Navy for formalizing and scheduling remedial activities. The contents of this agreement were negotiated in 1990. In 1991, HNUS was tasked to complete RI/FS activities at the facility.

1.3.3 Current Status

To date, the NAWC Warminster sites are being addressed by the Navy in two long-term remedial phases. The study for the first phase began at the end of 1989 and was completed in April 1991. Phase I involved mapping VOCs in soil gas and detecting magnetic and conductive anomalies through electromagnetic surveys. Approximate site boundaries were identified and confirmation of site contamination was made through soil borings, installation of new overburden and shallow bedrock monitoring wells, and groundwater sampling and analysis. In addition, test pits were excavated, local wells were inventoried, and a fracture-trace analysis was conducted.

Phase II began at the end of 1991 and is currently ongoing. This phase will help determine the type and extent of groundwater contamination, evaluate groundwater flow and add to the hydrogeologic database, and ascertain possible remedial alternatives. Both phases will explore the nature and extent of groundwater contaminants and will pinpoint the most effective strategies for cleanup.

NAWC Warminster is scheduled for realignment under the Base Realignment and Closure (BRAC) Program managed by the Department of Defense. The realignment of the facility is tentatively scheduled for March 1995; however, this timetable is still being developed. As such, the future use of the NAWC Warminster property had not been finalized at the time of this report.

1.4 PREVIOUS INVESTIGATIONS

Since 1979, NAWC Warminster, regulatory agencies, and others have been involved in various regional environmental response actions for the study area. Some regional actions have been specific investigations of the NAWC Warminster sites. Table 1-2 provides a chronological list of regional response actions and previous investigations.

Previous investigations have found groundwater to be contaminated with VOCs, including methylene chloride, toluene, trichloroethene (TCEA), 1,2-dichloroethene, chloroform, tetrachloroethylene (PCE), 1,1,1-trichloroethane (1,1,1-TCEA), and various heavy metals (beryllium, copper, lead, nickel, zinc). Groundwater concentrations have exceeded the Safe Drinking Water Act Maximum Contaminant Levels (MCLs) for several VOCs detected. A number of off-site drinking water wells have also been affected by VOC contamination, although it has not been determined whether this contamination is related to waste disposal operations at NAWC Warminster. The soil at NAWC Warminster is also contaminated with VOCs, polycyclic aromatic hydrocarbons (PAHs) (e.g., chrysene and fluorene), petrochemical sludges, lead, and waste oils.

Nearby residents risk potential exposure through direct contact with contaminated soil and groundwater. Residential wells sampled in 1984 showed the presence of some VOCs, but these were not detected when the wells were resampled later that year. People using the site could be exposed to contaminants through accidental ingestion or direct contact with soils or through inhaling contaminated air.

Since 1979, a number of wells within Warminster Township and other nearby townships have been sampled for VOCs, and contamination by VOCs has made some groundwaters unsuitable for public supply. Between September 1979 and April 1980, five nearby municipal authorities (including NAWC Warminster) removed a total of 18 public wells from service due to VOC contamination, primarily TCE and PCE. VOC concentrations in deeper aquifers underlying NAWC Warminster are within the low range of regional concentrations (maximum of 87,000 ppb for TCE and 26,000 ppb for PCE). TCE has been found in NAWC Warminster supply wells SW-1 and SW-2 at 147 and 293 ppb, respectively; PCE has been found in NAWC Warminster supply wells SW-5 and SW-2 at 36 and 33 ppb, respectively. Figure 1-3 shows the location of the facility's supply wells.

TABLE 1-2
HISTORY OF RESPONSE ACTIONS FOR NAWC WARMINSTER

DATE	RESPONSE ACTION
September 1, 1979	The United States Environmental Protection Agency (EPA) recognized NAWC Warminster as a site needing investigation because of regional groundwater contamination.
September 1979	The Warminster Municipal Authority discontinued the use of water supply wells due to volatile organic compound (VOC) contamination. The Upper Southampton Authority removed three wells from the public water supply system because of VOC contamination.
October 1979	EPA began testing municipal, industrial, and domestic wells within the region for VOC contamination. The Warminster Heights Development Corporation and the Warrington Water Company discovered VOCs in water supply wells.
November 1, 1979	EPA officially completed a preliminary assessment of NAWC Warminster.
December 1979	NAWC Warminster removed three water supply wells from service. The Hatboro Water Authority closed six supply wells.
1980	In response to the discovery of regional groundwater contamination, the United States Department of the Navy implemented the Navy Assessment and Control Installation Pollutants (NACIP) program. This program has been assessing the potential for groundwater contamination to emanate from the NAWC facility.
January, 1980	The Horsham Township Authority removed one water supply well from service.
February 6, 1980	EPA filed a "tentative disposition form" to NAWC. The form was officially sent for distribution on February 29, 1980. EPA uses the form to identify potential hazardous waste sites. The February 6 EPA tentative disposition concluded that there was insufficient evidence available to determine if NAWC was a contributing source for the regional trichloroethylene (TCE) groundwater contamination. EPA proposed that NAWC perform an investigation of the facility including the drilling of test borings.
February 19, 1980	SMC Martin, subcontracted by the Navy, performed a soil boring investigation at NAWC. A total of eight test borings were drilled.

TABLE 1-2
HISTORY OF RESPONSE ACTIONS FOR NAWC WARMINSTER

DATE	RESPONSE ACTION
May 28, 1980	SMC Martin, under contract to the Navy, completed the report entitled Investigation of TCE Concentrations in Soils at the U.S. Naval Air Development Center, Warminster, Pennsylvania. The report discussed the discovery of TCE contamination of soils within the vicinity of the NAWC wastewater treatment plant. The maximum soil contamination detected was 78 parts per billion (ppb). SMC Martin recommended a groundwater monitoring program adjacent to the sewage treatment plant.
December 1980	A series of birth defects occurred in a development southwest of NAWC Warminster and were reported to the Bucks County Health Department. The Health Department conducted a house-to-house survey of the residents in the area. The Health Department determined that the series of birth defects was within a normal range of statistical probability for the area. However, due to the confirmed reports of regional groundwater contamination and the public concern for the problem, the Department of the Navy continued study of the facility.
December 4, 1980	The Navy completed the Clay/Law report entitled "Navy Shore Activity Disposal Site Fact Form." This document outlined waste disposal activities at each site and constituted the first phase of the Navy's NACIP assessment.
December 10, 1980	SMC Martin, under contract to the Navy, completed a report entitled Investigation of TCE Contamination of Groundwater at the Naval Air Development Center, Warminster, Pennsylvania. The report indicated that TCE contamination of groundwater was detected in a shallow well and in a deep well adjacent to the NAWC sludge lagoons. TCE concentration for the shallow well was 130 ppb. TCE concentration for the deeper well was 7 ppb. SMC Martin suggested that the source of the TCE groundwater contamination may be leakage from the NAWC sludge lagoons. The report stated that it was unlikely lagoons were the sole source or even a major source of the contamination found in two nearby NAWC water supply wells.
April 1981	The Horsham Township Authority removed an additional well from the public water supply system.
June 9, 1981	NAWC submitted a Hazardous Waste Site Notification Form to EPA.

TABLE 1-2
HISTORY OF RESPONSE ACTIONS FOR NAWC WARMINSTER

DATE	RESPONSE ACTION
June 24, 1981	EPA filed a "US EPA Final Strategy Determination for a Potential Hazardous Waste Site" for NAWC. The form was officially sent for distribution. The EPA final strategy determination concluded that off-site contamination had not been linked to NAWC and that contamination off site was unlikely. It was recommended that EPA, state, local, and private parties should take no further action.
December 21, 1981	JRB Associates, under contract to the Navy, completed the Hydrogeologic Investigation of the Naval Air Development Center Waste Disposal Sites, Warminster, Pennsylvania. Task 1 - Records Search, Preliminary Site Investigation, and Recommendations for Task 2. This report detailed the recorded waste disposal practices that had occurred at the facility and ranked each of the nine suspected problem locations with respect to their potential for contaminating groundwater.
March 1, 1982	JRB Associates completed a Hydrogeologic Investigation of the Naval Air Development Center Waste Disposal Sites, Addendum to Task 1. This report investigated NAWC Sites 1, 2, and 3 with respect to their potential for contaminating groundwater.
August 1982	Malcolm Pirnie, under contract to the Navy, completed the Organic Contaminant Treatability Study, Naval Air Development Center, Warminster, Pennsylvania. This report recommended a specific treatment process for treating contaminated NAWC water supply wells. The recommended treatment was intended to produce potable water meeting EPA and PA DER drinking water standards.
March 17, 1983	JRB Associates, under contract to the Navy, completed the Hydrogeologic Investigation of the Naval Air Development Center Waste Disposal Sites, Warminster, Pennsylvania. Task 2 - Monitoring Well Installation, Sampling, Analysis of Samples and Groundwater Hydrology. This study included the installation of 14 shallow groundwater monitoring wells and the collection of groundwater samples from eight of the waste disposal sites. Site 9 was determined to be a soil stockpile area for clean, native soils. The results of the laboratory analysis of the NAWC groundwater samples confirmed the presence of certain VOCs. Generally, VOCs were found at concentrations lower than the regional norm. JRB Associates recommended a second confirmatory round of groundwater sampling and stated that it was unlikely that drinking water sources in the study area were being affected by NAWC sites.

TABLE 1-2
HISTORY OF RESPONSE ACTIONS FOR NAWC WARMINSTER

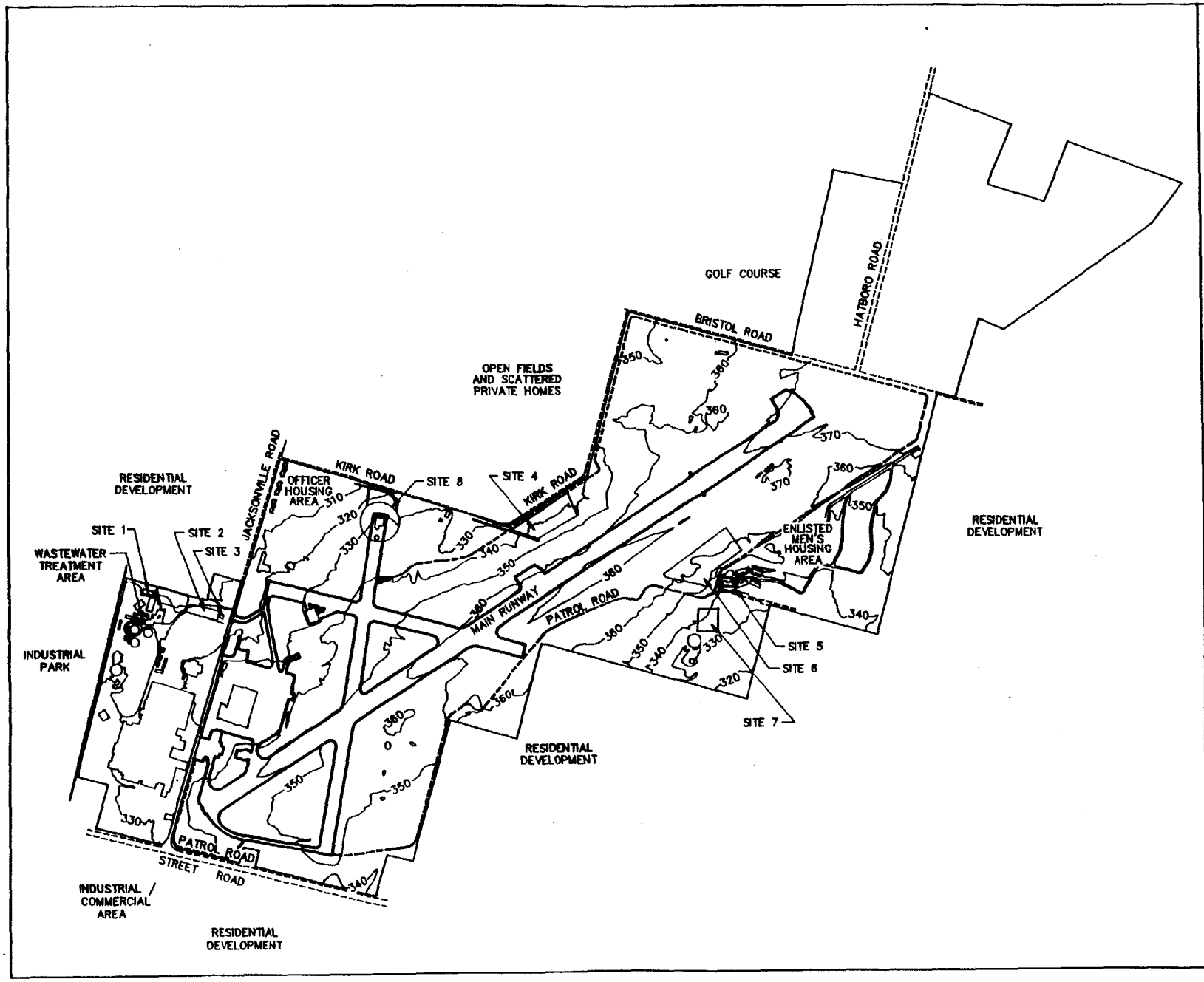
DATE	RESPONSE ACTION
May 1984	Walter B. Satterthwaite Associates, under contract to the Navy, completed the Final Report on the Groundwater Monitoring and Hydrogeologic Investigation for the Naval Air Development Center, Warminster, Pennsylvania. A second round of groundwater monitoring and an evaluation for the potential of contaminants migrating from the NAWC waste sites to the groundwater were performed. Water quality data collected during the second round of sampling identified volatile organic contamination consisting mostly of TCE in the NAWC water-table and semi-artesian zones adjacent to the centrifuge building. An off-site railroad grade and some off-site industrial buildings were implicated as sources for contamination found in NAWC water supply wells SW-1 and SW-2. The report proposed a hydrogeologic model for the NAWC study area consisting of four different zones or conditions in which groundwater may migrate. It was concluded that off-site groundwater quality had not been significantly influenced by NAWC sites.
June 24, 1984	PA DER outlined procedures that NAWC should follow during use of the fire training area (Site 8).
June 3, 1985	The Earth Technology Corporation, under contract to the Navy, completed the Well Profile Studies (Wells #1 and #2). The analytical results of the water quality samples collected from supply wells SW-1 and SW-2 indicated the presence of certain volatile organic and base/neutral compounds in the groundwater. Concentrations of TCE were found throughout the aquifer system(s) penetrated by the two supply wells. No determination was made as to the possible source for the contamination.
June 7, 1985	EPA completed a Preliminary Assessment and Site Inspection (PA/SI) of the facility. This assessment was performed for the EPA by NUS Corporation. The assessment outlined much of the NAWC work performed by JRB Associates and stated the importance of considering other possible sources (other than NAWC) for the regional groundwater contamination.
October 10, 1985	EPA completed a National Priorities List (NPL) ranking for the waste sites at NAWC. This NPL ranking provided a score for NAWC with respect to environmental risk. This score was used by EPA to determine if NAWC should be proposed for the NPL.

TABLE 1-2
HISTORY OF RESPONSE ACTIONS FOR NAWC WARMINSTER

DATE	RESPONSE ACTION
December 1985	The Earth Technology Corporation, under contract to the Navy, completed the Well Profile Studies (Wells #4 and #5). The laboratory results of the groundwater samples collected from supply wells SW-4 and SW-5 indicated the presence of certain volatile organic and base/neutral compounds. The report made recommendations on how the NAWC water supply could be remediated to produce potable water.
June 1, 1986	EPA proposed that NAWC be included on the NPL.
October 10, 1986	A representative of PA DER performed an on-site inspection of NAWC sites 1 through 9. The most salient PA DER recommendation concerning NAWC was the remediation of Site 8. PA DER recommended the following remedial actions for this site: the residue and contaminated soils should be excavated and properly/legally disposed; the site should not be used in its present form; and lining the site should help to protect groundwater and surface water.
October 1986 to February 1988	The Navy evaluated the impact of SARA and reorganized/converted the NACIP program to the IR program. NAWC continued periodic monitoring of on-site wells.
February 1988	The Earth Technology Corporation, under contract to the Navy, completed the Supplemental Well Profile Study (SW-3). Water quality results indicated concentrations of VOCs and metals throughout the aquifer(s) tested. The report recommended remedial alternatives to treat the well water in order to produce potable drinking water.
September 30, 1988	SMC Martin entered into an agreement to provide additional services for Navy at the NAWC. Navy Contract No. N62472-87-C-1283 called for SMC Martin to continue IRP studies of the eight sites at NAWC. Studies of the sites included a description of the current situation and the formulation of site-specific work plans.

TABLE 1-2
HISTORY OF RESPONSE ACTIONS FOR NAWC WARMINSTER

DATE	RESPONSE ACTION
October 21, 1988	As part of the on-going contract with the Navy, SMC Martin performed a site visit and observed the present condition of each site.
October 1989 to January 1991	SMC Environmental Services Group (formerly SMC Martin) performed a Phase I RI to investigate each site at NAWC Warminster.
April 1991	SMC Environmental Services Group completed a rough draft RI report for Phase I.
October 1991	HNUS entered into an agreement to complete a Phase II RI/FS for the Navy at NAWC Warminster under Contract No. N62472-90-D-1298.
June through September 1992	HNUS performed Phase II RI field activities.



LEGEND

SITE 6 — SITE

360 — TOPOGRAPHIC CONTOUR MAP

RAILROAD TRACKS

NAWC
WARMINSTER, PA

FIGURE 1-2

LOCATION OF EIGHT NAWC WASTE SITES

HALLIBURTON NUS
Environmental Corporation

Adapted From SMC Environmental Services Group, 1991

SCALE: 1"=1000' | DATE: 10/12/92

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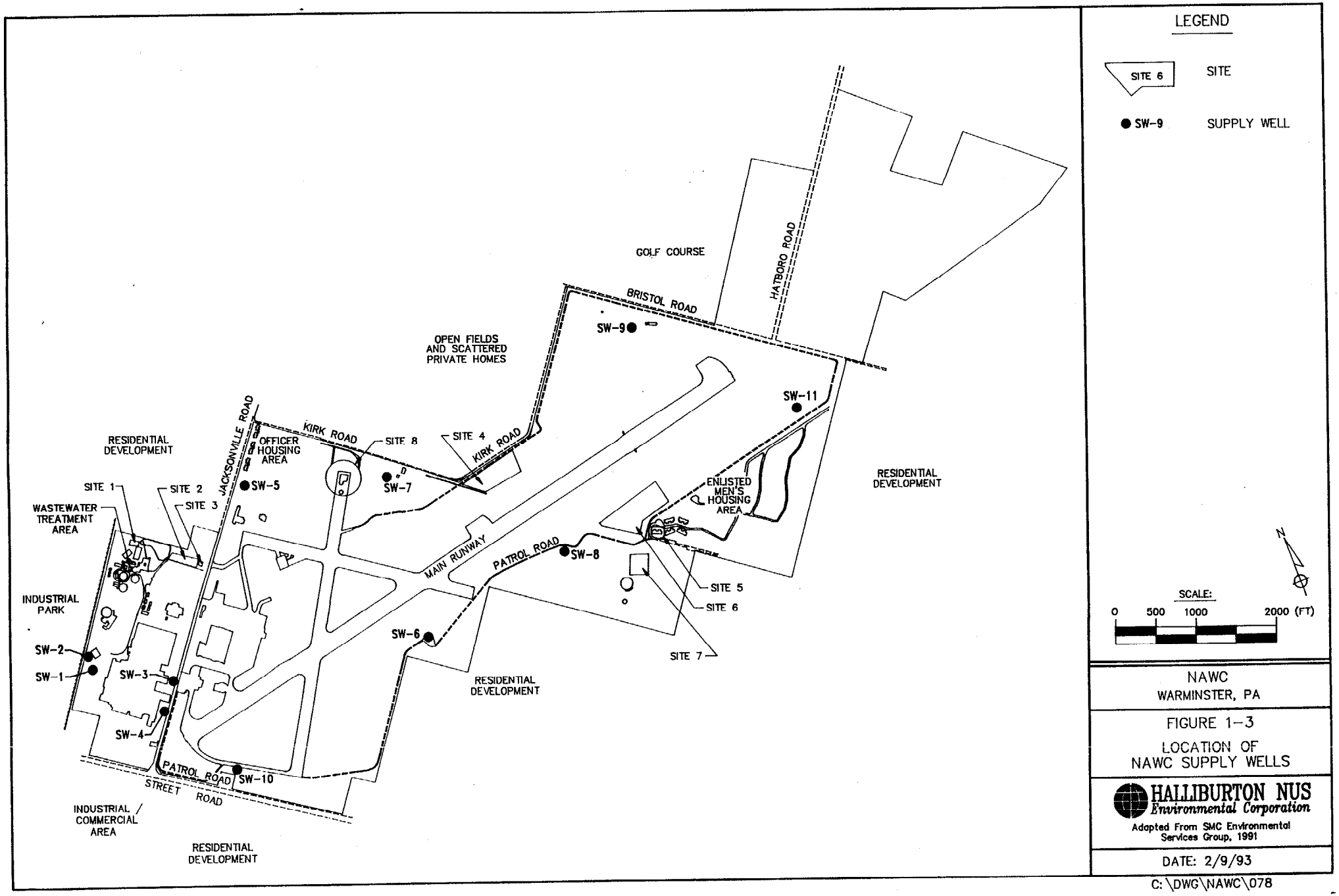

NAWC
WARMINSTER, PA

FIGURE 1-3
LOCATION OF NAWC SUPPLY WELLS

HALLIBURTON NUS
Environmental Corporation

Adapted From SMC Environmental Services Group, 1991

DATE: 2/9/93

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The deep wells at NAWC Warminster have been shown to be contaminated, but these wells are not immediately adjacent to those portions of OU-1 discussed in this RI report. The contaminated deep wells are hydrologically upgradient from Areas A and B.

1.5 REPORT ORGANIZATION

This report presents the results and recommendations related to the following investigation tasks performed at NAWC Warminster during the RI:

- Local well inventory
- Fracture-trace analysis
- Electromagnetic surveys
- Soil gas surveys
- Confirmation borehole drilling
- Test pit excavations
- Monitoring well installation
- Groundwater sampling
- Aquifer testing
- Surveying

Section 1.0 discusses the purpose, scope, and objectives of the report and provides a brief background summary for the NAWC Warminster sites. Section 2.0 details the field activities performed during the RI for Areas A and B. This section describes the objectives and methods of each investigative task conducted at these areas.

Section 3.0 presents the base-wide physical characteristics based on existing literature, previous investigations, and recently developed information and conclusions derived from the RI.

Sections 4.0 and 5.0 present a summary of previous and current investigations, analytical results, and contaminant migration pathways, as well as a summary and recommendations for each Sites 1, 2, 3, 5, 6, and 7. These sites have been grouped into two general areas based on geographic location (i.e., their proximity to one another), similarities regarding source and waste characteristics (i.e., methods of waste disposal and types of wastes deposited), and their common effects on nearby receptors (e.g., aquifers, surface water bodies, and human populations). The general areas are

- Area A -- Sites 1, 2, and 3 (Section 4)
- Area B -- Sites 5, 6, and 7 (Section 5)

Each site-specific section is an analysis of the physical aspects (e.g., site features, soils, hydrology, hydrogeology) of those sites in the respective general area. These sections also describe the nature and extent of contamination discovered at each site during field investigation tasks. In addition, the site-specific sections summarize the routes of migration and persistence of contaminants found at each site. These two factors are used to determine the possibility of contamination reaching areas of public or environmental concern.

The site-specific sections determine the potential risks posed by each general area to human health and the environment given the limiting factors of contaminant fate and transport. Finally, these sections summarize the findings of the RI and provide recommendations for further site characterization or remediation efforts.

Section 6.0 discusses the results of additional groundwater investigations (including off-site well sampling), primarily by describing the nature and extent of contamination discovered at wells not located within Areas and B. In addition, this section summarizes the potential risks to human health for off-site individual points of exposure.

Several appendices have been enclosed as separate volumes of the RI report; these present specific results of the field investigations (e.g., monitoring well logs, analytical data). (Note that some appendices (i.e., Appendices K and L) contain information that is not germane to this report.

2.0 STUDY AREA INVESTIGATION

The work plans to study NAWC Warminster were submitted as final documents on October 9, 1989 and May 29, 1992, respectively. Both work plans incorporated comments received from the Technical Review Committee (TRC). These plans described RI activities that were to be implemented to help identify those sites potentially releasing groundwater contaminants from current NAWC Warminster property.

Field activities were performed at the facility between October 1989 and January 1991 during Phase I and between June and August 1992 during Phase II. Field investigation procedures pertaining to NAWC Warminster OU-1, specifically Areas A and B, are described in the following sections.

2.1 GENERAL FIELD INVESTIGATION PROCEDURES

Implementation of Phase I was divided into two stages. Stage I was conducted between November 1989 and April 1990 and included

- A local well inventory
- A fracture-trace analysis
- Electromagnetic (EM) surveys
- Soil gas surveys
- Confirmation borehole drilling
- Test pit excavations

Stage II was completed after review and discussion of the Stage I data by TRC. Stage II was conducted between November 1990 and January 1991 and included

- Monitoring well installation
- Groundwater sampling
- Monitoring well location and elevation survey

Phase II was conducted between June and August 1992 and included

- Monitoring well installation
- Groundwater sampling
- Hydrogeologic investigations
- Monitoring well and soil sample location and elevation survey

The specific methods of the RI for Areas A and B are explained in the remainder of the section.

2.1.1 Local Well Inventory

Groundwater in much of the Warminster area is used as a source of drinking water. The objective of the local well inventory was to identify residential, business, and public water supply wells within 0.25 mile of the facility. With this information, sampling of private and/or municipal wells could be quickly completed, if deemed necessary by the RI program. Figure 2-1 displays the 0.25-mile study area.

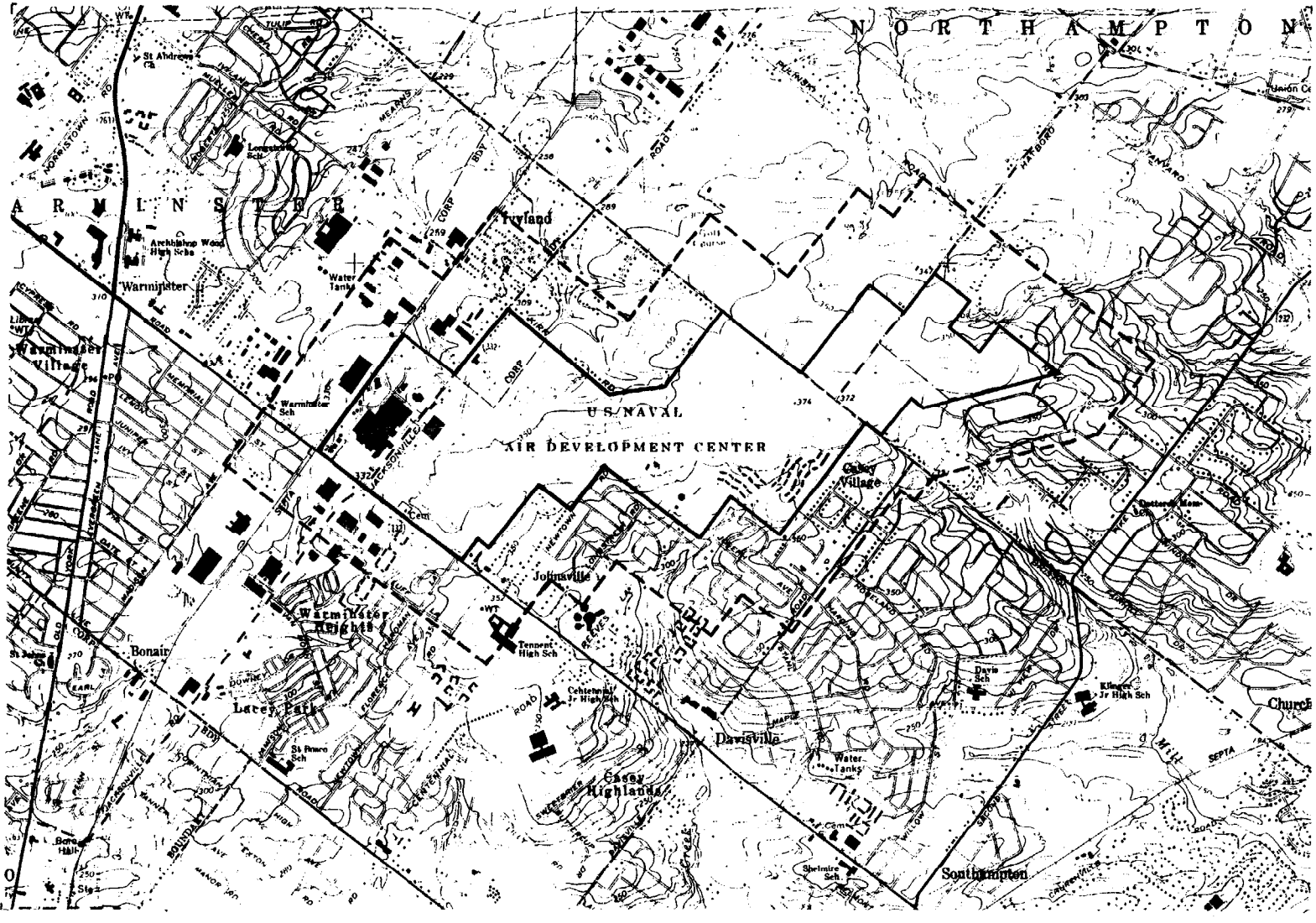
The local well inventory was completed as follows:

1. Information from the following sources was reviewed to identify properties within or near the study area possibly having groundwater wells:

   - Warminster Municipal Authority
   - Upper Southampton Municipal Authority
   - Northampton Municipal Authority
   - PA DER
   - Pennsylvania Geological Survey
   - Bucks County Health Department

   This review produced a list of properties, provided as Table 2-1, suspected to have groundwater wells.

2. A door-to-door survey of the study area was completed to confirm properties with groundwater wells. The survey was completed as follows:



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0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

0 .5 1 KILOMETER

CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

HATBORO QUADRANGLE
PENNSYLVANIA
7.5 MINUTE SERIES (TOPOGRAPHIC)

1966
PHOTOREVISED 1983
DMA 5964 II NE-SERIES V831

LEGEND

NAWC PROPERTY BOUNDARY

1/4 – MILE LIMIT OF RESIDENTIAL WELL SURVEY

N

NAWC
WARMINSTER, PA

FIGURE 2-1
1/4 MILE STUDY AREA FOR THE LOCAL WELL INVENTORY

HALLIBURTON NUS
Environmental Corporation

Adapted From SMC Environmental Services Group, 1991

SCALE: AS SHOWN | DATE: 10/12/92

TABLE 2-1
PROPERTIES SUSPECTED TO HAVE GROUNDWATER WELLS
NAWC WARMINSTER, PENNSYLVANIA

NAME	LOCATIONS
Lee	167 Kirk Road
Aztec Corp.	1218 Jacksonville Road
Wagner and Sons	Jacksonville Road
McCandless, Thomas R.	1026 Jacksonville Road
Garrano, Mrs. Frank	980 Jacksonville Road
Dunn, Roderick Jr.	1054 Jacksonville Road
Bull Sr., Tom W.	995 Davisville Road
Trauter, Maryann	
Inglin, Alfred, Jr.	1013 Davisville Road
Feichthalter, Nicholas	1023 Davisville Road
Ehrenfeuchter, Walter	1033 Davisville Road
Avayou, David J.	1043 Davisville Road
Santopietro, David J.	1111 Davisville Road
Hauber, Henry J.	1121 Davisville Road
Hanna, Joel	1131 Davisville Road
Dunleavy, Thomas F.	1141 Davisville Road
Russ, Joseph	1160 Davisville Road
Detwiler, David	1174 Davisville Road
Heiser, Walter	1203 Davisville Road
Getzler, Nathaniel	1213 Davisville Road
Greene, Joseph C.	1221 Davisville Road
White, Ethel K.	1229 Davisville Road
Gump, Raymond	1237 Davisville Road
Mueller, William	1355 Davisville Road
Keddie, Dale	1425 Davisville Road
Shiminske, Robert M.	1435 Davisville Road
WTMA Well #3	Munro Community Park
WTMA Well #2	Reeves Lane
WTMA Well #2 (PA DER list two wells as WTMA #2)	Hardinan Lane
WTMA Well #26	Thomas Drive
WTMA Well #3	Davisville Road and Elsie Drive
Golf Course Well	North of Bristol Road

TABLE 2-1 (continued)
PROPERTIES SUSPECTED TO HAVE GROUNDWATER WELLS
NAWC, WARMINSTER, PENNSYLVANIA

Name	Locations
USMA Well #4	Dungan and Yerkes Road
NMA Well #1	Boxwood Road and Upland Drive
USMA Well #3	Maple Avenue and Elsie Drive
Greco, Michael	266 Maple Street
Liebel, Lambert	256 Maple Street
Bofinger, John	250 Maple Street
Zelonis, Frank F.	227 Maple Street
Dougherty, Viola	286 Nemoral Street
French, Robert	256 Nemoral Street
Gerow, Gilbert H.	240 Nemoral Street
White, William J.	210 Nemoral Street
Narisi, Lucian	204 Nemoral Street
Dailey, Francis III	215 Nemoral Street
Armstrong, George B.	598 Newtown Road
Arrington, Anna S.	594 Newtown Road
McDonald, Thomas	628 Newtown Road
Rhodeside, Glenn	620 Newtown Road
Blackway, Richard	710 Newtown Road
Watson, David	740 Newtown Road
Garner, John W.	780 Newtown Road
Pitcher, Edwin	715 Newtown Road
Krueger, James	693 Newtown Road
Yerkes, Horace W.	685 Newtown Road
Kline, Kurt	673 Newtown Road
Fries, Wayne, N.	655 Newtown Road
Stanton, Robert	645 Newtown Road
Nice, Gerald A.	365 Newtown Road
	1280 Newtown Road
Palmer, George	26 Gough Avenue
McEntire, Barney	90 Gough Avenue
Troutman, Rudy	401 E. Street Road

TABLE 2-1 (continued)
PROPERTIES SUSPECTED TO HAVE GROUNDWATER WELLS
NAWC, WARMINSTER, PENNSYLVANIA

Name	Locations
Bergaver, Fred	638 Schoolhouse Lane
McKown, Mrs. Thelma	680 Schoolhouse Lane
Huf, Karl	651 Schoolhouse Lane
Porter, Stephen B.	891 Hostman Avenue
Russell, Richard	1060 Davisville Road
Carr, John	1094 Davisville Road
Dibattista, Michael	1104 Davisville Road
Niles, Joseph	1114 Davisville Road
Hood, Samuel A.	715 Rambler Road
Clawges, Elmer	718 Rambler Road
Greenstreet, Charles	727 Rambler Road
Finegan, Joseph B.	737 Rambler Road
Wolf, Robert	747 Rambler Road
Haertsch, Thomas	757 Rambler Road
Smith, George	767 Rambler Road
Robers, William C. Jr.	777 Rambler Road
Kulb, Albert	789 Rambler Road
Kenkelen, Edward	786 Rambler Road
Hopely, George	1125 Azalea Drive
Meissner, Edward	1103 Azalea Drive
Nomes, Mrs. Gloria	1093 Azalea Drive
Walter, Charles	1085 Azalea Drive
Tomko, Alex & Ruth	1065 Azalea Drive
Koelzer, Frederick Jr.	1055 Azalea Drive
Dershimer, John	1080 Azalea Drive
Jenceleski, Leon	1096 Azalea Drive
Neumann, Cora F.	1106 Azalea Drive
James, Robert	1116 Azalea Drive
Quigley, Francis	1126 Azalea Drive
Smith, Thomas	1069 Azalea Drive
Testa, Louis	1060 Orchid Road
Reiss, William J. Jr.	1100 Orchid Road
Schada, William	1110 Orchid Road
Tata, Angelo	1130 Orchid Road
Sabol, Joseph	1115 Orchid Road
Patton, James Jr.	1105 Orchid Road
Parabak, Stephen	1095 Orchid Road
Johnston, William	1063 Orchid Road

- Personnel visited properties listed on Table 2-1. These properties were suspected to have groundwater wells.

- When possible, a questionnaire was completed during the visit. Low response rates were obtained on the initial day of the survey. Subsequently, a questionnaire was left at the door if nobody was available during the door-to-door visits. At each property where a questionnaire was left, an attempt was made to retrieve a completed questionnaire the next day.

After a review of the completed questionnaires, a large aerial photograph was used to mark the probable locations of nearby local wells.

2.1.2 Fracture-Trace Analysis

A fracture-trace analysis was completed for the general study area utilizing stereoscopic aerial photographs taken on March 23, 1959. These photographs were the oldest stereoscopic pair available and were used to minimize the loss of significant surface features due to development on and off base. The objective of the fracture-trace analysis was to map the location of possible fractures, joints, and faults that occur in the bedrock underlying the site. These fracture-trace features are important because they may act as conduits for groundwater flow. Locating the fractures within the study area helped characterize the site groundwater flow patterns and was used to refine the locations of Phase I monitoring wells.

Fractures, joints, and faults in underlying bedrock may appear in aerial photographs as natural linear features upon the ground surface. Three different linear features have been named according to their length: fracture traces, lineaments, and joint traces. Lattman (1958, p. 569) defined a fracture trace as a geologic linear feature with a length of less than one mile and "lineaments" as those whose length is greater than one mile. Joint traces can be inches to 300 feet in length. All natural geologic linear features are referred to as "fracture traces" regardless of length in this report.

A figure was prepared using reproductions of aerial photographs for the study area with the confirmed fracture traces. These photographs were viewed with a stereoscope, and the linear features (i.e., the suspected fracture traces) were marked on an overlay. The linear features were field checked to eliminate man-made or other non-geologic features such as drainage ditches, unpaved roads, fences, and wildlife pathways. A final map, based on the field check, was also prepared. These fracture traces are shown on Figure 3-1, Section 3.4.1.

2.1.3 Electromagnetic Surveys

EM conductivity surveys were performed at all sites within Areas A and B except Site 5. These surveys helped delineate areas of underground anomalous conductivity. Areas of anomalous conductivity can indicate areas of waste burial, contaminated groundwater, and filling or other subsurface disturbance. The surveys also were important in indicating where metallic objects may be buried. This information was used in combination with the results of the soil gas surveys to indicate possible site boundaries, orientations of trenches or pits, depths of burial, and areas of waste and/or contamination.

EM surveys were conducted in two modes. The conductivity mode was used to map electrical conductivity anomalies possibly caused by the presence of contaminants or wastes. The "compensation mode" was used to map areas possibly containing large metallic objects.

The field work was performed during Phase I using an EM31-D Terrain Conductivity meter. The EM31-D works by transmitting an electromagnetic signal from the transmitting coil. This signal induces a secondary signal in the ground that is then measured by a receiving coil. The phase change in the signal received from the signal transmitted is proportional to the ground conductivity. The amplitude of the portion of the signal received, which is in phase with the transmitted signal, can be used to identify highly conductive materials, such as metal.

Readings are relative, not absolute; therefore, all surveys utilized profile lines to establish grid systems to aid in establishing relative differences across the target areas. Profiles utilized maximum station spacings of 30 feet, and the grids consisted of intersecting profile lines.

Before the surveys at Area A were conducted, the EM31-D was used to test these areas for cultural interferences before a full-scale survey was completed across the sites. Asphalt-paved areas near Site 2 were not suitable for the acquisition of competent data; however, Site 1, the remainder of Site 2, and Site 3 could be covered with reasonable success except in close proximity of fences, light posts, the wastewater lagoons, and other cultural objects.

2.1.4 Soil Gas Surveys

A soil gas survey was conducted at each site within Areas A and B during Phase I. The survey objective was to measure the concentrations of VOCs in soil gas around the sites. Waste reportedly handled or disposed at each site contained VOCs. Elevated VOC levels in soil gas could indicate soil and/or groundwater contaminated with VOCs. Information obtained from the soil gas survey was combined with data from the EM survey to locate Phase I confirmation soil borings and test pits.

The soil gas survey utilized both a Photovac 10S70 portable gas chromatograph (GC) and a photoionization detector (PID). The GC has the capability to identify specific VOCs with a general detection limit in the 10 to 100 ppb range. The GC was calibrated to identify six VOCs. These six target compounds were acetone, benzene, TCE, PCE, toluene, and meta-xylene. These compounds were chosen based on a review of the materials reported to have been disposed at the sites and VOCs detected within deep aquifers in the study area.

The PID was used to protect the GC from column saturation caused by high VOC concentrations and to measure total VOC concentration in the soil gas.

Equipment difficulties and unusually cold weather conditions during Phase I required modifying the soil gas survey method. After completing the soil gas survey near Sites 1 and 2, the GC became inoperable, necessitating factory repair. While the GC was being repaired, all remaining sites were screened with the PID only.

The GC repair was completed in January 1990. New readings were taken on January 5 at Sites 1 and 2. These results generally confirmed earlier readings. On January 17, the GC was taken to Site 6, but levels of VOCs were not detected by either the PID or GC. This was compared to the higher PID readings obtained between December 14 and 20, 1989. The equipment was rechecked and recalibrated, and new readings were taken at Site 6. After additional readings of non-detected were obtained, the work was halted, and the Navy was contacted. Causes for the difference between December 1989 and January 1990 readings were discussed.

Equipment failure as a cause for the difference between the December and January readings was discounted. The GC had recently been factory repaired and evaluated, and the January readings remained the same after repeated equipment checks and recalibration. Also, the PID readings remained the same using different PID meters.

After further discussion, weather conditions were identified as the most likely cause for the change in site soil gas conditions. Unseasonably cold temperatures during the initial site screenings with the PID in December 1989 froze the upper six to 12 inches of top soil on all the sites. This freezing action apparently reduced the permeability of soils over the site and allowed a buildup of VOCs in the soil gases below the frost line. In January 1990, when the GC work was being performed, the weather was warmer, and the melting snow cover accompanied by heavy rainfall had saturated site soils. This saturation had filled all pore spaces of the upper layer of soils with water, displacing soil gas containing VOCs from the pore spaces. This change in field conditions is suspected to have created a large difference between the generally high PID readings in December and the lower PID and GC readings in January.

After consulting with the Navy, the December PID readings from all sites were selected for use in locating confirmation boreholes and test pits. GC readings obtained for each site were used to identify specific compounds and as a check on the PID readings.

A PID survey was conducted over a grid centered near either the estimated middle of each site or near areas where the electromagnetic survey had previously detected anomalous areas (e.g., Site 7). The spacing of soil gas stations for each site was determined by several factors, such as site size, terrain, and the presence of impenetrable surfaces such as hard-packed gravel and concrete.

The locations and identification numbers of all soil gas stations are given in the site-specific sections. A summary of the soil gas survey PID readings and GC analyses for Areas A and B are included in Appendix A of this report.

2.1.5 Soil Confirmation Borings

Confirmation borings were completed at all sites within Areas A and B except Site 6. The borings were conducted to gather data about the extent, nature, and depth of contamination that was suspected to be located in each site. The confirmation borings provide a direct method to visually identify the above mentioned parameters. Volatile organic compound (VOC) concentrations were monitored during the drilling of each boring. The presence of VOCs were used as further confirmation of suspected contamination. Data from the confirmation borings were used to help determine the placement of monitoring wells around each site.

The locations of the confirmation borings were determined after data gathered during the soil gas and EM surveys were reviewed.

Confirmation borings were completed at preselected locations by using a drilling rig with cleaned, decontaminated, hollow-stemmed augers. The cuttings were inspected for any waste material or VOCs as the auger brought them to the surface. Each boring was drilled until a significant amount of waste was encountered or to 10 feet below ground surface, unless bedrock or some other impenetrable surface was encountered above 10 feet. Upon completion, all boreholes were backfilled with the cuttings and a cement cap was placed on each.

A PID was primarily utilized at each boring to detect any VOCs that may have been present. The PID has a detection limit of approximately 1 ppm. A flame ionization detector (FID) was used in conjunction with the PID when necessary. An explosimeter, commonly referred to as a triple gas meter, was used in conjunction with the PID to determine if there were any hazardous gases present in the air in the immediate vicinity of the boring.

Each confirmation boring was logged by a geologist. Information recorded by the geologist during the investigations included lithology, waste materials encountered, volatile organic concentrations, the depth at which waste was found, and any other pertinent observations. This information was recorded on logs presented in Appendix B.

Upon completion of the confirmation boring survey, each boring location was determined in relation to a fixed point so that the exact location of the boring could be determined in the future should the need arise.

Near the completion of the confirmation boring survey, the locations of six additional borings were identified. The six borings were placed in locations where additional data were needed to better delineate areas containing waste material. The locations of all the confirmation borings are displayed in the site-specific sections.

All field data were peer reviewed and checked for accuracy upon the completion of the confirmation boring survey.

2.1.6 Test Pit Excavation

Test pits were excavated at Sites 6 and 7 within Area B. The objective of the test pits was to visually identify the extent and nature of waste material thought to be present at these two sites. Because the waste at Site 6 was unevenly distributed, test pits gave a better indication of the lateral extent of waste material than confirmation borings would have provided.

Each test pit was completed by using a backhoe to dig a trench approximately three feet wide. The length of each pit ranged from 30 to 110 feet. The target depth of each pit was approximately 10 feet or until bedrock or groundwater was encountered.

A PID was utilized at each test pit to detect any VOCs that may have been present. An FID was used in conjunction with the PID at Site 7 test pits. An explosimeter was used in conjunction with the PID to determine if there were any hazardous gases present in the air in the immediate vicinity of the test pit.

Each test pit was logged by a geologist. Information recorded by the geologist during the investigations included lithology, waste encountered, volatile organic concentrations, the depth at which waste was found, and any other pertinent observations. Copies of test pit logs have been included in Appendix C.

Upon completion, each test pit was backfilled with the excavated soil. The location of each test pit was confirmed in relation to a fixed point so that the location of the test pit could be determined exactly in the future should the need arise. The locations of all test pits are displayed in the site-specific sections.

2.1.7 Monitoring Well Drilling and Installation

The objective of the RI groundwater monitoring wells was to better define the nature and extent of potential groundwater contamination at the facility. The monitoring network, consisting of new and existing wells, was used to obtain additional information on the hydrologic characteristics of the overburden and shallow bedrock aquifers and the potential role of the subsurface flow system in transporting contaminants from the facility. Data gathered from the groundwater sampling activities were used during the risk assessment to identify sites requiring remediation or further study. A summary of monitoring wells installed at NAWC Warminster within OU-1 during previous investigations and during Phase I and II is shown in Table 2-2. Construction specifications for new wells installed during the RI, and for previous wells, are included in Appendix D.

2.1.7.1 Phase I RI

A total of 11 shallow bedrock and two overburden wells were installed at sites within Areas A and B during Phase I to augment the existing monitoring well network. Wells were designated with a DG- or BG- prefix followed by the well number. The new wells were placed upgradient (i.e., background or BG) and downgradient (DG) from each site based on the known hydrogeologic characteristics. The locations and objectives of the Phase I monitoring wells along with the surveyed locations of wells installed during previous investigations are presented in the site-specific sections of this report.

Water generated during drilling and well development was containerized and transported to the NAWC Warminster wastewater treatment plant if contamination was discovered either visually or by the FID/PID.

All cuttings were containerized in 55-gallon metal drums and were left next to the well head from which the cuttings were produced. All well cuttings were screened with an FID or a PID. Cuttings from two wells, DG-20 and DG-23, were found to contain volatile organic vapors.

During drilling operations, a geologist kept a descriptive log of each well using a drilling log sheet. These logs are included in Appendix B.

TABLE 2-2
SUMMARY OF MONITORING WELL INSTALLATION
NAWC WARMINSTER, OPERABLE UNIT 1

Installation Period	Area A: Sites 1, 2, and 3		Area B: Sites 5, 6, and 7	
	Overburden Wells	Shallow Bedrock Wells	Overburden Wells	Shallow Bedrock Wells
Previous Investigations	4	5	5	0
Phase I RI	2	4	1	7
Phase II RI	3	3	2	2
Total	8	12	8	9

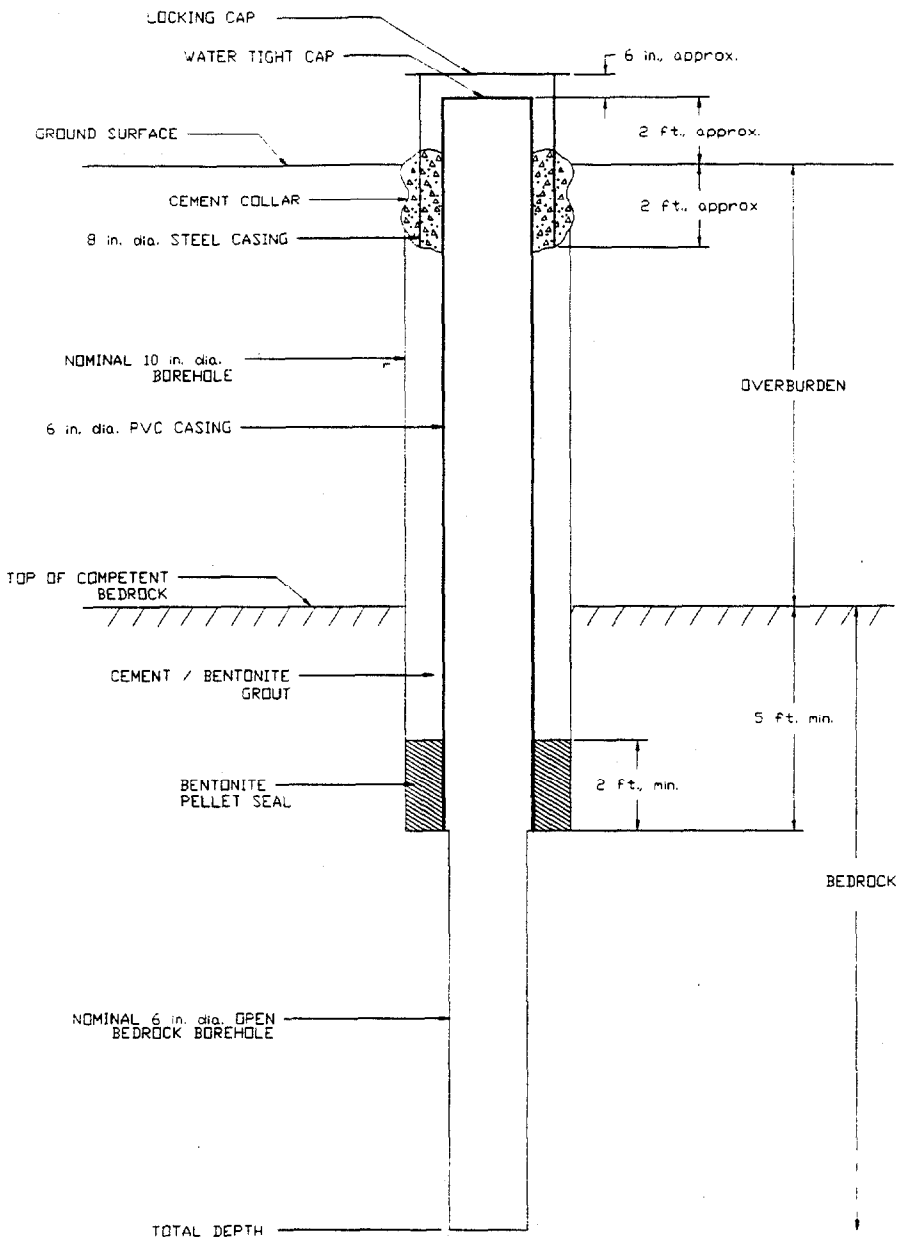
Note: Overburden wells range in depth from approximately 7 to 19 feet. Shallow bedrock wells range in depth from approximately 22 to 100 feet. Deep bedrock well SMC-2 installed at Areas A during previous investigations is not included in this table.

Shallow bedrock monitoring wells were drilled prior to overburden wells at each site so that depth to bedrock and water-table elevation could be measured. If site access conditions permitted, the wells were installed in a general sequence starting with the upgradient wells and finishing with the downgradient wells.

The shallow bedrock wells were drilled using an air rotary drilling rig. The borehole was advanced into competent bedrock, at which time a six-inch-diameter, threaded, flush joint Schedule 40 PVC casing was set into the borehole. Figure 2-2 displays the construction specifications for the shallow bedrock wells. This PVC casing was set so as to protrude one to two feet above the land surface. A two-foot-thick bentonite seal was added to the bottom of the annulus surrounding the PVC casing. A bentonite-cement grout was then pumped into the annulus from the top of the bentonite seal to approximately two feet below ground surface. This grout was allowed to set overnight before drilling continued. When drilling resumed, a drill bit was then advanced through the casing to drill an open borehole until a confining water-bearing zone was encountered. The open borehole construction maximizes the number of fractures or water-producing zones encountered, thereby increasing the probability of intercepting contaminant migration pathways through the fractured rock. A protective steel outer casing fitted with a locking well cap was set into the cement collar. Upon completion, a depth to water measurement was obtained from each well.

Following well completion, the pH borehole was blown with pressurized air to remove cuttings and sediment from the well water. The wells were developed for one hour or until the well water appeared free of sediment. Measurements of pH, Eh, temperature, and conductivity were taken at the beginning, middle, and end of development. The well yield was estimated and recorded during well development.

The overburden wells were drilled utilizing hollow-stemmed auger equipment. The overburden well borehole was drilled to auger refusal, which was used as an indicator of competent bedrock. Figure 2-3 displays the construction specifications for the overburden wells. Five-foot lengths of four-inch-diameter PVC well screen with appropriate slot size and bottom cap were set to screen the entire saturated zone exposed by the borehole. Four-inch-diameter, threaded, flush joint, Schedule 40 PVC casing was attached to the well screen. The PVC casing was set to protrude one to two feet above ground surface. A sand pack was placed in the annulus surrounding the well screen to a height of two feet above the top of the screen. A two-foot-thick bentonite seal was placed above the top of the sand pack. Cement-bentonite grout was pumped into the annular space from the top of the bentonite seal to approximately two feet below ground surface. A six-inch-diameter protective steel casing with locking cap was set into the cement collar.

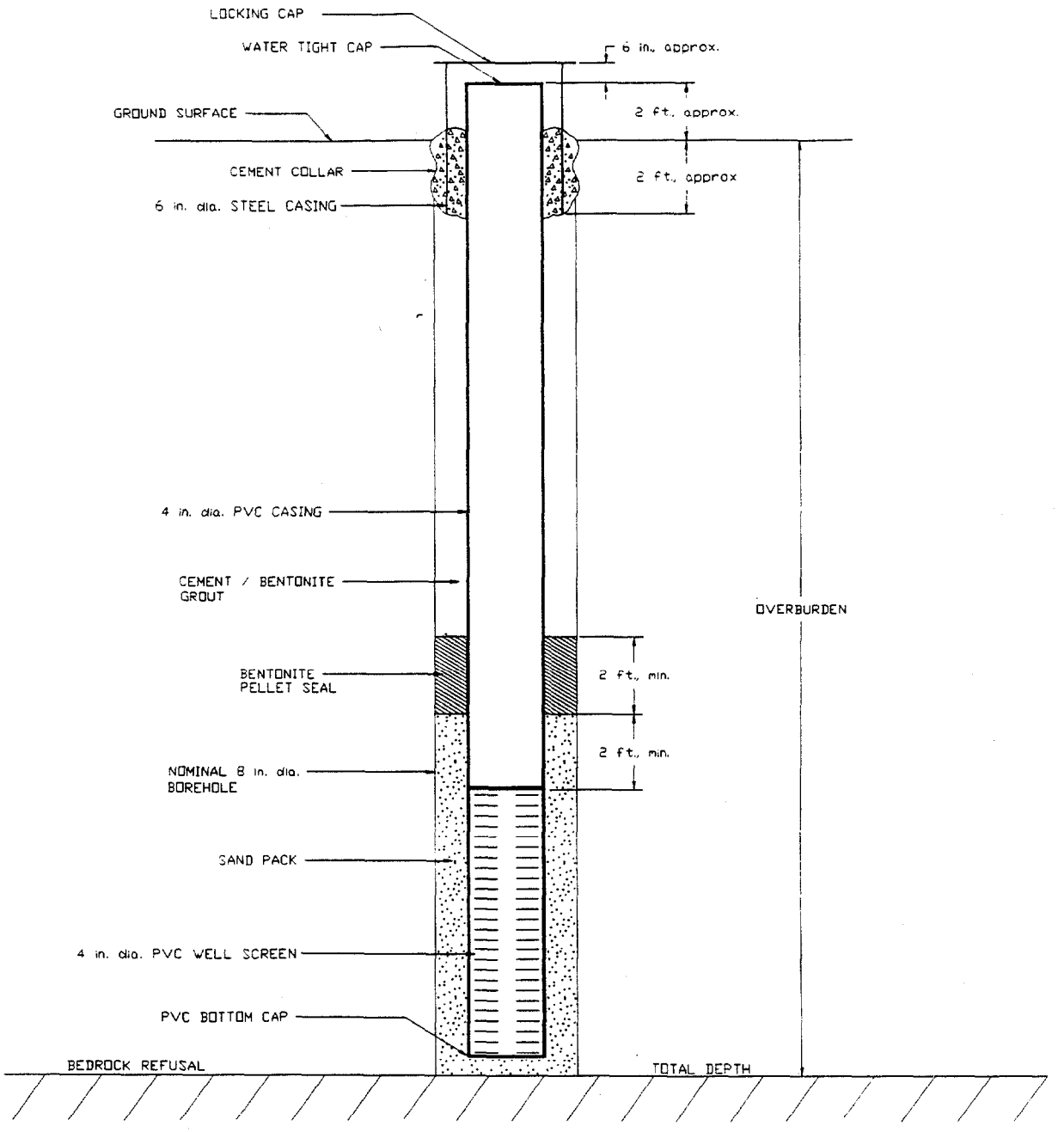


(NOT TO SCALE)

FIGURE 2-2

SHALLOW BEDROCK MONITORING WELL
CONSTRUCTION DIAGRAM
NAWC WARMINSTER

HALLIBURTON NUS
Environmental Corporation



(NOT TO SCALE)

FIGURE 2-3

OVERBURDEN MONITORING WELL

CONSTRUCTION DIAGRAM

NAWC WARMINSTER

HALLIBURTON NUS
Environmental Corporation

During the drilling of each overburden well, the soil was continuously sampled using a split-spoon sampling device. The physical characteristics of each lithologic sample were described and recorded based on visual observations. These logs are included in Appendix B. All split-spoon samples were screened for volatile organics using a PID and/or FID. No volatile organic vapors were detected in any of the split-spoon samples taken during the drilling of the overburden wells.

Following well completion, each overburden well was developed using a submersible pump. The wells were pumped for one hour or until the water appeared clear of sediment. Measurements of pH, temperature, and conductivity were taken at the beginning, middle, and end of development.

2.1.7.2 Phase II RI

Five shallow bedrock and five overburden wells were installed within Areas A and B during Phase II to augment the existing monitoring well network. These wells were designated with an MW- prefix followed by the well number. The objectives and rationale behind the placement of the new wells are discussed as part of the individual study area investigations.

A continuous lithologic visual description of the materials encountered during drilling was maintained in borehole logs. Boring logs are included in Appendix B. Drilling equipment and monitoring well material were decontaminated by steam cleaning. A PID was used to monitor for the presence of VOCs during drilling.

Cuttings generated during drilling were spread evenly around the borehole. Water produced during drilling and well development was discharged to the ground surface and allowed to infiltrate a short distance from the borehole. Drill cuttings and water were to be collected, containerized, and staged in a secure area if visually observed to be contaminated or if PID/FID readings indicated contamination. None of the cuttings or water were determined to be contaminated by these criteria.

Shallow bedrock monitoring wells were drilled prior to overburden wells so that depth to bedrock and water-table elevations could be determined. The wells were installed in a general sequence starting from upgradient locations and moving to downgradient locations to minimize the potential for cross-contamination during drilling. The shallow bedrock wells were drilled using air percussion methods. Figure 2-2 displays the specifications for shallow bedrock wells. A nominal 10-inch-diameter borehole was advanced a minimum of five feet into competent bedrock at which time a six-inch-diameter, threaded, flush joint Schedule 40 PVC casing was set. The depth at which competent bedrock was reached was determined based on changes in the drilling rate and characteristics and on the composition and hardness of the drill cuttings. The PVC casing extends about two feet above the ground surface. At least two feet of bentonite seal was added to the bottom of the annulus surrounding the PVC casing.

Next, a bentonite-cement grout was pumped into the annulus from the top of the bentonite seal to about two feet below ground surface. The grout was allowed to set overnight before drilling continued. The cement/benonite grout mixture was 94 pounds of Portland Type I cement, three to five pounds of granular bentonite, and five to seven gallons of potable water. When drilling continued, a drill bit was advanced through the casing to drill a nominal six-inch-diameter open borehole to total depth.

Upon reaching total depth, the borehole was developed with air until all cuttings were removed, and a protective steel outer casing with locking cap was set into a cement collar.

Overburden wells were drilled and installed using hollow-stem augering equipment. A nominal eight-inch-diameter borehole was drilled to auger refusal, which was used to indicate competent bedrock at each overburden well location. During overburden drilling, the material was continuously sampled using split spoons. The physical characteristics of the samples were described and recorded based on visual observations and were screened for VOCs using PID/FID equipment. Boring logs are included in Appendix B. Figure 2-3 displays the specifications for overburden wells. Five-foot lengths of four-inch-diameter PVC well screen with 0.020-inch slot size and bottom cap screen the entire saturated zone. Four-inch-diameter, threaded, flush joint Schedule 40 PVC casing is attached to the screen. The PVC casing extends from the well screen to about two feet above the ground surface.

A sand pack of appropriate grade was placed in the annulus surrounding the well screen to about two feet above the top of the screen. Above this sand pack is a two-foot bentonite seal. Bentonite-cement grout was pumped into the annulus from the top of the bentonite seal to the point where the concrete collar was constructed (about two feet below ground surface). The cement/bentonite grout mixture is the same as that used for the shallow bedrock wells. A six-inch-diameter protective steel casing with locking cap was set into the cement collar.

Following completion, all newly installed wells of sufficient yield or water storage were developed by pumping. During development, temperature, pH, and specific conductance were measured initially and for each well volume removed. Development continued until three consecutive temperature, pH, and conductivity measurements did not vary by more than 10 percent, or for a maximum of three hours.

2.1.8 Groundwater Sampling

Groundwater samples were collected from new and existing monitoring wells within Areas A and B and were analyzed for a comprehensive set of parameters during the RI. Analytical parameters are discussed in Section 2.3.

A total of 24 wells within Areas A and B were sampled during Phase I of the RI. Of these, 13 were new wells and 11 were existing wells. Existing well BG-1, upgradient from Area B, was dry and could not be sampled. The locations of all wells included in the sampling program are shown in the site-specific sections of this report.

A total of 33 wells within Areas A and B were sampled during Phase II. Of these, eight were new wells and 25 were existing wells. Four wells within Areas A and B were not sampled during Phase II: wells BG-1, MW-08, and MW-10 were dry at the time of sampling and well BG-3 could not be located because the indicated location was paved over. The locations of all wells included in the sampling program are shown in the site-specific sections of this report.

During Phase I, either a submersible or centrifugal pump system was used to purge monitoring wells prior to sample collection. After decontamination, the submersible pump or suction hose was lowered down the well and operated to purge three well volumes or to pump the well completely dry. The pump or hose was then pulled from the hole and the well was allowed to recover. After a significant amount of groundwater had recharged in the well (typically 70 to 80 percent or more of the original static water level), a dedicated PVC bailer was lowered into the well to collect the sample. The groundwater was then transferred with a minimum amount of agitation from the bailer into sample bottles provided by the laboratory. Bottles for VOC analysis were filled first, followed by other bottles.

Field measurements of temperature, pH, and specific conductivity were obtained on all groundwater samples during purging and after sampling. Once the sample collection and groundwater characterization procedures were finished at a particular well, all samples from that well were placed into a cooler containing ice. Information such as sample identification, date and time of collection, analysis parameters, and number and type of sample bottles used was noted on chain-of-custody records.

During Phase II, either submersible pumps, centrifugal pumps, or stainless-steel bailers were used to purge monitoring wells prior to sampling. Low-volume and low-yield wells were typically purged by hand bailing, higher yielding overburden wells were frequently purged using centrifugal pumps, and the deeper wells with larger water volumes were usually purged using submersible pumps. Off-site wells were purged by opening the tap at the sampling point and allowing the water to run for five to 10 minutes. Monitoring wells were purged until three well volumes were removed or until the well was purged completely dry. After a sufficient amount of groundwater had recharged in the well, a stainless-steel bailer was lowered into the well to collect the sample. The groundwater was then transferred with a minimum of agitation into sample bottles provided by the laboratory. Bottles for VOC analyses were filled first, followed by the remaining sample bottles.

Field measurements of temperature, pH, and specific conductivity were obtained for all groundwater samples, wherever possible, during purging and after sampling. Field measurements of dissolved oxygen content were then taken for selected groundwater samples after sampling. Groundwater samples were preserved in coolers containing ice following sampling. Sample logsheets including sample identification, date and time of collection, field measurements, purge data, analysis parameters, and other pertinent information were completed for each sample.

2.1.9 Soil and Geologic Investigations

Site-specific information on soil types was obtained from cuttings produced during the drilling of confirmation borings and overburden wells and from visual observation of soils within test pits during Phase I. Site-specific information on soil types was obtained from split spoon samples during subsurface soil sampling and the drilling of overburden wells during Phase II. Detailed descriptions of the soil types encountered during Phases I and II are included in Appendices B and C.

Site-specific information on bedrock lithologies was obtained from cuttings produced during air rotary drilling of the Phase I RI shallow bedrock wells and from cuttings produced during air percussion drilling of the Phase II RI shallow bedrock wells.

During Phase I, the bedrock lithologies encountered during drilling of the shallow bedrock wells were correlated to develop geological cross-sections of each site. The geological cross-sections represent a summary of the bedrock lithologies encountered at each site. These cross-sections were constructed by first drawing on to a site map a section line running perpendicular to the suspected strike of the bedrock bedding. Rima's (1962) value of N46E was used as the strike direction. Then, the locations of wells were transferred to the section line. The lithologies encountered were then transferred to the cross-section based on the well log diagrams prepared during the completion of each well. This method of cross-section construction assumes lateral continuity of lithologies across each site.

2.1.10 Hydrogeologic Investigations

Included in the discussions on hydrogeology at each site are site water-table maps, vertical groundwater gradients groundwater travel times, the estimated yields of the monitoring wells, and flow rates for the surface water bodies near NAWC Warminster. The methods used to determine each of these parameters are briefly discussed below.

Site water-table maps were produced by obtaining depth-to-water measurements from each well during Phase II and subtracting this value from each well's surveyed elevation. This produced a value for the static water elevation in units of feet above mean sea level for all overburden and shallow bedrock wells. These data were then contoured to produce overburden and shallow bedrock water-table maps for each site. From these maps, hydraulic gradients can be determined and groundwater flow directions can be inferred. Well casing elevations, measured depths to groundwater, and groundwater elevations for both phases of the RI are included in Appendix E of this report.

Vertical groundwater gradients were established by comparing the static water elevation for each nested well couplet during the Phase I and/or Phase II RI investigations. A nested well couplet consists of an overburden and bedrock well placed adjacent to one another. These gradients are used to estimate the vertical direction of groundwater movement between the overburden and bedrock aquifers.

Groundwater travel times were calculated during Phase I using the formula:

$$\frac{(i)\ (k)}{n}$$

where: i = horizontal groundwater gradient
k = hydraulic conductivity (from Satterthwaite, 1984)
n = percent porosity (from Todd, 1980 and Satterthwaite, 1984)

The horizontal groundwater gradient is the change in groundwater elevation divided by the distance over which the change is measured perpendicular to the groundwater elevation contours (i.e., in the inferred direction of groundwater flow).

The value for the hydraulic conductivity was taken from a study of the hydrologic conditions at NAWC Warminster conducted by Satterthwaite in 1984. These values were 0.1 ft./day for overburden material and 1.5 ft./day in the bedrock.

The values for porosity were taken from Groundwater Hydrology (Todd, 1980), which listed average values for the predominant type of material present in the overburden and bedrock. These values were 46 percent for the silty overburden and 41 percent for fine- to medium-grained sandstone. Satterthwaite's (1984) value for porosity (15 percent) for both the overburden and shallow bedrock was also used in a separate set of calculations. When compared, the values determined using Satterthwaite's and Todd's porosity figures provide a maximum and minimum estimate of groundwater velocities. The calculations of groundwater velocities are included in Appendix F of this report.

Groundwater travel times were calculated during Phase II using the same formula as described above.

The horizontal groundwater gradient was determined from the Phase II groundwater elevation maps. The gradients chosen for travel time calculations were those considered to be most representative for the individual sites.

Values for the hydraulic conductivity were obtained from slug tests performed in several Phase II monitoring wells within Areas A and B. The average of the calculated hydraulic conductivity values for a given aquifer at each site was used to calculate travel times. For aquifers and sites where slug tests were not performed, the hydraulic conductivity values of Satterthwaite were used.

The values of porosity for the shallow bedrock aquifer were taken from Geology and Hydrology of the Stockton Formation in Southeastern Pennsylvania (Rima, et al., 1962). This reference lists laboratory determination of porosity from undisturbed samples of the various lithofacies of the Stockton Formation. The porosity values used range from a low of about 10 percent, the average value for siltstone, to a high of about 25 percent for medium-grained sandstone. Lower porosity values were listed for some of the coarse- to very coarse-grained arkosic sandstones and conglomerates; however, this lithology is relatively uncommon at NAWC. Groundwater travel times calculated using porosity values of 10 percent and 25 percent provide maximum and minimum estimates of groundwater velocity for the shallow bedrock aquifer.

The values of porosity for the overburden were the same as those used in the Phase I RI calculations. Groundwater travel times calculated using porosity values of 15 percent (Satterthwaite, 1984) and 46 percent (Todd, 1980) provide maximum and minimum estimates of groundwater velocity for the overburden aquifer. The calculations of groundwater velocities are included in Appendix F.

The yields of the newly installed wells during Phase I and II were determined by estimating the amount of water produced during well drilling and development and by observing the rate of recharge during well sampling.

More detailed hydrogeologic investigations during the Phase II RI work included three stages. Stage I consisted of performing slug tests on new monitoring wells and step-drawdown tests on two wells within Area A. Stage II included a two-week water level study of 11 wells within Area A to determine the background interference and rate of natural recharge to the overburden and shallow bedrock aquifers (hydrogeologic zones). Stage III consisted of an aquifer pumping test near Area A. A more detailed discussion of the hydrogeologic investigation and the interpretation of the results are included in Section 4.4.3.

During Stage I, the hydraulic conductivity of the overburden and bedrock aquifers was determined through rising and falling head slug tests. The falling head slug tests were performed by quickly inserting a slug of known volume into the tested well, which displaced an equivalent volume of water and raised the water level in the well. The rate of recovery back to static conditions was measured and recorded using a 10 psi pressure transducer and computerized data logger.

For the rising head tests, the slug was then quickly removed, resulting in a drop in the water level within the well. Once again, the rate of recovery back to static conditions was measured and recorded. Due to volume losses within a well sand pack, those wells with partially penetrating screens could only be tested using the rising head method. Slug test results and calculations are included in Appendix G to this report.

Upon completion of the slug tests, step-drawdown tests were performed in two wells within Area A. The step-drawdown tests consisted of pumping the wells for one to two hours at successively higher rates and measuring the amount of drawdown for each pumping rate. In addition, nearby wells installed at similar and different depths were also measured for drawdown to help predict hydraulic interconnection between the hydrogeologic zones. The resulting data were used to predict drawdown versus time for various pumping rates and to determine the optimum pumping rate and well to be used for the pumping test. The optimum rate should provide maximum drawdown, while not exceeding the recharge characteristics of the shallow bedrock hydrogeologic zone.

During Stage III of the hydrogeologic investigation, a large-capacity pump test was performed to predict the

- Rate of groundwater migration
- Radius of the cone of influence
- Effect of pumping withdrawals on existing wells
- Degree of interconnection between hydrogeologic zones
- Characterization of aquifer performance (i.e., transmissivity and storage coefficient)

Pump test waters were discharged at the ground surface at a sufficient distance from the pumping and observation wells so as to not cause incidental recharge to the aquifer.

Based on step-drawdown tests, the optimum pumping rate selected for the pumping test was 4.0 gallons per minute (gpm) and was be performed on Well E. Before the test was performed, static water-level measurements were recorded for the pumping well and for all observation wells. During the test, rates of drawdown and full recovery were measured in the pumping well and all observation wells. Groundwater levels in at least nine observation wells were measured and recorded using pressure transducers and computerized data loggers. Other wells were measured using an electronic water level indicator (M-scope) and manually recorded in the field. Data and calculations for the pumping tests are included in Appendix H.

Continuous observation of the pumping well was performed to maintain a continuous pumping rate and to ensure that the natural well yield can sustain the 4.0 gpm pumping rate. The nine-hour duration of the pumping test was determined in the field based on the observed aquifer response.

Data generated by the test were documented on the appropriate data sheets according to HNUS Standard Operating Procedure (SOP) GH-2.4. Periodically, water-level measurements were manually recorded in the observation wells in which transducers were installed. This eliminated the potential loss of data caused if a data logger malfunctions. In addition, the drawdown in the pumping well and nearby observation wells was plotted during the test to determine the current aquifer response characteristics. At a minimum, the following information was collected where appropriate for the pumping and observation wells during the pumping test:

- Well number/depth/screened or cased depth/inside diameter
- Static water level
- Drawdown and recovery data
- Duration of pumping and recovery test
- Pumping volume
- Distance from pumping well

2.1.11 Documentation

All samples were collected in approved sample containers provided by the laboratory (RMC Environmental Services during Phase I; Ceimic, Incorporated during Phase II). Immediately upon collection, each sample was sealed in the appropriate bottle, labeled, and placed on ice in an insulated container. All samples were forwarded to RMC or Ceimic under approved EPA procedures for chain of custody and sample handling. Copies of the chain-of-custody forms for all samples are included in Appendix I.

2.2 SURVEYING

Surveying was conducted as part of the RI in order to determine the exact location and elevation of the newly installed monitoring wells. The locations of several existing wells were also surveyed to obtain additional groundwater elevation reference points and because site visits revealed that the actual locations of many of the existing wells were different from their positions indicated on facility maps. The well elevations and locations were used in the construction of groundwater contour maps, which are presented in the site-specific sections of this report.

To determine the location of Phase II monitoring wells, three horizontal traverses, which began and ended on property corner monuments, were conducted. At least three corner monuments were tied on each traverse. All three traverses closed relative to the Survey Map entitled "Survey Map, U.S. Naval Air Development Center, Warminster Township, Bucks County, Pennsylvania" with a tolerance better than the proposed standard of 1 part in 10,000.

During Phase I, it was discovered that many of the benchmarks denoted on the Survey Map were poorly described and that property corner monuments with elevations were often missing or disturbed. The survey crew used the best identified benchmark to orient each level run. In the runs involving Area A, the crew began at one benchmark, attempted to close on another (i.e., the intermediate bench mark), and then closed back on the original. The closures on the intermediate benchmarks varied from 0.14 to 0.72 feet. The closures back to the starting point varied from 0.01 to 0.04 feet. The level run for Area B began and ended on the same benchmark and closed by 0.02 feet.

During Phase II, the locations of all new monitoring wells, existing unsurveyed wells, and soil sample locations were surveyed for elevation and horizontal coordinates. The surveys also included two Phase I wells in each study area to ensure datum consistency between the Phase I and II survey results.

The Phase II horizontal and vertical survey locations of all points utilized survey traverse control established in 1985, 1986, and 1987 during aerial mapping of the entire base and field survey location of all utilities. All coordinates are based on the Pennsylvania State Plane Coordinate System (South Zone, 1927 Datum). The error of closure of all horizontal survey work is better than 1 part in 10,000. All elevations are based on the North American Vertical Datum of 1929.

Although the elevations of wells in the various study areas relative to other study areas and the base as a whole are not definite because of the benchmark problems, the relative elevations of wells within each site are of a high order of accuracy.

All well casing elevations are included in Appendix E, and survey data for Phase II are found in Appendix J to this report.

2.3 ANALYTICAL PROCEDURES AND DATA VALIDATION

2.3.1 Analytical Procedures

During Phase I, samples were analyzed as specified by EPA's Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition. Groundwater samples were analyzed for Target Compound List (TCL) volatile organic compounds, TCL semivolatile organic compounds, TCL pesticides/PCBs, and Target Analyte List (TAL) metals. Samples analyzed for TAL metals were not filtered. Data packages were submitted under Naval Energy and Environmental Support Activity (NEESA) Level C requirements. The complete analytical database for the validated groundwater data is presented in Appendix K to this report.

For Phase II, a subcontracted NEESA-approved laboratory analyzed groundwater samples collected at NAWC Warminster for TCL volatile and semivolatile organics, pesticides and PCBs, TAL inorganics, cyanide, and a variety of physical-chemical parameters (e.g., hardness, alkalinity, total suspended solids, chlorides, grain size). The analytical methods selected for these analyses are presented in Table 2-3. Data packages were submitted under NEESA Level D requirements.

Background samples were collected during the RI, and representative groundwater background concentrations or levels are discussed in Section 4.5.

Section 2.5 summarizes the number of samples collected during both phases of the RI and provides information regarding the laboratory analyses performed on these samples.

TABLE 2-3
SUMMARY OF ANALYTICAL PARAMETERS
PHASE II RI

MEDIA	ANALYSIS	METHOD	CRQL/CRDL
Groundwater	Low concentration volatile organics	CLP SOW 6/91	1 to 5 ug/l
	Hardness	EPA 130.2	10 mg/l
	Alkalinity (as $CaCO_3$)	EPA 310.1	1 mg/l
	Total organic carbon	EPA 415.1	5 mg/l
	Total dissolved solids	EPA 160.1	10 mg/l
	Total suspended solids	EPA 160.2	4 mg/l
	Biochemical oxygen demand (5-Day)	SM 52108	1 mg/l
	NH_3-nitrogen (ammonia)	EPA 350.2; titration	0.1 mg/l
	Sulfates	EPA 375.4	1 mg/l
	Chlorides	EPA 325.2	2 mg/l
	NO_3/NO_2-nitrogen	EPA 353.3	0.01 mg/l
	Chemical oxygen demand	EPA 410.2	5 mg/l

2.3.2 Data Validation

The data validation process serves three basic functions:

- An independent quality assurance check for accuracy of laboratory results.
- A means of evaluating laboratory performance and determining the impact of noncompliances to the data.
- Through the use of data qualifiers, it lends interpretive guidance as to the limitations of the data.

The validation process is a systematic review and evaluation of the analytical data conducted according to applicable and relevant quality control criteria, including

- EPA's National Functional Guidelines for Evaluating Laboratory Analyses
- Method-specific quality control criteria
- Navy-specified technical guidelines
- HNUS data validation formats and standard operating procedures

Organic data were evaluated based on

- Data completeness
- Holding times
- GC/MS tuning and mass calibration (when applicable)
- Initial and continuing calibrations
- Laboratory blank analyses
- Field blank analyses (when applicable)
- Internal standards performance
- Surrogate spike recoveries
- Matrix spike/matrix spike duplicate results
- Field duplicate precision (when applicable)
- Compound detection limits

- Compound identification
- Compound quantitation
- Tentatively Identified Compound (TIC) evaluation (when applicable)

Inorganic data were evaluated on the basis of

- Data completeness
- Holding times
- Initial and continuing calibrations
- Contract Required Detection Limit (CRDL) standard analyses
- Laboratory and field blank analyses (when applicable)
- Matrix spike results
- Laboratory control sample results and duplicate analyses
- Field duplicate precision (when applicable)
- ICP interference check sample results
- ICP serial dilution analyses
- Furnace atomic absorption results
- Analyte detection limits
- Analyte quantitation

Data validation reports were generated from these results and conclusions drawn from the validation process described above. The narrative portions of these reports are contained in Appendix K. The specific format of the data validation report varies with the applicable protocol, but all reports address the following:

- Explanation of the findings of the data evaluation process, giving interpretations of actions taken on the data and limits of data usability.

- Presentation of the qualified analytical results.

- A validation worksheet and/or support documentation section depicting the problem areas and noncompliances addressed in the data validation memoranda and supporting the validation actions taken.

As a result of the data validation process, qualifiers are added to some analytical data. Data qualifiers provide an identifiable flag that inform the data user of potential problems with respect to data usability. The data qualifiers applied to analytical data for all sites at NAWC Warminster are specific to EPA Region III and include the following:

- B Reported result considered nondetected due to the presence of this compound/analyte in associated laboratory method and/or field QC blanks (Blank contamination actions are described in detail in data validation reports, Appendix L.
- UL Reported quanititation/detection limit biased low.
- UJ Reported quanititation/detection limit estimated. Biased unable to be determined.
- L Reported positive result biased low.
- K Reported positive result biased high.
- J Reported positive result estimated. Bias unable to be determined.
- R Result considered unusable and rejected.

The use of qualified analytical data (save rejected data) is considered acceptable and appropriate for risk assessment and other end uses of data.

2.4 QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

All analytical data collected for both phases of the RI were validated. The purpose of this section is to provide an overview of the field and laboratory QA/QC samples associated with the data.

2.4.1 Field QA/QC

The Phase I samples were analyzed under NEESA Level C QA/QC criteria, and Phase II samples were analyzed under Level D. NEESA requirements for field QA/QC samples are as follows:

QA/QC TYPE	NEESA REQUIREMENTS (Level C/Level D)
Field Duplicate	One duplicate in 10 samples per sample matrix.
Rinsate Blank	One sample of the final rinse during decontamination of sampling equipment per day. Initially, samples from every other day are analyzed. If analytes pertinent to the project are found in the rinsate, the remaining samples are analyzed.
Field Blank	One sample per decontamination water source.
Trip Blank	One sample of analyte-free water per day, for each shipment of samples for volatile organic analysis.

Field QA/QC samples for both phases of the RI consisted of the following:

QA/QC TYPE	PHASE I	PHASE II
Field Duplicates	8	11
Rinsate Blanks	9	12
Field Blanks	4	6
Trip Blanks	9	12

Toluene and 1,1,1-TCEA were the only contaminants detected in the trip blanks for Phase I. A total of eight volatile organics, two semivolatile organics, and 12 inorganic compounds were detected as contaminants in the field and rinsate blanks for this phase.

For Phase II, organic contamination in the field quality control blanks was limited to acetone (detected in trip and rinsate blanks), methylene chloride (detected in rinsate blanks), and toluene (found in the field blanks). Various concentrations of metals and miscellaneous parameters were also detected in the field and rinsate blanks.

Affected sample results are considered to be false positives due to blank contamination if the concentration of the compound is less than or equal to action levels of 10 times (10X) the amount in any blank for the common laboratory contaminants (acetone, methylene chloride, 2-butanone, and phthalates) or five times (5X) the amount for other compounds.

2.4.2 Laboratory QA/QC

Several organic and inorganic chemicals were detected as contaminants in the laboratory method blanks for both phases of the RI, resulting in the qualification of associated sample data. Qualified sample data are considered to be false positive results (i.e., nondetects). The reader is referred to the "Minor Problems" sections of all organic/inorganic data validation report narratives found in Appendix L.

Some severe calibration problems were evident for 2-butanone, acetone, and 4,4'-DDT. Associated sample data were considered to be unreliable and were rejected on this basis. See the "Major Problems" section of the organic data validation narratives for Phase I and the following Phase II SDGs: WMW05, WMW17, and WMW41.

Various matrix spike samples exhibited extremely poor recovery for several organic compounds, antimony, mercury, selenium, and thallium. The associated sample data were considered to be unreliable and were rejected for this reason. The reader is referred to the "Major Problems" section of the organic data validation narratives for Phase I and the SDGs for Phase II [WMW31 (TCLP)] and the inorganic narratives for Phase II SDGs (WMW31, WMW41, and MW41).

Many other problems were evident with the analysis of several QA/QC samples such as calibration standards, internal standards, laboratory duplicates, laboratory method blanks (i.e., negative blank concentrations), matrix spikes, laboratory control samples, ICP interference check samples, and ICP serial dilutions. The quality of the associated data is not believed to be significantly affected due to these problems; therefore, the associated sample data were either estimated or assigned a directional bias.

2.5 SAMPLE COLLECTION AND ANALYTICAL TESTING PROGRAM

This section summarizes the number of groundwater samples collected during both phases of the RI and provides information regarding the types of laboratory analyses performed on these samples. During Phase I, 24 groundwater samples were collected; Phase II involved taking 37 groundwater samples. These numbers do not reflect field QA/QC samples and laboratory QA/QC samples such as matrix spikes and matrix spike duplicates.

Table 2-4 summarizes the number of groundwater samples taken during the RI for Areas A and B.

TABLE 2-4
GROUNDWATER ANALYTICAL TESTING SUMMARY
NAWC WARMINSTER, PENNSYLVANIA

PARAMETER	SITES 1, 2, AND 3		SITES 5, 6, AND 7	
	PHASE I	PHASE II	PHASE I	PHASE II
Total Samples[1]	12	23	12	14
Target Compound List (TCL) Volatile Organics[2]	12	23	12	14
TCL Semivolatile Organics	12	3	12	1
TCL PCBs/Pesticides	0	3	0	1
Target Analyte List (TAL) Metals - Total; Cyanide[3]	12	23	12	14
TAL Metals - Filtered	0	23	0	14

[1] Number of samples does not include QA/QC samples.

[2] Low-concentration TCL volatile organic analyses for Phase II groundwater samples.

[3] Samples were not analyzed for cyanide during Phase I.

3.0 PHYSICAL CHARACTERISTICS OF THE STUDY AREA

Several environmental studies concerned with the NAWC Warminster sites have been completed over the last 10 years. A number of these studies, including JRB Associates (1981 and 1983), Sloto and Davis (1983), Satterthwaite (1984), and Earth Technology Corporation (1985), have provided information on local surface features, soils, meteorology, surface water hydrology, demography and land use, and hydrogeology.

A description of the physical characteristics of NAWC Warminster has been prepared on the basis of published information, reports of previous site studies, and information obtained and interpreted during the course of the RI. Section 3.0 provides information related to physical characteristics that are considered to be consistent throughout the facility. The physical characteristics of Areas A and B 1are discussed in Sections 4.0 and 5.0, respectively.

3.1 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 snow fall 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 being west-southwest (NAWC Warminster Emergency Response Plan, August 13, 1990).

3.2 SURFACE WATER HYDROLOGY AND TOPOGRAPHY

NAWC Warminster is situated on an upland area divided between two local drainage basins, the Little Neshaminy Creek Basin on the north and the Southampton Creek basin on the south. The northern 65 percent of the facility (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 facility (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 NAWC Warminster 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 Warminster 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 facility 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 (JRB Associates, 1981 and SMC Martin, 1991). An underground tile drainage system was used to drain the eastern portion of the facility when it was farmed in the 1940s (JRB Associates, 1981). The present conditions of the tile drains and their influence on surface or near-surface drainage are unknown.

The location of NAWC Warminster represents a relative topographic high based on the U.S.G.S. quadrangle for the vicinity (Hatboro, Pennsylvania quadrangle, 1966). The crest of a local hilltop trends from west to east within the facility and is roughly coincident with the location of the main runway. Surface topography within the facility slopes away from the main runway to the north, west, and south, precluding surface water flow onto the facility from surrounding properties. Slopes range from nearly level to eight percent and average from three to five percent. Surface elevations range from a high of approximately 380 feet mean sea level (MSL) near the eastern end of the main runway to a low of approximately 300 feet where a small stream exits the northwestern part of the facility.

NAWC Warminster lies in a populated suburban area surrounded by private homes and various commercial/industrial activities. The complex covers approximately 734 acres located in the township of Warminster, Pennsylvania, Bucks County. On-site areas include various buildings and other complexes connected by paved roadways, the runway and ramp area, mowed fields, and a small wooded area. Off-site areas consist of wooded, park, and residential areas and commercial/industrial facilities.

3.3 SOILS

According to the Soil Survey of Bucks and Philadelphia Counties, Pennsylvania (United States Department of Agriculture, Soil Conservation Service, 1975), Areas A and B at NAWC Warminster are underlain by four major soil types. These are Urban land and soils of the Duncannon, Lawrenceville, and Doylestown Series (see Table 3-1).

TABLE 3-1
NAWC WARMINSTER SOILS

Area	Mapped Soil Series
A	Urban land - Lansdale complex, 0-8% slopes
B	Lawrenceville silt loom, 0 to 3% slopes Lawrenceville silt loom, 3 to 8% slopes Duncannon silt loom, 3 to 8% slopes Doylestown, silt loom, 0 to 3% slopes

Urban land occurs in highly developed areas where urban structures and works cover so much of the land type that identification of the soils is not practical. Most areas have been graded, and the original soil material has been disturbed, filled over, or otherwise altered prior to construction. As a consequence of these activities, the soil and foundation materials may be highly variable. The Urban land type within the facility is classified as Urban land Lansdale complex, zero to eight percent slopes. It consists of approximately 60 percent urban land, 35 percent Lansdale soils, and five percent other soils. Also included are some areas of various types of fill material. This complex has good drainage and is nearly level to gently sloping.

Duncannon soils are deep, well drained, and nearly level to gently sloping. They occur on the upper elevations of low-relief upland areas and formed in silty wind-deposited sediment overlying shale and sandstone bedrock. The soils consist primarily of brown, yellowish-brown, dark brown, and dark reddish-brown silt loam and shaly silt loam. These soils have moderate permeability ranging from 4.4×10^{-4} to 1.4×10^{-3} cm/sec. The depth to bedrock and the seasonal high water table are each typically greater than four feet below the surface.

Lawrenceville soils are deep, moderately well drained, and nearly level to gently sloping. They occur on the middle and lower elevations of low relief upland areas and formed in silty wind blown deposits underlain mainly by material weathered from shale and sandstone. The soils consist primarily of dark brown, yellowish-brown, and brown silt loam with some sandy loam in the substratum. These soils have moderately slow permeability ranging from 1.4×10^{-4} cm/sec to 4.4×10^{-4} cm/sec. The depth to bedrock is typically from four to eight feet below the surface, and the seasonal high water table may be within 18 to 36 inches of the surface in wet seasons.

Doylestown soils are deep, poorly drained, and nearly level to gently sloping. They occur at the bases of slopes and in depressions and formed in silty wind-blown deposits overlying loamy material weathered from shale and sandstone. The soils consist primarily of grayish-brown and dark grayish-brown to brown and dark brown silt loam and silty clay loam that is firm, dense, and brittle at places within the subsoil. These soils have slow permeability of less than 1.4×10^{-4} cm/sec. The depth to bedrock is typically four to seven feet below the surface, and a seasonal high water table is at or near the surface in wet seasons.

3.4 REGIONAL GEOLOGY

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

The bedrock underlying NAWC Warminster belongs to the late Triassic age Stockton Formation. The Stockton Formation is unconformably underlain by basement rocks of Ordovician to Precambrian age that crop out approximately two miles south of the facility. The Stockton Formation is conformably overlain by the shale- and argillite-rich Lockatong Formation, also of late Triassic age, which crops out approximately 2.5 miles north of the facility.

The beds of the Stockton Formation strike to the northeast and dip from seven to 16 degrees northwest in the vicinity of NAWC Warminster. The average dip of the beds is 12 degrees to the northwest. Based on outcrop width and an average dip of 12 degrees, the Stockton Formation is estimated to be approximately 2,200 feet thick beneath NAWC Warminster. The Stockton Formation is extensively faulted and is cut by a well-developed joint or fracture system. A more detailed discussion of bedding, fracture, and joint orientation within the Stockton Formation in the immediate vicinity of the facility is contained in Section 3.4.1 of this report.

The Stockton Formation is composed of fine- to coarse-grained arkosic sandstone and conglomerate interbedded with shale and siltstone. These rocks are interpreted to have been deposited by coalescing alluvial fans that deposited sediment eroded from highlands to the south (Sloto and Davis, 1983). Throughout the Stockton Formation, units of varying lithology are irregularly interbedded, with coarse-grained units commonly overlying fine-grained units. Beds commonly pinch out or form gradational contacts with overlying or underlying beds over lateral distances greater than several hundred feet (Rima, et al., 1962).

The Stockton Formation is divided into lower arkose, middle arkose, and upper shale members. Detailed geologic mapping of these three members is not available within Bucks County where NAWC Warminster is located. However, projections from geologic maps one mile west of the facility in Montgomery County indicate that the facility is underlain by the middle arkose member of the Stockton Formation (Rima, et al., 1962).

The middle arkose member of the Stockton Formation consists of beds of fine- and medium-grained arkosic sandstone with interbedded red shale, siltstone, and very fine red sandstone. Also contained within this member are a few beds of coarse-grained arkose. The arkosic sandstones are usually pale brown to pale red, gray, and pale orange. Beds of shale and siltstone are more common in the upper portion of this member, and coarser grained units are more common in the lower portion. Many of the beds are weakly cemented and well sorted, accounting for relatively high porosity compared to the upper shale and lower arkose members of the Stockton Formation (Rima, et al., 1962). The thickness of the middle arkose member of the Stockton Formation at NAWC Warminster is unknown but is estimated to be approximately 500 feet near the southeastern boundary of the facility, increasing to between 1,500 and 2,000 feet thick near the northwestern boundary.

The lower arkose member of the Stockton Formation underlies the middle arkose member and is projected to crop out approximately 2,000 feet or more southeast of the facility. The lower arkose member is dominated by coarse-grained arkosic sandstone and conglomerate. Beds of medium-grained arkosic sandstone are common, although less abundant than coarser grained units. The lower arkose member is estimated to be approximately 1,700 to 1,800 feet thick near NAWC Warminster (Rima, et al., 1962).

The upper shale member of the Stockton Formation is generally not present in the vicinity of NAWC Warminster but overlies the middle arkose member several miles northwest of the facility. The upper shale member consists of shale, siltstone, and fine-grained arkosic sandstone. In general, grain size decreases upward within this member, with beds of fine-grained sandstone most common in the lower portions.

A layer of saprolite (extensively weathered bedrock) commonly underlies the area soils and overlies the unweathered shale, siltstone, or sandstone bedrock of the Stockton Formation. The saprolite usually occurs at an approximate depth of four to 10 feet and was found to be between eight and 25 feet thick during previous well installation at NAWC Warminster (JRB Associates, 1983).

3.4.1 Fracture-Trace Analysis

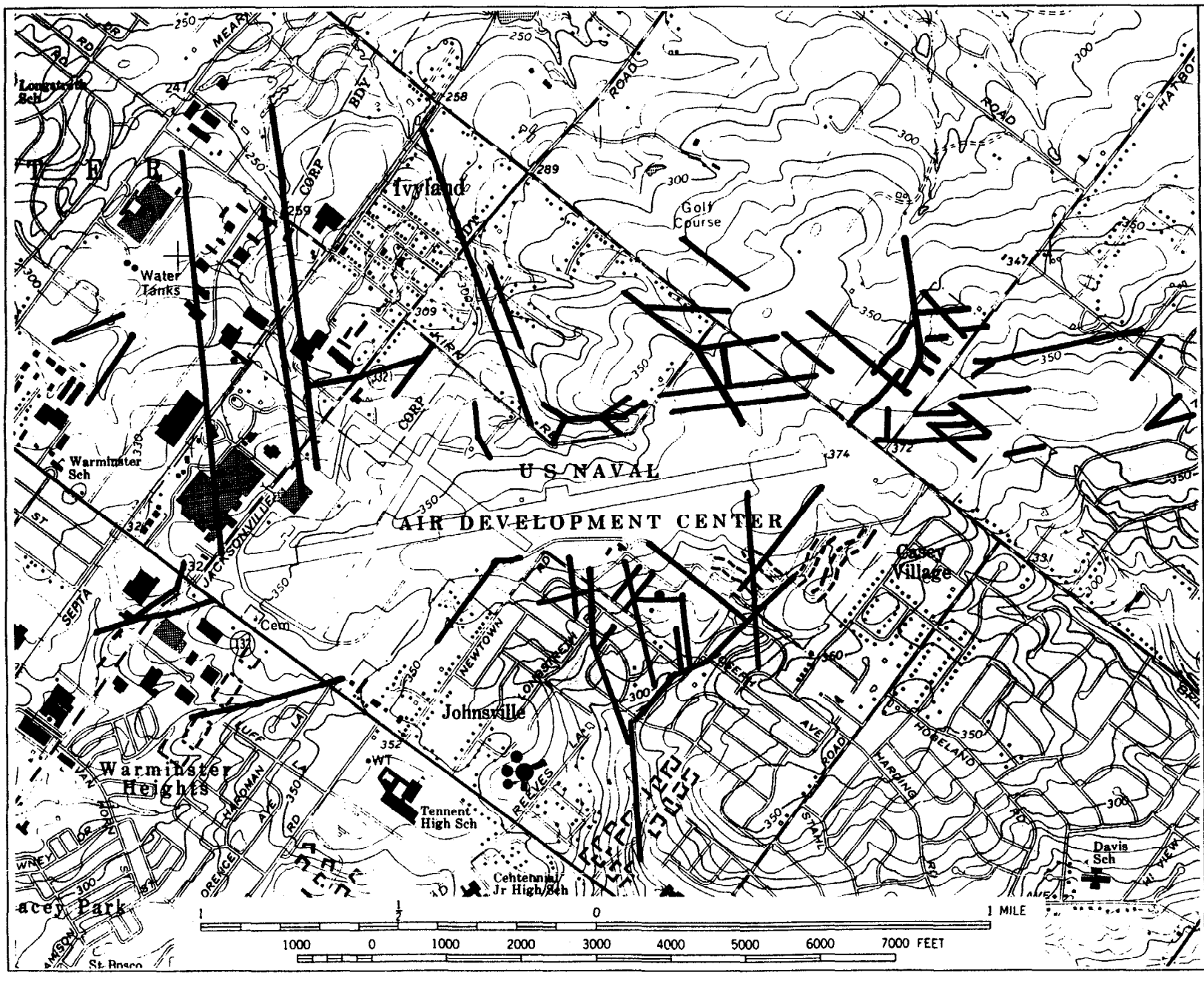
A map showing the approximate locations of fracture traces in the NAWC Warminster area is provided as Figure 3-1. The majority of the fracture traces shown on this map are those of the Phase I analysis; however, a few fracture traces from an analysis by Satterthwaite (1984) have also been shown.

Construction and reworking of the surface soil within the NAWC boundary have obscured the geologic linear features to a large degree. Despite this reworking of soil, some of the adjacent fracture traces were traceable onto the facility itself. Agricultural fields visible on the aerial photograph of the general study area used for the analysis show clear fracture traces.

Table 3-2 shows the approximate length and orientation of the fracture traces identified during the Phase I analysis. Fracture-trace lengths ranged from approximately 160 to 2,880 feet in length. Fracture-trace orientations were plotted on a circular diagram to determine the primary orientations. The primary fracture trace orientations were N39°E, N84°E, N53°W, and N8°W.

The fracture traces identified during Phase I may be compared to structural bedrock features found during previous regional studies in the area. According to an authoritative study of the geology and hydrogeology of the Stockton Formation by Rima, et al. (1962), the Stockton beds generally dip to the northwest in Bucks and eastern Montgomery Counties, where NAWC Warminster is located. Strike and dip of the bedding were measured about one mile southwest of the facility for Rima's study. This strike was about N46°E and the dip was 10 degrees in the northwest direction. Strike is defined as the direction taken by a structural surface (e.g., a bedding plane) as it intersects the horizontal. Dip is the angle that a planar feature makes with the horizontal.

In a study conducted by Satterthwaite (1984) at NAWC Warminster, the bedding underlying the facility approximately 1,000 feet southwest of Area A was calculated to dip seven degrees to the north. This estimate was based on the geologic logs made from three wells (MP-1, 2, and 3) installed by Satterthwaite.



LEGEND

APPROXIMATE FRACTURE TRACE LOCATION

N

NAWC
WARMINSTER, PA

FIGURE 3-1
FRACTURE TRACE LOCATION MAP

(CONTOUR INTERVAL 10 FT.)

HALLIBURTON NUS
Environmental Corporation

Adapted From SMC Environmental Services Group, 1991

SCALE: AS SHOWN | DATE: 10/12/92

TABLE 3-2
PHASE I FRACTURE TRACE ANALYSIS
NAWC, WARMINSTER, PENNSYLVANIA

SOUTH OF BRISTOL ROAD

Length (feet)	Orientation (Degrees East From North)	Location
500	N 37°E	South of Bristol Road
380	N 82°E	South of Bristol Road
280	N 0°E	South of Bristol Road
160	N 15°E	South of Bristol Road
600	N 37°E	At Site 7
640	N 38°E	At Site 7
540	N 87°E	At Site 7
800	N 15°2	At Site 7
300	N 8°W	South of Site 7
800	N 5°W	South of Site 7
2880	N 39°E	North and parallel to enlisted men's housing
880	N 52°W	South of Site 6
1440	N 4°W	South of Site 6
600	N 46°E	South of Site 6

TABLE 3-2 (cont'd)
PHASE I FRACTURE TRACE ANALYSIS
NAWC, WARMINSTER, PENNSYLVANIA

SOUTH OF BRISTOL ROAD

Length (feet)	Orientation (Degrees East from North)	Location
1800	N 83°E	South of Bristol and Kirk Roads
1640	N 84°E	South of Bristol and Kirk Roads
500	N 90°E	South of Bristol and Kirk Roads
1040	N 24°W	South of Bristol and Kirk Roads
560	N 9°W	South of Bristol and Kirk Roads
350	N 39°W	Site 4 Area
460	N 57°W	Site 4 Area
600	N 20°W	Site 8
680	N 44°E	Officer Housing Area at Jacksonville and Kirk Park
960	N 74°E	Officer Housing Area at Jacksonville and Kirk Park
400	N 0°W	Site 2
200	N 39°E	Site 1

TABLE 3-2 (cont'd)
PHASE I FRACTURE TRACE ANALYSIS
NAWC, WARMINSTER, PENNSYLVANIA

NORTH OF BRISTOL ROAD

Length (feet)	Orientation (Degrees East from North)	Location
1260	N 90°E	North of Bristol Road
400	N 3°E	North of Bristol Road
800	N 85°E	North of Bristol Road
860	N 90°E	North of Bristol Road
920	N 54°W	North of Bristol Road
600	N 52°W	North of Bristol Road
620	N 80°E	North of Bristol Road
1180	N 85°E	North of Bristol Road
380	N 49°E	North of Bristol Road
280	N 39°E	North of Bristol Road
900	N 47°W	North of Bristol Road
1000	N 75°E	North of Bristol Road
1000	N 83°E	North of Bristol Road
400	N 54°W	North of Bristol Road
400	N 54°W	North of Bristol Road
640	N 9°W	North of Bristol Road
1000	N 34°E	North of Bristol Road
800	N 39°E	North of Bristol Road
900	N 76°E	North of Bristol Road
1040	N 56°E	North of Bristol Road
800	N 50°E	North of Bristol Road

Joint sets (i.e., fractures within the formation noticeable while on foot and not necessarily on air photos) of the Stockton Formation occurred in a discernible pattern. According to Rima, et al. (1962), the most frequently occurring joint sets trend perpendicular and parallel to the strike of the bedding. Another commonly occurring joint set trends northwestward at an angle of about 50 degrees to strike. Assuming that the strike and dip of the bedding beneath the facility are N46°E, 10 degrees as measured a mile away, then the expected primary fracture orientations found by Rima would be about N46°E, N44°W, and N4°W. These joint set orientations generally match the fracture-trace orientations of N39°E, N53°W, and N8°W.

Satterthwaite's fracture-trace analysis of NAWC Warminster found the most commonly occurring fracture sets were oriented approximately N77°W and N4°W. During the RI, fracture-trace analysis of found fracture sets oriented at N84°E and N8°W, which closely match Satterthwaite's orientations. Two additional fracture sets at N39°E and N53°W were measured during the Phase I RI.

3.5 REGIONAL HYDROGEOLOGY

The major groundwater production aquifer in the vicinity of NAWC Warminster consists of the fractured bedrock of the Stockton Formation. The middle arkose member of the Stockton Formation is considered to be the most productive bedrock aquifer in Bucks County. These rocks form a multiaquifer 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 NAWC Warminster area 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 aquifer
- Shallow bedrock aquifer
- Deeper bedrock aquifer

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 soil and saprolite (weathered bedrock) 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. JRB Associates (1983) concluded that groundwater flow is primarily lateral through the overburden aquifers; however, Satterthwaite (1984) felt that flow within these aquifers is primarily vertical. The overburden controls the rate at which water percolates to the water table. In areas of high permeability, rainfall will percolate to the water table within hours of a precipitation event. In areas of low permeability, a week or more may be required for precipitation to fully percolate, and a perched water table may be created within the overburden aquifers. In either case, the Satterthwaite study concluded that vertical percolation is much more important than lateral migration within the overburden aquifers.

The shallow bedrock aquifers underlie the overburden aquifers and may extend to depths of between 75 and 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 occur within the unweathered and weathered shallow bedrock. The shallow bedrock aquifers occurring under water-table conditions 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 usually occur at depths greater than 75 to 100 feet below the ground surface. These aquifers do not have any significant ability to store groundwater, and water within them occurs under semi-confined or confined conditions. 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.

Additional information can be found in several hydrologic investigations, and more detailed discussions of these results can be found in reports prepared by JRB Associates, 1983; Earth Technology, 1985; and 1988; and SMC Martin, 1991.

In general, the Stockton Formation behaves as a complex multiple aquifer system with low-permeability beds within the deeper bedrock acting as confining layers for highly permeable beds. However, bedrock fractures may occur in both the confining layers and highly permeable beds. 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. These conditions have been documented by U.S.G.S. studies using geophysical logs and brine trace logs for numerous deep wells both within and in the vicinity of NAWC Warminster (Sloto, et al., 1992; Sloto, 1992).

3.6 GROUNDWATER USE

Nearby residents rely primarily on groundwater sources for their water supply. The majority of these people are served by municipal water authorities, and the remainder utilize private domestic or commercial wells. The main NAWC Warminster supply system obtains water from three deep wells located at the facility. Some local municipal water authorities supplement their groundwater withdrawals with water from the Philadelphia Suburban Water Company.

Within the immediate vicinity of NAWC Warminster (less than one mile) are supply wells for

- Warminster Municipal Authority
- Upper Southampton Municipal Authority
- Warminster Heights Development Corporation
- Other commercial facilities

Municipal supply wells and other wells in the area pump several hundred million gallons of groundwater per year, mainly from the deeper bedrock aquifers of the Stockton Formation. Several public and commercial water-supply wells near NAWC Warminster have encountered significant levels of VOC groundwater contamination (Sloto and Davis, 1983).

3.6.1 Local Well Inventory

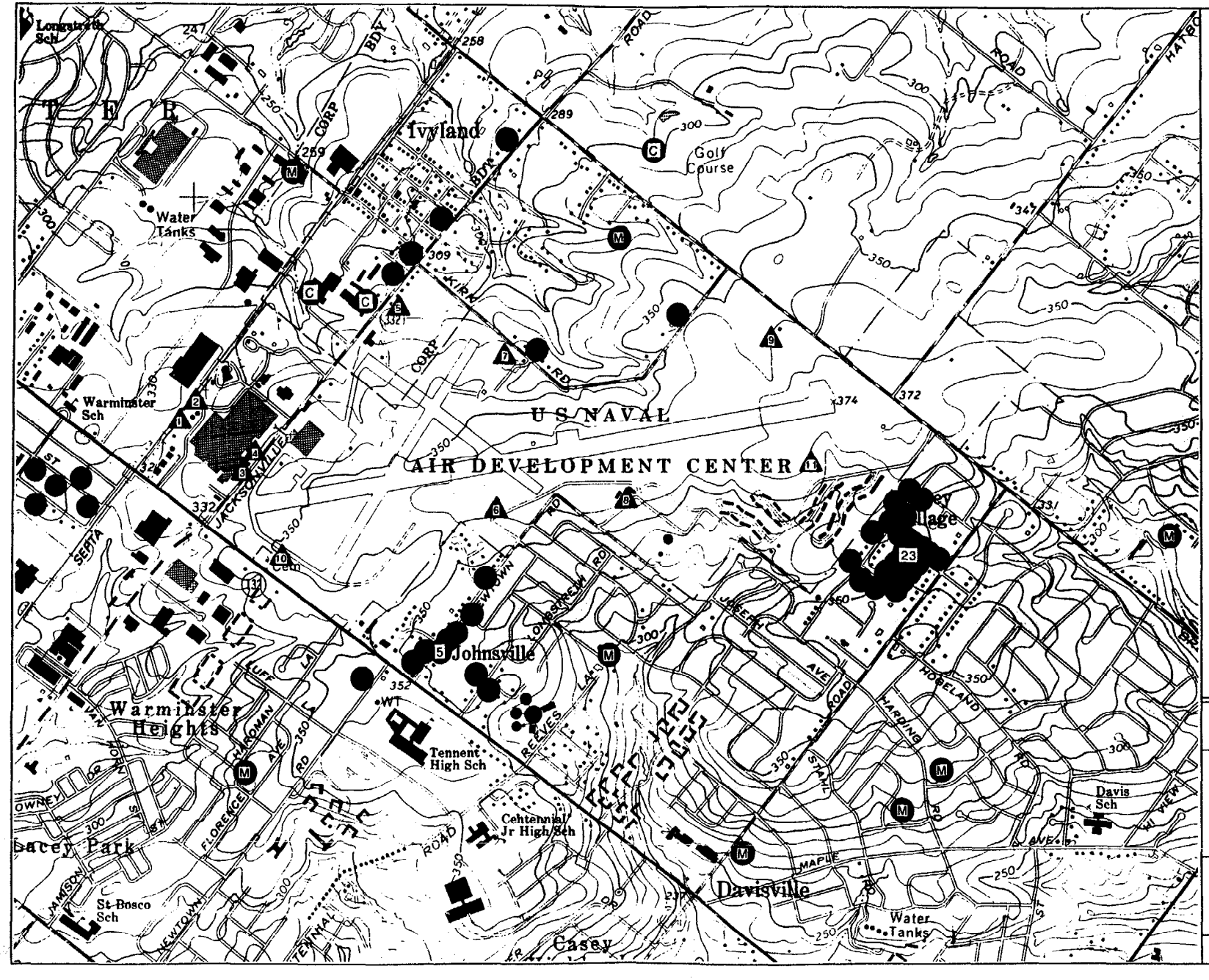
Three types of wells were confirmed to exist within or near the local well inventory study area surrounding NAWC Warminster. These three types were residential, commercial, and municipal wells. Figure 3-2 displays the location of each residential, commercial, and municipal well that was confirmed to exist by the inventory. Figure 3-2 also shows the locations of the NAWC Warminster supply wells.

The largest concentrations of residential wells are in the housing developments west of Davisville Road and east of NAWC Warminster. Responses to the door-to-door confirmation survey represent 56 percent of the total number of properties suspected to have wells. The door-to-door residential survey response has been summarized in Table 3-3. Table 3-4 presents the address of each confirmed residential well and other available well information.

The eight municipal wells and three commercial wells that were confirmed during the course of the well inventory are listed in Table 3-5. None of the municipal water supply wells were within 0.25 mile of the base, but several are near the 0.25-mile boundary. The three commercial wells are operated by Aztec Corporation, Wagner & Sons, and a local golf course.

As listed on Tables 3-4 and 3-5, three residential wells and three commercial or municipal wells reportedly have VOC contamination. One of the three residential wells found to contain contamination filters the water prior to use. Whether the other two wells have filter systems in place is unknown. Municipal wells that have been found to contain volatile organic concentrations have been outfitted with appropriate treatment systems. Measures taken at the commercial wells (Aztec and Wagner & Sons) reportedly found to contain VOCs are unknown.

Additional information regarding several local wells was obtained during sampling of selected off-site wells during Phase II.



NAWC
WARMINSTER, PA

FIGURE 3-2
LOCATIONS OF COMMERCIAL, MUNICIPAL, RESIDENTIAL AND NAWC SUPPLY WELLS

HALLIBURTON NUS
Environmental Corporation

Adapted From SMC Environmental Services Group, 1991

SCALE: 1" = 1000' | DATE: 10/12/92

TABLE 3-3
RESIDENTIAL DOOR-TO-DOOR WELL INVENTORY RESPONSES
NAWC, WARMINSTER, PENNSYLVANIA

Street	Number of Properties Reported to have Wells	Number of Responses to Door-to-Survey	Number of Properties with Confirmed Wells
Maple Street	4	1	1
Newtown Road	15	9	9
Memoral Street	6	4	4
Jacksonville Road	4	4	4
Kirk Road	1	1	1
Rambler Road	10	8	8
Hostman Avenue	1	0	0
Schoolhouse Lane	3	2	2
East Street Road	1	0	0
Gough Avenue	2	0	0
Azalea Road	12	11	10
Orchid Road	8	6	5
Davisville Road	24	5	0
Total	91	51	44

Note: All residents contacted on Davisville Road said that none of the houses on Davisville Road had wells.

TABLE 3-4
CONFIRMED RESIDENTIAL WELLS
NAWC WELL INVENTORY RESULTS
DECEMBER 4-7, 1989

NAME	ADDRESS	WELL DEPTH	DATE DRILLED	CASING DIAMETER	TYPE OF USE	PUMP TYPE	DEPTH OF INTAKE	CASING DEPTH	DRILLER	OWNER COMMENTS
Lee	167 Kirk Rd.	130'	1964	6"	Domestic	Sub.	?	?	?	TCE reportedly in well, (10 ppm), drinking water reportedly filtered
McKecvie	1280 Newtown Rd.	66'	1955	6"	Domestic	Sub.	~60'	60'	?	
Ganer	780 Newtown Rd.	135'	1960	8"	Domestic	?	>100'	35'	Rabbs	
Pitcher	715 Newtown Rd.	?	1950's	?	Domestic	?	?	?	?	
Kline	673 Newtown Rd.	?	?	?	Domestic	?	?	?	?	
Fries	655 Newtown Rd.	30'	?	4"	No Drink	Cent.	?	?	?	
Stanton	654 Newtown Rd.	?	?	?	Domestic	Cent.	?	?	?	
McDonald	628 Newtown Rd.	40'	~1890	?	Domestic	Sub.	40'	?	?	
Frederick	620 Newtown Rd.	?	1800's	?	Domestic	Cent.	?	?	?	
Armstrong	598 Newtown Rd.	110'	1939	?	Domestic	?	?	?	?	
Liebel	256 Maple St.	?	1950's	?	Domestic	?	?	?	?	
Dougherty	286 Nemoral St.	?	?	8"	Domestic	Cent.	?	~100'	Carson	
Gerow	240 Nemoral St.	?	?	?	Domestic	?	?	?	?	
Dailey	215 Nemoral St.	?	?	?	Domestic	?	?	?	?	Green stains from water
Narisi	204 Nemoral St.	?	1920's	?	Domestic	?	?	?	?	Green stains from water
Scullion	1218 Jacksonville Rd.	90'?	1940's	?	Domestic	?	?	?	?	
Dunn	1054 Jacksonville Rd.	?	?	?	Domestic	?	?	?	?	
McCandles	1026 Jacksonville Rd.	~100'	1928	4"	Domestic	Cent.	~95'	~90'	?	
Garrano	980 Jacksonville Rd.	?	?	6"	Domestic	Cent.	?	15'	?	
Hood	715 Rambler Rd.	?	?	?	?	?	?	?	?	
Clawges	718 Rambler Rd.	150'	1969	?	Domestic	?	?	?	?	
Greenstre	727 Rambler Rd.	?	?	?	Domestic	Cent.	?	?	?	

TABLE 3-4 - CONTINUED

NAME	ADDRESS	WELL DEPTH	DATE DRILLED	CASING DIAMETER	TYPE OF USE	PUMP TYPE	DEPTH OF INTAKE	CASING DEPTH	DRILLER	OWNER COMMENTS
Finegan	737 Rambler Rd.	70'	1960	?	Domestic	Sub.	70'	?	?	
Haertsch	757 Rambler Rd.	?	1950's	?	Domestic	Cent.	?	?	?	
Smith	767 Rambler Rd.	90'	1954	6"	No Drink	Sub.	?	45'	Rabb	
Roberts	777 Rambler Rd.	101'	1954	?	Domestic	Cent.	3'	?	?	
Kulb	789 Rambler Rd.	~100'	1959	4-6"	No Drink	Cent.	?	?	?	
McKown	680 Schoolhouse La.	80'	1959	?	Domestic	Sub.	?	?	Mr. Beans	
Huf	651 Schoolhouse La.	63'	1963	?	Domestic	Cent.	?	?	?	
Quigley	1126 Azalea Dr.	145'	1953	4"	Domestic	Cent.	100'	30'	?	
Hopely	1125 Azalea Dr.	85-90'	1961	6"	Domestic	Sub.	?	18'	?	
James	1116 Azalea Dr.	60-80'	1951	?	Domestic	?	?	?	?	
Neumann	1106 Azalea Dr.	?	?	?	Domestic	?	?	?	?	
Meissner	1103 Azalea Dr.	105'	1957	8"	Domestic	Sub.	65'	25-30'	Raab	
Jencelesk	1096 Azalea Dr.	92'	1962	8"	Domestic	Sub.	?	?	?	Water is hard
Nomes	1093 Azalea Dr.	?	1954-5	?	Domestic	?	85'	?	?	Water reportedly tested: Fine
Walker	1085 Azalea Dr.	60'	?	6"	Domestic	Cent.	?	?	?	
Dershimer	1080 Azalea Dr.	70-80'	1957	4-6"	Domestic	Cent.	65-80'	?	?	Reportedly have PCE in well
Smith	1069 Azalea Dr.	~115'	1955	6-8"	Domestic	Cent.	~100'	?	Haldemann	Reportedly have PCE or TCE in well (20ppb), drinking water reportedly filtered.
Tata	1130 Orchid Rd.	?	?	?	Domestic	Cent.	?	?	?	
Sabol	1115 Orchid Rd.	115'	1955	6"	Domestic	Cent.	?	?	?	
Schada	1110 Orchid Rd.	55-60'	?	?	Domestic	?	?	?	?	
Parabak	1095 Orchid Rd.	?	?	?	?	Cent.	?	?	?	
Johnston	1063 Orchid Rd.	93'	1954	?	Domestic	Sub.	?	?	?	

Total Confirmed Residential Wells = 44

TABLE 3-5

CONFIRMED MUNICIPAL AND COMMERCIAL WELLS
WELL INVENTORY RESULTS
DECEMBER 4-7, 1989

NAWC WARMINSTER, PA

Name/ID	Within 1\4 Mile Area From Base	Approximate Distance From Border of Base	Type	Reported Water-Quality Info.
Aztec Corp./ Jacksonville Road	Yes		Commercial	TCE- None Detected, PCE- 10 parts per billion (ppb)
Wagner & Sons/ Jacksonville Road	Yes		Commercial	TCE- 465 ppb, PCE- 8.7 ppb
WTMA Well #13	No	.6 miles	Municipal	No Stripper
WTMA Well #2	No	.3 miles	Municipal	No Stripper
WTMA Well #26	No	.3 miles	Municipal	Has Stripper
WTMA Well #12	No	.45 miles	Municipal	No Stripper
NMA Well #1	No	.4 miles	Municipal	No Stripper
USMA Well #4	No	.75 miles	Municipal	-----
1145 Charter Well	No	.3 miles	Municipal	-----
Golf Course Well	No	.4 miles	Commercial	-----
USMA #3	No	.75 miles	Municipal	-----

Total- 11

----- denotes information not available

The Wagner & Sons property actually contains two wells. An older, lower yielding well supplies water to the basic plumbing facilities of the plant such as sinks, wash basins, toilets, etc. No treatment of water from this well was reported, and the extent to which this water is used for drinking is unknown. A newer, higher yielding well supplies water for the production process of the facility. Water from this well is reported to undergo carbon filtration and ultraviolet light treatment prior to any use. No production or construction details were available for either well, except the production well is at least 200 feet deep.

The Warminster Township Municipal Authority (WTMA) Well No. 26 (WTMA-26) is reported to pump continuously for 24 hours per day, seven days per week at a rate of approximately 250 to 255 gpm. All water produced is treated through an air stripper unit. Available well records indicate that WTMA-26 is 250 feet deep with 10-inch-diameter casing to a depth of 70 feet. The reported specific capacity is 8.8 gpm per foot of drawdown at a pumping rate 420 gpm (Sloto and Davis, 1983).

An additional residential well was identified north-northwest of Site 8. This well serves the residence of Carl Lewis, 20 Kirk Road. Water from this well is reportedly untreated. The construction details of the well are not known.

Eleven supply wells are located on the NAWC Warminster facility (Figure 3-2). The construction details and well status of these supply wells are summarized in Appendix D of the Phase I. Water for the NAWC Warminster main supply system is currently withdrawn from Wells 3, 4, and 10. Wells 1 and 2 are used only for the facility's Warminster fire protection system. Well 6 is not in use because the building it serves is no longer used. Well 7 is not in use because Quarters A now obtains water from the main supply system. Both wells 6 and 7 could used if necessary. Well 8 supplies water to Quarters B, and Well 9 supplies water to one or two remote buildings and a few workers. Well 5 is permanently out of service, and Well 11 is used by the Bucks County Planning Commission and U.S.G.S. for continuous water-level monitoring.

3.7 ECOLOGY

Openland, woodland, and wetland habitats are all found within or near the facility. These include mowed fields and lawns, nonforested overgrown land, wooded areas, forested wetlands, scrub/shrub wetlands, and streams and their adjacent riparian areas.

According to the Master Plan for Naval Air Development Center, Warminster, Pennsylvania, 1985, there are no permanent threatened or endangered species on or near the facility; however, some transient species do traverse the area. This same plan states that no areas have been designated as wetlands on the NAWC Warminster property according to Corps of Engineers criteria.

Mourning doves, pheasants, and various songbirds such as sparrows, red-winged black birds, gold finches, cardinals, blue jays, and robins are present throughout NAWC Warminster. Canada geese and ducks have been observed in the streams south of Area B and north of Area A. Snakes, leopard frogs, and muskrat 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.

4.0 SITES 1, 2, AND 3 (AREA A)

4.1 SITE HISTORY AND DESCRIPTION

Site 1 (Waste Burn Pit No. 1), Site 2 (Sludge Disposal Pit), and Site 3 (Waste Burn Pit No. 3) have been combined into one general study area (Area A) for purposes of this report. Figure 4-1 shows the location of each site. All sites are within the fenced NAWC Warminster perimeter and are found in the northwestern corner of the facility bordering an industrial/commercial area. The inferred groundwater flow direction, surface water flow, and runoff are to the north for all sites within this area.

4.1.1 Waste Burn Pit No. 1 - Site 1

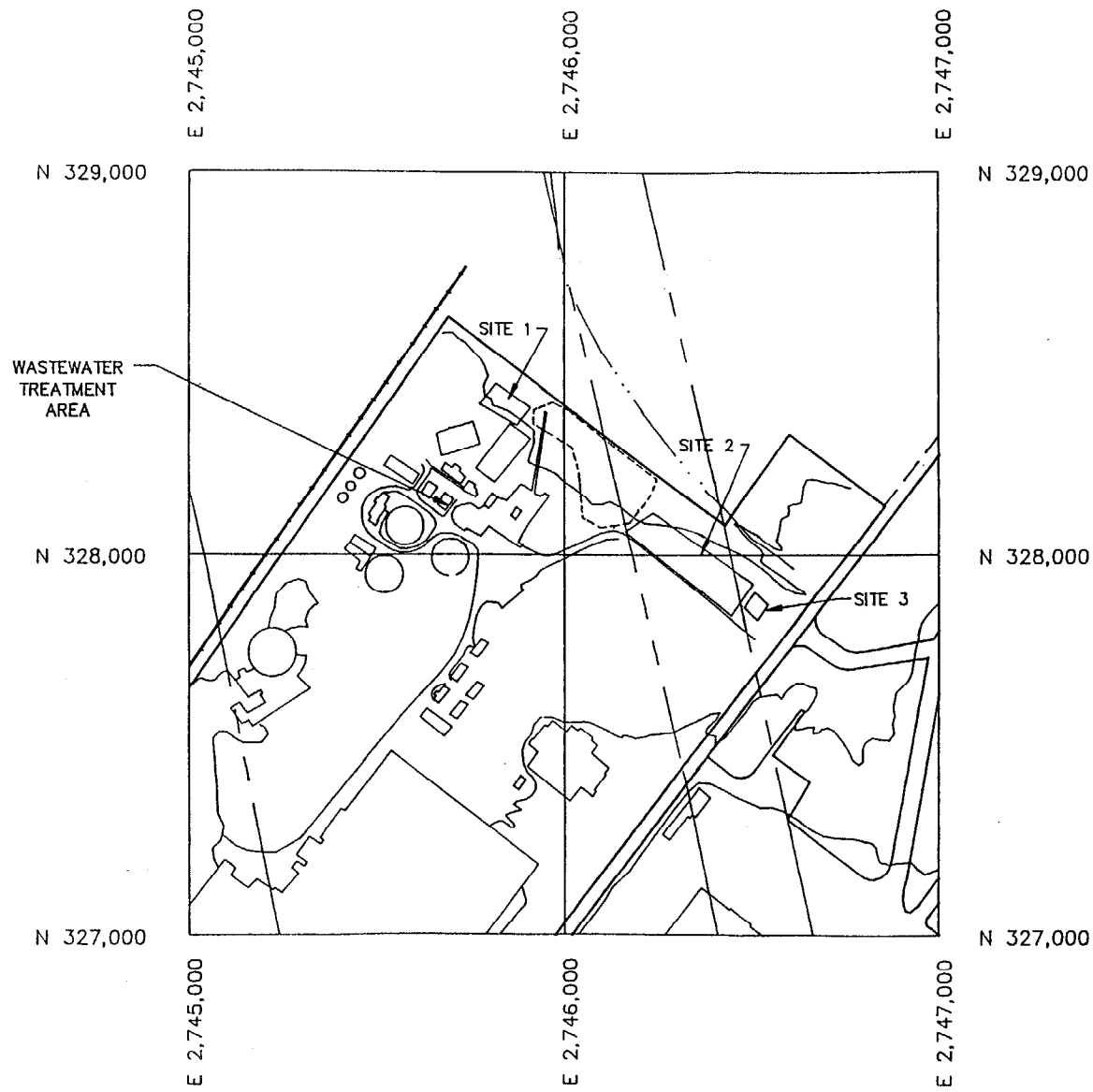
Site 1 is located on a portion of the NAWC Warminster property lying northwest of Jacksonville Road and is adjacent to the wastewater treatment plant (Figure 4-1). The site is within 1,000 feet of an off-site food processing facility (Wagner & Sons) and within 300 feet of an unnamed tributary that flows to Little Neshaminy Creek.

Site 1 reportedly 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 (25 feet wide by 100 feet long).

Historical aerial photos indicate that the area between Sites 1 and 2 may have received fill material. After use of Site 1 was discontinued, the burn pit was covered with soil from an on-site source.

4.1.2 Sludge Disposal Pit - Site 2

Site 2 is located southeast of Site 1 and is also northwest of Jacksonville Road (Figure 4-1). Site 2 allegedly received wastewater sludges from 1965 to 1970. The site reportedly consisted of two disposal trenches; each trench was approximately 12 feet wide by 200 feet long by eight feet deep and may potentially contain about 700 cubic yards of wastewater sludge. The total area of the site may be 20,600 square feet (75 feet wide by 275 feet long).



LEGEND

SITE 1 — SITE

FRACTURE TRACE

STREAM

AREA SUSPECTED TO HAVE RECEIVED FILL MATERIAL

TOPOGRAPHIC CONTOUR LINE

N

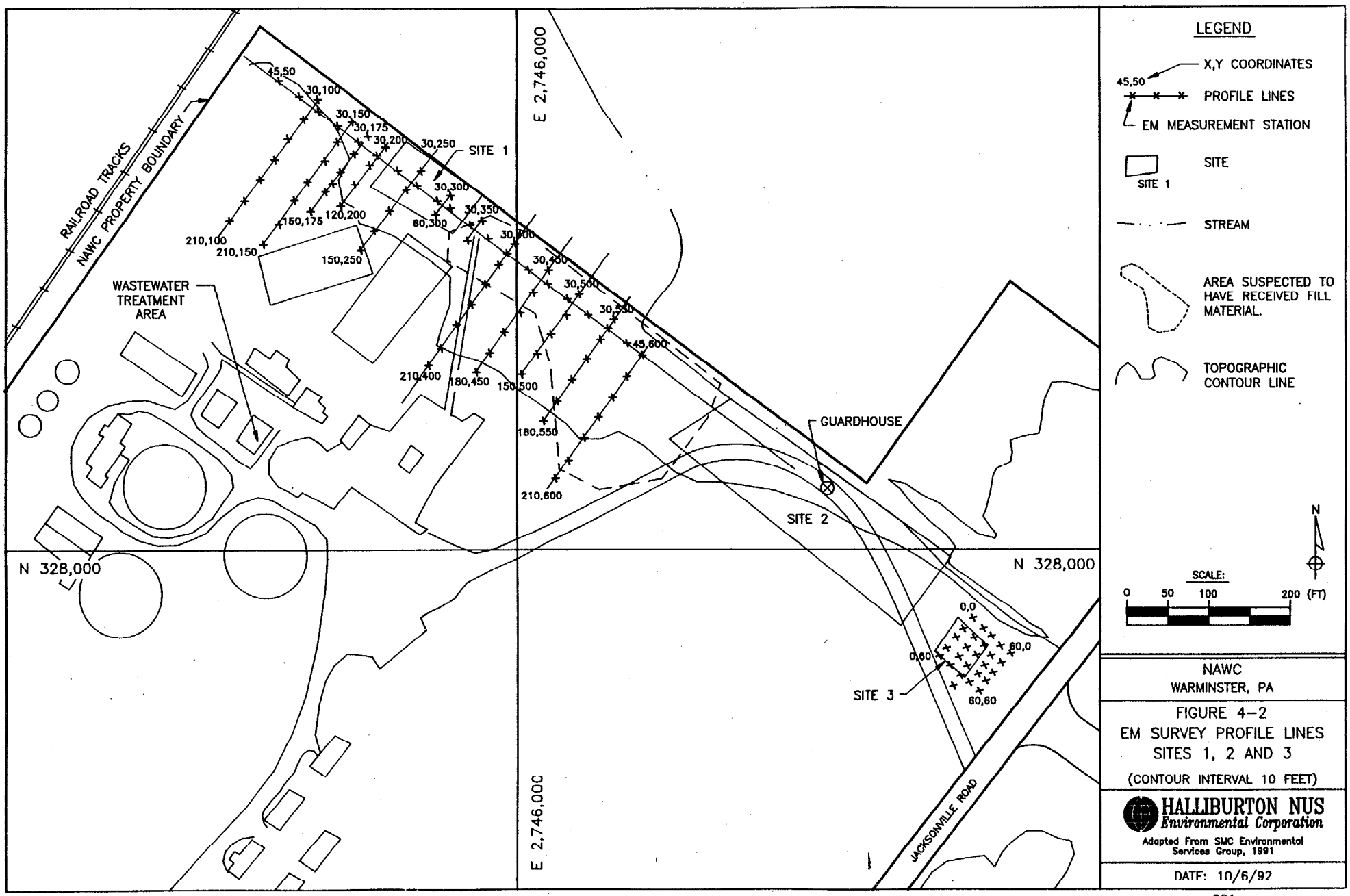
NAWC
WARMINSTER, PA

FIGURE 4-1
WASTE DISPOSAL SITES 1, 2 AND 3
(CONTOUR INTERVAL 10 FEET)

HALLIBURTON NUS
Environmental Corporation

Adapted From SMC Environmental Services Group, 1991

SCALE: 1"=300' | DATE: 10/12/92



NAWC
WARMINSTER, PA

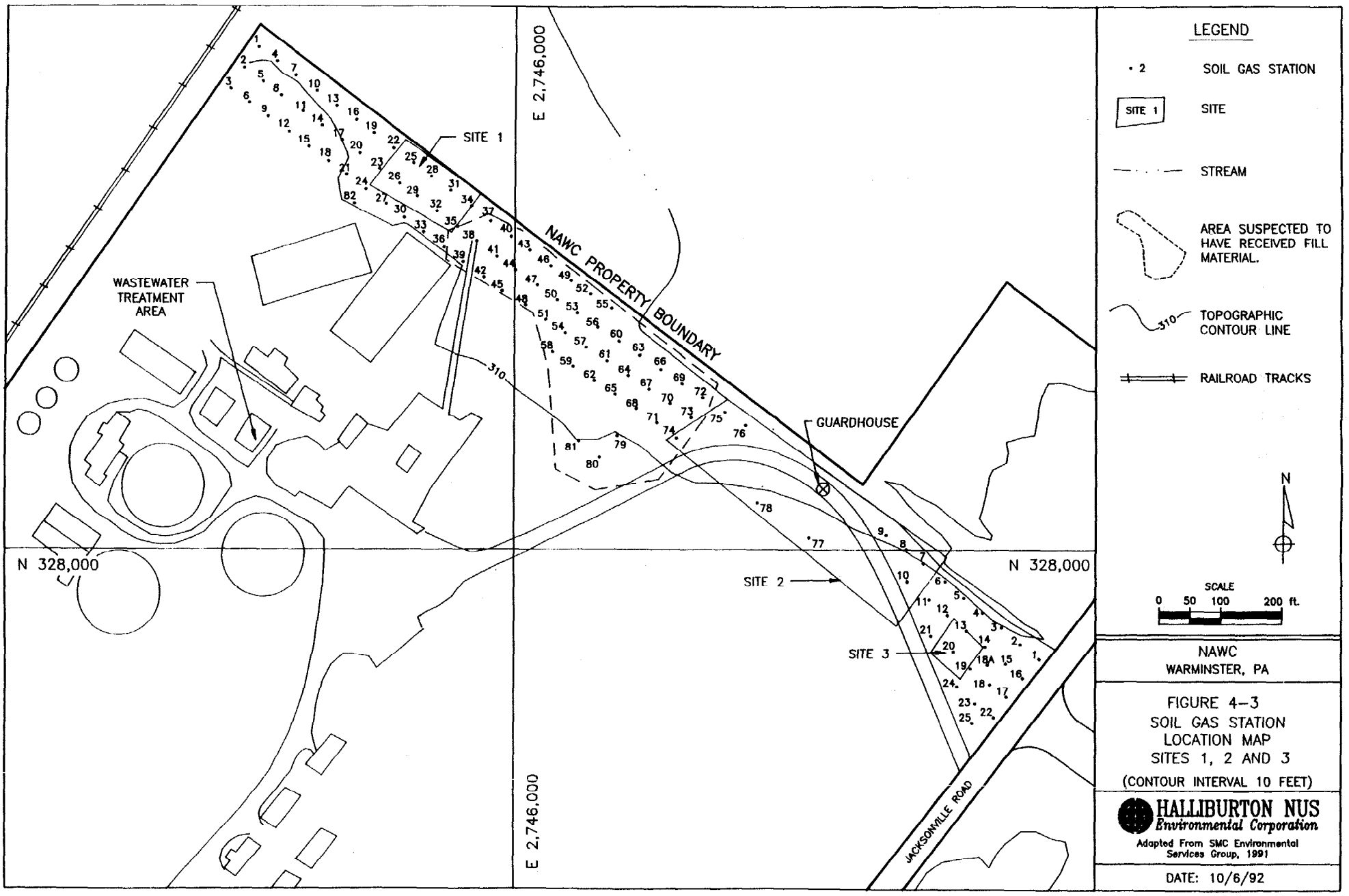
FIGURE 4–2
EM SURVEY PROFILE LINES
SITES 1, 2 AND 3
(CONTOUR INTERVAL 10 FEET)

HALLIBURTON NUS
Environmental Corporation

Adapted From SMC Environmental Services Group, 1991

DATE: 10/6/92

001



NAWC
WARMINSTER, PA

FIGURE 4-3
SOIL GAS STATION
LOCATION MAP
SITES 1, 2 AND 3
(CONTOUR INTERVAL 10 FEET)

HALLIBURTON NUS
Environmental Corporation

Adapted From SMC Environmental Services Group, 1991

DATE: 10/6/92

002

4.3.3 Confirmation Soil Borings

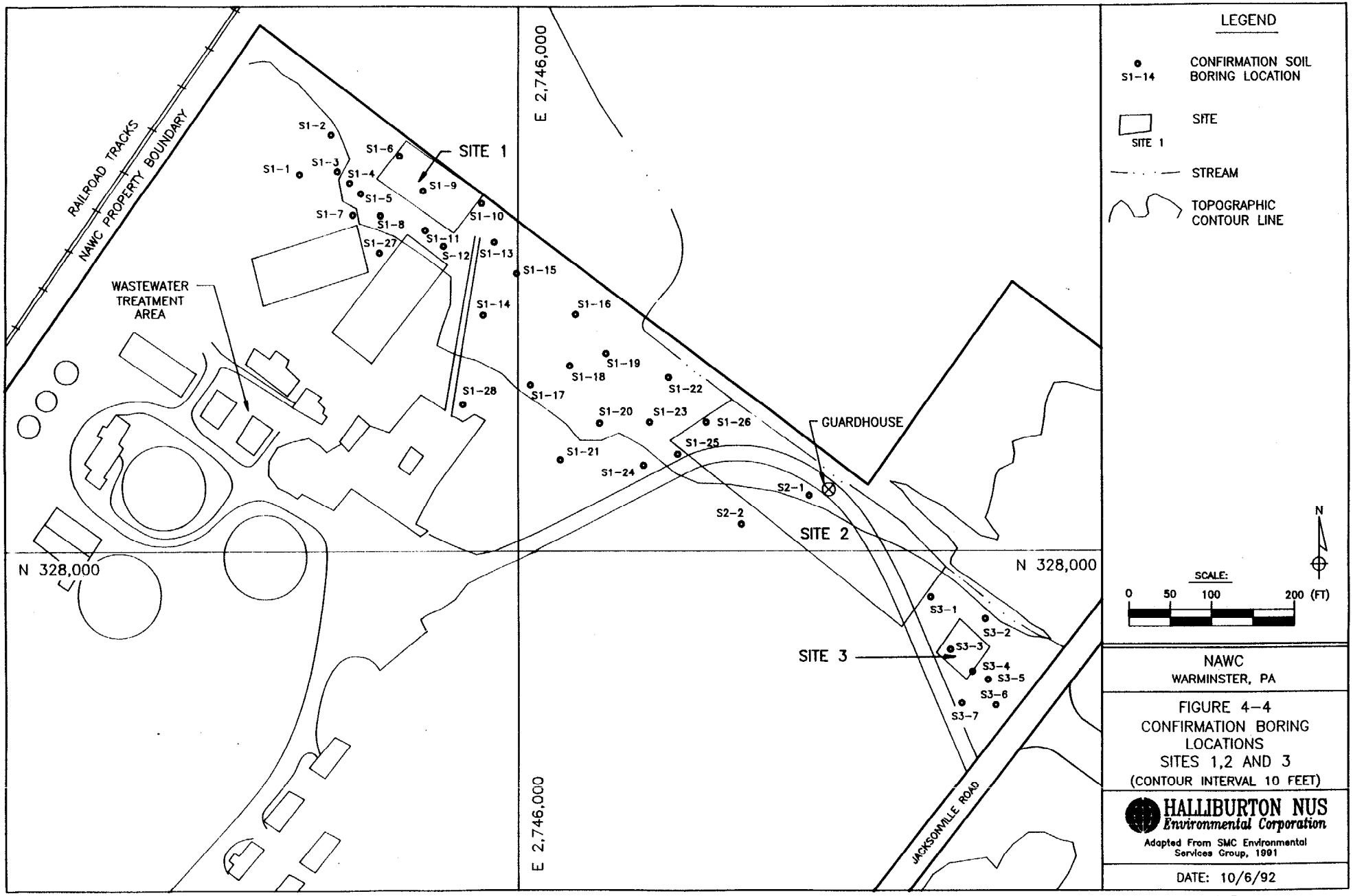
A confirmation soil boring program was conducted at Area A during the Phase I RI in accordance with procedures detailed in Section 2.1.5. Thirty confirmation soil borings were drilled in the area of Sites 1 and 2, and seven borings were drilled at Site 3 (Figure 4-4). The results of these borings are discussed in Section 4.5.1. The borings logs are contained in Appendix B.

4.3.4 Monitoring Well Installation

Twenty-one monitoring wells are present within Area A. Ten wells were installed during previous investigations (Figure 4-5), five wells were installed during Phase I (Figure 4-6), and six wells were installed during Phase II (Figure 4-7). Construction specifications for the monitoring wells are included in Appendix D.

Four shallow bedrock wells and one overburden well were installed at Area A during the Phase I RI following procedures detailed in Section 2.1.7.1. Two of the bedrock well were installed to complete well couplets with pre-existing overburden wells. One bedrock well was installed to provide upgradient control to several existing bedrock wells. One bedrock well and one overburden well were installed to create a new well couplet in an area lacking sufficient groundwater sampling and measurement points. The well numbers, aquifers, and installation rationale for each of the Phase I wells are summarized in Table 4-1.

Three shallow bedrock and three overburden wells were installed at Area A during the Phase II RI following procedures detailed in Section 2.1.7.2. Three bedrock wells and one overburden well were installed to provide groundwater sample and measurement points upgradient to the sites or along the northwestern NAWC boundary. One overburden well was installed to provide additional control in an area containing only shallow bedrock wells. One overburden well was installed on the opposite side of the stream from Sites 2 and 3 to investigate the stream's influence on the overburden aquifer. The well numbers, aquifers, and installation rationale for each of the Phase II wells are summarized in Table 4-2.



NAWC
WARMINSTER, PA

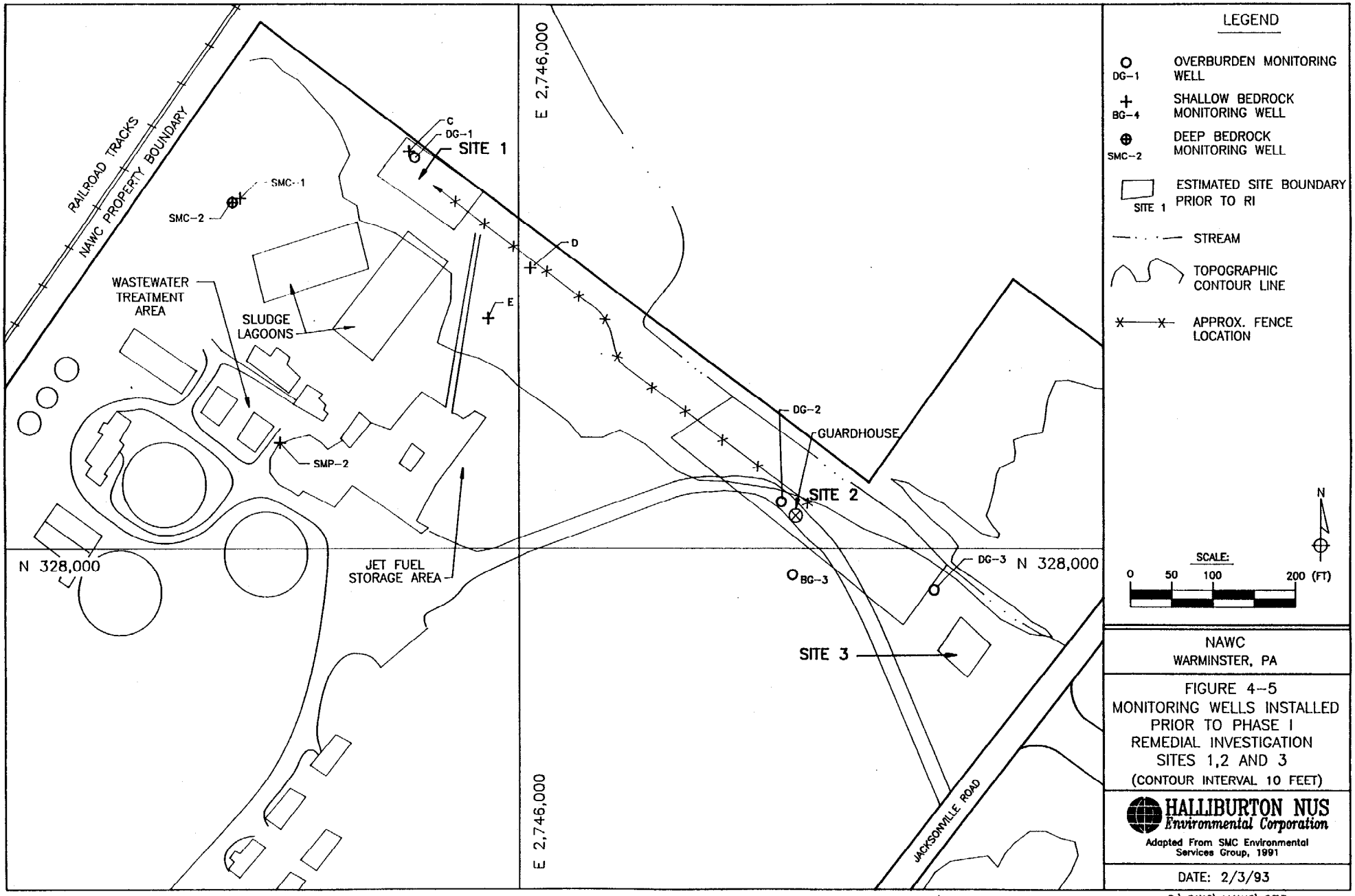
FIGURE 4-4
CONFIRMATION BORING LOCATIONS
SITES 1,2 AND 3
(CONTOUR INTERVAL 10 FEET)

HALLIBURTON NUS
Environmental Corporation

Adapted From SMC Environmental Services Group, 1991

DATE: 10/6/92

003



NAWC
WARMINSTER, PA

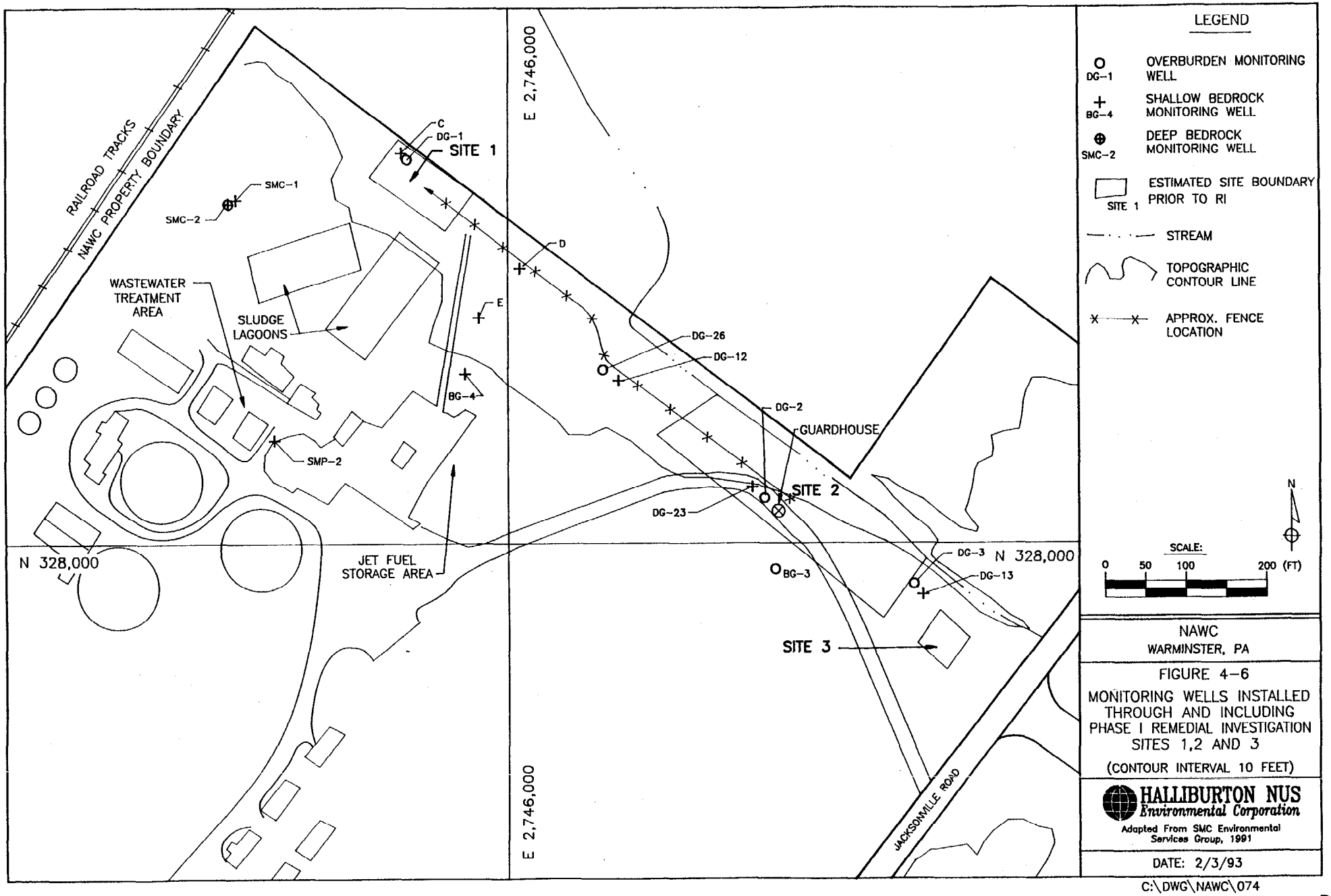
FIGURE 4-5
MONITORING WELLS INSTALLED PRIOR TO PHASE I REMEDIAL INVESTIGATION SITES 1,2 AND 3
(CONTOUR INTERVAL 10 FEET)

HALLIBURTON NUS Environmental Corporation

Adapted From SMC Environmental Services Group, 1991

DATE: 2/3/93

C:\DWG\NAWC\073



NAWC
WARMINSTER, PA

FIGURE 4-6
MONITORING WELLS INSTALLED THROUGH AND INCLUDING PHASE I REMEDIAL INVESTIGATION SITES 1,2 AND 3
(CONTOUR INTERVAL 10 FEET)

HALLIBURTON NUS Environmental Corporation

Adapted From SMC Environmental Services Group, 1991

DATE: 2/3/93

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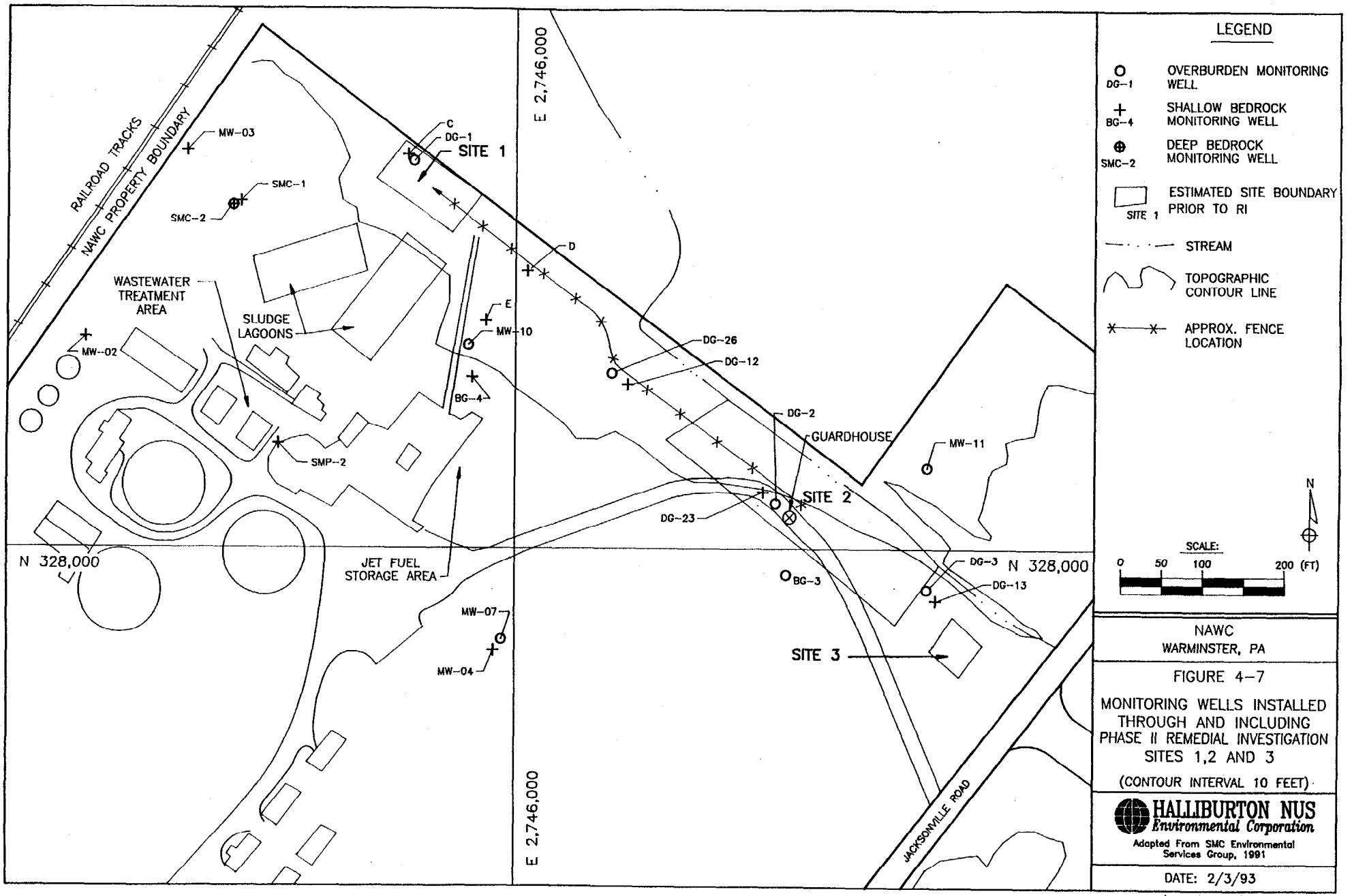

RAILROAD TRACKS
NAWC PROPERTY BOUNDARY
MW-03
SMC-1
SMC-2
C
DG-1
SITE 1
E 2,746,000
D
WASTEWATER TREATMENT AREA
SLUDGE LAGOONS
E
MW-10
MW-02
BG-4
SMP-2
DG-26
DG-12
DG-2
GUARDHOUSE
MW-11
SITE 2
DG-23
N 328,000
JET FUEL STORAGE AREA
BG-3
DG-3
DG-13
N 328,000
MW-07
MW-04
SITE 3
E 2,746,000
JACKSONVILLE ROAD
LEGEND
DG-1 OVERBURDEN MONITORING WELL
BG-4 SHALLOW BEDROCK MONITORING WELL
SMC-2 DEEP BEDROCK MONITORING WELL
SITE 1 ESTIMATED SITE BOUNDARY PRIOR TO RI
STREAM
TOPOGRAPHIC CONTOUR LINE
APPROX. FENCE LOCATION
N
SCALE:
0 50 100 200 (FT)
NAWC
WARMINSTER, PA
FIGURE 4-7
MONITORING WELLS INSTALLED THROUGH AND INCLUDING PHASE II REMEDIAL INVESTIGATION SITES 1,2 AND 3
(CONTOUR INTERVAL 10 FEET)
HALLIBURTON NUS Environmental Corporation
Adapted From SMC Environmental Services Group, 1991
DATE: 2/3/93
C:\DWG\NAWC\075

TABLE 4-1
RATIONALE FOR INSTALLATION OF MONITORING WELLS
DURING PHASE I REMEDIAL INVESTIGATION
NAWC WARMINSTER, SITES 1, 2, AND 3

Well Number	Aquifer Monitored	Summary of Rationale for Well Installation
BG-4	Shallow Bedrock	Upgradient or background sample and elevation location to sites 1 and 2 and wells C, D, and E.
DG-12	Shallow Bedrock	Additional downgradient sample and elevation location for sites 1 and 2; creates new well couplet with DG-26.
DG-13	Shallow Bedrock	Downgradient sample and elevation location for site 3; completes well couplet with DG-3.
DG-23	Shallow Bedrock	Downgradient sample and elevation location for site 2; complete wells couplet with DG-2.
DG-26	Overburden	Additional downgradient sample and elevation location for sites 1 and 2; creates new well couplet with DG-12.

TABLE 4-2
RATIONALE FOR INSTALLATION OF MONITORING WELLS
DURING PHASE II REMEDIAL INVESTIGATION
NAWC WARMINSTER, SITES 1, 2, AND 3

Well Number	Aquifer Monitored	Summary of Rationale for Well Installation
MW-02	Shallow Bedrock	Upgradient or lateral sample and elevation location along northwestern facility boundary.
MW-03	Shallow Bedrock	Upgradient or lateral sample and elevation location along northwestern facility boundary.
MW-04	Shallow Bedrock	Upgradient sample and elevation location; forms new well couplet with MW-07.
MW-07	Overburden	Upgradient sample and elevation location; forms new well couplet with MW-04.
MW-10	Overburden	Overburden groundwater sample and elevations near shallow bedrock wells BG-04 and E.
MW-11	Overburden	Sample and elevation location on opposite side of stream from sites 2 and 3.

Originally, the Phase II RI work plan called for well couplets along the northwestern NAWC Warminster property boundary. However, saturated conditions did not exist in the overburden at these locations and only the shallow bedrock monitoring wells were installed (MW-02 and MW-03 in Figure 4-7). The corresponding overburden wells were moved from the originally proposed locations in the well couplets to their current locations (MW-10 and MW-11 in Figure 4-7) for reasons described previously. Shallow bedrock wells MW-02 and MW-03 were drilled to total depths greater than other shallow bedrock wells because no significant water-bearing zones were encountered during drilling.

4.3.5 Groundwater Sampling

Groundwater samples were obtained from wells within Area A during both phases of the RI in accordance with procedures detailed in Section 2.1.8. Samples were obtained from five overburden wells and seven shallow bedrock wells during Phase I. Samples were obtained from six overburden wells, 12 shallow bedrock wells, and one deep bedrock well during Phase II. Existing wells SMC-1, SMC-2, and SMP-2 were not sampled during Phase I. Well MW-10 was dry and the location of well BG-3 was paved over during Phase II. The groundwater sample analytical results are summarized in Section 4.5.3.

4.3.6 Soil and Geologic Investigations

During Phase I, soil and geologic investigations performed at Area A included descriptions of materials and cuttings produced during the drilling of confirmation soil borings and monitoring wells and the construction of a geologic cross-section for the sites. During Phase I, split-spoon samples from subsurface soil sampling and overburden well installation were also described. These investigations were performed in accordance with procedures detailed in Sections 2.1.5, 2.1.7, and 2.1.9. The results of these activities are presented in Sections 4.4.1 and 4.4.2.

4.3.7 Hydrogeologic Investigations

Hydrogeologic investigations performed during both phases of the RI include

- Estimates of yield from newly installed wells
- Construction of groundwater elevation maps
- Determination of horizontal groundwater gradients
- Calculation of horizontal groundwater flow velocities
- Determination of vertical hydraulic gradients at well couplets

Hydrogeologic investigations performed only during Phase I include

- Estimates of flow rates for surface water near the sites

Hydrogeologic investigations performed only during Phase II include

- Performance of hydraulic conductivity slug tests in Phase II monitoring wells
- Performance of a long-term (approximately two weeks) groundwater-level monitoring program
- Step-drawdown pump tests in selected wells
- A long-term (approximately nine hours) pumping test

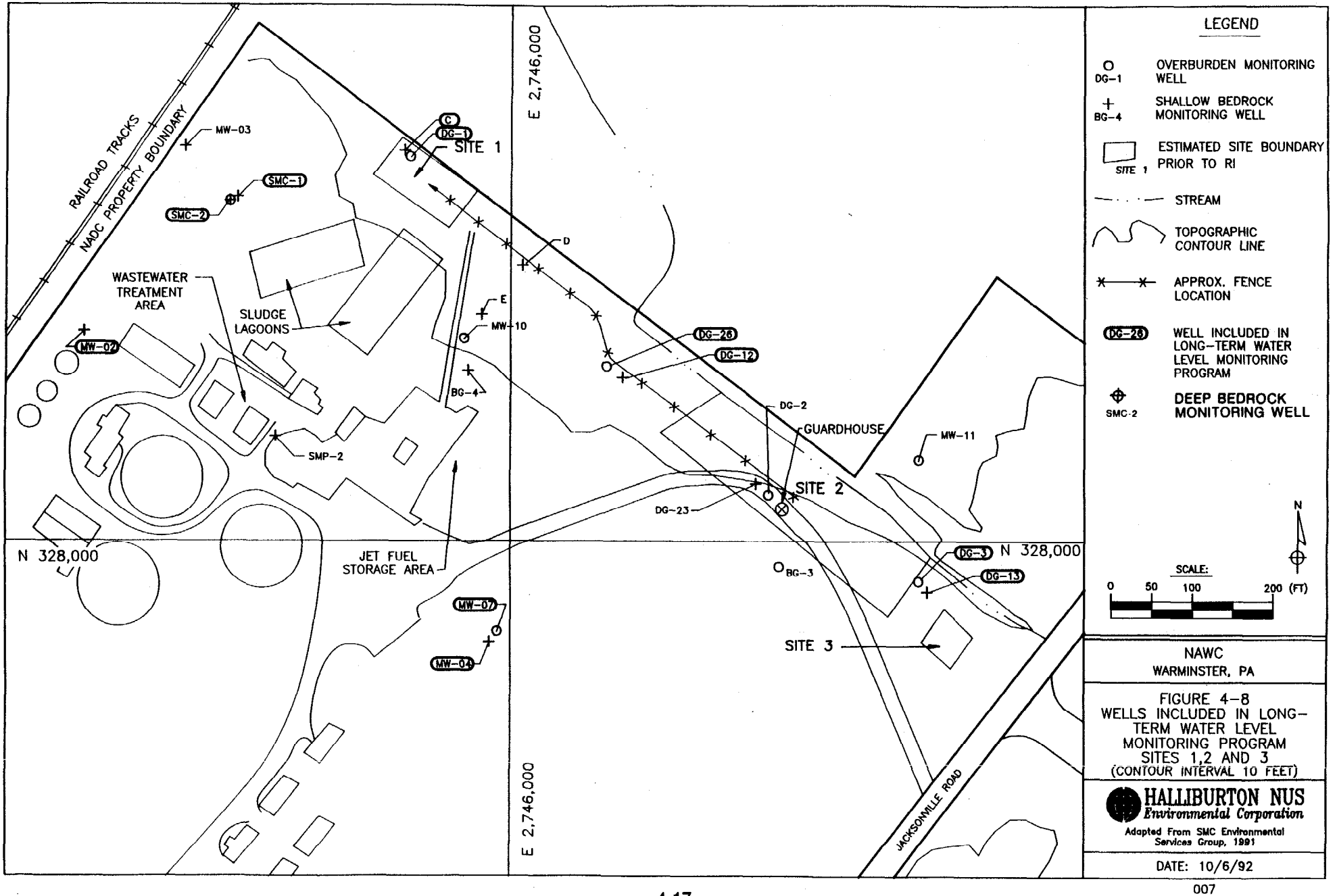
Most of these tasks were performed for both the overburden and shallow bedrock aquifer. Step-drawdown and long-term pumping tests were performed for the shallow bedrock aquifer only. All hydrogeologic investigations were performed as detailed in Section 2.1.10. The results of the hydrogeologic investigations are presented in Sections 4.4.3.1 through 4.4.3.5.

Long-Term Water-Level Study

A long-term groundwater-level monitoring program was conducted for 11 wells within Area A for a period of 17 days from July 24 to August 10, 1992 (Figure 4-8). Water levels in these wells were recorded for the entire period at 15-minute increments using pressure transducers and programmable electronic data loggers. The static water levels were measured and recorded manually in each well at the beginning of the study to serve as a reference elevation. The results of the study are presented in Section 4.4.3.3.

Pump Tests

Two step-drawdown pump tests and one long-term pump test were performed at Area A in accordance with procedures detailed in Section 2.1.10. The step-drawdown tests were performed in wells E and SMC-1. The pumping well (E) and primary observation wells of the long-term pumping test are shown in Figure 4-9. The results of these pump tests are presented in Section 4.4.3.4. Pump test data and calculations are included in Appendix H.



NAWC
WARMINSTER, PA

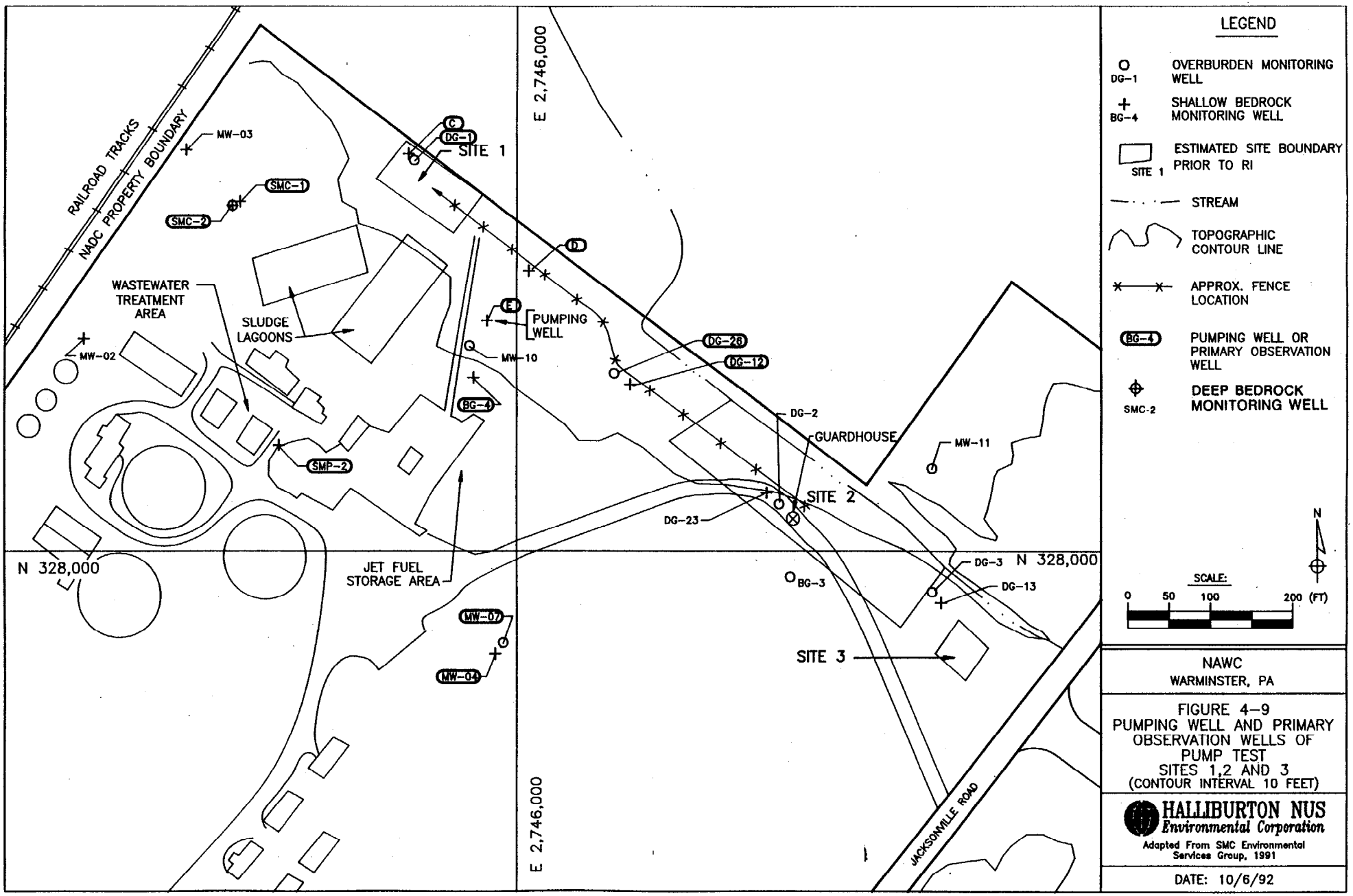
FIGURE 4-8
WELLS INCLUDED IN LONG-TERM WATER LEVEL MONITORING PROGRAM
SITES 1,2 AND 3
(CONTOUR INTERVAL 10 FEET)

HALLIBURTON NUS
Environmental Corporation

Adapted From SMC Environmental Services Group, 1991

DATE: 10/6/92

007



NAWC
WARMINSTER, PA

FIGURE 4-9
PUMPING WELL AND PRIMARY OBSERVATION WELLS OF PUMP TEST
SITES 1,2 AND 3
(CONTOUR INTERVAL 10 FEET)

HALLIBURTON NUS
Environmental Corporation

Adapted From SMC Environmental Services Group, 1991

DATE: 10/6/92

008

4.4 SITE CHARACTERISTICS

The sites within Area A are located on the northern boundary of NAWC Warminster, west of Jacksonville Road. The sites are located on a generally flat-lying area. The unnamed tributary of Little Neshaminy Creek is located north of Area A, and the wastewater treatment facility, jet fuel storage area, and parking lots are immediately to the south.

No springs were seen on or adjacent to Area A. Isolated and/or displaced fragments of the underlying bedrock were observed in the stream embankment north of the sites.

An orange-colored seep was observed along the creek bank north of Sites 2 and 3. The seep was observed at several points along the creek, suggesting that there may be more than one entrance point of the seep into the creek. Preliminary analysis of the seep with the portable GC indicated that no volatile compounds were present. It is not known if the seep material is spring fed.

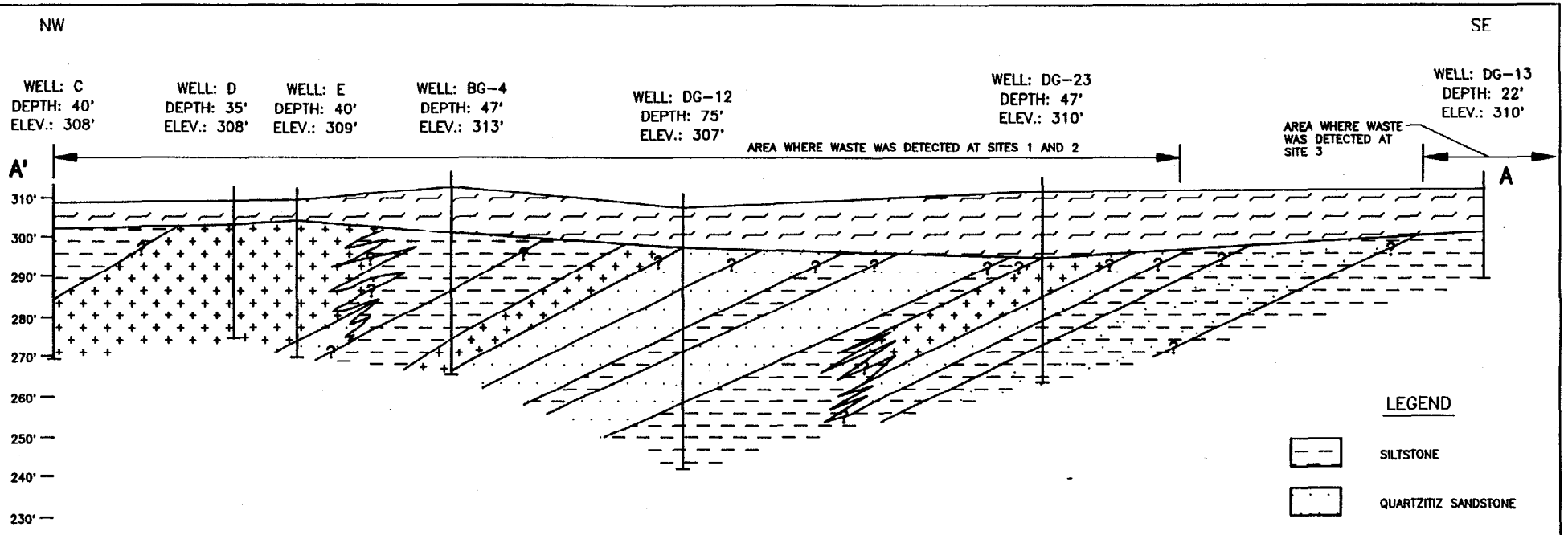
4.4.1 Soils

Soil thicknesses at Area A ranged from 6-1/2 to 16 feet. The soil appeared to be thinnest (6.5 to eight feet) north of the wastewater lagoons in the area of confirmation borings S1-9, S1-6, and S1-10 and monitoring wells D and E. Soil types observed at Area A were mostly orange-red, red, and brown silt with less common thin beds of red and tan, fine-to medium-grained arkosic sand.

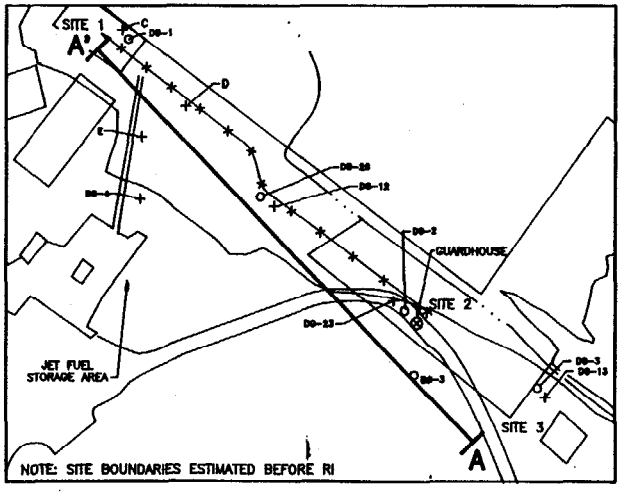
The United States Soil Conservation Service (SCS) has mapped the soil at Area A as "Urban land soils." During Phase I, waste material was discovered, including cinders and wood, glass, and metal fragments, indicating that these soils have been reworked. A more thorough discussion of this waste material is presented in Section 4.5.2.

4.4.2 Geology

The geological cross-section of Area A is presented in Figure 4-10. The bedrock lithology consists mainly of maroon-red to brownish-red micaceous siltstone interbedded with light red, very fine- to medium-grained arkosic sandstone and tan, medium-grained quartzitic sandstone. These rock units were observed to strike northeast and dip 12 to 13 degrees toward the northwest. The thickness of the lithologic units ranges from five to 25 feet. Waste material was detected in the overburden above all the different types lithologies listed above.



LINE OF SECTION



LEGEND

- SILTSTONE
- QUARTZITIZ SANDSTONE
- ARKOSIC SANDSTONE
- SANDY SILTSTONE
- OVERBURDEN

HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 25'

ELEVATION REPORTED IN FEET ABOVE MEAN SEA LEVEL

VERTICAL EXAGGERATION = x2

NAWC
WARMINSTER, PA

FIGURE 4-10
GEOLOGICAL CROSS-SECTION
SITES 1,2 AND 3

HALLIBURTON NUS
Environmental Corporation

Adapted From SMC Environmental Services Group, 1991

SCALE: AS SHOWN | DATE: 10/6/92

009

A fragment of diabase was encountered in soils from confirmation boring S1-28. This fragment may have been brought in as fill or may have originated from an igneous dike within NAWC Warminster. However, no direct observations of a diabase dike within the bedrock were found during the RI.

4.4.3 Hydrogeology

Breakdown of feldspar minerals in arkosic sandstones often leads to the precipitation of a white, kaolinitic clay at the bedrock/overburden interface. Evidence of this process was seen in several test pits and confirmation borings. The presence of this clay may possibly create a semi-permeable layer between the bedrock and overburden, which may retard the movement of groundwater between the two aquifers. However, the effect of this layer on groundwater transport at the facility is not known.

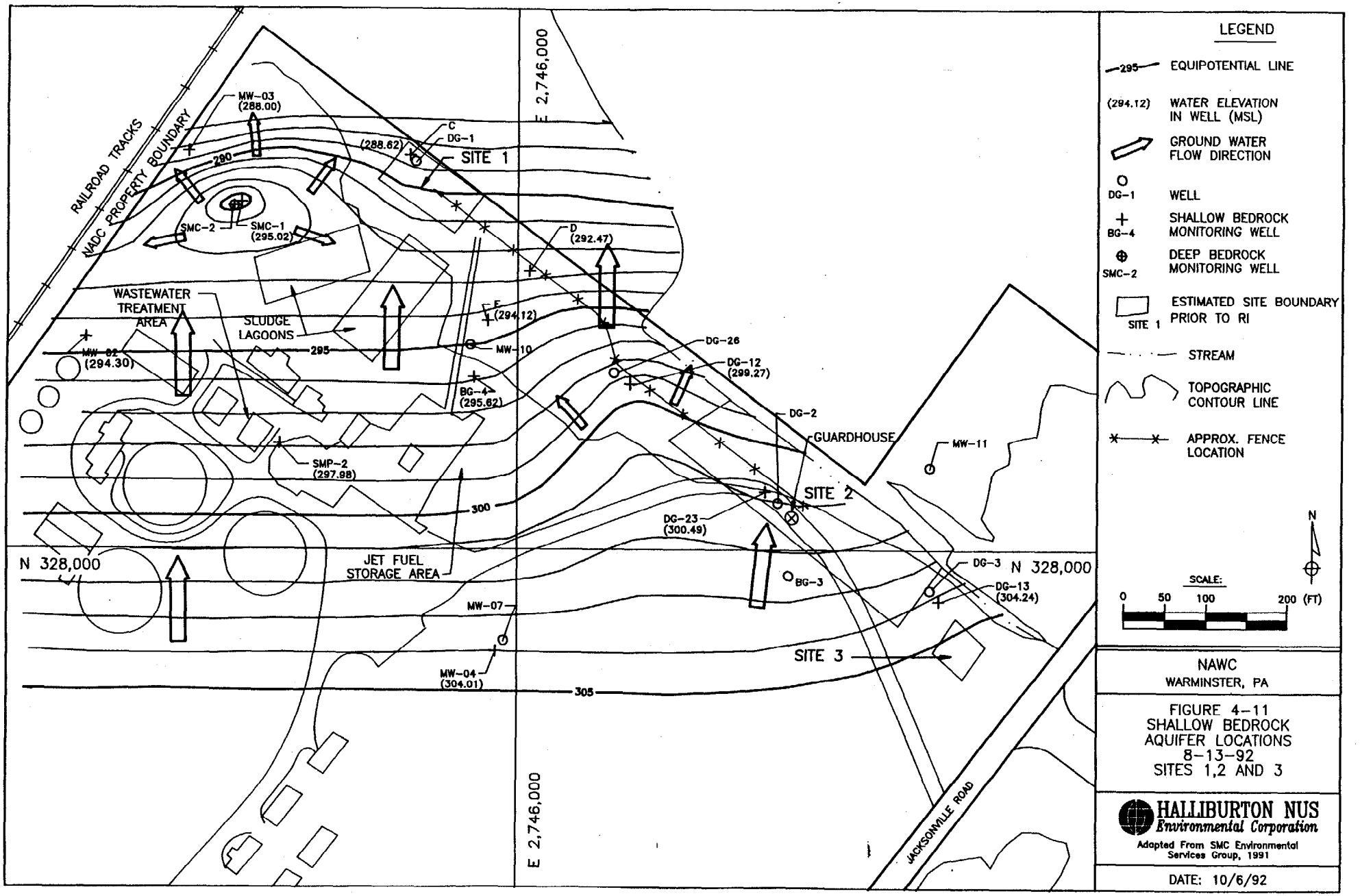
The widely varying depth at which water was encountered in the bedrock at Area A, between 18 and 72 feet below land surface, indicates that secondary porosity (e.g., fractures, joints) plays a role in groundwater transport. Evidence of groundwater flow through the intergranular space within the matrix of the bedrock (e.g., perching of groundwater at bedding planes) was also seen. Thus, both of these mechanisms may affect groundwater transport.

A discussion of the shallow bedrock and overburden aquifers underlying Area A is presented in the following sections.

4.4.3.1 Shallow Bedrock Aquifer

The shallow bedrock aquifer groundwater elevation map for Area A is shown in Figure 4-11. The inferred general flow direction of the groundwater in this area is from the south to the north, with a horizontal gradient of approximately 2.5 percent. The inferred groundwater flow direction in the eastern part of this area is apparently toward the unnamed tributary of Little Neshaminy Creek, which is located north of the sites.

Groundwater flow directions in the Stockton Formation bedrock are not completely predictable due to the heterogeneity of the aquifer. The principal groundwater flow avenues are within beds with well-developed primary or secondary porosity, along fractures parallel to bedding, or along near-vertical fractures either parallel to or cutting across the strike of bedding. Due to the complex nature of Stockton Formation aquifers, it is not possible to define the actual direction of groundwater flow at specific locations.


LEGEND
295 EQUIPOTENTIAL LINE
(294.12) WATER ELEVATION IN WELL (MSL)
GROUND WATER FLOW DIRECTION
DG-1 WELL
BG-4 SHALLOW BEDROCK MONITORING WELL
SMC-2 DEEP BEDROCK MONITORING WELL
SITE 1 ESTIMATED SITE BOUNDARY PRIOR TO RI
STREAM
TOPOGRAPHIC CONTOUR LINE
APPROX. FENCE LOCATION
N
SCALE:
0 50 100 200 (FT)
NAWC
WARMINSTER, PA
FIGURE 4-11
SHALLOW BEDROCK
AQUIFER LOCATIONS
8-13-92
SITES 1,2 AND 3
HALLIBURTON NUS
Environmental Corporation
Adapted From SMC Environmental Services Group, 1991
DATE: 10/6/92
RAILROAD TRACKS
NADC PROPERTY BOUNDARY
MW-03 (288.00)
C
DG-1
(288.62)
SITE 1
290
SMC-2
SMC-1 (295.02)
D (292.47)
WASTEWATER TREATMENT AREA
SLUDGE LAGOONS
E (294.12)
295
MW-02 (294.30)
MW-10
BG-4 (295.62)
DG-26
DG-12 (299.27)
DG-2
GUARDHOUSE
MW-11
SMP-2 (297.98)
300
SITE 2
DG-23 (300.49)
N 328,000
JET FUEL STORAGE AREA
BG-3
DG-3
N 328,000
DG-13 (304.24)
MW-07
SITE 3
MW-04 (304.01)
305
E 2,746,000
E 2,746,000
JACKSONVILLE ROAD

010

A "recharge mound" and corresponding variations in local horizontal gradients and flow directions are evident near well SMC-1. This was interpreted during the Phase II RI to be caused by recharge to the shallow bedrock aquifer from the confined deeper bedrock aquifers penetrated by well SMC-2, which is uncased from 51 to 298 feet and adjacent to well SMC-1. This interpretation was confirmed by U.S.G.S. studies in which geophysical and brine-trace logs were run in well SMC-2 on April 17, 1991 (Sloto, 1992). These results are discussed in Section 4.4.3.5.

Estimated yields of the newly installed bedrock aquifer wells at Area A range from less than 1/2 to greater than five gpm.

The hydraulic conductivity of the shallow bedrock aquifer at Area A was estimated through rising and falling head slug tests performed in wells MW-02, MW-03, and MW-04. These results are shown in Table 4-3.

TABLE 4-3
SLUG TEST TYPES AND HYDRAULIC CONDUCTIVITIES
SHALLOW BEDROCK AQUIFER - AREA A

Well Number	Test Type	Hydraulic Conductivity
MW-02	Rising Head	2.05×10^{-4} cm/sec
MW-03	Rising Head	1.35×10^{-4} cm/sec
MW-04	Rising Head	7.29×10^{-4} cm/sec
MW-04	Falling Head	6.91×10^{-4} cm/sec

The average hydraulic conductivity for the shallow bedrock aquifer underlying Area A based on the slug test results is 3.5×10^{-4}cm/sec or 0.992 feet per day.

The results of the pump test at Area A indicate that the shallow bedrock has the properties of a semi-confined aquifer with the following average values:

- Average hydraulic conductivity (k) . . . . . 3.9×10^{-4} cm/sec (1.1 ft/day)
- Average transmissivity (T) . . . . . 7.9×10^{-1} cm^2/sec
- Average storativity (S) . . . . . 4.0×10^{-4}

Additional discussion of the results, of the pump test at Area A is included in Section 4.4.3.4.

Horizontal groundwater velocities for the shallow bedrock aquifer at Area A were calculated during Phase I to be between 20 and 55 feet per year. Velocities during Phase II were calculated using porosity values from Rima, et al. (1962), hydraulic conductivity values from slug test results, and a horizontal gradient of 2.5 percent derived from the Phase II groundwater elevation map. These velocities were found to range from 36 to 91 feet per year. The calculation of a horizontal groundwater velocity of 120 feet per year (0.33 feet per day) based on the results of the pump test is discussed in greater detail in Section 4.4.3.4.

December 1990, January 1991, July 1992, and August 1992 vertical hydraulic gradients were estimated from head differences between wells in couplets at Area A and are shown in Table 4-4. Vertical gradients were upward for all dates of measurement in well couplets DG-26/DG-12 and MW-07/MW-04 and on three of the four dates in well couplets DG-02/DG-23 and DG-3/DG-13. This indicates that the bedrock aquifer may have been supplying groundwater to the overburden aquifer at these locations a majority of the time.

Consistently downward gradients in well couplet DG-1/C indicate that the overburden aquifer may supply groundwater to the shallow bedrock aquifer at this location. The downward gradient at well couplets DG-2/DG-23 and DG-3/DG-13 indicates that the same circumstances may apply for these locations on occasion, probably following significant precipitation events.

Changing vertical hydraulic gradients at different locations and at different times may result from any of several factors. These include the varying composition and degree of interconnection between the overburden and bedrock aquifers, the relative properties of pervious and impervious surface cover at a given location, the frequency and magnitude of precipitation events, and the influence that the nearby stream or underground water drainage culverts have on groundwater discharge or recharge.

Available water-level measurements in shallow bedrock wells at Area A between December 1990 and August 1992 show that water levels were highest in January 1991 and lowest in August 1992 with one exception (Table 4-5). This trend is typical of seasonal variations for the area: i.e., groundwater levels are highest in late winter and early spring and are lowest in late summer through early fall (Sloto and Davis, 1983). Well DG-12 had its highest recorded water levels in July 1992 and the lowest in December 1990. A clear explanation for these contrasting water levels is not readily apparent. Water levels in all Area A shallow bedrock wells, except for SMC-1, declined an average of 1.25 feet over a five-week period from July to August 1992. It is interpreted that water levels in SMC-1 are more strongly influenced by the adjacent deep artesian well SMC-2 than by seasonal variations of the water table.

TABLE 4-4
NAWC SITES 1, 2, 3
VERTICAL HYDRAULIC GRADIENTS ESTIMATED FROM HEAD DIFFERENCES BETWEEN OVERBURDEN AND SHALLOW BEDROCK MONITORING WELLS IN COUPLETS

Well Couplet	Estimated Vertical Hydraulic Gradient			
Overburden / Shallow Bedrock	12/90	1/90	7/92	8/92
DG-1 / C	NA(1)	NA(1)	5.81↓	6.45↓
DG-26 / DG-12	0.40↑	0.03↑	1.53↑	1.48↑
DG-2 / DG-23	0.41↑	0.22↑	0.03↑	0.04↓
DG-3 / DG-13	1.91↑	0.47↓	2.87↑	2.76↑
MW-07 / MW-04	NA(2)	NA(2)	1.02↑	0.82↑

NA - Water level measurements necessary to calculate gradient not available.

(1)- Water level measurements not recorded for these dates.

(2)- Wells not installed at time of measurements.

SMC-1* / SMC-2	NA(1)	NA(1)	10.16↑	7.64↑

* - Shallow Bedrock / Deep Bedrock

TABLE 4-5
NAWC SITES 1, 2, 3
GROUNDWATER ELEVATIONS

Surface Elev

Well Number	Groundwater Elevation (feet (MSL)			
	12/90	1/91	7/92	8/92
Overburden Aquifer				
MW-07	NA	NA	303.59	303.19
MW-10	NA	NA	NA	NA
MW-11	NA	NA	300.95	300.73
BG-3	305.43	306.70	NA	NA
DG-1	295.92	298.09	296.03	295.07
DG-2	300.83	301.71	300.99	300.53
DG-3	303.18	306.14	302.04	301.48
DG-26	297.97	298.96	298.33	397.79
Shallow Bedrock Aquifer				
MW-02	NA	NA	296.08	294.30
MW-03	NA	NA	291.60	388.00
MW-04	NA	NA	304.61	304.01
SMC-1	NA	NA	294.80	295.02
SMP-2	NA	NA	299.29	297.98
C	NA	NA	290.22	288.62
D	NA	NA	293.40	292.47
E	NA	NA	295.29	294.12
BG-4	295.98	298.00	296.74	295.62
DG-12	298.37	298.99	299.86	299.27
DG-13	305.09	306.67	304.91	304.24
DG-23	301.24	301.93	301.01	300.49
Deep Bedrock Aquifer				
SMC-2	NA	NA	304.96	302.66

NA = Measurement not available

MSL= Above U.S.G.S. Mean Sea Level Datum

4.4.3.2 Overburden Aquifer

The overburden aquifer groundwater elevation map for Area A is presented in Figure 4-12. The general inferred flow direction is from the south to the north, generally toward the unnamed tributary of Little Neshaminy Creek, at a horizontal gradient of approximately 1.5 percent. Interpretation of overburden water-table elevations indicates that the stream near Area A acts as a groundwater divide for the overburden aquifer. Yields for the overburden wells at Area A are between less than 1/2 to two gpm.

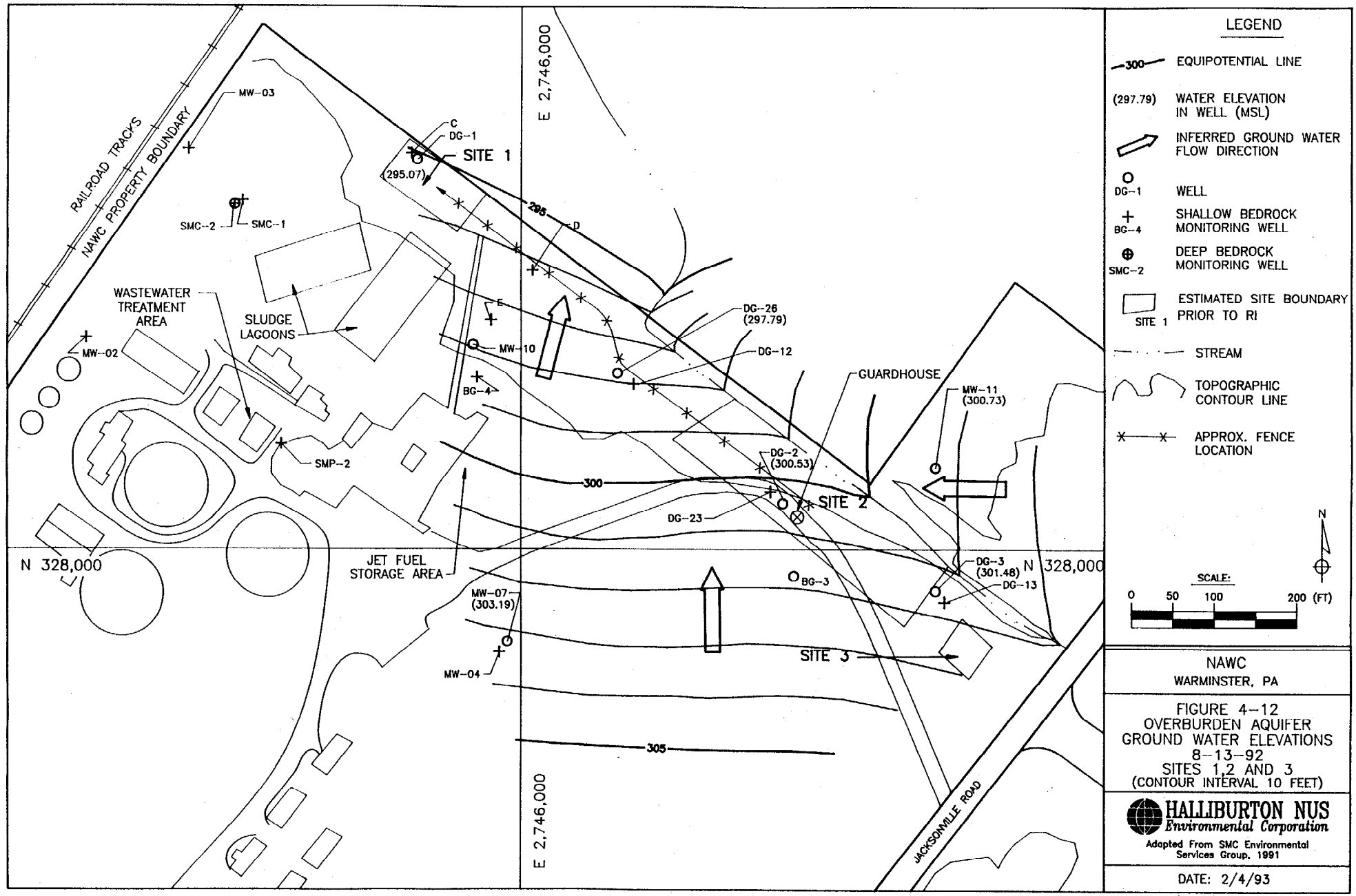
The hydraulic conductivity of the overburden aquifer at Area A was estimated through rising and falling head slug tests performed in wells MW-07 and MW-11. These results are shown in Table 4-6.

TABLE 4-6
SLUG TEST TYPES AND HYDRAULIC CONDUCTIVITIES
OVERBURDEN AQUIFER - AREA A

Well Number	Test Type	Hydraulic Conductivity
MW-07	Falling Head	8.13×10^{-4}
MW-07	Rising Head	4.78×10^{-4}
MW-11	Rising Head	5.57×10^{-6}

The hydraulic conductivity values within the overburden are observed to vary by as much as two orders of magnitude between different locations based on the slug test results.

The results of the pump test indicate that the saprolite layer at the base of the overburden may act as a confining layer between the overburden aquifer and shallow bedrock aquifer and that the degree of interconnection between these two aquifers is very limited in the pump test area. This is discussed in greater detail in Section 4.4.3.4.



NAWC
WARMINSTER, PA

FIGURE 4-12
OVERBURDEN AQUIFER
GROUND WATER ELEVATIONS
8-13-92
SITES 1,2 AND 3
(CONTOUR INTERVAL 10 FEET)

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Environmental Corporation

Adapted From SMC Environmental Services Group, 1991

DATE: 2/4/93

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Horizontal groundwater velocities for the overburden aquifer underlying Area A were calculated during Phase I to be between 20 and 55 feet per year. Velocities during Phase II were calculated using a horizontal gradient of 1.5 percent from the Phase II groundwater elevation map, a hydraulic conductivity range of 0.016 to 1.83 feet per day from slug test results, and the same porosities as the Phase I calculations. These velocities were found to range from 0.2 to 0.6 feet per year in the low-permeability overburden to 22 to 67 feet per year in the higher permeability overburden area.

As indicated in Section 4.4.3.1 (Table 4-4), vertical hydraulic gradients are upward at most locations at most of the times of measurement, indicating that the overburden may have been receiving recharge from the bedrock on these occasions. Consistently downward gradients at the DG-1/C well couplet suggest that the overburden provides recharge to the bedrock aquifer in this area or that there is a perched water table near this couplet.

Available water-level measurements in overburden wells at Area A between December 1990 and August 1992 show that water levels were highest in January 1991 and lowest in August 1992 with an average difference of 2.5 feet (Table 4-5). Water levels in these overburden wells dropped an average 0.52 feet during a five-week period from July to August 1992. These types of water-level variations are generally consistent with seasonal fluctuations and recharge patterns for this area in which groundwater levels are highest in late winter and early spring and are lowest in late summer and early fall (Sloto and Davis, 1983).

4.4.3.3 Results of Long-Term Water-Level Study

The major findings of the long-term water-level study at Area A are as follows:

- The shallow bedrock aquifer in the northern portion of this study area is influenced by the pumping of a nearby well, inferred to be the Wagner well.

- The deep bedrock aquifer in the northern portion of the study area is influenced by the pumping of what is inferred to be the Wagner well.

- The overburden aquifer in the northern portion of the study area is only very slightly influenced by the pumping of what is inferred to be the Wagner production well.

- Aquifer recharge in response to precipitation varies among different wells in Area A in both the overburden and the shallow bedrock aquifers.

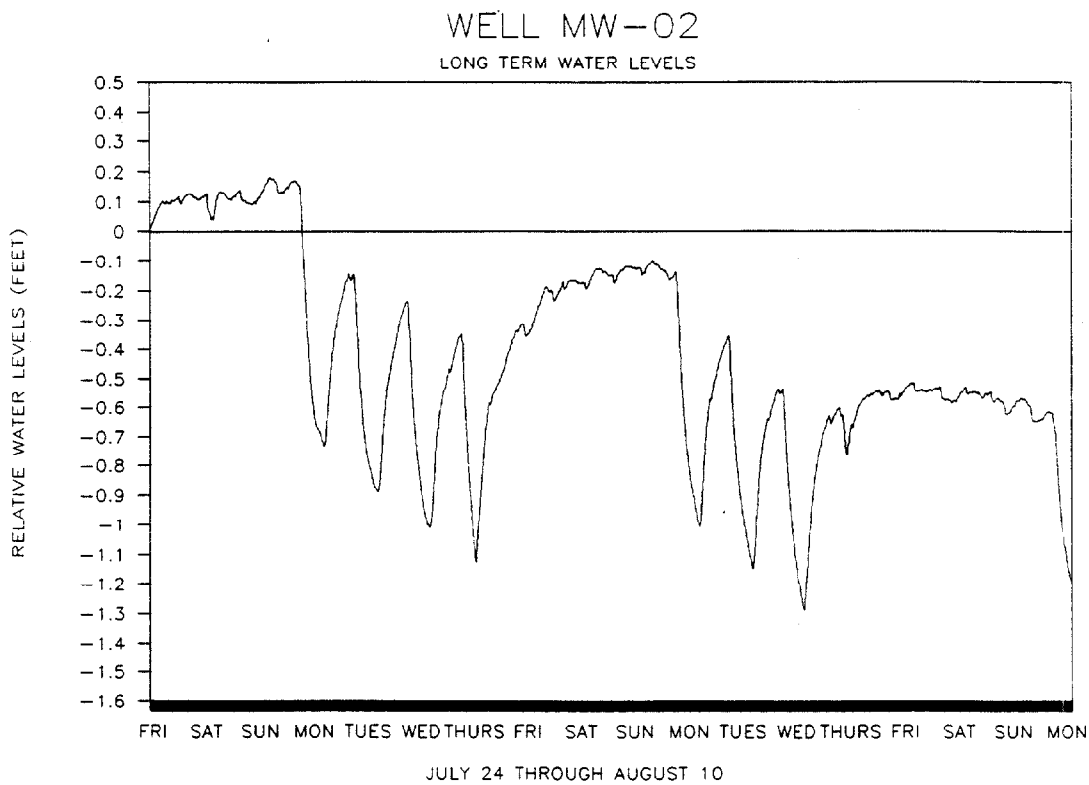
- The qualitative degree of interconnection between the overburden and the shallow bedrock aquifers underlying Area A varies from good to poor at different locations.

- The shallow bedrock and overburden aquifers in the southwestern part of Area A, as well as the deep bedrock aquifer, are influenced by another unidentified pumping well.

Water-level records for wells MW-02, SMC-1, C, D, and DG-12 (Figures 4-13, 4-14, and 4-15) show clearly recognizable drawdown and recovery cycles in response to the pumping of a nearby well. This cycle occurs weekdays from Monday through Thursday during the first week of the study and Monday through Wednesday the second week of the study. This cycle correlates directly to the reported usage of the Wagner Company production well, which is located approximately 500 feet north of the study area (production stopped early on Thursday of the second week due to Wagner's company picnic). The Wagner production well is reported to be at least 200 feet deep. The pumping rate and completion zone are unknown; however, most wells of this type are not cased to depths much greater than about 50 feet and are capable of yielding several tens to several hundred gpm (Sloto and Davis, 1983).

Daily drawdown in shallow bedrock wells in response to pumping in the Wagner well ranges from approximately 0.13 feet in DG-12 to 0.73 feet in MW-02. During the week, water levels in the affected wells never completely recover to the original static level before pumping begins again on the following day. This creates a net decline of water levels over the course of each week; however, this trend may also be a result of seasonal water-level decline.

The deep bedrock well at Area A, SMC-2, also shows a pronounced drawdown and recovery cycle that correlates directly to the reported usage of the Wagner production well (see Figure 4-16). The daily drawdown within SMC-2 in response to pumping in the Wagner well is approximately 1.2 feet, significantly greater than the drawdown observed in the shallow bedrock wells.



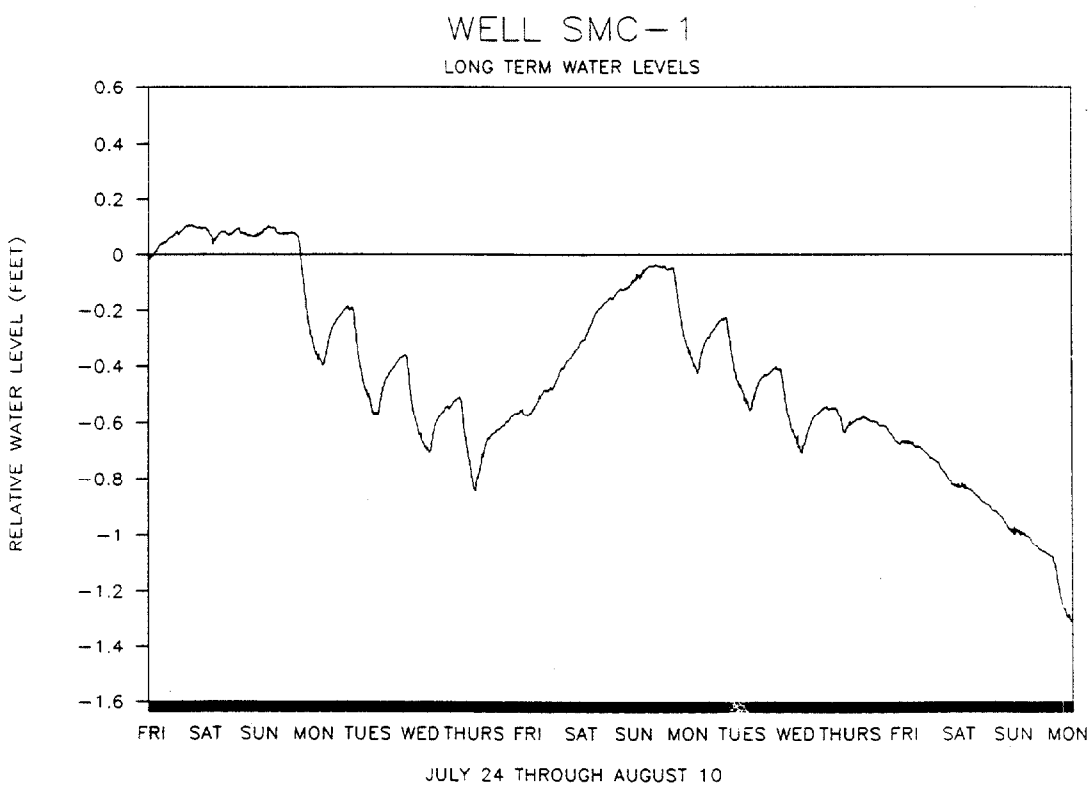


FIGURE 4-13

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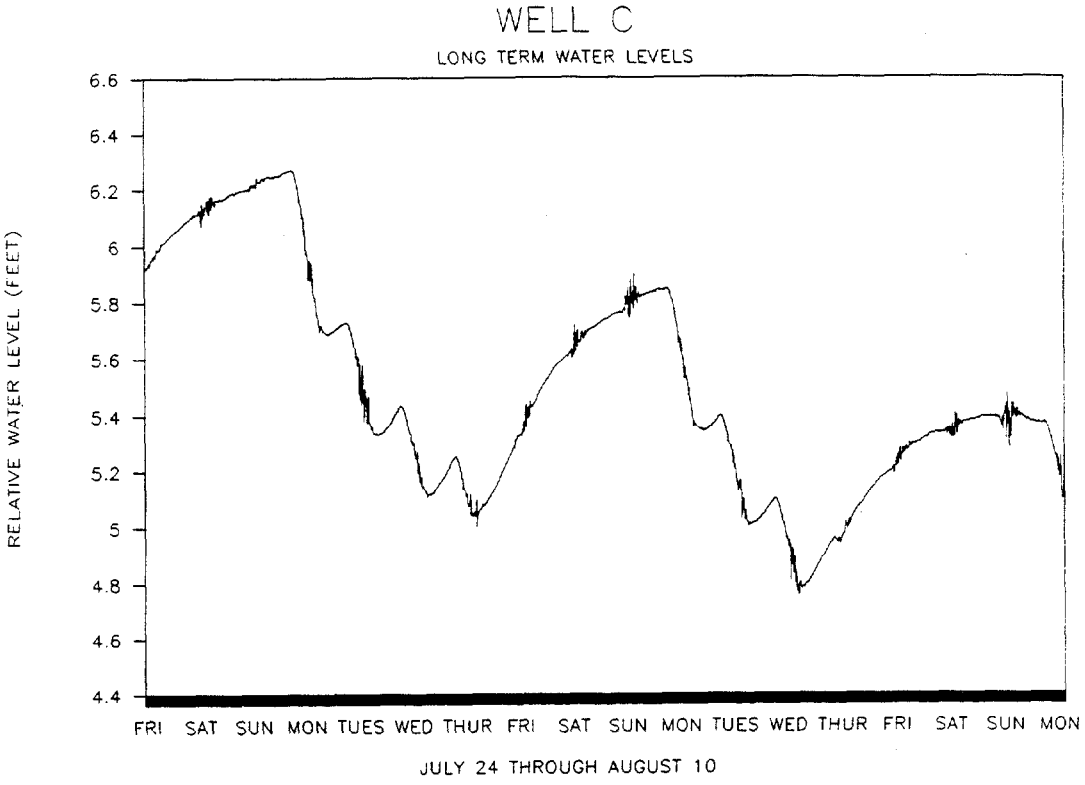

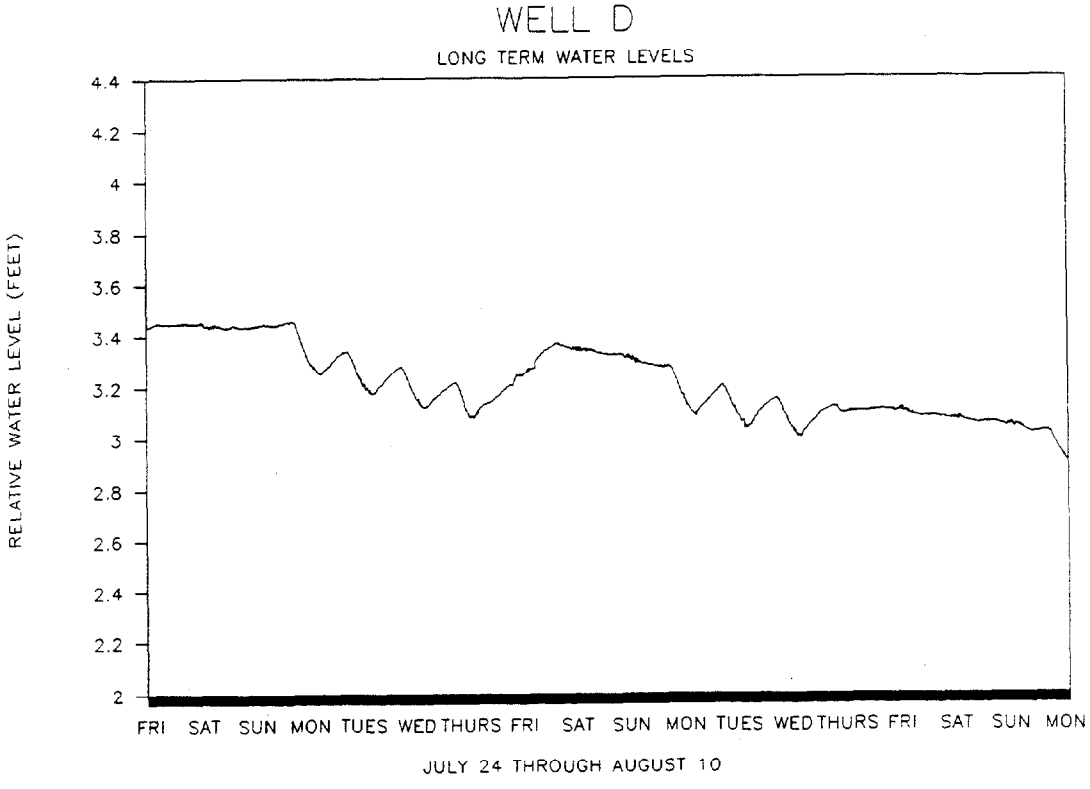

FIGURE 4-14

HALLIBURTON NUS
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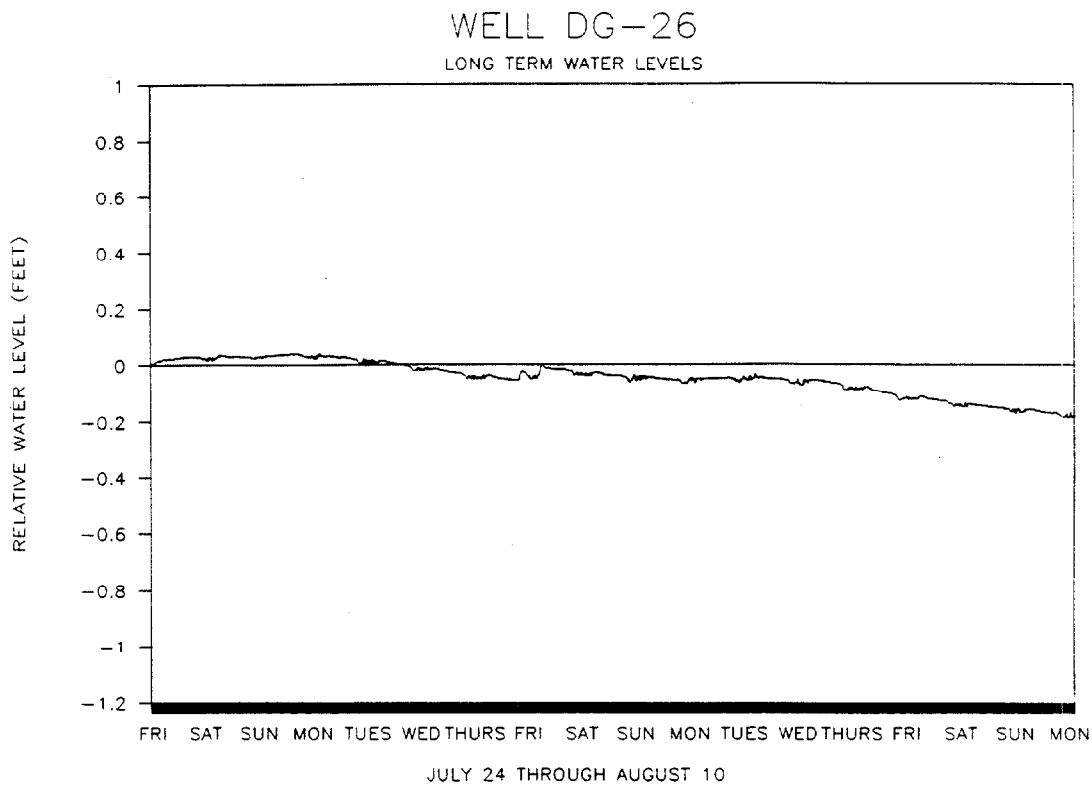

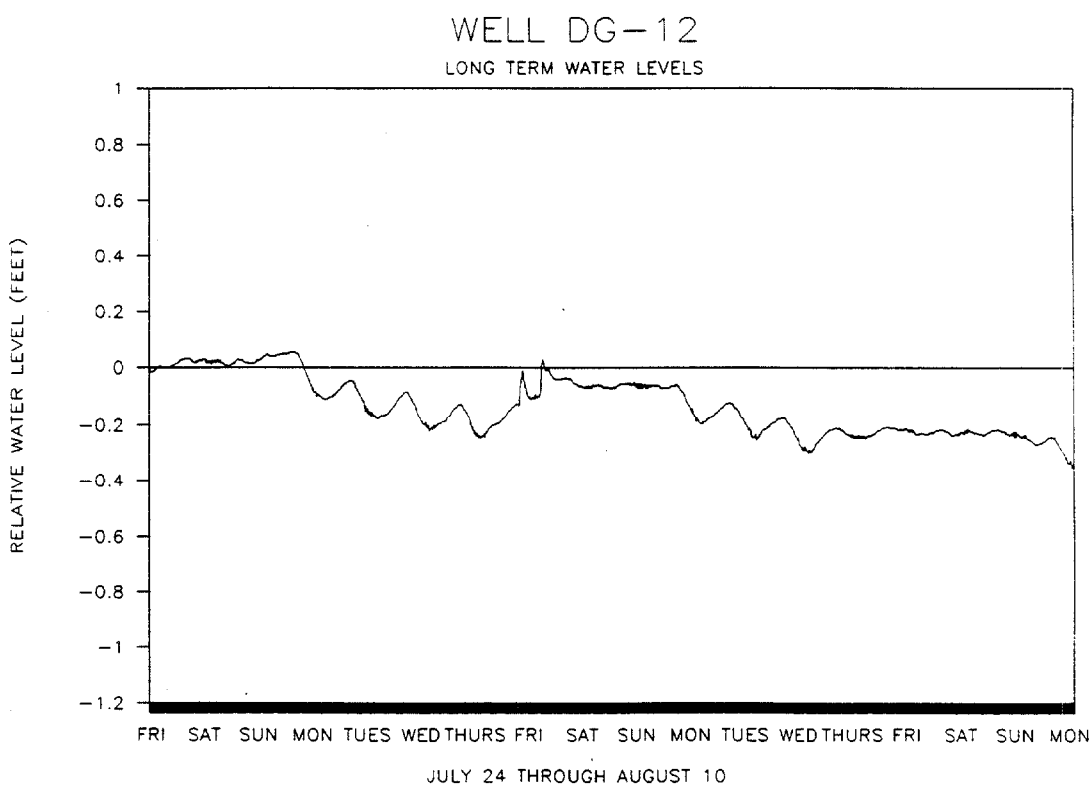

FIGURE 4-15

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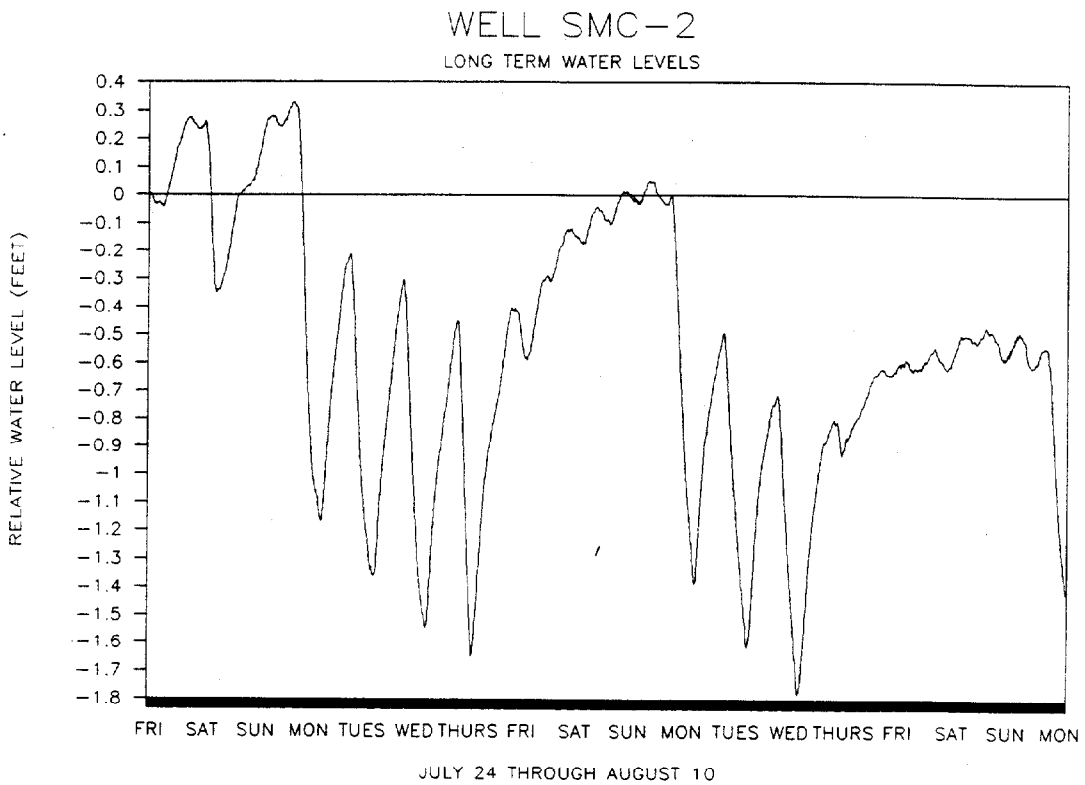


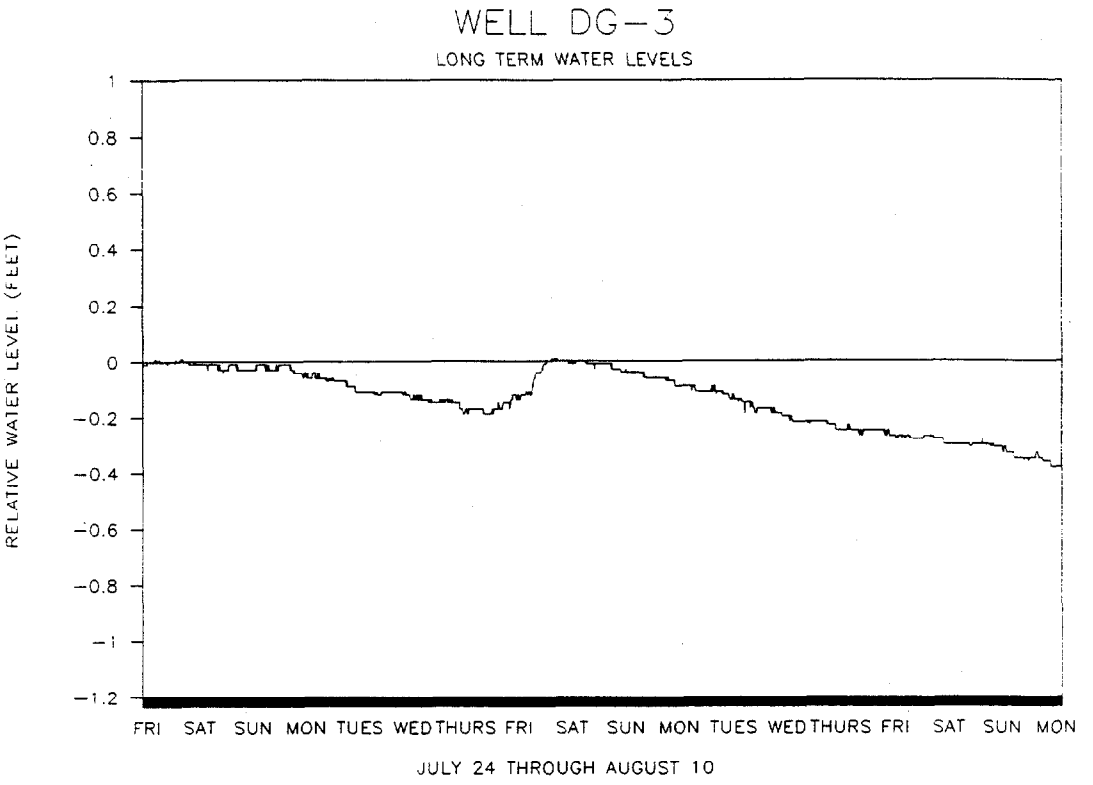
FIGURE 4-1

HALLIBURTON NUS
Environmental Corporation

Overburden wells DG-3 and MW-07 (Figures 4-17 and 4-18) show no recognizable drawdown and recovery cycle correlating to the usage of the Wagner production well. Overburden well DG-26 (Figure 4-15) shows a very slight drawdown (approximately 0.02 feet) coincident with the pumping cycle of the Wagner well. However, similar drawdown patterns are evident in the water levels of DG-26 at times when the Wagner production well is not in operation. Based on this information, it may be concluded that the Wagner well's influence on the overburden aquifer is very slight to non-existent.

Similar water-level fluctuations of the overburden and shallow bedrock wells within individual well couplets MW-07/MW-04 (Figure 4-18) and DG-3/DG-13 (Figure 4-17) are a qualitative indication that the degree of interconnection between the two aquifers is good at these locations. This is supported by the fact that the average hydraulic conductivities calculated from slug tests in MW-04 and MW-07 were within 10 percent of one another. The significantly different patterns of water-level changes between the overburden and shallow bedrock wells of couplet DG-26/DG-12 are a qualitative indication that the degree of interconnection between the two aquifers is poor at this location.

Daily precipitation amounts recorded at NAS Willow Grove (approximately five miles northwest of NAWC Warminster) are shown in Figure 4-19. The precipitation event that occurred on the second Friday of the long-term water-level study resulted in varying degrees of groundwater recharge in the wells involved in the study. The recharge is evident as rising water levels concurrent with, or closely following, the time of the precipitation event. However, the pumping cycle of the Wagner well may also have affected water levels in several on-site monitoring wells. The amount of recharge can be subjectively estimated by first subtracting or adding the recovery or drawdown in response to pumping wells. Water levels in wells DG-3 and DG-13 most clearly illustrate the groundwater recharge in response to precipitation, as well as seasonal water-level declines, because they show no significant influence by pumping wells. Bedrock wells SMC-1, D, DG-12, MW-04, and DG-13 and overburden wells DG-26, MW-07, and DG-3 all exhibit evidence of varying degrees of groundwater recharge in response to the Friday precipitation event. Shallow bedrock wells MW-02 and C and deep bedrock well SMC-2 exhibit little or no evidence of groundwater recharge in response to this precipitation event.



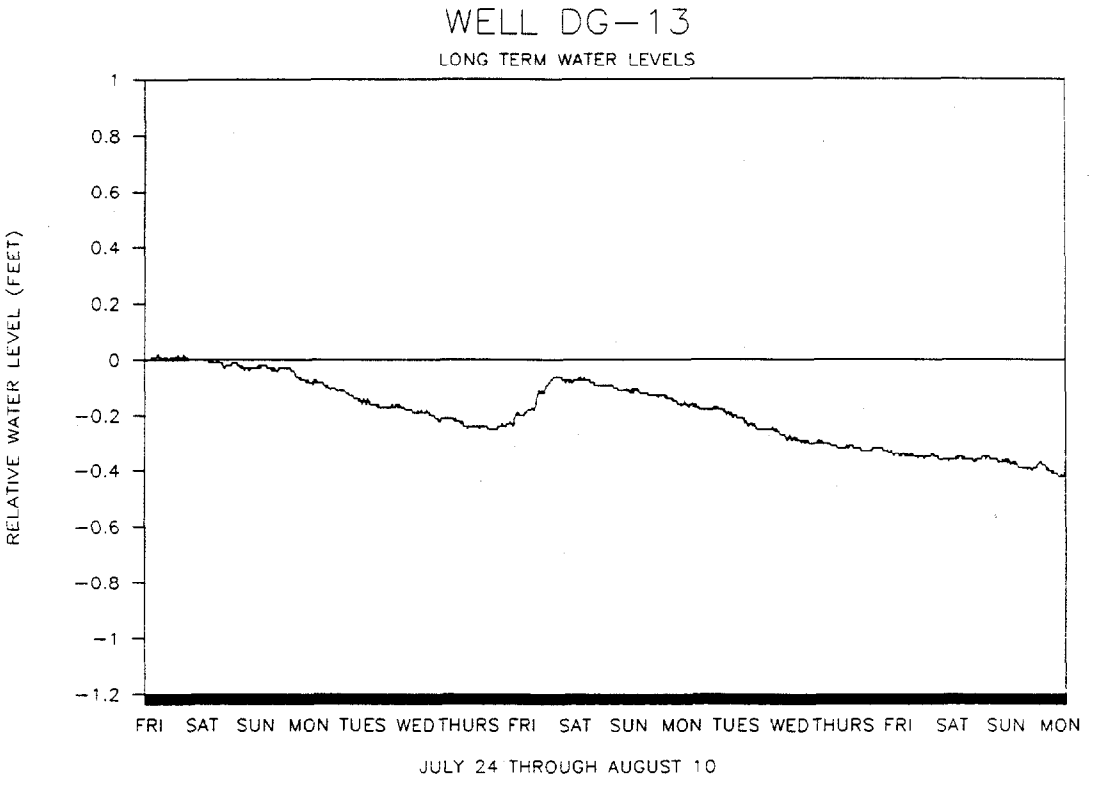


FIGURE 4-17

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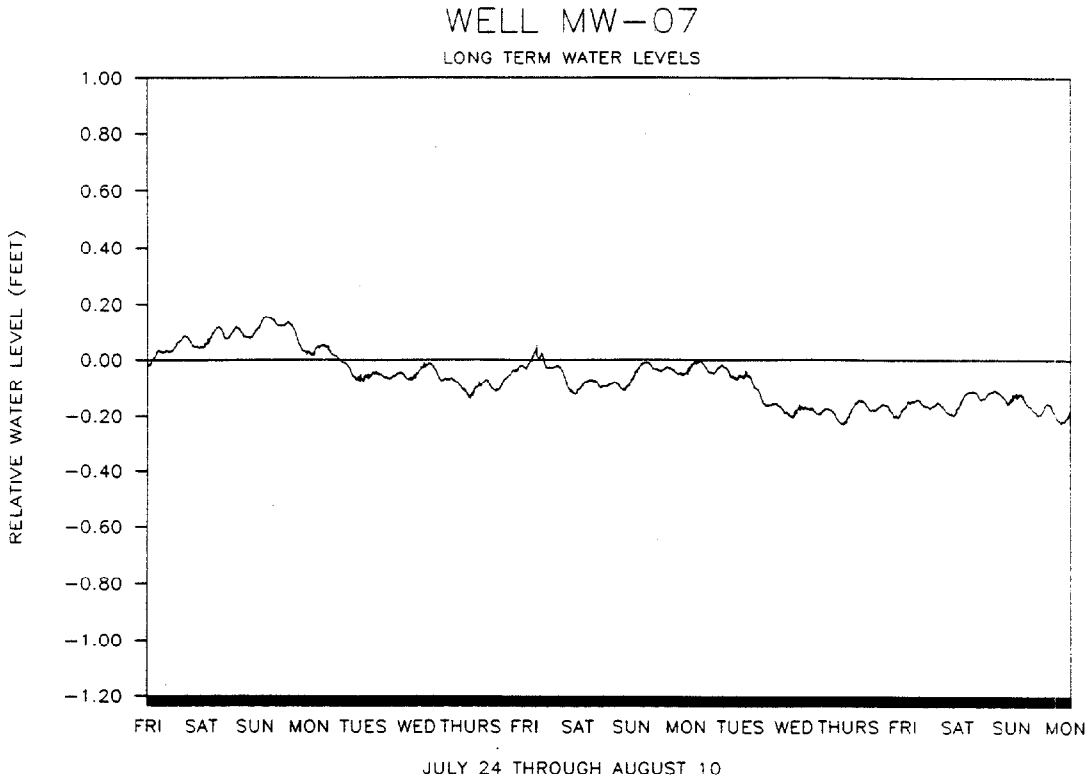

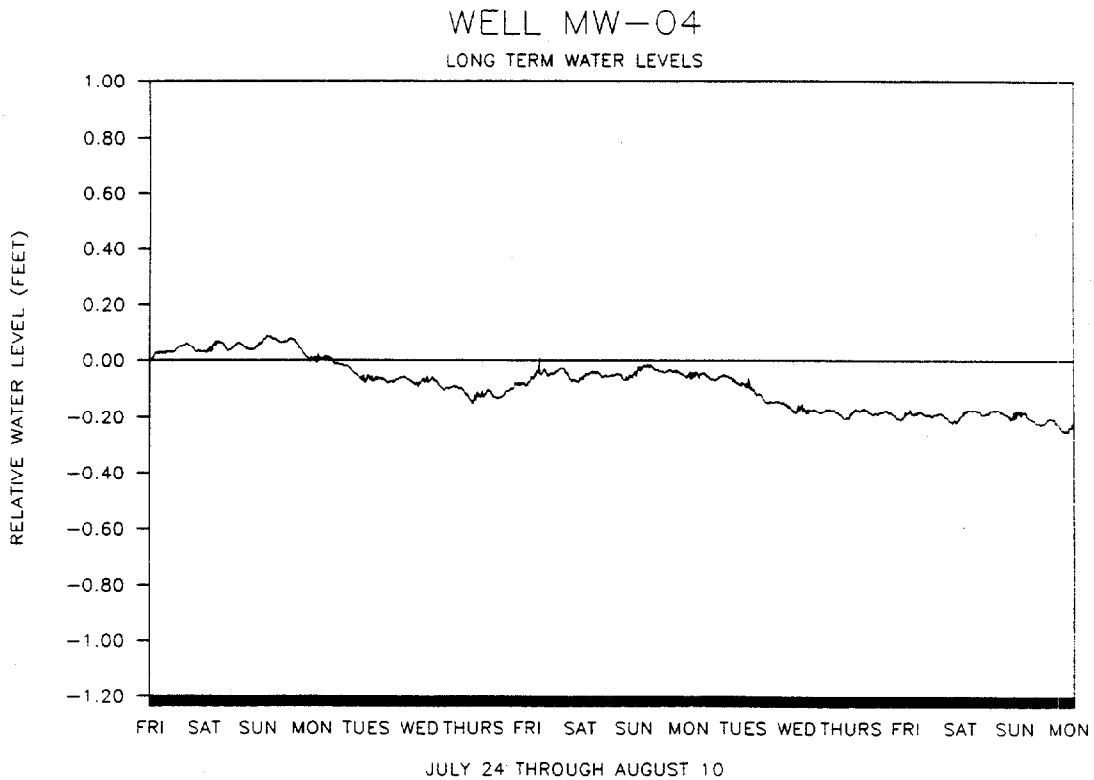

FIGURE 4-18

HALLIBURTON NUS
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DAILY PRECIPITATION RECORDS

N.A.S. WILLOW GROVE

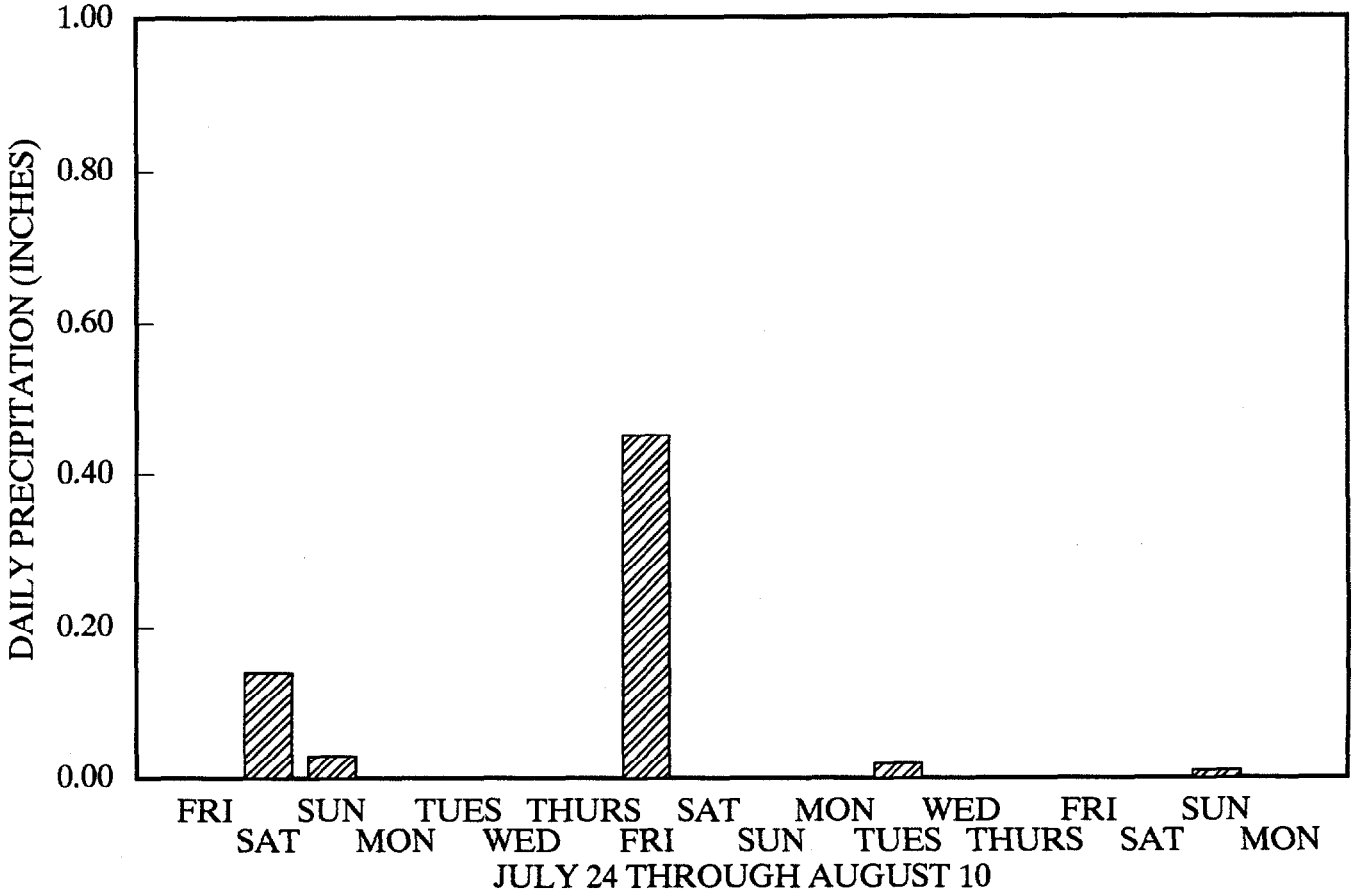


FIGURE 4-19

HALLIBURTON NUS
Environmental Corporation

Wells MW-02, SMC-2, MW-04, and MW-07 all appear to show the influence of another unidentified pumping well near Area A. A fairly regular pump and recovery cycle with a period of approximately 12 hours creates a pattern of water-level drawdown and recovery in these wells. This can be observed only for the weekends in wells SMC-2 and MW-02 because of the much larger drawdown and recovery due to the Wagner well during the weekdays. The amplitude of the drawdown and recovery caused by the unidentified well is less than 0.1 foot from all the wells, much less than that caused by the Wagner well. The general location of the unidentified pumping well cannot be determined because of the unknown distribution and orientation of fractures within the bedrock of this area.

4.4.3.4 Aquifer Pumping Test

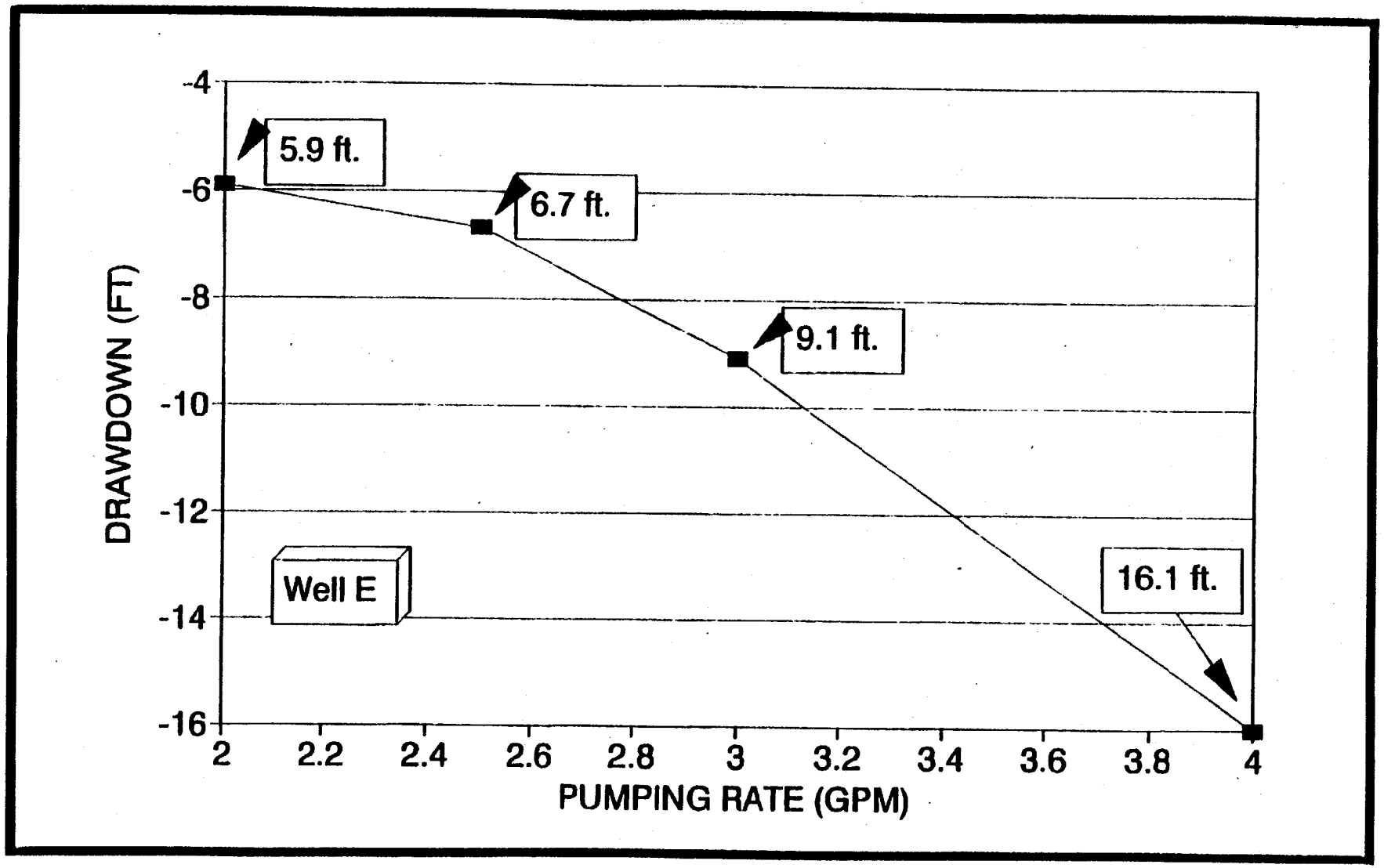
The aquifer pumping test was the third stage of the aquifer characterization study and was performed in the vicinity of Area A. The first stage consisted of the performance of slug tests on newly installed monitoring wells and step-drawdown tests on two well clusters within this area. The second stage consisted of a two-week water-level study to determine the background interference and rate of natural recharge to the overburden and shallow bedrock aquifers.

The pumping test was designed to determine aquifer characteristics (e.g., transmissivity, storativity, and hydraulic conductivity) for the shallow bedrock aquifer, as well as

- Rate of groundwater migration
- Radius of the cone of influence
- Effect of pumping withdrawals on existing wells
- Degree of interconnection between hydrogeologic zones

Methodology

The maximum allowable drawdown in the pumping well (Well E), based on pumping test constraints and total well depth, was 20 feet. The step-drawdown test results indicated that the maximum expected drawdown in Well E was approximately 16 feet, given a pumping rate of 4.0 gpm (Figure 4-20). During the beginning of the pumping test, this rate was reduced to 3.9 gpm. This reduction was determined to be ideal based on well yield during the test, pumping efficiency, and flow resistance through the discharge hose.



STEP-DRAWDOWN TEST
RESULTS - WELL E

FIGURE 4-20

HALLIBURTON NUS
Environmental Corporation

The water withdrawn from the pumping well was discharged approximately 95 feet downgradient from the pumping well and observation wells so as not to cause incidental recharge to the shallow bedrock aquifer.

Well E is a four-inch inside diameter screened bedrock well installed to approximately 40 feet below ground surface (bgs). The well is cased to approximately 30 feet bgs and has a static water level of approximately 14 feet bgs. Before the test was performed, static water level measurements were recorded for the pumping well and for all observation wells. During the test, rates of drawdown and recovery were measured in the pumping well and in all relevant observation wells. Groundwater levels in nine observation wells were measured and recorded using pressure transducers and computerized data loggers. The observation wells included C, D, DG-1, DG-12, DG-26, BG-4, SMP-2, SMC-1, and SMC-2 (Figure 4-9). Continuous observation of the pumping well was performed to maintain a continuous pumping rate and to ensure that the natural well yield could sustain the proposed pumping rate for the duration of the test.

The duration of the pumping test was determined in the field based on the observed aquifer response but was not expected to exceed 12 hours. The actual pumping phase of the test was performed for nine hours. The pumping phase was terminated after steady state conditions were observed in two nearby observation wells. The pumping well (Well E) reached equilibrium after approximately five hours of pumping. After completion of the pumping phase, monitoring of the recovery phase was performed for an additional nine hours.

Periodically, water-level measurements were manually recorded on data sheets for the pumping well and observation wells in which transducers were installed. This was to eliminate the potential loss of data caused if a data logger malfunctioned. In addition, the drawdown in the pumping well and nearby observation wells was plotted on semi-log paper during the test to determine the current aquifer response characteristics.

Upon completion of the pumping test, Wells BG-4, D, E, and SMP-2 were selected for evaluation using the numerical methods described below. The drawdown in the other wells was negligible compared to the overriding effects of the nearby production wells.

The data generated from the pumping test were used to determine the hydraulic conductivity (K), transmissivity (T), and storativity (S) values when permissible by the selected method employed. The following methods were applied, when applicable, to the particular test data obtained.

- The Theis analysis method, as modified by W.C. Walton for semi-confined aquifers, employs curve-matching solutions to transmissivity and storativity as a function of time versus drawdown in the observation wells. This method also utilizes the Hantush-Jacob formulas that allow for the determination of hydraulic characteristics for both the screened aquifer and semi-pervious (confining) layers (C.W. Fetter, 1988).

- The Cooper-Jacob straight line analysis employs a graphical method to solve for transmissivity and storativity as a function of time versus drawdown (plotted on a semi-log plot) for the observation wells (C.W. Fetter, 1988).

- A modified approach to the Cooper-Jacob straight line method utilizes the recovery data generated during a pump test. The head ratio is plotted on a linear scale against the ratio t/t'. t represents the duration of time since pumping began (including recharge time) and t' represents the duration of time since pumping was terminated (recovery time only) (Driscol, 1986).

The Theis method and the modified distance-drawdown method of analysis, which were expected to be performed on the pumping test data, were not applied due to the unexpected levels of drawdown in observation wells BG-4 and D. The relative drawdown in these wells is not consistent with the assumption that the closer the observation well is to the pumping well the greater the drawdown. Although BG-4 is closer to the pumping well than is well D, the drawdown recorded in D exceeded that of BG-4. This is because Well BG-4 is located stratigraphically up-dip from Well E and Well D is located along strike or slightly down-dip from Well E. In addition, Well BG-4 is screened over a 40-foot interval, whereas Wells D and E are screened over a five-foot interval.

The methods employed to evaluate the pump test data are based on the following assumptions about the physical properties of the aquifer:

- Isotropic conditions exist
- Homogeneous lithology
- Darcian flow describes water movement through the aquifer

Because these physical properties of the aquifer are not known with certainty, the results of the analyses should be viewed as approximations only.

Pumping Test Findings

The shallow bedrock consists primarily of a silty sandstone. Based on the boring log for Well DG-12, the sandstone grades to a micaceous siltstone at approximately 75 feet bgs. This value was used in the numerical calculations as the bottom of the shallow bedrock aquifer. The top of the shallow bedrock aquifer is marked by the saprolite or weathered siltstone/sandstone interface. Thus, the effective aquifer thickness (b) was determined from the boring logs for each well incorporated in the pumping test data evaluation. The thickness of the overlying confining layer (b') is considered to be the thickness of saprolite and weathered siltstone unit (approximately two to three-feet thick).

Based on the boring logs from previous and newly installed wells, it was anticipated that the aquifer characteristics would represent semiconfined conditions. The geometries of the log-log plots confirmed this interpretation. The locus of data points departs from the nonequilibrium portion of the Theis type curve and becomes parallel to the horizontal axis. This departure from the nonequilibrium Theis curve is indicative of a leaky confining layer. In addition, the plots indicate that storage in the confining layer is negligible. All plots are included in Appendix B.

The specific discharge ($V = K_x i$), also known as the average groundwater velocity, was calculated using the hydraulic conductivity (K) and average hydraulic gradient (i) across the site. The resultant value is V =.03 ft/day. The average linear velocity ($V_x = K_x i/n_e$), also known as the seepage velocity, is the true velocity of the groundwater flowing within the pore space of the aquifer. The average linear velocity was calculated using the average hydraulic conductivity (K), the average hydraulic gradient (i), and the estimated effective porosity (n_e). The resultant value is V_x =.33 ft/day.

The estimated effective porosity value of 0.10 is based on the storativity values derived by the pump test analyses and on published porosity values for the bedrock lithology. The average hydraulic gradient was determined graphically from the potentiometric contour surface map.

The radius of the cone of influence depends on aquifer characteristics, pumping rate, and pumping duration. This radius was estimated using the farthest observation well that was influenced during the performance of the pumping test. Observation well SMP-2, located 287.0 feet upgradient and roughly along the strike of bedding from the pumping well, was the farthest well in which measurable drawdown was recorded. Since there are no wells at that distance in the downgradient direction, it was not possible to determine an accurate value for the downgradient influence. However, the cone of influence in the downgradient direction along the strike of bedding is expected to extend 287 feet or farther.

Data from the pumping test indicate that the cone of influence created by pumping well E is asymmetrically elongated in a direction parallel to the strike of bedding (southwest to northeast) compared to its extent in the downdip (northwest) and updip (southeast) directions. In addition, the cone of influence appears to extend farther in the downdip direction than in the updip direction. This asymmetry is observed when comparing water-level drawdowns in observation wells located at similar distances and different directions from the pumping well.

Wells BG-4 and D are located at similar distances from pumping well E. Well BG-4 is 69 feet away at an angle in the updip direction, and well D is 75 feet away in a direction along strike or slightly downdip. At the conclusion of the pumping test, the maximum observed drawdown was 1.6 feet in well BG-4 and 2.34 feet in well D. Wells C and SMP-2 are also located at similar distances from well E. Well C is 220 feet from well E in the downdip direction, and well SMP-2 is 287 feet from well E in a direction roughly along strike. At the conclusion of the pumping test, the maximum observed drawdown was 0.29 feet in well C and 0.85 feet in well SMP-2.

Wells C and DG-12 are also located at similar distances from well E. Well C is 220 feet downdip from well E and well DG-12 is 187 feet updip from well E. At the conclusion of the pumping test, no drawdown was observed in well DG-12, and 0.29 feet of drawdown was observed in well C. Based on the construction details of wells C, E, and DG-12 and an assumed bedding dip of 10 degrees to the northwest, neither well C nor DG-12 intercepts the producing layer in well E. The observed drawdown in well C indicates that there is a component of groundwater flow across bedding in the downdip direction.

The asymmetrical shape of the cone of influence for pumping well E may be realistic considering that the Stockton Formation is not an isotropic and homogeneous aquifer. In this instance, the cone of influence is elongated in a direction parallel to the strike of bedding. This may indicate a stratigraphically controlled anisotropic groundwater flow pattern in which flow is greatest within individual permeable beds and along bedding plane fractures but that also has components of flow across bedding planes. The asymmetrical cone of influence for pumping well E could also be related to the arrangement of water transmitting, vertical or near-vertical fractures in the shallow bedrock. However, there are insufficient data to determine the specific groundwater flow mechanisms and pathways at Area A.

The saprolite interface between the overburden soils and the underlying bedrock acts as the confining layer between the overburden aquifer and the shallow bedrock aquifer. The degree of interconnection between the two hydrogeologic zones is difficult to quantify but appears to be very limited in this area since the overburden wells showed no discernible drawdown during the nine-hour pumping test. Based on the Theis analysis method, the average vertical hydraulic conductivity of the confining layer is 4.2 x 10-6 cm/sec (0.01 ft/day).

Characterization of the aquifers performance can be quantified by averaging the transmissivity, storativity, and hydraulic conductivity values obtained during the data evaluation. The results from the numerical analysis are shown in Table 4-7. These resulting average values are as follows for the shallow bedrock aquifer:

- Average hydraulic conductivity (K) . . . . . 3.9×10^{-4} cm/sec (1.1 ft/day)
- Average transmissivity (T) . . . . . 7.9×10^{-1} cm^2/sec
- Average storativity (S) . . . . . 4.0×10^{-4}

All field data and calculations are included in Appendix H.

4.4.3.5 Deep Bedrock Aquifer

Only one well, SMC-2, is present in the deep bedrock aquifer underlying Area A. Therefore, it was not possible to construct an elevation map or to determine flow directions, horizontal gradients, and groundwater flow velocities for this aquifer. For a more detailed investigation of the intermediate and deep semiconfined and confined aquifers at NAWC Warminster, refer to the study by Satterthwaite (1984). The general flow direction in the deep aquifer determined by Satterthwaite is to the north in the study area. The general aquifer properties are summarized in Section 3.5. Well SMC-2 is also open through the shallow bedrock and intermediate aquifers because the well casing only extends to a depth of 51 feet (based on well logs) or 60 feet (reported in Phase I).

The vertical hydraulic gradient between SMC-2 and adjacent shallow bedrock well SMC-1, estimated from the hydraulic head differences, is upward, with a magnitude of approximately seven to 10 feet during Phase II. This gradient and the shallow bedrock water-elevation map strongly suggest that the deeper bedrock aquifers are discharging to the shallow bedrock aquifer through well SMC-2. This is confirmed by the results of U.S.G.S. studies performed in well SMC-2 on June 17, 1991 (see Section 4.2.1). Slugs of high-conductance fluid (brine) were injected in well SMC-2 at 85, 125, 140, 200, 240, and 280 feet below ground surface. These slugs moved upward at rates of 1.3, 3, 3, 2.2, 1.5, and 1.5 gpm, respectively (Sloto, 1992).

TABLE 4-7
EVALUATION SUMMARY OF PUMPING TEST CALCULATIONS

Well ID	Type	Analysis Method	Transmissivity (cm^2/sec)	Storativity	Aquifer Thickness (ft.)	Hydraulic Conductivity (cm/sec)	Confining Layer Thickness (ft.)	Confining Layer Vert. Hydraulic Conductivity (cm/sec)
E	Pumping Well	1	1.15	NA	63	6.0×10^{-4}	NA	NA
BG-4	Observ. Well	2	0.18	5.0×10^{-4}	63	9.3×10^{-5}	2	5.5×10^{-6}
BG-4	Observ. Well	3	0.79	7.0×10^{-4}	63	4.1×10^{-4}	NA	NA
D	Observ. Well	2	0.46	2.0×10^{-4}	65	2.3×10^{-4}	3	2.9×10^{-6}
D	Observ. Well	3	0.75	2.0×10^{-4}	65	3.9×10^{-4}	NA	NA
SMP-2	Observ. Well	2	0.78	3.0×10^{-4}	59	4.4×10^{-4}	NA	NA
SMP-2	Observ. Well	3	1.40	3.0×10^{-4}	59	7.8×10^{-4}	NA	NA
		Average:	**0.79**	**4.0×10^{-4}**		**3.9×10^{-4}**		**4.2×10^{-6}**

Analysis Method:

1) Modified Jacob Straight-Line Method using recovery data by plotting t/t'.
(C.W. Fetter, 1988)

2) Theis Curve Matching Method using drawdown data by plotting time/drawdown.
(C.W. Fetter, 1988)

3) Cooper-Jacob Straight-Line Method using drawdown data by plotting time/drawdown.
(Driscol, 1986)

Geophysical logs run in well SMC-2 indicate the presence of several discrete, potentially water-bearing zones. U.S.G.S. interpretations conclude that water is entering the borehole from zones at 186, 234, and 290 feet below ground surface, flowing upward within the borehole, and exiting the borehole through zones at 80 and 105 to 107 feet below the ground surface (Sloto, 1992).

4.4.4 Hydrology

An unnamed tributary of Little Neshaminy Creek is located north of Area A. This stream originates from a storm water culvert under Jacksonville Road and flows from the southeast to the northwest before turning north, away from NAWC Warminster. Flow rates were estimated in several of the narrow, faster-flowing areas at approximately three gpm. During base-flow conditions (i.e., when groundwater discharge into the stream contributes most of, if not all, the stream's flow), large sections of the stream appear stagnant.

Surface water drainage from portions of the airfield and hangar area discharges from the culvert where the stream originates. Surface water runoff from Area A and adjacent areas also enters this stream. A culvert located near the point where the stream turns to the north and exits the property was observed to be discharging water to the stream during the Phase II RI. Groundwater-flow patterns indicate that overburden and possibly shallow bedrock groundwater discharge to the stream.

The stream adjacent to this area is a small urban headwater reach, but it appears to be perennial. The portion of the stream within the NAWC Warminster property is channelized with a very high (10- to 12-feet) and steeply sloped (4:1 to 5:1) southern bank, which leads up to a paved driveway and parking area near Site 2 and to a gravel parking area in the vicinity of Site 3. The stream channel averages approximately four feet in width and five inches in depth. It contains some pool areas of one to two feet or more in depth. The streambed is very rocky and gravelly, with little fine sediment. Construction debris such as concrete and some steel or aluminum metal debris were also observed in the stream.

4.4.5 Ecology

The south bank of the stream is sparsely vegetated with various wildflowers, vines, and shrubs (i.e., goldenrod, greenbriar, and blackberry). The north bank of this stream reach is more gradually sloped and is vegetated with similar herbaceous plants and shrubs. A small forested wetland dominated by mature red maple and arrowwood exists just north of the stream and beyond the fence-line that delineates the limit of the NAWC Warminster property. At the time of the biological characterization, an orange-colored flocculent, presumed to be oxidized iron precipitate, was observed in certain sections of the channelized stream reach. A relatively small amount of epilithic and filamentous algae was covered with the orange material, as were nearby sediments. Substrates in this stream reach are sands and small gravel, and fine sediments (i.e., silts) have accumulated in each of the pools.

Snails and earthworms were commonly found in this part of the stream. Larval insect families (e.g., midges, mayflies, etc.) were not collected during the characterization. Small fish, believed to be creek chubs, were observed in the pool near Jacksonville Road but were not seen in the pool at the opposite end of the study area. Leopard frogs were observed along the edge of the stream. Neither turtles nor snakes were observed, but they are believed to inhabit the riparian zone of the stream and adjacent wetland. Songbirds (including sparrows, red-winged black birds, and goldfinches) were common in shrubs and trees near the edge of the stream. During subsequent investigation, a nesting female duck was also observed along the edge of the stream. Raccoon tracks were observed on a sand bar in the stream.

4.5 NATURE AND EXTENT OF CONTAMINATION

The nature and extent of environmental contamination at Area A are discussed in this section. The validated data generated during the RI provide the basis for this discussion. The complete analytical database for groundwater to date is included as Appendix K.

4.5.1 Extent of Contamination for Area A

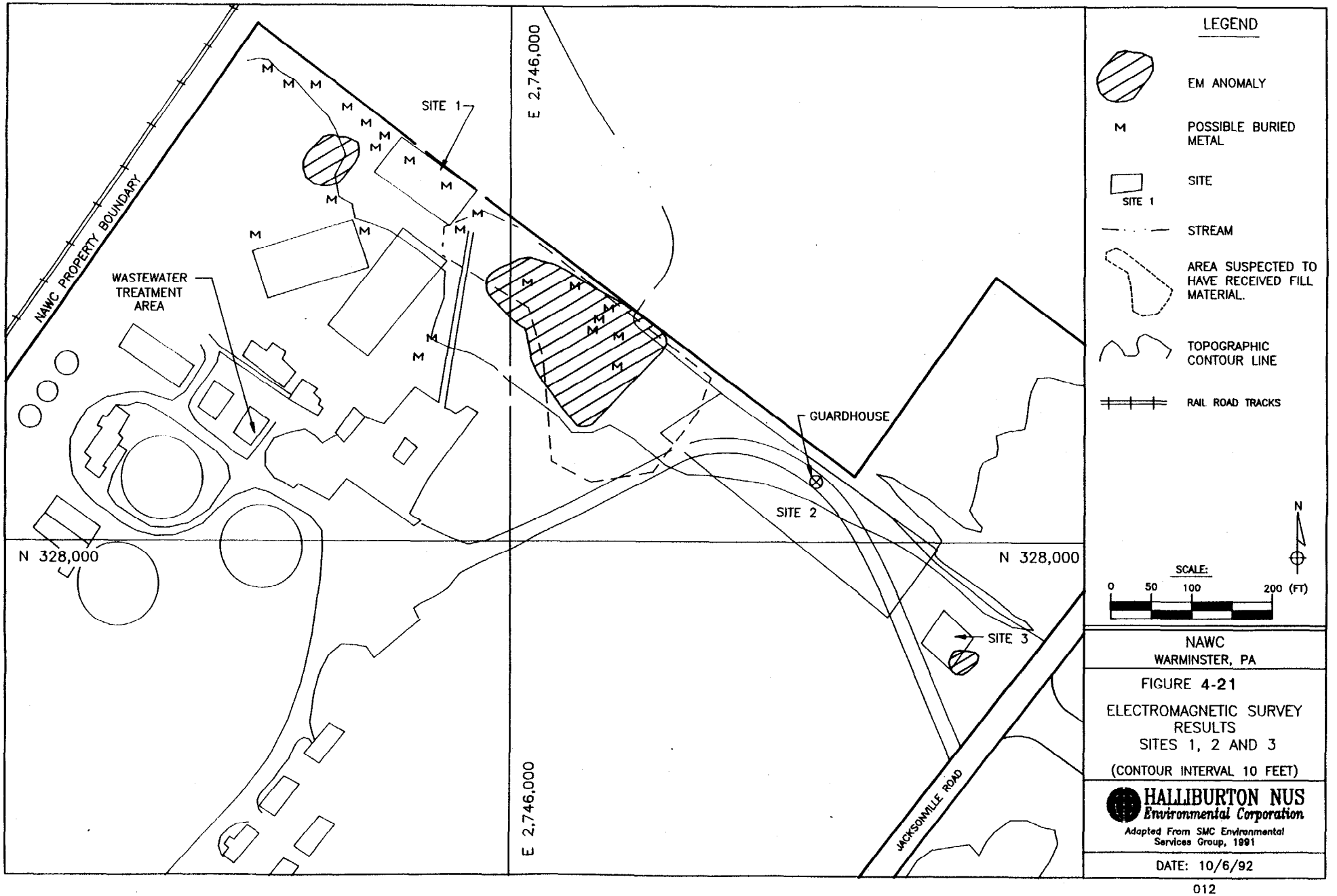
The EM survey over Site 1 delineated an area with low conductivity approximately 70 feet southeast of the fence that borders the northwestern side of NAWC Warminster and approximately 60 to 100 feet south of the northwest to southeast fence (as marked on Figure 4-21). This anomaly was seen as a negative 3 millimho per meter anomaly (umho/m). Specifically, the anomaly was detected as a 27 umho/m reading compared to a 30 umho/m reading, which was determined to be background for Sites 1 and 2. Possible buried metal objects in the vicinity of Sites 1 and 2 are marked with an "M" in Figure 4-21.

The EM survey over Site 2 delineated a second conductivity low over the entire eastern corner of the survey area extending toward the access road. Due to interference from overhead power lines and other man-made features (e.g., roads, fences, underground utilities, parking lots, and cars), the full extent of this area could not be delineated by the EM survey. This area closely corresponds with the area suspected to have received fill based on the review of historical aerial photographs. The Site 2 anomalous area is seen as a 3 to 11 umho/m anomaly (i.e., 19 to 27 umho/m compared to a background of 30 umho/m).

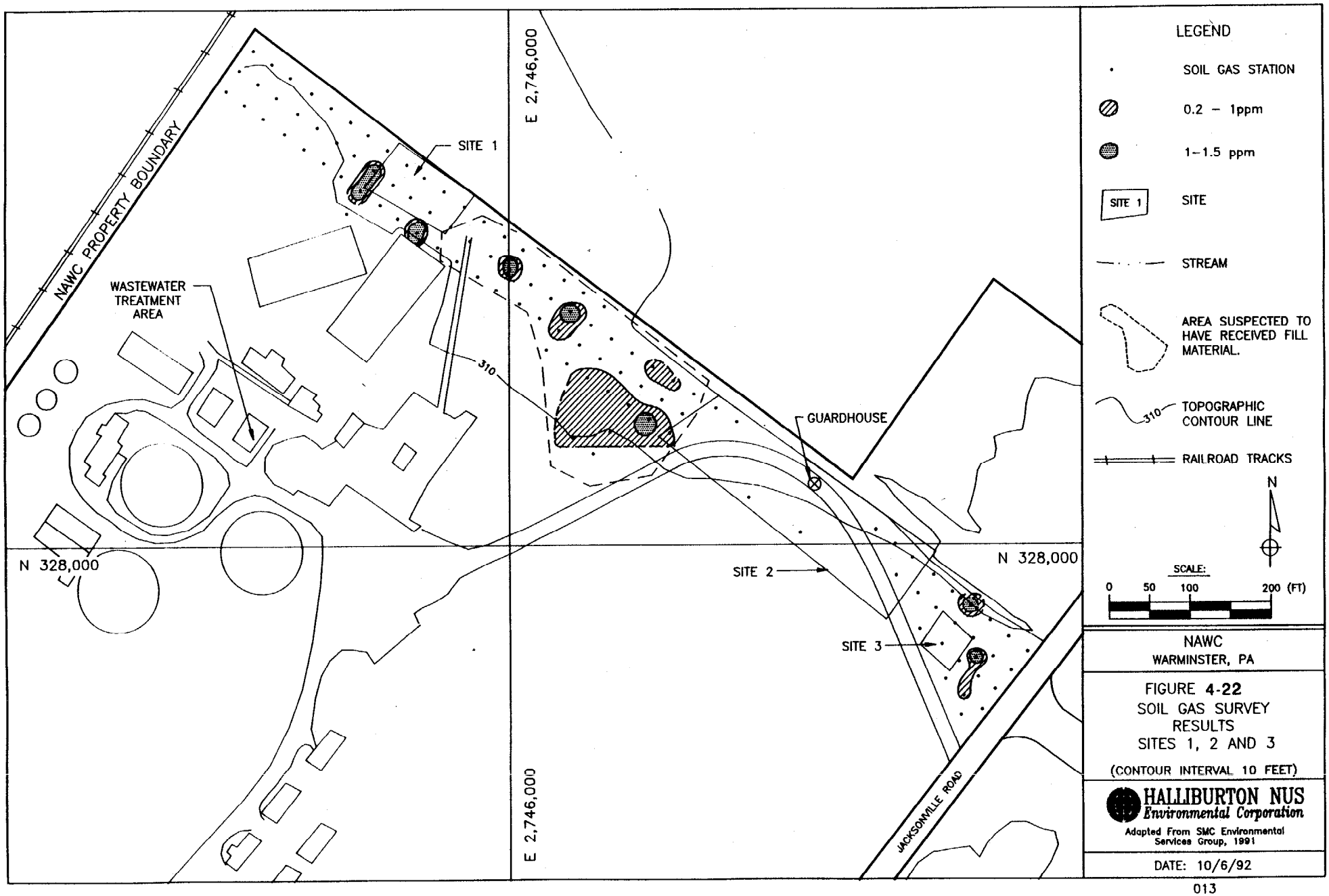
The EM survey over Site 3 showed an anomalous area of approximately 30 by 40 feet (Figure 4-21). This area is seen as a positive anomaly ranging from 10 to 30 umho/m above background (i.e., 60 to 80 umho/m compared to a background of approximately 50 umho/m in the area).

As shown in Figure 4-22, six soil gas stations had VOC levels of 1 to 1.5 ppm as measured by the PID at Sites 1 and 2. Nine other soil gas stations had detectable levels of VOCs but at concentrations below 1 ppm. All other soil gas points in the Site 1 and 2 area were non-detected. The stations where elevated levels of VOCs were encountered were widely distributed and were located both inside and outside EM anomalies.

Low levels of volatile organics were found in the soil gas at Site 3. Figure 4-22 displays the soil gas survey results obtained at Site 3. The PID indicated that only three soil gas locations had levels between 0.2 and 1.5 ppm. These points were located north and east of the suspected location of the Site 3 burn pit. All remaining PID points were non-detected. VOCs were encountered in confirmation borings S3-1, S3-3, and S3-5.


LEGEND
EM ANOMALY
M
POSSIBLE BURIED METAL
SITE
SITE 1
STREAM
AREA SUSPECTED TO HAVE RECEIVED FILL MATERIAL.
TOPOGRAPHIC CONTOUR LINE
RAIL ROAD TRACKS
N
SCALE:
0
50
100
200 (FT)
NAWC
WARMINSTER, PA
FIGURE 4-21
ELECTROMAGNETIC SURVEY RESULTS
SITES 1, 2 AND 3
(CONTOUR INTERVAL 10 FEET)
HALLIBURTON NUS
Environmental Corporation
Adapted From SMC Environmental Services Group, 1991
DATE: 10/6/92
NAWC PROPERTY BOUNDARY
WASTEWATER TREATMENT AREA
SITE 1
SITE 2
SITE 3
GUARDHOUSE
E 2,746,000
N 328,000
JACKSONVILLE ROAD

012


NAWC PROPERTY BOUNDARY
WASTEWATER TREATMENT AREA
SITE 1
310
E 2,746,000
GUARDHOUSE
N 328,000
SITE 2
SITE 3
JACKSONVILLE ROAD
LEGEND
SOIL GAS STATION
0.2 – 1ppm
1–1.5 ppm
SITE 1
SITE
STREAM
AREA SUSPECTED TO HAVE RECEIVED FILL MATERIAL.
TOPOGRAPHIC CONTOUR LINE
RAILROAD TRACKS
N
SCALE:
0 50 100 200 (FT)
NAWC
WARMINSTER, PA
FIGURE 4-22
SOIL GAS SURVEY RESULTS
SITES 1, 2 AND 3
(CONTOUR INTERVAL 10 FEET)
HALLIBURTON NUS
Environmental Corporation
Adapted From SMC Environmental Services Group, 1991
DATE: 10/6/92

013

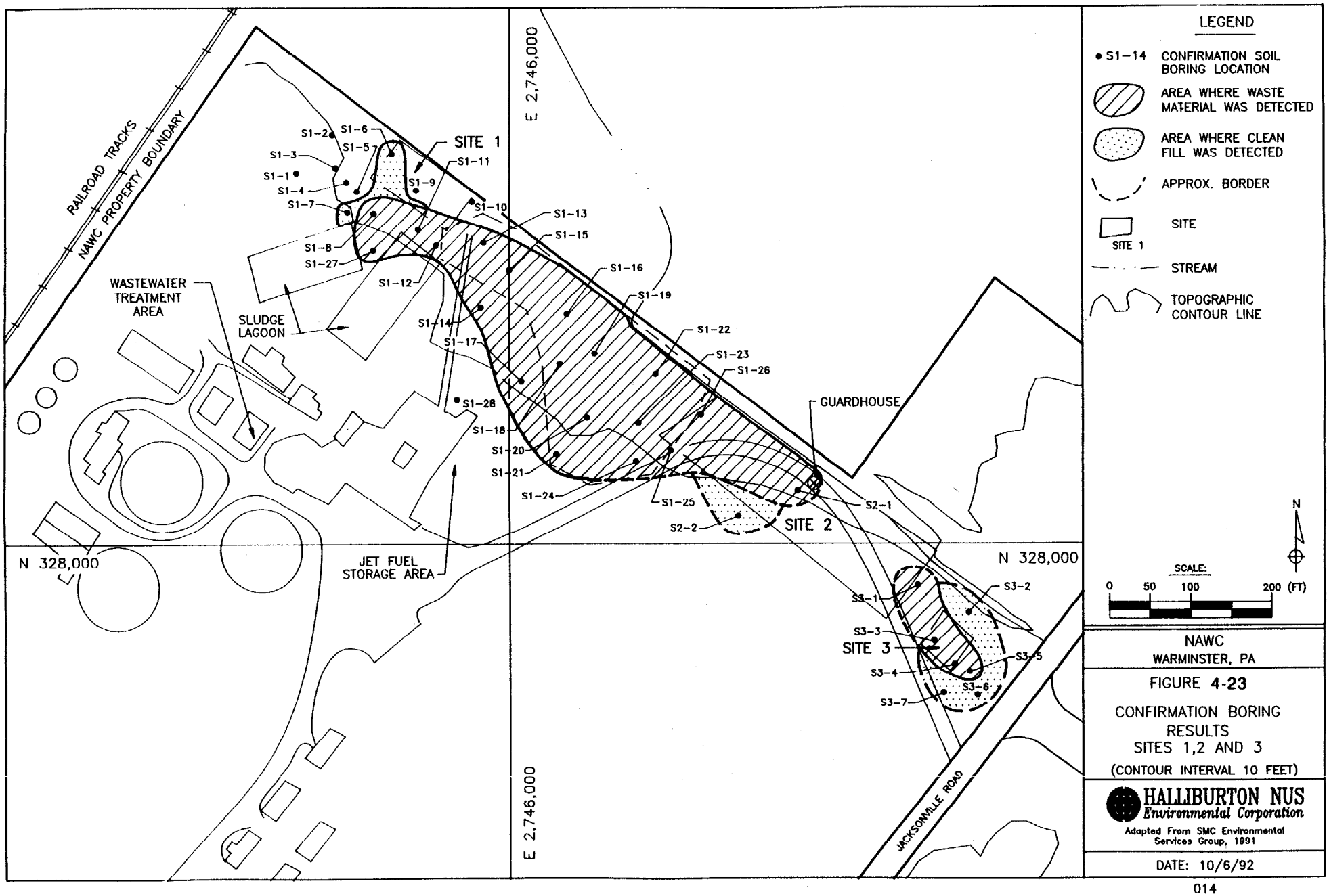
A total of 30 confirmation borings were conducted across Sites 1 and 2. Nineteen confirmation borings encountered waste material. Three encountered clean fill with no waste, and the remaining eight encountered only natural material.

The confirmation borings delineated the extent of these two sites except on the eastern side. Figure 4-23 displays the area in which waste was found at Sites 1 and 2. The western edge of Site 1 is not thought to extend past the westernmost existing sludge lagoon. The southern boundaries of Sites 1 and 2 are defined by the existing sludge lagoons, confirmation boring S1-28, which did not find waste or fill material, and the existing jet fuel storage area. The border between Sites 1 and 2 cannot be distinguished because waste and fill material of similar type were found to extend continuously from the area north of the western sludge lagoon to the area adjacent to the guardhouse on the entrance road. The eastern edge of Site 2 could not be positively identified since the easternmost confirmation boring on Site 2 was found to contain waste material. The eastern edge of Site 2 may extend to Site 3 boring S3-1, where a gray, clay-like material containing volatile organic vapors was discovered. Further discussion of this gray material is included in Section 4.5.2. The northern boundary of Sites 1 and 2 is assumed to be the embankment and stream along the NAWC Warminster property line. The location of Sites 1 and 2, with boundaries identified on three sides, was considered sufficient to proceed with groundwater monitoring.

Cinders at Sites 1 and 2 were detected in an area approximately 600 feet long by 60 to 200 feet wide, as indicated on Figure 4-23. This area is larger than the original size of the Site 1 burn pit, which was reported to be 25 by 100 feet. This, coupled with the observation that natural soil was encountered both above and below fill and waste material in borings S1-7 and S1-8, may indicate that considerable regrading of the soils in and around the Site 1 burn pit was conducted.

The thickness of surficial and subsurface fill material at Sites 1 and 2 averaged between four and five feet. The average thickness of waste containing material was between five and six feet. VOCs were detected in borings S1-25 and S1-26 at 2 to 5 and 1 to 10 ppm concentrations, respectively. The types and thicknesses of material found in each boring conducted at Sites 1 and 2 are included in Appendix B.

Seven confirmation borings were conducted at Site 3. All of these borings encountered fill and/or waste material, which suggests that the entire area north of the entrance road and south of the creek has been re-worked.



NAWC
WARMINSTER, PA

FIGURE 4-23

CONFIRMATION BORING RESULTS
SITES 1,2 AND 3
(CONTOUR INTERVAL 10 FEET)

HALLIBURTON NUS
Environmental Corporation

Adapted From SMC Environmental Services Group, 1991

DATE: 10/6/92

014

The suspected extent of Site 3 is shown on Figure 4-23. Because of recent construction over the area identified as Site 3, a portion of this site may lie beneath the paved entrance road. The eastern, southern, and northern borders of Site 3 are presumed to be the area of clean fill marked by borings S3-2, S3-6, and S3-7 and the adjacent unnamed tributary of Little Neshaminy Creek. The western boundary of Site 3 cannot be exactly distinguished, because no definite horizon of burned soil that would indicate the exact location of the Site 3 burn pit was encountered and borings were not placed west of the patrol road.

The confirmation borings revealed that, over the northeastern portion of Site 3, the thickness of fill and waste material was 10 feet or greater. Boring S3-6 and S3-7 (Figure 4-23) contained only nine and seven feet of fill material, respectively. This may suggest a pinching out of fill material towards the southwest. The thickness of waste and non-native fill material at Site 3 averaged approximately six feet and seven feet in thickness, respectively. The types and thicknesses of waste material found in each boring at Site 3 are included in Appendix B.

4.5.2 Content of Area A

The EM survey indicated a possibility of scattered buried metallic objects adjacent to the sludge lagoons and along the northern portion of the Sites 1 and 2 area. These areas are marked with an "M" on Figure 4-21.

Gas chromatograph (GC) readings obtained from soil gas on December 13, 1989 indicated that acetone, benzene, and two unknowns (i.e., compounds not in the GC library) were present. The acetone and benzene levels detected in the soil gas were 116 ppb and 126 ppb, respectively. The unknown compounds were found in the method blanks and therefore may not have originated from the sites.

Acetone is a common constituent of various solvents. Benzene is often a constituent of oils, roofing materials, and asphalt. The acetone and benzene present at Sites 1 and 2 may be products of wastes reported to have been deposited in the sites. Levels of VOCs found during the soil gas survey were uniformly low.

During the initial PID survey, an orange-colored fluid with an oily metallic sheen was observed to be seeping from the stream bank along the northeastern edge of Site 2. Samples of both orange-stained sediment and the seep water were taken. Vapors from the headspace of the sample containers were analyzed by the GC. The GC indicated that no VOCs were detectable in the seep materials at that time.

Waste material detected in confirmation borings conducted at Sites 1 and 2 included fill material, cinders, glass fragments, ceramic fragments, wood particles, brick fragments, and metal fragments. This waste may represent the regraded remains of material from the Site 1 burn pit, although no distinct scorched soil horizon was encountered.

The origin of the brick, glass, and metal fragments found at Site 1 is not certain, but the materials are probably the remains of construction or building demolition wastes disposed in or around the burn pit.

Waste found in the area believed to encompass Sites 1 and 2 did not yield any evidence of the wastewater sludge reported to be present at Site 2. However, a gray, clay-like material containing volatile vapors was discovered in boring S3-1 at Site 3. This material may possibly be sewage sludge and as such may represent the eastern edge of the Site 2 sludge trenches.

The results of the confirmation borings confirmed that the area of the EM survey indicated as having anomalous readings did contain waste material.

The EM survey did not indicate the presence of any buried metallic objects at Site 3. The GC readings tentatively indicated that unknown concentrations of xylene isomer(s) and one unknown compound were present in the soil gas at Site 3. The identification of xylenes is tentative because the GC had originally listed the xylene concentration as an unknown compound. After a subsequent calibration to account for a temperature rise, the retention time for the "unknown" compound fell within the range of xylenes. The final quality control check of the Site 3 chromatograms indicated one of the unknown compounds could be tentatively identified as xylenes. Xylenes are common constituents in roofing materials, which were reported to have been disposed and/or burned at Site 3.

No distinct scorched soil horizon that would indicate the exact presence of the burn pit at Site 3 was found. However, widely distributed cinders presumably resulting from the use and regrading of the burn pit were often encountered. Buried wood, metal, brick, and glass fragments, probably representing unburned portions of material disposed in the pit, were also encountered at the site.

A gray, clay-like material was encountered in boring S3-1. This material contained volatile organic vapors at a steady 1 to 2 ppm concentration. This material may represent a decomposition product of the sewage sludge disposed in the Site 2 trenches or a landfill-type cap for buried wastes. If so, boring S3-1 would mark the extreme eastern edge of the Site 2 trenches.

4.5.3 Groundwater

Fifteen unfiltered samples were obtained from wells considered to be upgradient of the study areas. Table 4-8 presents the occurrence and distribution of these results. Table 4-9 presents filtered results (Phase II wells only) for upgradient wells, and Table 4-10 presents organic results. These three tables were used for comparison with groundwater data obtained from this and other study areas.

Twenty-four unfiltered samples were obtained from wells considered to be within the influence of sites in Area A. Table 4-11 presents the occurrence and distribution of these results. In accordance with EPA policy, unfiltered groundwater results are used for risk assessment. However, monitoring wells can contain significant amounts of suspended material that result in overestimation of metal contamination in groundwater. Therefore, filtered results (available for Phase II wells only) are discussed in this section, presented in Table 4-12 for comparison, and used to qualify the risk assessment.

Comparison of downgradient unfiltered results to downgradient filtered results reveals that the filtered results are generally much lower. Many elements, such as cadmium, cobalt, copper, nickel, silver, and thallium, are not even detected in the filtered samples.

Almost every metal for which unfiltered downgradient samples were analyzed was detected. High representative concentrations include those of arsenic, cadmium, lead, manganese, and thallium. A discussion of these results with respect to drinking water criteria and dose-response parameters is included in Section 4.7. Unfiltered concentrations of downgradient wells exceeded those of upgradient wells (except for potassium and sodium). Zinc and vanadium concentrations in filtered downgradient wells exceed those of upgradient wells.

The well primarily responsible for higher representative concentrations of arsenic and cadmium in unfiltered downgradient water was BG-4 (Phase I and known as MW-38 in Phase II). Lead and manganese concentrations were particularly noted in DG-23 (MW-42 in Phase II), BG-4/MW-38, Well C (known as MW-31 and MW-31D in Phase II), Phase II DG-13 (MW-27),and DG-2 (known as MW-44 in Phase II). Manganese concentrations were also noted in DG-26 (known as MW-36 in Phase II). All of these wells, except DG-26, were located in shallow rather than overburden bedrock. There does not appear to be an identifiable plume of metals contamination in the groundwater, based on these data, although a general trend of higher concentrations of metals in the downgradient samples was observed for unfiltered results.

TABLE 4-8
OCCURRENCE AND DISTRIBUTION OF UNFILTERED MONITORING WELL INORGANICS - UPGRADIENT
NAWC, WARMINSTER, PENNSYLVANIA
(ug/L)

Element	CRDL	Frequency of Positive Detection	Range of Positive Detection	Representative Concentration
Aluminum	200	13/15	1470-20000	10710
Arsenic	10	5/15	2.1-4.1	2.5
Barium	200	10/15	66-588	358
Cadmium	5	2/15	3-4	2.28
Calcium	5000	10/15	10800-93800	46240
Chromium	10	5/15	5-58	20.1
Cobalt	50	7/15	3-16	9.47
Copper	25	1/15	37	33.2
Iron	100	15/15	422-129000	15550
Lead	3	6/15	2.2-150	35.8
Magnesium	5000	10/15	4310-31400	16130
Manganese	15	15/15	80-4830	2200
Nickel	40	9/15	18-40	27.8
Potassium	5000	9/15	940-8690	3880
Sodium	5000	10/15	6980-55900	24460
Vanadium	50	7/15	7-40	15.5
Zinc	20	8/15	22-117	56.6

TABLE 4-9
OCCURRENCE AND DISTRIBUTION OF FILTERED MONITORING WELL INORGANICS - UPGRADIENT
NAWC, WARMINSTER, PENNSYLVANIA
(ug/L)

Element	CRDL	Frequency of Positive Detection	Range of Positive Detection	Rep Conc
Barium	200	9/10	61-286	172
Calcium	5000	10/10	9430-80100	53710
Chromium	10	1/10	60	21.3
Cobalt	50	1/10	12	5.94
Iron	100	2/10	1170-1430	663
Magnesium	5000	10/10	3370-28000	18990
Manganese	15	9/10	4-4220	420
Nickel	40	1/10	23	13.2
Potassium	5000	9/10	781-8460	4220
Sodium	5000	10/10	6970-54200	32630
Zinc	20	3/10	17-46	25.8

TABLE 4-10
OCCURRENCE AND DISTRIBUTION OF MONITORING WELL ORGANICS - UPGRADIENT
NAWC, WARMINSTER, PENNSYLVANIA
(ug/L)

Compound	CRQL	Frequency of Positive Detection	Range of Positive Detection	Rep Conc
Chloroform	1/5	3/15	2-4	2.6
Carbon tetrachloride	1/5	3/15	1-3	2.6
Trichloroethene	1/5	4/15	7-47	13.7
Tetrachloroethene	1/5	3/15	12-130	29.8
1,1-Dichloroethene	1/5	2/15	2-8	3.2
1,1-Dichloroethane	1/5	2/15	2-8	3.2
Cis-1,2-Dichloroethene	1/5	2/10	2-45	15.1
Trans-1,2-Dichloroethene	1/5	1/10	2	2.0
1,1,1-Trichloroethane	1/5	2/15	6-13	4.7
Phenanthrene	10	1/6	17	12.1
Fluoranthene	10	1/6	46	29.4
Pyrene	10	1/6	35	22.8
Benz[a]anthracene	10	1/6	17	12.1
Chrysene	10	1/6	30	19.9
Benzo[b]fluoranthene	10	1/5	52	40.5
Benzo[a]pyrene	10	1/5	24	19.3
Indeno[1,2,3-c,d]pyrene	10	1/5	20	16.3
Dibenz[a,h]anthracene	10	1/5	5	5.0
Benzo[g,h,i]perylene	10	1/5	20	16.3
Butylbenzylphthalate	10	1/6	0.4	0.4
Diethylphthalate	10	1/6	0.2	0.2
Di-n-octylphthalate	10	2/5	0.8-1	1.0
TICs	-	3	+	-

TICs=Tentatively identified compounds

TABLE 4-11
OCCURRENCE AND DISTRIBUTION OF UNFILTERED MONITORING WELL INORGANICS - SITES 1, 2, 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

TABLE 4-12
OCCURRENCE AND DISTRIBUTION OF FILTERED MONITORING WELL INORGANICS - SITES 1, 2, 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

Table 4-13 presents a summary of positive organic detections for groundwater in Area A. Most notable of the positive results are vinyl chloride, chlorinated ethenes, chlorinated ethanes, benzene, toluene, ethylbenzene, xylenes, phthalates, and PAHs. While several of these compounds were detected in upgradient wells, the concentrations of downgradient volatiles were much higher. Maps showing the shallow bedrock concentrations of TCE, PCE, cis-1,2-dichloroethene (cis-1,2-DCE), 1,1,1-TCEA, and 1,1-DCA are included in Figures 4-24 through 4-28.

Degradation of PCE to TCE, 1,2-dichloroethene (1,2-DCE), 1,1-dichloroethene (1,1-DCE), and ultimately vinyl chloride in the environment has been reported (Cline and Viste, 1984). A similar effect for 1,1,1-TCEA to 1,2-dichloroethane (1,2-DCA), 1,1-DCA, and chloroethane has also been reported (Cline and Viste,1984). These compounds are generally detected in groups in the wells; that is, more than one chlorinated ethene would be found in a single well and more than one chlorinated ethane would be found, when they are detected at all.

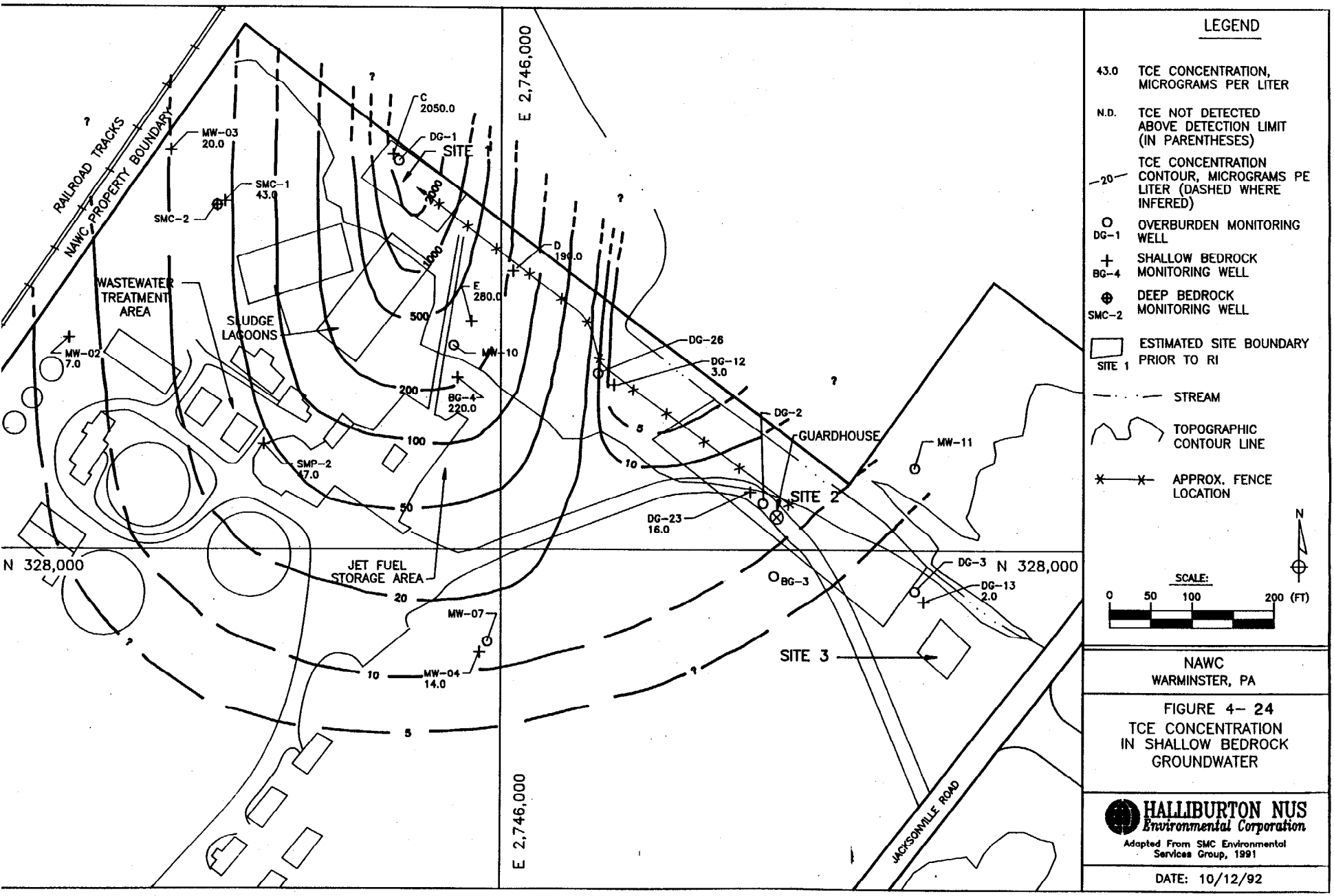
Wells containing the greatest concentrations of the chlorinated VOCs are BG-4 (Phase I known as MW-38 in Phase II), Well D (known as MW-39/39-D in Phase II), Well E (known as MW-33 in Phase II), and Well C, which had the highest concentration of TCE reported during both phases. These are shallow wells located from just north of the jet fuel storage area north to Site 1; Well C, where the highest concentration of TCE was reported, is located on Site 1. Concentrations of chlorinated ethenes and ethanes in overburden wells are much lower, with TCE detected up to 14 ug/l (DG-26, also known as Phase II MW-36, located between Sites 1 and 2). The positive detections of chloroform, carbon tetrachloride, and trichlorofluoromethane are also found in samples from these wells.

The benzene, toluene, ethylbenzene, and xylenes results are relatively low (2 ug/l or less for each compound), and results are scattered, with no clear pattern. Phthalates are detected in both shallow and overburden wells at trace to low levels, and their representative concentrations exceed the upgradient representative concentrations. These detections are also scattered and may be attributable to suspended materials that can be found in turbid monitoring well samples. No clear pattern of contamination is observed for phthalates, except that downgradient results generally exceed upgradient results.

TABLE 4-13
OCCURRENCE AND DISTRIBUTION OF MONITORING WELL ORGANICS - SITES 1,2,3
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



NAWC
WARMINSTER, PA

FIGURE 4- 24
TCE CONCENTRATION IN SHALLOW BEDROCK GROUNDWATER

HALLIBURTON NUS Environmental Corporation

Adapted From SMC Environmental Services Group, 1991

DATE: 10/12/92

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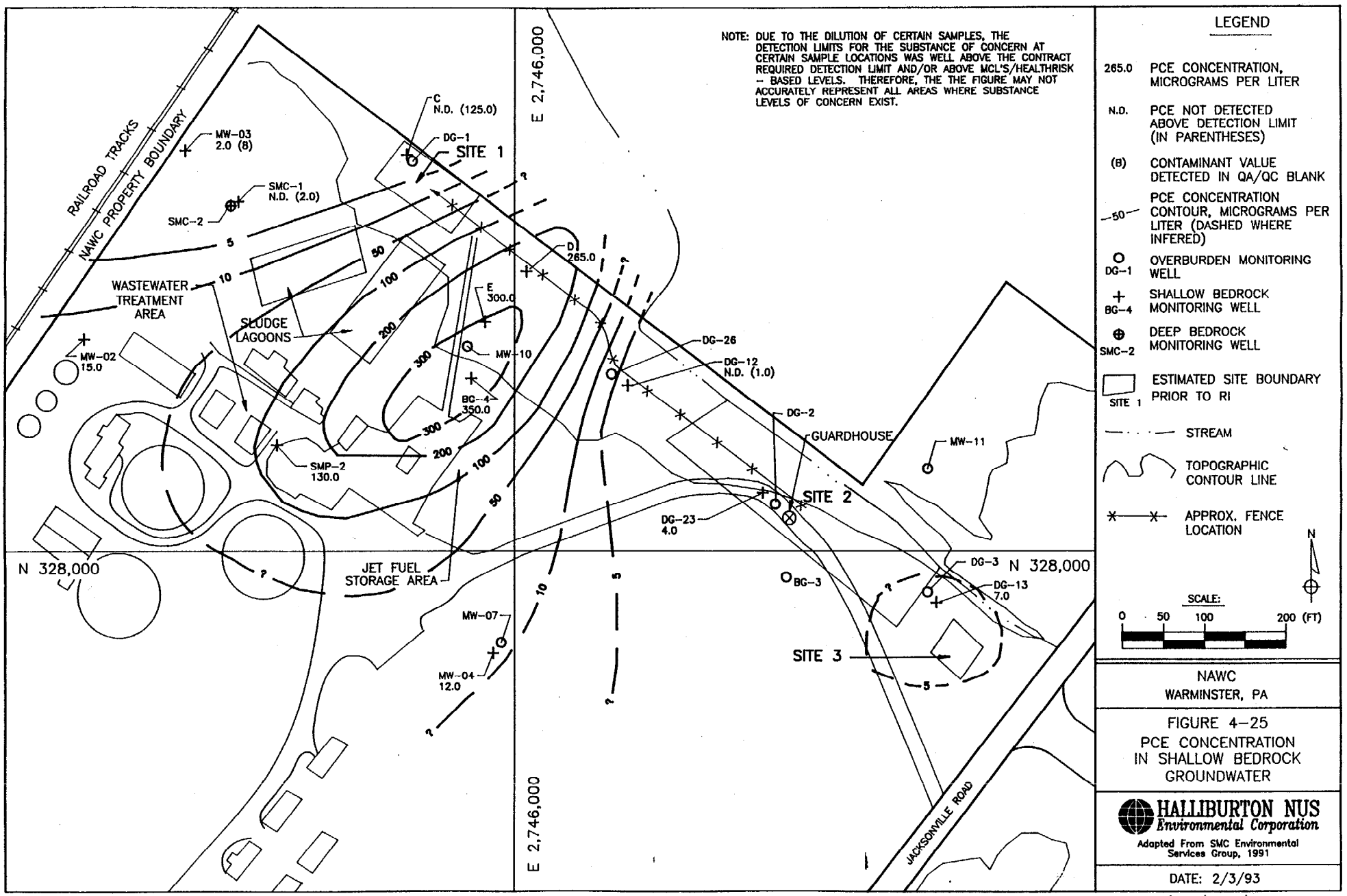
NOTE: DUE TO THE DILUTION OF CERTAIN SAMPLES, THE DETECTION LIMITS FOR THE SUBSTANCE OF CONCERN AT CERTAIN SAMPLE LOCATIONS WAS WELL ABOVE THE CONTRACT REQUIRED DETECTION LIMIT AND/OR ABOVE MCL'S/HEALTHRISK – BASED LEVELS. THEREFORE, THE THE FIGURE MAY NOT ACCURATELY REPRESENT ALL AREAS WHERE SUBSTANCE LEVELS OF CONCERN EXIST.
LEGEND
265.0 PCE CONCENTRATION, MICROGRAMS PER LITER
N.D. PCE NOT DETECTED ABOVE DETECTION LIMIT (IN PARENTHESES)
(B) CONTAMINANT VALUE DETECTED IN QA/QC BLANK
50 PCE CONCENTRATION CONTOUR, MICROGRAMS PER LITER (DASHED WHERE INFERED)
DG-1 OVERBURDEN MONITORING WELL
BG-4 SHALLOW BEDROCK MONITORING WELL
SMC-2 DEEP BEDROCK MONITORING WELL
SITE 1 ESTIMATED SITE BOUNDARY PRIOR TO RI
STREAM
TOPOGRAPHIC CONTOUR LINE
APPROX. FENCE LOCATION
N
SCALE:
0 50 100 200 (FT)
RAILROAD TRACKS
NAWC PROPERTY BOUNDARY
MW-03 2.0 (8)
SMC-1 N.D. (2.0)
SMC-2
C N.D. (125.0)
DG-1
SITE 1
D 265.0
E 300.0
WASTEWATER TREATMENT AREA
SLUDGE LAGOONS
MW-02 15.0
MW-10
BG-4 350.0
SMP-2 130.0
DG-26
DG-12 N.D. (1.0)
DG-2
GUARDHOUSE
MW-11
SITE 2
DG-23 4.0
BG-3
DG-3
DG-13 7.0
N 328,000
JET FUEL STORAGE AREA
MW-07
MW-04 12.0
SITE 3
E 2,746,000
JACKSONVILLE ROAD
NAWC
WARMINSTER, PA
FIGURE 4-25
PCE CONCENTRATION IN SHALLOW BEDROCK GROUNDWATER
HALLIBURTON NUS Environmental Corporation
Adapted From SMC Environmental Services Group, 1991
DATE: 2/3/93
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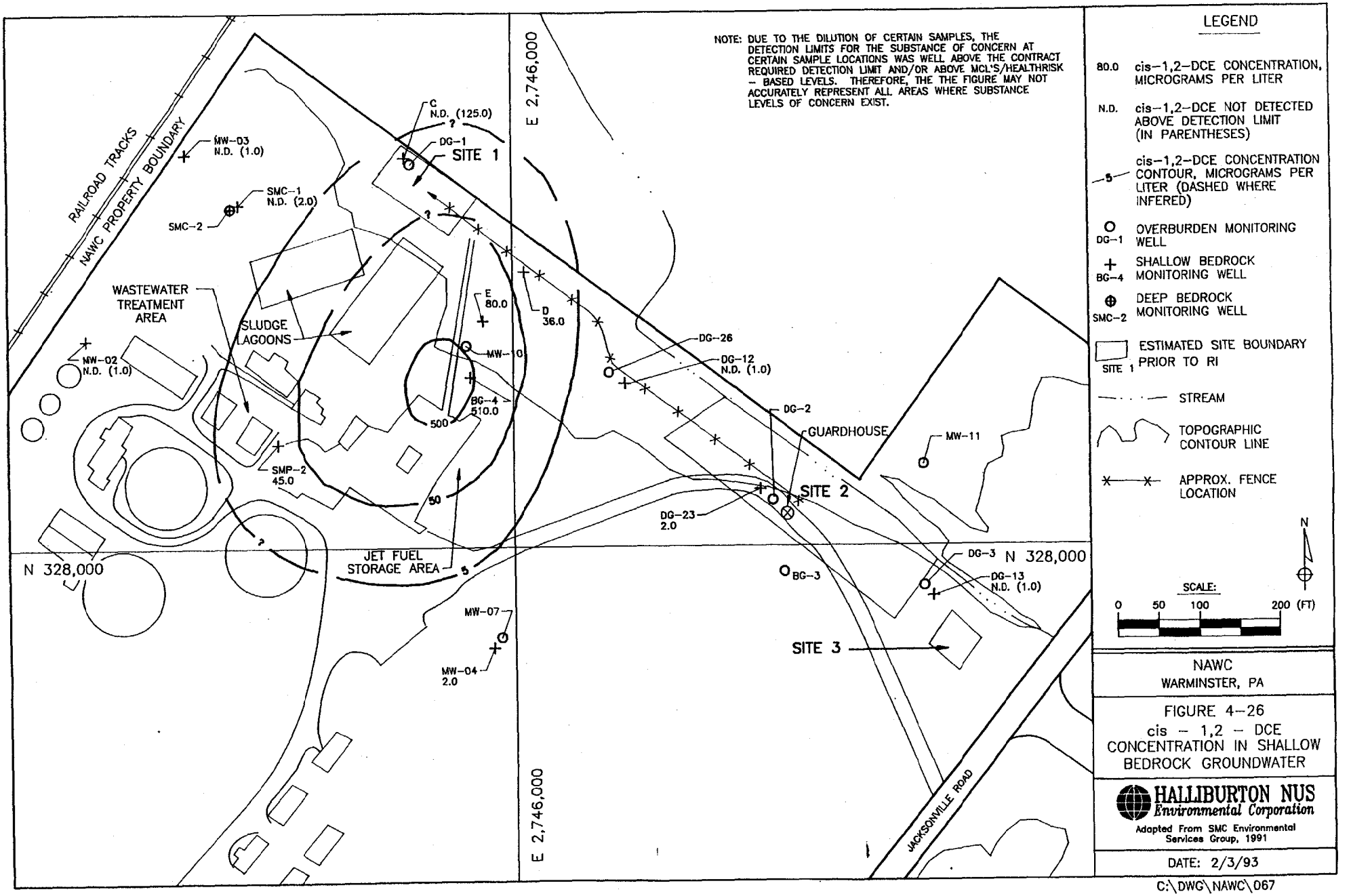
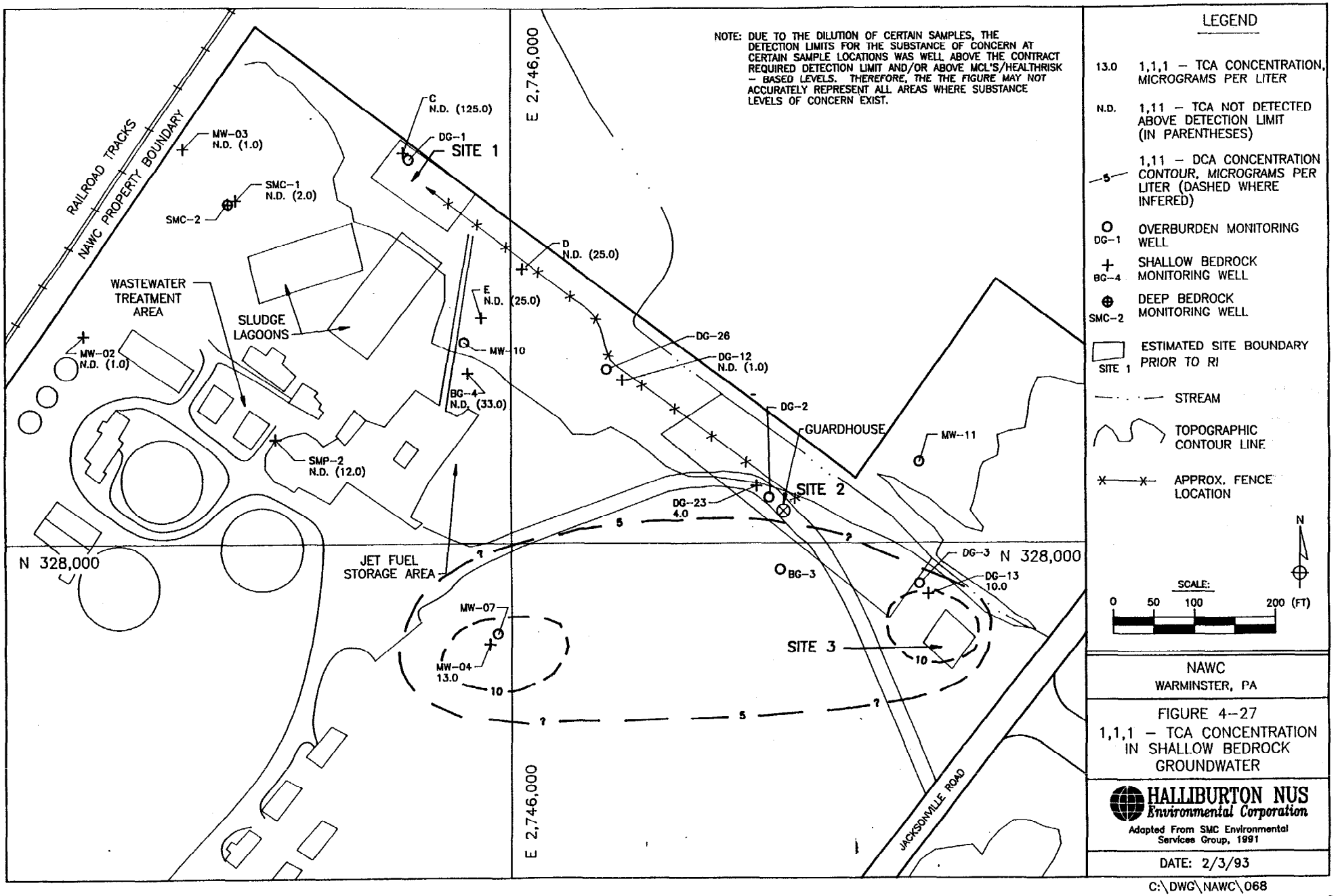

NOTE: DUE TO THE DILUTION OF CERTAIN SAMPLES, THE DETECTION LIMITS FOR THE SUBSTANCE OF CONCERN AT CERTAIN SAMPLE LOCATIONS WAS WELL ABOVE THE CONTRACT REQUIRED DETECTION LIMIT AND/OR ABOVE MCL'S/HEALTHRISK - BASED LEVELS. THEREFORE, THE THE FIGURE MAY NOT ACCURATELY REPRESENT ALL AREAS WHERE SUBSTANCE LEVELS OF CONCERN EXIST.
LEGEND
80.0 cis-1,2-DCE CONCENTRATION, MICROGRAMS PER LITER
N.D. cis-1,2-DCE NOT DETECTED ABOVE DETECTION LIMIT (IN PARENTHESES)
5 cis-1,2-DCE CONCENTRATION CONTOUR, MICROGRAMS PER LITER (DASHED WHERE INFERED)
DG-1 OVERBURDEN MONITORING WELL
BG-4 SHALLOW BEDROCK MONITORING WELL
SMC-2 DEEP BEDROCK MONITORING WELL
SITE 1 ESTIMATED SITE BOUNDARY PRIOR TO RI
STREAM
TOPOGRAPHIC CONTOUR LINE
APPROX. FENCE LOCATION
N
SCALE:
0 50 100 200 (FT)
NAWC
WARMINSTER, PA
FIGURE 4-26
cis - 1,2 - DCE CONCENTRATION IN SHALLOW BEDROCK GROUNDWATER
HALLIBURTON NUS Environmental Corporation
Adapted From SMC Environmental Services Group, 1991
DATE: 2/3/93
C:\DWG\NAWC\067
RAILROAD TRACKS
NAWC PROPERTY BOUNDARY
MW-03 N.D. (1.0)
SMC-1 N.D. (2.0)
SMC-2
WASTEWATER TREATMENT AREA
SLUDGE LAGOONS
MW-02 N.D. (1.0)
SMP-2 45.0
JET FUEL STORAGE AREA
N 328,000
E 2,746,000
C N.D. (125.0)
DG-1
SITE 1
E 80.0
D 36.0
MW-01
BG-4 510.0
500
50
5
MW-07
MW-04 2.0
DG-26
DG-12 N.D. (1.0)
DG-2
GUARDHOUSE
MW-11
SITE 2
DG-23 2.0
BG-3
DG-3
DG-13 N.D. (1.0)
SITE 3
JACKSONVILLE ROAD


NOTE: DUE TO THE DILUTION OF CERTAIN SAMPLES, THE DETECTION LIMITS FOR THE SUBSTANCE OF CONCERN AT CERTAIN SAMPLE LOCATIONS WAS WELL ABOVE THE CONTRACT REQUIRED DETECTION LIMIT AND/OR ABOVE MCL'S/HEALTHRISK – BASED LEVELS. THEREFORE, THE THE FIGURE MAY NOT ACCURATELY REPRESENT ALL AREAS WHERE SUBSTANCE LEVELS OF CONCERN EXIST.
RAILROAD TRACKS
NAWC PROPERTY BOUNDARY
MW-03 N.D. (1.0)
SMC-1 N.D. (2.0)
SMC-2
C N.D. (125.0)
DG-1
SITE 1
D N.D. (25.0)
E N.D. (25.0)
WASTEWATER TREATMENT AREA
SLUDGE LAGOONS
MW-02 N.D. (1.0)
MW-10
BG-4 N.D. (33.0)
SMP-2 N.D. (12.0)
DG-26
DG-12 N.D. (1.0)
DG-2
GUARDHOUSE
MW-11
SITE 2
DG-23 4.0
5
?
N 328,000
JET FUEL STORAGE AREA
BG-3
DG-3
DG-13 10.0
N 328,000
MW-07
MW-04 13.0
10
SITE 3
E 2,746,000
E 2,746,000
JACKSONVILLE ROAD
LEGEND
13.0 1,1,1 – TCA CONCENTRATION, MICROGRAMS PER LITER
N.D. 1,11 – TCA NOT DETECTED ABOVE DETECTION LIMIT (IN PARENTHESES)
5 1,11 – DCA CONCENTRATION CONTOUR, MICROGRAMS PER LITER (DASHED WHERE INFERED)
DG-1 OVERBURDEN MONITORING WELL
BG-4 SHALLOW BEDROCK MONITORING WELL
SMC-2 DEEP BEDROCK MONITORING WELL
SITE 1 ESTIMATED SITE BOUNDARY PRIOR TO RI
STREAM
TOPOGRAPHIC CONTOUR LINE
APPROX. FENCE LOCATION
N
SCALE:
0 50 100 200 (FT)
NAWC
WARMINSTER, PA
FIGURE 4-27
1,1,1 – TCA CONCENTRATION IN SHALLOW BEDROCK GROUNDWATER
HALLIBURTON NUS Environmental Corporation
Adapted From SMC Environmental Services Group, 1991
DATE: 2/3/93
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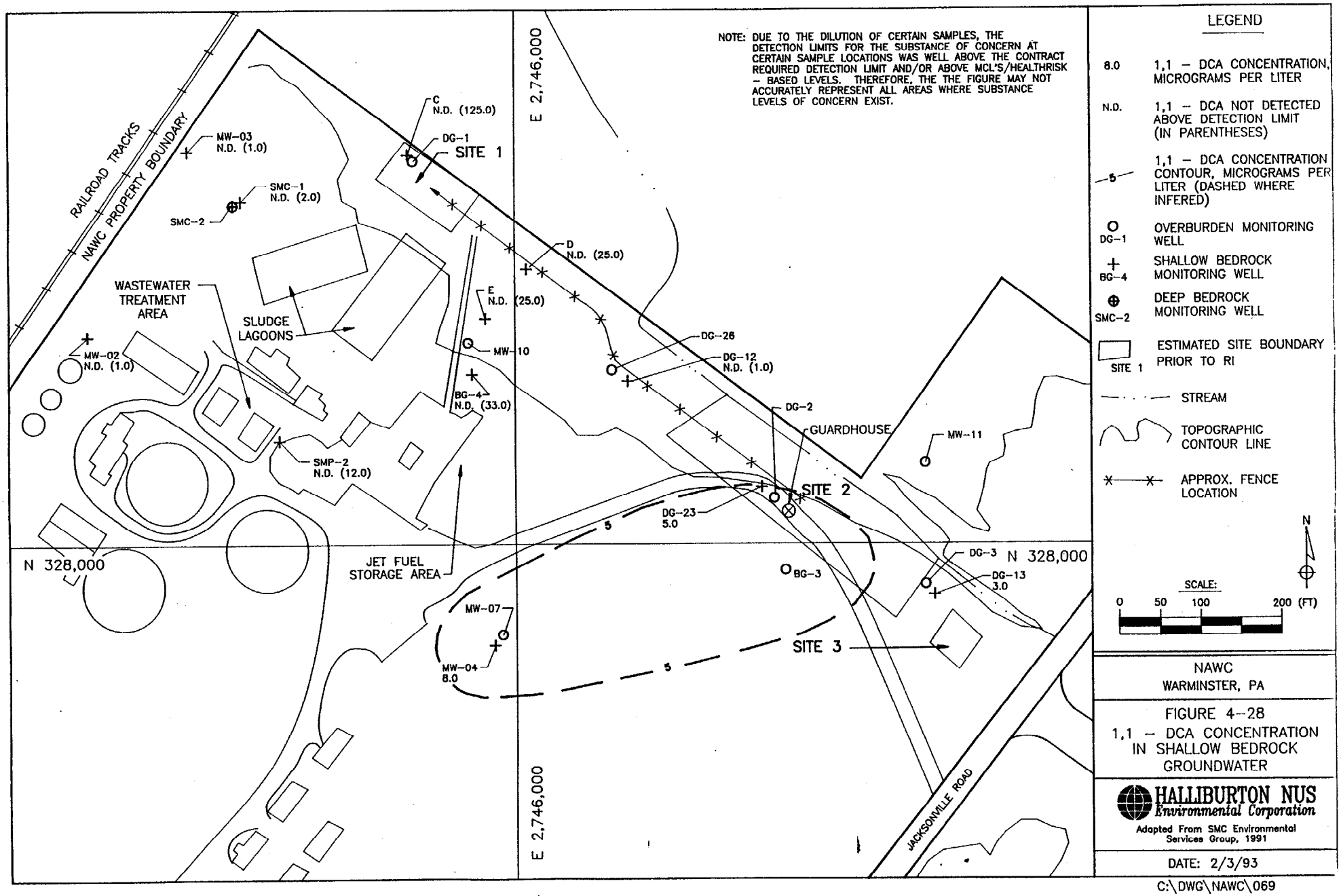
NOTE: DUE TO THE DILUTION OF CERTAIN SAMPLES, THE DETECTION LIMITS FOR THE SUBSTANCE OF CONCERN AT CERTAIN SAMPLE LOCATIONS WAS WELL ABOVE THE CONTRACT REQUIRED DETECTION LIMIT AND/OR ABOVE MCL'S/HEALTHRISK – BASED LEVELS. THEREFORE, THE THE FIGURE MAY NOT ACCURATELY REPRESENT ALL AREAS WHERE SUBSTANCE LEVELS OF CONCERN EXIST.
RAILROAD TRACKS
NAWC PROPERTY BOUNDARY
MW-03 N.D. (1.0)
SMC-1 N.D. (2.0)
SMC-2
C N.D. (125.0)
DG-1
SITE 1
E 2,746,000
D N.D. (25.0)
E N.D. (25.0)
WASTEWATER TREATMENT AREA
SLUDGE LAGOONS
MW-02 N.D. (1.0)
MW-10
BG-4 N.D. (33.0)
SMP-2 N.D. (12.0)
DG-26
DG-12 N.D. (1.0)
DG-2
GUARDHOUSE
MW-11
SITE 2
DG-23 5.0
5
N 328,000
JET FUEL STORAGE AREA
BG-3
DG-3
DG-13 3.0
N 328,000
MW-07
MW-04 8.0
SITE 3
5
E 2,746,000
JACKSONVILLE ROAD
LEGEND
8.0 1,1 – DCA CONCENTRATION, MICROGRAMS PER LITER
N.D. 1,1 – DCA NOT DETECTED ABOVE DETECTION LIMIT (IN PARENTHESES)
5 1,1 – DCA CONCENTRATION CONTOUR, MICROGRAMS PER LITER (DASHED WHERE INFERED)
DG-1 OVERBURDEN MONITORING WELL
BG-4 SHALLOW BEDROCK MONITORING WELL
SMC-2 DEEP BEDROCK MONITORING WELL
SITE 1 ESTIMATED SITE BOUNDARY PRIOR TO RI
STREAM
TOPOGRAPHIC CONTOUR LINE
APPROX. FENCE LOCATION
N
SCALE:
0 50 100 200 (FT)
NAWC
WARMINSTER, PA
FIGURE 4-28
1,1 – DCA CONCENTRATION IN SHALLOW BEDROCK GROUNDWATER
HALLIBURTON NUS
Environmental Corporation
Adapted From SMC Environmental Services Group, 1991
DATE: 2/3/93
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PAHs, on the other hand, exhibited the opposite trend; upgradient results (entirely due to a single well, BG-3, located south of Site 2) exceeded downgradient results. Downgradient PAHs are detected only in Phase I well DG-2, which was located on Site 2. It is unusual to find PAHs in regularly pumped wells; they are sometimes found in the more turbid monitoring well samples and may be attributable to suspended materials in the samples. No PAHs were detected in the Phase II sample from DG-2 (known as MW-44).

Groundwater contamination appears to be highest in shallow downgradient wells, especially those between the jet fuel storage area and Site 1.

4.5.4 Summary

Concentrations of metals are reported in groundwater underlying Area A. The metals detected in groundwater include arsenic, cadmium, lead, manganese, and thallium. Downgradient well metals were generally found at higher concentrations than upgradient metals.

Chlorinated ethenes and/or ethanes are detected in shallow wells. Other volatiles, such as chloroform, carbon tetrachloride, and trichlorofluoromethane, are detected in on-site shallow wells. Benzene, toluene, ethylbenzene, and xylenes are detected in monitoring wells at low levels.

Phthalates are detected in monitoring wells at low levels. PAHs are detected in one upgradient monitoring well and one downgradient monitoring well.

4.6 CONTAMINANT FATE AND TRANSPORT

Various aspects of groundwater contaminant fate and transport at Area A are discussed in this section. Various chemical and physical properties affecting contaminant migration are discussed in Section 4.6.1. Potential contaminant migration routes are identified and discussed in Section 4.6.2. Section 4.6.3 presents a brief discussion of contaminant persistence.

4.6.1 Physical and Chemical Transport Properties

This section provides a qualitative discussion of potential migration of the contaminants found at Area A. The physical and chemical properties of the chemicals found in the study area, where available, are presented in Tables 4-14 and 4-15. These parameters may be used to assess the behavior of a chemical in the environment.

TABLE 4-14
MOBILITY PARAMETERS FOR ORGANIC CHEMICALS - SITE 1, 2, 3
NAWC, WARMINSTER, PENNSYLVANIA

CHEMICAL	MOL[1] WT. (g)	SOL[1] (mg/L)	Log Kow [2][3][4]	V.P.[1] (mmHg,20C)	H[1][3] atm.m^3 mol	BCF[1]	SP.GRAV.[2][5] (20C)	Koc[1]
Trichloroethene	131.39	1100	2.53	5.79E1	9.1E-3	9.7E1	1.46	1.26E2
Tetrachloroethene	165.83	200	2.6(20C)	1.4E1	1.53E-2	2.52E2	1.626	3.64E2
Chloroform	119.38	8200	1.97(20c)	1.5E2	2.88E-3	5.56[6]	1.489	4.4E1
Toluene	92.13	534.8(25C)	2.69(20C)	2.87E1	6.66E-3	2.5E1[6]	0.867	3E2
4-Methylphenol	108.1	4400	1.92/1.94	4E-2	1.29E-6	1.1E1[7]	1.0347	2.43E1
DDT	354.5	0.0055(25C)	6.19(20C)	1.9E-7(25C)	1.58E-5	8E6	-	3.9E6
DDD	320.1	0.09(25C)	1.6x10^6	1.2E-7(25C)	2.2E-8	1.8E5	NA[9]	7.7E5
Aroclor 1248	299.5[4]	0.054[4]	5.75	4.9E-4(25C)[4]	3.6E-3	-	-	2.5E5
Aroclor 1254	328.4	0.031(25C)	6.03	7.71E-5(25C)	2.6E-3	1.3E5	-	5.3E5
Bis[2-ethylhexyl]phthalate	390.62	0.4(25C)	5.3	2E-7	3E-7	2.3E8	0.99	2E9
Butylbenzylphthalate	312	2.9	4.78	6E-5	8.3E-6	4.7E4	1.1(25C)	1.7E5
Di-n-butylphthalate	278.3	13(25C)	5.2	1E-5(25C)	2.8E-7	4.7E4	1.0465	1.7E5
Naphthalene	128.2	31.7(25C)	3.01/3.45	8.7E-3(25C)	4.6E-4	4.2E2	1.152	9.4E2
2-Methylnaphthalene	142.19[2]	26-28(25C)	4.26	0.087(25C)	6E-4[7]	1E3[7]	0.994	5.8E3[7]
Acenaphthene	154.2	3.42(25C)	3.92	1.55E-3(25C)	9.1E-5	1.8E3	1.0242	4.6E3
Acenaphthylene	152.2	3.93(25C)	3.72	2.9E-2	1.45E-3	1E3	NA	2.5E3
Anthracene	178.2	0.045(25C)	4.45	1.7E-5(25C)	8.6E-5	4.7E3	1.283	1.4E4
Fluoranthene	202.3	0.26(25C)	5.33	5E-6(25C)	6.5E-6	1.2E4	1.252	3.8E4
Pyrene	202.3	0.13(25C)	5.18	2.5E-6(25C)	5.1E-6	1.2E4	-	3.8E4
Phenanthrene	178.2	1.0(25C)	4.45	9.6E-4(25C)	2.3E-4	4.7E3	1.025	1.4E4
Benz[a]anthracene	228.28	0.0057	5.61	2.2E-8	1E-6	5.3E4	-	2E5
Chrysene	228.3	0.0018(25C)	5.61	6.3E-9(25C)	1.05E-6	5.3E4	1.274	2E5
Benzo[b]fluoranthene	252.3	0.0014(25C)	6.57	5E-7	1.22E-5	1.4E5	-	5.5E5
Benzo[k]fluoranthene	252.3	0.0043(25C)	6.84	5E-7	3.87E-5	1.4E5	-	5.5E5
Benzene	78.12	1780	2.13	95.2(25C)	5.5E-3	7.84	-	6.5E1
Benzo[a]pyrene	252	0.0038(25C)	5.98	5.6E-9	4.9E-7	1.09E4[6]	-	5.5E6
Indeno[1,2,3-c,d]pyrene	276.3	0.00053(25C)	7.66	1E-10	6.95E-8	3.5E5	-	1.6E6

TABLE 4-14
MOBILITY PARAMETERS FOR ORGANIC CHEMICALS - SITES 1, 2, 3
NAWC, WARMINSTER, PENNSYLVANIA
PAGE TWO

CHEMICAL	MOL[1] WT. (g)	SOL[1] (mg/L)	Log Kow [2][3][4]	V.P.[1] (mmHg,20C)	H[1][3] atm.m³ mol	BCF[1]	SP.GRAV.[2][5] (at 20 C)	Koc[1]
Dibenz[a,h]anthracene	278.4	0.0005(25C)	5.97	1E-10	7.3E-8	6.9E5	-	3.3E6
Benzo[g,h,i]perylene	276	0.00026(25C)	7.23	1.03E-10(25C)	1.44E-7	3.5E5	-	1.6E6
Fluorene	116.2	1.69(25C)	4.18	7.1E-4	6.4E-5	3.8E3	1.203	7.3E3
1,1,1-Trichloroethane	133.41	720	2.47	1.23E2(25C)	3E-2	8.1E1	1.35	1.52E1
1,1-Dichloroethane	98.96	5500	1.79	1.8E2	4.26E-3	1.9E1	1.174	3E1
1,1-Dichloroethene	96.94	400	1.48	5.91E2	1.9E-1	5.3E1	1.218	6.5E1
Carbon tetrachloride	153.82	785	2.64	9E1	2.3E-2	2.11E2	1.59	4.39E2
Ethylbenzene	106.16	152	3.15	7E0	6.6E-3	6.68E1	0.867	1.1E3
Xylenes	106.16	187	2.77-3.2	6.5E0	4.33E-3	1.5E-2	0.86-0.88	2.48E2
Di-n-octylphthalate	391	3(25C)	9.2	1.4E-4	1.7E-5	3.9E8	0.99	3.6E9
4-Methylphenol	108.1	4400	1.92/1.94	4E-2	1.29E-6	1.1E1	1.0347	2.43E1
1,4-Dichlorobenzene	147.01	79(25C)	3.56	1.18(25C)	3.1E-3	7.3E2	1.458	1.7E3
Carbazole	167.21	-	3.29	400(323C)	-	-	1.10	1202[7]
Aroclor 1260	375.7	0.08(24C)	7.15	4E-5(25C)	0.74	1E5	-	6.7E6
Chlorobenzene	112.56	500	2.84	1.17E1	3.58E-3	1.64E2	1.1066	3.3E2
Dibenzofuran	168.2	10	4.12	-	-	-	-	8128
Vinyl chloride	62.5	2700	1.23	2.66E3(25C)	8.14E-2	5.7	0.9121	8.2
1,2-Dichloroethane	98.96	8690	1.48	6.1E1	9.14E-4	9	1.25	14
cis-1,2-Dichloroethene	96.94	800(20C)	-	200(25C)	4.08E-3	48	1.28	59
Trichlorofluoromethane	137.4	1100	2.52	9.04E-1	0.11	-	1.494	159
1,2-Dichlorobenzene	147.01	100	3.56	1	1.93E-3	7.3E2	1.305	1.7E3
2-Butanone	72.1	35300	0.26	7.8E1	2.08E-5	6E-1[7]	0.805	17
Diethylphthalate	222.2	210	2.47	3.5E-3(25C)	1.2E-6	1.07E2	1.12	1.42E2
Chloromethane	50.94	6450	0.95	3.76E3	4E-2	3.2	0.991	4.3
Acetone	58.08	680000	-0.24	2.7E2(30C)	3.43E-5	3E-1[7]	0.791	9.2
1,2-Dichloropropane	112.99	2700	2.02	4.2E1	2.31E-3	3E1	1.16	5.1E1

TABLE 4-14
MOBILITY PARAMETERS FOR ORGANIC CHEMICALS - SITES 1, 2, 3
NAWC, WARMINSTER, PENNSYLVANIA
PAGE THREE

(1) EPA, 1982

(2) Verschueren, 1983

(3) EPA RREL

(4) Versar, 1979

(5) Weast, 1988

(6) NLM, January 13, 1992

(7) Estimated as per Lyman, et al, 1990

(8) Estimated from NLM, January 13, 1992.

(9) Not available

MOL. WT. = Molecular weight

SOL. = Solubility

Kow = Octanol - water partition coefficient

V.P. = Vapor pressure

H = Henry's law constant

BCF = Bioconcentration factor

SP. GRAV. = Specific gravity

Koc = Organic carbon partition coefficient

TABLE 4-15
MOBILITY PARAMETERS AND PROPERTIES FOR INORGANIC CHEMICALS - SITES 1, 2, 3
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	MOL WT. (g)	SP. GRAV. (at 20C)[1]	BCF		Described Environmental Fate [2]
			(2)	(3)	
Arsenic	74.92	5.727	333	0-17	Sorption important
Antimony	121.75	6.684	40-16000	-	Sorption important; many species mobile
Barium	137.34	3.51	-	-	-
Cadmium	112.4	8.642	1000-4000	2-3520	Bioaccumulation, sorption important
Chromium	51.996	7.20	70-4000	<1-2.8	CrVI soluble, mobile; CrIII insoluble
Copper	63.54	8.92	12-30000	0-2000	Sorption, bioaccumulation important
Lead	207.19	11.3	60-200	42-1700	Sorption, bioaccumulation important
Manganese	55	7.2	-	-	-
Mercury	200.59	13.5939	1000-100000	4994-64000	Some insoluble species; sorption, metabolism, bioaccumulation important
Nickel	58.71	8.9	40-100	0.8-192	Soluble species, some bioaccumulation, sorption
Silver	107.87	10.5	200-3080	<1-240	Sorption important, some bioaccumulation
Vanadium	50.942	5.96	-	-	-
Zinc	65.38	7.14	1000-40000	51-1130	Sorption, bioaccumulation important
Selenium	78.96	4.81	400-800	28-351	Sorption important
Thallium	204.38	11.85	100000-150000	34-130	Sorption, bioaccummulation important

MOL. WT. = Molecular weight
Sp. Grav. = Specific gravity
BCF = Biocentration or bioaccumulation factor; freshwater species
(1) Weast, 1988
(2) Versar, 1979
(3) EPA, 1983a; EPA, 1983b; EPA, 1983c; EPA, 1986b; EPA, 1983d; EPA, 1986c; EPA, 1986d; EPA, 1983e; EPA, 1980a; EPA, 1980b; EPA, 1980c; EPA, 1980d

Empirically determined literature values of water solubility,octanol-water partition coefficient (Kow), Koc, vapor pressure, Henry's Law constant, bioconcentration factor (BCF), and specific gravity are presented for organic chemicals, as available. Many of these parameters are not applicable to inorganic chemicals. For inorganics, specific gravity and BCFs have been presented, along with qualitative descriptions of important environmental fate properties. Calculated values, which were obtained using approximation methods, are presented when literature values are unavailable. A discussion of the environmental significance of each of these parameters follows.

The rate at which a chemical is leached from a waste deposit by infiltrating precipitation is proportional to its water solubility. More soluble chemicals are expected to enter water much more readily and rapidly than less soluble chemicals. The water solubilities presented in Table 4-14 indicate that the VOCs are several orders of magnitude more water-soluble than semivolatile organic compounds (SVOCs) (including phthalates and PAHs), pesticides, or PCBs. This conclusion is reinforced by the fact that VOCs were discovered more frequently and at greater concentrations in groundwater than in surface media. (Volatilization of VOCs from surface media is also an important factor in the observed distribution of these chemicals.)

Although phthalates, PAHs, and PCBs were detected in soil, such compounds have not been detected to a great extent in groundwater. When detected, they are observed in monitoring wells, where they may be part of the sediment in the sample instead of the aqueous fraction. This is a manifestation of their limited water solubility and tendency to adsorb onto soil/sediment particles.

The Kow is a measure of the equilibrium partitioning of a chemical between octanol and water. The Kow is also used to estimate BCFs in aquatic organisms. A linear relationship between the Kow and the uptake of chemicals by fatty tissues of animal and human receptors has been determined (Lyman et al, 1990). PAHs, phthalates, and PCBs are several orders of magnitude more likely to partition to fatty tissues than the more water-soluble VOCs. The Kow is also useful in characterizing the sorption of compounds by organic soils when experimental values are not available.

The Koc is related to the water solubility and the Kow. This parameter indicates the tendency of a chemical to bind to soil particles containing organic carbon. Chemicals with high Koc generally have low water solubilities, and vice versa. Chemicals such as phthalates, PAHs, pesticides, and PCBs are relatively immobile in the subsurface environment and are preferentially bound to the soil phase. These compounds are not subject to groundwater transport to the same extent as compounds with high water solubilities.

Koc may be used to infer the relative rates at which the more mobile chemicals are transported in the groundwater. The Koc and the fractional organic carbon content of the soil (FOC) may be used to determine an equilibrium distribution coefficient (Kd) for the solid and aqueous matrices:

$$Kd = Koc \times FOC$$

where: Kd = Distribution coefficient
FOC = Soil organic carbon content
Koc = Organic carbon partition coefficient

TOC results may be used to calculate FOC for soils. One subsurface soil taken at Sites 1, 2, and 3 was analyzed for TOC, and the result was 2600 mg/kg. Thus:

$$FOC = (2600\ mg/kg)\ (1E\text{-}6\ kg/mg)$$
$$= 0.0026\ kg\ organic\ carbon/kg\ soil$$

Vapor pressure provides an indication of the rate at which a chemical volatilizes from both soil and water. It is of primary significance in instances where environmental interfaces such as surface soil/air and surface water/air are important, rather than in evaluation of groundwater and subsurface soils. Vapor pressures for VOCs are generally many times higher than vapor pressures for phthalate esters and PAHs. Chemicals with higher vapor pressures are expected to enter the atmosphere much more readily than chemicals with lower vapor pressures. Volatilization has also been reported to be one of the environmental fate pathways of PCBs. For example, of 700,000 pounds of PCBs in uncapped landfills in the Hudson River Basin area, an estimated 3,000 pounds (about 4 percent) volatilize annually (Lunsford, 1982). Volatilization depends upon such factors as total exposed surface area, PCB concentrations, and amount of organic matter in the soil.

Both vapor pressure and water solubility are of use in determining volatilization rates from surface water bodies. The Henry's Law Constant is the equilibrium vapor pressure of a chemical above a solution divided by its concentration in the solution (for dilute systems). The Henry's Law constant may also be used to calculate the equilibrium contaminant concentrations in the vapor versus liquid phases for dilute solutions commonly encountered in environmental settings. The Henry's Law constant is also useful for mass transfer applications for air-stripping column design.

BCFs represent the ratio of aquatic-organism tissue concentration to water concentration. The ratio is both contaminant- and species-specific, as well as tissue-specific. When site-specific values are not measured, literature values may be used, or the BCF may be derived from the Kow. Phthalate esters, PAHs, and pesticides will bioconcentrate at orders of magnitude greater than those concentrations found in the water where the exposed species reside. Bioconcentration is a well-known property of PCBs; PCBs can be stored in fatty tissues of exposed organisms at concentrations much higher than the environmental concentration. VOCs are not as readily bioconcentrated as the pesticides or PCBs.

Specific gravity is the ratio of the mass of a given volume of pure chemical at a specified temperature to the mass of the same volume of water at a given temperature. Its primary use is to determine whether pure compounds or very high concentrations of a contaminant will float or sink in water. As shown in Table 4-14, most of the chemicals detected in this study area were denser than water, although ethylbenzene and xylenes are less dense.

As shown in Table 4-15, most of the inorganic chemicals have a strong tendency to adsorb onto sediment particles, a factor that greatly reduces their mobility. For some metals, such as cadmium, lead, and mercury, bioaccumulation also plays an important role in environmental fate. While the metals themselves are insoluble in water, soluble species of some metals, such as chromium and antimony, can increase contaminant mobility.

4.6.2 Potential Migration Routes

In general, numerous potential migration routes exist in areas contaminated with hazardous materials. Such migration routes include, but are not limited to, atmospheric migration via particulate or volatile/semivolatile emissions, overland migration of dissolved or adsorbed contaminants, surface water transport, and groundwater transport. Only the transport pathway for migration of shallow groundwater is evaluated in this section.

One possible migration route in this area is from groundwater into the adjacent stream located north of the three sites. This process may be taking place because groundwater flow maps indicate that flow in the both overburden and shallow bedrock aquifers is toward the stream, and upward vertical gradients in well couplets near the stream have been measured. Groundwater movement to the stream may be via both overburden and shallow bedrock aquifers. Surface water was sampled downstream of this area. Some of the same compounds in monitoring wells, such as BTEX, PAHs, and phthalates, were detected in downstream surface water and sediment, although most of the chlorinated VOCs were not found. These results are not presented in this report.

The second possible route of groundwater migration is from the shallow bedrock aquifer beneath Area A into the deeper bedrock aquifers downdip and north of the site. Once the contaminants have entered the deeper aquifers, migration may occur along geologic structures such as permeable bedding planes, subsurface fractures, and joints. Contaminants were detected in the shallow bedrock aquifer underlying this area. Drawdown in water levels for some shallow bedrock wells in response to nearby pumping wells (e.g., Wagner and Sons) suggests that this aquifer may be recharging deeper aquifers, downdip from Area A. The upward flow of groundwater within well SMC-2 from deeper bedrock aquifers to the shallow bedrock aquifer indicates that the shallow bedrock aquifer within Area A is not recharging the deeper aquifers directly beneath the area. This interpretation is consistent with published studies of the regional hydrogeology.

The third possible route of groundwater migration is from the facility to off-site areas, including those which are north of the unnamed tributary. The stream is likely to act as a groundwater divide for the overburden aquifer, however, this has not been documented for the shallow bedrock aquifer.

4.6.3 Contaminant Persistence

Several transformation processes are believed to affect the persistence of organic chemicals in the environment. The primary processes affecting contaminant fate in the environment include microbial and chemical degradation.

Generally, organic molecules are subject to several chemical reactions under environmental conditions. Such reaction mechanisms include acid/base reaction, addition, elimination, and hydrolysis. However, monocyclic aromatics are not particularly amenable to the majority of these degradation mechanisms. Hydrolysis is considered to be negligible for PAHs, halogenated hydrocarbon pesticides, and PCBs. Phthalates can be more susceptible (Versar, 1979; EPA, 1982; Lyman et al, 1990). Hydrolysis reactions can occur under acidic, basic, or neutral conditions.

Another possible type of degradation is the dechlorination of PCE and TCE to 1,2-DCE, 1,1-DCE, and ultimately vinyl chloride (Cline and Viste, 1984). A similar type of reaction has been reported for 1,1,1-TCEA in degradation to 1,2-DCA, 1,1-DCA, and chloroethane. In groundwater at Sites 1, 2, and 3, PCE, TCE, 1,2-DCE, 1,1-DCE, and vinyl chloride were detected. 1,1,1-TCEA, 1,1-DCA, and 1,2-DCA were also detected.

Bacterial degradation is a potential environmental fate mechanism. The compounds for which biodegradation is potentially considerable are toluene, 4-methylphenol, and, to some extent, naphthalene and phthalates (USEPA, Dec 1982; Verschueren, 1983). This degradation is primarily biological, and anaerobic conditions are typically required for these reactions to occur.

4.7 BASELINE RISK ASSESSMENT

This section provides a description of the risk assessment methods employed for NAWC Warminster at Area A, as well as a summary of the risk assessment results. The objectives of the risk assessment are to define the actual or potential risks to human health and the environment resulting from the presence of contamination in groundwater and to provide the basis for determining appropriate remedial measures for this medium in the FS.

Three major aspects of chemical contamination must be considered when assessing public health risks: contaminants with toxic characteristics must be found in environmental media and must be released by either natural processes or by human action; potential exposure points must exist; and human or environmental receptors must be present at the point of exposure. Risk is a function of both toxicity and exposure; without any one of the three factors listed above, there will be no risk.

The risk assessment estimates the potential for human health risk at the site. Information regarding the toxicity of the compounds detected in the various media, the distribution of contamination, and a site-specific estimate of chemical intake via assumed exposure routes will be combined to estimate potential risks. The processes used for this report are generally in accordance with current EPA risk assessment guidance (EPA, 1989a; EPA, 1991a).

The human health risk assessment consists of four components: Data Evaluation, Toxicity Assessment, Exposure Assessment, and Risk Characterization. Each component is briefly discussed below.

- The data evaluation (Section 4.7.1) is primarily concerned with the selection of chemicals of concern that are representative of the type and magnitude of potential human health and/or environmental effects. Contaminant concentrations relative to background levels, contaminant release and environmental transport mechanisms, exposure routes, and toxicity are considered in order to develop a list of contaminants used to define the site-associated risks.

- The toxicity assessment (Section 4.7.2) presents available human health and environmental criteria for all chemicals of concern. Quantitative toxicity indices are presented where they are available, including any applicable regulatory standards and criteria. Enforceable standards such as Maximum Contaminant Levels (MCLs), regulatory guidelines such as AWQCs and Health Advisories, and dose-response parameters, such as Reference Doses (RfDs) and Cancer Slope Factors (CSFs), are presented for each chemical of concern. Chemicals classified by EPA as Group A (human), B (probable human), or C (possible human) carcinogens were treated as carcinogens, and other chemicals were treated as noncarcinogens. A special discussion of lead is included because of the lack of quantitative dose-response parameters for this analyte.

- The exposure assessment (Section 4.7.3) identifies potential human health or environmental exposures either at the source area or off-site. Exposure routes are developed from information on the source area concentrations, contaminant release mechanisms, patterns of human activity, and other pertinent information.

- The risk characterization (Section 4.7.4) defines the risks associated with threshold (noncarcinogenic) and nonthreshold (carcinogenic) effects of the chemicals of concern through the use of estimated intakes and the RfDs/CSFs.

4.7.1 Data Evaluation

4.7.1.1 Representative Concentrations

The risk assessment for NAWC Warminster was performed using a representative concentration for each chemical in groundwater identified at Area A. Current conditions were evaluated. Usability of results is discussed below.

The validated data were used to calculate representative concentrations. For chemicals with at least one positive detection, non-detects were assumed to be one-half the detection limit (sample quantitation limit). Rejected values (R) were eliminated from further consideration. For values attributed to blank contamination (B), where there were also some positive detections, one-half the (B) value was used. Estimated and biased values (J, K, L) were used at the reported value. Duplicate samples were averaged together and considered as one result. For duplicates, where one result was positive and the other result was a non-detect, the problem of calculating an average result arose whenever half the detection limit exceeded the positive result. It was considered undesirable for the average to exceed the positive result; therefore, one-half the positive result was used to represent the non-detect in such cases.

Phase I data from the SMC report (SMC Martin, 1991), were combined with Phase II data. In cases where the same location had been sampled during both phases, the results were simply treated as individual samples indicating media contamination over time and were not treated as duplicates.

The calculation of the representative concentration is a two-step process. First, the standard deviation of the sample set must be determined, as follows:

$$S = \text{sqrt}\ [\text{sum}\ (Xi-Xm)^2/(n-1)]$$

where: S = Standard deviation
Xi = Individual sample value
Xm = Arithmetic mean for the n samples
n = Number of samples

The two-sided upper 95 percent confidence limit (UCL) was then calculated as follows:

$$UCL = Xm + tS/\text{sqrt}\ n$$

where: Xm = Arithmetic mean
t = Two-sided t distribution factor where $\alpha = 0.05$
S = Standard deviation
n = Number of samples

This procedure is a minor deviation from current EPA policy, which dictates that the one-sided 95 percent UCL on the mean should be used as the representative concentration. At the time this report was originally prepared (November 1992), EPA guidance regarding the use of the two-sided or one-sided limit was somewhat unclear, and the two sided limit was used rather than the one-sided limit. However, use of the two-sided 95 percent UCL is equivalent to the use of a one-sided 97.5 percent UCL. Therefore, use of the two-sided limit is more conservative than the current approach suggested by EPA and its use will tend to slightly overestimate risks rather than underestimate them.

For small sample sets or sample sets in which all positive results equal less than one-half the detection limit, the UCL can exceed the maximum detected concentration. In these cases, the maximum concentration was selected as the representative concentration. A sample calculation is provided in Appendix M. UCLs for all contaminants, from which the representative concentrations are derived, are presented in Appendix N.

The calculation of chemical-specific representative concentrations was generally performed assuming the available data were normally distributed. However, current EPA Region III guidance suggests that environmental monitoring data are typically log-normally distributed because of samples obtained from locations at known or suspected areas of contamination and from locations that are not contaminated (i.e., biased or non-random sampling). Therefore, use of the 95 percent UCL on the geometric mean is suggested unless this value exceeds the maximum observed concentration, in which case distributional assumptions should be investigated.

Several groundwater chemicals of concern (e.g., PCE and TCE) for Area A were checked for distribution using the Shapiro-Wilk W test and it was determined that neither the normal nor log-normal assumptions are valid at the $\alpha = 0.05$ level of significance. The 95 percent UCL on the geometric mean was noted to exceed the maximum observed concentration for these chemicals. Therefore, it was considered appropriate to use the 95 percent UCL on the arithmetic mean, which is similar in magnitude to the maximum observed value. The maximum observed value was used as the representative concentration for many of the remaining chemicals of concern.

The representative concentrations that were not set at the maximum observed value are all roughly similar to the latter value (i.e., of the same order of magnitude) and are considered reasonable representative concentrations because no drinking water wells exist within Area A and, if a well was installed in the center of the pattern of groundwater contamination, it would not be expected to continuously draw at the maximum concentrations given the potential for contaminant migration.

The issue of the representative concentrations is not considered significant from the standpoint of the suitability of the aquifer as a drinking water source. Many chemicals were detected in groundwater at concentrations above MCLs. Therefore, groundwater cannot be used for drinking water without treatment regardless of the representative concentrations.

4.7.1.2 Chemicals of Concern

Chemicals of concern are identified in this section, based on various aspects of their occurrence and distribution, mobility, persistence, and toxicity. These chemicals are selected to represent site contamination and will provide the framework for the quantitative risk assessment.

The occurrence and distribution of groundwater contaminants in Area A were discussed in Section 4.5. Metals, chlorinated ethenes, chlorinated ethanes, benzene, toluene, ethylbenzene, and xylenes, phthalates, and PAHs were considered notable in groundwater. The chemicals will be discussed in more detail in the following sections.

Appendix O summarizes the toxic effects for selected groundwater chemicals of concern. The summaries are presented in the form of toxicity profiles. Adverse effects on both human and environmental receptors are discussed. The chemical of concern selection process for groundwater is discussed in the remainder of this section.

Current Groundwater

The chemicals that were positively detected in monitoring wells from this study area were presented in Tables 4-11, 4-12, and 4-13. Table 4-16 presents the chemicals of concern for current groundwater in Area A. Because metals in groundwater can be naturally occurring, comparison to both upgradient groundwater (Tables 4-8 and 4-9) and drinking water criteria, guidelines, and dose-response parameters (see Section 4.7.2.2) was used to select the inorganic chemicals of concern. Any element that fell below drinking water criteria, guidelines, and/or dose-response parameters for a 15-kilogram child consuming one liter per day of water and upgradient concentrations was eliminated. Essential metals that are common minerals not usually noted for toxicity, such as calcium, magnesium, potassium, sodium, and iron, were eliminated. Any chemical that exceeded either the upgradient concentration or drinking water criteria, guidelines, or dose-response parameters was selected as a chemical of concern. Additionally, any positively detected chemical classified as a Group A, B1, B2, or C carcinogen was classified as a chemical of concern for groundwater.

According to EPA policy, risk assessment must be performed using unfiltered groundwater samples. However, because of the potential influence of sediments in turbid monitoring well water, representative concentrations of inorganics in filtered groundwater are also shown for comparison's sake.

All organic chemicals detected in monitoring well water from Area A were selected as chemicals of concern. Because two different types of analyses were performed for 1,2-dichloroethene (total and trans versus cis), these chemicals are shown separately. However, total 1,2-DCE will be assumed to be 100 percent cis [conservative, worst-case because cis has a lower MCL, MCL Goal (MCLG), and RfD than trans] for the purposes of quantitative risk assessment. Most chemical-specific parameters are available for the cis or trans isomer only.

TABLE 4-16
CHEMICALS OF CONCERN-MONITORING WELLS SITES 1, 2, 3
NAWC, WARMINSTER, PENNSYLVANIA
(ug/L)

ORGANICS			
Carcinogens	Rep. Conc.	Noncarcinogens	Rep. Conc.
Vinyl chloride	1.5	1,1-Dichloroethane	8.0
1,1-Dichloroethene	3.0	1,2-Dichloroethene	27.0
1,2-Dichloroethane	3.5	cis-1,2-Dichloroethene	138
Trichloroethene	469	1,1,1-Trichloroethane	10.0
Tetrachloroethene	128	Trichlorofluoromethane	29.8
Chloroform	13.8	Toluene	4.0
Carbon tetrachloride	16.8	Ethylbenzene	0.2
Benzene	2.0	Xylenes	2.0
1,2-Dichloropropane	1.0	1,2-Dichlorobenzene	0.7
Pyrene	0.6	2-Butanone	24.0
		Di-n-octylphthalate	3.0
		Diethylphthalate	0.375
		Phenanthrene	0.3
		Fluoranthene	0.6
UNFILTERED INORGANICS			
Carcinogens	Rep. Conc.	Noncarcingens	Rep. Conc.
Arsenic	10.6	Manganese	5410
Lead	85.5	Thallium	1.14
Chromium	49.4	Aluminum	25820
		Barium	873
		Cobalt	22.8
		Copper	236
		Mercury	0.22
		Nickel	43.6
		Silver	5.58
		Vanadium	24.5
		Zinc	400
FILTERED INORGANICS			
Carcinogens	Rep. Conc.	Noncarcinogens	Rep. Conc.
Lead	1.86	Barium	210
		Manganese	210
		Vanadium	3.39

4.7.2 Toxicity Assessment

The purpose of this section is to identify the potential health hazards associated with exposure to each of the groundwater chemicals of concern. A toxicological evaluation characterizes the inherent toxicity of a compound. The literature indicates that the chemicals of concern cause carcinogenic and/or noncarcinogenic health effects in humans. In addition, many of the chemicals have adverse effects on environmental receptors. Although the chemicals of concern may cause adverse health effects, dose-response relationships and the potential for exposure must be evaluated before the risks to receptors can be determined. Dose-response relationships correlate the magnitude of the intake with the probability of toxic effects, as discussed below. Toxicity information for the groundwater chemicals of concern at Area A is presented in Appendix O.

4.7.2.1 Health Effects

An important component of the risk assessment process is the relationship between the intake of a compound (the amount of a chemical that is absorbed by a receptor) and the potential for adverse health effects resulting from exposure to that dose. Dose-response relationships provide a means by which potential public health impacts may be quantified. The published information of doses and responses is used in conjunction with information on the nature and magnitude of human exposure to develop an estimate of potential health risks.

RfDs and CSFs have been developed by EPA for many organics and inorganics. This section provides a brief description of these parameters.

Reference Doses (RfDs)

The RfD is developed by EPA for chronic and/or subchronic human exposure to hazardous chemicals and is based solely on the noncarcinogenic effects of chemical substances. The RfD is usually expressed as a dose (mg) per unit body weight (kg) per unit time (day). It is generally derived by dividing a No-Observed-(Adverse)-Effect-Level (NOAEL or NOEL) or a Lowest-Observed-Adverse-Effect-Level (LOAEL) by an appropriate uncertainty factor. NOAELs, etc. are determined from laboratory or epidemiological toxicity studies. The uncertainty factor is based on the availability of toxicity data.

Uncertainty factors are generally applied as multiples of 10 to represent specific areas of uncertainty in the available data. A factor of 10 is used to account for variations in the general population (to protect sensitive subpopulations) when extrapolating test results from animals to humans (to account for interspecies variability), when a NOAEL derived from a subchronic study (instead of a chronic study) is used to develop the RfD, and when a LOAEL is used instead of a NOAEL. In addition, EPA reserves the use of a modifying factor of up to 10 for professional judgment of uncertainties in the data base not already accounted for. The default value of the modifying factor is 1.

The RfD incorporates the surety of the evidence for chronic human health effects. Even if applicable human data exist, the RfD (as diminished by the uncertainty factor) still maintains a margin of safety so that chronic human health effects are not underestimated. Thus, the RfD is an acceptable guideline for evaluation of noncarcinogenic risk, although the associated uncertainties preclude its use for precise risk quantitation. RfDs for site contaminants are provided in Table 4-17.

Noncarcinogenic risks for lead were not quantitated and compared to RfDs, because no EPA consensus currently exists with respect to a lead RfD. Instead, expected blood-lead increases were estimated, and a discussion of these results is presented in Section 4.7.4.6.

Cancer Slope Factors (CSFs)

CSFs are applicable for estimating the lifetime probability (assumed 70-year lifespan) of human receptors developing cancer as a result of exposure to known or potential carcinogens. This factor is generally reported in units of 1/(mg/kg/day) and is derived through an assumed low-dosage linear relationship of extrapolation from high to low dose-responses determined from animal studies. The value used in reporting the slope factor is the upper 95 percent confidence limit. CSFs for site contaminants are provided in Table 4-17.

Carcinogenic risks for lead will not be quantitated, because no EPA consensus currently exists with respect to an inorganic lead CSF. Instead, potential lead exposure will be calculated using a biokinetic model to estimate expected blood-lead increases, and a discussion of these results will be presented.

TABLE 4-17
DOSE-RESPONSE PARAMETERS AND ARARS - GROUNDWATER CHEMICALS AT SITES 1, 2, 3
NAWC, WARMINSTER PENNSYLVANIA

Chemical	RFD Oral (mg/kg/day) (1)(2)(3)	(RFD Inhalation (mg/kg/day) (1)(2)(3)	CSF Oral $(mg/kg/day)^{-1}$ (1)(2)(3)	CSF Inhalation $(mg/kg/day)^{-1}$ (1)(2)(3)	MCL (ug/L) (4)(5)(6)(7)(8) (9)(10)	MCLG (ug/L) (4) (10)	DWHA (mg\L) (4)	AWQC[11] FRESH CHRONIC AQUATIC LIFE (ug/L)	AWQC[12] INGESTION WATER & FISH	AWQC[12] FISH ONLY
Aluminum	*2.9	-	-	-	50(s)	-	-	87	-	-
Arsenic	*3E-4	-	*+1.75	*1.5E1	50(N)	0	-	48 (PENT)	0.018	0.14
Barium	7E-2	*1E-4	-	-	2000(F), 1000(N)	2000	Lifetime adult:2	-	-	-
Chromium III	1E0	-	-	-	100(TOT)	100(TOT)	1 day child:1 10 day child:1 Longer-term child:0.2 Longer-term adult:1 Lifetime adult:2.6(TOT)	210+	33000	670000
Cobalt	-	-	-	-	-	-	-	-	-	-
Copper	*3.7E-2	-	-	-	1300(A)	1300	-	12+	1300	-
Lead	-	-	-	-	50(N), 15(A)	0	-	3.2+	50	-
Manganese	E-3	1E-4	-	-	50(S)	-	-	-	-	-
Mercury	*3E-4	*9E-5	-	-	2	2	Longer-term adult:0.002 Lifetime adult:0.002	0.012	0.14	0.15
Nickel	2E-2	-	-	-	100(P)	100	1 day child:1 10 day child:1 Longer-term child:0.5 Longer-term adult:1.7 Lifetime adult:0.1	160+	510	3800
Thallium	7E-5	-	-	-	1-2(P)	0.5	1 day child:0.007 10 day child:0.007 Longer-term child:0.007 Longer-term adult:0.02 Lifetime adult:0.0004	40(LOEL)	2.0	7.2
Silver	5E-3	-	-	-	50(N)	-	1 day child:0.2 10 day child:0.2 Longer-term child:0.2 Longer-term adult:0.2 Lifetime adult:0.1	0.12	91	-
Vanadium	*7E-3	-	-	-	-	-	1 day child:0.08 10 day child:0.08 Longer-term child:0.03 Longer-term adult:0.11 Lifetime adult:0.02	-	-	-
Zinc	3E-1	-	-	-	5000(s)	-	Lifetime adult:0.1	110+	-	-

TABLE 4-17
DOSE-RESPONSE PARAMETERS AND ARARS - GROUNDWATER CHEMICALS AT SITES 1, 2, 3
NAWC, WARMINSTER PENNSYLVANIA
PAGE TWO

Chemical	RFD Oral (mg/kg/day) (1)(2)(3)	RFD Inhalation (mg/kg/day) (1)(2)(3)	RFD Oral (mg/kg/day)$^{-1}$ (1)(2)(3)	RFD Inhalation (mg/kg/day)-1 (1)(2)(3)	MCL (ug/L) (4)(5)(6)(7)(8) (9)(10)	MCLG (ug/L) (4)(10)	DWHA (4)	AWQC[11] FRESH CHRONIC AQUATIC LIFE (ug/L)	AWQC[12] INGESTION WATER & FISH	AWQC[12] FISH ONLY
Chromium VI	5E-3	-	-	A4.2E1	100(TOT)	100(TOT)	1 day child:1 (TOT) 10 day child:1 Longer-term child:2 Longer-term adult:0.8 Lifetime adult:0.1	11	170	3400
Benzo[k]fluoranthene	-	-	0.48	4.0E-1	0.2(P)	0	-	300(LOEL)(ma) (TOT PAHs)	0.0028	0.0311
Carbazole	-	-	*2E-2	-	-	-	-	300(LOEL)(ma) (TOT PAHs)	-	-
1,4-Dichlorobenzene	-	*2E-1	*2.4E-2	-	75	75	1 day child:10 10 day child:10 Longer-term child:10 Longer-term adult:40 Lifetime adult:0.075	763(LOEL) (TOT DCB)	400	2600
Aroclor - 1254	-	-	[m]7.7	-	0.5	0	-	0.014 (TOT PCBs)	4.4E-5	4.5E-5
2-Butanone	*5E-2	2.9E-1	-	-	-	-	1 day child:80 10 day child:8 Longer-term child:3 Longer-term adult:9 Lifetime adult:0.2	-	-	-
Chlorobenzene	2E-2	*5.71E-3	-	-	100	100	1 day child:2 10 day child:2 Longer-term child:2 Longer-term adult:7 Lifetime adult:0.1	-	488	-
1,1-Dichloroethene	9E-3	-	[c]6E-1	[c]1.75E-1	7	7	1 day child:2 10 day child:1 Longer-term child:1 Longer-term adult:4 Lifetime adult:0.007	11600 (LOEL) (fa) (DICHLOROETHENE S)	0.057	3.2
1,1-Dichloroethane	1E-1[2]	*1.43E-1	-	-	-	-	-	-	-	-
1,1,1-Trichloroethane	9E-2[2]	*3E-1	-	-	200	200	1 day child:100 10 day child:40 Longer-term child:40 Longer-term adult:100 Lifetime adult:0.2	31200 (LOEL) (ma)	3100	170000
Phenanthrene	-	-	-	-	-	-	-	-	0.0028	0.0311

TABLE 4-17
DOSE-RESPONSE PARAMETERS AND ARARS - GROUNDWATER CHEMICALS AT SITES 1, 2, 3
NAWC, WARMINSTER PENNSYLVANIA
PAGE THREE

Chemical	RFD Oral (mg/kg/day) (1)(2)(3)	RFD Inhalation (mg/kg/day) (1)(2)(3)	CSF Oral $(mg/kg/day)^{-1}$ (1)(2)(3)	CSF Inhalation (mg/kg/day)-1 (1)(2)(3)	MCL (ug/L) (4)(5)(6)(7)(8)(9)(10)	MCLG (ug/L) (4)(10)	DWHA (mg/L) (4)	AWQC[11] FRESH CHRONIC AQUATIC LIFE (ug/L)	AWQC[12] INGESTION WATER & FISH	AWQC[12] FISH ONLY
Fluoranthene	4E-2	-	-	-	-	-	-	3980	42	54
Pyrene	3E-2	-	NA	-	-	-	-	-	0.0028	0.0311
Benz[a]anthracene	-	-	-	-	0.1(P)	0	-	-	0.0028	0.0311
Chrysene	-	-	-	-	0.2(P)	0	-	-	0.0028	0.0311
Benzo[b]fluoranthene	-	-	8.96E-1	7.49E-1	0.2(P)	0	-	-	0.0028	0.0311
Indeno[1,2,3-c,d]pyrene	-	-	2.03	1.7	0.4(P)	0	-	300(ma) (LOEL) (TOT PAHs)	0.0028	0.0311
Benzo[g,h,i]perylene	-	-	1.55E-1	1.29E-1	-	-	-	300(ma) (LOEL) (TOT PAHs)	0.0028	0.0311
Di-n-octylphalate	*2E-2	-	-	-	-	-	-	3 (LOEL) (TOT PHTHAL)	-	-
Diethylphthalate	8E-1	-	-	-	-	-	Lifetime adult:5	3 (LOEL) (TOT PHTHAL)	23000	120000
Vinyl chloride	-	-	1.9E0	3	2	0	1 day child:3 10 day child:3 Longer-term child:0.01 Longer-term adult:0.05	-	2	525
cis-1,2-Dichloroethene	*1E-2	-	-	-	70	70	1 day child:4 10 day child:3 Longer-term child:3 Longer-term adult:11 Lifetime adult:0.07	11600 (fa) (LOEL) (DCE)	-	-
Chloroform	1E-2	-	[2]6.1E-3	[2]8.1E-2	100(THM)	-	1 day child:4 10 day child:4 Longer-term child:0.1 Longer-term adult:0.4	1240 (LOEL)	5.70	470
1,2-Dichloroethane	-	-	[2]9.1E-2	[2]9.1E-2	5	0	1 day child:0.7 10 day child:0.7 Longer-term child:0.7 Longer-term adult:2.6	20000 (LOEL)	0.38	99
Carbon tetrachloride	7E-4	-	[2]1.3E-1	[2]5.25E-2	5	0	1 day child:4 10 day child:0.2 Longer-term child:0.07 Longer-term adult:0.3	35200(fa) (LOEL)	0.25	45
Trichloroethene	6E-3	-	[2]1.1E-2	6E-3	5	0	-	21900 (LOEL)	2.7	81

TABLE 4-17
DOSE-RESPONSE PARAMETERS AND ARARS - GROUNDWATER CHEMICALS AT SITES 1, 2, 3
NAWC, WARMINSTER PENNSYLVANIA
PAGE FOUR

Chemical	RFD Oral (mg/kg/day) (1)(2)(3)	RFD Inhalation (mg/kg/day) (1)(2)(3)	CSF ORAL $(mg/kg/day)^{-1}$ (1)(2)(3)	CSF Inhalation $(mg/kg/day)^{-1}$ (1)(2)(3	MCL (ug/L) (4)(5)(6)(7)(8)(9)(10)	MCLG (4)(10)	DWHA (mg/L) (4)	AQWC[11] FRESH CHRONIC AQUATIC LIFE (ug/L)	AQWC[12] INGESTION WATER & FISH	AQWC[12] FISH ONLY
Benzene	-	-	[a]2.9E-2	[a]2.9E-2	5	0	1 day child:2 10 day child:0.2	5300(fa) (LOEL)	1.2	71
Tetrachloroethane	1E-2	-	[a]5.2E-2	2.0E-3	5	0	1 day child:2 10 day child:2 Longer-term child:1 Longer-term adult:5	640 (LOEL)	0.5	0.05
Trichlorofluoromethane	3E-1	7E-1	-	-	-	-	1 day child:7 10 day child:7 Longer-term child:3 Longer-term adult:10 Lifetime adult:2	-	-	-
Ethylbenzene	1E-1	3E-1	-	-	700	700	1 day child:30 10 day child:3 Longer-term child:1 Longer-term adult:3 Lifetime adult:0.7	32000(fa) (LOEL)	3100	29000
Xylenes	2E0	-	-	-	10000	10000	1 day child:40 10 day child:40 Longer-term child:40 Longer-term adult:100 Lifetime adult:10	-	-	-
1,2-Dichlorobenzene	9E-2	5.71E-2	-	-	600	600	-	763 (LOEL) (DICHLOROBENZENES)	2700	17000
1,2-Dichloropropane	-	1.1E-3	6.8E-2	-	5	0	10 day child:0.09	5700 (LOEL)	-	-
Toluene	2E-1	1E-1	-	-	1000	1000	1 day child:20 10 day child:2 Longer-term child:2 Longer-term adult:7 Lifetime adult:1	17500 (fa) (LOEL)	10000	300000
Naphthalene	*4E-2	-	-	-	-	-	1 day child:0.5 10 day child:0.5 Longer-term child:0.4 Longer-term adult:1 Lifetime adult:0.02	620 (LOEL)	-	-
2-Methylnaphthalene	**8.2E-3	-	-	-	-	-	-	300(ma) (LOEL) (TOT PAHs)	-	-
Acenaphthylene	***4E-2	-	-	-	-	-	-	300(ma) (LOEL) (TOT PAHs)	0.0028	0.0311

TABLE 4-17
DOSE-RESPONSE PARAMETERS AND ARARS - GROUNDWATER CHEMICALS AT SITES 1, 2, 3
NAWC, WARMINSTER PENNSYLVANIA
PAGE FIVE

Chemical	RFD Oral (mg/kg/day) (1)(2)(3)	RFD INHALATION (mg/kg/day) (1)(2)(3)	CSF ORAL $(mg/kg/day)^{-1}$ (1)(2)(3)	CSF INHALATION $(mg/kg/day)^{-1}$ (1)(2)(3)	MCL (ug/L) (4)(5)(6)(7)(8)(9)(10)	MCLG (4)(10)	DWHA (mg/L) (4)	AWQC[11] FRESH CHRONIC AQUATIC LIFE (ug/L)	AWQC[12] INGESTION WATER & FISH	AWQC[12] FISH ONLY
Acenaphthene	6E-2	-	-	-	-	-	-	520	1200	2700
Dibenzofuran	***4E-2	-	-	-	-	-	-	300(ma) (LOEL) (TOT PAHs)	-	-
Fluorene	4E-2	-	-	-	-	-	-	300(ma) (LOEL) (TOT PAHs)	0.0028	0.0311
Anthracene	3E-1	-	-	-	-	-	-	300(ma) (LOEL) (TOT PAHs)	0.0028	0.0311

TABLE 4-17
DOSE-RESPONSE PARAMETERS AND ARARS - GROUNDWATER CHEMICALS AT SITES 1, 2, 3
NAWC, WARMINSTER PENNSYLVANIA
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*	From HEAST instead of IRIS
**	Provisional ADI as per Layton, using rat LD50 of 1630 mg/kg (Sax, 1989) and Layton's most conservative multiplier of 5E-6.
***	Estimate based on RFDs of similar PAHs

Under CSF:

A=	Group A human carcinogen
B=	Group B1 probable human carcinogen
B2=	Group B2 probable human carcinogen
C=	Group C possible human carcinogen

Under MCL:

S=	Secondary
F=	Final; effective 1/1/93
N=	National Primary Drinking Water Regulation
A=	Action Level
P=	Proposed
THM=	Trihalomethane

Under AWQC:

+=	Based on hardness of 100 mg/L
LOEL=	Lowest observed effects level
ma=	marine acute
PAHs=	Polycyclic aromatic hydrocarbons
PCB=	Polychlorinated biphenyls
DCB=	dichlorobenzenes
PHTHAL=	phthalates
fa=	freshwater acute
DCE=	dichloroethenes
TOT=	Total
PENT=	Pentavalent

RFD=	Reference dose
CSF=	Cancer slope factor
MCL=	Maximum Contaminant Level
MCLG=	MCL Goal
DWHA=	Drinking Water Health Advisory
AWQC=	Ambient Water Quality Criteria

(1)	EPA, 1992a - IRIS, August 2, 1992
(2)	EPA, 1992b - HEAST, FY 1992
(3)	EPA, 1992c - HEASt, July 1992 update
(4)	EPA, 1992d - SOWA Summary November 1992
(5)	EPA, 1991b
(6)	EPA, 1991c
(7)	EPA, 1990a
(8)	EPA, 1991d
(9)	EPA, 1991e
(10)	EPA, 1992e
(11)	EPA, 1987a
(12)	EPA, 1990b
(2a)	RfD based on 1.3 mg/L Drinking Water Standard

EPA Weight-of-Evidence

The weight-of-evidence designations indicate the preponderance of evidence regarding carcinogenic effects in humans and animals. The categories are defined in Table 4-18.

Lead

No RfDs or CSFs for oral or inhalation exposures to lead are currently available. An evaluation of effects of lead in groundwater at NAWC Warminster was performed with an EPA biouptake model. The obtained estimates of increases in blood-lead levels are used to evaluate the potential for adverse developmental and systemic effects. Such effects include, but are not limited to, toxicity to central nervous system and renal function, birth defects associated with pregnant women, the level of intelligence exhibited by small children, reproductive and immune system impairment, and developmental toxicity.

4.7.2.2 Applicable or Relevant and Appropriate Requirements (ARARs)

This section presents available regulatory standards or guidelines for the chemicals of concern selected in the preceding section. Currently, the only enforceable regulatory standards for exposure to groundwater contaminants are the MCLs. However, MCLs have not been specified for many of the chemicals of concern. Therefore, other regulatory guidelines may be used for comparative purposes to determine health risks and environmental impacts. Relevant regulatory guidelines include AWQCs, MCLGs, and EPA Drinking Water Health Advisories (DWHAs). ARARs and dose-response parameters are presented in Table 4-17. The environmental criteria are discussed briefly below.

Maximum Contaminant Levels (MCLs)

MCLs are enforceable standards promulgated under the Safe Drinking Water Act and are designed for the protection of human health. MCLs are based on laboratory or epidemiologic studies and apply to drinking water supplies consumed by a minimum of 25 persons. They are designed for prevention of human health effects associated with lifetime exposure (70 years) of an average adult (weighing 70 kilograms) consuming two liters of water per day, but they also reflect technical limits on removing the contaminant from water. These enforceable standards are also based upon the fraction of toxicant expected to be absorbed by the gastrointestinal tract.

TABLE 4-18
EPA WEIGHT-OF-EVIDENCE CARCINOGENIC CLASSIFICATIONS
NAWC, WARMINSTER, PENNSYLVANIA

EPA Category	Description of Group	Description of Evidence
Group A	Human carcinogen	Sufficient evidence from epidemiologic studies to support a causal association between exposure and cancer.
Group B1	Probable human carcinogen	Limited evidence of carcinogenicity in humans from epidemiologic studies.
Group B2	Probable human carcinogen	Sufficient evidence of carcinogenicity in animals; inadequate evidence of carcinogenicity in humans.
Group C	Possible human carcinogen	Limited evidence of carcinogenicity in animals.
Group D	Not classified	Inadequate evidence of carcinogenicity in animals.
Group E	No evidence of carcinogenicity in humans.	No evidence for carcinogenicity in at least two adequate animal test or in both epidemiologic and animal studies.

Source: EPA, 1992b

Maximum Contaminant Level Goals (MCLGs)

MCLGs are generally specified as zero for carcinogenic substances (although exceptions, such as beryllium, do exist) and do not consider the technical or economic feasibility of achieving these goals. MCLGs are nonenforceable guidelines based entirely on health effects. MCLs have been set as close to the MCLGs as is considered technologically and economically feasible.

Ambient Water Quality Criteria (AWQCs)

AWQCs were developed under the Clean Water Act and are not enforceable federal regulatory guidelines but are of primary utility in assessing the potential for toxic effects in aquatic organisms as well as human receptors. AWQCs consider acute and chronic human health effects from ingestion of both water (two liters per day) and aquatic organisms (6.5 grams per day). The AWQCs may also be adjusted to consider ingestion of water alone (two liters per day). The AWQCs for protection of human health for carcinogenic substances are based on EPA's specified incremental cancer risk range of one additional case of cancer in an exposed population of 100,000 to 10,000,000 persons and are generally based on older toxicological data.

Drinking Water Health Advisories (DWHAs)

DWHAs are guidelines developed by the EPA Office of Drinking Water for non-regulated contaminants in drinking water. These guidelines are designed to consider both acute and chronic toxic effects in children (with an assumed body weight of 10 kilograms who consume one liter of water per day and in adults (assumed body weight of 70 kilograms) who consume two liters of water per day. Health Advisories are generally available for acute (one-day), subchronic (10-day), and chronic (longer-term or lifetime) exposure scenarios. These guidelines are designed to consider only threshold effects and, as such, are not used to set acceptable levels for known or probable human carcinogens.

Values of the available regulatory standards and guidelines are presented in Table 4-17. This table presents values for the chemicals of concern that are human, probable human, or possible human carcinogens; for chemicals having only noncarcinogenic effects; and for chemicals having both carcinogenic and noncarcinogenic effects.

4.7.2.3 Summary

Table 4-17 presents the values of the available federal ARARs and dose-response parameters for both carcinogenic and noncarcinogenic groundwater chemicals of concern. If the concentration or intake of a chemical exceeds these standards or guidelines, the possibility exists that a receptor may experience adverse health effects. Expected intakes of each chemical are presented in the Exposure Assessment (Section 4.7.3).

4.7.3 Exposure Assessment

The purpose of this section is to evaluate the potential for human exposure to the hazardous chemicals in groundwater at Area A. This section characterizes the exposed populations, identifies actual or potential exposure routes, and provides exposure estimates. The nature and extent of contamination upon which the exposures are based were presented in Section 4.6.

To determine whether there is an actual or potential exposure in this area, the most likely pathways of contaminant release and transport, as well as the human and environmental activity patterns, must be considered. A complete exposure pathway has three components: a source, a route of transport, and an exposure point for receptors. These components are addressed in the following subsections.

4.7.3.1 Exposure Routes

There are several environmental media in this study area through which receptors can be either directly or indirectly exposed to site-related contaminants, including soil and groundwater and surface water and sediment downstream of this study area. Exposure routes involved include dermal contact, incidental ingestion, and inhalation. Only shallow groundwater exposures are discussed in this report.

Groundwater

In order to evaluate groundwater quality, potential groundwater exposure scenarios using current groundwater conditions were evaluated. The receptors include adult employees and adult and child residents. It was assumed that the theoretical exposure to employees would be via ingestion and dermal (hand washing) routes; exposure to adult residents would occur via ingestion, dermal (showering), and inhalation (showering) routes; and exposure to child residents would occur via ingestion and dermal (bathing) routes. These exposure scenarios, along with their input parameters, are shown in Tables 4-19, 4-20, and 4-21.

TABLE 4-19
EXPOSURE INPUT PARAMETERS - GROUNDWATER INGESTION - SITES 1, 2, 3
NAWC, WARMINSTER, PENNSYLVANIA

Ingestion of Groundwater			
Input Parameters	Description	Value	Rationale
C	Exposure concentration	Rep. conc.; [1] (mg/L) (wells in plume)	Upper 95% confidence limit on arithmetic average (EPA, 1989a)
IR	Ingestion rate	2L/day (adult resident) 1L/day (adult employee) 1L/day (child resident)	(EPA, 1991a)
EF	Exposure frequency	250 days/yr. (employees) 350 days/yr. (residents)	(EPA, 1991a)
ED	Exposure duration	25 yrs. (adult employees) 30 yrs. (adult residents) 6 yrs. (child resident)	90th percentile time at one residence (EPA, 1989a; EPA, 1991a)
BW	Body weight	70 kg (adult) 15 kg (child)	(EPA, 1989a; EPA, 1991a)
AT	Averaging time	ED x 365 day/yr. 70 yrs. x 365 days/yr.	Noncarcinogens Carcinogens (EPA, 1989a)

(1) Upper 95% confidence limit (UCL) on arithmetic average, or maximum if UCL exceeds maximum detected.

TABLE 4-20
EXPOSURE INPUT PARAMETERS - GROUNDWATER DERMAL CONTACT - SITES 1, 2, 3
NAWC, WARMINSTER, PENNSYLVANIA

Dermal Contact with Groundwater			
Input Parameters	Description	Value	Rationale
C	Exposure concentration	Rep. conc.; [1] (mg/L) (wells in plume) or maximum	Upper 95% confidence limit on arithmetic average (EPA, 1989a)
SA	Skin surface area available for contact[2]	2,270 cm^2 (adult employee) 5,910 cm^2 (child resident) 19,400 cm^2 (adult resident)	Hands and forearms Body Body (EPA, 1989b)
ET	Exposure time[2]	0.2 hr/day (residents) 0.03 hr/day (employees, handwashing)	12 minutes/day (EPA, 1991a) 2 minutes/day (Professional judgement)
EF	Exposure frequency	250 days/yr. (employees) 350 days/yr. (residents)	(EPA, 1991a)
ED	Exposure duration	25 yrs. (adult employees) 30 yrs. (adult residents) 6 yrs. (child resident)	(EPA, 1991a)
BW	Body weight	Adult: 70 kg Child: 15 kg	(EPA, 1989a; EPA, 1991a)
AT	Averaging time	ED x 365 days/yr. 70 yrs. x 365 days/hr.	Noncarcinogens Carcinogens (EPA, 1989a)
K,Kp	Permeability coefficients (cm/hr.)	Contaminant-specific	(EPA, 1992f)
TAU	Lagtime (hr.)	Contaminant-specific	(EPA, 1992f)
B	Partition coefficient	Contaminant-specific	(EPA, 1992f)

(1) Upper 95% confidence limit (UCL) on arithmetic average, or maximum if UCL exceeds maximum detected.

(2) Adult residents assumed to shower daily; child residents assumed to bathe daily; employees assumed to wash hands daily.

TABLE 4-21
EXPOSURE INPUT PARAMETERS - GROUNDWATER INHALATION - SITES 1, 2, 3
NAWC, WARMINSTER, PENNSYLVANIA

Inhalation of Volatile Emissions During Showering (Adult Residents only)			
Input Parameters	Description	Value	Rationale
C	Exposure concentration	Rep. conc.; [1] (mg/L)	Used to calculate volatile chemical generation rate (ug/m^3/min)
H	Henry's law constant	Contaminant-specific	Required for model application
$K_G K_l$	Gas and liquid phase mass transfer coefficients	Contaminant-specific	Required for model application
D_s	Shower duration	12 minutes	(EPA, 1991a)
D_t	Total time in bathroom	20 minutes	Professional judgement
R_a	Air exchange rate	0.0083 min^{-1}	Foster and Chrostowski, 1987
IR	Inhalation rate	10.4 L/min[2]	(EPA, 1989a)
EF	Exposure frequency	0.96 day^{-1}	One shower per day, 350 days/yr. (EPA, 1991a)
ED	Exposure duration	30 yrs.	90th percentile time at one residence (EPA, 1989a)
BW	Body weight	70 kg	Convention (EPA, 1989a)
AT	Averaging time	ED x 365 days/yr. 70 yrs. x 365 days/yr.	Noncarcinogens Carcinogens (EPA, 1989a)

(1) Upper 95% confidence limit (UCL) on arithmetic average, or maximum if UCL exceeds maximum detected.

(2) Specific EPA Regional guidance recommends an inhalation rate of 14.4 L/min; the value used in this report for this exposure scenario would tend to slightly underestimate groundwater inhalation risk.

4.7.3.2 Exposure Estimates

The estimation methods and models used in this section are consistent with current EPA risk assessment guidance (EPA, 1989a; EPA, 1991a). Exposure estimates associated with the groundwater exposure route are presented below. All exposure scenarios incorporate the representative concentrations in the estimation of intakes.

Noncarcinogenic risks are estimated using the concept of an average annual exposure. The intake incorporates terms describing the exposure time and/or frequency that represent the number of hours per day and the number of days per year that exposure occurs. This is used with a term known as the averaging time, which converts the daily exposure frequency and duration to an annual exposure by dividing by 365 days per year of exposure.

Noncarcinogenic risks are generally greater for children than for adults because of the much lower body weights of children and their similar or higher ingestion rates. Carcinogenic risks, on the other hand, are calculated as an incremental lifetime risk and, therefore, incorporate terms to represent the exposure duration (years) over the course of a lifetime (70 years).

Groundwater Exposure

Current groundwater was evaluated for the same exposure scenarios and the same receptors (theoretical adult and child residents and adult employees), using representative concentrations for each study area.

Ingestion of groundwater was evaluated for all receptors. The equation used was the same as that presented above for ingestion of surface water. A sample calculation is provided in Appendix M. Input parameters for groundwater ingestion, along with the rationale for the selection of each value, are presented in Table 4-19. Conventional input parameters were used.

Dermal exposure to groundwater contaminants was evaluated for all receptors. The equation used was the same as that presented above for dermal exposure to surface water. A sample calculation is provided in Appendix M. Input parameters for groundwater dermal exposure, along with the rationale for the selection of each value, are presented in Table 4-20. Adult and child residents were assumed to take daily showers and baths, respectively, and therefore their total body surface areas were used. Employees were assumed to wash their hands for approximately two minutes per day at the workplace, and the surface area of their hands and forearms was used.

Inhalation exposure to groundwater (during showering) was calculated for adult residents only using the following equations (EPA, 1989a; Foster and Chrostowski, 1987):

$$IEX = (S \times IR \times K \times EF \times ED)/(BW \times AT \times Ra \times CF)$$

$$K = Ds + \exp(-Ra \times Dt)/Ra - \exp[Ra(Ds - Dt)]/Ra$$

where:

IEX	=	Inhalation exposure dose (mg/kg/day)
S	=	Volatile chemical generation rate (ug/m^3/min)
IR	=	Inhalation rate (L/min)
K	=	Constant value (min)
EF	=	Exposure frequency (day/yr)
ED	=	Exposure duration (yr)
BW	=	Body weight (kg)
AT	=	Averaging time (days)
Ra	=	Air exchange rate (1/min)
CF	=	Conversion factor (10^6 L • ug/m^3 • mg)
Ds	=	Duration of shower (min)
Dt	=	Total time in shower room (min)

The volatile chemical generation rate was estimated using the Foster and Chrostowski mass transfer model, which is based on two-phase film theory. The model employs contaminant-specific mass transfer coefficients, Henry's Law constants, droplet drop time, viscosity, temperature, etc. Specific details regarding the application of the mass transfer model are included in Appendix M.

A sample calculation is provided in Appendix M. The input parameters for this exposure route, along with the rationale for the selection of each value, are presented in Table 4-21. It was assumed that small children would take baths rather than showers and that employees would not shower at work. Conventional input parameters were used.

Blood-Lead Modeling

No EPA consensus has been reached concerning an RfD or CSF for lead. However, some research has been done concerning typical lead intakes and blood-lead levels. A determination of lead uptake from drinking water was considered. Potential blood-lead level increases were estimated and are discussed, along with the potential implications of blood-lead results, in Section 4.7.4.6.

For drinking water exposure, children zero to six months old are expected to experience blood lead increases at the rate of 0.26 ug/dL per ug/l lead in water up to 15 ug/l and at the rate of 0.04 ug/dL for every ug/l lead in water above 15 ug/l (EPA, 1991e). For older children, the ratio is 0.12 ug/dL blood lead per ug/l lead in water up to 15 ug/l, and 0.06 ug/dL for every ug/l lead in water above 15 ug/l (EPA, 1991e). For adults, the ratio is approximately 0.06 ug/dL blood lead per ug/L in water (EPA, 1991e).

4.7.4 Risk Characterization

Potential human health risks resulting from groundwater exposure are characterized on a quantitative and qualitative basis in this section. Quantitative risk estimates are generated based on risk assessment methods outlined in current EPA guidance (EPA, 1989a); whereas the qualitative assessment consists of the toxicological profiles.

Noncarcinogenic risk estimates are presented in the form of Hazard Quotients and Hazard Indices that are determined through comparison of estimated intakes with published RfDs. Incremental cancer risk estimates are provided in the form of dimensionless probabilities based on CSFs.

Estimated human intakes were developed for the groundwater exposure route discussed in the preceding sections. Both carcinogenic and noncarcinogenic risks are summarized for the groundwater exposure route on a series of tables in this section. Detailed calculations and spreadsheets are provided in Appendix N.

Noncarcinogenic risk is assessed using the concept of Hazard Quotients (HQs) and Hazard Indices (HIs). The Hazard Quotient is the ratio of the estimated intake and the RfD for a selected chemical of concern, as follows:

Hazard Quotient = Intake/RfD

A Hazard Index is generated by summing the individual Hazard Quotients for the chemicals of concern. If the value of the Hazard Index exceeds unity (1.0), the potential for noncarcinogenic health risks associated with exposure to that particular chemical mixture cannot be ruled out (EPA, 1986f). In that case, particular attention should be paid to the target organs affected by each chemical. The Hazard Index is not a mathematical prediction of the severity of toxic effects; it is simply a numerical indicator of the possibility of the occurrence of noncarcinogenic (threshold) effects. If the ratio of the intake and the RfD for any individual chemical exceeds unity, there is the possibility that toxic effects could occur.

Incremental cancer risk estimates are generated for each of the exposure pathways using the estimated intakes and published CSFs, as follows:

$$\text{Risk} = \text{Intake} \times \text{CSF}$$

If the above equation results in a risk greater than 0.01, the following equation is used:

$$\text{Risk} = 1 - [\exp(\text{Intake} \times \text{CSF})]$$

The risk determined using these equations is a unitless expression of an individual's increased likelihood of developing cancer as a result of exposure to carcinogenic chemicals. An incremental cancer risk of 1E-6 indicates that the exposed receptor has a one in a million chance of developing cancer under the defined exposure scenario. Alternatively, such a risk may be interpreted as representing one additional case of cancer in an exposed population of one million persons. The calculated cancer risks should be recognized as upper-limit estimates. CSFs are the upper 95 percent confidence limit of a dose-response curve generally derived from animal studies. Actual human risk, while not identifiable, is not expected to exceed the upper limit based on the CSFs and may, in fact, be lower.

EPA has generally defined risks in the range of 1E-4 to 1E-6 as being acceptable for most hazardous waste facilities addressed under CERCLA. For CERCLA activities, residual risks on the order of 1E-6 are the primary goal but are often modified by such regulatory requirements as MCLs or chemical-specific cleanup goals.

Because there is as yet no EPA consensus concerning an RfD or CSF for inorganic lead, the evaluation of this analyte was handled separately. Section 4.7.3.2 discusses blood-lead estimation methods. Blood-lead estimation results are assessed in Section 4.7.4.3.

The following section includes summaries of risks estimated by the groundwater exposure model. Complete descriptions and calculation results (including spreadsheets) are presented for this model in Appendix N.

It should be noted that, where HQs are reported as "N/A", the HQs were not calculable because no RfD has been established. Usually, in such cases, carcinogenicity is considered to be more important, since carcinogenicity will generally be seen at lower doses than noncarcinogenic effects. Cancer risks of zero generally indicate that the chemical is not carcinogenic or that a CSF has not yet been developed.

4.7.4.1 Potential Groundwater Exposure

Tables 4-22 through 4-26 present estimated noncarcinogenic risks to hypothetical adult employee and adult and child resident receptors for current groundwater conditions. For hypothetical adult employees, only the ingestion HI exceeded 1.0. The chemicals largely responsible for this were arsenic, PCE, carbon tetrachloride, cis-1,2-DCE, thallium, and barium. However, no single HQ exceeded 1.0. If filtered groundwater were used instead of unfiltered groundwater, the HI would be 0.7, with manganese still contributing a large part of the risk (see Table 4-25).

Total HIs for hypothetical adult residents via the ingestion and dermal routes exceeded 1.0. Separation of these noncarcinogenic risks via target organs would not be useful, since HQs of some individual chemicals exceeded 1.0 (manganese and TCE via ingestion, PCE and TCE via dermal). Other significant contributors to oral risk were PCE, carbon tetrachloride, cis-1,2-DCE, arsenic, chromium, thallium, aluminum, barium, and copper. If filtered groundwater were used instead of unfiltered groundwater, the total ingestion HI would still exceed 1.0 (see Table 4-25), with manganese contributing the significant portion of the risk. The HI for organics alone for the ingestion route exceeds 1.0. The chemicals mainly responsible, PCE, carbon tetrachloride, TCE, and cis-1,2-DCE, are expected to affect many of the same organ systems (skin, liver, central nervous system) (Sax, 1989). Therefore, potential effects could no longer be ruled out for the hypothetical adult resident receptor under the described conditions. Without PCE, the estimated noncarcinogenic dermal risk would be approximately 2E-2.

TABLE 4-22
CURRENT GROUNDWATER NONCARCINOGENIC RISKS TO ADULT EMPLOYEES - SITES 1, 2, 3
(POTENTIAL CURRENT EXPOSURE)
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep Conc. (mg/L)	HQ ING	HQ DERM
Vinyl chloride	0.0015	N/A	N/A
1,1-Dichloroethene	0.003	3.3E-3	3.3E-5
1,2-Dichloroethane	0.0035	N/A	N/A
Trichloroethene	0.469	7.6E-1	1.4E-1
Tetrachloroethene	0.128	1.3E-1	4.8E-2
Chloroform	0.0138	1.4E-2	1.3E-3
Carbon tetrachloride	0.168	2.3E-1	4.9E-3
Benzene	0.002	N/A	N/A
1,2-Dichloropropane	0.001	N/A	N/A
Pyrene	0.0006	2.0E-4	1.4E-4
1,1-Dichloroethane	0.008	7.8E-4	4.5E-6
1,2-Dichloroethene	0.027	2.6E-2	9.2E-5
cis-1,2-Dichloroethene	0.138	1.4E-1	4.7E-4
1,1,1-Trichloroethane	0.01	1.1E-3	1.5E-5
Trichlorofluoromethane	0.0298	9.7E-4	1.4E-5
Toluene	0.004	2.0E-4	1.2E-4
Ethylbenzene	0.0002	2.0E-5	1.3E-5
Xylenes	0.002	9.8E-6	5.3E-7
1,2-Dichlorobenzene	0.0007	7.6E-5	4.2E-6
2-Butanone	0.024	4.7E-3	1.2E-5
Di-n-ocylphthalate	0.003	1.5E-3	2.4E-4
Diethylphthalate	0.000375	4.6E-6	3.4E-8
Phenanthrene	0.0003	1.0E-4	2.6E-5
Fluoranthene	0.0006	1.5E-4	7.0E-5
Arsenic	0.0106	3.5E-1	2.4E-5
Lead	0.0855	N/A	N/A
Chromium	0.0494	9.7E-2	1.3E-5
Manganese	5.41	1.1E1	7.2E-4
Thallium	0.00114	1.6E-1	1.1E-5
Aluminum	25.82	8.7E-2	5.9E-6
Barium	0.873	1.2E-1	8.3E-6
Cobalt	0.0228	N/A	N/A
Copper	0.236	6.2E-2	4.2E-6
Mercury	0.00022	7.2E-3	4.9E-7
Nickel	0.0436	2.1E-2	1.4E-7
Silver	0.00558	1.1E-2	4.5E-7
Vanadium	0.0245	3.4E-2	2.3E-6
Zinc	0.4	2.0E-2	8.0E-7
HAZARD INDEX		1.3E1	2.0E-1

TABLE 4-23
CURRENT GROUNDWATER NONCARCINOGENIC INGESTION RISKS TO ADULT EMPLOYEES - SITES 1, 2, 3 - MODIFIED WITH FILTERED INORGANICS (POTENTIAL CURRENT EXPOSURE)
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep. Conc. (mg/L)	HQ Ingestion
Organics (See Table 4-22)	-	1.3E0
Manganese	1.31	1.3E-1
Barium	0.21	2.9E-2
Vanadium	0.00339	4.7E-3
TOTAL HAZARD INDEX		1.5E0

TABLE 4-24
CURRENT GROUNDWATER NONCARCINOGENIC RISKS TO ADULT RESIDENTS - SITES 1, 2, 3
(POTENTIAL CURRENT EXPOSURE)
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep Conc. (mg/L)	HQ ING	HQ DERM	HQ-Inhalation
Vinyl chloride	0.0015	N/A	N/A	N/A
1,1-Dichloroethene	0.003	9.1E-3	1.0E-3	N/A
1,2-Dichloroethane	0.0035	N/A	N/A	N/A
Trichloroethene	0.469	2.1E0	4.4E0	N/A
Tetrachloroethene	0.128	3.5E-1	1.5E0	N/A
Chloroform	0.0138	3.8E-2	4.0E-2	N/A
Carbon tetrachloride	0.168	6.6E-1	1.5E-1	N/A
Benzene	0.002	N/A	N/A	N/A
1,2-Dichloropropane	0.001	N/A	N/A	2.8E-2
Pyrene	0.0006	5.5E-4	4.3E-3	N/A
1,1-Dichloroethane	0.008	2.2E-3	1.4E-4	1.9E-3
1,2-Dichloroethene	0.027	7.4E-2	2.8E-3	N/A
cis-1,2-Dichloroethene	0.138	3.8E-1	1.4E-2	N/A
1,1,1-Trichloroethane	0.01	3.0E-3	4.7E-4	1.0E-3
Trichlorofluoromethane	0.0298	2.7E-3	4.3E-4	4.6E-3
Toluene	0.004	5.5E-4	3.7E-3	1.4E-3
Ethylbenzene	0.0002	5.5E-5	4.1E-4	2.2E-5
Xylenes	0.002	2.7E-5	1.6E-5	N/A
1,2-Dichlorobenzene	0.0007	2.1E-4	1.3E-4	3.3E-4
2-Butanone	0.024	1.3E-2	3.9E-4	3.3E-4
Di-n-ocylphthalate	0.003	4.1E-3	7.4E-3	N/A
Diethylphthalate	0.000375	1.3E-5	1.0E-6	N/A
Phenanthrene	0.0003	2.8E-4	8.2E-4	N/A
Fluoranthene	0.0006	4.1E-4	2.2E-3	N/A
Arsenic	0.0106	9.7E-1	1.9E-3	N/A
Lead	0.0855	N/A	N/A	0
Chromium	0.0494	2.7E-1	1.0E-3	0
Manganese	5.41	3.0E1	1.5E-4	0
Thallium	0.00114	4.5E-1	8.7E-4	0
Aluminum	25.82	2.4E-1	4.7E-4	0
Barium	0.873	3.4E-1	6.6E-4	0
Cobalt	0.0228	N/A	N/A	0
Copper	0.236	1.7E-1	3.4E-4	0
Mercury	0.00022	2.0E-2	3.9E-5	0
Nickel	0.0436	6.0E-2	1.2E-5	0
Silver	0.00558	3.1E-2	3.6E-5	0
Vanadium	0.0245	9.6E-2	1.9E-4	0
Zinc	0.4	5.5E-2	6.4E-5	0
HAZARD INDEX		3.6E1	6.1E0	3.7E-2

TABLE 4-25
CURRENT GROUNDWATER NONCARCINOGENIC INGESTION RISKS TO ADULT RESIDENTS - SITES 1, 2, 3 - MODIFIED WITH FILTERED INORGANICS (POTENTIAL CURRENT EXPOSURE)
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep. Conc. (mg/L)	HQ Ingestion
Organics (See Table 4-24)	-	1.5E0
Manganese	1.31	1.8E-2
Barium	0.21	8.2E-2
Vanadium	0.0339	1.3E-2
TOTAL HAZARD INDEX		1.7E0

TABLE 4-26
CURRENT GROUNDWATER NONCARCINOGENIC RISKS TO CHILD RESIDENTS - SITES 1, 2, 3
(POTENTIAL CURRENT EXPOSURE)
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep Conc. (mg/L)	HQ ING	HQ DERM
Vinyl chloride	0.0015	N/A	N/A
1,1-Dichloroethene	0.003	2.1E-2	1.4E-3
1,2-Dichloroethane	0.0035	N/A	N/A
Trichloroethene	0.469	5.0E0	6.2E0
Tetrachloroethene	0.128	8.2E-1	2.1E0
Chloroform	0.0138	8.8E-2	5.7E-2
Carbon tetrachloride	0.168	1.5E0	2.2E-1
Benzene	0.002	N/A	N/A
1,2-Dichloropropane	0.001	N/A	N/A
Pyrene	0.0006	1.3E-3	6.0E-3
1,1-Dichloroethane	0.008	5.1E-3	2.0E-4
1,2-Dichloroethene	0.027	1.7E-1	4.0E-3
cis-1,2-Dichloroethene	0.138	8.8E-1	2.1E-2
1,1,1-Trichloroethane	0.01	7.1E-3	6.7E-4
Trichlorofluoromethane	0.0298	6.4E-3	6.1E-4
Toluene	0.004	1.3E-3	5.3E-3
Ethylbenzene	0.0002	1.3E-4	5.8E-4
Xylenes	0.002	6.4E-5	2.3E-5
1,2-Dichlorobenzene	0.0007	5.0E-4	1.8E-4
2-Butanone	0.024	3.1E-2	5.5E-4
Di-n-ocylphthalate	0.003	9.6E-3	1.1E-2
Diethylphthalate	0.000375	3.0E-5	1.5E-6
Phenanthrene	0.0003	6.6E-4	1.2E-3
Fluoranthene	0.0006	9.6E-4	3.1E-3
Arsenic	0.0106	2.2E0	2.7E-3
Lead	0.0855	N/A	N/A
Chromium	0.0494	6.3E-1	1.5E-3
Manganese	5.41	6.9E1	4.1E-3
Thallium	0.00114	1.0E0	1.2E-3
Aluminum	25.82	5.7E-1	6.7E-4
Barium	0.873	8.0E-1	9.4E-4
Cobalt	0.0228	N/A	N/A
Copper	0.236	4.1E-1	4.8E-4
Mercury	0.00022	4.7E-2	5.5E-5
Nickel	0.0436	1.4E-1	1.6E-5
Silver	0.00558	7.1E-2	5.1E-5
Vanadium	0.0245	2.2E-1	2.6E-4
Zinc	0.4	1.3E-1	9.1E-5
HAZARD INDEX		8.4E1	8.7E0

Total HIs for child residents for both the ingestion and dermal routes also exceeded 1.0. Individual HQs for TCE, carbon tetrachloride, manganese, arsenic, and thallium exceeded 1.0 for the oral route, with HQs for PCE, cis-1,2-DCE, and barium approaching 1.0. TCE and PCE were almost entirely responsible for the dermal HI of 8.7. Without TCE and PCE, the noncarcinogenic dermal HI would not be greater than 4E-1. When HQs exceed 1.0, potential noncarcinogenic effects can no longer be ruled out. If this water were potable in an untreated state, potential noncarcinogenic effects due to TCE, PCE, carbon tetrachloride, cis-1,2-DCE, and possibly certain metals, could occur. The potential is increased when certain chemicals, such as TCE, PCE, and cis-1,2-DCE, affect similar target organs.

Tables 4-27, 4-28, and 4-29 present estimated carcinogenic risk increases for potential current groundwater exposure to adult employees and adult and child residents. Carcinogenic risks for hypothetical adult employees would exceed 1E-4 for ingestion (1.3E-4) and 1E-5 for the dermal route (1.3E-5). Oral risks greater than 1E-5 were estimated for vinyl chloride, TCE, PCE, and arsenic (not detected in the filtered sample). Ingestion risks greater than 1E-6 were estimated for 1,1-DCE, 1,2-DCA, and carbon tetrachloride. Dermal risks greater than 1E-6 were estimated for TCE and PCE. Without TCE and PCE, the estimated total dermal cancer risk would be less than 1E-6.

Estimated cancer risk increases for hypothetical adult residents exceeded 1E-4 for ingestion (4.4E-4) and dermal (4.6E-4) routes and exceeded 1E-5 for the inhalation route (8.6E-5). The individual oral risks of note were arsenic (2.2E-4; not detected in the filtered sample), vinyl chloride (3.3E-5), 1,1-DCE (2.1E-5), TCE (6E-5), PCE (7.8E-5), carbon tetrachloride (2.6E-5), and 1,2-DCA (3.7E-6). Individual dermal risks of note were TCE (1.2E-4), PCE (3.3E-4), vinyl chloride (1.3E-6), 1,1-DCE (2.4E-6), chloroform (1E-6), and carbon tetrachloride (5.9E-6). The individual inhalation risks of note were TCE (2.6E-5), vinyl chloride (1.9E-6), 1,1-DCE (1.9E-6), chloroform (3.6E-6), and carbon tetrachloride (2.7E-6).

Both ingestion (2.1E-4) and dermal (1.3E-4) cancer risk increases for hypothetical child receptors exceeded 1E-4. Oral risks of note were those of arsenic (1E-4; not detected in the filtered sample), vinyl chloride (1.6E-5), TCE (2.8E-5), PCE (3.6E-5), carbon tetrachloride (1.2E-5), 1,1-DCE (9.9E-6), and 1,2-DCA (1.7E-6). Dermal risks of note were those of TCE (3.5E-5), PCE (9.4E-5), and carbon tetrachloride (1.7E-6).

Estimated cancer risk increases for ingestion and dermal risks exceeded 1E-4 for most hypothetical receptors. The adult resident inhalation risk also exceeded 1E-5. A variety of chemicals, including VOCs, pyrene, and arsenic, were responsible for this, and some individual carcinogenic risks exceeded 1E-4, and several exceeded 1E-6. The EPA cancer risk range is noted to be 1E-4 to 1E-6.

TABLE 4-27
CURRENT GROUNDWATER CARCINOGENIC RISKS TO ADULT EMPLOYEES - SITES 1, 2, 3
(POTENTIAL CURRENT EXPOSURE)
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep Conc. (mg/L)	CA ING	CA-DERM
Vinyl chloride	0.0015	1.0E-5	3.6E-8
1,1-Dichloroethene	0.003	6.3E-6	6.4E-8
1,2-Dichloroethane	0.0035	1.1E-6	3.8E-9
Trichloroethene	0.469	1.8E-5	3.3E-6
Tetrachloroethene	0.128	2.3E-5	8.9E-6
Chloroform	0.0138	2.9E-7	2.8E-8
Carbon tetrachloride	0.168	7.6E-6	1.6E-7
Benzene	0.002	2.0E-7	1.2E-8
1,2-Dichloropropane	0.001	2.4E-7	1.7E-9
Pyrene	0.0006	0	0
1,1-Dichloroethane	0.008	0	0
1,2-Dichloroethene	0.027	0	0
cis-1,2-Dichloroethene	0.138	0	0
1,1,1-Trichloroethane	0.01	0	0
Trichlorofluoromethane	0.0298	0	0
Toluene	0.004	0	0
Ethylbenzene	0.0002	0	0
Xylenes	0.002	0	0
1,2-Dichlorobenzene	0.0007	0	0
2-Butanone	0.024	0	0
Di-n-ocylphthalate	0.003	0	0
Diethylphthalate	0.000375	0	0
Phenanthrene	0.0003	0	0
Fluoranthene	0.0006	0	0
Arsenic	0.0106	6.5E-5	4.4E-9
Lead	0.0855	0	0
Chromium	0.0494	0	0
Manganese	5.41	0	0
Thallium	0.00114	0	0
Aluminum	25.82	0	0
Barium	0.873	0	0
Cobalt	0.0228	0	0
Copper	0.236	0	0
Mercury	0.00022	0	0
Nickel	0.0436	0	0
Silver	0.00558	0	0
Vanadium	0.0245	0	0
Zinc	0.4	0	0
TOTAL CANCER RISK		1.3E-4	1.3E-5

TABLE 4-28
CURRENT GROUNDWATER CARCINOGENIC RISKS TO ADULT RESIDENTS - SITES 1, 2, 3
(POTENTIAL CURRENT EXPOSURE)
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep Conc. (mg/L)	CA ING	CA DERM	CA Inhalation
Vinyl chloride	0.0015	3.3E-5	1.3E-6	7.7E-6
1,1-Dichloroethene	0.003	2.1E-5	2.4E-6	7.9E-6
1,2-Dichloroethane	0.0035	3.7E-6	1.4E-7	3.9E-6
Trichloroethene	0.469	6.0E-5	1.2E-4	3.7E-5
Tetrachloroethene	0.128	7.8E-5	3.3E-4	3.1E-6
Chloroform	0.0138	9.9E-7	1.0E-6	1.5E-5
Carbon tetrachloride	0.168	2.6E-5	5.9E-6	1.1E-5
Benzene	0.002	6.8E-7	4.6E-7	9.1E-7
1,2-Dichloropropane	0.001	8.0E-7	6.3E-8	0
Pyrene	0.0006	0	0	0
1,1-Dichloroethane	0.008	0	0	0
1,2-Dichloroethene	0.027	0	0	0
cis-1,2-Dichloroethene	0.138	0	0	0
1,1,1-Trichloroethane	0.01	0	0	0
Trichlorofluoromethane	0.0298	0	0	0
Toluene	0.004	0	0	0
Ethylbenzene	0.0002	0	0	0
Xylenes	0.002	0	0	0
1,2-Dichlorobenzene	0.0007	0	0	0
2-Butanone	0.024	0	0	0
Di-n-ocylphthalate	0.003	0	0	0
Diethylphthalate	0.000375	0	0	0
Phenanthrene	0.0003	0	0	0
Fluoranthene	0.0006	0	0	0
Arsenic	0.0106	2.2E-4	4.2E-7	0
Lead	0.0855	0	0	0
Chromium	0.0494	0	0	0
Manganese	5.41	0	0	0
Thallium	0.00114	0	0	0
Aluminum	25.82	0	0	0
Barium	0.873	0	0	0
Cobalt	0.0228	0	0	0
Copper	0.236	0	0	0
Mercury	0.00022	0	0	0
Nickel	0.0436	0	0	0
Silver	0.00558	0	0	0
Vanadium	0.0245	0	0	0
Zinc	0.4	0	0	0
TOTAL CANCER RISK		4.4E-4	4.6E-4	8.6E-5

TABLE 4-29
CURRENT GROUNDWATER CARCINOGENIC RISKS TO CHILD RESIDENTS - SITES 1, 2, 3
(POTENTIAL CURRENT EXPOSURE)
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep Conc. (mg/L)	CA ING	CA DERM
Vinyl chloride	0.0015	1.6E-5	3.8E-7
1,1-Dichloroethene	0.003	9.9E-6	6.7E-7
1,2-Dichloroethane	0.0035	1.7E-6	4.0E-8
Trichloroethene	0.469	2.8E-5	3.5E-5
Tetrachloroethene	0.128	3.6E-5	9.4E-5
Chloroform	0.0138	4.6E-7	3.0E-7
Carbon tetrachloride	0.168	1.2E-5	1.7E-6
Benzene	0.002	3.2E-7	1.3E-7
1,2-Dichloropropane	0.001	3.7E-7	1.8E-8
Pyrene	0.0006	0	0
1,1-Dichloroethane	0.008	0	0
1,2-Dichloroethene	0.027	0	0
cis-1,2-Dichloroethene	0.138	0	0
1,1,1-Trichloroethane	0.01	0	0
Trichlorofluoromethane	0.0298	0	0
Toluene	0.004	0	0
Ethylbenzene	0.0002	0	0
Xylenes	0.002	0	0
1,2-Dichlorobenzene	0.0007	0	0
2-Butanone	0.024	0	0
Di-n-ocylphthalate	0.003	0	0
Diethylphthalate	0.000375	0	0
Phenanthrene	0.0003	0	0
Fluoranthene	0.0006	0	0
Arsenic	0.0106	1.0E-4	1.2E-7
Lead	0.0855	0	0
Chromium	0.0494	0	0
Manganese	5.41	0	0
Thallium	0.00114	0	0
Aluminum	25.82	0	0
Barium	0.873	0	0
Cobalt	0.0228	0	0
Copper	0.236	0	0
Mercury	0.00022	0	0
Nickel	0.0436	0	0
Silver	0.00558	0	0
Vanadium	0.0245	0	0
Zinc	0.4	0	0
TOTAL CANCER RISK		2.1E-4	1.3E-4

Tables 4-30 and 4-31 provide summaries of noncarcinogenic and carcinogenic groundwater risks for all exposure/receptor scenarios for Area A. MCLs were exceeded for several VOCs (i.e., TCE, PCE, carbon tetrachloride, vinyl chloride, and 1,2-DCE) and inorganics (i.e., cadmium, manganese, nickel, arsenic, and barium) in the groundwater samples collected from the 19 monitoring wells located in the vicinity of Area A. For manganese, the secondary MCL of 50 ppb was exceeded by all Area A monitoring wells during Phase II. Among the VOCs, MCLs for TCE and PCE (5 ppb) were exceeded most frequently in these wells: 12 times and 9 times, respectively.

4.7.4.2 Exposures to Lead

As discussed in Section 4.7.3.2, lead was assessed separately because of the lack of an EPA consensus concerning a RfD or CSF. Determination of lead uptake from drinking water was considered. Potential blood-lead level increases were estimated and are discussed below.

For drinking water exposure, children zero to six months old are expected to experience blood-lead increases at the rate of 0.26 ug/dL per ug/l lead in water up to 15 ug/l and at the rate of 0.04 ug/dL for every ug/l lead in water above 15 ug/l (EPA, 1991e). For older children, the ratio is 0.12 ug/dL blood lead per ug/l lead in water up to 15 ug/l, and 0.06 ug/dL for every ug/l lead in water above 15 ug/l (EPA, 1991e). For adults, the ratio is approximately 0.06 ug/dL blood lead per ug/L in water (EPA, 1991e). These ratios were used to estimate current groundwater exposure to adult and child residents. Since hypothetical child receptor was approximately three years old, the "older child" scenario was considered applicable. For an unfiltered lead-in-groundwater representative concentration of 85.5 ug/l at Sites 1, 2, and 3, the estimated blood-lead concentration increases would be 5.1 ug/dL for adult residents and 6.7 ug/dL for child residents. For adult employees, this scenario, which was designed for residential exposure, does not exactly apply. It can be assumed that the employee blood-lead increase would be less than the adult resident's. If the dietary ratio of 0.04 ug/dL blood lead per ug/day ingested were used (using the upper end of the range because the vehicle is water), the employee would have an estimated increase of 3.4 ug/dL.

TABLE 4-30
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

TABLE 4-31
SUMMARY OF CARCINOGENIC RISKS - SITES 1, 2, AND 3
NAWC WARMINSTER - GROUNDWATER

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

No threshold has been defined for effects related to blood-lead increases. The estimated increases at Area A are well below the concentrations at which effects such as anemia and neuropathy occur (40 ug/dL and above) (Doull et al., 1986). Effects below 10 ug/dL are difficult to define. Inhibition of certain enzymes involved in red blood cell metabolism has been reported to occur at 10 to 15 ug/dL and possibly lower (EPA, 1991e). Small increases in blood pressure have been related to adults with blood-lead levels down to 7 ug/dL (EPA, 1991e). Probably the most sensitive subpopulation to effects at the 3 to 7 ug/dL range (where the concentrations estimated for this study area would fall) would be infants, whose early neurological development can be affected by blood-lead concentrations reportedly down to 5 ug/dL (EPA, 1991e). Lead is also a fairly common environmental contaminant and, for this reason, typical blood-lead levels in the population at large may already exceed the concentrations discussed here. For boys and girls under age 12, typical United States blood-lead levels for the years 1976 to 1980 ranged from approximately 10 to 17 ug/dL (Doull et al., 1986). For men and women, typical United States blood-lead levels for the years 1976 to 1980 ranged from approximately 10 to 18 ug/dL (Doull et al., 1986).

In conclusion, the groundwater pathway would not be expected to pose a significant detectable risk in and of itself. However, it must be mentioned that lead is an oral Group B2 probable human carcinogen and has no identifiable threshold for noncarcinogenic toxicity and, as such, has an ideal exposure of zero.

4.7.5 Uncertainty Analysis

There are uncertainties associated with exposure assumptions because not all people weigh 70 kilograms, not all people drink two liters of water per day, not all people live at the same residence for 30 years. The rationale for each assumption was provided in each table of input parameters. Receptor characteristics, such as age and body weight, were based on published values. Land use and activity patterns in the area were limited to the observations made during the field investigation and known land uses in the surrounding area. Every attempt was made to use conservative assumptions, except where average values were expected to better correspond to reality.

The chemical-analytical data base has some limitations in such areas as sample number and location and the validity and representativeness of laboratory results. However, every effort was made to collect samples that reflect actual site conditions. The use of representative concentrations is a conservative estimate since it uses the 95 percent upper confidence limit (UCL) on the arithmetic mean or the maximum concentration.

The use of the 95 percent UCL for normally distributed data has some measure of validity. However, EPA suggests that environmental data be examined statistically for log-normal distribution to determine the most appropriate method for developing site-specific representative concentrations. The use of the 95 percent UCL for normally distributed data may possible result in underestimating representative concentrations; however, the amount of difference that would be reflected in the final conclusions of the risk assessment is expected to be insignificant in view of the high noncarcinogenic risks noted.

The chemical-specific parameters such as Koc were either derived from other parameters or measured under conditions that may or may not be representative of on-site conditions. Parameters such as vapor pressure and solubility were not always obtainable at the desired temperature.

The use of unfiltered monitoring well data for the evaluation of groundwater inorganics provides in all probability a gross overestimation of exposure and risk. Comparison with the filtered data reveals how many of the metals may have been attributable to suspended sediment. However, because of the significant concentrations of organics, the inorganics were in most cases not the primary contributors to total risk.

There is uncertainty associated with the RfDs and CSFs. The uncertainty results from the extrapolation of animal data to humans, the extrapolation of carcinogenic effects from the laboratory high-dose to the environmental low-dose scenarios, and interspecies and intraspecies variations in toxicological endpoints caused by chemical exposure. The use of EPA RfD values is generally considered to be conservative because the doses are based on no-effects or lowest-observed-effects levels and then further reduced with uncertainty factors to increase the margin of safety. The RfDs and CSFs of some chemicals have not been established, and therefore toxicity could not be quantitatively assessed. In most cases, where CSFs were unavailable for carcinogens, the carcinogenic risk is considered to be much more significant since carcinogenic effects usually occur at much lower doses.

From a toxicologist's standpoint, it is not strictly correct to add HQs for a total HI, because RfDs are based on effects to varying target organs. However, if the HI is less than 1.0, this demonstrates that, even when this conservative calculation is performed, the noncarcinogenic risk does not indicate a hazard. At this study area, for all HIs greater than 1.0, further assessment was done to determine whether this was due to a single chemical of a combination of chemicals and whether the combinations of chemicals affected the same target organs.

These models also assumed that chemicals did not interact synergistically (a possible underestimate) or antagonistically (a possible overestimate). Degradation was not taken into account; this was generally a conservative approach.

In summary, several sources of uncertainty might contribute to overall uncertainty in the final risk estimates, including those sources discussed in the exposure and hazard sections of this assessment. Throughout this assessment, if levels of uncertainty were unknown, or if impacts associated with uncertainty could not be estimated accurately, a conservative approach was taken. The consistent use of conservative assumptions may overestimate actual risks in nearly all cases, but no appropriate or reasonable alternative to conservatism has been identified.

4.8 SUMMARY AND CONCLUSIONS

Groundwater samples were collected to document conditions within Area A. Findings, conclusions, and recommendations from these and other RI activities conducted at these sites are provided below.

4.8.1 Summary

Findings for Area A have been summarized in this section. Discussion of conclusions and recommendations specific to these sites follow in subsequent sections.

4.8.1.1 Field Activities

EM conductivity and soil gas surveys were performed at Area A during Phase I. The EM survey at Sites 1 and 2 consisted of 13 northeast to southwest profile lines which were connected by a perpendicular line. The survey at Site 3 consisted of a 60- by 60-foot grid utilizing 15-foot station spacing. Soil gas readings were taken from 80 stations at Sites 1 and 2 and from 26 stations at Site 3. Soil confirmation borings were drilled at 30 locations near Sites 1 and 2 and seven borings were drilled at Site 3 to further delineate site boundaries.

Ten wells were installed during previous investigations in this area, five wells were installed during Phase I, and six wells were installed during Phase II. Four shallow bedrock monitoring wells and one overburden well were installed during Phase I; three shallow bedrock and three overburden wells were installed during Phase II. A total of 21 monitoring wells (including five well couplets) are present in this area. Five overburden and seven shallow bedrock wells were sampled during Phase I; six overburden wells, 12 shallow bedrock wells, and one deep bedrock well were sampled during Phase II.

Hydrogeologic investigations within Area A included estimates of yields from new monitoring wells; calculations of horizontal groundwater flow velocities and vertical hydraulic gradients; construction of groundwater elevation maps; and estimates of flow rates for the surface water near the site. During Phase II, slug tests were performed on several new monitoring wells, step-drawdown tests were done for selected wells, and an aquifer pumping test was conducted. A two-week water-level study was also performed.

Groundwater samples were analyzed for TCL volatile organics, TAL metals (both total and dissolved samples), and cyanide. Selected samples were also analyzed for TCL semivolatiles and pesticides/PCBs. A variety of engineering parameters were analyzed for selected groundwater samples.

4.8.1.2 Physical Characteristics

The sites within Area A are found in the northwestern corner of the fenced facility bordering an industrial/commercial area. The sites are located on a generally flat lying area. An unnamed tributary of Little Neshaminy Creek is located north of this area, while the NAWC Warminster wastewater treatment facility, jet fuel storage area, and parking lots are immediately to the south.

No springs were seen on or adjacent to this area. Isolated and/or displaced fragments of the underlying bedrock were observed in the stream embankment north of the sites. Orange-colored seeps were observed at several points along the creek bank north of Sites 2 and 3 during both phases of the RI.

The average soil thickness at Area A range from six and one-half to 16 feet. The soil cover appeared to be thinnest in the area north of the waste water sludge lagoons. Soils were primarily silts with less common medium sands. The area has been extensively reworked and filled with waste and imported, natural, clean soils used as backfill. The current location of the stream channel, adjacent to the sites, may partially be a result of filling operations.

Waste and fill were generally similar in character throughout the area. The pattern of waste and fill indicates burning of waste may have occurred at the same time as filling and grading with imported clean fill. The lack of a buried discrete burn area or pit representing Site 1 indicates that either burning occurred over a large area or that waste from a small burn pit was regraded over the area.

The buried, gray, wet, clay-like material may represent the eastern extent of 200 foot long trenches. This material was found between the Site 2 and 3 areas. Seeps found along the stream bank adjacent to Site 2 may represent a potential contaminant migration path from groundwater to the stream. The wide distribution of burned cinders found in the Site 3 area may represent the regraded contents of this former burn pit.

The bedrock lithology for the area was generally composed of micaceous siltstones interbedded with arkosic and quartzitic sandstones. The beds within the bedrock appeared to dip towards the northwest with an eight to 12 degree dip towards the northwest. Overburden and shallow bedrock aquifer flow was generally inferred to be toward the north and the adjacent creek. Vertical groundwater gradients between the overburden and shallow bedrock were both upward and downward, and varied with time and location.

Overburden groundwater flow appears to be influenced by discharge to the stream. The overburden well north of the stream was not contaminated, while those south of the stream exhibited positive concentrations. For the shallow bedrock aquifer, groundwater flow direction and upward gradients indicate that discharge to the stream is possible.

The results of the aquifer pumping test indicate that the saprolite layer at the base of the overburden may act as a confining layer between the overburden and shallow bedrock aquifers, and that the degree of interconnection between these two aquifers is very limited in the pump test area. The results also suggest that the shallow bedrock has the properties of a semi-confined aquifer with the following average values:

- Average hydraulic conductivity (k): 3.9×10^{-4} cm/sec (1.1 ft/day)
- Average transmissivity (T): 7.9×10^{-1} cm^2/sec
- Average storativity (S): 4.0×10^{-4} cm/sec

The hydraulic conductivity values within the overburden are observed to vary by as much as two orders of magnitude between different locations based on the slug test results.

The long-term water-level study indicates that the shallow and deeper bedrock aquifers in the northern portion of this area are influenced by the pumping of a nearby well, inferred to be the Wagner & Sons commercial well. The overburden aquifer in the same portion of this area is not significantly influenced. Both the shallow bedrock and overburden aquifers in the southwestern part of the area, as well as the deep bedrock aquifer, are influenced by another unidentified pumping well.

The degree of interconnection between the overburden and shallow bedrock aquifers in this area varies from good to poor at different locations. Aquifer recharge in response to precipitation varies among different wells in both the overburden and shallow bedrock. A recharge mound and corresponding variations in local horizontal gradients and flow directions are evident near well SMC-1. This is caused by recharge to the shallow bedrock from the confined deeper bedrock aquifers in well SMC-2.

4.8.1.3 Nature and Extent of Contamination

The EM survey at Site 1 delineated an area with low conductivity approximately 70 feet southeast of the fence that borders the northwestern side of NAWC Warminster and approximately 60 to 100 feet south of the northwest to southeast fence. The EM survey over Site 2 delineated a second conductivity low over the entire eastern corner of the survey area extending toward the access road. This area closely corresponds with the area suspected to have received fill based on the review of historical aerial photographs. The EM survey at Site 3 showed an anomalous area of approximately 30 feet by 40 feet.

Soil gas readings at Area A yielded VOC concentrations ranging from not detected to 1.5 ppm. The positive detections at Sites 1 and 2 are scattered and are located both inside and outside the EM anomalies. At Site 3, the positive detections for VOCs are located north and east of the suspected location of the Site 3 burn pit. Acetone and benzene are detected from the soil-gas readings at Sites 1 and 2. Xylenes are tentatively identified from the soil gas readings at Site 3.

Confirmation borings delineated the extent of Sites 1 and 2, except on the eastern side, from observations of waste and fill. The western edge of Site 1 appears not to extend past the westernmost existing sludge lagoon. The southern boundaries of Sites 1 and 2 are defined by the existing sludge lagoons and the existing jet fuel storage area. The border between Sites 1 and 2 cannot be distinguished. The eastern edge of Site 2 may extend to Site 3, where a gray, clay-like fill is found. The northern boundary of Sites 1 and 2 is assumed to be the embankment and stream along the NAWC Warminster property line. The detection of cinders in Sites 1 and 2 in an area approximately twice as large as the original burn pit and the finding of natural soil above and below fill material may indicate that considerable regrading of soil around the Site 1 burn pit was done. The thickness of surficial and subsurface fill material at Sites 1 and 2 averages between four and five feet. The average thickness of waste-containing material is between five and six feet. Waste material includes fill, cinders, glass, ceramic fragments, wood, bricks, and metal fragments.

The eastern, southern, and northern borders of Site 3 are presumed to be the area of clean fill marked by borings S3-2, S3-6, and S3-7, and the tributary of Little Neshaminy Creek. The thickness of fill and waste material over the northeastern part of Site 3 is 10 feet or greater. Waste and fill material at Site 3 average approximately six and seven feet in thickness, respectively. Organic vapors are detected at one boring in Site 3 that contains a gray, clay-like sludge. Cinders, wood, metal, brick, and glass fragments are also found at Site 3.

Notable concentrations of arsenic, cadmium, lead, manganese, and thallium are detected in unfiltered monitoring well samples downgradient of Area A. The metals concentrations are generally higher in shallow bedrock rather than overburden wells. Most unfiltered downgradient metal concentrations exceed upgradient concentrations. Beyond that, however, no identifiable pattern of metal contamination in groundwater is observed. Chlorinated ethanes, chlorinated ethenes, benzene, and alkylbenzenes, and phthalates are detected in wells downgradient of Area A at concentrations greater than those in upgradient wells.

Concentrations of organics in shallow bedrock wells generally exceed those in overburden wells. The highest concentrations of chlorinated ethenes and ethanes are found in shallow bedrock wells located just north of the jet fuel storage area north to (and including) Site 1. No noticeable pattern of groundwater contamination by benzene, alkylbenzenes, and phthalates is observed. PAHs are detected only in upgradient wells.

4.8.1.4 Contaminant Fate and Transport

The major contaminant transport pathways for Area A include

- Contaminants leaching from source areas to groundwater because of infiltrating precipitation. The shallow depth to water and bedrock (i.e., less than 20 feet) promotes migration through the unsaturated zone. VOCs are most amenable to such transport.

- Contaminant migration by groundwater discharging to nearby surface water bodies.

Chemicals found in soil, especially subsurface soil, can leach into groundwater. This is especially likely to happen with soluble, low-Koc compounds such as VOCs.

Another possible migration route in this area is from groundwater into the adjacent surface water located north of the three sites. Groundwater movement to the stream may be via both overburden and shallow bedrock aquifers. Some of the same compounds found in monitoring wells, such as benzene, alkylbenzenes, PAHs, and phthalates, are detected in downstream surface water and sediment, although most of the chlorinated VOCs are not found.

The second possible route of groundwater migration is from the shallow bedrock aquifer beneath the sites into the deeper bedrock aquifers downdip and north of the sites. Migration may then occur along geologic structures such as permeable bedding planes, subsurface fractures, and joints. This aquifer is not believed to be recharging deeper aquifers in the areas that are upgradient or directly beneath Area A.

The third possible route of groundwater migration is from the facility to off-site areas, including those which are across the unnamed tributary. It is likely that the stream acts as a groundwater divide for the overburden aquifer; however, this has not been documented for the shallow bedrock aquifer.

Potential human and environmental exposure pathways identified under current land use scenarios for Area A include ingestion, dermal exposure, and inhalation exposure to chemicals in groundwater.

4.8.1.5 Risk Assessment

Chemicals of concern were selected for each medium. The chemicals of concern were selected based on exceedance of background or upgradient concentrations, exceedance of ARARs or dose-response parameters, and carcinogenic status. Three receptors were chosen for the groundwater exposure pathway: adult residents, child residents, and adult employees. Contact with subsurface soil and groundwater are considered to be potential exposures, since there are currently no direct-contact routes for these media. Contact of child residents with sediment and surface water are considered to be potential current exposures that could theoretically occur at the present time. Blood-lead levels were estimated for potential exposure to lead.

Noncarcinogenic risks were estimated by use of Hazard Quotients (HQs) and Hazard Indices (HIs) (ratio of estimated dose to RfD). When HQs exceed 1.0, potential adverse effects can no longer be ruled out. Carcinogenic risks were estimated using cancer slope factors. Cancer risk increases should ideally be below 1E-6, although sometimes risks up to 1E-4 may be considered acceptable.

HIs for hypothetical ingestion of groundwater at Area A exceeded 1.0 for all receptors. The primary contributors to noncarcinogenic risk were arsenic, TCE, PCE, carbon tetrachloride, manganese, cis-1,2-DCE, thallium, and barium. For residential receptors, individual HQs of manganese would exceed 1.0. Also, the aforementioned organics act on many of the same target organ systems, and their combined HIs for residential receptors exceeded 1.0. HIs for hypothetical dermal exposure to groundwater exceeded 1.0 for residential receptors because the individual HQs of TCE and PCE exceeded 1.0. Without PCE and TCE, the dermal HIs would be less than 1.0.

Estimated cancer risk increases for hypothetical ingestion of groundwater would exceed 1E-4 for all receptors. The major contributors to ingestion risk were vinyl chloride, TCE, PCE, arsenic (unfiltered water only), 1,1-DCE, 1,2-DCEA, and carbon tetrachloride. Estimated cancer risks for hypothetical dermal exposure to groundwater would exceed 1E-4 for residential receptors and 1E-5 for employee receptors because of TCE and PCE, and to a lesser extent, vinyl chloride, 1,1-DCE, chloroform, and carbon tetrachloride.

Estimated cancer risk increases for hypothetical inhalation exposure to groundwater would exceed 1E-5 for adult residents because of TCE, vinyl chloride, 1,1,-DCE, chloroform, and carbon tetrachloride.

4.8.2 Conclusions

Conclusions developed for Area A, based on the findings presented, are provided below.

4.8.2.1 Data Limitations and Recommendations for Future Work

Additional investigation should be performed to better define the nature and extent of groundwater, surface water, and sediment contamination in this area.

The significant data gaps identified for Area A are as follows.

- The extent of contamination for the shallow bedrock aquifer in off-site areas primarily north and west of Area A.
- The extent of contamination for the shallow bedrock aquifer in on-site areas south and southwest of Area A.
- The extent of groundwater contamination for the deeper aquifers underlying the general vicinity of Area A and whether any such contamination is due to releases from the facility.
- The extent of downstream contamination (particularly PCBs and DDT) in the unnamed tributary near Area A.
- The degree to which the shallow bedrock recharges deeper bedrock aquifers in this area.
- Well construction and production details for nearby off-site wells.

To address these data gaps, additional tasks should include, at a minimum,

- Additional monitoring wells as needed to define the upgradient and downgradient extent of groundwater contamination due to releases from sites within Area A to the overburden, shallow bedrock, and deep bedrock aquifers.

- Additional surface water and sediment sampling within the unnamed tributary downstream of Area A. Biota sampling may also be warranted to explore food chain impacts, if necessary.

- Modelling to estimate bioaccumulation of contaminants (e.g., PCBs, DDD, DDT) in the unnamed tributary near Area A.

- Research and generation of production information and construction details for several off-site wells, including the Wagner & Sons, Aztec, and Warminster Township Municipal Authority No. 26 wells.

- Generation and analysis of water-level and production data for all on-site wells, including both monitoring and NAWC Warminster production wells.

- Additional surface and subsurface soil sampling as necessary within Area A to assess the nature and extent of contamination and associated risks.

- Modelling to estimate future groundwater concentrations in the shallow bedrock aquifer using analytical data generated by additional soil sampling.

- Review historical data for off-site or other sources of VOC contamination in the vicinity of the western portion of NAWC Warminster.

- Additional well survey work as needed to identify groundwater receptors potentially at risk. Off-site sampling should be performed based on the survey results, if necessary. The survey should be extended to at least one mile north of Area A.

- Hydrogeologic investigation as necessary to determine deep bedrock aquifer characteristics and the effect of nearby supply wells on groundwater flow directions in the vicinity of Area A.

Groundwater in overburden and shallow bedrock contaminated by NAWC Warminster beneath Area A has been found to present an unacceptable risk to human health because some HQs (e.g, manganese) as well as HIs based on total risks of organic compounds (e.g, TCE) that act on similar target organs exceeded unity (1.0), and potential noncarcinogenic impacts could not be ruled out if groundwater was actually used by employees or residents. Estimated dermal and ingestion cancer risk increases would exceed 1E-4 because of chlorinated VOCs and possibly arsenic. The absence of arsenic in filtered groundwater samples suggests that its presence in unfiltered samples was due to suspended materials.

Based on information generated during the RI, adequate data exist to proceed with the evaluation of remedial alternatives for overburden and shallow bedrock contaminated groundwater through the FS process. Additional sampling and investigation are needed for other media associated with Area A, including groundwater in deep bedrock aquifers.

4.8.2.2 Recommended Remedial Action Objectives

This section develops and establishes remedial action objectives that specify the hazardous substances and media of interest, exposure pathways, and remediation goals that permit development of a range of treatment and containment alternatives.

A remedial action objective is a medium-specific (e.g., groundwater) or operable-unit specific goal (e.g., groundwater at the site) for protecting human health and the environment. An operable (or discrete) unit is that geographic-specific, media-specific, or contaminant-specific area to which a remedial action might be applied. Based on these objectives, cleanup goals or acceptable contaminant levels for each exposure route are developed. These goals are based on contaminant-specific ARARs or other appropriate guidance and on risk factors.

When ARARs or other Federal and State guidelines are considered protective, these are used as the acceptable exposure levels. Where an ARAR is not protective (i.e., where it allows risk levels greater than a hazard index of 1 for non-carcinogens or greater than a cancer risk of 1×10^{-4} for carcinogens) or where an ARAR does not exist, acceptable exposure levels are identified through the risk assessment process. NAWC Warminster remedial action objectives and cleanup goals are based on ARARs, following Federal guidance for considering ARARs and for risk assessment methodology.

<u>Applicable or Relevant and Appropriate Requirements</u>

Tables 4-32 and 4-33 present a summary of preliminary Federal and State ARARs for NAWC Warminster. These ARARs will be refined and revised as necessary during the FS. In developing and selecting remedial action alternatives, the degree of public health or environmental protection afforded by each remedy must be considered. Actions that attain or exceed ARARs are given primary consideration.

TABLE 4-32
PRELIMINARY FEDERAL ARARs
NAWC WARMINSTER, PENNSYLVANIA

CONTAMINANT-SPECIFIC REQUIREMENTS	RATIONALE
Safe Drinking Water Act (42 USC 300) Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs) (40 CFR Part 141)	Remedial actions may include groundwater cleanup to MCLs and MCLGs, SARA Section 121(d)(2)(A)(iii)
Clean Water Act (33 USC 1251-1376) Federal Ambient Water Quality Criteria (AWQC) (40 CFR 131)	Remedial actions may result in surface water discharges that could impact aquatic life
Air Emissions for Nonattainment Areas (OSWER Directive 9355.0-28)	Remedial alternatives may result in air emissions
Clean Air Act (42 USC 7401) National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50) National Emission Standards for Hazardous Air Pollutants (NESHAPs) (40 CFR 61.60-61.71) New Source Performance Standards (NSPS) (40 CFR Part 60)	Remedial alternatives may include groundwater volatilization technologies Remedial alternatives may result in hazardous chemical emissions Remedial alternatives may include groundwater volatilization technologies
Reference Doses (RfDs), EPA Office of Research and Development; Cancer Slope Factors, EPA Environmental Criteria and Assessment Office; EPA Carcinogen Assessment Group Health Advisories, EPA Office of Drinking Water Health Effects Assessments, EPA Environmental Criteria and Assessment Office	Considered in the human health risk assessment

TABLE 4-32 (continued)
PRELIMINARY FEDERAL ARARs
NAWC WARMINSTER, PENNSYLVANIA

LOCATION-SPECIFIC REQUIREMENTS	RATIONALE
Endangered Species Act of 1978 (16 USC 1531) (40 CFR 502)	Considered in the environmental assessment
Fish and Wildlife Coordination Act of 1980 (16 USC 661) Fish and Wildlife Conservation Act (16 USC 2901) Fish and Wildlife Improvement Act of 1978 (16 USC 742a)	Remedial alternatives may affect fish and wildlife habitat
Federal Protection of Wetlands Executive Order (E.O. 11990)	Wetlands may be affected by remedial action
Groundwater Protection Strategy (EPA, 1984)	Remedial alternatives may be determined by category designation

ACTION-SPECIFIC REQUIREMENTS	RATIONALE
Hazardous Waste Generator Requirements (40 CFR Part 262) Hazardous Waste Requirements (RCRA Subtitle C, 40 CFR Part 264)	Standards applicable to treating, storing, and disposing of hazardous wastes
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, or Disposal (TSD) Facilities (40 CFR 264) Interim Status Standards for Owners and Operators of Hazardous Waste or TSD Facilities (40 CFR Part 264)	Operating standards for the disposal of hazardous wastes
Hazardous Waste Transportation Requirements (40 CFR Part 263) Department of Transportation (DOT) Rules for Hazard Materials Transport (49 CFR Parts 107, 171-179)	Remedial alternatives may require transportation of hazardous materials off site for treatment/disposal
National Environmental Policy Act	Requires consideration of environmental effects due to federal actions
Clean Water Act (40 CFR Part 122) National Pollutant Discharge Elimination System (NPDES)	Remedial actions may involve discharge to surface waters
Threshold Limit Values, American Conference of Governmental Industrial Hygienists	May be applicable to air concentrations during remedial activities
Land Disposal Restrictions (40 CFR Part 268)	Standards for the disposal of hazardous wastes

TABLE 4-33
PRELIMINARY STATE ARARs
NAWC WARMINSTER, PENNSYLVANIA

CONTAMINANT-SPECIFIC REQUIREMENTS	RATIONALE
State Water Quality Standards (25 PA Code, Chapter 93)	Remedial actions may include discharge to surface waters
State Air Pollution Regulations (25 PA Code, Chapters 121-143)	Remedial actions may include technologies with atmospheric emissions
State Water Quality Toxics Management Strategy (25 PA Code, Chapter 16)	Water quality criteria for toxics
State Safe Drinking Water Regulations (25 PA Code, Chapter 109)	State MCLs and treatment technologies

LOCATION-SPECIFIC REQUIREMENTS	RATIONALE
State Air Pollution Regulations (25 PA Code, Chapters 121-143)	Remedial actions may include technologies with atmospheric emissions

ACTION-SPECIFIC REQUIREMENTS	RATIONALE
State Hazardous Waste Management (25 PA Code, Article VII)	Standards for treating, storing, and disposing of hazardous wastes
State Solid Waste Disposal Regulations (25 PA Code, Chapter 75)	Standards for treating, storing, and disposing of solid wastes
State Pollutant Discharge Elimination System (NPDES) Rules (25 PA Code, Chapter 92) State Wastewater Treatment Requirements (25 PA Code, Chapter 95) State Industrial Waste Management Regulations (25 PA Code, Chapter 97)	Remedial actions may include discharge to surface waters
State General Provisions (25 PA Code, Chapter 95)	Standards for the reinjection of treated groundwater
State Construction, Modification, Reactivation, and Operation of Sources Regulations (25 PA Code, Chapter 127)	Standards for the operation of air pollution control of potential air sources
State Special Water Pollution Regulations (25 PA Code, Chapter 101)	Applicable for permitted solid waste disposal facilities
State Erosion Control Regulations (25 PA Code, Chapter 102)	Soil disturbance during proposed remedial actions may require erosion and sedimentation control measures
State Hazardous Substances Transportation Regulations PA Code Title 13 (Flammable Liquids and Flammable Solids) and Title 15 (Oxidizing Materials, Poisons, and Corrosive Liquids)	Applicable to wastes shipped off site for analysis, treatment, or disposal

Potential Remedial Action Objectives

An initial list of potential response objectives for contaminated groundwater at Area A included

1. Protect uncontaminated groundwater for current use by preventing contamination of existing wells within the affected aquifer or by minimizing the migration of contaminants to adjacent or deeper aquifers.

2. Protect uncontaminated groundwater for future use by reducing contaminant concentrations within the affected aquifer or by minimizing the migration of contaminants to adjacent or deeper aquifers.

3. Restore contaminated groundwater for future use by reducing contaminant concentrations within the contaminated aquifer to levels that are safe to drink.

4. Protect environmental receptors (e.g., human food chain species, sensitive ecosystems) by reducing those groundwater contaminant levels that are being released to surface water.

Within the vicinity (0.25-mile radius) of NAWC Warminster, three residential wells, two commercial wells, and at least one municipal well reportedly have VOC contamination. The largest concentration of residential wells are in the housing development west of Davisville Road and east of NAWC Warminster. For confirmed residential wells, well depths range from 30 to 145 feet below grade. Therefore, some nearby residential wells are assumed to be drawing from the shallow bedrock aquifer underlying the facility.

Given the uncertainty regarding realignment of the NAWC Warminster property by the Department of Defense, current groundwater and land uses in the vicinity of the base may change in the future. Remedial Action Objective #3 would therefore be more protective of human health than Objective #2.

Groundwater

Routine exposure to contaminated groundwater through ingestion and inhalation present the greatest potential human health risks posed by Area A. Based on the data collected and evaluated during the RI and previous investigations, sufficient information is available to develop and establish remedial action objectives for only the shallow groundwater underlying Area A.

For the shallow groundwater underlying Area A, potential remedial objectives include remediating groundwater or managing contaminant migration to

- Prevent further migration of groundwater contaminants from current NAWC Warminster property.

- Initiate restoration of the overburden and shallow bedrock aquifers while additional investigations are being completed.

5.0 SITES 5, 6, AND 7 - AREA B

5.1 SITE HISTORY AND DESCRIPTION

Site 5 (South Runway Landfill), Site 6 (Waste Pit No. 3), and Site 7 (Sludge Disposal Pits) have been combined into one general area (i.e., Area B) for the purpose of this report. Figure 5-1 shows the location of each site. All sites are within the fenced NAWC Warminster perimeter. The inferred groundwater flow direction, surface water flow, and runoff are to the south for all sites within Area B.

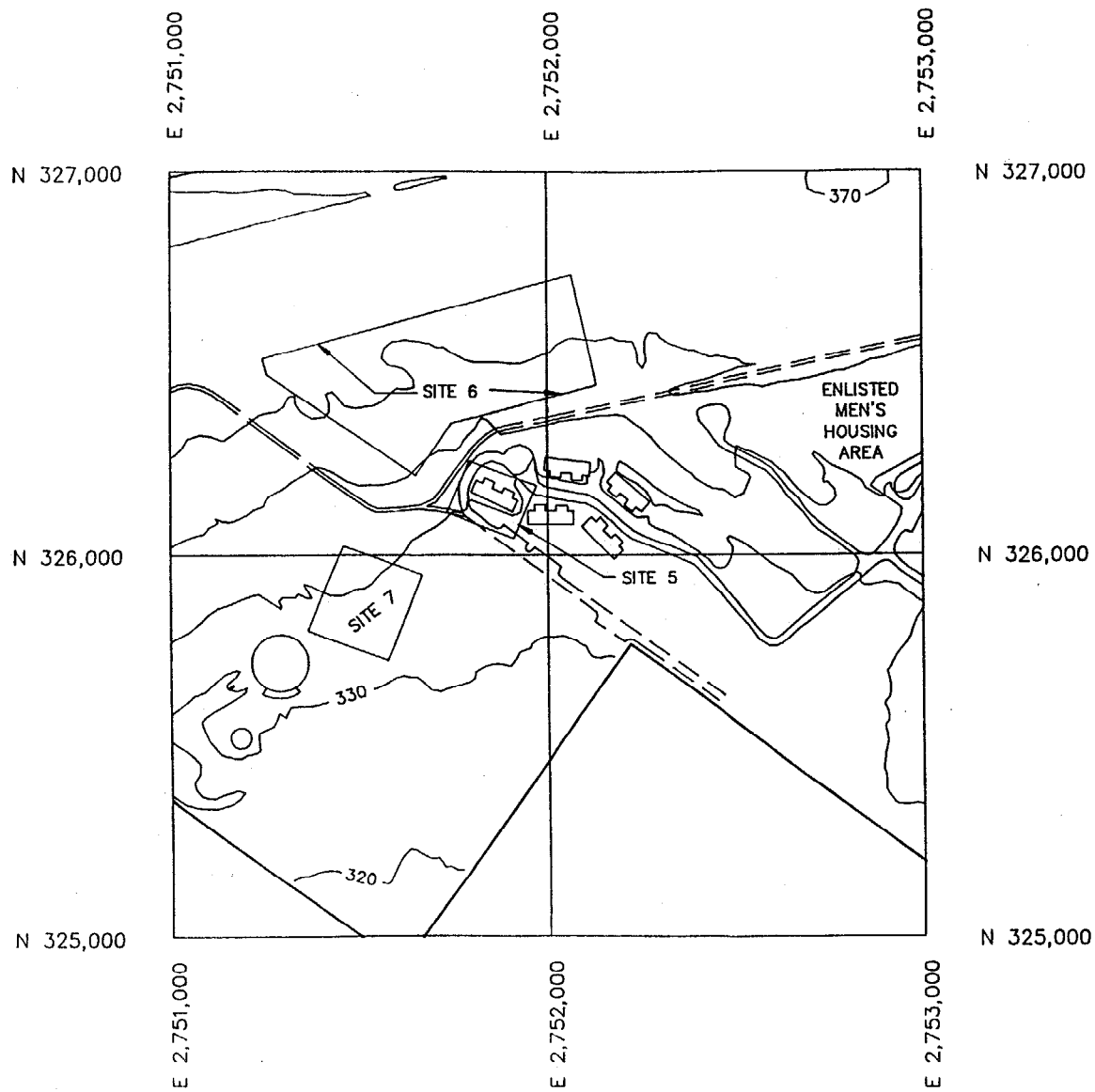
5.1.1 South Runway Landfill - Site 5

Site 5 is located south of the main runway and adjacent to a baseball field at NAWC Warminster (Figure 5-1). The site reportedly operated from 1955 to 1970 and was rediscovered during construction for the foundation of a housing unit. Site 5 reportedly consisted of six to eight disposal trenches in which paints, solvents, scrap metal, demolition debris, and 30 drums of asphalt were disposed. Each trench was 12 feet wide by 70 feet long and eight feet deep. The maximum potential capacity of each trench may have been 1,500 to 2,000 cubic yards. The asphalt itself may account for about eight cubic yards.

After Site 5 was closed, two feet of fill was placed over the disposal area, and the area was reseeded. The Shenandoah Woods Navy townhouse complex was constructed in the vicinity of Site 5; within 100 feet of the site are about eight other housing units. This townhouse complex consists of approximately 199 units. Navy housing unit 401 was constructed adjacent to and possibly over Site 5. Unit 401 consists of four townhouses: 566, 568, 570, and 572 Skyhawk Drive.

5.1.2 Waste Pit No. 3 - Site 6

Site 6 reportedly consists of an unknown number of disposal pits or trenches on the northern side of the patrol road and the south side of the main runway (Figure 5-1). Site 6 is north of Site 5 and northeast of Site 7. This site allegedly received paint, solvents, demolition waste, waste oils, flammable waste, and grease trap waste from 1960 to 1980. The site is currently wooded and debris has been piled on parts of the surface. Where the site is not wooded, it is naturally vegetated. The site covers an area of about 70,000 square feet.



LEGEND

SITE 7 — SITE

TOPOGRAPHIC CONTOUR LINE

N

NAWC
WARMINSTER, PA

FIGURE 5-1
WASTE
DISPOSAL SITES
5, 6 AND 7
(CONTOUR INTERVAL 10 FEET)

HALLIBURTON NUS
Environmental Corporation

Adapted From SMC Environmental Services Group, 1991

SCALE: 1"=300' | DATE: 10/12/92

Information regarding waste disposal operations for Site 6 is poor. An unknown number of waste pits of uncertain dimensions reportedly received unrecorded quantities of various waste types. Site 6 is within 400 feet of the housing area described for Site 5 and about 900 feet from the facility boundary.

5.1.3 Sludge Pits - Site 7

Site 7 reportedly consisted of two disposal trenches that were used from 1950 to 1955 to receive sludge from the wastewater treatment plant. The site is located south of the main runway and adjacent to the western side of Site 5 (Figure 5-1). This site is currently grass covered and relatively flat, with a slight slope toward the fenceline to the south.

The trenches were reportedly 100 feet long by 12 feet wide and eight feet deep. The estimated potential capacity of each trench is 356 cubic yards. The trenches were reportedly backfilled with fill after each dumping episode. Upon site closure in 1955, the trenches were covered with two feet of soil, regraded, and reseeded.

5.2 SUMMARY OF PREVIOUS SITE INVESTIGATIONS

5.2.1 South Runway Landfill - Site 5

In July 1982, one monitoring well was installed; this well has been sampled several times since 1982. Analysis of groundwater samples from monitoring wells near Site 5 has detected copper, chromium, nickel, and zinc. Analysis in 1983 of a downstream surface water sample did not detect any Priority Pollutant List (PPL) contaminants.

In October 1988, SMC Martin observed that the site was well vegetated and covered by roads, pavement, lawns, and buildings.

5.2.2 Waste Pit No. 3 - Site 6

In July 1982, two monitoring wells and several observation wells were installed in the vicinity of Site 6. These wells have been sampled several times since 1982. Analysis of groundwater samples from monitoring wells near Site 6 has detected copper, chromium, nickel, and zinc. Analysis of a downstream surface water sample in 1983 did not detect any PPL contaminants. This was the same sample described for Site 5.

In October 1988, SMC Martin observed that the site was covered with scrub vegetation and construction debris. A small deer population inhabits Site 6.

5.2.3 Sludge Pits - Site 7

In July 1982, one monitoring well and one observation well were installed in the vicinity of Site 7. The monitoring well has been sampled several times since 1982. Analysis of groundwater samples from the monitoring well has detected antimony, copper, chromium, nickel, and zinc. Analysis of a downstream surface water sample in 1983 did not detect any PPL contaminants. This was the same sample described for Site 5.

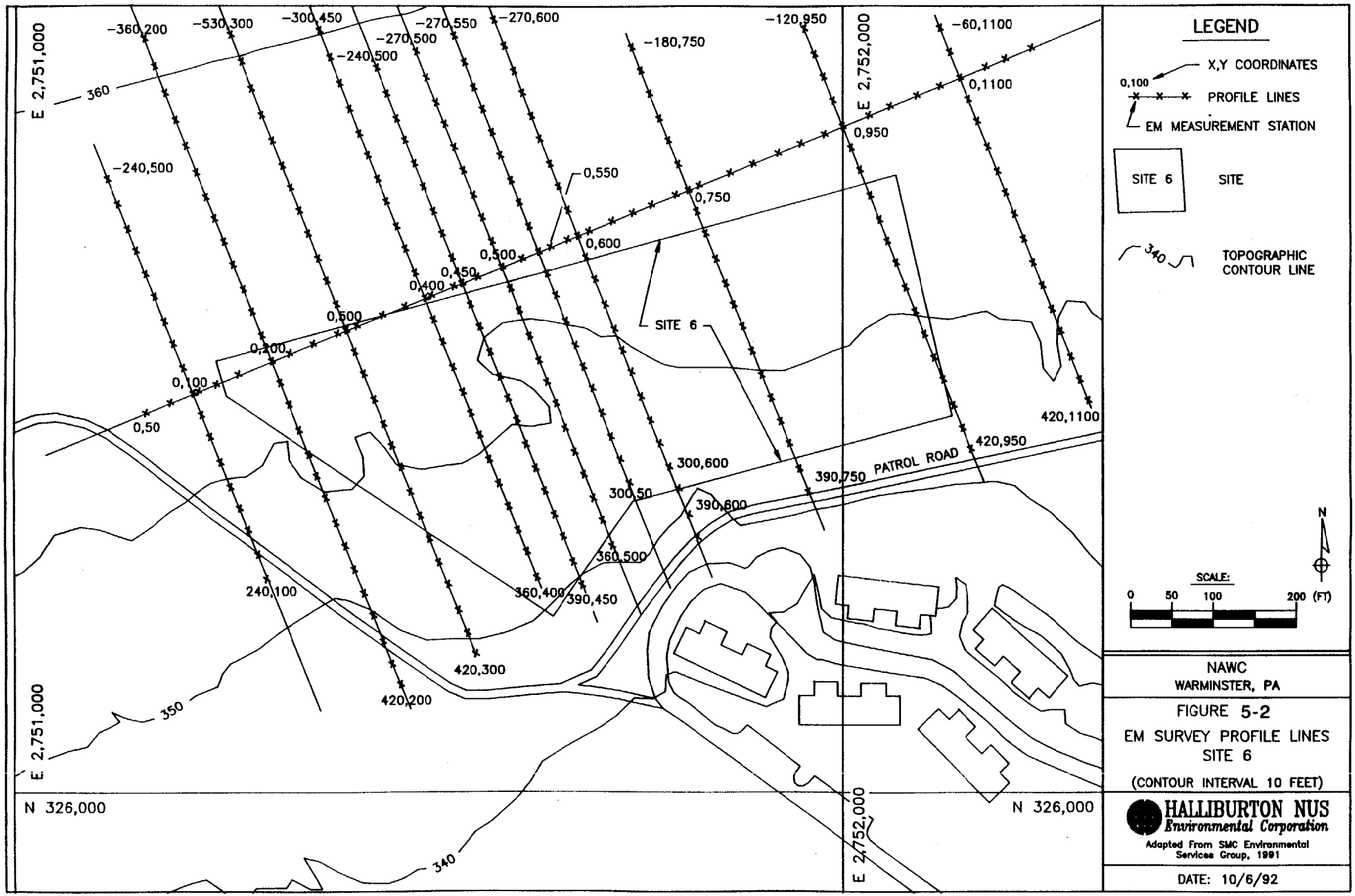
In October 1988, SMC Martin noted that the Site 7 area was well vegetated with grasses.

5.3 PHASE I AND II REMEDIAL INVESTIGATION

Field activities performed during the RI at Area B are summarized in Sections 5.3.1 through 5.3.9.

5.3.1 Electromagnetic (EM) Survey

Electromagnetic (EM) conductivity surveys were performed at Sites 6 and 7 during Phase I. The surveys were performed in accordance with procedures detailed in Section 2.1.3. The survey at Site 6 consisted of one baseline trending north 70 degrees east and 11 profile lines running perpendicular to this baseline (Figure 5-2). The survey at Site 7 consisted of eight northwest to southeast trending profile lines with two northwest to southeast to southwest trending profile lines (Figure 5-3). An EM survey could not be conducted at Site 5 due to the proximity of both buried and overhead utility lines. The results of the EM surveys are presented in Sections 5.5.1 and 5.5.2.



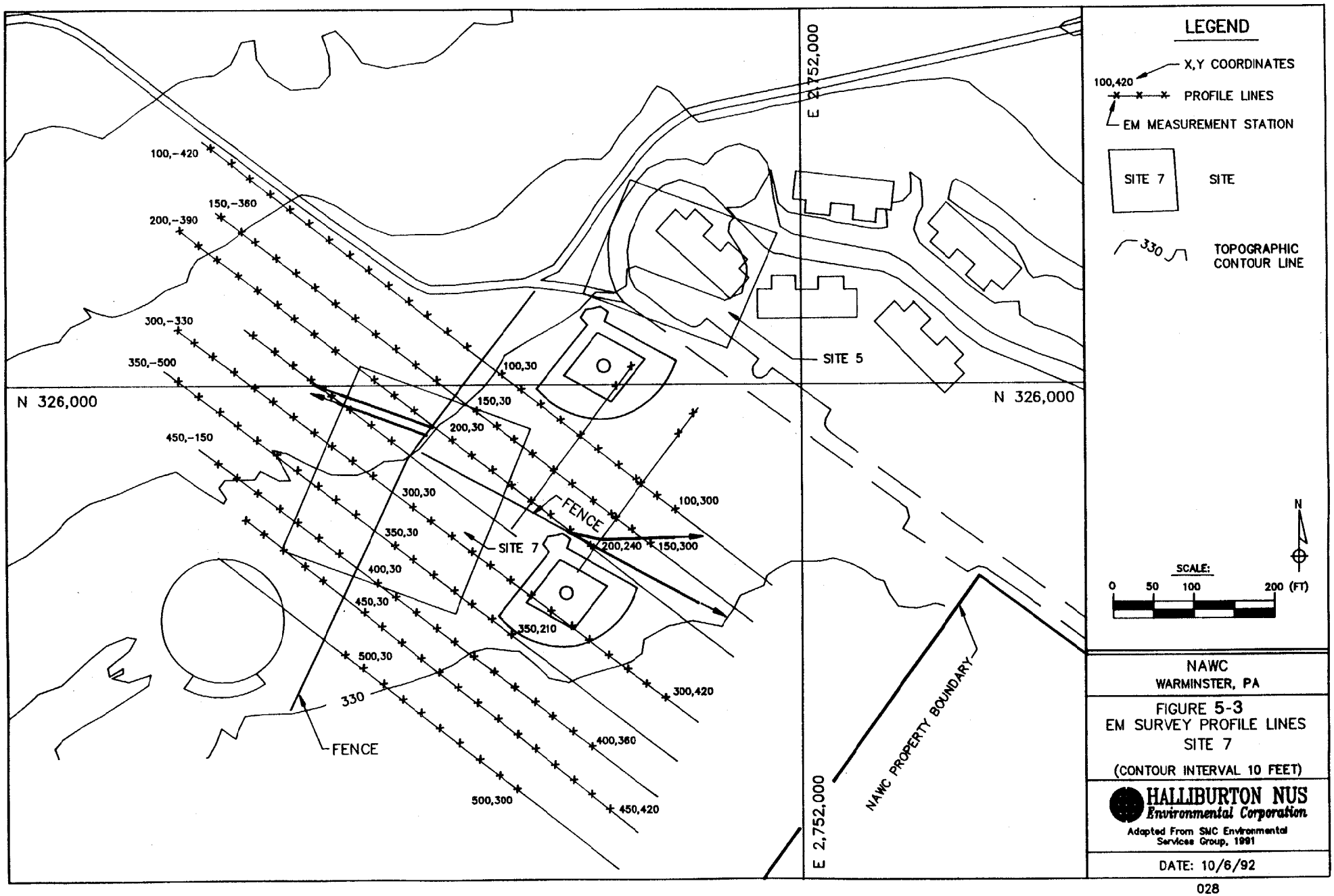
NAWC
WARMINSTER, PA

FIGURE 5-2
EM SURVEY PROFILE LINES
SITE 6
(CONTOUR INTERVAL 10 FEET)

HALLIBURTON NUS
Environmental Corporation
Adapted From SMC Environmental Services Group, 1991

DATE: 10/6/92

027


LEGEND
X,Y COORDINATES
100,420
PROFILE LINES
EM MEASUREMENT STATION
SITE 7
SITE
330
TOPOGRAPHIC CONTOUR LINE
N
SCALE:
0 50 100 200 (FT)
NAWC
WARMINSTER, PA
FIGURE 5-3
EM SURVEY PROFILE LINES
SITE 7
(CONTOUR INTERVAL 10 FEET)
HALLIBURTON NUS
Environmental Corporation
Adapted From SMC Environmental Services Group, 1991
DATE: 10/6/92
N 326,000
E 2,752,000
SITE 5
SITE 7
FENCE
NAWC PROPERTY BOUNDARY
100,-420
150,-360
200,-390
300,-330
350,-500
450,-150
100,30
150,30
200,30
300,30
350,30
400,30
450,30
500,30
100,300
150,300
200,240
350,210
300,420
400,360
450,420
500,300
330

028

5.3.2 Soil Gas Survey

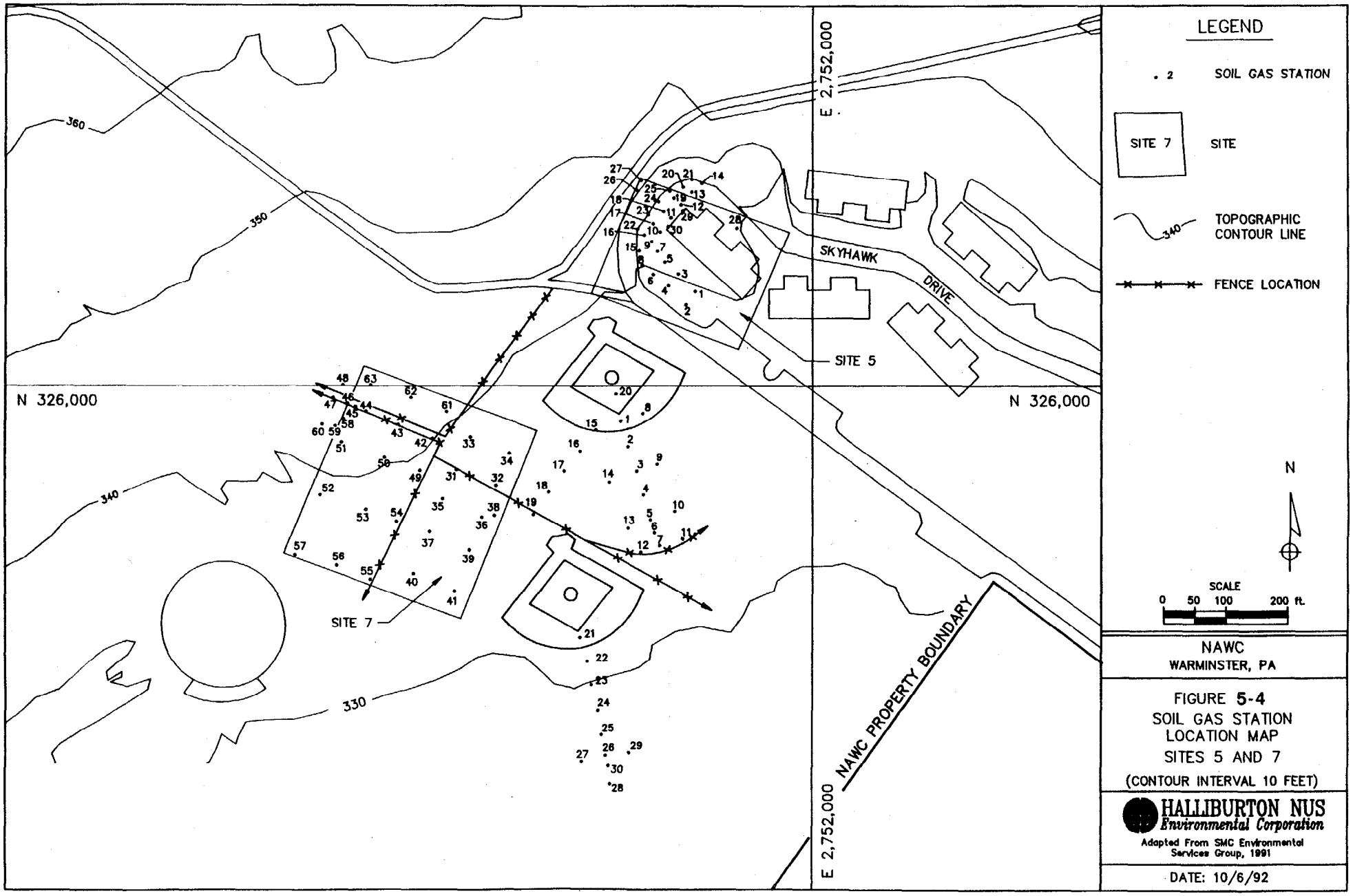
Soil gas surveys were performed at all sites in Area B during Phase I in accordance with procedures detailed in Section 2.1.4. The soil gas survey at Site 5 consists of 30 soil gas stations located to the north, west, and south of housing unit 401 on Skyhawk Drive (Figure 5-4). The soil gas survey at Site 6 consists of 53 soil gas stations covering the area of anomalous EM readings (Figure 5-5). The spacing of the stations was kept as regular as the wooded terrain of Site 6 would allow. The soil gas survey at Site 7 consists of 63 soil gas stations in the area originally identified as Site 7 based on reviews of aerial photographs and in the two baseball fields to the east and southeast of the site (Figure 5-4). The results of the soil gas surveys are presented in Sections 5.5.1 and 5.5.2.

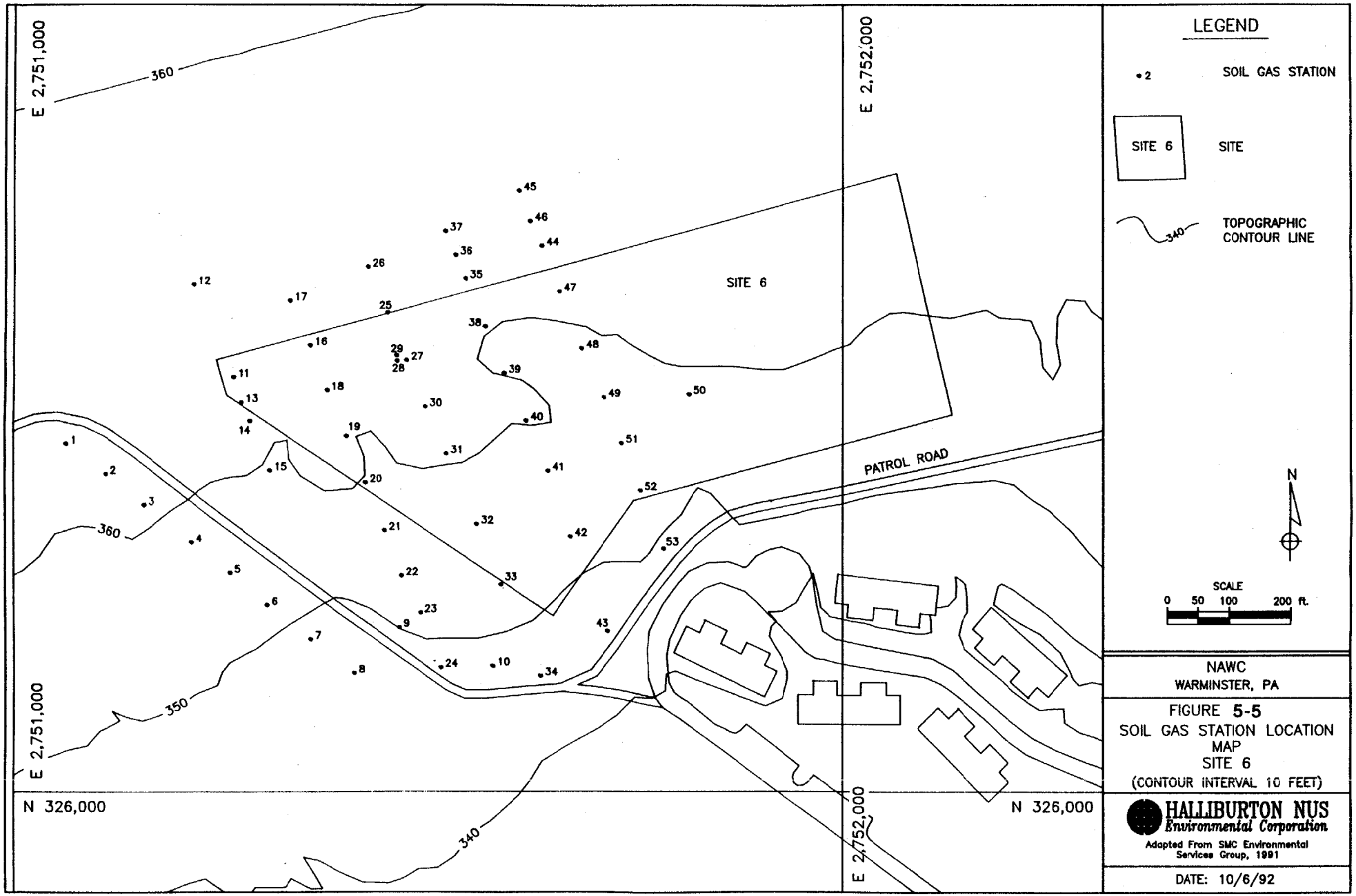
5.3.3 Confirmation Soil Borings

Confirmation soil boring programs were conducted at Sites 5 and 7 during Phase I in accordance with procedures detailed in Section 2.1.5. Ten confirmation soil borings were drilled at Site 5 in the areas to the north, west, and south of housing unit 401 on Skyhawk Drive (Figure 5-6). Fourteen confirmation soil borings were drilled at Site 7 in areas of anomalous EM and/or soil gas readings and in the area of Site 7 as reported by a former NAWC Warminster employee (Figure 5-6). The results of these boring programs are presented in Sections 5.5.1 and 5.5.2. The boring logs are included in Appendix B.

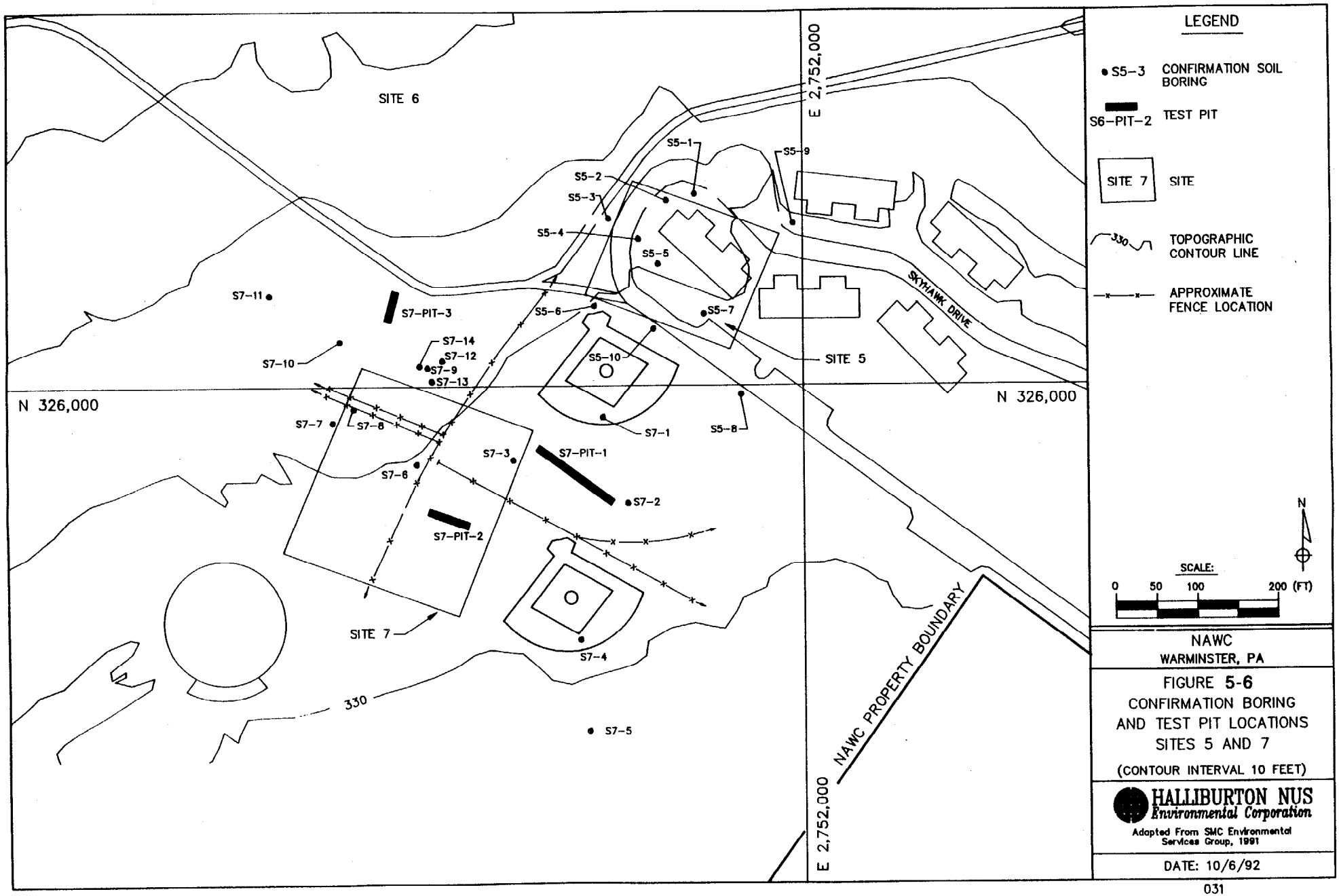
5.3.4 Test Pit Excavation

Test pits were excavated at Sites 6 and 7 during Phase I in accordance with procedures detailed in Section 2.1.6. Six test pits were excavated at Site 6 near the perimeter of the anomalous EM areas and adjacent to soil gas anomalies (Figure 5-7). Three test pits were excavated at Site 7 in areas of anomalous EM or soil gas readings (Figure 5-6). The findings of the test pit excavations are presented in Sections 5.5.1 and 5.5.2. Test pit logs are included in Appendix C.

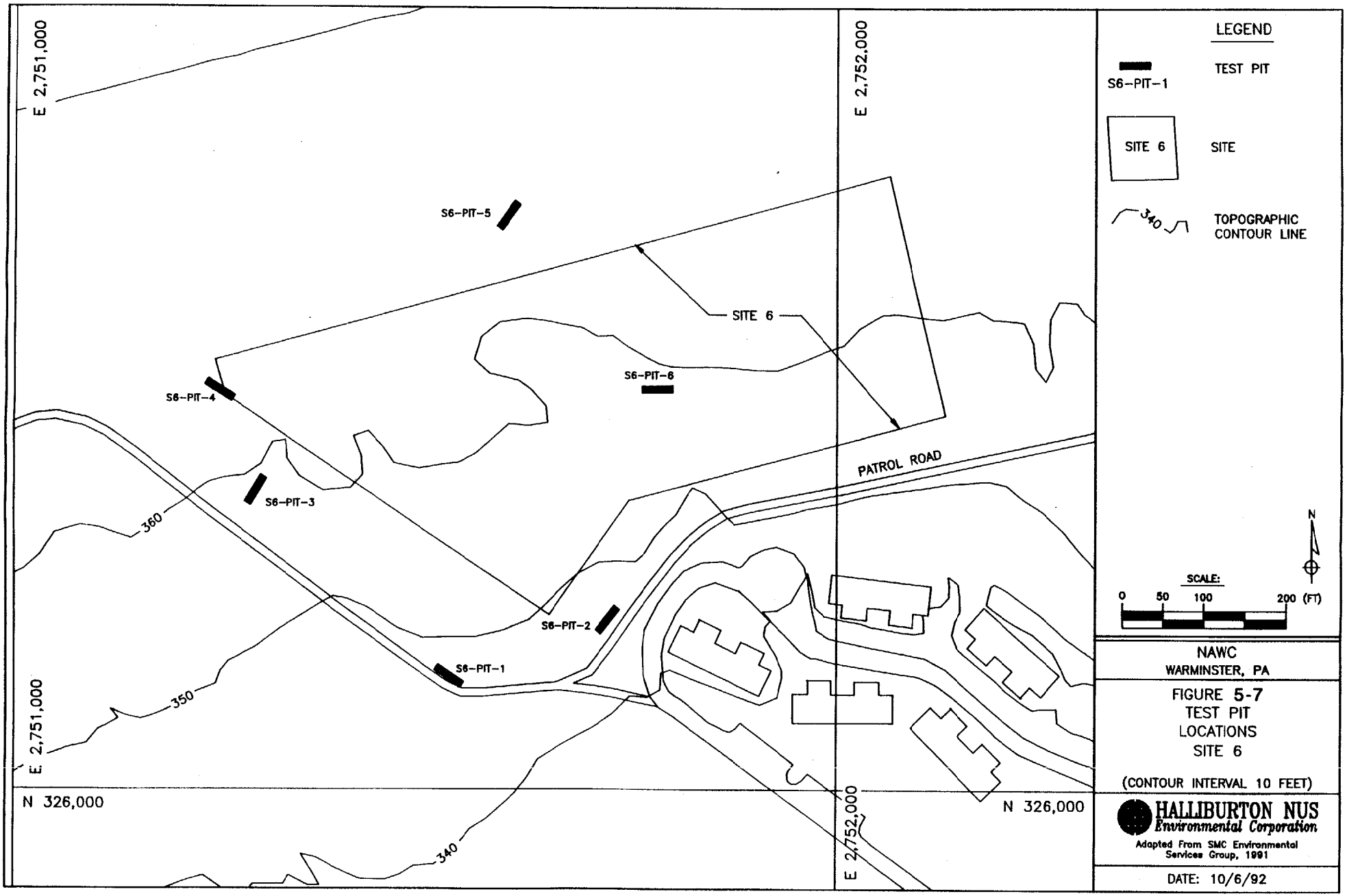

LEGEND
SOIL GAS STATION
SITE 7
SITE
TOPOGRAPHIC CONTOUR LINE
FENCE LOCATION
N
SCALE
0 50 100 200 ft.
NAWC
WARMINSTER, PA
FIGURE 5-4
SOIL GAS STATION
LOCATION MAP
SITES 5 AND 7
(CONTOUR INTERVAL 10 FEET)
HALLIBURTON NUS
Environmental Corporation
Adapted From SMC Environmental Services Group, 1991
DATE: 10/6/92
029
N 326,000
E 2,752,000
SKYHAWK DRIVE
SITE 5
SITE 7
NAWC PROPERTY BOUNDARY
360
350
340
330


E 2,751,000
E 2,752,000
360
350
340
SITE 6
PATROL ROAD
N 326,000
LEGEND
SOIL GAS STATION
SITE
TOPOGRAPHIC CONTOUR LINE
N
SCALE
0 50 100 200 ft.
NAWC
WARMINSTER, PA
FIGURE 5-5
SOIL GAS STATION LOCATION MAP
SITE 6
(CONTOUR INTERVAL 10 FEET)
HALLIBURTON NUS
Environmental Corporation
Adapted From SMC Environmental Services Group, 1991
DATE: 10/6/92

030


SITE 6
E 2,752,000
S5-1
S5-9
S5-2
S5-3
S5-4
S5-5
S5-6
S5-7
S5-10
S5-8
SKYHAWK DRIVE
SITE 5
S7-11
S7-PIT-3
S7-14
S7-12
S7-9
S7-13
S7-10
N 326,000
N 326,000
S7-7
S7-8
S7-1
S7-3
S7-PIT-1
S7-6
S7-2
S7-PIT-2
SITE 7
S7-4
330
S7-5
NAWC PROPERTY BOUNDARY
E 2,752,000
LEGEND
S5-3 CONFIRMATION SOIL BORING
S6-PIT-2 TEST PIT
SITE 7 SITE
330 TOPOGRAPHIC CONTOUR LINE
APPROXIMATE FENCE LOCATION
N
SCALE:
0 50 100 200 (FT)
NAWC
WARMINSTER, PA
FIGURE 5-6
CONFIRMATION BORING
AND TEST PIT LOCATIONS
SITES 5 AND 7
(CONTOUR INTERVAL 10 FEET)
HALLIBURTON NUS
Environmental Corporation
Adapted From SMC Environmental Services Group, 1991
DATE: 10/6/92

031


E 2,751,000
E 2,752,000
S6-PIT-5
SITE 6
S6-PIT-6
S6-PIT-4
S6-PIT-3
PATROL ROAD
360
S6-PIT-2
S6-PIT-1
350
340
N 326,000
N 326,000
E 2,751,000
E 2,752,000
LEGEND
S6-PIT-1
TEST PIT
SITE 6
SITE
340
TOPOGRAPHIC CONTOUR LINE
N
SCALE:
0 50 100 200 (FT)
NAWC
WARMINSTER, PA
FIGURE 5-7
TEST PIT
LOCATIONS
SITE 6
(CONTOUR INTERVAL 10 FEET)
HALLIBURTON NUS
Environmental Corporation
Adapted From SMC Environmental Services Group, 1991
DATE: 10/6/92

032

5.3.5 Monitoring Well Installation

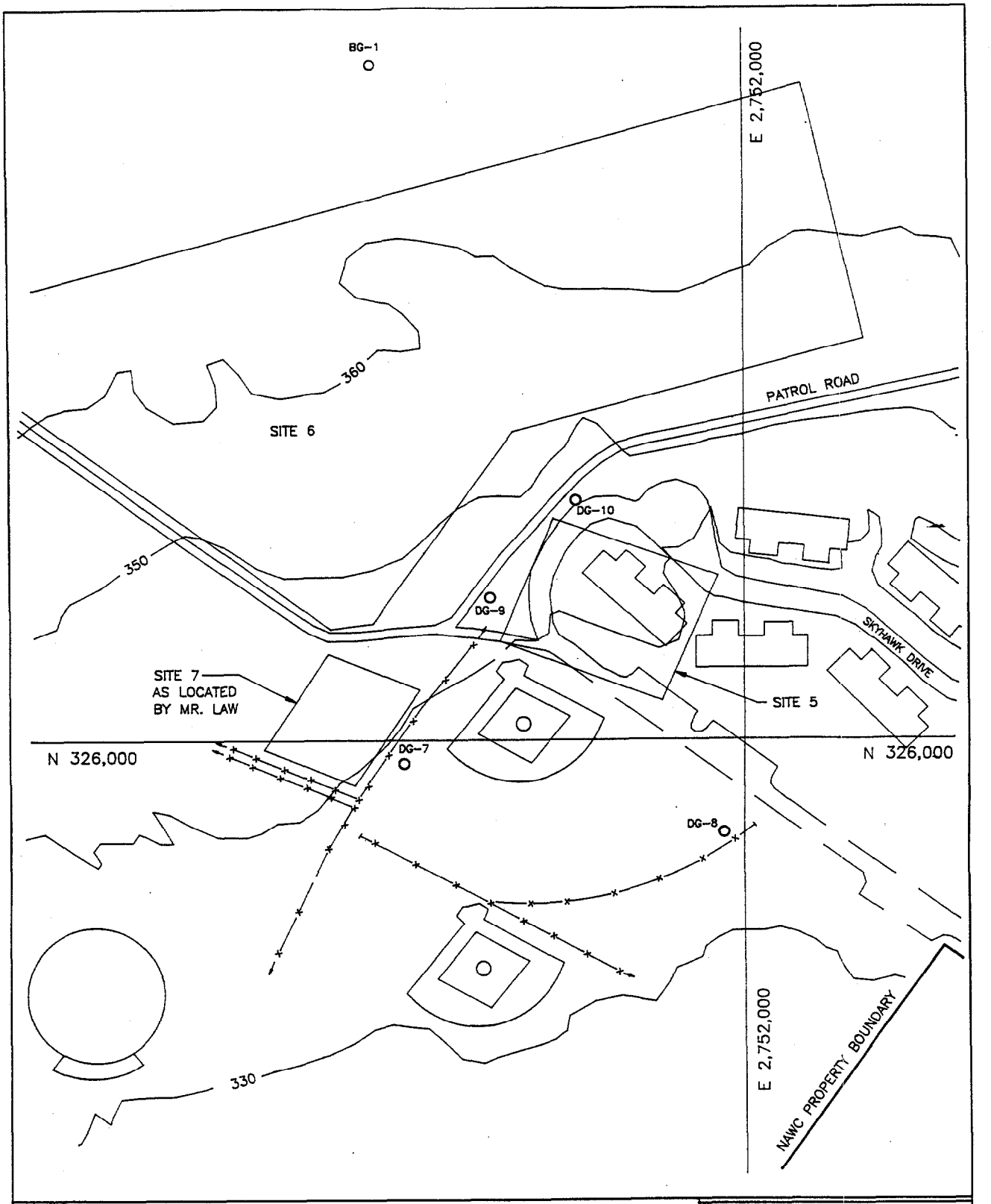
Seventeen monitoring wells are present in Area B. Five overburden wells were installed during previous investigations (Figure 5-8), eight wells were installed during Phase I (Figure 5-9), and four wells were installed during Phase II (Figure 5-10). Construction specifications for the monitoring wells and boring logs for the Phase I and II RI wells are included in Appendices D and B, respectively.

Seven shallow bedrock wells and one overburden well were installed during Phase I following procedures detailed in Section 2.1.7.1. Five of the shallow bedrock wells were installed to complete well couplets with overburden wells from previous investigations. One overburden well and one shallow bedrock well were installed to create a new well couplet downgradient of Site 5. One shallow bedrock well was installed to provide a groundwater sampling point downgradient from Site 6 and upgradient of Site 7. The well numbers, aquifers, and installation rationale for each of the Phase I wells are summarized in Table 5-1.

Two shallow bedrock wells and two overburden wells were installed during Phase I following procedures detailed in Section 2.1.7.2. These wells were installed to create two new well couplets downgradient of Areas B and the existing wells. The well numbers, aquifers, and installation rationale for each of the Phase II wells are summarized in Table 5-2.

5.3.6 Groundwater Sampling

Groundwater samples were obtained from Area B during both the Phases I and II in accordance with procedures detailed in Section 2.1.8. Groundwater sample analytical results results are summarized in Section 5.5.3.



LEGEND

DG-7 OVERBURDEN MONITORING WELL

—330— TOPOGRAPHIC CONTOUR LINE

N

SCALE:

0 50 100 200 (FT)

NAWC
WARMINSTER, PA

FIGURE 5-8
MONITORING WELLS INSTALLED PRIOR TO PHASE I 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

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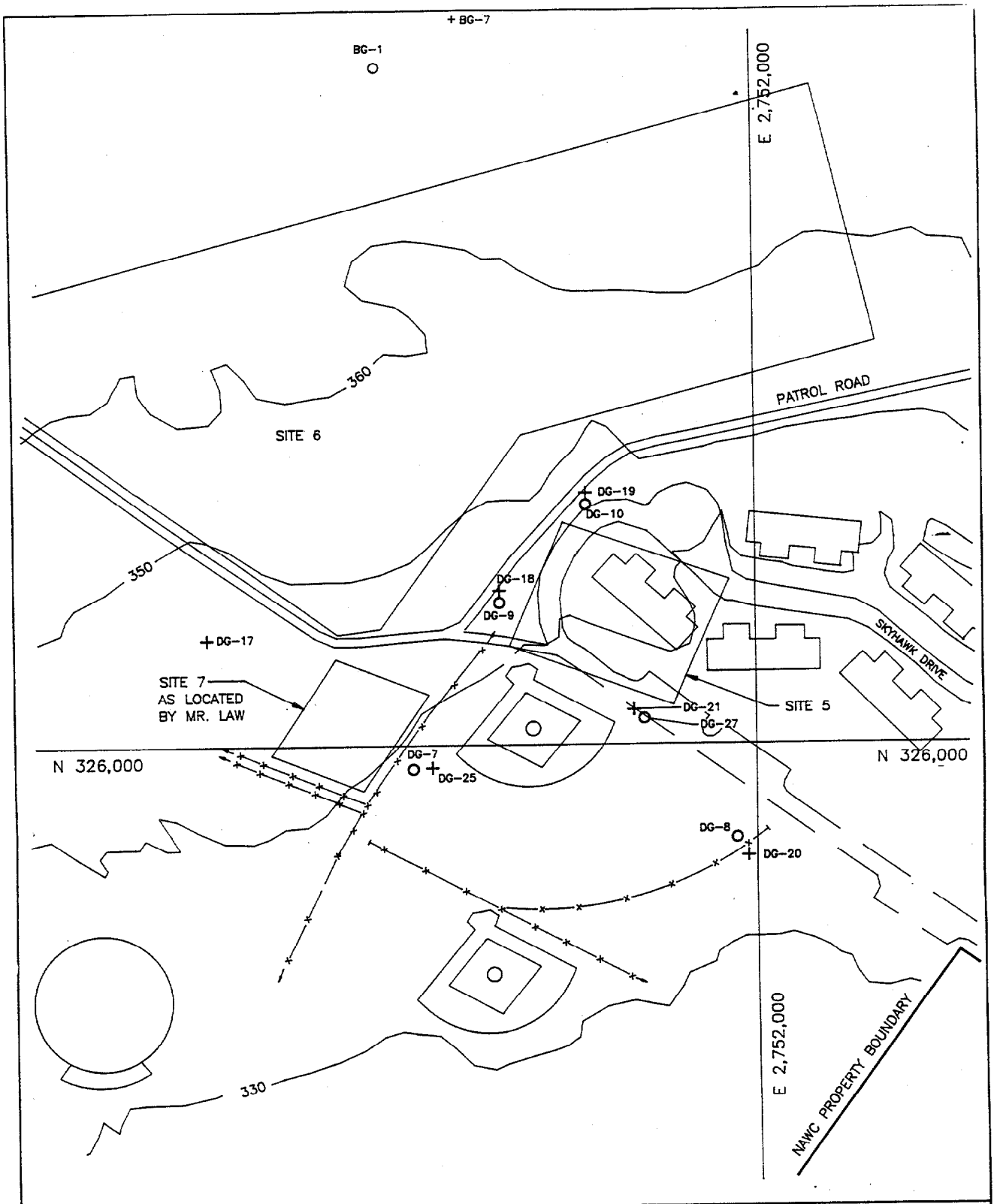

LEGEND

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 5-9
MONITORING WELLS INSTALLED THROUGH AND INCLUDING PHASE I 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

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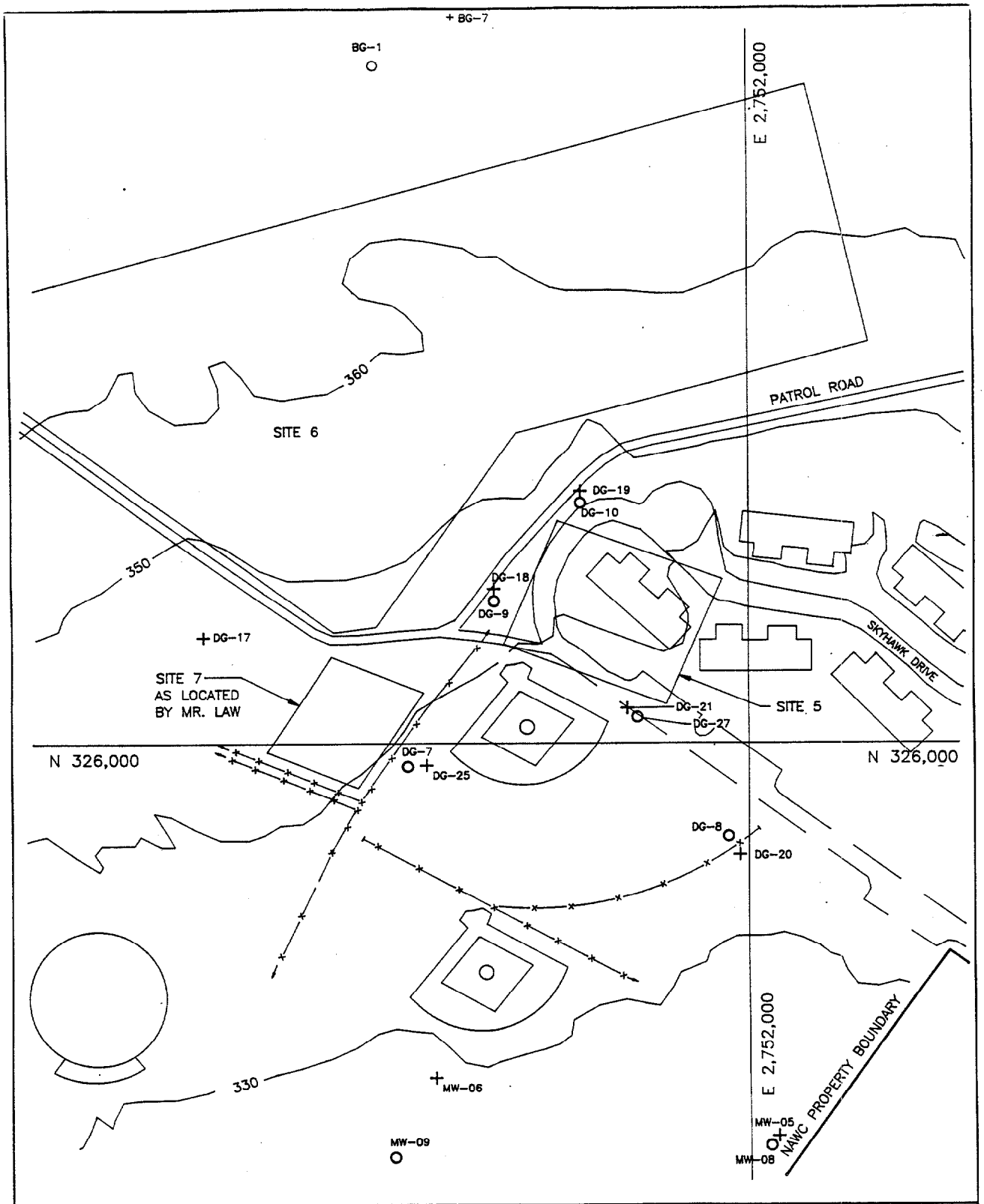

LEGEND

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 5-10
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

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TABLE 5-1
RATIONALE FOR INSTALLATION OF MONITORING WELLS
NAWC WARMINSTER, PHASE I RI
OPERABLE UNIT 1, AREA B

Well Number	Aquifer Monitored	Summary of Rationale for Well Installation
BG-7	Shallow Bedrock	Complete upgradient well couplet with existing overburden well, BG-1
DG-17	Shallow Bedrock	Additional sample and elevation location downgradient of Site 6 and upgradient of Site 7.
DG-18	Shallow Bedrock	Complete well couplet with existing overburden well DG-9 downgradient of Site 6 and upgradient of Site 5.
DG-19	Shallow Bedrock	Complete well couplet with existing overburden well DG-10 downgradient of Site 6 and upgradient Site 5.
DG-20	Shallow Bedrock	Complete well couplet with existing overburden well DG-8 downgradient of Sites 5 and 6.
DG-21	Shallow Bedrock	Additional sample and elevation location downgradient to Site 5; part of new well couplet with DG-27.
DG-25	Shallow Bedrock	Complete well couplet with existing overburden well DG-7 downgradient to Sites 6 and 7.
DG-27	Overburden	Additional sample and elevation location downgradient to Site 5; part of new couplet with DG-21.

TABLE 5-2
RATIONALE FOR INSTALLATION OF MONITORING WELLS
NAWC WARMINSTER, PHASE II RI
OPERABLE UNIT 1, AREA B

Well Number	Aquifer Monitored	Summary of Rationale for Well Installation
MW-05	Shallow Bedrock	Additional sample and elevation location near facility boundary downgradient of Sites 5, 6, and 7, and all existing wells. Part of new well couplet with MW-08.
MW-06	Shallow Bedrock	Additional sample and elevation location downgradient from Sites 5, 6, and 7, and all existing wells.
MW-08	Overburden	Additional sample and elevation location near property boundary downgradient from Sites 5, 6, and 7, and all existing wells. Part of new well couplet with MW-05.
MW-09	Overburden	Additional sample and elevation location downgradient from Sites 5, 6, and 7, and all existing wells.

Groundwater samples were obtained from five overburden wells (DG-7, DG-8, DG-9, DG-10, and DG-27) and from seven shallow bedrock wells (BG-7, DG-17, DG-18, DG-19, DG-20, DG-21, and DG-25) during Phase I. Overburden well BG-1 was dry during this sampling event. Groundwater samples were obtained from five overburden wells (DG-8, DG-9, DG-10, DG-27, and MW-09) and from nine shallow bedrock wells (BG-7, DG-17, DG-18, DG-19, DG-20, DG-21, DG-25, MW-05, and MW-06) during Phase II. Overburden wells BG-1 and MW-08 were dry during this sampling event, and overburden well DG-7 was filled to the surface with soil material.

5.3.7 Soil and Geologic Investigations

During Phase I, soil and geologic investigation performed at Area B included describing materials and cuttings produced during the drilling of confirmation soil borings and monitoring wells, and describing the materials encountered in test pit excavations and the construction of a geologic cross-section for the area. During Phase II cuttings from monitoring well drilling and split spoon samples from subsurface soil sample borings were also described. These investigations were performed in accordance with procedures detailed in Sections 2.1.5, 2.1.6, 2.1.7, and 2.1.9. The results of these investigations are presented in Sections 5.4.1 and 5.4.2.

5.3.8 Hydrogeologic Investigations

Hydrogeologic investigations performed during the RI include

- Estimates of yield from newly installed wells
- Construction of groundwater elevation maps
- Determination of horizontal groundwater gradients
- Calculation of hydraulic conductivity from slug tests
- Determination of vertical hydraulic gradients at well couplets
- Estimates of flow rates for surface water near the site

All of these tasks were performed in accordance with procedures detailed in Section 2.1.10. These tasks were conducted for both the overburden and shallow bedrock aquifers with one exception. Slug test determinations of hydraulic conductivity were performed only for shallow bedrock wells MW-05 and MW-06. Results from the hydrogeologic investigations are presented in Section 5.4.3.

5.4 SITE CHARACTERISTICS

The geological data for Area B were evaluated as a single body due to the proximity of the sites and the sparsity of bedrock data at each individual site. By analyzing the data from the three sites as a single body, a more complete study of the geology and hydrogeology of Area B can be conducted.

Site 5 is located under Housing Unit 401 in NAWC Warminster's enlisted men's housing area. Site 6 is south of the main runway and north of the patrol road near the eastern end of NAWC Warminster. Site 7 is located west of the other sites in Area B and east of the inertial reference building. The locations of the Area B sites can be seen in Figure 5-1.

No bedrock outcroppings were observed at or adjacent to Area B. One spring was found south of the baseball field adjacent to Site 5, in the vicinity of wells DG-8 and DG-20. Review of historical aerial photos revealed the presence of a stream in the area where the spring was found. It is believed that this creek was later filled with soil during construction activities conducted by NAWC Warminster.

5.4.1 Soils

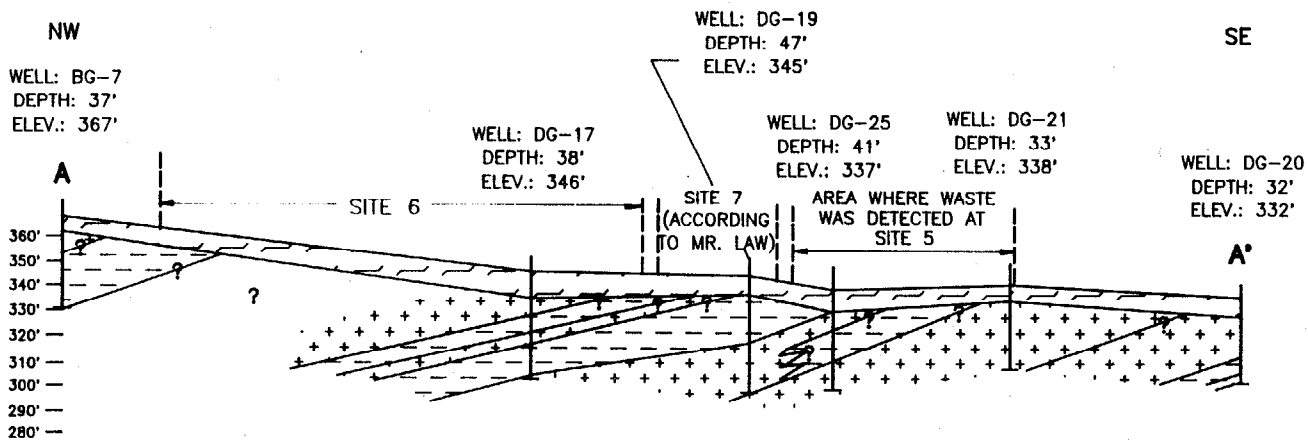
Soil thicknesses observed during the Phase I subsurface investigations at this area were between four and 14 feet. The soil thicknesses are generally uniform across the sites, with only local areas of variation.

SCS has mapped the soils at Area B as Doylestown silt loam with slow permeability, Lawrenceville silt loam with moderately slow permeability, and the Duncannon silt loam with moderate permeability.

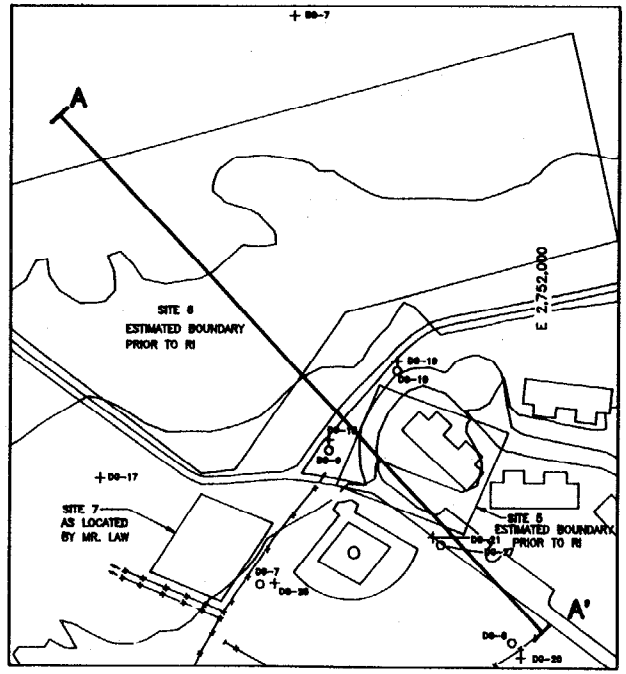
Construction debris and several mounded areas atypical of the normal topography were found at Site 6. This indicates that the soils at Site 6 have been reworked. A more comprehensive description of these features is given in Section 5.5.

5.4.2 Geology

The geological cross-section of Area B is presented in Figure 5-11. The bedrock lithology consists mainly of brownish-red micaceous siltstone interbedded with gray, red, and light to dark brown, fine- to coarse-grained arkosic sandstone and gray to brown medium-grained quartzitic sandstone. These rock units were observed to strike northeast and dip six to 10 degrees to the northwest. The thicknesses of the lithologic units range from five to 20 feet. The sandstone encountered during drilling in MW-05 appeared to be extensively fractured.



LINE OF SECTION



LEGEND

- SILTSTONE
- QUARTZITIC SANDSTONE
- ARKOSIC SANDSTONE
- OVERBURDEN

HORIZONTAL SCALE: 1" = 100'
VERTICAL SCALE: 1" = 50'

ELEVATION REPORTED IN FEET ABOVE MEAN SEA LEVEL

VERTICAL EXAGGERATION = x2

NAWC
WARMINSTER, PA

FIGURE 5-11
GEOLOGICAL CROSS-SECTION
SITES 5,6 AND 7

HALLIBURTON NUS
Environmental Corporation

Adapted From SMC Environmental Services Group, 1991

SCALE: AS SHOWN | DATE: 10/6/92

035

5.4.3 Hydrogeology

Breakdown of feldspar minerals in arkosic sandstones often leads to the precipitation of a white, kaolinitic clay at the bedrock/overburden interface. Evidence of this process was seen in several test pits and confirmation borings at NAWC Warminster. The presence of this clay may possibly create a semi-permeable layer between the bedrock and overburden, retarding the movement of groundwater between the two aquifers. However, the effect of this layer on groundwater transport at the facility is not known.

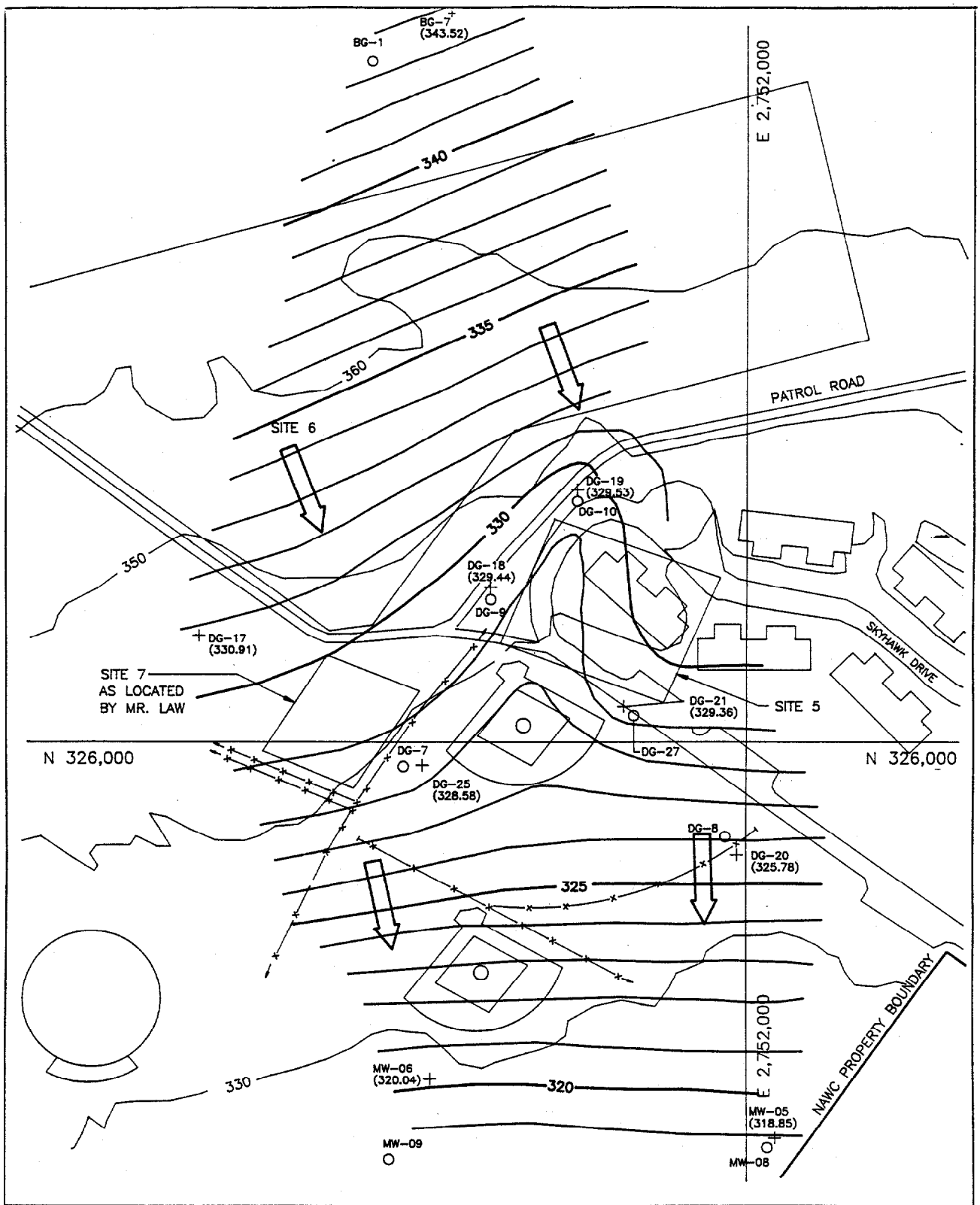
The varying depth at which water was encountered on a topographically level area at Area B, between 27 and 42 feet, indicates that secondary porosity (e.g., fractures, joints) plays a role in groundwater transport at the facility. Evidence of groundwater flow through the intergranular space within the matrix of the bedrock (e.g., perching of groundwater at bedding planes) was also seen. Thus, both of these mechanisms may affect groundwater transport.

A discussion of the bedrock aquifer, overburden aquifer, and surface water characteristics at Area B is presented in the following sections.

5.4.3.1 Shallow Bedrock Aquifer

The shallow bedrock aquifer groundwater elevation map for Area B is shown in Figure 5-12. The inferred general flow direction of the groundwater in this area is from north to south with a gradient of approximately 1.0 to 2.5 percent. The horizontal gradient determined during Phase I was 3.3 percent. The shallow bedrock aquifer groundwater elevations indicate that groundwater flow is away from the main runway and topographic high north of the sites toward the southern boundary of NAWC Warminster near the headwaters of Southampton Creek. These findings indicate that groundwater flows beneath Site 6 before it enters either Site 5 or 7.

Relatively lower groundwater elevations in the bedrock aquifer near the western part of Site 5 create a tight curvature of the groundwater elevation contours in this area. The cause of this feature may be an area of increased permeability within the bedrock aquifer at this location. Inferred groundwater flow directions may vary locally here with either eastward or westward components of flow; however, the overall inferred flow direction prevails throughout the larger area of the investigation.



LEGEND

—330—	EQUIPOTENTIAL LINE
(328.58)	WATER ELEVATION IN WELL (MSL)
⇨	GROUND WATER FLOW DIRECTION
○ 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 5-12
SHALLOW BEDROCK AQUIFER
GROUND WATER ELEVATIONS
8/13/92
SITES 5,6 AND 7

HALLIBURTON NUS
Environmental Corporation

Adapted From SMC Environmental Services Group, 1991

DATE: 2/3/93

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Estimated yields for the Phase I shallow bedrock aquifer wells at Area B are between less than 1/2 to one gallon per minute. Estimated yields for the Phase II shallow bedrock aquifer wells range from five to seven or more gallons per minute.

The hydraulic conductivity of the shallow bedrock aquifer at Area B was estimated from rising and falling head slug tests performed in wells MW-05 and MW-06. The slug tests were performed in accordance with procedures detailed in Section 2.1.10. The results of the slug tests are shown below.

TABLE 5-3
SLUG TEST RESULTS - AREA B

Well Number	Test Tube	Aquifer	Hydraulic Conductivity
MW-05	Falling Head	Bedrock	1.0×10^{-2} cm/sec.
MW-05	Falling Head	Bedrock	3.0×10^{-2} cm/sec.
MW-06	Falling Head	Bedrock	2.35×10^{-3} cm/sec.
MW-06	Falling Head	Bedrock	2.0×10^{-3} cm/sec.

Horizontal groundwater velocities for the bedrock aquifer were calculated to be between 44 and 120 feet per year during Phase I. Horizontal groundwater velocities during Phase II were calculated using the average hydraulic conductivity of the bedrock from slug test results, porosity values from Rima, et al. (1962), and the different horizontal gradients of Phase II. For the lower horizontal gradient of 1.0 percent, the velocities range from 455 to 1,140 feet per year. For the higher horizontal gradient of 2.5 percent, the velocities range from 1,140 to 2,850 feet per year.

Vertical hydraulic gradients, estimated from head differences between wells in the same couplet, were downward in all well couplets at Area B on all dates of measurement (Table 5-4). This indicates that the bedrock aquifer may receive recharge from the overburden throughout this study area and that the bedrock aquifer does not discharge groundwater to the overburden in this area.

TABLE 5-4
NAWC SITES 5, 6, 7
VERTICAL HYDRAULIC GRADIENTS ESTIMATED FROM HEAD DIFFERENCES BETWEEN OVERBURDEN AND SHALLOW BEDROCK MONITORING WELLS IN COUPLETS

Well Couplet	Estimated Vertical Hydraulic Gradient			
Overburden / Shallow Bedrock	12/90	1/90	7/92	8/92
BG-1 / BG-7	1.43↓	NA(1)	1.19↓	NA(1)
DG-10 / DG-19	5.75↓	7.59↓	7.23↓	6.70↓
DG-9 / DG-18	3.02↓	2.86↓	2.31↓	3.17↓
DG-27 / DG-21	0.43↓	1.01↓	0.51↓	0.29↓
DG-7 / DG-25	1.17↓	2.84↓	NA(2)	NA(2)
DG-8 / DG-20	1.91↓	2.38↓	2.57↓	2.16↓
MW-08 / DG-05	NA(3)	NA(3)	NA(1)	NA(1)

NA - Water level measurements necessary to calculate gradient not available.

(1)- Water level measurements not recorded for these dates.

(2)- Well DG-7 is obstructed.

(3)- Wells not installed at time of measurement.

The highest groundwater elevations at Area B in the bedrock aquifer were recorded during Phase I in January 1991, and the lowest elevations were recorded during Phase II in August 1992 (Table 5-5). Water levels in the bedrock aquifer dropped an average of 6.26 feet between these two dates. Water levels in all the Area B bedrock wells dropped an average of 2.16 feet from July to August 1992 over a five-week period. These elevation changes are generally consistent with seasonal variations and recharge patterns for this area in which groundwater levels are highest in late winter and early spring and are lowest in late summer through early fall (Sloto and Davis, 1983).

5.4.3.2 Overburden Aquifer

The overburden aquifer groundwater elevation map for Area B is shown in Figure 5-13. The general inferred flow direction of groundwater in the overburden aquifer in this area is from north to south with a gradient of approximately 2.5 percent. The horizontal gradient determined during Phase I was 1.8 percent. The overburden aquifer groundwater elevations indicate that flow is away from the main runway and topographic high north of the sites toward the southern boundary of NAWC Warminster. These findings indicate that groundwater flows beneath Site 6 before it enters either Sites 5 or 7.

Estimated well yields for the overburden aquifer monitoring wells at Area B are less than 1/2 to one gallon per minute.

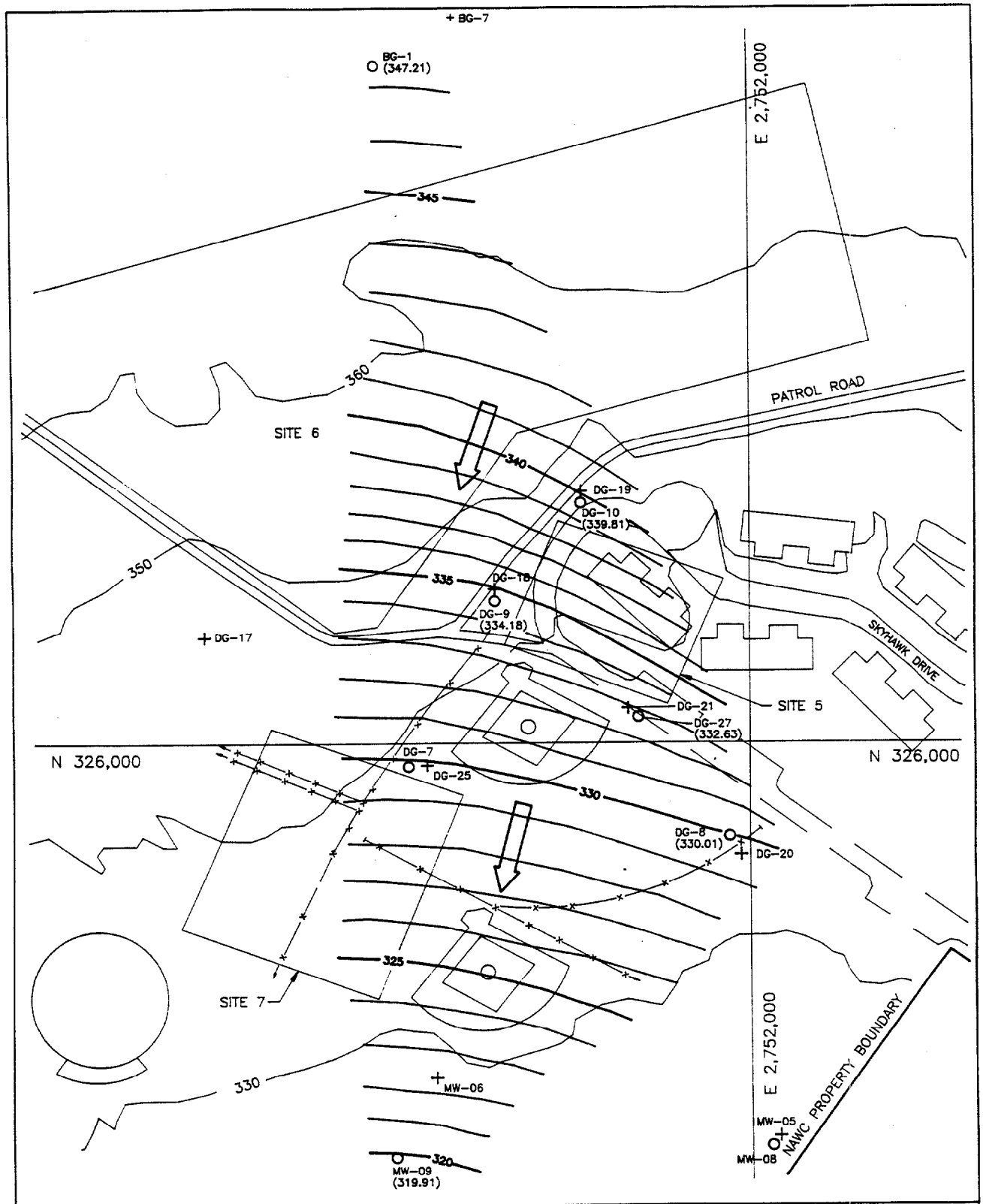
Horizontal groundwater velocities for the overburden aquifer were calculated to be between 1.43 and 4.38 feet per year during Phase. Horizontal groundwater velocities during Phase II were calculated using a horizontal gradient elevation map. These velocities ranged from 1.98 to 6.08 feet per year.

Vertical hydraulic gradients, estimated from head differences between wells in the same couplet, were downward in all well couplets at Area B on all dates of measurement (Table 5-4). This indicates that the overburden aquifer receives no recharge from the bedrock aquifer and that it may be supplying recharge to the underlying bedrock. The consistently downward gradients may indicate that the overburden has lower permeability than the bedrock and that water from precipitation events is stored within the overburden until it has had enough time to infiltrate downward to the bedrock.

TABLE 5-5
NAWC SITES 5, 6, 7
GROUNDWATER ELEVATIONS

Well Number	Groundwater Elevation (feet MSL)			
	12/90	1/91	7/92	8/92
Overburden Aquifer				
MW-08	NA	NA	NA	NA
MW-09	NA	NA	319.91	NA
BG-1	347.55	NA	347.21	NA
DG-7	330.25	337.59	NA	NA
DG-8	328.48	331.58	330.01	327.94
DG-9	333.23	339.07	334.18	332.61
DG-10	335.76	343.59	339.81	336.23
DG-27	330.09	337.20	332.63	329.65
Shallow Bedrock Aquifer				
MW-05	NA	NA	319.80	318.85
MW-06	NA	NA	320.98	320.04
BG-7	346.12	349.74	346.02	343.52
DG-17	332.58	338.82	333.61	330.91
DG-18	330.21	336.21	331.87	329.44
DG-19	330.01	336.00	332.58	329.53
DG-20	326.57	329.20	327.44	325.78
DG-21	329.66	336.19	332.12	329.36
DG-25	329.08	334.75	331.06	328.58

NA= Measurement not available



LEGEND

—330—	EQUIPOTENTIAL LINE
(328.58)	WATER ELEVATION IN WELL (MSL)
	GROUND WATER FLOW DIRECTION
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 5-13
OVERBURDEN AQUIFER
GROUND WATER ELEVATIONS
7/7/92
SITES 5,6 AND 7

HALLIBURTON NUS
Environmental Corporation

Adapted From SMC Environmental Services Group, 1991

DATE: 2/3/93

The highest groundwater elevations at Area B in the overburden aquifer were recorded in January 1991 (Table 5-5). The lowest elevations were recorded during either December 1990 or August 1992. The average elevation difference between the maximum and minimum elevations in overburden wells on these dates is 6.556 feet. Water-table elevations in the Area B overburden wells dropped an average of 2.55 feet during a five-week period from July to August 1992. Water-level declines in zone of the overburden wells are of sufficient magnitude to cause these wells to go dry on occasions. These elevation changes are generally consistent with seasonal variations and recharge patterns for this area in which groundwater levels are highest in late winter and early spring and are lowest in late summer through early fall (Sloto and Davis, 1983).

5.4.4 Hydrology

Southampton Creek is located south of the Area B area. The creek flows north to south, directly away from NAWC Warminster. The base flow rate was measured in an area where the creek is contained within a cement culvert at 98 gpm during Phase I.

Stormwater that collects near Area B is piped underground from the south-central NAWC Warminster property boundary to a point approximately 500 feet to the south, where it flows through a residential area in a concrete channel. The channel flows through the residential subdivision for approximately 1,000 feet and travels through a road culvert before flowing into a natural streambed. This stream flows through a shaded 250 feet reach before entering a small and shallow privately owned pond, which overflows into a second small pond, which in turn flows into Southampton Creek.

5.4.5 Ecology

There is very little flow and virtually no biotic component within the approximately 1,000-foot length of the concrete-lined ditch. Amphipods were observed at the point where this channel flows through the road culvert and into the natural streambed. Midge larvae were found in the fine (i.e., silt) sediments at the head end of the first pond. Fish were not observed, but mallard ducks and Canada geese were active in and around each of the ponds. Raccoon tracks were observed along the shore of the pond as well.

5.5 NATURE AND EXTENT OF CONTAMINATION

The nature and extent of environmental contamination at the area containing Area B are discussed in this section. The validated data generated during the RI provide the basis for this discussion. The complete analytical database to date is included as Appendix K.

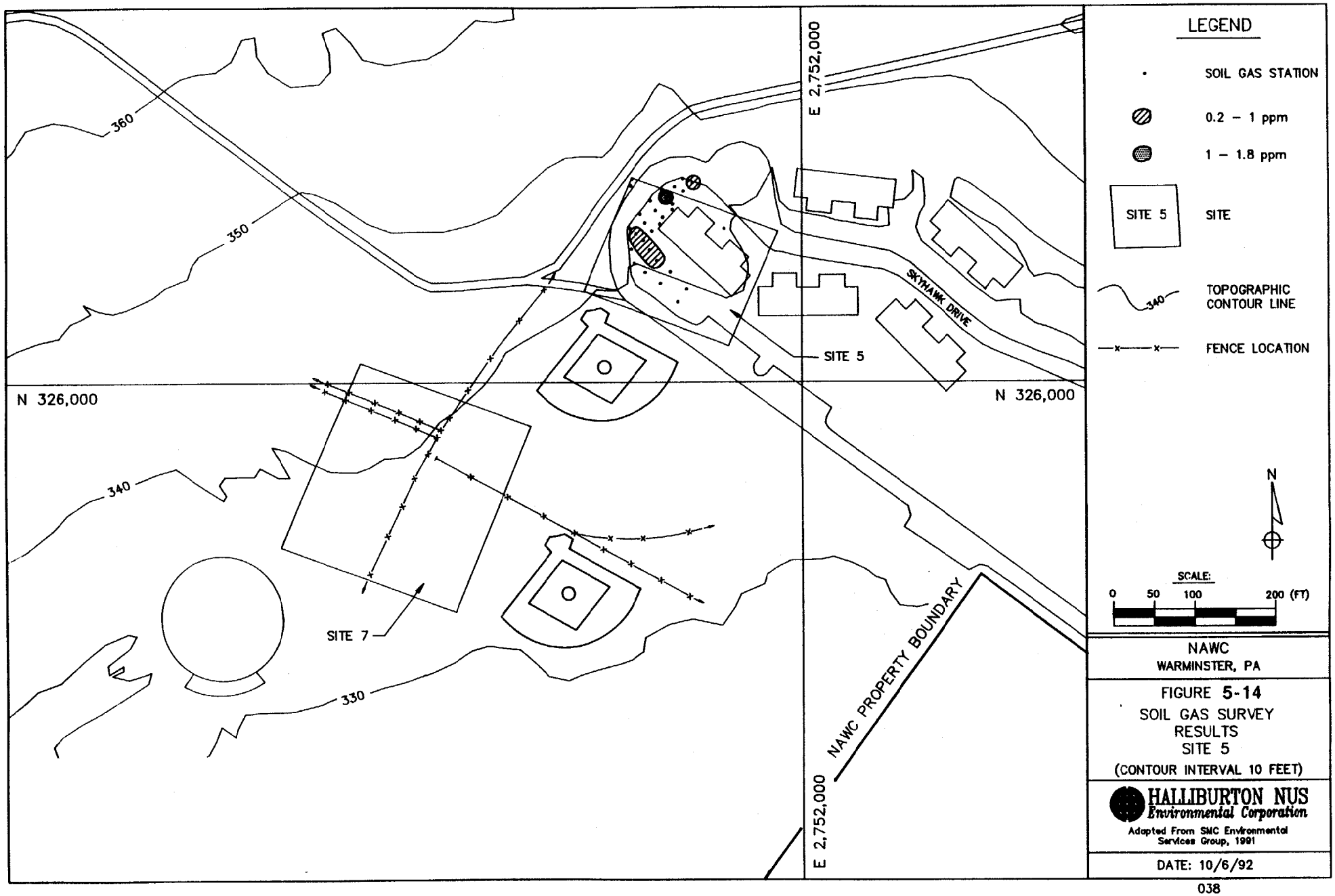
5.5.1 Extent of Contamination for Area B

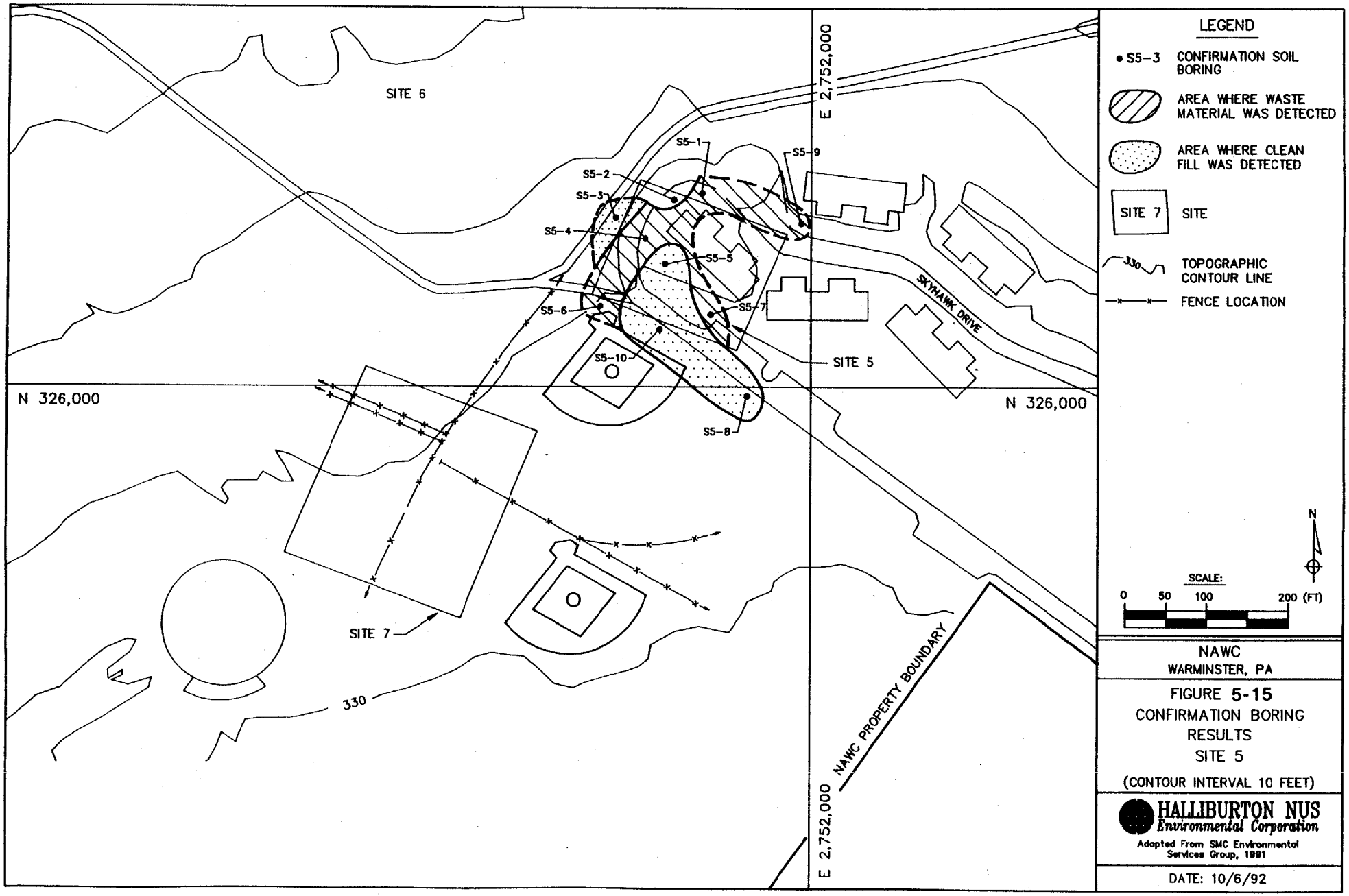
Site 5

Because of the proximity of both buried and overhead utility lines, an EM survey could not be conducted at Site 5. The soil gas survey at Site 5 was conducted to the north, west, and south of Housing Unit 401 on Skyhawk Drive. The small size of the study area allowed the use of a shorter distance between soil gas stations. Six soil gas stations at Site 5 were found to have detectable levels of volatile organic compounds (VOCs). These six soil gas stations were located to the north and west of Housing Unit 401. Figure 5-14 displays the results of the soil gas survey.

A total of 10 confirmation borings were drilled at Site 5. Five borings encountered waste, four encountered non-native clean fill, and one encountered only native soil. Figure 5-15 displays the findings of the confirmation borings conducted at Site 5.

The northernmost, westernmost, and easternmost confirmation borings conducted at Site 5 all encountered waste material. As a result, the exact boundaries of Site 5 cannot be exactly defined in these directions. The two southernmost borings (i.e., S5-8 and S5-10) encountered only non-native clean fill. Thus, the southern extent of Site 5 waste material is defined by the location of these two borings. The trenches reported to be located at Site 5 were not discovered during the boring program. Historical information included in earlier reports indicated that waste material was uncovered during Unit 401 construction only in the northwestern corner of the unit. Therefore, Figure 5-15 indicates waste material is not present under the entire unit.


LEGEND
SOIL GAS STATION
0.2 – 1 ppm
1 – 1.8 ppm
SITE 5
SITE
TOPOGRAPHIC CONTOUR LINE
FENCE LOCATION
N
SCALE:
0 50 100 200 (FT)
NAWC
WARMINSTER, PA
FIGURE 5-14
SOIL GAS SURVEY RESULTS
SITE 5
(CONTOUR INTERVAL 10 FEET)
HALLIBURTON NUS
Environmental Corporation
Adapted From SMC Environmental Services Group, 1991
DATE: 10/6/92
038
E 2,752,000
N 326,000
360
350
340
330
SITE 5
SITE 7
SKYHAWK DRIVE
NAWC PROPERTY BOUNDARY


SITE 6
E 2,752,000
S5-1
S5-9
S5-2
S5-3
S5-4
S5-5
S5-6
S5-7
S5-10
S5-8
SKYHAWK DRIVE
SITE 5
N 326,000
N 326,000
SITE 7
330
NAWC PROPERTY BOUNDARY
E 2,752,000
LEGEND
S5-3 CONFIRMATION SOIL BORING
AREA WHERE WASTE MATERIAL WAS DETECTED
AREA WHERE CLEAN FILL WAS DETECTED
SITE 7 SITE
330 TOPOGRAPHIC CONTOUR LINE
FENCE LOCATION
N
SCALE:
0 50 100 200 (FT)
NAWC
WARMINSTER, PA
FIGURE 5-15
CONFIRMATION BORING RESULTS
SITE 5
(CONTOUR INTERVAL 10 FEET)
HALLIBURTON NUS
Environmental Corporation
Adapted From SMC Environmental Services Group, 1991
DATE: 10/6/92

039

VOCs were detected from three to six feet below ground surface (bgs) in boring S5-1 at a 1 to 10 ppm concentration and from eight to 10 feet BGS in boring S5-5 at a 1 to 15 ppm concentration. The location of the confirmation borings corresponds closely to some of the areas where VOCs were detected during the soil gas survey. In both of these borings, the VOCs were encountered in a zone of water-saturated soil. This indicates that there is a shallow zone of groundwater that presumably contains elevated levels of VOCs.

The average thickness of waste material detected at Site 5 was four to five feet. The average thickness of non-native clean fill at Site 5 was five to six feet.

Site 6

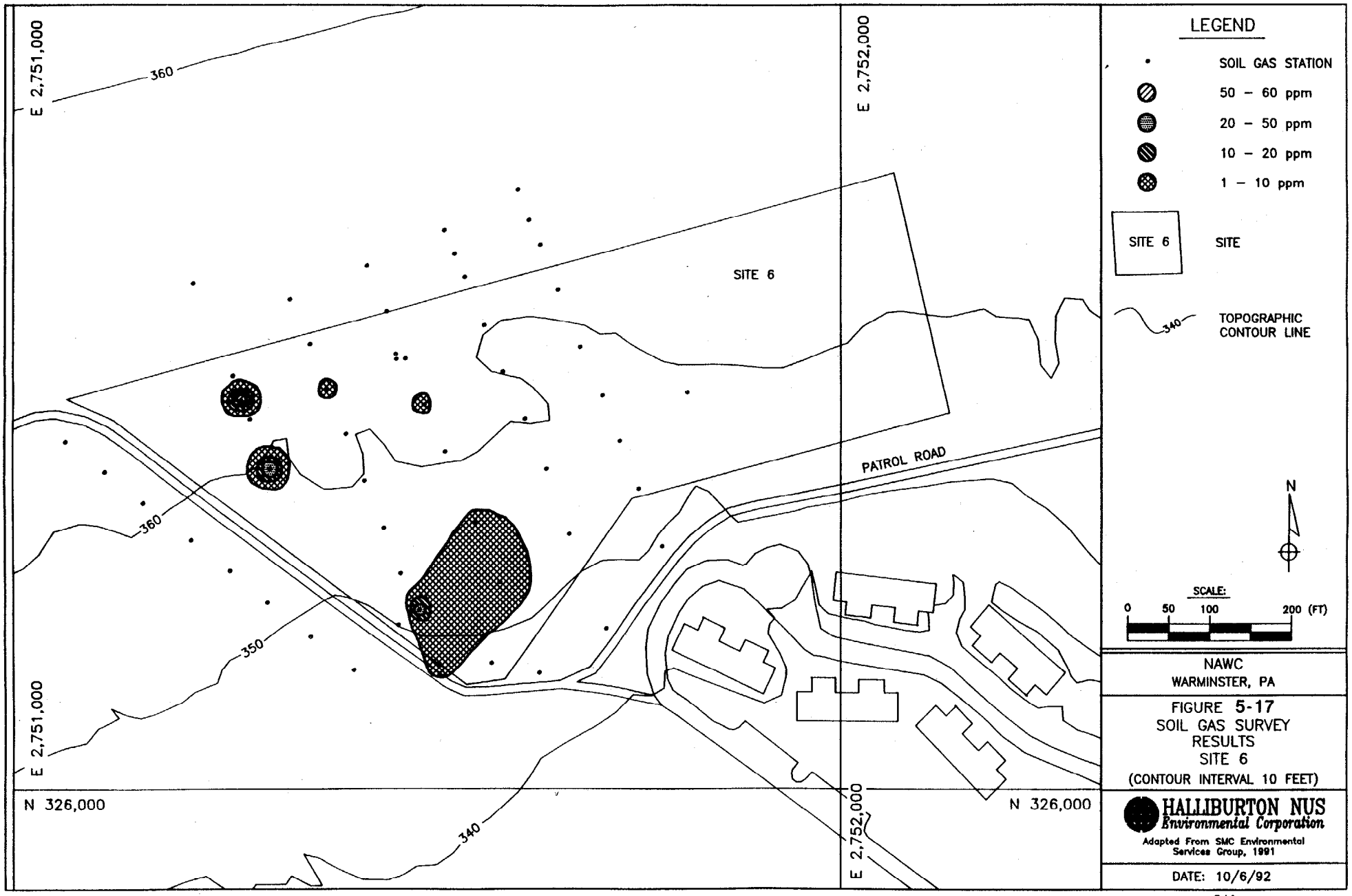
The EM survey at Site 6 identified two areas with anomalous readings. These are marked on Figure 5-16. The larger area is approximately 450 by 750 feet in size and is bordered by the patrol road to the south and the west. In the southwestern portion of this area, cement, brick, and other building materials can be seen on the ground surface or protruding through the soil. The second anomalous area, which appears to be a trench, is approximately 30 by 150 feet in size and is located just northeast of the large anomalous area. Although the larger anomalous area is generally seen as a conductivity high (i.e., up to 32 umhos/m compared to a background of 14 to 18 umhos/m), many fluctuations are apparent. These fluctuations indicate the buried material is heterogeneous. The smaller apparent trench area is generally seen as a conductivity low (i.e., 8 umhos/m compared to a background of 14 to 18 umhos/m). Both of these areas are suggested to contain scattered metallic objects; however, the EM survey indicates that the apparent trench area contains a much higher proportion of metal.

The depth profiles performed by the EM survey in the apparent trench area show a lower conductivity surface layer that is approximately 10 feet thick. This may represent up to 10 feet of waste or fill in this area. The depth profiles in the large anomalous area showed decreasing conductivity with depth and a surface layer or cap of approximately one to two feet thick, indicating that much of the burial or filling was close to the existing land surface.

Eight soil gas stations contained elevated VOC levels at 1 to 52 ppm. As shown in Figure 5-17, these soil gas stations are located in the western portion of the site, where scattered debris and mounded soil can be seen on the ground surface.

E 2,751,000
E 2,752,000
SITE 6
PATROL ROAD
360
350
340
N 326,000
N 326,000
E 2,751,000
E 2,752,000
LEGEND
EM ANOMALY
M
POSSIBLE BURIED METAL
SITE 6
SITE
340
TOPOGRAPHIC CONTOUR LINE
N
SCALE:
0 50 100 200 (FT)
NAWC
WARMINSTER, PA
FIGURE 5-16
ELECTROMAGNETIC SURVEY RESULTS
SITE 6
(CONTOUR INTERVAL 10 FEET)
HALLIBURTON NUS
Environmental Corporation
Adapted From SMC Environmental Services Group, 1991
DATE: 10/6/92

040


E 2,751,000
E 2,752,000
360
SITE 6
PATROL ROAD
360
350
340
N 326,000
N 326,000
LEGEND
SOIL GAS STATION
50 - 60 ppm
20 - 50 ppm
10 - 20 ppm
1 - 10 ppm
SITE 6
SITE
340
TOPOGRAPHIC CONTOUR LINE
N
SCALE:
0 50 100 200 (FT)
NAWC
WARMINSTER, PA
FIGURE 5-17
SOIL GAS SURVEY RESULTS
SITE 6
(CONTOUR INTERVAL 10 FEET)
HALLIBURTON NUS
Environmental Corporation
Adapted From SMC Environmental Services Group, 1991
DATE: 10/6/92

041

Six test pits were excavated near the perimeter of the anomalous EM areas and adjacent to soil gas anomalies. Figure 5-18 displays the location and findings of the test pits at Site 6. Test pits performed within the two EM anomalies encountered waste material. Therefore, Site 6 appears to extend throughout the areas of anomalous EM readings.

Clean fill material and construction debris were detected in five of the six test pits. The presence of the fill and the construction debris found lying on the ground and in the test pits indicates that the western portion of the Site 6 area had been extensively reworked. No VOCs were detected during the test pit excavations, with the exception of 0.1 ppm at S6-PIT-4.

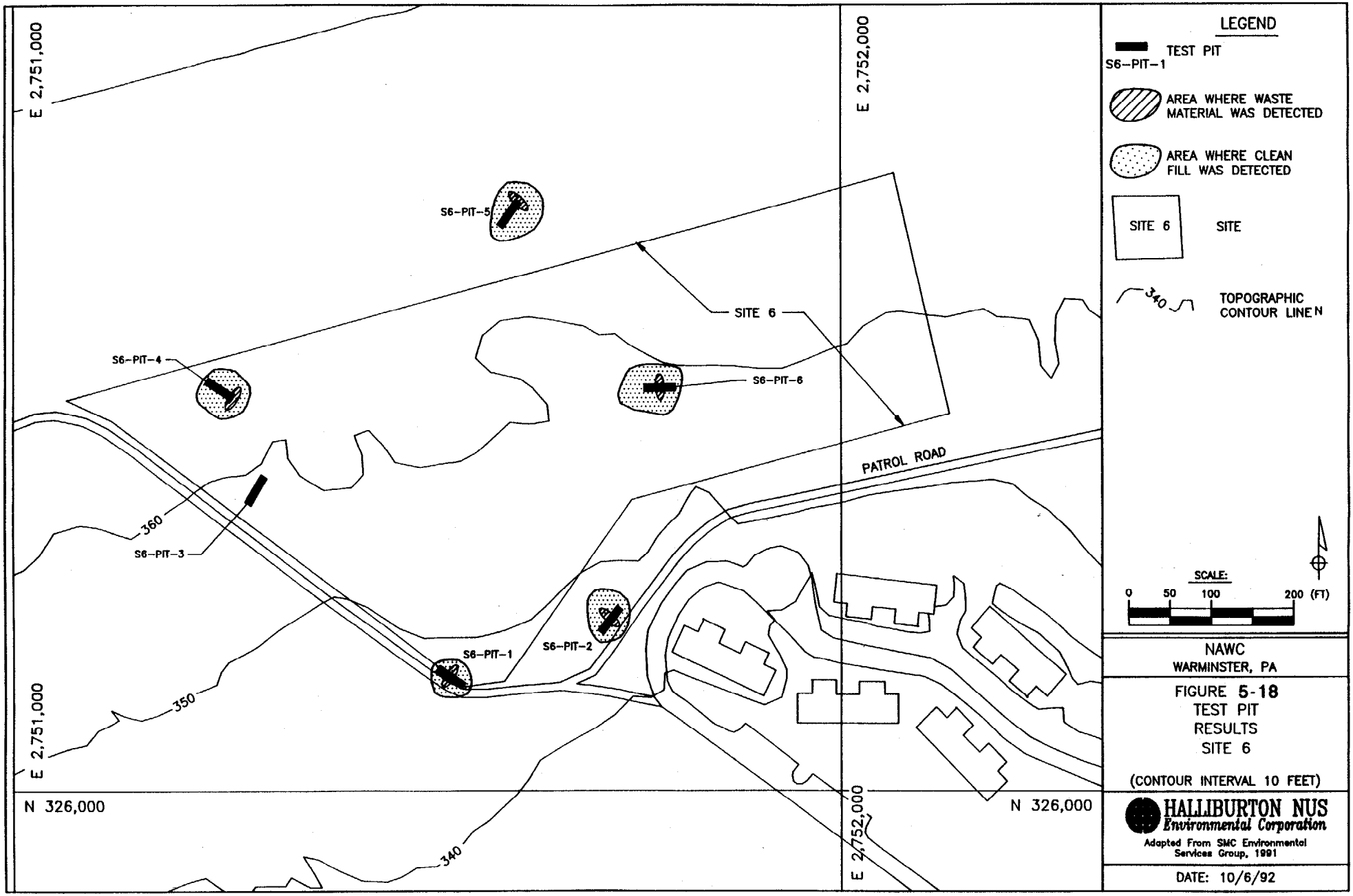
The findings of the EM survey, the soil gas survey, and the test pits indicate that waste material is concentrated in the western portion of Site 6 and that the eastern portion of the site contains comparatively little waste.

Site 7

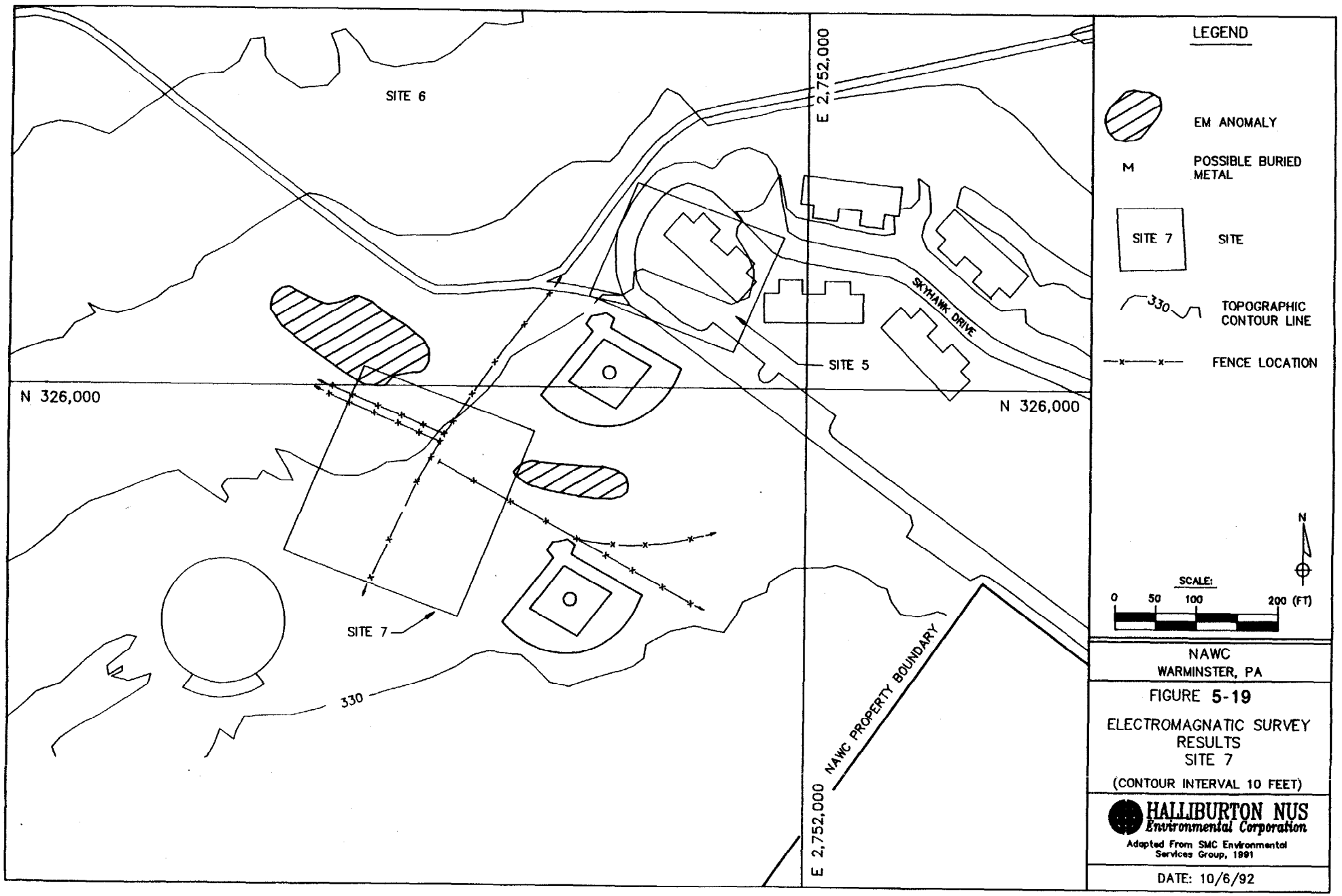
The EM survey over Site 7 delineated two anomalies. The first was near the patrol road, and the second was in the northern baseball field. These areas are marked on Figure 5-19. These anomalies were less than 3 umho/m above background levels. No indications of buried metal were found during the survey. The anomaly within the baseball field was probably caused by a bedrock pinnacle, subsequently discovered during the excavation of a test pit.

The soil gas survey area for Site 7 is shown on Figure 5-20. VOCs were detected at 12 soil gas points. The readings were uniformly low (i.e., between 0.4 and 1.5 ppm). Six of these points were in or immediately adjacent to the area previously identified as Site 7 based on the review of aerial photographs. None of the 12 soil gas points where VOCs were detected were inside the two EM anomalies present at Site 7. The location of the areas of elevated soil gas readings displayed no specific pattern.

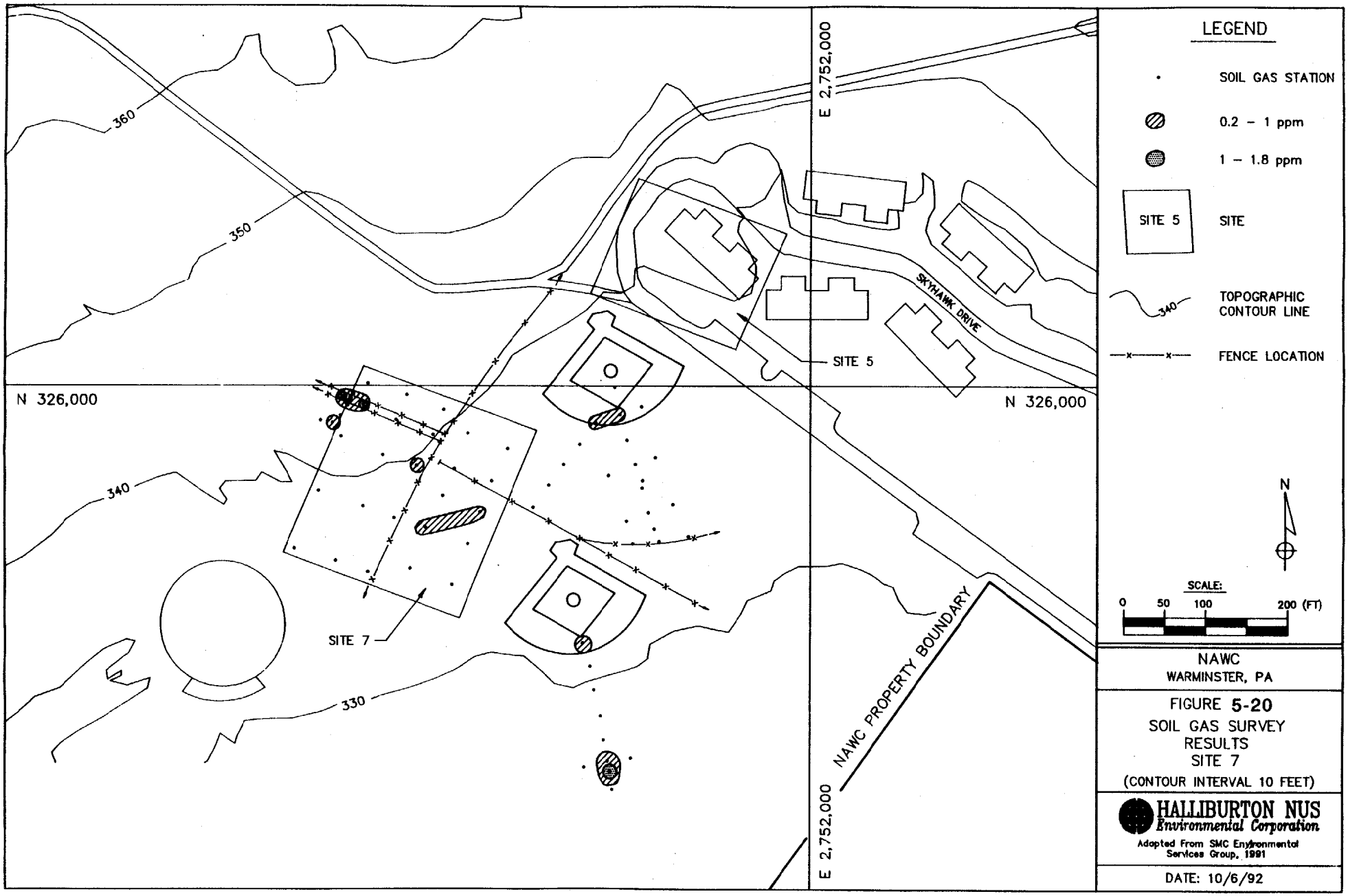
Figure 5-21 shows the locations of the confirmation borings and test pits conducted at Site 7. No waste or significant fill material was found in any of the 14 confirmation borings or three test pits completed at Site 7. These confirmation borings and test pits were located in areas where the EM and soil gas surveys had indicated anomalous readings. The testing conducted at Site 7 did not identify discernible evidence of filling or sewage sludge.


E 2,751,000
E 2,752,000
S6-PIT-5
SITE 6
S6-PIT-4
S6-PIT-6
PATROL ROAD
360
S6-PIT-3
S6-PIT-2
S6-PIT-1
350
340
N 326,000
N 326,000
LEGEND
TEST PIT
S6-PIT-1
AREA WHERE WASTE MATERIAL WAS DETECTED
AREA WHERE CLEAN FILL WAS DETECTED
SITE 6
SITE
340
TOPOGRAPHIC CONTOUR LINE
SCALE:
0 50 100 200 (FT)
NAWC
WARMINSTER, PA
FIGURE 5-18
TEST PIT
RESULTS
SITE 6
(CONTOUR INTERVAL 10 FEET)
HALLIBURTON NUS
Environmental Corporation
Adapted From SMC Environmental Services Group, 1991
DATE: 10/6/92

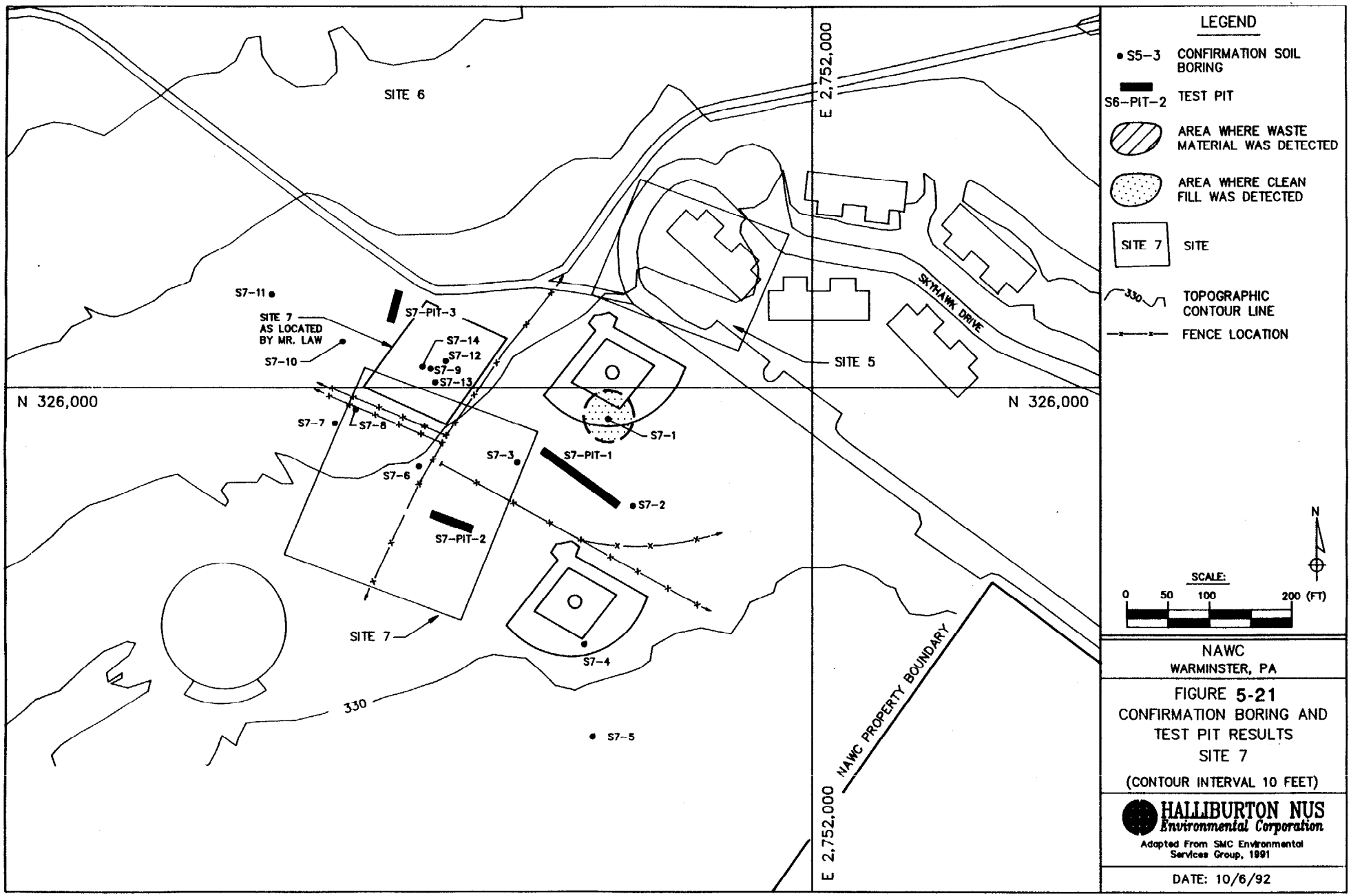
042


SITE 6
E 2,752,000
SKYHAWK DRIVE
SITE 5
N 326,000
N 326,000
SITE 7
330
NAWC PROPERTY BOUNDARY
E 2,752,000
LEGEND
EM ANOMALY
M
POSSIBLE BURIED METAL
SITE 7
SITE
330
TOPOGRAPHIC CONTOUR LINE
FENCE LOCATION
N
SCALE:
0 50 100 200 (FT)
NAWC
WARMINSTER, PA
FIGURE 5-19
ELECTROMAGNATIC SURVEY RESULTS
SITE 7
(CONTOUR INTERVAL 10 FEET)
HALLIBURTON NUS
Environmental Corporation
Adapted From SMC Environmental Services Group, 1991
DATE: 10/6/92

043


LEGEND
SOIL GAS STATION
0.2 – 1 ppm
1 – 1.8 ppm
SITE 5
SITE
TOPOGRAPHIC CONTOUR LINE
FENCE LOCATION
N
SCALE:
0 50 100 200 (FT)
360
350
340
330
N 326,000
E 2,752,000
SITE 5
SITE 7
SKYHAWK DRIVE
NAWC PROPERTY BOUNDARY
NAWC
WARMINSTER, PA
FIGURE 5-20
SOIL GAS SURVEY
RESULTS
SITE 7
(CONTOUR INTERVAL 10 FEET)
HALLIBURTON NUS
Environmental Corporation
Adapted From SMC Environmental Services Group, 1991
DATE: 10/6/92

044


SITE 6
E 2,752,000
SKYHAWK DRIVE
SITE 5
N 326,000
N 326,000
S7-11
SITE 7
AS LOCATED
BY MR. LAW
S7-10
S7-PIT-3
S7-14
S7-12
S7-9
S7-13
S7-7
S7-8
S7-6
S7-3
S7-PIT-1
S7-1
S7-2
S7-PIT-2
SITE 7
S7-4
330
S7-5
NAWC PROPERTY BOUNDARY
E 2,752,000
LEGEND
S5-3 CONFIRMATION SOIL BORING
S6-PIT-2 TEST PIT
AREA WHERE WASTE MATERIAL WAS DETECTED
AREA WHERE CLEAN FILL WAS DETECTED
SITE 7 SITE
330 TOPOGRAPHIC CONTOUR LINE
FENCE LOCATION
N
SCALE:
0 50 100 200 (FT)
NAWC
WARMINSTER, PA
FIGURE 5-21
CONFIRMATION BORING AND
TEST PIT RESULTS
SITE 7
(CONTOUR INTERVAL 10 FEET)
HALLIBURTON NUS
Environmental Corporation
Adapted From SMC Environmental Services Group, 1991
DATE: 10/6/92

045

On October 29, 1990, after Phase I had not confirmed the location of Site 7, a former employee of NAWC Warminster visited Site 7 with facility representatives. The employee indicated that the Site 7 disposal trenches were located just northeast of the paved walkway between the inertial reference building and Site 6. This area is marked on Figure 5-21 as "Site 7 as located by Mr. Law."

Review of data from investigative tasks conducted before the former employee's visit showed that the EM survey indicated a large anomaly in and near this area. However, the soil gas survey, confirmation borings, and test pits did not find any discernible evidence of the sewage sludge in this area.

5.5.2 Content of Area B

Site 5

The gas chromatograph (GC) indicated that the volatile organic vapors in Site 5 soil gas contained 25 ppb of acetone and one unknown compound. The acetone is possibly a product of the paints and solvents buried at Site 5, since GC method blanks run at Site 5 did not detect acetone.

Waste actually detected at the site included wood, glass, and an abundance of metal fragments. These materials may represent the scrap metal and building demolition wastes reportedly disposed at Site 5. None of the asphalt reported to have been placed at Site 5 was encountered by any of the confirmation borings.

VOCs were detected during the drilling of confirmation borings S5-1 and S5-5. These VOCs may be from the paints and solvents reportedly disposed in Site 5.

In summary, wastes found during this study at Site 5 are consistent with what was reportedly placed in the trenches.

The EM survey indicated possible buried metallic objects in the central portion of Site 6 and in an area north of the site. These areas are marked with an "M" on Figure 5-16.

Site 6

The soil gas survey at Site 6 was conducted over the area shown in Figures 5-5 and 5-17. The spacing of the soil gas stations was kept as regular as the wooded terrain would allow. The survey grid covered the area of anomalous EM readings.

GC readings taken during the soil gas survey on January 17, 1990 indicated that 56 ppb of acetone and two unknown compounds were present. However, the acetone and one of the unknown compounds had been detected at higher levels in a previously run GC method blank. Small amounts of acetone remained after several attempts to cleanse the system. Acetone was found in most samples collected on this day. The second unknown compound identified is probably present at the site. The acetone and the first unknown compound found in the method blank probably did not originate from waste present at the site.

In several areas at Site 6, especially along the eastern portion of the site, building demolition debris can be seen scattered on the ground surface. This debris consists of slabs of asphalt, concrete, and brick structures.

Several vegetated and mounded areas atypical of the normal topography in the area were found in the eastern portion of Site 6. Close inspection revealed that the mounds consist of building demolition debris similar to that seen lying on the ground surface nearby. A photoionization detector (PID) reading at one of these mounds indicated VOCs were present at a concentration of 52 ppm. These vapors may be from paints or solvents present in the soil or they may be emanating from asphalt found buried in the mound.

Five of the six test pits excavated at Site 6 encountered general construction debris including cement, glass, wires and electrical parts, scrap metal, and asphalt. One empty paint drum was discovered in test pit S6-Pit-5. The locations of the test pits are shown in Figure 5-7 and 5-18. In general, waste found at Site 6 was the same as that reported to have been disposed at the site (i.e., heterogeneous disposal of a wide variety of materials).

Site 7

The GC indicated that the VOCs detected during the soil gas survey contained two unknown compounds. These compounds were not detected in GC method blanks run at Site 7 and therefore may be present in soil gas.

Waste was not encountered in any of the test pits conducted at Site 7. Additionally, no volatile organic vapors were detected in any of the soils removed from the test pit excavations.

Confirmation boring S7-1 was found to contain fill near the ground surface, but this appears related to construction of the baseball diamond. All other confirmation borings at Site 7 did not detect waste material.

Since no waste material was detected during the investigative tasks conducted at Site 7, the content of the site cannot be further confirmed.

5.5.3 Groundwater

Twenty-four unfiltered samples were obtained from wells considered to be downgradient of Area B. Table 5-6 presents the occurrence and distribution of these results. Unfiltered groundwater results are used for risk assessment. However, monitoring wells can contain significant amounts of suspended material that result in overestimates of metal contamination in groundwater. Therefore, filtered results (for Phase II wells only) are presented in Table 5-7 for comparison purposes and may be used to qualify the risk assessment.

The cyanide result in Phase II DG-10 (MW-13) may be suspect, according to data validation. Because it is unusual to see cyanide in groundwater at such concentrations, especially when there are no other positive detections, and because the reported concentration matched the calibration standard nearly exactly, it is suspected that the calibration standard may have accidentally been run instead of the sample. However, since this could not be proven with available information, risk assessment must include this number and assume that it is real.

Comparison of downgradient unfiltered results to downgradient filtered results reveals that the filtered results are generally much lower, except for potassium, zinc, calcium, magnesium, and sodium. Many elements, such as aluminum, arsenic, cadmium, chromium, copper, lead, and vanadium, are not even detected in the filtered samples.

TABLE 5-6
OCCURRENCE AND DISTRIBUTION OF UNFILTERED MONITORING WELL INORGANICS - SITES 5, 6, 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

TABLE 5-7
OCCURRENCE AND DISTRIBUTION OF FILTERED MONITORING WELL INORGANICS - SITES 5, 6, 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

Notable representative concentrations in unfiltered downgradient wells include those of arsenic, lead, cyanide, and manganese. A detailed discussion of these results with respect to drinking water criteria and dose-response parameters is included in Section 5.7. Upgradient unfiltered and filtered monitoring well inorganics were presented in Tables 4-8 and 4-9, respectively. While concentrations of arsenic, barium, cobalt, iron, potassium, zinc, and cyanide exceed those of upgradient wells, the representative concentrations of many metals are lower in the unfiltered downgradient wells than in the upgradient wells. In filtered samples, the downgradient sample concentrations tend to be higher for barium, iron, potassium, thallium, and zinc.

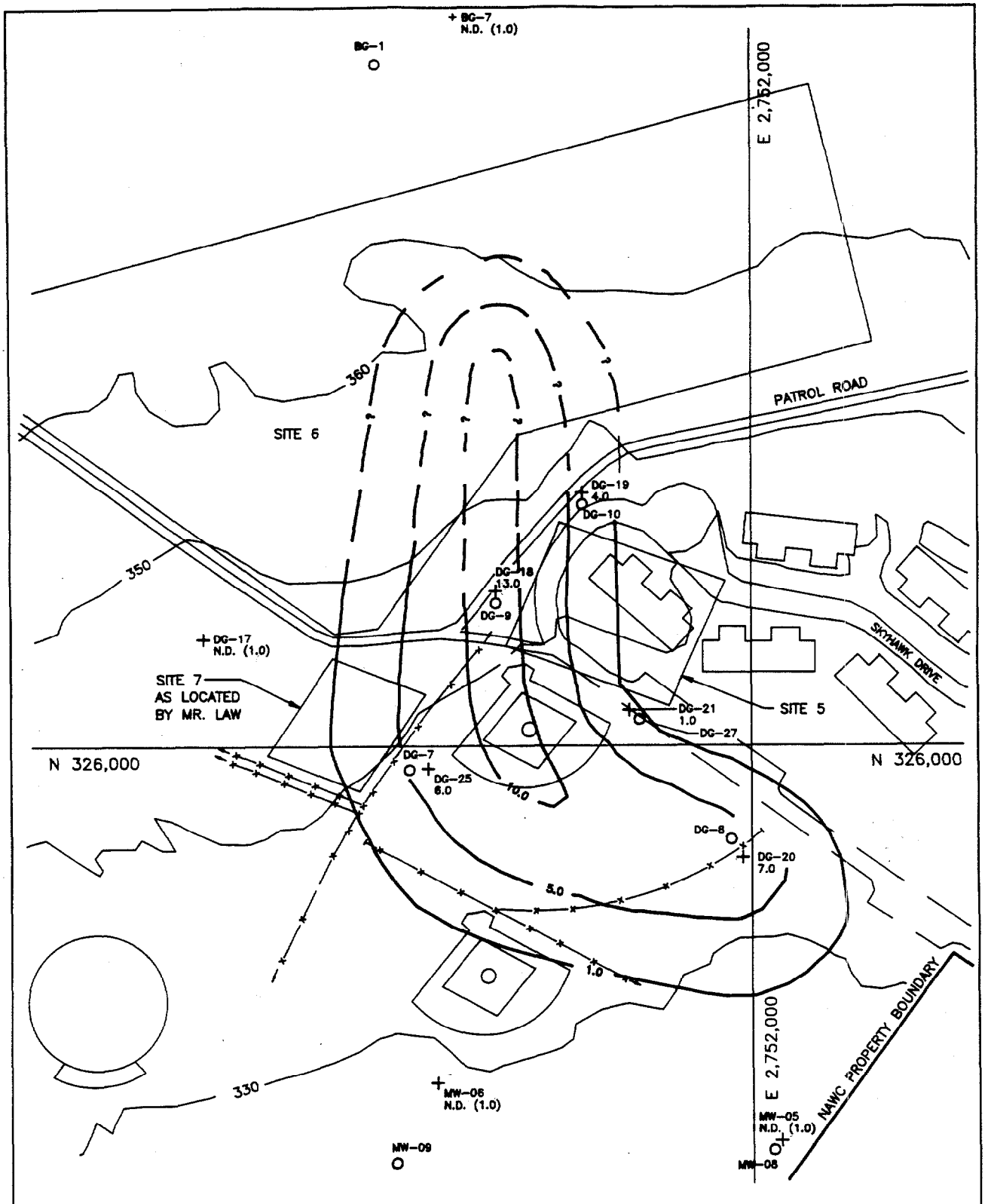
No pattern of contamination by well location was observed, although the maximum concentration for lead was reported in a well (Phase II MW-06; MW-18, located south of the sites, near a baseball diamond) in which the maximum concentrations of some other metals were detected. The well with the positive cyanide result (Phase II DG-10; MW-13) is located just north of Site 5. Manganese concentrations are particularly high in all wells, except DG-19 (Phase I; known as MW-15 in Phase II) (located just north of Site 5). There does not appear to be an identifiable plume of metals contamination in groundwater, based on these data. MW-06 and DG-19 are screened in the shallow bedrock, and DG-10 is screened in the overburden.

Table 5-8 summarizes the occurrence and distribution of monitoring well organics at Area B. VOCs and phthalates were detected in the monitoring wells. The VOCs included chlorinated ethenes, carbon tetrachloride, chloromethane, chloroform, toluene, and 1,1,1-trichloroethane (1,1,1-TCA). Concentrations of trichloroethene (TCE) and cis-1,2-dichloroethene (cis-1,2-DCE) in shallow bedrock groundwater are shown in Figures 5-22 and 5-23, respectively. Positive detections were generally low level and scattered throughout the study area. However, the extreme western well (DG-17; known as MW-16 in Phase II) and the southernmost wells [MW-06 (known as MW-18 in Phase II), MW-09 (known as MW-20 in Phase II), and MW-05 (known as MW-17 in Phase II)] exhibited only trace concentrations of toluene and/or 1,1,1-TCA. In general, concentrations were higher in shallow bedrock than in overburden wells, except for toluene at 6 ug/l in Phase II DG-8 (MW-22).

TABLE 5-8
OCCURRENCE AND DISTRIBUTION OF MONITORING WELL ORGANICS - SITES 5, 6, 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 indentified compounds



LEGEND

6.0	TCE CONCENTRATION, MICROGRAMS PER LITER	DG-7	OVERBURDEN MONITORING WELL
N.D.	TCE NOT DETECTED ABOVE DETECTION LIMIT (IN PARENTHESES)	DG-25	SHALLOW BEDROCK MONITORING WELL
5.0	TCE CONCENTRATION CONTOUR, MICROGRAMS PER LITER (DASHED WHERE INFERED)	330	TOPOGRAPHIC CONTOUR LINE

N

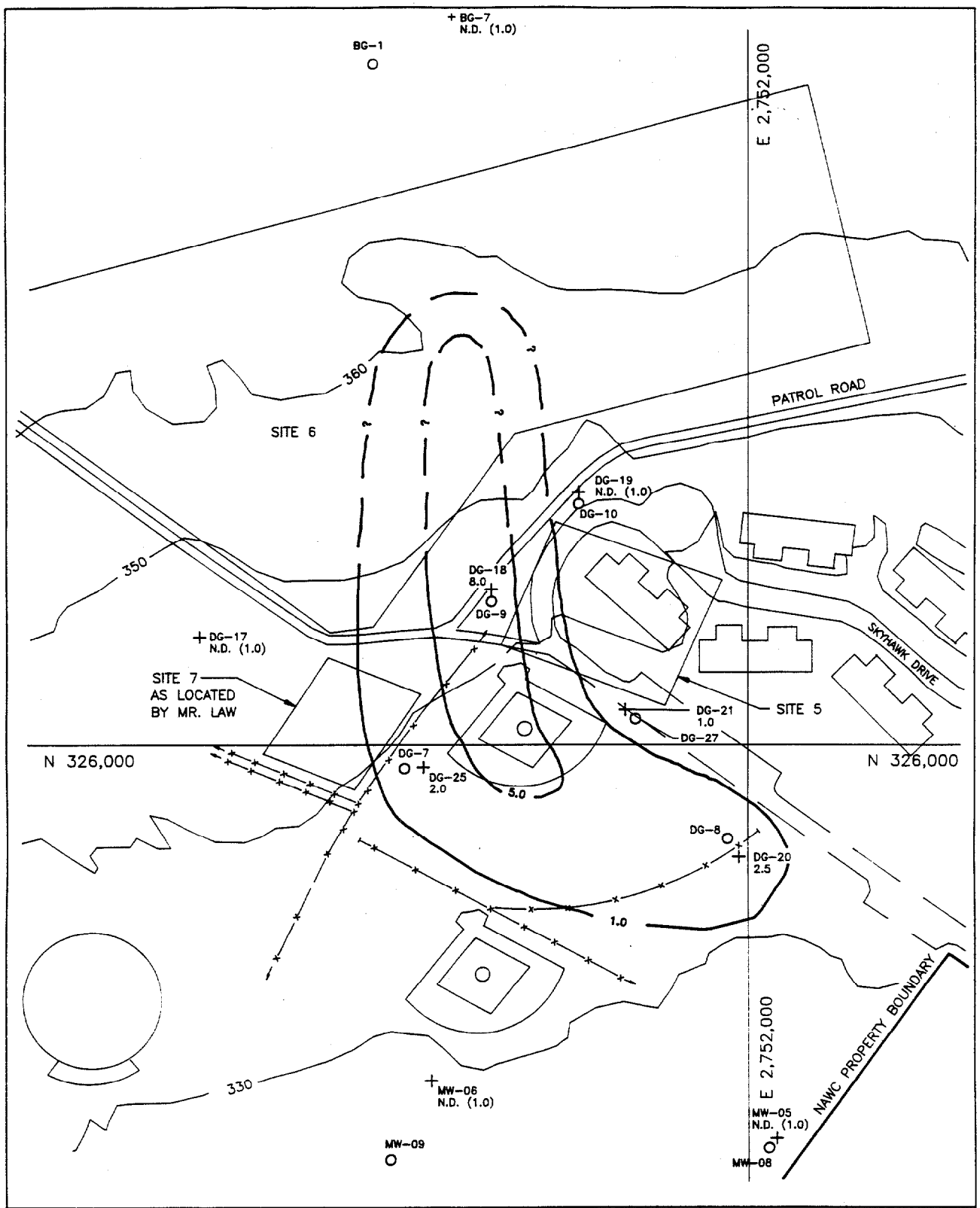
SCALE:
0 50 100 200 (FT)

NAWC
WARMINSTER, PA

FIGURE 5-22
TCE CONCENTRATIONS IN SHALLOW BEDROCK GROUNDWATER
(CONTOUR INTERVAL 10 FEET)

HALLIBURTON NUS
Environmental Corporation
Adapted From SMC Environmental Services Group, 1991

DATE: 10/12/92



LEGEND

2.0	cis – 1,2-DCE CONCENTRATION, MICROGRAMS PER LITER	O DG-7	OVERBURDEN MONITORING WELL
N.D.	cis – 1,2 – DCE NOT DETECTED ABOVE DETECTION LIMIT (IN PARENTHESES)	+ DG-25	SHALLOW BEDROCK MONITORING WELL
5.0	cis – 1,2-DCE CONCENTRATION CONTOUR, MICROGRAMS PER LITER (DASHED WHERE INFERED)	330	TOPOGRAPHIC CONTOUR LINE

N

SCALE:
0 50 100 200 (FT)

NAWC
WARMINSTER, PA

FIGURE 5-23
cis – 1,2-DCE
CONCENTRATION IN SHALLOW
BEDROCK GROUNDWATER

HALLIBURTON NUS
Environmental Corporation

Adapted From SMC Environmental Services Group, 1991

DATE: 10/12/92

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5.5.4 Summary

Notable representative concentrations in unfiltered downgradient wells include those of arsenic, lead, cyanide, and manganese. The maximum concentration for lead is reported in a well (Phase II MW-06; MW-18, located south of the sites, near a baseball diamond) in which the maximum concentrations of some other metals are detected. The well with the positive cyanide result (Phase II DG-10; MW-13) is located just north of Site 5. Manganese concentrations are particularly notable in all wells, except DG-19 (Phase I and known as MW-15 in Phase II) (located just north of Site 5). There does not appear to be an identifiable plume of metals contamination in the groundwater, based on these data. The cyanide result is questionable but could not be proven to be a false positive.

Toluene is detected in monitoring wells, as are chlorinated ethenes, carbon tetrachloride, chloromethane, chloroform, and 1,1,1-TCA. Positive detections are generally low-level and scattered throughout Area B. In general, concentrations are higher in shallow bedrock wells than in overburden wells, except for toluene at 6 ug/l in Phase II DG-8 (MW-22).

5.6 CONTAMINANT FATE AND TRANSPORT

Various aspects of groundwater contaminant fate and transport at Area B are discussed in this section. Various chemical and physical properties affecting contaminant migration are discussed in Section 5.6.1. Potential groundwater contaminant migration routes are identified and discussed in Section 5.6.2. Section 5.6.3 presents a brief discussion of contaminant persistence.

5.6.1 Physical and Chemical Transport Properties

This section provides a qualitative discussion of potential migration of groundwater contaminants found at Area B. The physical and chemical properties of the chemicals found in Area B, where available, are presented in Tables 5-9 and 5-10. These parameters may be used to assess the behavior of a chemical in the environment.

TABLE 5-9
MOBILITY PARAMETERS FOR ORGANIC CHEMICALS - SITES 5, 6, 7
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Mol[1] Wt.(g)	Sol[1] (mg/L)	Low Kow [2][3][4]	V.P.[1] (mmHg,20C)	H[1][3]atm.m^3 mol	BCF[1]	Sp. Grav.[2][5] (25C)	Koc[1]
Trichloroethene	131.39	1100	2.53	5.79E1	9.1E-3	9.7E1	1.46	1.262E2
Tetrachloroethene	165.83	200	2.6(20C)	1.4E1	1.53E-2	2.52E2	1.626	3.64E2
Chloroform	119.38	8200	1.97(20C)	1.5E2	2.88E-3	5.56[6]	1.489	4.4E1
Toluene	92.13	534.8(25C)	2.69(20C)	2.87E1	6.66E-3	2.5E1[6]	0.867	3E2
Aroclor 1248	299.5[4]	0.054[4]	5.75	4.9E-4(25C)[4]	4.4E-4	-	-	-
Aroclor 1254	328.4	0.031(25C)	6.03	7.71E-5(25C)	2.6E-3	1.3E5	-	5.3E5
Naphthalene	128.2	31.7(25C)	3.01/3.45	8.7E-3(25C)	4.6E-4	4.2E2	1.152	9.4E2
Fluoranthene	202.3	0.26(25C)	5.33	5E-6(25C)	6.5E-6	1.2E4	1.252	3.8E4
Pyrene	202.3	0.13(25C)	5.18	2.5E-6(25C)	5.1E-6	1.2E4	-	3.8E4
Benz[a]anthracene	228.28	0.0057	5.61	2.2E-8	1E-6	5.3E4	-	2E5
Chrysene	228.3	0.0018(25C)	5.61	6.3E-9(25C)	1.05E-6	5.3E4	1.274	2E5
Benzo[b]fluoranthene	252.3	0.0014(25C)	6.57	5E-7	1.22E-5	1.4E5	-	5.5E5
Chloromethane	50.94	6450	0.95	3.76E3	4E-2	3.2	0.991	4.3
Benzo[a]pyrene	252	0.0038(25C)	5.98	5.6E-9	4.9E-7	1.09E4[6]	-	5.5E6
1,1,1-Trichloroethane	133.41	720	2.47	1.23E2(25C)	3E-2	8.1E1	1.35	1.52E1
Carbon tetrachloride	153.82	785	2.64	9E1	2.3E-2	2.11E2	1.59	4.39E2
Di-n-octylphthalate	391	8700	9.2	1.4E-4	1.7E-5	3.9E8	0.99	3.6E9
cis-1,2-Dichloroethene	96.94	800(20C)	-	200(25C)	4.08E-3	48	1.28	59
N-nitrosodiphenylamine	198.2	40	-	1E-1(25C)	6.6E-4	4.62E2	-	6.48E2
Dieldrin	381	0.1	3.54	1.8E-7(25C)	4.57E-10	7.1E2	1.75	1.7E3
4,4'-DDE	318	0.04(20C)	4.28	6.5E-6	6.8E-5	8E6	-	4.4E6
4,4'-DDT	354.5	0.0055(25C)	6.19	1.9E-7(25C)	1.58E-5	8E6	-	3.9E6
Methoxychlor	345.66	0.04(24C)	-	-	-	8.3E3	1.41	8E4
4-Methylphenol	108.1	4400	1.92	4E-2	1.29E-6	11	1.0347	2.4E1
Di-n-butylphthalate	278.34	400(25C)	-	0.1(115C)	2.8E-7	4.7E4	1.0465	1.7E5
Diethylphthalate	222.2	210	2.47	3.5E-3(25C)	1.2E-6	1.07E2	1.12	1.42E2

TABLE 5-9
MOBILITY PARAMETERS FOR ORGANIC CHEMICALS - SITES 5, 6, 7
NAWC, WARMINSTER, PENNSYLVANIA
PAGE TWO

Chemical	Mol[1] Wt. (g)	Sol[1] (mg/L)	Low Kow[2][3][4]	V.P.[1] (mmHg,20C)	H[1][3] atm.m^3 mol	BCF[1]	Sp. Grav.[2][5] (25C)	Koc[1]
Bis[2-ethylhexyl]phthlate	390.62	0.4(25C)	5.3	2E-7	3E-7	2.3E8	0.99	2E9
Acenaphthene	154.2	3.42(25C)	3.92	1.55E-3(25C)	9.1E-5	1.8E3	1.0242	4.6E3
Anthracene	178.2	0.045(25C)	4.45	1.7E-5(25C)	8.6E-5	4.7E3	1.283	1.4E4
Phenanthrene	178.2	1.0(25C)	4.45	9.6E-4(25C)	2.3E-4	4.7E3	1.025	1.4E4
Benzo[k]fluoranthene	252.3	0.0043(25C)	6.84	5E-7	3.87E-5	1.4E5	-	5.5E5
Indeno[1,2,3-c,d]pyrene	276.3	0.00053(25C	7.66	1E-10	6.9E5-8	3.5E5	-	1.6E6
Dibenz[a,h]anthracene	278.4	0.0005(25C)	5.97	1E-10	7.3E-8	6.9E5	-	3.3E6
Benzo[g,h,i]perylene	276	0.00026(25C)	7.23	1.03E-10(25C)	1.44E-7	3.5E5	-	1.6E6
Fluorene	116.2	1.69(25C)	4.18	7.1E-4	6.4E-5	3.8E3	1.203	7.3E3
Carbazole	167.21	-	3.29	400(323C)	-	-	1.10	1202[7]
Dibenzofuran	168.2	10	4.12	-	-	-	-	8128
Acetone	58.08	680000	-0.24	2.7E2(30C)	3.43E-5	3E-1[7]	0.791	9.2
Chlordane	409.8	0.056	2.78	1E-5(25C)	9.4E-5	4E4	-	1.4E5

Mol. Wt. = Molecular weight
Sol. = Solubility
Kow = Octanol - water partition coefficient
V.P. = Vapor pressure
H = Henry's law constant
BCF = Bioconcentration factor
Sp. Grav. = Specific gravity
Koc. Organic carbon partition coefficient

(1) EPA, 1982
(2) Verschueren, 1983
(3) EPA RREL
(4) Versar, 1979
(5) Weast, 1988
(6) NLM, January 13, 1992

TABLE 5-10
MOBILITY PARAMETERS AND PROPERTIES FOR INORGANIC CHEMICALS - SITES 5, 6, 7
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	MOL WT. (g)	SP. GRAV. (at 20C)[1]	BCF		Described Environmental Fate [2]
			(2)	(3)	
Arsenic	74.92	5.727	333	0-17	Sorption important
Barium	137.34	3.51	-	-	-
Beryllium	9.01	1.85	100	-	Insoluble compounds; sorption important
Cadmium	112.4	8.642	1000-4000	2-3520	Bioaccumulation, sorption important
Chromium	51.996	7.20	70-4000	<1-2.8	CrVI soluble, mobile; CrIII insoluble
Lead	207.19	11.3	60-200	42-1700	Sorption, bioaccumulation important
Manganese	55	7.2	-	-	-
Mercury	200.59	13.5939	1000-100000	4994-64000	Some insoluble species; sorption, metabolism, bioaccumlation important
Nickel	58.71	8.9	40-100	0.8-192	Soluble species, some bioaccumulation, sorption
Silver	107.87	10.5	200-3080	<1-240	Sorption important, some bioaccumulation
Vanadium	50.942	5.96	-	-	-
Zinc	65.38	7.14	1000-40000	51-1130	Sorption, bioaccumulation important
Cyanide	-	-	-	-	Biodegradation important
Thallium	204.38	11.85	100000-150000	34-130	Sorption bioaccumulation important

MOL. WT. = Molecular weight
Sp. Grav. = Specific gravity
BCF = Biocentration or bioaccumulation factor; freshwater species
(1) Weast, 1988
(2) Versar, 1979
(3) EPA, 1983a; EPA, 1983b; EPA, 1983c; EPA, 1986b; EPA, 1983d; EPA, 1986c; EPA, 1986d; EPA, 1983e; EPA, 1980a; EPA, 1980b; EPA, 1980c; EPA, 1980d

Empirically determined literature values of water solubility, octanol-water partition coefficient (Kow), Koc, vapor pressure, Henry's Law constant, bioconcentration factor (BCF), and specific gravity are presented for organic chemicals, as available. Many of these parameters are not applicable to inorganic chemicals. For inorganics, specific gravity and BCFs have been presented, along with qualitative descriptions of important environmental fate properties. Calculated values, which were obtained using approximation methods, are presented when literature values are unavailable. A discussion of the environmental significance of each of these parameters follows.

The rate at which a chemical is leached from a waste deposit by infiltrating precipitation is a function of its water solubility. More soluble chemicals are expected to enter water much more readily and rapidly than less soluble chemicals. The water solubilities presented in Table 5-9 indicate that the VOCs are several orders of magnitude more water soluble than semivolatile organic compounds (SVOCs) (including phthalates and PAHs) or PCBs. This conclusion is reinforced by the fact that VOCs were discovered more frequently and at greater concentrations in groundwater than less soluble chemicals. (Volatilization of VOCs from surface media is also an important factor in the observed distribution of these chemicals.)

Although PAHs and PCBs were detected in soil in Area B, such compounds have not been detected in groundwater. This is a manifestation of their limited water solubility and tendency to adsorb onto soil/sediment particles.

The Kow is a measure of the equilibrium partitioning of a chemical between octanol and water. The Kow is also used to estimate BCFs in aquatic organisms. A linear relationship between the Kow and the uptake of chemicals by fatty tissues of animal and human receptors has been determined (Lyman et. al, 1990). PAHs, phthalates, and PCBs are several orders of magnitude more likely to partition to fatty tissues than the more water-soluble VOCs. The Kow is also useful in characterizing the sorption of compounds by organic soils when experimental values are not available.

The Koc is related to the water solubility and the Kow. This parameter indicates the tendency of a chemical to bind to soil particles containing organic carbon. Chemicals with high Koc generally have low water solubilities and vice versa. Chemicals such as phthalates, PAHs, and PCBs are relatively immobile in the subsurface environment and are preferentially bound to the soil phase. These compounds are not subject to groundwater transport to the same extent as compounds with high water solubilities.

Koc may be used to infer the relative rates at which the more mobile chemicals are transported in the groundwater. The Koc and the fractional organic carbon content of the soil (FOC) may be used to estimate an equilibrium distribution coefficient (Kd) for the solid and aqueous matrices using the following relationship:

$$Kd = Koc \times FOC$$

where: Kd = Distribution coefficient
FOC = Soil organic carbon content
Koc = Organic carbon partition coefficient

Total organic carbon (TOC) results may be used to calculate FOC for soils. One subsurface soil taken at Area B was analyzed for TOC, and the result was 23,400 mg/kg. Thus

$$FOC = (23400 \text{ mg/kg})\ (1E\text{-}6 \text{ kg/mg})$$
$$= 0.0234 \text{ kg organic carbon/kg soil}$$

Vapor pressure provides an indication of the rate at which a chemical volatilizes from both soil and water. It is of primary significance in instances where environmental interfaces such as surface soil/air and surface water/air are important, rather than in evaluation of groundwater and subsurface soils. Vapor pressures for VOCs are generally many times higher than vapor pressures for phthalate esters and PAHs. Chemicals with higher vapor pressures are expected to enter the atmosphere much more readily than chemicals with lower vapor pressures. Volatilization has also been reported to be one of the environmental fate pathways of PCBs. For example, of 700,000 pounds of PCBs in uncapped landfills in the Hudson River Basin area, an estimated 3,000 pounds (about four percent) volatilize annually (Lunsford, 1982). Volatilization depends upon such factors as total exposed surface area, PCB concentrations, and amount of organic matter in the soil.

Both vapor pressure and water solubility are of use in determining volatilization rates from surface water bodies. The Henry's Law constant is the equilibrium vapor pressure of a chemical above a solution divided by its concentration in the solution (for dilute systems). The Henry's Law constant may also be used to calculate the equilibrium contaminant concentrations in the vapor versus liquid phases for dilute solutions commonly encountered in environmental settings. The Henry's Law constant is also useful for mass transfer applications for air-stripping column design.

BCFs represent the ratio of aquatic-organism tissue concentration to water concentration. The ratio is both contaminant and species specific, as well as tissue specific. When site-specific values are not measured, literature values may be used, or the BCF may be derived from the Kow. Phthalate esters and PAHs will bioconcentrate at orders of magnitude greater than those concentrations found in the water where the exposed species reside. Bioconcentration is a well-known property of PCBs; PCBs can be stored in fatty tissues of exposed organisms at concentrations much higher than the environmental concentration. VOCs are not as readily bioconcentrated as PCBs.

Specific gravity is the ratio of the mass of a given volume of pure chemical at a specified temperature to the mass of the same volume of water at a given temperature. Its primary use is to determine whether immiscible compounds or very high concentrations of a pure contaminant will float or sink in water. As shown in Table 5-9, most of the chemicals detected in this study area were denser than water, although toluene is less dense.

As shown in Table 5-10, most of the inorganic chemicals have a strong tendency to adsorb onto sediment particles, a factor which greatly reduces their mobility. For some metals, such as cadmium, lead, and mercury, bioaccumulation also plays an important role in environmental fate. While the metals themselves are insoluble in water, soluble species of some metals, such as chromium and antimony, can increase contaminant mobility. For cyanide, environmental fate is mainly controlled by biodegradation.

5.6.2 Potential Migration Routes

In general, numerous potential migration routes exist in areas contaminated with hazardous materials. Discussion of contaminant migration routes will be limited to groundwater transport.

One possible migration route is from groundwater at Area B into Southampton Creek, which is located downstream of the sites. Groundwater flow maps indicate that flow is toward this area. Surface water was sampled downstream of this study area, and the results will be discussed when available.

The second possible route of groundwater migration is from the areas immediately beneath the sites into the deeper portions of the bedrock aquifer. Once the contaminants have entered the bedrock aquifer, this deeper migration may occur along geologic structures such as permeable bedding planes, subsurface fractures, and joints. Vertical hydraulic gradients are consistently downward in this area and indicate that flow may be downward from the overburden toward the shallow bedrock aquifers. Other evidence for the migration of contaminants into deeper aquifers below the shallow bedrock is not currently available. The possibility of such migration was addressed by examining the regional hydrogeology. Because both shallow and overburden wells were contaminated, and because the shallow bedrock aquifer appears to be recharged by the overburden aquifer, the groundwater at Area B was assessed for the purpose of risk calculations as one entity. Where noticeable patterns in the shallow bedrock versus the overburden aquifers occur, they are noted in Section 5.5.

The third possible route of groundwater migration is from the site to off-site areas.

5.6.3 Contaminant Persistence

Several transformation processes are believed to affect the persistence of organic chemicals in the environment. The primary processes affecting contaminant fate in the environment include microbial and chemical degradation.

Generally, organic molecules are subject to several chemical reactions under environmental conditions. Such reaction mechanisms include acid/base reaction, addition, elimination, and hydrolysis. However, chlorinated alkanes and alkenes and monocyclic aromatics are not particularly amenable to the majority of these degradation mechanisms. Hydrolysis is considered to be negligible for PAHs and PCBs. Phthalates can be more susceptible (Versar, 1979; EPA, 1982; Lyman et. al, 1990). Hydrolysis reactions can occur under acidic, basic, or neutral conditions.

Another possible type of degradation is the dechlorination of tetrachloroethene (PCE) and TCE to 1,2-dichloroethene (1,2-DCE), 1,1-dichloroethene (1,1-DCE), and ultimately vinyl chloride (Cline and Viste, 1984). A similar type of reaction has been reported for 1,1,1-TCA in degradation to 1,2-dichloroethane (1,2-DCA), 1,1-dichloroethane (1,1-DCA), and chloroethane. In groundwater at Area B, PCE, TCE, and 1,2-DCE were detected. 1,1,1-TCA was also detected.

Bacterial degradation is a potential environmental fate mechanism. This degradation is primarily biological, and anaerobic conditions are typically required for these reactions to occur. The compounds for which biodegradation is potentially considerable are toluene, and, to some extent, naphthalene and phthalates (EPA, 1982; Verschueren, 1983). It should be noted that, for cyanide, environmental fate is mainly controlled by biodegradation (volatilization is a primary pathway for hydrogen cyanide). Some metallocyanide complexes may be more persistent in the environment (Versar, 1979). Cyanides usually are not observed as widespread, high-level contaminants in the environment, since they are metabolized so readily. The frequency of cyanide detections in this study area (and the entire facility) was very low (positive detection in one well). See Appendix L for discussion of this value as questionable.

5.7 BASELINE RISK ASSESSMENT (AREA B)

5.7.1 Data Evaluation

This section provides a description of the risk assessment methods employed for the Area B, as well as a summary of the risk assessment results. The objectives of the risk assessment are to define the actual or potential risks to human health resulting from the presence of contamination in groundwater, and to provide the basis for determining appropriate remedial measures for this medium in the FS.

Three major aspects of chemical contamination must be considered when assessing public health risks: contaminants with toxic characteristics must be found in environmental media and must be released by either natural processes or by human action; potential exposure points must exist; and human or environmental receptors must be present at the point of exposure. Risk is a function of both toxicity and exposure; without any one of the three factors, there will be no risk.

The risk assessment estimates the potential for human health risk at the site. Information regarding the toxicity of the compounds detected in the various media, the distribution of contamination, and a site-specific estimate of chemical intake via assumed exposure routes will be combined to estimate potential risks. The processes used at this site are in accordance with current EPA guidance (EPA, 1989a; EPA, 1991a).

A risk assessment consists of four components: data evaluation; toxicity assessment; exposure assessment; and risk characterization. Each of these components was discussed in Section 4.7.

5.7.1.1 Representative Concentrations

The risk assessment was performed using a representative concentration for each chemical detected in groundwater at Area B. Current groundwater conditions were evaluated. The validated data were used to calculate representative concentrations, as described in Section 4.7.1.1.

A sample calculation for a representative concentration is provided in Appendix M. Upper confidence limits (UCLs) for all contaminants, from which the representative concentrations are derived, are presented in Appendix N.

5.7.1.2 Chemicals of Concern

Groundwater chemicals of concern are identified in this section, based on various aspects of their occurrence and distribution, mobility, persistence, and toxicity. These chemicals are selected to represent site contamination and will provide the framework for the quantitative risk assessment.

The occurrence and distribution of groundwater contaminants in Area B were discussed in Section 5.6. Metals, chlorinated ethenes, other VOCs, and phthalates were considered notable in groundwater.

Appendix O summarizes the toxic effects for groundwater chemicals of concern. The summaries are presented in the form of toxicity profiles. Adverse effects on human (receptors) are discussed. The chemical of concern selection process for the groundwater medium is discussed in the remainder of this section.

Current Groundwater

The chemicals that were positively detected in monitoring wells within Area B were presented in Tables 5-6, 5-7, and 5-8. Table 5-11 presents the chemicals of concern for current groundwater at Area B. Because metals in groundwater can be naturally occurring, comparison to both upgradient groundwater (Tables 4-8 and 4-9) and drinking water criteria, guidelines, and dose-response parameters (see Section 5.7.2.2) was used to select the inorganic chemicals of concern. Any element that fell below drinking water criteria, guidelines, and/or dose-response parameters for a 15-kilogram child consuming one liter/day of water as well as the upgradient representative concentrations was eliminated. Cyanide was included because it is not expected to be naturally occurring. Essential metals that are common minerals not usually noted for toxicity, such as calcium, magnesium, potassium, and iron, were eliminated. Any chemical that exceeded either the upgradient concentration or drinking water criteria, guidelines, or dose-response parameters was selected as a chemical of concern. Additionally, any positively detected chemical classified as a Group A, B1, B2, or C carcinogen was classified as a chemical of concern for groundwater.

According to EPA policy, the risk assessment must be performed using unfiltered groundwater. However, because of the potential influence of sediments in turbid monitoring well water, representative concentrations of inorganics in filtered groundwater are also shown for comparison.

All organic chemicals detected in monitoring well samples near Area B were selected as chemicals of concern. Two different types of analyses were conducted for 1,2-DCE: one analysis was done for total, and one for the cis and trans isomers. The types of 1,2-DCE are included separately. However, risk assessment for total 1,2-DCE used parameters specific to the more toxic cis isomer in order to be conservative (assumption that the total was 100 percent cis because the actual percentage is unknown).

TABLE 5-11
CHEMICALS OF CONCERN-MONITORING WELLS SITES 5, 6, 7
NAWC, WARMINSTER, PENNSYLVANIA
(ug/L)

ORGANICS			
Carcinogens	Rep. Conc.	Noncarcinogens	Rep. Conc.
Trichloroethene	4.4	1,2-Dichloroethene	3.8
Tetrachloroethene	1.8	cis-1,2-Dichloroethene	2.6
Carbon tetrachloride	1.6	Toluene	2.4
Chloromethane	2.0	1,1,1-Trichloroethane	1.0
Chloroform	1.4	Di-n-octylphthalate	0.9
		Diethylphthalate	2.0
UNFILTERED INORGANICS			
Carcinogens	Rep Conc.	Noncarcinogens	Rep. Conc.
Arsenic	3.4	Barium	388
Cadmium	2.0	Cobalt	23.2
Lead	7.1	Copper	34.1
		Manganese	2000
		Nickel	32.3
		Cyanide	26.3
		Vanadium	16.3
		Zinc	228
FILTERED INORGANICS			
Carcinogens	Rep. Conc.	Noncarcinogens	Rep. Conc.
		Barium	214
		Thallium	1.2
		Zinc	31.0

5.7.2 Toxicity Assessment

The purpose of this section is to identify the potential health hazards associated with exposure to each of the chemicals of concern. A toxicological evaluation characterizes the inherent toxicity of a compound. The literature indicates that the chemicals of concern cause carcinogenic and/or noncarcinogenic health effects in humans. In addition, many of the chemicals have adverse effects on environmental receptors. Although the chemicals of concern may cause adverse health effects, dose-response relationships and the potential for exposure must be evaluated before the risks to receptors can be determined. Dose-response relationships correlate the magnitude of the intake with the probability of toxic effects, as discussed below. All toxicity information for the groundwater chemicals of concern at Area B is presented in Table 5-12 and Appendix O.

5.7.2.1 Health Effects

An important component of the risk assessment process is the relationship between the intake of a compound (the amount of a chemical that is absorbed by a receptor) and the potential for adverse health effects resulting from exposure to that dose. Dose-response relationships provide a means by which potential public health impacts may be quantified. The published information of doses and responses is used in conjunction with information on the nature and magnitude of human exposure to develop an estimate of potential health risks.

Reference doses (RfDs) and cancer slope factors (CSFs) have been developed by EPA for many organics and inorganics. These parameters were defined in detail in Section 4.7.2.1.

TABLE 5-12
DOSE-RESPONSE PARAMETERS AND ARARS - GROUNDWATER CHEMICALS AT SITES 5, 6, 7
NAWC, WARMINSTER PENNSYLVANIA

Chemical	RFD Oral (mg/kg/day) (1)(2)(3)	RFD Inhalation (mg/kg/day) (1)(2)(3)	CSF Oral $(mg/kg/day)^{-1}$ (1)(2)(3)	CSF Inhalation $(mg/kg/day)^{-1}$ (1)(2)(3)	MCL (ug/L) (4)(5)(6)(7) (8)(9)(10)	MCLG (ug/L) (4)(10)	DWHA (mg\L) (4)	AWQC[11] FRESH CHRONIC AQUATIC LIFE (ug/L)	AWQC[12] INGESTION WATER & FISH	AWQC[12] FISH ONLY
Arsenic	*3E-4	-	A*1.75	A*1.5E1	50(N)	0	-	48 (PENT)	0.018	0.14
Barium	7E-2	*1E-4	-	-	2000(F), 1000(N)	2000	Lifetime adult:2	-	-	-
Cadmium	5E-4 water	-	-	B1 6.3	5	5	1 day child:0.04 10 day child:0.04 Longer-term child:0.005 Longer-term adult:0.02 Lifetime adult:0.005	1.1+	10	170
Chromium III	1E0	-	-	-	100(TOT)	100(TOT)	1 day child:1 10 day child:1 Longer-term child:0.2 Longer-term adult:1 Lifetime adult:2.6(TOT)	210+	33000	670000
Cobalt	-	-	-	-	-	-	-	-	-	-
Copper	*3.7E-2	-	-	-	1300(A)	1300	-	12+	1300	-
Lead	-	-	-	-	50(N), 15(A)	0	-	3.2+	50	-
Manganese	5E-3	1E-4	-	-	50(S)	-	-	-	-	-
Mercury	*3E-4	*9E-5	-	-	2	2	Longer-term adult:0.002 Lifetime adult:0.002	0.012	0.14	0.15
Nickel	2E-2	-	-	-	100(P)	100	1 day child:1 10 day child:1 Longer-term child:0.5 Longer-term adult:1.7 Lifetime adult:0.1	160+	510	3800
Fluoranthene	4E-2	-	-	-	-	-	-	3980	42	54
Thallium	7E-5	-	-	-	1-2(P)	0.5	1 day child:0.007 10 day child:0.007 Longer-term child:0.007 Longer-term adult:0.02 Lifetime adult:0.0004	40 (LOEL)	2.0	7.2
Carbon tetrachloride	7E-4	-	B2 1.3E-1	B2 5.25E-2	5	0	1 day child:4 10 day child:0.2 Longer-term child:0.07 Longer-term adult:0.3	35200 (fa) (LOEL)	0.25	45
Silver	5E-3	-	-	-	50(N)	-	1 day child:0.2 10 day child:0.2 Longer-term child:0.2 Longer-term adult:0.2 Lifetime adult:0.1	0.12	91	-

TABLE 5-12
DOSE-RESPONSE PARAMETERS AND ARARS - GROUNDWATER CHEMICALS AT SITES 5, 6, 7
NAWC, WARMINSTER PENNSYLVANIA
PAGE TWO

Chemical	RFD Oral (mg/kg/day) (1)(2)(3)	RFD Inhalation (mg/kg/day) (1)(2)(3)	CSF Oral $(mg/kg/day)^{-1}$ (1)(2)(3)	CSF Inhalation $(mg/kg/day)^{-1}$ (1)(2)(3)	MCL (ug/L) (4)(5)(6)(7)(8)(9)(10)	MCLG (ug/L) (4)(10)	DWHA (mg/L) (4)	AWQC[11] FRESH CHRONIC AQUATIC LIFE (ug/L)	AWQC[12] INGESTION WATER & FISH	AWQC[12] FISH ONLY
Cyanide	2E-2	-	-	-	200	200	1 day child:0.2 10 day child:0.2 Longer-term child:0.2 Longer-term adult:0.8 Lifetime adult:0.2	5.2	700	215000
1,1,1-Trichloroethane	*9E-2	*3E-1	-	-	200	200	1 day child:100 10 day child:40 Longer-term child:40 Longer-term adult:100 Lifetime adult:0.2	31200 (LOEL) (ma)	3100	170000
Vanadium	*7E-3	-	-	-	-	-	1 day child:0.08 10 day child0.08 Longer-term child:0.03 Longer-term adult:0.11 Lifetime:0.02	-	-	-
Zinc	3E-1	-	-	-	5000(s)	-	Lifetime adult:2.1	110+	-	-
Chromium VI	5E-3	-	-	A4.2E-1	100(TOT)	100(TOT)	1 day child:1 (TOT) 10 day child:1 Longer-term child:2 Longer-term adult:0.8 Lifetime adult:0.1	11	170	3400
Aroclor 1248	-	-	B2 7.7	-	0.5	0	-	0.014 (TOT PCBs)	4.4E-5	4.5E-5
Aroclor 1254	-	-	B2 7.7	-	0.5	0	-	0.014 (TOT PCBs)	4.4E-5	4.5E-5
Pyrene	3E-2	-	-	-	-	-	-	-	0.0028	0.0311
Benz[a]anthracene	-	-	-	-	0.1(P)	0	-	-	0.0028	0.0311
Chrysene	-	-	-	-	0.2(P)	0	-	-	0.0028	0.0311
Benzo[b]fluoranthene	-	-	8.96E-1	7.49E-1	0.2(P)	0	-	-	0.0028	0.0311
Naphthalene	*4E-2	-	-	-	-	-	1 day child:0.5 10 day child:0.5 Longer-term child:0.4 Longer-term adult:1 Lifetime adult:0.02	620 (LOEL)	-	-
Benzo[a]pyrene	-	-	B2 7.3	6.1	0.2	0	-	-	0.0028	0.0311

TABLE 5-12
DOSE-RESPONSE PARAMETERS AND ARARS - GROUNDWATER CHEMICALS AT SITES 5, 6, 7
NAWC, WARMINSTER PENNSYLVANIA
PAGE THREE

Chemical	RFD Oral (mg/kg/day) (1)(2)(3)	RFD Inhalation (mg/kg/day) (1)(2)(3)	CSF ORAL (mg/kg/day)$^{-1}$ (1)(2)(3)	CSF Inhalation (mg/kg/day)$^{-1}$ (1)(2)(3)	MCL (ug/L) (4)(5)(6)(7) (8)(9)(10)	MCLG (4)(10)	DWHA (mg/L) (4)	AQWC[11] FRESH CHRONIC AQUATIC LIFE (ug/L)	AQWC[12] INGESTION WATER & FISH	AQWC[12] FISH ONLY
Chloromethane	-	-	1.3E-2	6.3E-3	-	-	1 day child:9 10 day child:0.4 Longer-term child:4 Longer-term adult:1 Lifetime adult:0.003	-	-	-
Toluene	2E-1	1E-1	-	-	1000	1000	1 day child:20 10 day child:2 Longer-term child:2 Longer-term adult:7 Lifetime adult:1	17500 (fa) (LOEL)	10000	300000
Di-n-octylphalate	*2E-2	-	-	-	-	-	-	3 (LOEL) (TOT PHTHAL)	-	-
Diethylphthalate	8E-1	-	-	-	-	-	Lifetime adult:5	3 (LOEL) (TOT PHTHAL)	23000	120000
cis-1,2-Dichloroethene	*1E-2	-	-	-	70	70	1 day child:4 10 day child:3 Longer-term child:3 Longer-term adult:11 Lifetime adult:0.07	11600 (fa) (LOEL) (DCE)	-	-
Chloroform	1E-2	-	[2]6.1E-3	[2]8.1E-2	100(THM)	-	1 day child:4 10 day child:4 Longer-term child:0.1 Longer-term adult:0.4	1240 (LOEL)	5.70	470
Trichloroethene	6E-3	-	[2]1.1E-2	6E-3	5	0	-	21900 (LOEL)	2.7	81
Tetrachloroethene	1E-2	-	[2]5.2E-2	2.0E-3	5	0	1 day child:2 10 day child:2 Longer-term child:1 Longer-term adult:5	840 (LOEL)	0.8	8.85

TABLE 5-12
DOSE-RESPONSE PARAMETERS AND ARARS - GROUNDWATER CHEMICALS AT SITES 5, 6, 7
NAWC, WARMINSTER PENNSYLVANIA
PAGE FOUR

*	From Heast instead of IRIS	(1) EPA, 1992a
**	Provisional ADI as per Layton, using oral rat LD50 of 1630 mg/kg (Sax, 1989) and Layton's most conservative multiplier of 5E-6.	(2) EPA, 1992b
***	Estimate based on RFDs of similar PAHs	(3) EPA, 1992c
		(4) EPA, 1992d
		(5) EPA, 1991b
Under CSF:		(6) EPA, 1991c
		(7) EPA, 1990a
A=	Group A human carcinogen	(8) EPA, 1991d
B1=	Group B1 probable human carcinogen	(9) EPA, 1991e
B2=	Group B2 probable human carcinogen	(10)EPA, 1992e
C=	Group C possible human carcinogen	(11)EPA, 1987a
		(12)EPA, 1990b

Under MCL:

S=	Secondary
F=	Final; effective 1/1/93
N=	National Primary Drinking Water Regulation
A=	Action Level
P=	Proposed
THM=	Trihalomethane

Under AWQC:

+=	Based on hardness of 100 mg/L
LOEL=	Lowest observed effects level
ma=	Marine acute
PAHs=	Polycyclic aromatic hydrocarbons
PCB=	Polychlorinated biphenyls
DCB=	Dichlorobenzenes
PHTHAL=	Phthalates
fa=	Freshwater acute
DCE=	Dichloroethenes

RFD=	Reference dose
CSF=	Cancer slope factor
MCL=	Maximum Contaminant Level
MCLG=	MCL Goal
DWHA=	Drinking Water Health Advisory
AWQC=	Ambient Water Quality Criteria

TOT=	Total
PENT=	Pentavalent

5.7.2.2 Applicable or Relevant and Appropriate Requirements (ARARs)

This section presents available regulatory standards or guidelines for the chemicals of concern selected in the preceding section. Currently, the only enforceable regulatory standards for exposure to groundwater contaminants are the Maximum Contaminant Levels (MCLs). However, MCLs have not been specified for many of the chemicals of concern. Therefore, other regulatory guidelines may be used for comparative purposes to infer health risks and environmental impacts. Relevant regulatory guidelines include Ambient Water Quality Criteria (AWQCs), MCL Goals (MCLGs), and EPA Drinking Water Health Advisories (DWHAs). ARARs and dose-response parameters are presented in Table 5-12. The environmental criteria were defined in detail in Section 4.7.2.2.

5.7.2.3 Summary

Table 5-12 presents the values of the available Federal ARARs and dose-response parameters for both carcinogenic and noncarcinogenic groundwater chemicals of concern. If the concentration or intake of a chemical exceeds these standards or guidelines, the possibility exists that a receptor may experience adverse health effects. Estimated intakes of each chemical are presented in the Exposure Assessment (Section 5.7.3).

5.7.3 Exposure Assessment

The purpose of this section is to evaluate the potential for human exposure to the hazardous chemicals in groundwater at Area B. This section characterizes the exposed populations, identifies actual or potential exposure routes, and provides exposure estimates. The nature and extent of contamination upon which the exposures are based were presented in Section 5.5.

To determine whether there is an actual or potential exposure in this area, the most likely pathways of contaminant release and transport, as well as the human and environmental activity patterns must be considered. A complete exposure pathway has three components: a source, a route of transport, and an exposure point for receptors. These components are addressed in the following subsections.

5.7.3.1 Exposure Routes

There are several environmental media in this study area through which receptors can be either directly or indirectly exposed to site-related contaminants, including soil and groundwater and surface water and sediment downstream of this study area. Exposure routes involved include dermal contact, incidental ingestion, and inhalation. Only groundwater exposures are evaluated in this report.

Groundwater

Groundwater beneath Area B is currently not used for drinking purposes. However, in order to evaluate groundwater quality, potential groundwater exposure scenarios using current groundwater conditions were assessed. The receptors include adult employees and adult and child residents. It was assumed that the theoretical exposure to employees would be via ingestion and dermal (hand-washing); exposure to adult residents would occur via ingestion, dermal (showering), and inhalation (showering); and exposure to child residents would occur via ingestion and dermal (bathing). These exposure scenarios, along with their input parameters, are shown in Tables 5-13, 5-14, and 5-15.

5.7.3.2 Exposure Estimates

The estimation methods and models used in this section are consistent with current EPA risk assessment guidance (EPA, 1989a; EPA, 1991a). Exposure estimates associated with the groundwater exposure route are presented below. All exposure scenarios incorporate the representative concentrations in the estimation of intakes.

Noncarcinogenic risks are estimated using the concept of an average annual exposure. The intake incorporates terms describing the exposure time and/or frequency that represents the number of hours per day and the number of days per year that exposure occurs. This is used with a term known as the averaging time, which converts the daily exposure frequency and duration to an annual exposure by dividing by 365 days/year of exposure. Noncarcinogenic risks for some exposure routes (e.g., soil) are generally greater for children than for adults because of the much lower body weights of children and their similar or higher ingestion rates. Carcinogenic risks, on the other hand, are calculated as an incremental lifetime risk and, therefore, incorporate terms to represent the exposure duration (years) over the course of a lifetime (70 years).

TABLE 5-13
EXPOSURE INPUT PARAMETERS - GROUNDWATER INGESTION - SITES 5, 6, 7
NAWC, WARMINSTER, PENNSYLVANIA

Ingestion of Groundwater			
Input Parameters	Description	Value	Rationale
C	Exposure concentration	Rep. conc.; [1] (mg/L) (wells in plume)	Upper 95% confidence limit on arithmetic average (EPA, 1989a)
IR	Ingestion rate	2L/day (adult resident) 1L/day (adult employee) 1L/day (child resident)	(EPA, 1991a)
EF	Exposure frequency	250 days/yr. (employees) 350 days/yr. (residents)	(EPA, 1991a)
ED	Exposure duration	25 yrs. (adult employees) 30 yrs. (adult residents) 6 yrs. (child resident)	90th percentile time at one residence (EPA, 1989a; EPA, 1991a)
BW	Body weight	70 kg (adult) 15 kg (child)	(EPA, 1989a, EPA, 1991a)
AT	Averaging time	ED x 365 day/yr. 70 yrs. x 365 days/yr.	Noncarcinogens Carcinogens (EPA, 1989a)

(1) Upper 95% confidence limit (UCL) on arithmetic average, or maximum if UCL exceeds maximum detected.

TABLE 5-14
EXPOSURE INPUT PARAMETERS - GROUNDWATER DERMAL CONTACT - SITES 5, 6, 7
NAWC, WARMINSTER, PENNSYLVANIA

Dermal Contact with Groundwater			
Input Parameters	Description	Value	Rationale
C	Exposure concentration	Rep. conc.; [1] (mg/L) (wells in plume) or maximum	Upper 95% confidence limit on arithmetic average (EPA, 1989a)
SA	Skin surface area available for contact[2]	2,270 cm^2 (adult employee) 5,910 cm^2 (child resident) 19,400 cm^2 (adult resident)	Hands and forearms Body Body (EPA, 1989b)
ET	Exposure time[2]	0.2 hr/day (residents) 0.03 hr/day (employees, handwashing)	12 minutes/day (EPA, 1991a) 2 minutes/day (Professional judgement)
EF	Exposure frequency	250 days/yr. (employees) 350 days/yr. (residents)	(EPA, 1991a)
ED	Exposure duration	25 yrs. (adult employees) 30 yrs. (adult residents) 6 yrs. (child resident)	(EPA, 1991a)
BW	Body weight	Adult: 70 kg Child: 15 kg	(EPA, 1989a; EPA, 1991a)
AT	Averaging time	ED x 365 days/yr. 70 yrs. x 365 days/hr.	Noncarcinogens Carcinogens (EPA, 1989a)
K,Kp	Permeability coefficients (cm/hr.)	Contaminant-specific	(EPA, 1992f)
TAU	Lagtime (hr.)	Contaminant-specific	(EPA, 1992f)
B	Partition coefficient	Contaminant-specific	(EPA, 1992f)

(1) Upper 95% confidence limit (UCL) on arithmetic average, or maximum if UCL exceeds maximum detected.

(2) Adult residents assumed to shower daily; child residents assumed to bathe daily; employees assumed to wash hands daily.

TABLE 5-15
EXPOSURE INPUT PARAMETERS - GROUNDWATER INHALATION - SITES 5, 6, 7
NAWC, WARMINSTER, PENNSYLVANIA

Inhalation of Volatile Emissions During Showering (Adult Residents only)			
Input Parameters	Description	Value	Rationale
C	Exposure concentration	Rep. conc.; [(1)] (mg/L)	Used to calculate volatile chemical generation rate (ug/m^3/min)
H	Henry's law constant	Contaminant-specific	Required for model application
$K_G K_l$	Gas and liquid phase mass transfer coefficients	Contaminant-specific	Required for model application
D_s	Shower duration	12 minutes	(EPA, 1991a)
D_t	Total time in bathroom	20 minutes	Professional judgement
R_a	Air exchange rate	0.0083 min^{-1}	Foster and Chrostowski, 1987
IR	Inhalation rate	10.4 L/min	(EPA, 1989a)
EF	Exposure frequency	0.96 day^{-1}	One shower per day, 350 days/yr. (EPA, 1991a)
ED	Exposure duration	30 yrs.	90th percentile time at one residence (EPA, 1989a)
BW	Body weight	70 kg	Convention (EPA, 1989a)
AT	Averaging time	ED x 365 days/yr. 70 yrs. x 365 days/yr.	Noncarcinogens Carcinogens (EPA, 1989a)

(1) Upper 95% confidence limit (UCL) on arithmetic average, or maximum if UCL exceeds maximum detected.

Current groundwater contaminants were evaluated for theoretical adult and child residents and adult employees, using representative concentrations for each study area. Ingestion of groundwater was evaluated for all receptors. The equation used was the same at that presented in Section 4.7.3.2 for ingestion of surface water. Input parameters were presented in Table 5-13 conventional values were used. Dermal exposure to groundwater contaminants was evaluated for all receptors. Input parameters were presented in Table 5-14. Adult and child residents were assumed to take daily showers and baths, respectively, and therefore their total body surface areas were used. Employees were assumed to wash their hands for approximately two minutes/day at the workplace, and the surface area of their hands and forearms was used. Inhalation exposure to groundwater (during showering) was calculated for adult residents only using the equations given in Section 4.7.3.2. Input parameters were presented in Table 5-15. It was assumed that only adult residents would shower.

Lead exposure was assessed using the blood-lead estimation methods described in Section 4.7.3.2.

5.7.4 Risk Characterization

Potential human health risks resulting from the exposures outlined in the preceding sections are characterized on a quantitative and qualitative basis in this section. Quantitative risk estimates are generated based on risk assessment methods outlined in current EPA guidance (EPA, 1989a); whereas the qualitative assessment consists of the toxicological profiles.

Noncarcinogenic risk estimates are presented in the form of Hazard Quotients (HQs) and Hazard Indices (HIs) that are determined through comparison of estimated intakes with published RfDs. Incremental cancer risk estimates are provided in the form of dimensionless probabilities based on CSFs.

Estimated human intakes were developed for the groundwater exposure route discussed in the preceding sections. Both carcinogenic and noncarcinogenic risks are summarized on a series of tables in this section. Detailed calculations and spreadsheets are provided in Appendix N.

Noncarcinogenic risk is assessed using the concept of Hazard Quotients and Hazard Indices. The Hazard Quotient is the ratio of the estimated intake and the RfD for a selected chemical of concern, as follows:

$$\text{Hazard Quotient} = \text{Intake}/\text{RfD}$$

A Hazard Index is generated by summing the individual Hazard Quotients for the chemicals of concern. If the value of the Hazard Index exceeds unity (1.0), the potential for noncarcinogenic health risks associated with exposure to that particular chemical mixture cannot be ruled out (EPA, 1986f). In that case, particular attention should be paid to the target organs affected by each chemical. The Hazard Index is not a mathematical prediction of the severity of toxic effects; it is simply a numerical indicator of the possibility of the occurrence of noncarcinogenic (threshold) effects. If the ratio of the intake and the RfD for any individual chemical exceeds unity, there is the possibility that toxic effects could occur.

Incremental cancer risk estimates are generated for each of the exposure pathways using the estimated intakes and published CSFs, as follows:

$$\text{Risk} = \text{Intake} \times \text{CSF}$$

If the above equation results in a risk greater than 0.01, the following equation is used:

$$\text{Risk} = 1 - [\exp(\text{Intake} \times \text{CSF})]$$

The risk determined using these equations is a unitless expression of an individual's likelihood of developing cancer as a result of exposure to carcinogenic chemicals. An incremental cancer risk of 1E-6 indicates that the exposed receptor has a one in a million chance of developing cancer under the defined exposure scenario. Alternatively, such a risk may be interpreted as representing one additional case of cancer in an exposed population of one million persons. The calculated cancer risks should be recognized as upper-limit estimates. CSFs are the upper 95 percent confidence limit of a dose-response curve generally derived from animal studies. Actual human risk, while not identifiable, is not expected to exceed the upper limit based on the CSFs and may, in fact, be lower.

EPA has generally defined risks in the range of 1E-4 to 1E-6 as being acceptable for most hazardous waste facilities addressed under the CERCLA. For CERCLA activities, residual risks on the order of 1E-6 are the primary goal but are often modified by such regulatory requirements as MCLs or chemical-specific clean-up goals.

Because there is as yet no Agency consensus concerning an RfD or CSF for inorganic lead, the evaluation of this analyte was handled separately. Section 4.7.3.2 discusses blood-lead estimation methods. Blood-lead estimation results for Area B are assessed in Section 5.7.4.6.

The following section includes summaries of risks estimated by the groundwater exposure model. Complete descriptions and calculation results are presented for this model in Appendix N. It should be noted that, where HQs are reported as "N/A," the HQs were not calculable because no RfD has been established. Usually, in such cases, carcinogenicity is considered to be more important, since carcinogenicity will generally be seen at lower doses than noncarcinogenic effects. Cancer risks of zero generally indicate that the chemical is not carcinogenic or that a CSF has not yet been developed.

5.7.4.1 Potential Groundwater Exposure

Tables 5-16 through 5-21 present estimated noncarcinogenic risks for hypothetical exposure of adult employees and adult and child residents to current groundwater downgradient of Area B. The total HIs for all receptors (adult and child residents, adult employees) via the ingestion route exceeded 1.0, primarily because of arsenic, cadmium, barium, and manganese. If the filtered inorganic samples were used instead, those metals are no longer the major contributors, but thallium (not detected in unfiltered samples) becomes significant, and the child resident's ingestion HI would exceed 1.0 because of thallium.

Tables 5-22, 5-23, and 5-24 present estimated carcinogenic risk increases for hypothetical exposure of adult employees and adult and child residents to current groundwater downgradient of Area B. Estimated ingestion risks for all hypothetical receptors exceeded 1E-5 but not 1E-4. Arsenic, which was not detected in filtered samples, was the most significant contributor to the ingestion risk. However, individual ingestion risks for PCE and carbon tetrachloride exceeded 1E-6 for the adult resident (and carbon tetrachloride's risk exceeded 1E-6 for the child resident). The estimated dermal cancer risk for adult residents exceeded 1E-6 but not 1E-5 because of TCE and PCE. All other carcinogenic risk increases were less than 1E-6.

Tables 5-25 and 5-26 provide summaries of noncarcinogenic and carcinogenic risks for all groundwater exposure/receptor scenarios for Area B. MCLs were exceeded for TCE (an MCL of 5 ppb) in the groundwater samples collected from monitoring wells located in the vicinity of Area B. These exceedances were detected in shallow bedrock wells DG-18, DG-20, and DG-25 during both phases of the RI.

TABLE 5-16
CURRENT GROUNDWATER NONCARCINOGENIC RISKS TO ADULT EMPLOYEES - SITES 5, 6, 7
(POTENTIAL CURRENT EXPOSURE)
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep. Conc. (mg/L)	HQ ING	HQ DERM
Trichloroethene	0.0044	7.2E-3	1.3E-3
Tetrachloroethene	0.0018	1.8E-3	6.7E-4
Carbon tetrachloride	0.0016	2.2E-2	4.7E-4
Chloromethane	0.002	N/A	N/A
Chloroform	0.0014	1.4E-3	1.3E-4
1,2-Dichloroethene	0.0038	3.7E-3	1.3E-5
cis-1,2-Dichloroethene	0.0026	2.5E-3	8.9E-6
Toluene	0.0024	1.2E-4	7.2E-5
1,1,1-Trichloroethane	0.001	1.1E-4	1.5E-6
Di-n-octylphthalate	0.0009	4.4E-4	7.2E-5
Diethylphthalate	0.002	2.4E-5	1.8E-7
Arsenic	0.0034	1.1E-1	7.6E-6
Cadmium	0.002	3.9E-2	2.7E-6
Lead	0.0071	N/A	N/A
Barium	0.388	5.4E-2	3.7E-6
Cobalt	0.0232	N/A	N/A
Copper	0.0341	9.0E-3	6.1E-7
Manganese	2	3.9E0	2.7E-4
Nickel	0.0323	1.6E-2	1.1E-7
Cyanide	0.0263	1.3E-2	8.8E-7
Vanadium	0.0163	2.3E-2	1.6E-6
Zinc	0.228	1.1E-2	4.6E-7
HAZARD INDEX		4.2E0	3.0E-3

TABLE 5-17
CURRENT GROUNDWATER NONCARCINOGENIC INGESTION RISKS TO ADULT EMPLOYEES - SITES 5, 6, 7 - MODIFIED WITH FILTERED INORGANICS (POTENTIAL CURRENT EXPOSURE)
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep. Conc. (mg/L)	HQ Ingestion
Organics (See Table 6-43)	-	3.9E-2
Barium	0.214	3.0E-2
Zinc	0.031	1.5E-3
Thallium	0.0012	1.7E-1
TOTAL HAZARD INDEX		2.4E-1

TABLE 5-18
CURRENT GROUNDWATER NONCARCINOGENIC RISKS TO ADULT RESIDENTS - SITES 5, 6, 7
(POTENTIAL CURRENT EXPOSURE)
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep. Conc. (mg/L)	HQ ING	HQ DERM	HQ INHALATION
Trichloroethene	0.0044	2.0E-2	4.1E-2	N/A
Tetrachloroethene	0.0018	4.9E-3	2.1E-2	N/A
Carbon tetrachloride	0.0016	6.3E-2	1.4E-2	N/A
Chloromethane	0.002	N/A	N/A	N/A
Chloroform	0.0014	3.8E-3	4.1E-3	N/A
1,2-Dichloroethene	0.0038	1.0E-2	4.0E-4	N/A
cis-1,2-Dichloroethene	0.0026	7.1E-3	2.8E-4	N/A
Toluene	0.0024	3.3E-4	2.2E-3	8.3E-4
1,1,1-Trichloroethane	0.001	3.0E-4	4.7E-5	1.0E-4
Di-n-octylphthalate	0.0009	1.2E-3	2.2E-3	N/A
Diethylphthalate	0.002	6.8E-5	5.6E-6	N/A
Arsenic	0.0034	3.1E-1	6.0E-4	0
Cadmium	0.002	1.1E-1	2.1E-4	0
Lead	0.0071	N/A	N/A	0
Barium	0.388	1.5E-1	2.9E-4	0
Cobalt	0.0232	N/A	N/A	0
Copper	0.0341	2.5E-2	4.9E-5	0
Manganese	2	1.1E1	2.1E-2	0
Nickel	0.0323	4.4E-2	8.6E-6	0
Cyanide	0.0263	3.6E-2	7.0E-5	0
Vanadium	0.0163	6.4E-2	1.2E-4	0
Zinc	0.228	3.1E-2	3.6E-5	0
HAZARD INDEX		1.2E1	1.1E-1	9.4E-4

TABLE 5-19
CURRENT GROUNDWATER NONCARCINOGENIC INGESTION RISKS TO ADULT RESIDENTS - SITES 5, 6, 7 - MODIFIED WITH FILTERED INORGANICS (POTENTIAL CURRENT EXPOSURE)
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep. Conc. (mg/L)	HQ Ingestion
Organics (See Table 6-45)	-	1.1E-1
Barium	0.214	8.4E-2
Zinc	0.031	4.2E-3
Thallium	0.0012	4.7E-1
TOTAL HAZARD INDEX		6.7E-1

TABLE 5-20
CURRENT GROUNDWATER NONCARCINOGENIC RISKS TO CHILD RESIDENTS - SITES 5, 6, 7
(POTENTIAL CURRENT EXPOSURE)
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep. Conc. (mg/L)	HQ ING	HQ DERM
Trichloroethene	0.0044	4.7E-2	1.3E-2
Tetrachloroethene	0.0018	1.2E-2	6.3E-3
Carbon tetrachloride	0.0016	1.5E-1	4.4E-3
Chloromethane	0.002	N/A	N/A
Chloroform	0.0014	9.0E-3	1.2E-3
1,2-Dichloroethene	0.0038	2.4E-2	1.2E-4
cis-1,2-Dichloroethene	0.0026	1.7E-2	8.3E-5
Toluene	0.0024	7.7E-4	6.8E-4
1,1,1-Trichloroethane	0.001	7.1E-4	1.4E-5
Di-n-octylphthalate	0.0009	2.9E-3	6.8E-4
Diethylphthalate	0.002	1.6E-4	1.7E-6
Arsenic	0.0034	7.2E-1	1.8E-4
Cadmium	0.002	2.6E-1	6.5E-5
Lead	0.0071	N/A	N/A
Barium	0.388	3.5E-1	9.0E-5
Cobalt	0.0232	N/A	N/A
Copper	0.0341	5.9E-2	1.5E-5
Manganese	2	2.6E1	6.5E-3
Nickel	0.0323	1.0E-1	2.6E-6
Cyanide	0.0263	8.4E-2	2.1E-5
Vanadium	0.0163	1.5E-1	3.8E-5
Zinc	0.228	7.3E-2	1.1E-5
HAZARD INDEX		2.8E1	3.3E-2

TABLE 5-21
CURRENT GROUNDWATER NONCARCINOGENIC INGESTION RISKS TO CHILD RESIDENTS - SITES 5, 6, 7 - MODIFIED WITH FILTERED INORGANICS (POTENTIAL CURRENT EXPOSURE)
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep. Conc. (mg/L)	HQ Ingestion
Organics (See Table 6-47)	-	2.7E-1
Barium	0.214	1.9E-1
Zinc	0.031	9.9E-3
Thallium	0.0012	1.1E0
TOTAL HAZARD INDEX		1.6E0

TABLE 5-22
CURRENT GROUNDWATER CARCINOGENIC RISKS TO ADULT EMPLOYEES - SITES 5, 6, 7
(POTENTIAL CURRENT EXPOSURE)
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep. Conc. (mg/L)	CA ING	CA DERM
Trichloroethene	0.0044	1.7E-7	3.1E-8
Tetrachloroethene	0.0018	3.3E-7	1.2E-7
Carbon tetrachloride	0.0016	7.3E-7	1.5E-8
Chloromethane	0.002	9.1E-8	1.8E-10
Chloroform	0.0014	3.0E-8	2.9E-9
1,2-Dichloroethene	0.0038	0	0
cis-1,2-Dichloroethene	0.0026	0	0
Toluene	0.0024	0	0
1,1,1-Trichloroethane	0.001	0	0
Di-n-octylphthalate	0.0009	0	0
Diethylphthalate	0.002	0	0
Arsenic	0.0034	2.1E-5	1.4E-9
Cadmium	0.002	0	0
Lead	0.0071	0	0
Barium	0.388	0	0
Cobalt	0.0232	0	0
Copper	0.0341	0	0
Manganese	2	0	0
Nickel	0.0323	0	0
Cyanide	0.0263	0	0
Vanadium	0.0163	0	0
Zinc	0.228	0	0
TOTAL CANCER RISK		2.2E-5	1.8E-7

TABLE 5-23
CURRENT GROUNDWATER CARCINOGENIC RISKS TO ADULT RESIDENTS - SITES 5, 6, 7
(POTENTIAL CURRENT EXPOSURE)
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep. Conc. (mg/L)	CA ING	CA DERM	CA INHALATION
Trichloroethene	0.0044	5.7E-7	1.2E-6	3.5E-7
Tetrachloroethene	0.0018	1.1E-6	4.6E-6	4.3E-8
Carbon tetrachloride	0.0016	2.4E-6	5.6E-7	1.0E-6
Chloromethane	0.002	3.0E-7	6.5E-9	2.3E-7
Chloroform	0.0014	1.0E-7	1.1E-7	1.5E-6
1,2-Dichloroethene	0.0038	0	0	0
cis-1,2-Dichloroethene	0.0026	0	0	0
Toluene	0.0024	0	0	0
1,1,1-Trichloroethane	0.001	0	0	0
Di-n-octylphthalate	0.0009	0	0	0
Diethylphthalate	0.002	0	0	0
Arsenic	0.0034	7.0E-5	1.4E-7	0
Cadmium	0.002	0	0	0
Lead	0.0071	0	0	0
Barium	0.388	0	0	0
Cobalt	0.0232	0	0	0
Copper	0.0341	0	0	0
Manganese	2	0	0	0
Nickel	0.0323	0	0	0
Cyanide	0.0263	0	0	0
Vanadium	0.0163	0	0	0
Zinc	0.228	0	0	0
TOTAL CANCER RISK		7.4E-5	6.6E-6	3.1E-6

TABLE 5-24
CURRENT GROUNDWATER CARCINOGENIC RISKS TO CHILD RESIDENTS - SITES 5, 6, 7
(POTENTIAL CURRENT EXPOSURE)
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep. Conc. (mg/L)	CA ING	CA DERM
Trichloroethene	0.0044	2.6E-7	7.1E-8
Tetrachloroethene	0.0018	5.1E-7	2.8E-7
Carbon tetrachloride	0.0016	1.1E-6	3.4E-8
Chloromethane	0.002	1.4E-7	4.0E-10
Chloroform	0.0014	4.7E-8	6.5E-9
1,2-Dichloroethene	0.0038	0	0
cis-1,2-Dichloroethene	0.0026	0	0
Toluene	0.0024	0	0
1,1,1-Trichloroethane	0.001	0	0
Di-n-octylphthalate	0.0009	0	0
Diethylphthalate	0.002	0	0
Arsenic	0.0034	3.3E-5	8.2E-9
Cadmium	0.002	0	0
Lead	0.0071	0	0
Barium	0.388	0	0
Cobalt	0.0232	0	0
Copper	0.0341	0	0
Manganese	2	0	0
Nickel	0.0323	0	0
Cyanide	0.0263	0	0
Vanadium	0.0163	0	0
Zinc	0.228	0	0
TOTAL CANCER RISK		3.5E-5	4.0E-7

TABLE 5-25
SUMMARY OF NONCARCINOGENIC RISKS - CURRENT GROUNDWATER
NAWC WARMINSTER - GROUNDWATER
SITES 5, 6, AND 7

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

TABLE 5-26
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

5.7.4.2 Exposures to Lead

As discussed in Section 4.7.3.2, lead was assessed separately because of the lack of EPA consensus concerning an RfD or CSF. Determinations of lead uptake from drinking water were considered. Potential blood-lead level increases were estimated and are discussed below.

For drinking water exposure, children older than six months are expected to experience blood-lead increases at the rate of 0.12 ug/dL blood-lead per ug/l lead in water up to 15 ug/l and 0.06 ug/dL for every ug/l lead in water above 15 ug/l (EPA, 1991e). For adults, the ratio is approximately 0.06 ug/dL blood-lead per ug/L in water (EPA, 1991e). These ratios were used to estimate current groundwater exposure to adult and child residents. For an unfiltered lead-in-groundwater representative concentration of 7.1 ug/l at Area B, the estimated blood-lead concentration increases would be 0.4 ug/dL for adult residents and 1.8 ug/dL for child residents. For adult employees, this scenario, which was designed for residential exposure, does not exactly apply. It can be assumed that the employee blood-lead increase would be less than the adult resident's. If the dietary ratio of 0.04 ug/dL blood-lead per ug/day ingested were used (using the upper end of the range because the vehicle is water), the employee would have an estimated increase of 0.3 ug/dL.

No threshold has been defined for effects related to blood-lead increases. The estimated increases at Area B are well below the concentrations at which effects such as anemia and neuropathy occur (40 ug/dL and above) (Doull et al., 1986). Effects below 10 ug/dL are difficult to define. Inhibition of certain enzymes involved in red blood cell metabolism has been reported to occur at 10 to 15 ug/dL, and possibly lower (EPA, 1991e). Lead is also a fairly common environmental contaminant and, for this reason, typical blood-lead levels in the population at large may already exceed the concentrations discussed here. For boys and girls under 12, typical United States blood-lead levels for the years 1976 to 1980 ranged from approximately 10 to 17 ug/dL (Doull et al., 1986). For men and women, typical United States blood-lead levels for the years 1976 to 1980 ranged from approximately 10 to 18 ug/dL (Doull et al., 1986).

In conclusion, groundwater pathway would not be expected to pose a significant detectable risk. However, it must be mentioned that lead is an oral Group B2 probable human carcinogen and has no identifiable threshold for noncarcinogenic toxicity and, as such, has an ideal exposure of zero.

5.7.5 Uncertainty Analysis

There are uncertainties associated with exposure assumptions since not all people weigh 70-kg, not all people drink 2 L of water per day, not all people live at the sample residence for 30 year, etc. The rational for each assumption was provided in each table of input parameters. Receptor characteristics, such as age and body weight, were based on published values. Land use and activity patterns in the area were limited to the observations made to use conservative assumptions, except where average values were expected to better correspond to reality.

The chemical-analytical data base has some limitations in such areas as sample number and location and the validity and representativeness of laboratory results. However, every effort was made to collect samples that reflect actual site conditions. The use of representative concentrations is a conservative estimate since it uses the upper 95 percent confidence limit on the arithmetic mean or the maximum concentration.

The use of unfiltered monitoring well data for the evaluation of groundwater inorganics provides in all probability a gross overestimation of exposure and risk. Comparison with the filtered data reveals how many of the metals may have been attributable to suspended sediment. However, because of the significant concentrations of organics, the inorganics were in most cases not the primary contributors to total risk.

There is uncertainty associated with the RfDs and CSFs. The uncertainty results from the extrapolation of animal data to humans, the extrapolation of carcinogenic effects from the laboratory high-dose to the environmental low-dose scenarios, and interspecies and intraspecies variations in toxicological endpoints caused by chemical exposure. The use of EPA CSF values is generally considered to be conservative because the doses are based on no-effects or lowest-observed-effects levels and then further reduced with uncertainty factors to increase the margin of safety. The RfDs and CSFs of some chemicals have not been established, and therefore toxicity could not be quantitatively assess. In most cases, where RfDs were unavailable for carcinogens, the carcinogenic risk is considered to be much more significant since carcinogenic effects usually occur at much lower doses.

From toxicologist's standpoint, it is not strictly correct to add HQs for a total HI, since RfDs are based on effects to varying target organs. However if the HI is less than 1.0, this demonstrates that even when this conservative calculation is performed, the noncarcinogenic risk does not indicate a hazard. At this study area, for all HIs greater than 1.0, further assessment was done to determine whether this was due to a single chemical or a combination of chemicals, and whether the combinations of chemicals affected the same target organs.

These models also assumed that chemicals did not interact synergistically (a possible under estimate) or antagonistically (a possible overestimate). Degradation was not taken into account; this was generally a conservative approach.

5.8 SUMMARY AND CONCLUSIONS

Groundwater samples were collected to document conditions at Area B. Findings, conclusions, and recommendations from these and other RI activities conducted at Area B are provided below.

5.8.1 Summary

Findings for Area B have been summarized in this section. Discussion of conclusions and recommendations specific to these sites follow in subsequent sections.

5.8.1.1 Field Activities

Electromagnetic conductivity surveys were performed at Sites 6 and 7 during Phase I. The survey at Site 6 consisted of one baseline trending north 70 degrees east, and eleven profile lines running perpendicular to this baseline. The survey at Site 7 consisted of eight northwest to southeast trending profile lines with two northwest to southeast to southwest trending profile lines. An EM survey could not be conducted at Site 5 due to the proximately of both buried and overhead utility lines.

Soil gas surveys were performed at all sites during Phase I. The soil gas survey at Site 5 consisted of 30 soil gas stations located to the north, west and south of a housing unit on Skyhawk Drive. The soil gas survey at Site 6 consisted of 53 stations. The soil gas survey at Site 7 consisted of 63 stations in an area identified based on aerial photographs, and in the two baseball fields to the east and southeast of this site.

During Phase I, 10 confirmation soil borings were drilled at Site 5 in the areas to the north, west, and south of the housing unit. Fourteen borings were drilled at Site 7. Six test pits at Site 6 and three pits at Site 7 were excavated near the perimeter of anomalous EM areas and adjacent to soil gas anomalies.

Seventeen monitoring wells are present in the vicinity of Area B. Five overburden wells were installed during previous investigations, and the twelve remaining wells were drilled during Phases I and II. Seven shallow bedrock wells and one overburden well were installed during Phase I. Most shallow bedrock wells were installed to complete well couplets with overburden wells from previous investigations. One shallow bedrock well was placed to provide a groundwater sampling point downgradient from Site 6 and upgradient of Site 7. Three shallow bedrock wells and two overburden wells were installed during Phase II to form a pair of well couplets downgradient from all sites in this area.

Groundwater samples were obtained from seven shallow bedrock and five overburden wells during Phase I, and from nine shallow bedrock and five overburden wells during Phase II. Well BG-1 was dry during both sampling events. Well DG-7 was obstructed and Well MW-08 was dry during Phase II.

Hydrogeologic investigations near Area B included estimates of yields from new monitoring wells; calculations of horizontal groundwater flow velocities and vertical hydraulic gradients; construction of groundwater elevation maps; and estimates of flow rates for nearby surface water. During Phase II, slug tests were performed on several new monitoring wells.

Groundwater samples were analyzed for TCL volatile organics, TAL metals (both total and dissolved samples), and cyanide. Selected samples were also analyzed for TCL semivolatiles and pesticides/PCBs. A variety of engineering parameters were also analyzed for selected groundwater samples.

5.8.1.2 Physical Characteristics

Site 5 is located under Housing Unit 401 in NAWC Warminster's enlisted men's housing area. Site 6 is south of the main runway and north of the patrol road near the eastern end of the facility. Site 7 is located west of Sites 5 and 6 and east of the inertial reference building.

The Site 5 area has been reworked and filled with waste and imported natural clean soils used as backfill. The complete extent of the waste has not been determined, but was found north, east, and west of Building 401. One Site 5 boring north and three borings south of Building 401 did not encounter waste, and partially delineated the extent of the site. Waste material encountered included wood, glass and metal fragments in a matrix of fill material. Elevated PID readings at two borings north of Building 401 indicated some volatile materials are present. Both borings also encountered water.

Evidence of trenches and discrete zones of waste burial or waste burning were not found. The extensive re-working of the Site 5 area during construction of the housing units may have masked evidence of the trenches, and/or the trenches may extend under the building or into areas of utility lines where confirmation borings were not possible.

Two separate sections of Site 6 were identified. The larger extends over an area of six acres and is bounded by the patrol road to the south and west. The smaller area covers an area of 0.15 acres and is located over a trench-like area northeast of the larger section. Site 6 contains a heterogeneous mixture of building demolition materials, such as concrete, bricks, macadam, and metal. Some materials are not buried. The mixture of waste discovered at Site 6 indicates the burial of waste generally occurred in pits or within zones of previous filling or reworking, and waste piles initially placed on land surface were later surrounded by or graded into later backfilling. The current surface of this site contains several mounds of waste material covered with some or no soil.

The exact location of the two disposal trenches at Site 7 were not identified during the RI. The trenches are allegedly slightly north and west of Well DG-7.

Soils encountered in the Area B area were between four and 14 feet below land surface, and consisted of medium- to fine-grained silts and loams. Soil thicknesses are generally uniform, with only local areas of variation. The soils were silt loam with slow to moderate permeability. Construction debris and several mounded areas atypical of the normal topography were found at Site 6.

Several fracture traces are located south and southwest of Area B. No bedrock outcroppings were observed at or adjacent to this area. One spring was found south of the baseball field adjacent to Site 5 near Wells DG-8 and DG-20. Review of historical aerial photos revealed the presence of a stream in the area where the spring was found. This stream may have been filled with soil during construction activities.

The bedrock lithology consists mainly of brownish-red micaceous siltstone interbedded with gray, red, and light to dark brown, fine- to coarse-grained arkosic sandstone and gray to brown medium-grained quartzitic sandstone. These rock units were observed to strike northeast and dip six to 10 degrees to the northwest. The thicknesses of the lithologic units range from five to 20 feet. The sandstone encountered during drilling in one well appeared to be extensively fractured.

Vertical hydraulic gradients were consistently downward in all well couplets in this area. This indicates that the shallow bedrock aquifer may be recharged by the overburden aquifer throughout this area. Shallow bedrock and overburden groundwater flows generally toward the south and Southampton Creek. Horizontal groundwater velocities for the shallow bedrock aquifer ranged from 455 to 2,850 ft/yr; velocities for the overburden ranged from 2 to 6 ft/yr. In general, the depth to groundwater increases from south to north throughout the area.

Storm water collecting near these sites is piped underground from the south-central NAWC Warminster property boundary to a point approximately 500 feet to the south, where it flows through a residential area in a concrete channel. The channel flows through this area for about 1,000 feet and then travels through a road culvert before flowing into a streambed, which forms the headwaters of Southampton Creek.

5.8.1.3 Nature and Extent of Contamination

Because of the presence of buried and overhead utility lines, an EM survey could not be conducted at Site 5. The EM survey identified an anomalous area bordered by the patrol road to the south and west approximately 450 feet by 750 feet on Site 6. A second anomalous area on Site 6 is located just northeast of the first area. The second area is approximately 30 feet by 150 feet and appears to be a trench. Both areas are believed to contain scattered metal. Two EM anomalies were delineated at Site 7; there are no indications of buried metal.

Low concentrations of VOCs were detected during the soil gas survey at Site 5; acetone was identified by the GC. VOC readings from not detected to 52 ppm were reported at Site 6; the positive readings were detected in the western part of the site. Acetone was identified but believed to be attributable to blank contamination. Low concentrations of VOCs (0.4 to 1.5 ppm) were detected at Site 7; the positive detections did not correspond to the EM anomalies.

The boundaries of Site 5 could not be defined from confirmation borings since waste material was encountered in the borings farthest to the north, east and west. The waste included wood, glass, and metal fragments. VOCs were encountered in water-saturated soil in two borings. The average thickness of waste and clean fill was 4 to 5 feet and 5 to 6 feet, respectively. Test pits excavated within the EM-anomalous areas at Site 6 encountered waste material. Clean fill and construction debris were found in five of the six test pits. Building demolition debris (asphalt, concrete, and brick) was scattered around the eastern part of Site 6. Construction debris including cement, glass, wires, electrical parts, scrap metal, and asphalt, and one empty paint drum, were found in Site 6 test pits. No waste or significant fill material was found in the confirmation borings or test pits at Site 7.

Cyanide is detected in one monitoring well north of Site 5, but the result may be suspect. Notable concentrations of arsenic, lead, and manganese are detected in unfiltered monitoring wells downgradient of the site. No plume of metals contaminations in groundwater is identified. Toluene and phthalates are detected in monitoring wells in no identified pattern by well location.

With respect to the nature and extent of groundwater VOC contamination in the vicinity of Area B, several observations are noted, including

- Recognizable patterns of VOC contamination are found within the shallow bedrock aquifer but not the overburden aquifer

- Two recognizable groundwater contaminant patterns (i.e., TCE and 1,2-DCE) appear to originate in an area upgradient of Sites 5 and 7 and downgradient of the background wells in this area

- Both patterns appear to share a similar shape and size

- Both patterns appear to be elongated parallel to the generally southern groundwater flow direction before trending toward the southeast near Wells DG-8 and DG-20

The extent of these patterns suggests that contaminants enter the shallow bedrock aquifer from a relatively discrete area within Site 6 and that both patterns may originate from the same source. The known history of waste disposal practices at Site 6 indicates that the potential source of contaminants occurs atop, or within, the overburden materials at this site. Consistently downward vertical gradients in the well couplets in this area, and the lack of recognizable contaminant plumes in the overburden aquifer, suggest that groundwater movement within the overburden is primarily downward to the shallow bedrock aquifer.

The elongated northern portion of the patterns parallel to the inferred southern groundwater flow direction may indicate that groundwater within the shallow bedrock aquifer is moving laterally. The change in direction of the plumes toward the southeast may be related to a zone (or zones) of higher permeability near areas where a stream and spring formerly existed. The potential for contaminated groundwater to migrate from the shallow bedrock to deeper bedrock aquifers cannot be determined with the available information. Whether the shallow bedrock aquifer is discharging to nearby surface water is also unknown.

5.8.1.4 Contaminant Fate and Transport

The major contaminant transport pathways for encompassing Area B include:

- Contaminants leaching from source areas to groundwater because of infiltrating precipitation. The shallow depth to water and bedrock (i.e., less than 20 feet) promotes migration through the unsaturated zone. VOCs are most amenable to such transport.

- Contaminant migration by groundwater discharging to nearby surface water bodies.

Chemicals found in soil, especially subsurface soil, can leach into groundwater. This is especially likely to happen with soluble, low-Koc compounds such as VOCs.

Another possible migration route in this area is from groundwater into nearby Southampton Creek, and the pond. The second possible route of groundwater migration is from the shallow bedrock aquifer beneath the sites into the deeper bedrock aquifers downdip and north of the sites. Migration may then occur along geologic structures such as permeable bedding planes, subsurface fractures, and joints. The third possible route of groundwater migration is from the facility to off-site areas.

Potential human and environmental exposure pathways identified under current or future land use scenarios for Area B include:

- Ingestion, dermal exposure, and inhalation exposure to chemicals in groundwater.

5.8.1.5 Risk Assessment

Chemicals of concern were selected for the groundwater medium. The chemicals of concern were selected based on exceedance of background or upgradient concentrations, exceedance of ARARs or dose-response parameters, and carcinogenic status. The receptors chosen for the groundwater exposure included: adult residents, child residents, and adult employees. Blood-lead levels were estimated for potential exposure to lead.

Noncarcinogenic risks were estimated by use of Hazard Quotients (HQs) and Hazard Indices (HIs) (ratio of estimated dose to RfD). When HQs exceed 1.0, potential adverse effects can no longer be ruled out. Carcinogenic risks were estimated using cancer slope factors. Cancer risk increases should ideally be below 1E-6, although sometimes risks up to 1E-4 may be considered acceptable.

The HIs for hypothetical ingestion of current groundwater by residents would exceed 1.0 because of arsenic, barium, cadmium and manganese. If filtered groundwater were used instead, the child resident's HI would exceed 1.0 because of thallium. Estimated cancer risk increases for the hypothetical ingestion of current groundwater by all receptors would exceed 1E-5 because of arsenic, PCE, and carbon tetrachloride. The estimated cancer risk increases for dermal exposure to adult residents would exceed 1E-6 due to TCE and PCE.

Estimated blood-lead concentrations from exposure to lead in groundwater, would not be expected to pose a significant detectable risk. However, some potential (currently unquantifiable) carcinogenic risk could occur, according to the no-threshold theory of carcinogenicity.

5.8.2 Conclusions

Conclusions developed for Area B, based on the findings presented, are provided below.

5.8.2.1 Data Limitations and Recommendations for Future Work

Additional investigation should be performed in the vicinity of Area B, particularly to better define the nature and extent of groundwater contamination in this area. No conclusive evidence was collected during the RI to confirm the location of Site 7 or to determine if hazardous materials are present at this site.

The significant data gaps identified for Area B are as follows.

- The upgradient extent of contamination for the shallow bedrock aquifer in the vicinity of Site 6.
- The potential source of contamination for the shallow bedrock aquifer within Site 6.
- The degree to which the shallow bedrock recharges deeper bedrock aquifers in this area.
- The extent of groundwater contamination for the deeper aquifers underlying the general vicinity of Area B and whether any such contamination is due to releases from the facility.
- The potential for contaminated groundwater discharges to nearby Southampton Creek.
- The extent of downstream contamination in Southampton Creek near Area B.
- The location of Site 7 and whether this site received hazardous substances.

To address these data gaps, additional tasks should include, at a minimum,

- Additional monitoring wells as needed to define the upgradient extent of shallow bedrock aquifer contamination and the extent of deeper aquifer contamination.

- Additional soil borings and test pits to better define the possible source area of groundwater contamination within Site 6.

- Additional soil samples determine the potential impacts from uncovered waste at Site 6. Surface debris at Site 6 may be the source of surface water sediment contamination via the air of runoff. The surface debris should be located, characterized, sampled, and mapped.

- Review and interpretation of historical aerial photographs to determine if additional investigation should be performed in the vicinity of Area B.

- Additional surface and subsurface sampling to determine the extent of soil contamination and to assess potential risks from direct contact with any contaminated soils within Area B.

- Additional sediment sampling to determine the extent of stream contamination due to the sites located within Area B.

- Additional groundwater investigation to characterize flow in the shallow bedrock aquifer beneath Area B, hydraulic interconnections between the shallow and deeper aquifers, and the potential for contaminated groundwater to discharge to Southampton Creek.

- Evaluate the need for additional air monitoring to assess risks in areas of potential concern identified through aerial photointerpretation.

- An additional well survey to determine whether nearby groundwater receptors (e.g., residential wells) are potentially at risk due to releases from Area B. Off-site groundwater sampling should be performed as necessary on this survey.

It is recommended that further investigation be explored for metals in groundwater near Area B. Suspended materials may be responsible for significant concentrations of arsenic, barium, cadmium, and manganese, but thallium was the only contaminant detected at significant concentrations in filtered groundwater samples (one well only). Resampling of both filtered and unfiltered water may be warranted to confirm the presence of thallium.

Groundwater in overburden and shallow bedrock contaminated by NAWC Warminster beneath Area B has been found to present an unacceptable risk to human health. Based on information generated during the RI, adequate data exist to proceed with the evaluation of remedial alternatives for overburden and shallow bedrock contaminated groundwater through the FS process. Additional sampling and investigation are needed for other media associated with Area B, including groundwater in deep bedrock aquifers.

5.8.2.2 Recommended Remedial Action Objectives

As described in Section 4.8.2.2, remedial action objectives consist of medium-specific goals for protecting human health and the environment. Based on these objectives, cleanup goals or acceptable contaminant levels for each exposure route are developed. These goals are based on contaminant-specific ARARs or other appropriate guidance and on risk factors.

Applicable or Relevant and Appropriate Requirements

Tables 4-72 and 4-73 present a summary of preliminary Federal and State ARARs for NAWC Warminster. These ARARs will be refined and revised as necessary during the FS. In developing and selecting remedial action alternatives, the degree of public health or environmental protection afforded by each remedy must be considered. Actions that attain or exceed ARARs are given primary consideration.

An initial list of potential response objectives for contaminated groundwater at Sites 1, 2, and 3 (Area A) was developed and discussed in Section 4.8.2.2. This list also applies to Area B.

Groundwater

Routine exposure to contaminated groundwater through ingestion and inhalation present the greatest potential human health risks posed by Area B. Based on the data collected and evaluated during the RI, sufficient information is available to develop and establish remedial action objectives for only the shallow groundwater underlying Area B.

For shallow groundwater underlying Area B, potential remedial objectives include remediating groundwater or managing contaminant migration to:

- Prevent further migration of groundwater contaminants from current NAWC Warminster property.
- Initiate restoration of the overburden and shallow bedrock aquifers while additional investigations are being completed.

6.0 ADDITIONAL GROUNDWATER INVESTIGATIONS

6.1 INTRODUCTION

This section discusses additional groundwater investigation and presents the findings of well sampling for those wells within, or near, NAWC Warminster Operable Unit 1 that are not located within Areas A or B.

6.2 SUMMARY OF PREVIOUS INVESTIGATIONS

Since 1979, a number of wells within Warminster Township and other nearby townships have been sampled for VOCs, and contamination by VOCs has made some groundwater unsuitable for public supply. Between September 1979 and April 1960, five nearby municipal authorities (along with NAWC Warminster) removed a total of 18 public wells from service due to VOC contamination, primarily TCE and PCE. Some of these wells have been returned to service following the installation of air-stripper treatment facilities.

TCE has been found in NAWC Warminster supply wells SW-1 and SW-2 at 147 and 293 ppb, respectively; PCE has been found in supply wells SW-5 and SW-2 at 36 and 33 ppb, respectively. Earth Technology Corporation (ETC) took depth-specific groundwater samples from five of the NAWC Warminster supply wells during packer tests conducted in the wells. A summary of the depth ranges and sample results for these wells (SW-1 through SW-5) is provided in Table 6-1. Well construction details for the NAWC Warminster supply wells are included in Appendix D.

TABLE 6-1

SUMMARY OF DEPTH-DISCRETE CHEMICAL ANALYTICAL RESULTS FOR SELECT NAWC WARMINSTER SUPPLY WELLS

Well	Depth (feet)	TVO[1] (ppb)	TBN[2] (ppb)
SW-1	<90	133.3	91.30
	>190	54.15	72.80
SW-2	<80	65.22	93.00
	110-160	204.49	106.80
	180-200	72.93	49.80
	>220	54.25	96.50
SW-3	30-95	6	---
	198-238	6	---
	298-338	5	---
	411-451	27	---
	>510	8	---
SW-4	<100	1.68	73.10
	140-180	---	108.80
	280-320	1.9	94.20
	400-440	2.24	123.40
	>500	0.80	98.40
SW-5	>90	4.19	89.60
	120-160	5.62	88.30
	160-200	1.70	40.40
	200-240	21.41	69.10
	>280	4.64	36.70

Notes:

1 TVO - Total Volatile Organic Compounds

2 TBN - Total Base/Neutral Compounds

Sources: Earth Technology Corporation, June 1985, December 1985 and 1988

Most of the VOC and base/neutral (B/N) contamination found in well SW-1 by ETC was in a shallower zone of the well (the upper 90 feet). The most contaminated zone in well SW-2 was found in the deeper portion of the well. The SW-2 110- to 160-foot zone has more VOC and B/N contamination than any other zone within the well. Relatively few to no contaminant concentrations were detected in well SW-3. The highest level SW-3 contamination was found within the 411- to 451-foot zone. The primary contaminant found in this zone was 13 ppb of PCE. Contaminants were generally found uniformly throughout well SW-4. The magnitude of VOC contamination for this well was much lower than that found in wells SW-1 or SW-2. However, relatively higher concentrations of B/N compounds were detected in well SW-4. The B/N contaminants were generally distributed uniformly throughout the well. The most VOC contamination detected in SW-5 was found in a deeper portion of the well (200 to 240 feet). VOC contamination in this well was much less than contamination detected in SW-1 and SW-2. Similar to well SW-4, relatively higher amounts of B/N compounds were detected almost uniformly within SW-5.

A hydrogeologic study conducted by Satterthwaite Associates (1984) included the installation of three monitoring wells (MP-1, MP-2, and MP-3), located over 500 feet southwest of Area A. These wells are completed to depths of 100 to 130 feet in the shallow bedrock water-table and semi-artesian zones and are cased through the overburden. The well construction details are included in Appendix D. TCE represents the only notable contaminant found in groundwater samples obtained from these wells. TCE was found at a concentration of 525 ppb in well MP-3, at a concentration of 110 ppb in well MP-2 after purging 5,100 gallons of groundwater, and at a concentration of 140 ppb in well MP-2 after purging 13,700 gallons of groundwater. Well MP-1 was not sampled during this event.

NAWC Warminster well SW-11 was included in a study of the Stockton Formation Aquifer conducted by the U.S.G.S. Geophysical logs including caliper natural-gamma, single-point-resistance, fluid-resistivity, fluid-temperature, and brine trace logs were run in this well on June 17, 1991. Interpretation of these logs indicates that groundwater is flowing downward within this well at a maximum rate of 2.0 gpm. Water is entering the borehole through fractures at 62 feet and 102.5 to 104 feet and exits the borehole through fractures at 134 to 142 feet, 226 to 229 feet, and 272 feet. A sample of groundwater moving downward within the well at a depth of 70 feet detected no VOCs (detection limit, 0.2 ppb) (Sloto, 1992).

Within the vicinity (0.25-mile radius) of NAWC Warminster, three residential wells and two commercial wells reportedly have VOC contamination, as does WTMA-26 located 0.4 mile from the facility boundary. Although the deep wells at the facility are contaminated, these wells are not immediately adjacent to Areas A and B. The contaminated deep wells are hydrologically upgradient from these sites.

6.3 PHASE I AND II REMEDIAL INVESTIGATION

During Phase I, a local well inventory was performed to determine the number of residential and municipal wells that were near the facility. During Phase II, the investigation primarily focused on shallow groundwater contamination; however, some information was collected to evaluate the deeper aquifers in terms of their flow direction and hydraulic connection with overlying aquifers.

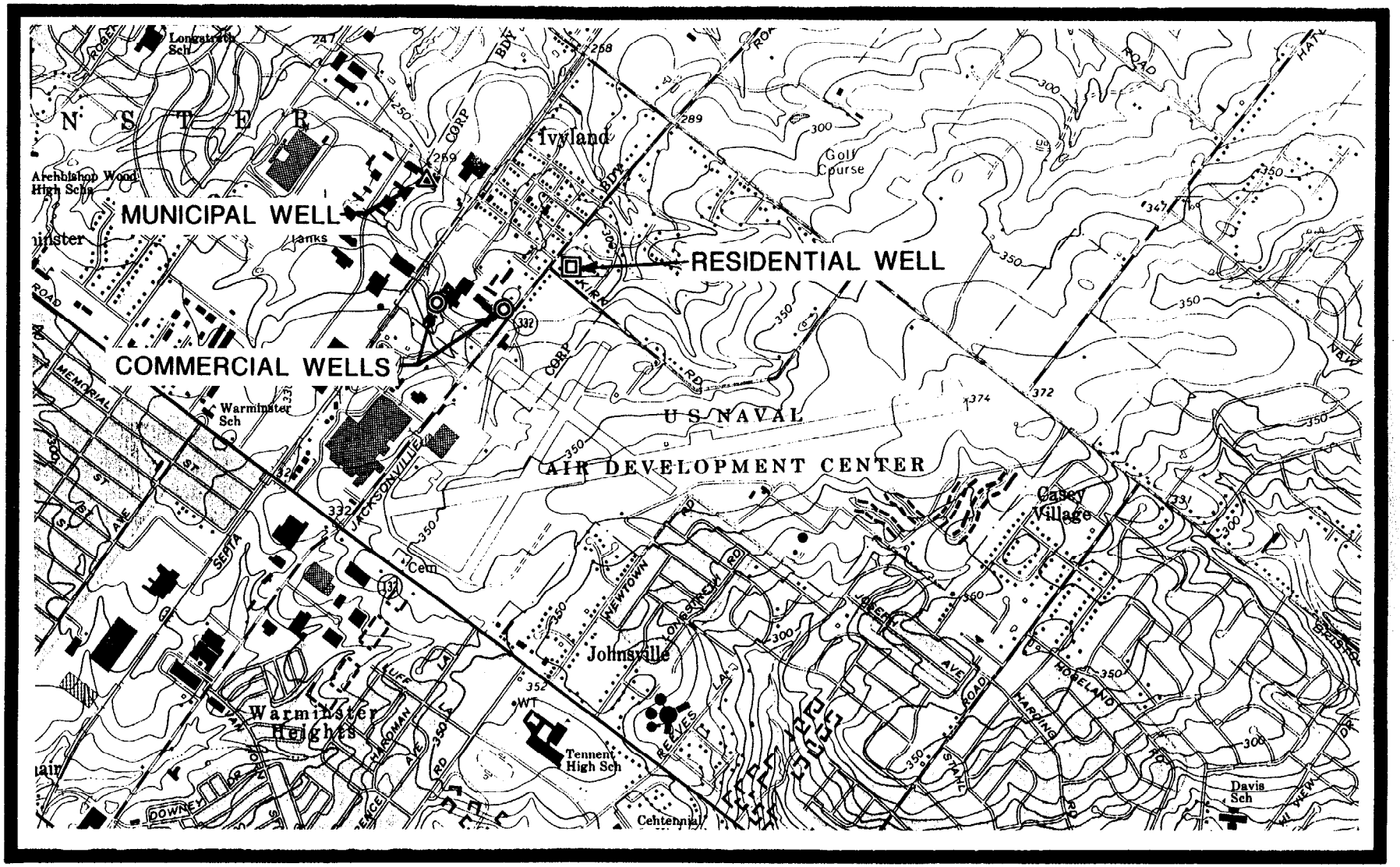
During Phase II, four off-site wells were sampled as shown in Figure 6-1. All samples were analyzed for TCL volatile organics, TAL metals (both total and dissolved), and cyanide. One groundwater sample was also tested for TCL semivolatile organics and pesticides/PCBs.

6.3.1 Local Well Inventory

Groundwater in much of the Warminster area is used as a source of drinking water. Groundwater use is discussed in greater detail in Section 3.6. The objective of the local well inventory (described in Section 2.1.1) was to identify residential, business, and public water supply wells within 0.25 mile of the facility. Figure 2-1 displays the 0.25-mile study area. The locations of confirmed wells are included in Section 3.6.1 (Figure 3-3 and Tables 3-3 through 3-5).

6.3.2 Sampled Off-Site Wells

The Wagner & Sons production well is located approximately 500 feet northeast of the NAWC Warminster facility boundary between Sites 1 and 2 (Figure 6-1). The well is located within the Wagner building and supplies water for the production process. No production or construction details were available for the well other than the fact that it is at least 200 feet deep. Water from this well is reported to undergo carbon filtration and ultraviolet light treatment prior to any use. An older, lower yielding well is also present at the Wagner facility, supplying water to the basic plumbing system for use in sinks, toilets, etc. This well was not sampled during Phase II. No treatment of water from this well was reported, and the extent to which this water is used for drinking is unknown.



OFFSITE GROUNDWATER SAMPLE LOCATIONS

FIGURE 6-1

HALLIBURTON NUS Environmental Corporation

Based on local hydrogeologic information, the Wagner production well penetrates bedrock layers that are either along strike or down-dip from those that subcrop beneath Area A. Groundwater flow directions in the shallow bedrock aquifer indicate that the Wagner production well is generally downgradient from the sites. The deep bedrock aquifer flow direction determined by Satterthwaite (1984) suggests that the Wagner production well is also generally downgradient from the facility within this aquifer as well.

WTMA-26 is located approximately 2,000 or more feet north of Area A. Available records indicate that the well is 250 feet deep with 10-inch-diameter casing to a depth of 70 feet and that it has a specific capacity of 8.8 gpm per foot of drawdown at a pumping rate of 420 gpm (Sloto and Davis, 1983). Pumping in this well has produced drawdown in an observation well located 2,500 feet to the southwest, which is the approximate direction of the strike of bedding within the Stockton Formation (Sloto and Davis, 1983). WTMA-26 is reported to pump continuously at an approximate rate of 250 gpm. All water produced is treated through an air stripper unit.

Available geologic data indicate that WTMA-26 is located down-dip of Area A. If the northeastern strike direction and northwest dips of 12 and 13 degrees determined during Phase I are correct, then the deeper bedrock layers (below about 200 feet) penetrated by WTMA-26 may subcrop beneath the northwesternmost portions of the Area A. The approximate locations of two fracture traces mapped by Satterthwaite (1984) extend northward from within the facility boundary near Area A passing within about 200 feet, or less, of the WTMA-26 location. The well is hydrogeologically downgradient of Area A within both the shallow bedrock and deep bedrock aquifers based on groundwater flow directions determined during the RI and by Satterthwaite (1984).

The Aztec Corporation well is located approximately 900 feet northeast of Site 3. Information on the construction details, production figures, and use of this well is not available. Local geological data indicate that the bedrock layers penetrated by this well are either along strike or in a structurally up-dip direction from those which subcrop beneath Area A. The Aztec well is not directly downgradient of any of Area A sites within the shallow bedrock aquifer.

The Lewis well is located approximately 1,000 feet north-northwest of Site 8. The construction details of this well are unknown. Water from the well serves the Lewis residence and is reportedly untreated. This well is located downgradient of Site 8 within the shallow bedrock aquifer.

6.4 GROUNDWATER TARGETS

Nearby residents rely primarily on groundwater sources for water supply. The majority of these people are served by municipal water authorities, and the remainder utilize private domestic or commercial wells. The main NAWC Warminster supply system obtains water from three deep wells located at the facility. Some local municipal water authorities supplement their groundwater withdrawals with water from the Philadelphia Suburban Water Company.

Within the immediate vicinity of NAWC Warminster (less than one mile) are supply wells for

- Warminster Municipal Authority
- Upper Southampton Municipal Authority
- Warminster Heights Development Corporation
- Other commercial facilities

Municipal supply wells and other wells in the area pump several hundred million gallons of groundwater per year, mainly from deeper bedrock zones of the Stockton Formation. Several public and commercial water supply wells near NAWC Warminster have encountered significant levels of VOC groundwater contamination. None of the municipal water supply wells are within 0.25 mile of the base.

Three types of wells were confirmed to exist within or near the local well inventory study area, including residential, commercial, and municipal wells. Figure 3-1 displays the location of each residential, commercial, and municipal well that was confirmed to exist by the inventory, as well as the NAWC Warminster supply wells.

6.4.1 Residential Wells

The largest concentrations of residential wells are in the housing developments west of Davisville Road and east of NAWC Warminster. Responses to the door-to-door confirmation survey represent 56 percent of the total number of properties suspected to have wells. The door-to-door residential survey response has been summarized in Table 3-3. Table 3-4 presents the address of each confirmed residential well and other available well information.

Between 47 and 91 residences and businesses within 0.25 mile of the facility property boundary have private supply wells (Figure 3-3). For confirmed residential wells, well depths range from 30 to 145 feet below grade. Therefore, some nearby residential wells are assumed to be drawing from the shallow bedrock aquifer which also underlies the facility.

Residences served by wells are concentrated in three principal areas. One area is between Davisville Road and the facility. Another area is on Newtown Road, north of Street Road, and the third is on Maple and Memorial Streets, southwest of NAWC Warminster. None of these areas are directly downgradient of any identified NAWC Warminster sites with respect to the shallow bedrock aquifer.

The well group near Davisville Road is 1,500 feet from Site 6. The well group on Newtown Road is 2,500 feet from Site 4. The well group on Maple and Memorial Streets is 2,500 feet from Area A.

The well groups along Newtown Road and on Maple/Memorial Streets are along strike with NAWC Warminster sites. The well group near Davisville Road is up-dip from the facility. Strike and dip are geological features that, along with pumping of municipal or other wells, may significantly influence the route of groundwater flow.

Several residential wells (e.g., 167 Kirk Road, 1069 Azalea Drive, and 1080 Azalea Drive) were reported to contain TCE and/or PCE during the well survey. Independent sampling to confirm this has not been performed as a part of the RI.

6.4.2 Municipal and Commercial Wells

The eight municipal and three commercial wells that were confirmed during the course of the well inventory are listed in Table 3-3 and shown on Figure 3-3. None of the municipal water supply wells were within 0.25 mile of the base, but several are in close proximity to the 0.25-mile boundary. The three commercial wells are operated by Aztec Corporation, Wagner & Sons, and a local golf course.

6.4.3 NAWC Warminster Supply Wells

NAWC Warminster has 10 groundwater supply wells located on base. These are designated as SW-1 through SW-10. Their locations are shown on Figures 1-3 and 3-2. SW-11 is not actually an NAWC Warminster supply well but is a monitoring well. The Bucks County Planning Commission and U.S.G.S. continuously monitor the water level in this well. The construction details of these wells are contained in Appendix D.

Of the 10 supply wells

- Wells SW-1 and SW-2 provide water to the fire protection system.
- Well SW-5 is out of service because of VOC contamination. The well borehole was reported to be collapsed by NAWC Warminster personnel.
- Well SW-7 is currently out of service now that Quarters A is supplied by the main NAWC Warminster systems.
- Wells SW-3, SW-4, and SW-10 supply water to the main NAWC Warminster supply system. Average pumping rates are estimated as 9.7 million gallons per year (mgy) for SW-3, 10.6 mgy for SW-4, and 21.2 mgy for SW-10.
- Well SW-6 provides water to one building but is not generally in use since this building is no longer used.
- Wells SW-8 and SW-9 provide water to individual buildings within the NAWC Warminster property.

6.4.4 Contamination in Local Wells

As listed on Tables 3-4 and 3-5, three residential wells and three commercial or municipal wells reportedly have VOC contamination. One of the three residential wells allegedly containing contamination was reported to be filtered prior to use. Whether the other two wells have filter systems in place is unknown. Municipal wells that have been found to contain volatile organic concentrations have been outfitted with appropriate treatment systems. Measures taken at some commercial wells, reportedly found to contain volatile organic compounds, are unknown. However, the Wagner & Sons well is carbon filtered.

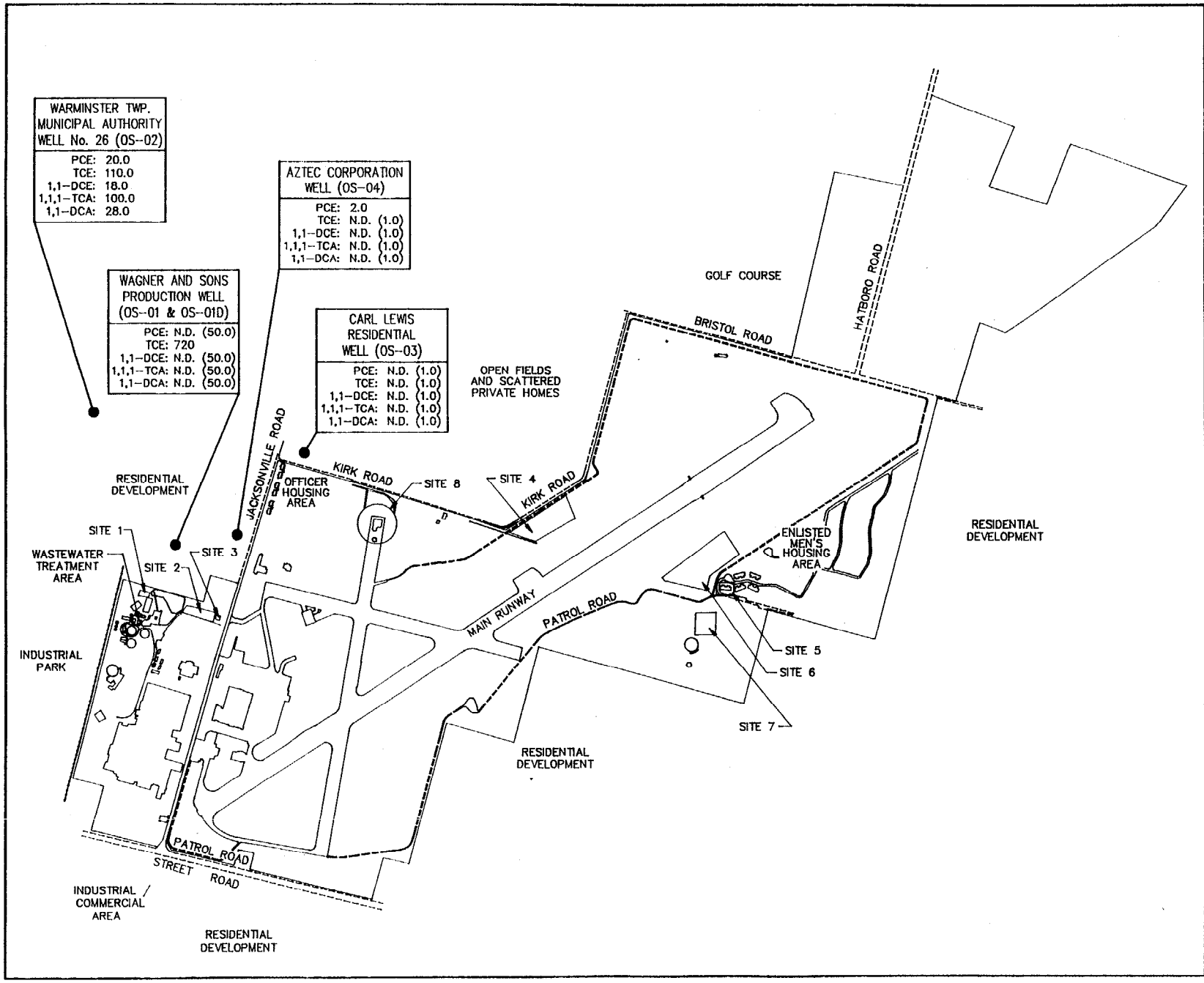
6.5 NATURE AND EXTENT OF CONTAMINATION

The sampled off-site wells are OS-01 and OS-01D, the Wagner & Sons well, OS-02, WTMA-26, OS-03, the Lewis well, and OS-04, the Aztec Corporation well. The locations of these wells with respect to sites within Area A and a general summary of the VOC sample results are shown in Figure 6-2. The Wagner well is used for industrial purposes, including food processing. WTMA-26 supplies potable water to local homes and businesses. The Lewis well is a residential well, and the uses of the Aztec well are unknown.

The Wagner well is treated with carbon filtration and UV treatment but was sampled prior to treatment. Table 6-2 shows that TCE is found in this well at 720 ug/L. Filtered and unfiltered results are comparable, except for lead, which is much lower in the filtered sample. The notable inorganic results include arsenic and lead (carcinogens).

WTMA-26 is treated with an air stripper but was sampled prior to treatment. Table 6-2 presents the analytical results for this well. Both chlorinated ethenes and chlorinated ethanes are detected. Filtered and unfiltered inorganic results are comparable, and arsenic, a Group A human carcinogen, is detected in OS-02.

The Lewis well is not reported to be treated. It can be seen from Table 6-2 that no organic compounds are positively detected in OS-03. Filtered and unfiltered inorganic results are basically comparable.



NAWC
WARMINSTER, PA

FIGURE 6-2

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

HALLIBURTON NUS Environmental Corporation

Adapted From SMC Environmental Services Group, 1991

DATE: 2/9/93

C:\DWG\NAWC\079

TABLE 6-2
OFF-SITE WELL SAMPLE RESULTS
NAWC, WARMINSTER, PENNSYLVANIA
(ug/L)

Chemical	CRDL/CRQL	OS-01/01D	OS-02	OS-03	OS-04
Organics		WAGNER	WTMA-26	LEWIS	AZTEC
Tetrachloroethene	1		20		2
Trichloroethene	1	720	110		
1,1-Dichloroethene	1		18		
1,1,1-Trichloroethane	1		100		
1,1-Dichloroethane	1		28		
Inorganics (unfiltered)					
Arsenic	10	4.45	3.7		4.6
Barium	200	243	216	376	209
Calcium	5000	48200	54200	35800	33200
Copper	25	73		41	
Lead	3	467.85			
Magnesium	5000	11950	15800	14800	12100
Manganese	15	52.5	41		26
Potassium	5000	1360	2080	705	1200
Sodium	5000	13900	14000	8950	10200
Zinc	20	70			
Inorganics (filtered)					
Arsenic	10		3.4	4.3	3.2
Barium	200	244.5	216	374	214
Calcium	5000	48700	55000	35900	34600
Lead	13	23.5			
Magnesium	5000	11450	15100	14000	11300
Manganese	15	10	33		25
Potassium	5000		12200		
Sodium	5000	12350		7810	8970
Zinc	20	45.5		22	

The chemicals detected in the Aztec well are shown on Table 6-2. PCE is detected at a low concentration (2 ug/L). Filtered and unfiltered inorganic results are similar; arsenic (a Group A human carcinogen) is especially notable.

6.6 TRANSPORT OF CONTAMINATED GROUNDWATER OFF SITE

Various aspects of contaminant fate and transport of chemicals found in off-site wells are discussed in this section. Various chemical and physical properties affecting contaminant migration are discussed in Section 6.6.1. Potential contaminant migration routes are identified and discussed in Section 6.6.2. Section 6.6.3 presents a brief discussion of contaminant persistence.

6.6.1 Physical and Chemical Transport Properties

This section provides a qualitative discussion of potential migration of the contaminants found in off-site wells. The physical and chemical properties of the chemicals found in these wells, where available, are presented in Tables 6-3 and 6-4. These parameters may be used to assess the behavior of a chemical in the environment.

Empirically determined literature values of water solubility, octanol-water partition coefficient (Kow), organic carbon partition coefficient (Koc), vapor pressure, Henry's Law constant, bioconcentration factor (BCF), and specific gravity are presented for organic chemicals, as available. Many of these parameters are not applicable to inorganic chemicals. For inorganics, specific gravity and BCFs have been presented, along with qualitative descriptions of important environmental fate properties. Calculated values, which were obtained using approximation methods, are presented when literature values are unavailable. A discussion of the environmental significance of each of these parameters follows.

The rate at which a chemical is leached from a waste deposit by infiltrating precipitation is a function of its water solubility. More soluble chemicals are expected to enter water much more readily and rapidly than less soluble chemicals. The water solubilities presented in Table 6-3 indicate that VOCs can be relatively soluble in water; unlike less soluble chemicals such as phthalates, they are detected in groundwater much more frequently.

The Kow is a measure of the equilibrium partitioning of a chemical between octanol and water. The Kow is also used to estimate BCFs in aquatic organisms. A linear relationship between the Kow and the uptake of chemicals by fatty tissues of human receptors has been determined (Lyman et al., 1990). VOCs are generally less likely to partition to fatty tissues than many other organic chemicals, such as chlorinated hydrocarbon pesticides.

TABLE 6-3
MOBILITY PARAMETERS FOR ORGANIC CHEMICALS - OFFSITE WELLS
NAWC, WARMINSTER, PENNSYLVANIA

CHEMICAL	MOL[1] WT. (g)	SOL[1](mg/L)	Log Kow [2][3][4]	V.P.[1] (mmHg,20C)	H[1][3] atm.m^3 mol	BCF[1]	SP.GRAV.[2][5] (20C)	Koc[1]
Trichloroethene	131.39	1100	2.53	5.79E1	9.1E-3	9.7E1	1.46	1.26E2
Tetrachloroethene	165.83	200	2.6(20C)	1.4E1	1.53E-2	2.52E2	1.626	3.64E2
1,1,1-Trichloroethane	133.41	720	2.47	1.23E2(25C)	3E-2	8.1E1	1.35	1.52E1
1,1-Dichloroethane	98.96	5500	1.79	1.8E2	4.26E-3	1.9E1	1.174	3E1
1,1-Dichloroethene	96.94	400	1.48	5.91E2	1.9E-1	5.3E1	1.218	6.5E1

(1) EPA, 1982
(2) Verschueren, 1983
(3) EPA RREL
(4) Versar, 1979
(5) Weast, 1988
MOL. WT. = Molecular weight
SOL. = Solubility
Kow = Octanol - water partition coefficient
V.P. = Vapor pressure
H = Henry's law constant
BCF = Bioconcentration factor
SP. GRAV. = Specific gravity
Koc = Organic carbon partition coefficient

TABLE 6-4
MOBILITY PARAMETERS AND PROPERTIES FOR INORGANIC CHEMICALS - OFFSITE WELLS
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	MOL WT. (g)	SP. GRAV. (at 20C)[1]	BCF		Described Environmental Fate [2]
			(2)	(3)	
Arsenic	74.92	5.727	333	0-17	Sorption important
Barium	137.34	3.51	-	-	-
Copper	63.54	8.92	12-30000	0-2000	Sorption, bioaccumulation important
Lead	207.19	11.3	60-200	42-1700	Sorption, bioaccumulation important
Manganese	55	7.2	-	-	-
Zinc	65.38	7.14	1000-40000	51-1130	Sorption, bioaccumulation important

MOL. WT. = Molecular weight
Sp. Grav. = Specific gravity
BCF = Biocentration or bioaccumulation factor; freshwater species
(1) Weast, 1988
(2) Versar, 1979
(3) EPA, 1983a; EPA, 1983b; EPA, 1983c; EPA, 1986b; EPA, 1983d; EPA, 1986c; EPA, 1986d; EPA, 1983e; EPA, 1980a; EPA, 1980b; EPA, 1980c; EPA, 1980d

The Koc is related to the water solubility and the Kow. This parameter indicates the tendency of a chemical to bind to soil particles containing organic carbon. Chemicals with high Koc generally have low water solubilities and vice versa. Therefore, chemicals such as the VOCs, with relatively low Koc and high water solubility, are more likely to be found in well water than high-Koc compounds, which would be more likely to adsorb onto aquifer sediments.

Vapor pressure provides an indication of the rate at which a chemical in water volatilizes when exposed to air. It is of primary significance in instances where interfaces such as surface soil/air and surface water/air are important, rather than in evaluation of groundwater and subsurface soils. Vapor pressures for VOCs are relatively high, compared to compounds such as PAHs and phthalates. Chemicals with higher vapor pressures are expected to enter the atmosphere much more readily than chemicals with lower vapor pressures.

The Henry's Law constant is the equilibrium vapor pressure of a chemical above a solution divided by its concentration in the solution (for dilute systems). The Henry's Law constant may also be used to calculate the equilibrium contaminant concentrations in the vapor versus liquid phases for dilute solutions commonly encountered in environmental settings. The Henry's Law constant is also useful for mass transfer applications for air-stripping column design.

BCFs represent the ratio of aquatic organism tissue concentration to water concentration. This parameter is not expected to be important for the evaluation of potable wells.

Specific gravity is the ratio of the mass of a given volume of pure chemical at a specified temperature to the mass of the same volume of water at a given temperature. Its primary use is to determine whether immiscible compounds or very high concentrations of a pure contaminant will float or sink in water. As shown in Table 6-3, most of the chemicals detected in off-site wells are denser than water.

As shown in Table 6-4, most of the inorganic chemicals have a strong tendency to adsorb onto suspended particulates, a factor that greatly reduces their mobility. This is generally not important for continually pumped and treated wells such as these off-site wells, and the filtered and unfiltered inorganic results were much more similar than for monitoring wells. Although the metals themselves are insoluble in water, soluble species of some metals can increase contaminant mobility.

6.6.2 Potential Migration Routes

The major possible migration routes for contaminants found in off-site groundwater are to move laterally within the overburden aquifer to the shallow bedrock aquifer and from the shallow bedrock aquifer to the deeper bedrock aquifers. Upon reaching the deeper aquifers, groundwater may move parallel to bedding planes within these aquifers.

Horizontal migration of groundwater in the overburden aquifer in response to regional hydraulic gradients is significant. These gradients may be established by topographic controls and discharge to surface water bodies or by long-term pumping trends. Pumping of water from the deeper bedrock aquifers induces leakage from the overlying aquifers. Pumping of water from the deeper aquifers induces the flow of groundwater parallel to bedding within these aquifers. The permeable layers of the deeper bedrock aquifers are fed by water that flows down-dip from areas of recharge in the overlying aquifers.

6.6.3 Contaminant Persistence

Several transformation processes are believed to affect the persistence of organic chemicals in the environment. The primary processes affecting contaminant fate in the environment include microbial and chemical degradation.

Generally, organic molecules are subject to several chemical reactions under environmental conditions. Such reaction mechanisms include acid/base reaction, addition, elimination, and hydrolysis. For chlorinated ethanes, some hydrolysis can reportedly occur under neutral conditions (EPA, 1982). For chlorinated ethenes, hydrolysis is reported to be virtually nonexistent (EPA, 1982).

Another possible type of degradation is the dechlorination of PCE and TCE to 1,2-DCE, 1,1-DCE, and ultimately vinyl chloride (Cline and Viste, 1984). 1,1,1-TCEA can also degrade to 1,2-DCEA, 1,1-DCEA, and chloroethane (Cline and Viste, 1984). In OS-02, TCE and PCE are detected along with 1,1-DCE, and 1,1,1-TCEA is detected along with 1,1-DCEA. In OS-01, TCE is detected alone.

Bacterial degradation is a potential environmental fate mechanism. Such degradation has been reported for some organics, especially, of the chemicals detected in off-site wells, for chlorinated ethenes (EPA, 1982).

6.7 RISK ASSESSMENT

This section provides a description of the risk assessment methods employed for off-site wells, sampled during Phase II as well as a summary of the risk assessment results. The objectives of the risk assessment are to define the actual or potential risks to human health and the environment resulting from the presence of contamination in the groundwater and to provide the basis for determining appropriate remedial measures for the FS.

Three major aspects of chemical contamination must be considered when assessing public health risks: contaminants with toxic characteristics must be found in environmental media and must be released by either natural processes or by human action; potential exposure points must exist; and human or environmental receptors must be present at the point of exposure. Risk is a function of both toxicity and exposure; without any one of the three factors listed above, there will be no risk.

A fundamental difference between these wells and the exposures considered in Sections 4.0 and 5.0 is that these wells are known to be used for certain purposes. Therefore, each well is considered as a point source to the receptor at that location.

The risk assessment estimates the potential for human health risk at the site. Information regarding the toxicity of the compounds detected in the various media, the distribution of contamination, and a site-specific estimate of chemical intake via assumed exposure routes will be combined to estimate potential risks. The processes used at this site are generally in accordance with current EPA risk assessment guidance (EPA, 1989a; EPA, 1991a).

The human health risk assessment consists of four components: Data Evaluation, Toxicity Assessment, Exposure Assessment, and Risk Characterization. Each component was defined in Section 4.7.

6.7.1 Data Evaluation

6.7.1.1 Representative Concentrations

Ordinarily, risk assessment is performed using a representative concentration for each chemical in each medium. Representative concentrations were defined in Section 4.7.1.1. However, because each off-site well is considered to be an exposure source, the result for each chemical as it appears in the validated database was used for each well. For wells with duplicate results, the results were averaged as described in Section 4.7.1.1. and treated as a single result.

6.7.1.2 Chemicals of Concern

Chemicals of concern are identified in this section, based on various aspects of their occurrence and distribution, mobility, persistence, and toxicity. These chemicals are selected to represent site contamination and will provide the framework for the quantitative risk assessment.

The occurrence and distribution of contaminants in off-site wells were discussed in Section 6.5. Lead is detected at relatively high concentrations in OS-01/01D. Arsenic is detected in three of the four wells (all except OS-03). TCE is detected in OS-01/01D, and chlorinated ethenes and ethanes are detected in OS-02.

Appendix O summarizes the toxic effects for selected chemicals of concern. The summaries are presented in the form of toxicity profiles. Adverse effects on human receptors are discussed. The chemical of concern selection process for each well is discussed in the remainder of this section.

OS-01/01D, Wagner & Sons

The chemicals that were positively detected in this well were presented in Table 6-2. Table 6-5 presents the chemicals of concern for this well. TCE was selected because it is an organic chemical not believed to be naturally occurring and it was also detected on site. Arsenic and lead were selected because, as carcinogens, they have ideal exposures of zero.

TABLE 6-5
CHEMICALS OF CONCERN - OS-01/01D - WAGNER & SONS WELL
NAWC, WARMINSTER, PENNSYLVANIA
(ug/L)

Organics			
Carcinogens	Rep. Conc.	Noncarcinogens	Rep. Conc.
Trichloroethene	720		
Inorganics (unfiltered)			
Carcinogens	Rep. Conc.	Noncarcinogens	Rep. Conc.
Arsenic	4.45	Barium	243
Lead	467.85	Copper	73
		Manganese	52.5
		Zinc	70

Since there were no "upgradient" well data for these deep off-site wells, all remaining inorganics were also selected as chemicals of concern, except the common, relatively nontoxic minerals calcium, magnesium, potassium, and sodium.

OS-02, WTMA-26

The chemicals that were positively detected in this well were presented in Table 6-2. Table 6-6 presents the chemicals of concern for this well. All organics were selected because they are organic chemicals not believed to be naturally occurring and they were also detected on site. Arsenic was selected because, as a carcinogen, it has an ideal exposure of zero. Since there were no "upgradient" well data for these deep off-site wells, all remaining inorganics were also selected as chemicals of concern, except the common, relatively nontoxic minerals calcium, magnesium, potassium, and sodium.

OS-03, Lewis

The chemicals that were positively detected in this well were presented in Table 6-2. Table 6-7 presents the chemicals of concern for this well. There were no positively detected organic compounds. All inorganic chemicals except calcium, magnesium, potassium, and sodium were selected as chemicals of concern.

OS-04, Aztec Corporation

The chemicals that were positively detected in this well were presented in Table 6-2. Table 6-8 presents the chemicals of concern for this well. PCE was selected because it is an organic chemical not believed to be naturally occurring and it was also detected on site. Arsenic was selected because, as a carcinogen, it has an ideal exposure of zero. Since there were no "upgradient" well data for these deep off-site wells, all other inorganics were also selected as chemicals of concern, except the common, relatively nontoxic minerals calcium, magnesium, potassium, and sodium.

TABLE 6-6
CHEMICALS OF CONCERN - OS-02 - WTMA WELL NO. 26
NAWC, WARMINSTER, PENNSYLVANIA
(ug/L)

Organics			
Carcinogens	Rep. Conc.	Noncarcinogens	Rep. Conc.
Tetrachloroethene	20	1,1,1-Trichloroethane	100
Trichloroethene	110	1,1-Dichloroethane	28
1,1-Dichloroethene	18		
Inorganics (unfiltered)			
Carcinogens	Rep. Conc.	Noncarcinogens	Rep. Conc.
Arsenic	3.7	Barium	216
		Manganese	41

TABLE 6-7
CHEMICALS OF CONCERN - OS-03 - LEWIS RESIDENCE
NAWC, WARMINSTER, PENNSYLVANIA
(ug/L)

Organics			
Carcinogens	Rep. Conc.	Noncarcinogens	Rep. Conc.
None		None	
Inorganics (unfiltered)			
Carcinogens	Rep. Conc.	Noncarcinogens	Rep. Conc.
		Barium	376
		Copper	41

TABLE 6-8
CHEMICALS OF CONCERN - OS-04 - AZTEC CORPORATION WELL
NAWC, WARMINSTER, PENNSYLVANIA
(ug/L)

Organics			
Carcinogens	Rep. Conc.	Noncarcinogens	Rep. Conc.
Tetrachloroethene	2		
Inorganics (unfiltered)			
Carcinogens	Rep. Conc.	Noncarcinogens	Rep. Conc.
Arsenic	4.6	Barium	209
		Manganese	26

6.7.2 Toxicity Assessment

The purpose of this section is to identify the potential health hazards associated with exposure to each of the chemicals of concern. A toxicological evaluation characterizes the inherent toxicity of a compound. The literature indicates that the chemicals of concern cause carcinogenic and/or noncarcinogenic health effects in humans. Although the chemicals of concern may cause adverse health effects, dose-response relationships and the potential for exposure must be evaluated before the risks to receptors can be determined. Dose-response relationships correlate the magnitude of the intake with the probability of toxic effects, as discussed below. Toxicity information for the chemicals of concern in off-site wells is presented in Appendix O.

6.7.2.1 Health Effects

An important component of the risk assessment process is the relationship between the intake of a compound (the amount of a chemical that is absorbed by a receptor) and the potential for adverse health effects resulting from exposure to that dose. Dose-response relationships provide a means by which potential public health impacts may be quantified. The published information of doses and responses is used in conjunction with information on the nature and magnitude of human exposure to develop an estimate of potential health risks.

Reference doses (RfDs) and cancer slope factors (CSFs) have been developed by EPA for many organics and inorganics. These parameters are used to evaluate noncarcinogenic and carcinogenic toxicity, respectively, and were defined in detail in Section 4.7.2.1. The dose-response parameters for the chemicals of concern in off-site wells are displayed on Table 6-9.

TABLE 6-9
DOSE-RESPONSE PARAMETERS AND ARARS - CHEMICALS AT OFF-SITE WELLS
NAWC, WARMINSTER PENNSYLVANIA

Chemical	RFD Oral (mg/kg/day) (1)(2)(3)	RFD Inhalation (mg/kg/day) (1)(2)(3)	CSF Oral $(mg/kg/day)^{-1}$ (1)(2)(3)	CSF Inhalation $(mg/kg/day)^{-1}$ (1)(2)(3)	MCL (ug/L) (4)(5)(6)(7)(8)(9)(10)	MCLG (ug/L) (4) (10)	DWHA (mg\L) (4)	AWQC[11] FRESH CHRONIC AQUATIC LIFE (ug/L)	AWQC[12] INGESTION WATER & FISH	AWQC[12] FISH ONLY
Arsenic	*3E-4	-	A*1.75	A*1.5E1	50(N)	0	-	48 (PENT)	0.018	0.14
Barium	7E-2	*1E-4	-	-	2000(F), 1000(N)	2000	Lifetime adult:2	-	-	-
Copper	*3.7E-2	-	-	-	1300(A)	1300	-	12+	1300	-
Lead	-	-	-	-	50(N), 15(A)	0	-	3.2+	50	-
Manganese	5E-3	1E-4	-	-	50(S)	-	-	-	-	-
1,1-Dichloroethane	*9E-3	-	°6E-1	°1.754E-1	7	7	1 day child:2 10 day child:1 Longer-term child:1 Longer-term adult:4 Lifetime adult:0.007	11600 (LOEL) (fa) (DICHLOROETHENES)	0.057	3.2
1,1-Dichloroethane	*1E-1	*1.43E-1	-	-	-	-	-	-	-	-
1,1,1-Trichloroethane	*9E-2	*3E-1	-	-	200	200	1 day child:100 10 day child:40 Longer-term child:40 Longer-term adult:100 Lifetime adult:0.2	31200 (LOEL) (ma)	3100	17000
Trichloroethene	6E-3	-	B2 1.1E-2	6E-3	5	0	-	21900 (LOEL)	2.7	81
Tetrachloroethene	1E-2	-	B2 5.2E-2	2.0E-3	5	0	1 day child:2 10 day child:2 Longer-term child:1 Longer-term adult:5	840 (LOEL)	0.8	8.85

* From HEAST instead of IRIS
** Provisional ADI as per Layton, using rat LD50 of 1630 mg/kg (Sax, 1989) and Layton's most conservative multiplier of 5E-6.

*** Estimate based on RFDs of similar PAHs

Under CSF:

A= Group A human carcinogen
B= Group B1 probable human carcinogen
B2= Group B2 probable human carcinogen
C= Group C possible human carcinogen

Under MCL:

S= Secondary
F= Final; effective 1/1/93
N= National Primary Drinking Water Regulation
A= Action Level
P= Proposed
THM= Trihalomethane

Under AWQC:

+= Based on hardness of 100 mg/L
LOEL= Lowest observed effects level
ma= marine acute
PAHs= Polycyclic aromatic hydrocarbons

PCB= Polychlorinated biphenyls
DCB= dichlorobenzenes
PHTHAL= phthalates
fa= freshwater acute
DCE= dichloroethenes
TOT= Total
PENT= Pentavalent

RFD= Reference dose
CSF= Cancer slope factor
MCL= Maximum Contaminant Level
MCLG= MCL Goal
DWHA= Drinking Water Health Advisory
AWQC= Ambient Water Quality Criteria

(1) EPA, 1992a
(2) EPA, 1992b
(3) EPA, 1992c
(4) EPA, 1992d
(5) EPA, 1991b
(6) EPA, 1991c
(7) EPA, 1990a
(8) EPA, 1991d
(9) EPA, 1991e
(10) EPA, 1992e
(11) EPA, 1987a
(12) EPA, 1990b

6.7.2.2 Applicable or Relevant and Appropriate Requirements (ARARs)

This section presents available regulatory standards or guidelines for the chemicals of concern selected in the preceding section. Currently, the only enforceable regulatory standards for exposure to groundwater contaminants are the Maximum Contaminant Levels (MCLs). However, MCLs have not been specified for many of the chemicals of concern. Therefore, other regulatory guidelines may be used for comparative purposes to determine health risks. Relevant regulatory guidelines include Ambient Water Quality Criteria (AWQCs), MCL Goals (MCLGs), and EPA Drinking Water Health Advisories (DWHAs). ARARs and dose-response parameters are presented in Table 6-7. The ARARs were defined in detail in Section 4.7.2.2.

6.7.2.3 Summary

Table 6-9 presents the values of the available Federal ARARs and dose-response parameters for both carcinogenic and noncarcinogenic chemicals of concern. If the concentration of intake of a chemical exceeds these standards or guidelines, the possibility exists that a receptor may experience adverse health effects. Expected intakes of each chemical are presented in the Exposure Assessment (Section 6.7.3).

6.7.3 Exposure Assessment

The purpose of this section is to evaluate the potential for human exposure to the hazardous chemicals in the off-site wells. This section characterizes the exposed populations, identifies actual or potential exposure routes, and provides exposure estimates. The nature and extent of contamination upon which the exposures are based were presented in Section 6.5.

To determine whether there is an actual exposure in this area, the most likely pathways of human activity patterns must be considered. A complete exposure pathway has three components: a source, a route of transport, and an exposure point for receptors. These components are addressed in the following subsections.

6.7.3.1 Exposure Routes

Each of the wells is associated with a home or business. Therefore, exposure is known or assumed to occur at each location. Exposure routes include dermal contact, ingestion, and inhalation.

OS-01/01D, Wagner & Sons

OS-01/01D is reportedly used for industrial purposes, including food processing. Although exposure could theoretically occur for consumers of the food products, the processing involves various treatment procedures for both water and food. Additionally, food products must comply with all applicable city, county, state, and federal requirements. The model needed to estimate theoretical exposure via food products would be very complex, and the results would be irrelevant because of the required water treatments involved.

Use of water at the plant is therefore assumed to be most likely to occur for adult employees of Wagner & Sons. It was assumed that the theoretical exposure to employees would be via ingestion and dermal (hand washing) routes. The exposure input parameters for these exposure routes are shown in Tables 6-10 and 6-11. The exposures are believed to be conservative estimates because the water is actually treated, but untreated samples will be used to calculate risks.

OS-02, WTMA-26

OS-02 is a municipal well used to supply residents and businesses. Therefore, exposure scenarios were developed for adult and child residents and adult employees. It was assumed that the exposure to employees would be via ingestion and dermal (hand washing) routes; exposure to adult residents would occur via ingestion, dermal (showering), and inhalation (showering) routes; and exposure to child residents would occur via ingestion and dermal (bathing) routes. Exposure input parameters for these routes are shown in Tables 6-10, 6-11, and 6-12.

OS-03, Lewis

OS-03 is a residential well. Therefore, the receptors were assumed to be adult and child residents. It was assumed that exposure to adult residents would occur via ingestion, dermal (showering), and inhalation (showering) routes, and exposure to child residents would occur via ingestion and dermal (bathing) routes. Exposure input parameters for these routes are shown in Tables 6-10, 6-11, and 6-12.

TABLE 6-10
EXPOSURE INPUT PARAMETERS - GROUNDWATER INGESTION - OFFSITE WELLS
NAWC, WARMINSTER, PENNSYLVANIA

Ingestion of Groundwater			
Input Parameters	Description	Value	Rationale
C	Exposure concentration	Rep. conc.(1) (mg/L) (wells in plume)	Upper 95% confidence limit on arithmetic average (EPA, 1989a)
IR	Ingestion rate	2L/day (adult resident) 1L/day (adult employee) 1L/day (child resident)	(EPA, 1991a)
EF	Exposure frequency	250 days/yr. (employees) 350 days/yr. (residents)	(EPA, 1991a)
ED	Exposure duration	25 yrs. (adult employees) 30 yrs. (adult residents) 6 yrs. (child residents)	90th percentile time at one residence (EPA, 1989a; EPA, 1991a)
BW	Body weight	70 kg (adult) 15 kg (child)	(EPA, 1989a, EPA, 1991a)
AT	Averaging time	ED x 365 day/yr. 70 yrs. x 365 days/yr.	Noncarcinogens Carcinogens (EPA, 1989a)

(1) Upper 95% confidence limit (UCL) on arithmetic average, or maximum if UCL exceeds maximum detected.

TABLE 6-11
EXPOSURE INPUT PARAMETERS - GROUNDWATER DERMAL CONTACT - OFFSITE WELLS
NAWC, WARMINSTER, PENNSYLVANIA

Dermal Contact with Groundwater			
Input Parameters	Description	Value	Rationale
C	Exposure concentration	Rep. conc.;[1] (mg/L) (wells in plume) or maximum	Upper 95% confidence limit on arithmetic average (EPA, 1989a)
SA	Skin surface area available for contact[2]	2,270 cm^2 (adult employee) 5,910 cm^2 (child resident) 19,400 cm^2 (adult resident)	Hands and forearms Body Body (EPA, 1989b)
ET	Exposure time[2]	0.2 hr/day (residents) 0.03 hr/day (employees, handwashing)	12 minutes/day (EPA, 1991a) 2 minutes/day (Professional judgement)
EF	Exposure frequency	250 days/yr. (employees) 350 days/yr. (residents)	(EPA, 1991a)
ED	Exposure duration	25 yrs. (adult employees) 30 yrs. (adult residents) 6 yrs. (child resident)	(EPA, 1991a)
BW	Body weight	Adult: 70 kg Child: 15 kg	(EPA, 1989a; EPA, 1991a)
AT	Averaging time	ED x 365 days/yr. 70 yrs. x 365 days/hr.	Noncarcinogens Carcinogens (EPA, 1989a)
K1,Kp	Permeability coefficients (cm/hr.)	Contaminant-specific	(EPA, 1992f)
TAU	Lagtime (hr.)	Contaminant-specific	(EPA, 1992f)
B	Partition coefficient	Contaminant-specific	(EPA, 1992f)

(1) Upper 95% confidence limit (UCL) on arithmetic average, or maximum if UCL exceeds maximum detected.

(2) Adult residents assumed to shower daily; child residents assumed to bathe daily; employees assumed to wash hands daily.

TABLE 6-12
EXPOSURE INPUT PARAMETERS - GROUNDWATER INHALATION - OFF-SITE WELLS
NAWC, WARMINSTER, PENNSYLVANIA

Inhalation of Volatile Emissions During Showering (Adult Residents only)			
Input Parameters	Description	Value	Rationale
C	Exposure concentration	Rep. conc.; (1) (mg/L)	Used to calculate volatile chemical generation rate (ug/m^3/min)
H	Henry's law constant	Contaminant-specific	Required for model application
$K_G K_L$	Gas and liquid phase mass transfer coefficients	Contaminant-specific	Required for model application
D_s	Shower duration	12 minutes	(EPA, 1991a)
D_t	Total time in bathroom	20 minutes	Professional judgement
R_a	Air exchange rate	0.0083 min^{-1}	Foster and Chrostowski, 1987
IR	Inhalation rate	10.4 L/min	(EPA, 1989a)
EF	Exposure frequency	0.96 day^{-1}	One shower per day, 350 days/yr. (EPA, 1991a)
ED	Exposure duration	30 yrs.	90th percentile time at one residence (EPA, 1989a)
BW	Body weight	70 kg	Convention (EPA, 1989a)
AT	Averaging time	ED x 365 days/yr. 70 yrs. x 365 days/yr.	Noncarcinogens Carcinogens (EPA, 1989a)

(1) Upper 95% confidence limit (UCL) on arithmetic average, or maximum if UCL exceeds maximum detected.

OS-04, Aztec Corporation

The uses of OS-04 are unknown. However, since this is a workplace, it was assumed that the most likely receptors, if any, would be adult employees. It was assumed that exposure to employees would occur via ingestion and dermal (hand washing) routes. Exposure input parameters for these routes are shown in Tables 6-10 and 6-11.

6.7.3.2 Exposure Estimates

The estimation methods and models used in this section are consistent with current EPA risk assessment guidance (EPA, 1989a; EPA, 1991a). Exposure estimates associated with each exposure route are presented below.

Noncarcinogenic risks are estimated using the concept of an average annual exposure. The intake incorporates terms describing the exposure time and/or frequency that represent the number of hours per day and the number of days per year that exposure occurs. This is used with a term known as the averaging time, which converts the daily exposure frequency and duration to an annual exposure by dividing by 365 days per year of exposure. Noncarcinogenic risks for some exposure routes are generally greater for children than for adults because of the much lower body weights of children. Carcinogenic risks, on the other hand, are calculated as an incremental lifetime risk and, therefore, incorporate terms to represent the exposure duration over the course of a lifetime (70 years).

The medium for off-site wells is groundwater. The potential exposure routes have been identified as ingestion, dermal, and inhalation.

Ingestion of groundwater was evaluated for all receptors. The equation used was presented in Section 4.7.3.2. A sample calculation is provided in Appendix M; the spreadsheets with all risk estimates are included in Appendix N. Input parameters for groundwater ingestion, along with the rationale for the selection of each value, are presented in Table 6-10. Conventional input parameters were used.

Dermal exposure to groundwater contaminants was evaluated for all receptors. The equation used was presented in Section 4.7.3.2. A sample calculation is provided in Appendix M; the spreadsheets with all risk estimates are included in Appendix N. Input parameters for groundwater dermal exposure, along with the rationale for the selection of each value, are presented in Table 6-11. Adult and child residents were assumed to take daily showers and baths, respectively, and therefore their total body surface areas were used. Employees were assumed to wash their hands for approximately two minutes per day at the workplace, and the surface area of their hands and forearms was used.

Inhalation exposure to groundwater (during showering) was estimated for adult residents only using the equation presented in Section 4.7.3.2. Specific details regarding the application of the model, along with a sample calculation, are included in Appendix M. The spreadsheets with all risk estimates are included in Appendix N. The input parameters for this exposure route, along with the rationale for the selection of each value, are presented in Table 6-12. It was assumed that small children would take baths rather than showers and that employees would not shower at work. Conventional input parameters were used.

Blood-Lead Modeling

No EPA consensus has been reached concerning a RfD or CSF for lead. However, some research has been done concerning typical lead intakes and blood-lead levels. A determination of lead uptake from groundwater was considered. Potential blood-lead level increases were estimated and are discussed, along with the potential implications of blood-lead results, in Section 5.7.4.2.

For drinking water exposure, children zero to six months old are expected to experience blood lead increases at the rate of 0.26 ug/dL per ug/l lead in water up to 15 ug/l and at the rate of 0.04 ug/dL for every ug/l lead in water above 15 ug/l (EPA, 1991e). For older children, the ratio is 0.12 ug/dL blood lead per ug/l lead in water up to 15 ug/l, and 0.06 ug/dL for every ug/l in water above 15 ug/l (EPA, 1991e). For adults, the ratio is approximately 0.06 ug/dL blood lead per ug/l lead in water (EPA, 1991e).

6.7.4 Risk Characterization

Potential human health risks resulting from the groundwater exposures outlined in the preceding sections are characterized on a quantitative and qualitative basis in this section. Quantitative risk estimates are generated based on risk assessment methods outlined in current EPA guidance (EPA, 1989a), whereas the qualitative assessment consists of the toxicological profiles.

Noncarcinogenic risk estimates are presented in the form of Hazard Quotients (HQs) and Hazard Indices (HIs) that are determined through comparison of estimated intakes with published RfDs. Incremental cancer risk estimates are provided in the form of dimensionless probabilities based on CSFs. HIs, HQs, and cancer risks were defined in detail in Section 4.7.4. Estimated human intakes were developed for each of the specific exposure routes discussed in the preceding sections. Both carcinogenic and noncarcinogenic risks are summarized for each exposure route on a series of tables in this section. Detailed calculations and spreadsheets are provided in Appendix N.

Because there is as yet no EPA consensus concerning a RfD or CSF for inorganic lead, the evaluation of this analyte was handled separately. Section 6.7.3.2 discusses blood-lead estimation methods. Blood-lead estimation results are assessed in Section 6.7.4.5.

The following section includes summaries of risks estimated by the exposure model. Complete descriptions and calculation results (including spreadsheets) are presented in Appendix N.

It should be noted that, where HQs are reported as "N/A," the HQs were not calculable because no RfD has been established. Usually, in such cases, carcinogenicity is considered to be more important, since carcinogenicity will generally be seen at lower doses than carcinogenic effects. Cancer risks of zero generally indicate that the chemical is not carcinogenic or that a CSF has not yet been developed.

6.7.4.1 OS-01/01D, Wagner & Sons Well

Table 6-13 displays noncarcinogenic and carcinogenic risks to adult employees for potential exposure to untreated groundwater from OS-01/01D. With the exception of TCE, all HIs were less than 1.0, indicating the potential for adverse health effects only due to TCE from groundwater ingestion. However, the cancer risks via ingestion exceeded 1E-5 because of TCE and arsenic, both of which had individual cancer risk increases above 1E-5. The dermal cancer risk for TCE also exceeded 1E-6. None of these cancer risks exceeded 1E-4.

Prior to treatment, MCLs were exceeded for TCE (an MCL of 5 ppb), lead (an action level of 15 ppb), and manganese (a secondary MCL of 50 ppb) in the groundwater samples collected from the Wagner well.

6.7.4.2 OS-02, WTMA Well 26

Tables 6-14, 6-15, and 6-16 display noncarcinogenic risks to adult employees and adult and child residents for potential exposure to untreated groundwater from OS-02. The HI for ingestion of, and dermal contact with, this water by child residents and dermal contact with groundwater by adult residents exceeded 1.0. The individual HQs for TCE in both receptors via dermal contact exceeded 1.0. Other major contributors to the noncarcinogenic risk were arsenic and barium, with PCE and 1,1-DCE contributing to a lesser extent. Exposure to groundwater by residents is expected to produce noncarcinogenic health effects.

Tables 6-17, 6-18, and 6-19 display estimated carcinogenic risk increases to adult employees and adult and child residents for potential exposure to untreated groundwater from OS-02. The total dermal cancer risk exceeded 1E-6 for adult employees and exceeded 1E-5 for residents, primarily due to PCE, TCE, and 1,1-DCE. The total ingestion risk exceeded 1E-5 for adult employees and exceeded 1E-4 for residents, primarily due to arsenic, PCE, TCE, and 1,1-DCE. The inhalation risk for adult residents exceeded 1E-5 because of 1,1-DCE; the risk for TCE exceeded 1E-6.

Tables 6-20 and 6-21 present summaries of noncarcinogenic and carcinogenic risks, respectively, for the receptor/exposure scenarios examined in association with groundwater at OS-02. Prior to treatment, MCLs were exceeded for TCE, PCE (an MCL of 5 ppb), and 1,1-DCE (7 ppb) in the groundwater sample collected from the WTMA-26 well.

TABLE 6-13
NONCARCINOGENIC AND CARCINOGENIC RISKS TO ADULT EMPLOYEES - OS-01/01D - WAGNER NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep. Conc. (mg/L)	Hazard Quotients		Cancer Risks	
		HQ - ING	HQ - DERM	CA - ING	CA - DERM
Trichloroethene	0.72	1.2EO	2.2E-1	2.8E-5	5.1E-6
Arsenic	0.00445	1.4E-1	9.9E-6	2.7E-5	1.8E-9
Lead	0.46785	N/A	N/A	0	0
Barium	0.243	3.4E-2	2.3E-6	0	0
Copper	0.073	1.9E-2	1.3E-6	0	0
Manganese	0.0525	1.0E-1	7.0E-6	0	0
Zinc	0.07	3.4E-3	1.4E-7	0	0
Total		1.5E0	2.2E-1	5.5E-5	5.1E-6
Cumulative Risk		1.7E0		6.0E-5	

TABLE 6-14
NONCARCINOGENIC RISKS TO ADULT EMPLOYEES - OS-02-WTMA-26
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep. Conc. (mg/L)	HQ - ING	HQ - DERM
Tetrachloroethene	0.02	2.OE-2	7.5E-3
Trichloroethene	0.11	1.8E-1	3.3E-2
1,1-Dichloroethene	0.018	2.0E-2	2.0E-4
1,1,1-Trichloroethane	0.1	1.1E-2	1.5E-4
1,1-Dichloroethane	0.028	2.7E-3	1.6E-5
Arsenic	0.0037	1.2E-1	8.2E-6
Barium	0.216	3.0E-2	2.0E-6
Manganese	0.041	8.0E-2	5.5E-6
Hazard Index		4.6E-1	4.1E-2
Cumulative Noncarcinogenic Risk		5.0E-1	

TABLE 6-15
NONCARCINOGENIC RISKS TO ADULT RESIDENTS - OS-02-WTMA-26
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep. Conc. (mg/L)	HQ - ING	HQ - DERM	HQ - INHAL
Tetrachloroethene	0.02	5.5E-2	2.3E-1	N/A
Trichloroethene	0.11	5.0E-1	1.0E0	5.6E-3
1,1-Dichloroethene	0.018	5.5E-2	6.1E-3	N/A
1,1,1-Trichloroethane	0.1	3.0E-2	4.7E-3	2.5E-3
1,1-Dichloroethane	0.028	7.7E-3	4.8E-4	1.6E-3
Arsenic	0.0037	3.4E-1	6.6E-4	N/A
Barium	0.216	8.E4-2	1.6E-4	0
Manganese	0.041	2.2E-1	4.4E-4	0
Hazard Index		1.3E0	1.3E0	9.7E-3
Cumulative Noncarcinogenic Risk		2.6E0		

TABLE 6-16
NONCARCINOGENIC RISKS TO CHILD RESIDENTS - OS-02-WTMA-26
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep. Conc. (mg/L)	HQ - ING	HQ - DERM
Tetrachloroethene	0.02	1.3E-1	3.3E-1
Trichloroethene	0.11	1.2E0	1.5E0
1,1-Dichloroethene	0.018	1.3E-1	8.7E-3
1,1,1-Trichloroethane	0.1	7.1E-2	6.7E-3
1,1-Dichloroethane	0.028	1.8E-2	6.9E-4
Arsenic	0.0037	7.9E-1	9.3E-4
Barium	0.216	2.0E-1	2.3E-4
Manganese	0.041	5.2E-1	6.2E-4
Hazard Index		3.0E0	1.8E0
Cumulative Noncarcinogenic Risk		4.8E0	

TABLE 6-17
CARCINOGENIC RISKS TO ADULT EMPLOYEES - OS-02-WTMA-26
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep. Conc. (mg/L)	CA - ING	CA - DERM
Tetrachloroethene	0.02	3.6E-6	1.4E-6
Trichloroethene	0.11	4.2E-6	7.8E-7
1,1-Dichloroethene	0.018	3.8E-5	3.8E-7
1,1,1-Trichloroethane	0.1	0	0
1,1-Dichloroethane	0.028	0	0
Arsenic	0.0037	2.3E-5	1.5E-9
Barium	0.216	0	0
Manganese	0.041	0	0
Total Cancer Risk		6.8E-5	2.6E-6
Cumulative Cancer Risk		3.3E-6	

TABLE 6-18
CARCINOGENIC RISKS TO ADULT RESIDENTS - OS-02-WTMA-26
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep. Conc. (mg/L)	CA - ING	CA - DERM	CA - INHAL
Tetrachloroethene	0.02	1.2E-5	5.1E-5	1.2E-7
Trichloroethene	0.11	1.4E-5	2.9E-5	6.0E-6
1,1-Dichloroethene	0.018	1.3E-4	1.4E-5	1.1E-5
1,1,1-Trichloroethane	0.1	0	0	0
1,1-Dichloroethane	0.028	0	0	0
Arsenic	0.0037	7.6E-5	1.5E-7	0
Barium	0.216	0	0	0
Manganese	0.041	0	0	0
Total Cancer Risk		2.3E-4	9.5E-5	1.8E-5
Cumulative Cancer Risk		3.4E-4		

TABLE 6-19
CARCINOGENIC RISKS TO CHILD RESIDENTS - OS-02-WTMA-26
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep. Conc. (mg/L)	CA - ING	CA - DERM
Tetrachloroethene	0.02	5.7E-6	1.5E-5
Trichloroethene	0.11	6.6E-6	8.3E-6
1,1-Dichloroethene	0.018	5.9E-5	4.0E-6
1,1,1-Trichloroethane	0.1	0	0
1,1-Dichloroethane	0.028	0	0
Arsenic	0.0037	3.5E-5	4.2E-8
Barium	0.216	0	0
Manganese	0.041	0	0
Total Cancer Risk		1.1E-4	2.7E-5
Cumulative Cancer Risk		1.4E-4	

TABLE 6-20
SUMMARY OF NONCARCINOGENIC RISK
OFF-SITE WELL - OS-02 - GROUNDWATER
NAWC WARMINSTER

Exposure Route	Adult Employee	Adult Resident	Child Resident
Ingestion	4.6E-1	1.3E0	3.0E0
Dermal Contact	4.1E-2	1.3E0	1.8E0
Inhalation	NA	9.7E-3	NA
Cumulative Risk	5.0E-1	2.6E0	4.8E

TABLE 6-21
SUMMARY OF CARCINOGENIC RISK
OFF-SITE WELL - OS-02 - GROUNDWATER
NAWC WARMINSTER

Exposure Route	Adult Employee	Adult Resident	Child Resident
Ingestion	6.8E-5	2.3E-4	1.1E-4
Dermal Contact	2.6E-6	9.5E-5	2.7E-5
Inhalation	NA	1.8E-5	NA
Cumulative Risk	3.3E-6	3.4E-4	1.4E-4

Because public water supplies must comply with National Primary Drinking Water Regulations (NPDWRs), these estimated risks are not expected to reflect exposures to actual current consumers of this water. Rather, they indicate anticipated risks for consumption of this water in an untreated state.

6.7.4.3 OS-03, Lewis Residence Well

Tables 6-22 and 6-23 display noncarcinogenic risks to adult and child residents for potential exposure to untreated groundwater from OS-03. Total HIs for both receptors were less than 1.0.

Tables 6-24 and 6-25 display estimated carcinogenic risk increases to adult and child residents for potential exposure to untreated groundwater from OS-03. Because the chemicals of concern are not classified as carcinogens, the estimated cancer risk increases were zero.

6.7.4.4 OS-04, Aztec Corporation Well

Table 6-26 displays noncarcinogenic and carcinogenic risks to adult employees for potential exposure to untreated groundwater from OS-04. HIs were less than 1.0, indicating that significant noncarcinogenic impacts are not expected. The total cancer risk increase via the ingestion route exceeded 1E-5 because of arsenic, whose individual cancer risk exceeded 1E-5. The cancer risks did not exceed 1E-4.

6.7.4.5 Exposures to Lead

As discussed in Section 6.7.3.2, lead was assessed separately because of the lack of an EPA consensus concerning an RfD or CSF. Determinations of lead uptake from drinking water were considered. Potential blood-lead level increases were estimated and are discussed below. The only well for which lead was selected as a chemical of concern was OS-01/01D, the Wagner & Sons well. The potential receptors were considered to be adult employees.

For adult residents, the relationship between blood-lead increase and drinking water lead is believed to be approximately 0.06 ug/dL blood-lead per ug/L lead in water (EPA, 1991e). For a representative concentration of 467.85 ug/L lead in water, the estimated blood-lead increase would be about 28 ug/dL for an adult resident. It is expected that an employee blood-lead increase would be less than an adult resident's.

TABLE 6-22
NONCARCINOGENIC RISKS TO ADULT RESIDENTS - OS-03-LEWIS
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep. Conc. (mg/L)	HQ - ING	HQ - DERM	HQ - INHAL
Barium	0.376	1.5E-1	2.8E-4	0
Copper	0.041	3.0E-2	5.9E-5	0
Hazard Index		1.8E-1	3.4E-4	0
Cumulative Noncarcinogenic Risk		1.8E-1		

TABLE 6-23
NONCARCINOGENIC RISKS TO CHILD RESIDENTS - OS-03-LEWIS
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep. Conc. (mg/L)	HQ - Ing	HQ - DERM
Barium	0.376	3.4E-1	4.0E-4
Copper	0.041	7.1E-2	8.4E-5
Hazard Index		4.1E-1	4.9E-4
Cumulative Noncarcinogenic Risk		4.1E-1	

TABLE 6-24
CARCINOGENIC RISKS TO ADULT RESIDENTS - OS-03-LEWIS
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep. Conc. (mg/L)	CA - ING	CA - DERM	CA - INHAL
Barium	0.376	0	0	0
Copper	0.041	0	0	0
Total Cancer Risk		0	0	0

TABLE 6-25
CARCINOGENIC RISKS TO CHILD RESIDENTS - OS-03-LEWIS
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep. Conc. (mg/L)	CA - ING	CA - DERM
Barium	0.376	0	0
Copper	0.041	0	0
Total Cancer Risk		0	0

TABLE 6-26
NONCARCINOGENIC AND CARCINOGENIC RISKS TO ADULT EMPLOYEES - OS-04-AZTEC
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Rep. Conc. (mg/L)	Hazard Indices		Cancer Risks	
		HQ - ING	HQ - DERM	CA - ING	CA - DERM
Tetrachloroethene	0.002	2.0E-3	7.5E-4	3.6E-7	1.4E-7
Arsenic	0.0046	1.5E-1	1.0E-5	2.8E-5	1.9E-9
Barium	0.209	2.9E-2	2.0E-6	0	0
Manganese	0.026	5.1E-2	3.5E-6	0	0
Total		2.8E-1	7.6E-4	2.8E-5	1.4E-7
Cumulative Risk		2.3E-1		2.8E-5	

No threshold has been defined for effects related to blood-lead increases. The estimated increases at the Wagner well are below the concentrations at which effects such as anemia and neuropathy occur (40 ug/dL and above) (Doull, et al., 1986). Under 40 ug/dL, some enzymes in red blood cells may be affected (Doull, et al., 1986). Lead is also a fairly common environmental contaminant. For men and women, typical United Stated blood-lead levels for the years 1976 to 1980 ranged from approximately to 10 to 18 ug/dL (Doull, et al., 1986). The estimated blood-lead results seem to fall in an area of potential concern, and the carcinogenic potential of lead may be cause for additional concern. It should be noted that the lead result in this well is 30 times higher than the Action Level of 15 ug/L, which is used to regulate public water supplies (EPA, 1991e).

6.7.5 Uncertainty Analysis

There are uncertainties associated with exposure assumptions because not all people weigh 70 kilograms, not all people drink two liters of water per day, not all people live at the same residence for 30 years, etc. The rationale for each assumption was provided in each table of input parameters. Receptor characteristics, such as age and body weight, were based on published values. Every attempt was made to use conservative assumptions, except where average values were expected to better correspond to reality.

The chemical-analytical database has some limitations in such areas as sample number and the validity and representativeness of laboratory results. However, every effort was made to collect samples that reflect actual conditions.

The chemical-specific parameters such as Koc were either derived from other parameters or measured under conditions that may or may not be representative of on-site conditions. Parameters such as vapor pressure and solubility were not always obtainable at the desired temperature.

There is uncertainty associated with the RfDs and CSFs. The uncertainty results from the extrapolation of animal data to humans, the extrapolation of carcinogenic effects from the laboratory high-dose to the environmental low-dose scenarios, and interspecies and intraspecies variations in toxicological endpoints caused by chemical exposure. The use of EPA CSF values is generally considered to be conservative because the doses are based on no-effects of lowest-observed-effects levels and then further reduced with uncertainty factors to increase the margin of safety. The RfDs and CSFs of some chemicals have not been established, and therefore toxicity could not be quantitatively assessed. In most cases, where RfDs were unavailable for carcinogens, the carcinogenic risk is considered to be much more significant since carcinogenic effects usually occur at much lower doses.

From a toxicological standpoint, it is not strictly correct to add HQs for a total HI, because RfDs are based on effects to varying target organs. However, if the HI is less than 1.0, this demonstrates that, even when this conservative calculation is performed, the noncarcinogenic risk does not indicate a hazard. At this study area, for all HIs greater than 1.0, further assessment was done to determine whether this was due to a single chemical or a combination of chemicals and where the combinations of chemicals affected the same target organs.

These models also assumed that chemicals did not interact synergistically (a possible underestimate) or antagonistically (a possible overestimate). Degradation was not taken into account; this was generally a conservative approach.

6.8 SUMMARY AND CONCLUSIONS

6.8.1 Summary

Findings for off-site wells have been summarized in this section. Discussion of conclusions and recommendations specific to off-site wells follow in subsequent sections.

6.8.1.1 Field Activities

Four wells were sampled during Phase II. Groundwater samples were analyzed for TCL volatile organics, TAL metals (both total and dissolved samples), and cyanide. One sample was also analyzed for TCL semivolatiles and pesticides/PCBs.

6.8.1.2 Physical Characteristics

Within 0.25-mile of NAWC Warminster, 44 private homes and three businesses were confirmed to have on-site wells. Eight municipal wells were identified within 0.75 mile of the facility.

Fifty-six percent of private residences and businesses suspected to have groundwater wells within the study area responded to the well inventory survey. Assuming that all non-respondents use private wells, the maximum number of wells within the approximately 0.25 mile study area would be 91.

6.8.1.3 Nature and Extent of Contamination

TCE, arsenic, and lead were detected in the Wagner & Sons well. Arsenic, chlorinated ethenes, and chlorinated ethanes were detected in WTMA-26. No organic compounds were detected in the Lewis Well. PCE and arsenic were detected in the Aztec well.

6.8.1.4 Contaminant Fate and Transport

The major potential migration routes for contaminants detected in off-site groundwater are migration within the water-table aquifer, from the water-table to the semi-artesian aquifers, from the semi-artesian to artesian aquifers, and further migration within the artesian aquifer. Hydrolysis, biodegradation, and dechlorination of chlorinated VOCs are among the potential environmental fates of these chemicals.

6.8.1.5 Risk Assessment

Chemicals of concern were selected, based on toxicity, possible relevance to the site, and carcinogenic status. Receptors were selected based on known and most probable uses of the wells.

Noncarcinogenic health effects are to be expected from groundwater ingestion due to TCE at the Wagner Well.

For employees exposed to untreated water from the Wagner well, the cancer risk via ingestion would exceed 1E-6 but not 1E-4 because of TCE and arsenic. The dermal risk would exceed 1E-6 but not 1E-4 because of TCE.

Ingestion of, and dermal contact with, groundwater by child residents and ingestion by adult residents of untreated water from OS-02 may pose some noncarcinogenic risk due to TCE. Other potential chemicals of conern may combine to produce such a risk actually affect different organ systems (arsenic: skin, barium: cardiovascular system, PCE and 1,1-DCE: liver). Dermal cancer risks for all receptors would exceed 1E-6 but not 1E-4 due to PCE, TCE, and 1,1-DCE. The ingestion risk for adult employees would exceed 1E-6 and for residents would exceed 1E-4 because of arsenic, PCE, TCE, and 1,1-DCE. The inhalation risk for adult residents would exceed 1E-6 but not 1E-4 due to 1,1-DCE and TCE. Because public water supplies must comply with NPDWRs, these estimated risks are not expected to reflect exposures to actual current consumers of this water. Rather, they indicate anticipated risks for consumption of this water in an untreated state.

Neither significant noncarcinogenic nor carcinogenic impacts were indicated for residential receptors of water from OS-03. Because of arsenic, the total cancer risk via the ingestion route would exceed 1E-6 but not 1E-4 for employees consuming untreated water from OS-04. Significant noncarcinogenic hazards are not indicated.

Prior to treatment, MCLs were exceeded for TCE in both the Wagner and WTMA-26 wells, as well as for lead and manganese in the Wagner well. For WTMA-26, MCLs were also exceeded for PCE and 1,1-DCE.

6.8.2 Conclusions

Conclusions developed for off-site groundwater, based on the findings presented, are provided below.

6.8.2.1 Data Limitations and Recommendations for Future Work

Based on the results of Phase I and II, three significant data gaps were identified for off-site groundwater, including

- The number of people using residential wells for drinking water and other groundwater uses in the vicinity of the facility, particularly those in close proximity to Areas A and B and remaining portions of OU-1.

- The nature and extent of off-site groundwater contamination for the overburden, shallow bedrock, and deeper bedrock aquifers in the vicinity of Area A and other portions of OU-1 west of Jacksonville Road.

- The potential for other sources to contribute to groundwater contamination found beneath Area A and other portions of OU-1 west of Jacksonville Road.

- The nature and extent of groundwater contamination for the deeper bedrock aquifers in the vicinity of Area B due to releases from current NAWC Warminster property.

To address these data gaps, additional investigation should be performed to evaluate the number of off-site residential wells near NAWC Warminster and the specific groundwater uses (e.g., drinking water) of these wells. Survey recipients who were suspected to have wells and did not respond to the survey should be contacted again. The local county health department should also be contacted. More specifically, the residences along Kirk and Newtown Roads are of particular interest. Residents within this area were reported by the TRC to have wells, even though many were not included on the list of properties originally suspected to have wells. It is recommended that all of the residents along these two roads should be canvassed. Another area of interest to the survey northeast of Area A (i.e., the area approximately between Jacksonville Road and WTMA Well 26).

While off-site deeper groundwater in the vicinity of the Wagner well presents a potential unacceptable risk, current information is inadequate to evaluate remedial alternatives. Additional sampling and investigation should be performed, including

- Installation of additional monitoring wells as needed to define the upgradient and downgradient extent of groundwater contamination due to releases from Area A to the overburden, shallow bedrock, and deeper bedrock aquifers in the vicinity of the western portion of NAWC Warminster.

- Review of historical data for off-site or other sources of groundwater contamination in the vicinity of the western portion of NAWC Warminster.

- Research and generation of production information and construction details for off-site wells, including the Wagner and Sons, WTMA-26, and Aztec wells.

- Generation and analysis of water-level and production data for all on-site wells, including both monitoring and NAWC Warminster production wells.

- Hydrogeolgic investigation as necessary to determine deeper bedrock aquifer characteristics and the effect of nearby supply wells on groundwater flow directions in the vicinity of the western portion of NAWC Warminster.

7.0 REFERENCES

Cline, P.V., and D.R. Viste. 1984. Migration and degradation patterns of volatile organic compounds. Presented at the Fifth National Conference on Management of Uncontrolled Hazardous Waste Sites, Washington, D.C. November 7-9.

Doull, J., C.D. Klaassen, and M.O. Amdur. 1986. Casarett and Doull's Toxicology: The Basic Science of Poisons. Third Edition. MacMillan Publishing Company, New York, New York.

Driscol, F.G., 1986. Groundwater and Wells. Second Edition. Johnson Division, St. Paul, Minnesota.

Earth Technology Corporation, 1985a. Well Profile Studies (Well Numbers 4 and 5) at the Naval Air Development Center, Warminster, Pennsylvania. December.

Earth Technology Corporation, 1985b. Well Profile Studies (Well Numbers 1 and 2) at the Naval Air Development Center, Warminster, Pennsylvania. June.

Earth Technology Corporation, 1988. Well Profile Studies (Well Number 3) at the Naval Air Development Center, Warminster, Pennsylvania. February.

EPA (United States Environmental Protection Agency), 1980a. Ambient Water Quality Criteria for Beryllium. EPA 440/5-80-024. Office of Water Regulations. Criteria and Standards Division. Washington, D.C.

EPA (United States Environmental Protection Agency), 1980b. Ambient Water Quality Criteria for Thallium. EPA 440/5-80-074. Office of Water Regulations. Criteria and Standards Division. Washington, D.C.

EPA (United States Environmental Protection Agency), 1980c. Ambient Water Quality Criteria for Silver. EPA 440/5-80-071. Office of Water Regulations. Criteria and Standards Division. Washington, D.C.

EPA (United States Environmental Protection Agency), 1980d. Ambient Water Quality Criteria for Lead. Office of Water Regulations. Criteria and Standards Division. Washington, D.C.

EPA (United States Environmental Protection Agency), 1982. Aquatic Fate Process Data for Organic Priority Pollutants. EPA 440/4-81-014, Washington, D.C.

EPA (United States Environmental Protection Agency), 1983a. Ambient Water Quality Criteria for Chromium, Aquatic Toxicology (Section B), Revised. Draft. Office of Water Regulations. Criteria and Standards Division. Washington, D.C.

EPA (United States Environmental Protection Agency), 1983b. Ambient Water Quality Criteria for Copper, Aquatic Toxicology (Section B), Revised. Draft. Office of Water Regulations. Criteria and Standards Division. Washington, D.C.

EPA (United States Environmental Protection Agency), 1983c. Ambient Water Quality Criteria for Mercury, aquatic Toxicology (Section B), Revised. Draft. Office of Water Regulations. Criteria and Standards Division. Washington, D.C.

EPA (United States Environmental Protection Agency), 1983d. Ambient Water Quality Criteria for Cadmium, Aquatic Toxicology (Section B), Revised. Draft. Office of Water Regulations. Criteria and Standards Division. Washington, D.C.

EPA (United States Environmental Protection Agency), 1983e. Ambient Water Quality Criteria for Arsenic, Aquatic Toxicology (Section B), Revised. Draft. Office of Water Regulations. Criteria and Standards Division. Washington, D.C.

EPA (United States Environmental Protection Agency), 1984. Review of dermal Absorption. EPA/600/8-84/033, Office of Health and Environmental Assessment, Washington, D.C. October.

EPA (United States Environmental Protection Agency), 1986b. Ambient Aquatic Life Water Quality Criteria for Nickel. Draft. Office of Research and Development, Environmental Research Laboratories, Duluth, Minnesota, and Narragansett, Rhode Island.

EPA (United States Environmental Protection Agency), 1986c. Ambient Aquatic Life Water Quality Criteria for Zinc. Draft. Office of Research and Development, Environmental Research Laboratories, Duluth, Minnesota, and Narragansett, Rhode Island.

EPA (United States Environmental Protection Agency), 1986d. Ambient Aquatic Life Water Quality Criteria for Selenium. Draft. Office of Research and Development, Environmental Research Laboratories, Duluth, Minnesota, and Narragansett, Rhode Island.

EPA (United States Environmental Protection Agency), 1986f. Guidelines for the Health Risk Assessment of Chemical Mixtures. 51 FR 185, 34014 et seq. September 24.

EPA (United States Environmental Protection Agency), 1987a. Update Number 2 to Quality Criteria for Water 1986. Office of Water Regulations and Standards, Criteria and Standards Division, Washington, D.C.

EPA (United States Environmental Protection Agency), 1988. Superfund Exposure Assessment Manual. Final Draft. EPA 540/1-88-001.

EPA (United States Environmental Protection Agency), 1989a. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). EPA/540-1-89/002. Office of Emergency and Remedial Response. Washington, D.C.

EPA (United States Environmental Protection Agency), 1989b. Exposure Factors Handbook. Office of Health and Environmental Assessment. EPA 600/8-89/043.

EPA (United States Environmental Protection Agency), 1990a. 55 Federal Register 30370-30448. July 25.

EPA (United States Environmental Protection Agency), 1990b. ARARs Q's and A's: Compliance with Federal Water Quality Criteria. Publication 9234.2-09/FS. Office of Solid Waste and Emergency Response. June.

EPA (United States Environmental Protection Agency), 1991a. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Directive 9285.6-03. March 25.

EPA (United States Environmental Protection Agency), 1991b. National Primary Drinking Water Regulations. Federal Register, January 30.

EPA (United States Environmental Protection Agency), 1991c. National Primary Drinking Water Regulations. 40 Code of Federal Regulations 141, Subparts B and G. July 1.

EPA (United States Environmental Protection Agency), 1991d. National Primary Drinking Water Regulations; Final Rule. 56 FR 30265-30281. July 1.

EPA (United States Environmental Protection Agency), 1991e. Maximum Contaminant Level Goals and National Primary Drinking Water Regulations for Lead and Copper; Final Rule. 56 Federal Register 26460-26564. June 7.

EPA (United States Environmental Protection Agency), 1992a. Integrated Risk Information System (IRIS). August 2.

EPA (United States Environmental Protection Agency), 1992b. Health Effects Assessment Summary Tables; Annual FY92. Office of Emergency and Remedial Response, Washington, D.C.

EPA (United States Environmental Protection Agency), 1992c. Health Effects Assessment Summary Tables; Update July 1992. Office of Emergency and Remedial Response, Washington, D.C.

EPA (United States Environmental Protection Agency), 1992d. Drinking Water Regulations and Health Advisories. Office of Water, Washington, D.C. April.

EPA (United States Environmental Protection Agency), 1992e. National Primary Drinking Water Regulations; Final Rule. 56 Federal Register 30265-30281. July 17.

EPA (United States Environmental Protection Agency), 1992f. Dermal Exposure Assessment: Principles and Applications. Office of Research and Development, Washington, D.C., January.

EPA RREL (United States Environmental Protection Agency Risk Reduction Engineering Laboratory). Treatability Database. Revision No. 3.0. Cincinnati, Ohio.

Fetter, C.W., 1988. Applied Hydrogeology. Second Edition. Merrill Publishing Company, Columbus, Ohio.

Foster, S.A., and P.C. Chrostowski, 1987. Inhalation Exposures to Volatile Organic Contaminants in the Shower. Presented at the 80th Annual Meeting of the Air Pollution Control Association, New York. June.

JRB Associates, 1981. Hydrogeologic Investigation of the Naval Air Development Center Waste Disposal Sites, Warminster, Pennsylvania. Task 1 - Records Search, Preliminary Site Investigation, and Recommendations for Task 2. December 21.

JRB Associates, 1983. Hydrogeologic Investigation of the Naval Air Development Center Waste Disposal Sites, Warminster, Pennsylvania. Task 2 - Final Report: Monitoring Well Installation, Sampling, Analysis of Samples, and Groundwater Hydrogeology.

Lunsford, C.A., 1982. Proposed Guidelines - Handling Upland Areas Contaminated with PCB-Contaminated Sediments and Soils. Division of Ecological Studies, Bureau of Surveillance and Field Studies.

Lyman, W.J., W.F. Reehl, and D.H. Rosenblatt, 1990. Handbook of Chemical Property Estimation Methods. American Chemical Society, Washington, D.C.

NAWC, Warminster Emergency Response Plan, August 13, 1990.

NLM (National Library of Medicine), January 13, 1992. Hazardous Substances Data Bank. Records for Koc of polychlorinated biphenyls, Aroclor 1248, Aroclor 1260, and Aroclor 1254, obtained January 13, 1992.

NUS Corporation, 1985. Preliminary Assessment and Site Inspection of Naval Air Development Center, Warminster, Pennsylvania. Prepared for the United States Environmental Protection Agency. June 7.

Rima, D.R., H. Meister, and S. Longwill, 1962. Geology and Hydrogeology of the Stockton Formation in Southeastern Pennsylvania. Bulletin W-14. Pennsylvania Department of Internal Affairs, Topographic and Geologic Survey.

Satterthwaite, Walter B. Associates, Incorporated, 1984. Final Report on the Groundwater Monitoring and Hydrogeologic Investigation for the Naval Air Development Center, Warminster, Pennsylvania. Volume I. May.

Sax, N.I., and R.J. Lewis, Sr. 1989. Dangerous Properties of Industrial Materials. Seventh Edition. Van Nostrand Reinhold Company, New York, New York.

Shapiro, S.S., and M.R. Wilk, 1965. An Analysis of Variance Test for Normality (Complete Samples). Biometritic. Volume 52, pages 591 to 611.

Sloto, R.A., and D.K. Davis, 1983. Effect of Urbanization on the Water Resources of Warminster Township, Bucks County, Pennsylvania. Water Resources Investigations 82-4020. United States Geological Survey.

Sloto, Ronald A., Paola Macchiaroli, and Michael T. Towle, 1992. Identification of a Multiaquifer Groundwater Cross-Contamination Problem in the Stockton Formation by Use of Borehole Geophysical Methods, Hatboro, Pennsylvania. Abstract in Proceedings of the Symposium on the Application of Geophysics to Engineering and Environmental Problems. Ronald S. Bell, Editor, Volume I, April 26-29, 1992.

Sloto, Ronald A., United States Geological Survey to Darius Ostrauskas, United States Environmental Protection Agency, Correspondence, November 20, 1992.

Sloto, Ronald A., United States Geological Survey to Darius Ostrauskas, United States Environmental Protection Agency, Correspondence, December 18, 1992.

SMC Martin, Incorporated, 1989. Installation Restoration Program for the Naval Air Development Center, Warminster, Pennsylvania. Task R2, Plan of Action and Milestones. Work Plans. May 15, revised July 17, revised October 9.

SMC Martin, 1991. Rough Draft Remedial Investigation Report. Prepared for Naval Facilities Engineering Company, Northern Division, Philadelphia, Pennsylvania. April 18.

Todd, D.K., 1980. Groundwater Hydrology. John Wiley and Sons, New York, New York.

USDA (United States Department of Agriculture) Soil Conservation Service, 1975. Soil Survey of Bucks and Philadelphia Counties, Pennsylvania.

Versar, Incorporated, for United States Environmental Protection Agency, 1979. Water-Related Fate of 129 Priority Pollutants. Monitoring and Data Support Division, Washington, D.C. EPA 440/4-79-029.

Verschueren, K. 1983. Handbook of Environmental Data on Organic Chemicals. Van Nostrand Reinhold, New York, New York.

Weast, R.C., Editor, 1988. CRC Handbook of Chemistry and Physics. First Student Edition. CRC Press Incorporated, Boca Raton, Florida.

Zar, Jerrold H., 1974. Biostatistical Analysis. Prentice - Hall, Incorporated, Englewood Cliffs, New Jersey.

45 v2

Phase II
Remedial Investigation Report
Volume II (Appendices A through J)

for

Operable Unit 1
Naval Air Warfare Center (NAWC)
Philadelphia Naval Shipyard

Warminster, Pennsylvania

Northern Division

Naval Facilities Engineering Command

Contract No. N62472-90-D-1298-0136

Contract Task Order 0022

April 1993

Halliburton NUS
CORPORATION

45 v2

D-51-2-3-7

PHASE II
REMEDIAL INVESTIGATION REPORT
VOLUME II (APPENDICES A THROUGH J)
for
OPERABLE UNIT 1
NAVAL AIR WARFARE CENTER (NAWC)
WARMINSTER, PENNSYLVANIA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Northern Division
Environmental Branch, Code 18
Naval Facilities Engineering Command
10 Industrial Highway, Mail Stop No. 82
Lester, Pennsylvania 19113-2090

Submitted by:
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Contract No. N62472-90-D-1298
Contract Task Order 0022

April 1993

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NAWC WARMINSTER APPENDICES
VOLUME II

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APPENDIX A

SOIL GAS SURVEY RESULTS

APPENDIX A-1

SOIL GAS SURVEY PID READINGS

TABLE 5-2

SOIL GAS SURVEY PID READINGS
DEC. 13, 14, 15, 18, 19, 1989

NADC WARMINSTER, PA

SITES 1 & 2

STATION	READING (ppm)	STATION	READING (ppm)	STATION	READING (ppm)	STATION	READING (ppm)	STATION	READING (ppm)	STATION	READING (ppm)	STATION	READING (ppm)
SG-1	ND	SG-2	ND	SG-3	ND	SG-4	ND	SG-5	ND	SG-6	ND	SG-7	ND
SG-8	ND	SG-9	ND	SG-10	ND	SG-11	ND	SG-12	ND	SG-13	ND	SG-14	ND
SG-15	ND	SG-16	ND	SG-17	ND	SG-18	ND	SG-19	ND	SG-20	ND	SG-21	ND
SG-22	ND	SG-23	1	SG-24	1	SG-25	ND	SG-26	ND	SG-27	ND	SG-28	ND
SG-29	ND	SG-30	ND	SG-31	ND	SG-32	ND	SG-33	1	SG-34	ND	SG-35	ND
SG-36	ND	SG-37	ND	SG-38	ND	SG-39	ND	SG-40	ND	SG-41	ND	SG-42	ND
SG-43	ND	SG-44	1	SG-45	ND	SG-46	ND	SG-47	ND	SG-48	ND	SG-49	ND
SG-50	ND	SG-51	ND	SG-52	ND	SG-53	1	SG-54	0.8	SG-55	ND	SG-56	ND
SG-57	ND	SG-58	ND	SG-59	ND	SG-60	ND	SG-61	ND	SG-62	0.5	SG-63	ND
SG-64	ND	SG-65	0.5	SG-66	0.5	SG-67	ND	SG-68	0.5	SG-69	0.8	SG-70	ND
SG-71	1	SG-72	ND	SG-73	ND	SG-74	0.5	SG-75	ND	SG-76	ND	SG-77	ND
SG-78	ND												

SITE 3

STATION	READING (ppm)	STATION	READING (ppm)	STATION	READING (ppm)	STATION	READING (ppm)	STATION	READING (ppm)	STATION	READING (ppm)	STATION	READING (ppm)
SG-1	ND	SG-2	ND	SG-3	ND	SG-4	1	SG-5	ND	SG-6	ND	SG-7	ND
SG-8	ND	SG-9	ND	SG-10	ND	SG-11	ND	SG-12	ND	SG-13	ND	SG-14	ND
SG-15	no reading	SG-16	ND	SG-17	ND	SG-18	ND	SG-18A	1.5	SG-19	ND	SG-20	ND
SG-21	ND	SG-22	ND	SG-23	0.5	SG-24	ND	SG-25	ND				

SITE 4

STATION	READING (ppm)	STATION	READING (ppm)	STATION	READING (ppm)	STATION	READING (ppm)	STATION	READING (ppm)	STATION	READING (ppm)	STATION	READING (ppm)
SG-1	ND	SG-2	ND	SG-3	ND	SG-4	0.25	SG-5	ND	SG-6	ND	SG-7	1.5
SG-8	1.5	SG-9	0.5	SG-10	ND	SG-11	0.6	SG-12	ND	SG-13	0.25	SG-14	0.25
SG-15	ND	SG-16	ND	SG-17	ND	SG-18	ND	SG-19	1	SG-20	1	SG-21	ND
SG-22	ND	SG-23	0.5	SG-24	0.25	SG-25	0.5	SG-26	0.25	SG-27	ND	SG-28	ND
SG-29	0.5	SG-30	0.5	SG-31	0.5	SG-32	ND	SG-33	ND	SG-34	ND	SG-35	ND
SG-36	ND	SG-37	1	SG-38	ND	SG-39	ND	SG-40	11	SG-41	1	SG-42	0.8
SG-43	ND	SG-44	ND	SG-45	ND	SG-46	ND	SG-47	ND	SG-48	ND	SG-49	ND
SG-50	ND	SG-51	ND	SG-52	ND	SG-53	ND	SG-54	0.5	SG-55	ND	SG-56	ND
SG-57	ND	SG-58	ND	SG-59	0.5	SG-60	ND	SG-61	ND	SG-62	0.5	SG-63	0.25
SG-64	0.2	SG-65	1	SG-66	ND	SG-67	0.25	SG-68	0.25	SG-69	0.5	SG-70	2

TABLE 5-2 (CONT.)

SOIL GAS SURVEY PID READINGS
DEC. 13, 14, 15, 18, 19, 1989

NADC WARMINSTER, PA

SITE 4 (CONT.)

STATION	READING (ppm)					STATION	READING (ppm)					STATION	READING (ppm)
SG-71	0.25	SG-72	ND	SG-73	ND	SG-74	ND	SG-75	ND	SG-76	ND	SG-77	ND
SG-78	ND	SG-79	ND	SG-80	ND	SG-81	ND	SG-82	ND	SG-83	ND	SG-84	ND
SG-85	ND	SG-86	ND	SG-87	ND	SG-88	ND	SG-89	ND	SG-90	ND	SG-91	ND
SG-92	ND	SG-93	ND	SG-94	ND	SG-95	ND	SG-96	ND	SG-97	ND	SG-98	ND
SG-99	ND												

SITE 5

STATION	READING (ppm)					STATION	READING (ppm)					STATION	READING (ppm)
SG-1	ND	SG-2	ND	SG-3	ND	SG-4	ND	SG-5	0.5	SG-6	ND	SG-7	0.6
SG-8	ND	SG-9	0.4	SG-10	ND	SG-11	ND	SG-12	ND	SG-13	ND	SG-14	0.8
SG-15	ND	SG-16	0.5	SG-17	ND	SG-18	ND	SG-19	1	SG-20	ND	SG-21	ND
SG-22	ND	SG-23	ND	SG-24	ND	SG-25	ND	SG-26	ND	SG-27	ND	SG-28	ND
SG-29	ND	SG-30	ND										

SITE 6

STATION	READING (ppm)					STATION	READING (ppm)					STATION	READING (ppm)
SG-1	ND	SG-2	0.2	SG-3	0.2	SG-4	0.3	SG-5	ND	SG-6	ND	SG-7	ND
SG-8	ND	SG-9	ND	SG-10	ND	SG-11	0.6	SG-12	0.3	SG-13	52	SG-14	0.5
SG-15	30	SG-16	0.2	SG-17	ND	SG-18	1.7	SG-19	0.2	SG-20	ND	SG-21	0.3
SG-22	0.6	SG-23	24	SG-24	1.2	SG-25	0.4	SG-26	0.3	SG-27	0.2	SG-28	ND
SG-29	0.8	SG-30	2.1	SG-31	0.25	SG-32	1	SG-33	2.5	SG-34	0.2	SG-35	0.2
SG-36	ND	SG-37	0.2	SG-38	0.4	SG-39	ND	SG-40	0.6	SG-41	0.4	SG-42	0.3
SG-43	0.3	SG-44	0.2	SG-45	0.3	SG-46	0.3	SG-47	0.5	SG-48	0.1	SG-49	ND
SG-50	ND	SG-51	0.8	SG-52	0.4	SG-53	0.6						

TABLE 5-2 (CONT.)

SOIL GAS SURVEY PID READINGS
DEC. 13, 14, 15, 18, 19, 1989

NADC WARMINSTER, PA

SITE 7

STATION	READING (ppm)	STATION	READING (ppm)	STATION	READING (ppm)	STATION	READING (ppm)	STATION	READING (ppm)	STATION	READING (ppm)	STATION	READING (ppm)
SG-1	0.4	SG-2	ND	SG-3	ND	SG-4	ND	SG-5	ND	SG-6	ND	SG-7	ND
SG-8	ND	SG-9	ND	SG-10	ND	SG-11	ND	SG-12	ND	SG-13	ND	SG-14	ND
SG-15	0.5	SG-16	ND	SG-17	ND	SG-18	ND	SG-19	ND	SG-20	ND	SG-21	0.5
SG-22	ND	SG-23	ND	SG-24	ND	SG-25	ND	SG-26	0.4	SG-27	ND	SG-28	ND
SG-29	ND	SG-30	1.5										

SITE 8

STATION	READING (ppm)	STATION	READING (ppm)	STATION	READING (ppm)	STATION	READING (ppm)	STATION	READING (ppm)	STATION	READING (ppm)	STATION	READING (ppm)
SG-1	0.3	SG-2	0.3	SG-3	0.3	SG-4	0.2	SG-5	65	SG-6	162	SG-7	0.8
SG-8	0.7	SG-9	0.2	SG-10	ND	SG-11	ND	SG-12	ND	SG-13	2	SG-14	0.5
SG-15	2	SG-16	0.3	SG-17	0.4	SG-18	0.2	SG-19	0.2	SG-20	0.4	SG-21	0.3
SG-22	0.2	SG-23	0.2	SG-24	ND	SG-25	0.2	SG-26	0.2	SG-27	ND	SG-28	0.6
SG-29	0.2	SG-30	0.4	SG-31	ND	SG-32	ND	SG-33	ND	SG-34	0.3	SG-35	ND

APPENDIX A-2

SUMMARIZED GC ANALYSES

TABLE 5-3

SUMMARIZED GC ANALYSES
SOIL GAS SURVEY

NADC WARMINSTER, PA

Date	Field Conditions	Site	Results GC
12/12-12/17/89	10 degrees F Snow Cover	1	Small peaks: Unknowns, 116ppb Acetone, 126ppb Benzene
		2	Small Unknown peaks[1]
1/5/90	40 degrees F soils saturated	1	None Identified
		2	None Identified
		8	None Identified
1/17/90	35 degrees F soils saturated	4	147ppb Acetone[1] Unknown
		6	56ppb Acetone[1] two Unknowns
		8	316ppb Acetone[1] two Unknowns
3/1/90	50 degrees F	3	Estimate 1-2ppm Xylene, one Unknown
		5	25ppb Acetone, one Unknown
		7	two Unknowns

[1]Indicates that these compounds were also found in the method blanks.

PID = Photoionization Detector
GC = Gas Chromatograph
PPM = Parts per Million
PPB = Parts per Billion

9522:NT1M.WP

APPENDIX B

BORING LOGS

APPENDIX B-1

CONFIRMATION BORINGS

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER N/A

LOCATION S1-1 W.O. NUMBER 9522-20005

WELL NUMBER N/A TOTAL DEPTH 10' DIAMETER 8 in

SURFACE ELEV. N/A WAT. LEV.: INIT. NONE 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY C.S. Garber & SONS DRILLING METHOD Auger

DRILLER D. Stoudt LOG BY PDB, JKW DATE DRILLED 4/26/90

K. KUZER

SKETCH MAP

SITE 1

See site map

NOTES START 11:15 Finish 11:45

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER (HNu/OVA)	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING) using unified classif. system ( )
1		N/A	ND		0 – 2" → grassy layer → brown silt (OL)
2			ND		2" → 10' → Red-Brown (ML/CL)
3			ND		fine grained silt ~~clean~~
4			ND		(ML/CL). soil is damp.
5			ND		No waste detected.
6			ND		
7			ND	N/A	
8			ND		~~Red-Brown ML-CL with~~
9			ND		~~brown clay. Fine grained~~ silt
10			ND		
					Bottom of Boring → 10'
					~~DAMP~~
					Appears to be native soil
					of Stockton → i.e. red shale
					It does not ~~look like~~ fill.
					Appear to be
					NO WASTE DETECTED

013 9018 86001

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER N/A

LOCATION S1-2 W.O. NUMBER 9522-20005

WELL NUMBER N/A TOTAL DEPTH 10' DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. NONE 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY C.S. Garber & Sons DRILLING METHOD Auger

DRILLER D. Stordt K. Kuzer LOG BY PDB, JKW DATE DRILLED 4/26/90

SKETCH MAP

SITE 1

See Site map

NOTES Started 1:15 Stop 1:30

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER (HNU/OVA)	BLOW COUNT/RQD/% REC. (~~OVA~~)	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1			ND		0'-~~Top~~ 1' Brown organic silt (OL)
2			0	0	
3			0		1'-4.5' Orange-Brown silt (CH) Damp
4					
5			0	0	
6					Red clay with silt (CH)
7			0		~~Dry~~ Drier than 1'-4.5' interval
8					
9			0		
10			ND		
					Generally not damp
					Bottom of boring - 10'
					Appears to be native soil and not fill
					NO WASTE DETECTED

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NAD c OWNER N/A

LOCATION S1-3 W.O. NUMBER 9522-20005

WELL NUMBER N/A TOTAL DEPTH 8' DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. NONE 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY C.S. Garber & Sons DRILLING METHOD Auger

DRILLER D. Stoudt K. Kuzer LOG BY DB to JKW DATE DRILLED 4/26/90

SKETCH MAP

SITE 1

See Site map

NOTES start 11:45 Stop 12:00

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER (HNU/OVA)	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING) Using unified classif. system ( )
1			ND		0 – Top 6" Brown organic silt with some gravel
2					
3			0		Red inorganic medium silt (ML/CL), DAMP. grained
4					
5			0	0	
6					
7			0		
8					
9					Red clay (CH), DAMP.
10			ND		~~Damp~~
					Bottom of boring – 10'
					Appears to be native soil, and not fill
					NO WASTE DETECTED

PAGE 1 OF 1

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NAD C OWNER N/A

LOCATION S1-4 W.O. NUMBER 9522-20005

WELL NUMBER N/A TOTAL DEPTH 10' DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. NONE 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY C.S. Gerber & SONS DRILLING METHOD Auger

DRILLER D. Stoudt K. KUZER LOG BY PDB, JKW DATE DRILLED 4/26/90

SKETCH MAP

SITE 1

See site map

NOTES Start 1:30 stop 2:05

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER (HNU ppm)	BLOW COUNT/~~RQD~~/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING) Using Unified Soil Classif System ( )
1			ND		Top 1' Brown, organic silt (OL)
2					
3			0		1'-4' Orange-brown clayey silt (CL)
4				0	Damp
5					
6					Red silty clay (CL)
7			0		slightly damp
8				0	Hit resistant material at 7'-7.5'
9					again at 8'-8.25' appears to be natural rock
10			ND		9-10' Microflakes → weathered bedrock
					Bedrock appears to be siltstone
					and ~~Soil/material~~ was very
					resistant. ~~May be near bedrock since some ground was coming up.~~
					Bottom of BORING.
					Boring → 10'
					Appears to be all natural material w/ no ~~contamination~~ waste material detected

PAGE 1 OF 1

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER N/A

LOCATION S1-5 W.O. NUMBER 9522-20005

WELL NUMBER N/A TOTAL DEPTH 7.5' DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. NONE 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY C.S. Garber & SONS DRILLING METHOD Auger

DRILLER D. Staudt K. Kuzeir LOG BY PDB, JKW DATE DRILLED 4/26/96

SKETCH MAP

SITE 1

See site map

NOTES Start 2:05 Finish 2:20

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER (HNU / OVA)	BLOW COUNT / RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
					Using Unif. Soil Classif. system ( )
1			ND		Top 4" brown, organic silt (OL)
2					
3					Red silty-clay (CL) DAMP
4					
5					
6					
7					
8	Bedrock				Hit weathered bedrock AT 7.0'
9					7.5' Bedrock refusal
10			ND		→ maroon red-siltstone
					APPEARS TO BE All natural, ~~No contamination~~ MATERIAL
					NO WASTE Detected

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER N/A

LOCATION S1-6 W.O. NUMBER 9522-20005

WELL NUMBER N/A TOTAL DEPTH 6.5' DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. NONE 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY C.S. Garber & SONS DRILLING METHOD Auger

DRILLER D. Stoudt / K. KUZER LOG BY PDB, JKW DATE DRILLED 4/26/90

SKETCH MAP

SITE 1

See Site Map

NOTES Started 15:30
finished 15:40

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER (HNU)	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
					Using unified soil classif system ( )
1			ND		0'-6.5' ~~Red~~ dark brown, ~~[illegible]~~ silt
2					with gravel (CL) May be fill
3			0		mater and not native soil.
4					GRAVEL appears to be Dk-Red
5			0		SILTSTONE.
6					
7			ND		weathered bedrock at 6.0'
8					REFUSAL bedrock at 6.5'
9					Bedrock - Dark red siltstone.
10					
					~~detected~~
					~~No contamination from HNU~~
					NO WASTE MATERIAL DETECTED

PAGE 1 OF 1

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NASC OWNER N/A

LOCATION S1-7 W.O. NUMBER 9522-20005

WELL NUMBER N/A TOTAL DEPTH 9.0' DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. NONE 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY C.S. Garber & SONS DRILLING METHOD Auger

DRILLER D. Stoudt K. Kuzer LOG BY PDB, JKu DATE DRILLED 4/26/90

SKETCH MAP

SITE 1

See Site Map

NOTES Started 3:10 Finished 3:30

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER (HNu)	BLOW COUNT/RQD/% REC. (N/A)	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
					Using Unified Soil classif system ( )
1					0' – ~~top~~ ~~13~~ brown, organic silt (OL)
2					
3					3-5 Orange clay (CL), Damp
4					
5			0		
6					Red clayey silt (CL)
7			0		~~Dry~~ Drier than above interval
8			0		
9					Weathered bedrock at 7.5'
10	Bedrock				REFUSAL ~~Bedrock~~ at 9'. Bedrock = maroon-red siltstone

~~No contamination encountered~~

NO WASTE material selected

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT _____ OWNER _____

LOCATION NAD C W.O. NUMBER _____

WELL NUMBER S1-8 TOTAL DEPTH N/A DIAMETER N/A

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD Auger

DRILLER D. Stoudt K. Kuzer LOG BY PDB, JKW DATE DRILLED 4/27/90

SKETCH MAP

Site 1

See site map

NOTES Start 8:50 Finish 9:20

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER OVA	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
	OL		ND		0-1' Brown, organic silt (OL)
1			ND		1-10' Red, medium grained silt with trace gravel
2	ML		ND		(ML) Slightly micaceous
3			ND		Possible cinders encountered at 6.5'
4			ND		
5			ND		
6			ND		
7			ND		
8			ND		
9			ND		
10					
					Boring stopped at 10'
					Not generally damp
					Appears to be native Stockton soil with exception of a few possible cinder chips.
					WASTE DETECTED:
					POSSIBLE Cinders!

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER

LOCATION S1-9 W.O. NUMBER

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD Auger

DRILLER D. Stoudt K. Kuzer LOG BY PDB, JKW DATE DRILLED 4/27/90

SKETCH MAP

Site 1

See Site map

NOTES Start 9:25 Finish 9:45

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER (OVA)	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1	OL		ND		0 - 2' Brown, organic silt (OL) Dry
2			ND		
3	ML		ND		2 - 7' Red medium grained silt (ML)
4			ND		
5			ND		7' - 8' Weathered bedrock encountered at 7'
6			ND		Red medium grained silt with gravel (GM)
7	GL		ND		
8			ND		8' - Bedrock
9					
10	Bedrock				Not damp
					Material is native Stockton with no waste material present
					NO Waste Detected

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NAPS OWNER

LOCATION S1-10 W.O. NUMBER N/A

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD Auger

DRILLER D. Stoudt K. Kuzer LOG BY PDB, JKW DATE DRILLED 4/27/90

SKETCH MAP

Site 1

See Site map

NOTES Start 9:45 Finish

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1	OL		ND		0-2' Brown, m-grained organic silt (OL)
2			ND		2'-3' Orange clayey silt (ML)
3	ML		ND		3'-8' Red, fine grained silt (ML) with gravel
4			ND		
5	ML		ND		8' Bedrock
6			ND		
7			ND		
8			ND		
9					
10	Bedrock				
					Material is all stockton with no waste detected.
					NO Waste Detected

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER

LOCATION S1-11 W.O. NUMBER N/A

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Gerber + Sons DRILLING METHOD Auger

DRILLER D. Stovdt K. Kuzer LOG BY PDB + JKW DATE DRILLED 4/27/90

SKETCH MAP

Site 1

See site map

NOTES Start 10:50 Finish 11:10

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1	OL		ND	ND	0 - 3' Brown organic silt (OL)
2			ND	ND	3' - 5' Orange-brown clay (CL)
3			ND	ND	which was wet for the top 6"
4	CL		ND	ND	
5			ND	ND	5 - 10' Red medium grained silt (ML)
6	ML		ND	ND	
7			ND	ND	
8			ND	ND	
9			ND	ND	
10			ND	ND	

Bottom of boring → 10'

Material appears to be native Stockton except for first 5' which is natural but not native.

* One cinder was found when cuttings were being put back in hole.

No waste detected

* See above

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER

LOCATION SI-12 W.O. NUMBER N/A

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD Auger

DRILLER D. Stoudt, K. Kuzer LOG BY PDB, JKW DATE DRILLED 4/27/90

SKETCH MAP

Site 1

See Site map

NOTES Started 11:10 Finished 11:35

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER (HNU)	BLOW COUNT/ RQD/% REC. (OVA)	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING) Unified Soil classif. syst. ( )
1			ND	ND	0-3' Brown organic silt (OL)
2	OL		ND	ND	contained cinders
3			ND	ND	3-4' Brown clay with cinders (in fine)
4	CL		ND	ND	Several cinders found around 6'
5	ML		ND	ND	4-10' Red medium grained silt (ML)
6			ND	ND	Dryer towards the bottom
7			ND	ND	
8			ND	ND	10' - RED Shale chips
9			ND	ND	
10			ND	ND	Boring depth - 10'
					Soil was dryer the further down ~~that out~~ WE drilled
					Waste encountered.
					Several chips of cinders were seen from ~~3' downwards~~ 0'-6

PAGE 1 OF 1

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER

LOCATION SL-13 W.O. NUMBER N/A

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber Bros DRILLING METHOD Auger

DRILLER D. Stordt / K. Kuzer LOG BY PDB + JKW DATE DRILLED 4/27/90

SKETCH MAP

Site 1

See site map

NOTES Started 12:30 Finished 12:55

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER (HNU)	BLOW COUNT/RQD/% REC. (OVA)	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1	OL		ND	ND	0-2' Brown organic silt (OL) found glass
2			ND	ND	and cinders
3	ML		ND	ND	2'-10' Red medium grained silt (ML)
4			ND	ND	Contained cinders and glass
5			ND	ND	between 2' and 10'
6			ND	ND	
7			ND	ND	
8			ND	ND	
9			ND	ND	
10			ND	ND	
					Boring depth - 10'
					Material appears to be native but it contains some waste within the Stockton Soils.
					~~Waste Found:~~
					~~Cinders → 0-10'~~
					~~Glass → 0-2'-8'~~

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER

LOCATION S1-14 10' from Well E W.O. NUMBER N/A

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD Auger

DRILLER D. Stoudt, K. Kuzer LOG BY PDB, JKW DATE DRILLED 4/27/90

SKETCH MAP

Site 1

See Site map

NOTES Started 12:55 Finished 1:15

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER (HNU)	BLOW COUNT/ RQD/% REC. (OVA)	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1	OL		ND	ND	0-2' Brown, organic silt (OL)
2			ND	ND	Contains cinders
3			ND	ND	2-7' Red medium grained silt (ML)
4			ND	ND	Contains cinders with tr gravel
5			ND	ND	7'- Bedrock, Red shale
6			ND	ND	
7			ND	ND	
8					Hit bedrock at 7'
9					
10	Bedrock				
					Material appears to be native but contains cinders.
					Waste Found:
					Small amounts of cinders
					~~especially [illegible] from 0'-5'~~

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER

LOCATION S1-15 W.O. NUMBER N/A

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber + Sons DRILLING METHOD Auger

DRILLER D. Stordt K. Kuzer LOG BY PDB, JKW DATE DRILLED 4/27/90

SKETCH MAP

Site 1

See Site map

NOTES Started 1:55 Finished 2:20

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER (HNU)	BLOW COUNT/RQD/% REC. (NA)	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1	OL		ND	ND	0-2' Brown, organic silt (OL)
2			ND	ND	2-4.5' Brown clay (CL)
3	CL		ND	ND	with glass and cinders
4			ND	ND	4.5-9' Maroon-Red medium grained silt (ML)
5			ND	ND	Encountered fragments of ceramics
6			ND	ND	ish-like material at 8'
7	ML		ND	ND	9-10' Weathered bedrock. Coarse-grained
8			ND	ND	Maroon-red shale cutting
9			ND	ND	
10	WB		ND	ND	
					Boring depth -10'
					Material appears to be native with some fill material.
					Probably weathered arkose PDB 5/9/90
					~~Waste~~ encountered: Cinders, ash, and ceramics
					↓ 2-8' ↓ 8' ↓ 5'

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER

LOCATION S1-16 W.O. NUMBER N/A

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber + Sons DRILLING METHOD Auger

DRILLER D. Stoudt K. Kuzer LOG BY PDB, JKW DATE DRILLED 4/27/90

SKETCH MAP

Site 1

See Site Map

NOTES Started 2:20
Finished

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER (HNU)	BLOW COUNT/ RQD/% REC. (OVA)	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1	OL		ND	ND	0-1' Brown, organic silt (OL)
2	CL		ND	ND	1-3' Brown-orange clay (CL)
3			ND	ND	3-10' Maroon-red silt (ML)
4			ND	ND	Ceramics and cinders at [redacted]
5	ML		ND	ND	5-10'
6			ND	ND	
7			ND	ND	
8			ND	ND	
9			ND	ND	
10			ND	ND	Boring depth -10'
					Native Stockton material interspersed with waste (fill)
					Waste found:
					Ceramics, cinders

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LO

PROJECT NADC OWNER

LOCATION S1-17 W.O. NUMBER N A

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER S

SURFACE ELEV. N/A WAT. LEV.: INIT. 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Gerber & Sons DRILLING METHOD Auger

DRILLER G. Stand LOG BY PDR DATE DRILLED 4/5/90

SKETCH MAP

NOTES Start 8:25 Finish 9:00

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1	CL		ND		0 - 6' Brown sandy silt (CL)
2			ND		Contained glass + cinders
3	ML		ND		6' - 4.5' Red medium-grained shale (ML)
4			ND		contained abundant glass
5			ND		and cinders
6	CL		ND		4.5 - 6 Purple-brown clay with glass
7			ND		and cinders (CL)
8	ML		ND		6' - 9' Red-brown silt (ML)
9			ND		with little or no
10			ND		waste material
					9' - 10' Weathered bedrock (red shale)
					Total boring depth - 10'
					Much waste material was seen between 0 and 6'.
					Waste found: cinders and glass

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER NAVY

LOCATION S1-18 W.O. NUMBER ~~N/A~~ 9522-20005

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD Auger

DRILLER B. Stoudt LOG BY PDB DATE DRILLED 5/2/90

SKETCH MAP

Site 1

See Site Map

NOTES Start 8:35
Finish 9.6

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	~~SAMPLE NUMBER~~ H.S.	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1			ND		0-2' Brown organic silt (OL)
2			ND		2'-7' Dk. red coarse silt (ML)
3			ND		
4			ND		
5			ND		
6			ND		
7			ND		
8					Auger Refusal → 7'
9					
10					
					Material appeared to be native Stockton soils
					Waste Found: One metal fragment One cinder

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER NAVY

LOCATION S1-19 W.O. NUMBER ~~N/A~~ 9522-20005

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Barber & Eng DRILLING METHOD Auger

DRILLER B. Stoudt / K. Kuzel LOG BY PDB DATE DRILLED 5/2/90

SKETCH MAP

Site 1
see Site Map

NOTES start: 8:15
Finish: 8:35

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	~~SAMPLE NUMBER~~ HNU	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1	OL		ND		0-2' Brown organic silt (OL)
2			ND		Some wood frags.
3	ML		ND		2'-4' Red-brown clayey silt (ML)
4			ND		4-6' Brown clay (CL)
5	CL		ND		6-8' Red-brown silt and clay (ML+CL)
6			ND		8'-9' Weathered bedrock (red siltstone)
7	N-X-C-		ND		used red silt (ML)
8			ND		
9	ML		ND		
10					Boring depth → 9'
					Material appeared to be fill and native soil.
					Waste Found: Wood Frags
					~~No Waste Found~~

PAGE ___ OF ___

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER

LOCATION 31-20 W.O. NUMBER

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER N/A

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Gerber & Sons DRILLING METHOD Auger

DRILLER B. Stout K. Kuzer LOG BY PDB DATE DRILLED 4/30/90

SKETCH MAP

Site 1

See site map

NOTES Start 9:00 Finish 9:25

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER (HNU)	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1	OL		ND		0-6" Brown (OL) organic silt
2			ND		6"-10' Maroon-Red silt (ML) with some
3	ML		ND		cinders
4			ND		
5			ND		
6			ND		
7			ND		
8			ND		
9			ND		
10			ND		
					Boring depth → 10'
					Material appeared to be all natural and no fill. Only trace amounts of cinders were found.
					Waste found: tr of cinders

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT _____ OWNER _____

LOCATION SL-21 W.O. NUMBER _____

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD _____

DRILLER B. Stoudt / K. Kuzer LOG BY PDR, EFT DATE DRILLED 4/30/90

SKETCH MAP

Site 1

See site map

NOTES Started 11:05 Finished 11:30

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	~~SAMPLE NUMBER~~ HNU	~~BLOW COUNT~~ / OVA ~~RQD/% REC.~~	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1	OL		ND	ND	0-4" Brown organic ~~soil~~ silt (OL)
2	ML		ND	ND	4"-6" Red silt (ML). Contains
3			ND	ND	a few cinders.
4			ND	ND	6'-7' Brown silty clay (CL)
5			ND	ND	7'-10' Red m-grained silt (ML)
6			ND	ND	tr gravel. Cinders and brick
7	CL		ND	ND	fragments seen.
8	ML		ND	ND	
9			ND	ND	
10			ND	ND	

Material appeared to be native except for brown clay layer which may or may not be native.

Waste found:
Cinders
brick fragments
Cement frags (?)

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT ~~NADC~~ OWNER NAVY

LOCATION S1-22 W.O. NUMBER ~~N/A~~ 9522-20005

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD Auger

DRILLER B Stoudt LOG BY PDB DATE DRILLED 5/2/90

SKETCH MAP

Site 1

See Site Map

NOTES Start 9:00
Finish 9:15

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	~~SAMPLE NUMBER~~ HNU	~~BLOW COUNT~~ OVA ~~RQD/% REC.~~	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1	OL		ND	ND	0-1' Brown organic silt (OL)
2	ML		ND	ND	1'-3' Bright red clayey silt (ML)
3			ND	ND	3'-5' Tan-brown clayey silt (ML)
4	ML		ND	ND	contains some glass frags
5			ND	ND	5'-6' Maroon-red silty clay (CL)
6	CL		ND	ND	large piece of metal
7	ML		ND	ND	6'-10' Brown clayey silt (ML)
8			ND	ND	and silty clay (CL)
9	CL		ND	ND	
10			ND	ND	

Material was interlayered fill and native Stockton.

Waste found:
Large piece of metal
Several large cinders
Concrete fragments

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT _____ OWNER _____

LOCATION S1 -23 W.O. NUMBER _____

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Gerber & Sons DRILLING METHOD Auger

DRILLER B. Stordt / K. Kuzer LOG BY PDB DATE DRILLED 4/30/90

SKETCH MAP

Site 1
See site map

NOTES Start 9:25
Finished 9:45

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER HNU	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
	OL		ND		0-4" Brown organic silt (OL)
1			ND		with some glass
2	ML		ND		4" 7' Red medium grained silt (ML)
3			ND		contained cinder / concrete material
4			ND		
5	ML		ND		7'-9' Brown silt (ML) with
6			ND		abundant and large cinders & nails
7			ND		9'-10' Brown clay (CL) damp.
8	ML		ND		
9			ND		
10	CL		ND		
					Boring depth -10'
					The different colors of the silt layers suggests deposition of fill material.
					Waste Found: Cinders, concrete, construction debris (nails)

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT _____ OWNER _____

LOCATION SI-24 W.O. NUMBER _____

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD Auger

DRILLER B. Stavat / K. Kuzer LOG BY PDB, EFT DATE DRILLED 4/30/90

SKETCH MAP

See site map Site 1

NOTES Started 10:40 Finished 11:05

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1	OL		ND	ND	0-4' Red, organic silt (OL)
2			ND	ND	with 25-30% gravel.
3			ND	ND	4'-6' Brown silt (ML) with
4			ND	ND	Some gravel and white
5	ML		ND	ND	flakes (possibly ground up gravel)
6			ND	ND	6'-8' Red medium-grained silt
7	ML		ND	ND	(ML) with some cinders
8			ND	ND	8'-10' Red clay (CL) with
9	CL		ND	ND	wood fragments, porcelain
10			ND	ND	and glass.
					Damp at 9'
					Boring Depth → 10'
					Appeared to be interlayered fill
					and native material.
					Waste found:
					Wood, porcelain, glass, and some cinders
					mainly bottom 3 feet

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT _____ OWNER _____

LOCATION SI-25 W.O. NUMBER _____

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD Auger

DRILLER B. Stoudt K. Kuzer LOG BY PDB DATE DRILLED 4/30/90

SKETCH MAP

Site 1

see site map

NOTES Start 10:25 Finish 10:40

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER (HNU)	BLOW COUNT/ RQD/% REC. (OVA)	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1	GM		ND		0-4" Brown organic silt (OL)
2			ND		~~with gravel~~.
3			5		4"-2' Gray gravel. Gravel
4	ML		2		is stained black.
5			3		2'-7' Maroon-red-brown silt (ML)
6					Contains white (concrete?) particles
7					with gravel.
8					7'-10' Red medium grained silt (ML)
9	ML				Some cinders were present
10			3	ND	along with wood fragments

Boring depth → 10'

0-7' appeared to be fill and waste material.
7-10' Was native soil but contained waste

Waste found:
Cinders, black stained gravel (probably fill) and wood fragments.

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT _____ OWNER _____

LOCATION S1-26 W.O. NUMBER _____

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. N/A 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD Auger

DRILLER B. Stoudt / K. Kuzer LOG BY PDB DATE DRILLED 4/3/90

SKETCH MAP

Site 1

see site map

NOTES Start 10:00 Finish 10:25

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER (HNu)	BLOW COUNT/ RQD/% REC. (OVA)	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
					(ML)
1			ND	ND	0 - 4' Red M-grained silt with
2			ND	ND	gravel. Some gravel appears
3	ML		ND	ND	black stained. There are also a
4			ND	ND	few nails present.
5			1	10	Also fragments of material
6	ML		3	ND	that have a green quartzite-
7			2	20?	like appearance.
8			ND	ND	4'-7' Brown silt (ML) with gravel
9	CL		ND	ND	contains cinders
10			ND	4	7'-10' Brown, wet clay (CL)
					contains chips of a white
					material
					Boring depth → 10'
					Appeared to be mostly fill
					material
					Material Found:
					Green quartzite
					White fragments (cement)
					Cinders

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SMC ENVIRONMENTAL SERV' 'S GROUP

DRILLING LOG

PROJECT NAD C OWNER

LOCATION S1 - 27 W.O. NUMBER 9522-20005

WELL NUMBER N/A TOTAL DEPTH 10' DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. NONE 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY C.S. GARBER DRILLING METHOD AUGER

DRILLER BARRY STOUDT Kevin Kuper LOG BY JEFF WALSH DATE DRILLED 5/3/90

SKETCH MAP

See SITE 1 MAP

NOTES 08:15 START ~08:50 Finish

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
					Unified soil classif. syst. ( )
					0'-3'
1	CINDERS		ND		BROWN SILT AND FINE SAND WITH
2					BLACK CINERS. (SM)
3					3'-7' MAROON RED SILT (micaceous (ML)
4					
5					
6					7'-10' MAROON RED FINE SAND
7					AND SILT ; MICACEOUS
8					w/ PEBBLE SIZED
9					PIECES OF weathered
10			ND		silt stone (SM)
					WASTE DETECTED
					CINDERS 0'-3'
					STOPPED @ 10' DEEP
					SOILS ARE DAMP

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING

PROJECT NADC OWNER NAVY

LOCATION S1-28 W.O. NUMBER 9522-20005

WELL NUMBER N/A TOTAL DEPTH _____ DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. _____ 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY C.S GARBER DRILLING METHOD AUGER

DRILLER BARRY STOUDT KEVIN KUZER LOG BY JEFF WALSH DATE DRILLED 5/3/90

SKETCH MAP

SEE SITE 1 MAP

NEXT TO SIDEWALK & TANK/FUEL FARM

NOTES START ~ 08:50 09:30

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER (Hnu)	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
					Unified Soil classif. syst. ( )
1			ND		0'-5' MAROON-RED SILTSTONE AND PURPLE ARKOSE COBBLES
2					AND; & MAROON RED SAND AND SILT (SM).
3					
4					@ 5' A PIECE OF DIABASE GRAVEL IS ENCOUNTERED
5					5'-7.5' Light Brown SILT
6					FINE SAND AND CLAY. (SC)
7					
8					7.5'-10' MAROON RED SILT AND
9					FINE SAND W/ PIECES
10			ND		OF MAROON RED SILTSTONE
					(weathered) (SC).
					NO WASTE DETECTED.

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER

LOCATION S2-1 W.O. NUMBER N/A

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Barber & Sons DRILLING METHOD Auger

DRILLER B. Stovall LOG BY PDB DATE DRILLED 5/1/90

SKETCH MAP

Site 2

See Site Map

NOTES Started 8:30
Finished 8:55

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
	OL		ND		0-4" Brown organic silt and gravel (OL)
1	fill		ND		4"-2' Gravel fill
2			ND		2'-5' Red-brown silt (ML) with
3	ML		ND		gravel some cinders and
4			ND		metal debris.
5			ND		5'-8' Red silty clay with brick
6	CL		ND		fragments. (CL)
7			ND		Glass and cinders at 7'
8	ML		ND		8'-10' Weathered bedrock and silt (ML)
9			ND		red siltstone
10					
					Material may be native, but it is generally a darker color than the normal maroon-red silt.
					Waste found; cinder
					Small amounts of: glass metal debris

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT _____ OWNER _____

LOCATION S2-2 W.O. NUMBER N/A

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. _____ 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE _____

DRILLING COMPANY Garber + Sons DRILLING METHOD Auger

DRILLER B. Stordt LOG BY PDB DATE DRILLED 5/1/90

SKETCH MAP

Site 2.

See site map

NOTES Started 9:00
Finished 9:20

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	~~SAMPLE NUMBER~~ HNU	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1			ND		0-4" Brown organic silt (OL)
2			ND		4"-1' Gravel fill
3			ND		1'-6' Red-~~Brown~~ medium grained silt (ML)
4			ND		
5			ND		
6			ND		
7					
8					Refusal at 6'
9					
10					
					Material appeared to be native soil with little or no waste.
					NO WASTE
					Waste Found!
					White rock fragments (cement?)
					ARKOSE

PAGE ____ OF ____

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT _____ OWNER _____

LOCATION Bally 53-1 W.O. NUMBER _____

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. N/A 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD Auger

DRILLER B. Stardt K. Kuzer LOG BY DDB DATE DRILLED 4/30/90

SKETCH MAP

Site 3

See site map

NOTES Started 12:35 Finished 12:55

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	~~SAMPLE NUMBER~~ HNU	~~BLOW COUNT~~ / ~~RQD/% REC.~~ OVA	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1	OL		ND	ND	0-2' Brown organic silt (OL) with cobbles
2			ND	ND	
3	ML		ND	ND	2'-3' Lt. Brown silt (ML)
4			1-2	ND	3'-8' Dark gray silt (ML) wet. Contains cinders, porcelain, brick, and nails.
5			1-2	ND	
6	ML		1-2	ND	
7			1-2	ND	8'-8.5' Red silty clay (CL) with metal debris.
8			1-2	ND	
9	CL		ND	ND	
10					

Refusal at 8.5

Material appears to be mostly fill with assorted waste material

Waste found:

Cinders, porcelain, brick, metal debris.

PAGE _____

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT _____ OWNER _____

LOCATION S3-2 W.O. NUMBER _____

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. _____ 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD Auger

DRILLER B. Stoudt K. Kuzer LOG BY PDB, EFT DATE DRILLED 4/30/90

SKETCH MAP

Site 3

See Site Map

NOTES Started 3:10 Finished 3:30

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1	OL		ND		0-2' Brown-black organic silt (OL)
2			ND		2'-4.5' Orange-brown silt (ML) with
3			ND		dark stained gravel
4	ML		ND		4.5-6' Olive-brown wet clay (CL)
5			ND		6'-7' Red-Brown silt (ML)
6	CL		ND		7'-9' Brown, wet silty clay (CL)
7	ML		ND		9'-10' Brown clayey silt (ML)
8	CL		ND		
9			ND		
10	ML		ND		
					Material was observed to consist totally of fill.
					No Waste ~~Found~~ Found

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT _____ OWNER _____

LOCATION S3-3 W.O. NUMBER _____

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. _____ 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Gerber & Sons DRILLING METHOD Auger

DRILLER B. Stordt / K. Kuzer LOG BY PDB, EFT DATE DRILLED 4/30/90

SKETCH MAP

Site 3

See Site map

NOTES Started 12:55 Finished 1:10

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1					0-4' Black silt and gravel (GM)
2	GM		2		4'-5' Red-brown silt (ML)
3			2-12		5'-7' Brown clay (CL). Wood fragments found.
4			5-15		
5	ML		5-10		7'-10 Orange-brown clayey silt (ML)
6	CL		20		
7			5[redacted]		
8			5-15		
9	ML		5-10		
10			5-10		

Material appeared to be all fill with very little native material. Although there was little waste present, the HNU readings were high.

Waste found:

Wood, glass.

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT _____ OWNER _____

LOCATION S3-4 W.O. NUMBER _____

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD Auger

DRILLER B. Stardt K. Kuzer LOG BY PDB, EFT DATE DRILLED 4/30/90

SKETCH MAP

Site 3

see site map

NOTES Started 1:10 Finished 1:25

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	~~SAMPLE NUMBER~~ HNU	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1			ND		0-2' Dk brown silt and gravel
2			ND		(GM)
3			ND		2-3' Red silt and gravel (GM)
4			ND		3-6' Red m-grained silt (ML)
5			ND		Contained wood fragments
6			ND		Cinders & glass
7			ND		6-10' Brown clay (CL) with
8			ND		cinders.
9			ND		
10			ND		
					Material was mostly non-
					native fill with waste material
					Wet at 9'
					Waste found:
					Cinders
					Wood
					Glass

PAGE ____ OF ____

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT _____ OWNER _____

LOCATION S3-5 W.O. NUMBER _____

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD Auger

DRILLER B. Stoudt K. Kuzer LOG BY PDB, EFT DATE DRILLED 4/30/90

SKETCH MAP

Site 3

see Site map

NOTES Started 1:30 Finished 1:55

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	~~SAMPLE NUMBER~~ HNU	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
			ND		0 - 6" Brown-black gravel and asphalt
1			ND		6" - 6' Red-brown silt (ML)
2			ND		with black-stained gravel
3			ND		and white fragments (cement?)
4	ML		ND		6' - 9' Olive-brown clay with wood frags.
5			1		(CL)
6			ND		9' - 10' Brown silt (ML) with wood
7	CL		ND		fragments.
8			ND		
9			ND		
10	ML				

Material was mostly fill, but with not as much waste as at other spots in Site 3.

Waste found:

wood

some brick

white fragments

PAGE ____ OF ____

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT _____ OWNER _____

LOCATION 53-6 W.O. NUMBER _____

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER ~~Ø~~ 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD Auger

DRILLER B. Stoudt K. Kuzer LOG BY PDB, EFT DATE DRILLED 4/30/90

SKETCH MAP

Site 3

see site map

NOTES start 2:40 Finish 3:10

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	HNV ~~SAMPLE NUMBER~~	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
			ND		0-6" Black gravel & silt (GM)
1			ND		6"-9' Brown silt (ML) with tr of
2			ND		black stained gravel.
3			ND		from 1-2'
4			ND		9'-10' Red-maroon silt (ML)
5			ND		
6			ND		
7			ND		
8			ND		
9			ND		
10					Bottom of boring → 10'
					From 0-9' appears to be clean fill
					9'-10' is native soil
					No Waste Found

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT _____ OWNER _____

LOCATION S3 [redacted] - 7 W.O. NUMBER _____

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY B. Stordt ~~W. Kuzer~~ DRILLING METHOD Auger

DRILLER Garber & Sons LOG BY PDB, EFT DATE DRILLED 4/30/90

SKETCH MAP

Site 3

See Site map

NOTES Started 1:55 Finished 2:15

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	~~SAMPLE NUMBER~~ HNU	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1			ND		0-2' Brown-black silt and gravel (GM)
2			ND		2-4' Red-brown silt (ML)
3			ND		4-7' Orange-brown clayey silt (ML)
4			ND		7'-9' Maroon-red silty clay (CL)
5			ND		white gravel struck at 8'-9'
6			ND		9'-10' Maroon silt (ML)
7			ND		
8			ND		
9			ND		
10			ND		
					Material is mixed fill and native material. Waste is limited to the white gravel which may be cement or part of the fill. No HNU hits.
					Waste found: Tr of possible cinders. White gravel.

PAGE ____ OF ____

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER

LOCATION SS-1 W.O. NUMBER N/A

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 3"

SURFACE ELEV. N/A WAT. LEV.: INIT. 6' 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Gurber & Sons DRILLING METHOD Auger

DRILLER B. Stendt LOG BY PDB DATE DRILLED 5/1/90

SKETCH MAP

Site 5

See site map

NOTES Start 10:10
Finish 10:30

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	~~SAMPLE NUMBER~~ HNU	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1	OL / ML		ND		0'-4" Brown organic silt (OL)
			ND		4"-1' Red-Brown silt (ML)
2	ML		ND		1'-3' Dark brown silt (ML)
3			ND		3'-6' Olive-brown silty clay (CL)
4	CL		1		Contains metal debris
5					Hit water & metal debris at 6'
6			5-10		
7					
8					
9					
10					
					Auger refusal → 6'
					Material appears to be fill
					Waste found:
					Much metal debris
					Metal cylinders and wires

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER

LOCATION SS-2 W.O. NUMBER N/A

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD Auger

DRILLER B. Stoudt LOG BY PDB DATE DRILLED 5/1/90

SKETCH MAP

Site 5

see site map

NOTES: Start 10:35 Finish 10:45

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER (HNU)	~~BLOW COUNT~~ / ~~RQD/% REC.~~ (O/A)	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1	OL		ND	ND	0-1' Brown organic silt (OL)
2			ND	ND	1'-4' Red-brown m-grained silt (ML)
3	ML		ND	ND	4' - Bedrock
4			ND	ND	
5	bedrock				
6					
7					
8					
9					
10					
					Material appeared to be native red silt. (Stockton)
					No Waste

PAGE ___ OF ___

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER NAVY

LOCATION SS-3 W.O. NUMBER 9522-20005

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Barber & Sons DRILLING METHOD Auger

DRILLER B Stavdt LOG BY PDB DATE DRILLED 5/2/90

SKETCH MAP

Site 5

See Site Map

NOTES Start 11:20
Finish 11:40

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	~~SAMPLE NUMBER~~ HNU	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
	OL				0-1' Brown organic silt (OL)
1					1'-4' Brown-gray Sandy silt (ML)
2	ML				4'-5' Orange-brown clayey silt (ML)
3					5'-10' Mar-Red-brown medium g silt (ML)
4	ML				
5					
6					
7					Boring Depth → 10'
8	ML				
9					
10					
					Top 4' appeared to be Fill
					From 4-6' " " " native Stockton
					No Waste Found

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER

LOCATION S5-4 W.O. NUMBER N/A

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD Auger

DRILLER B. Stoudt LOG BY PDB DATE DRILLED 5/1/90

SKETCH MAP

Site 5

See site map

NOTES Start 10:45
Finish 11:00

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	~~SAMPLE NUMBER~~ HNU	~~BLOW COUNT/ RQD/% REC.~~ OVA	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1	OL		ND	ND	0-4' Brown organic silt (OL)
2			ND	ND	with a little glass
3	ML		ND	ND	1-4.5' Orange-red silt (ML)
4			ND	ND	with small wood fragments
5			ND	ND	& glass
6	ML		ND	ND	4.5-7' Native maroon-red silt (ML)
7			ND	ND	7' Bedrock
8	Bedrock				
9					
10					
					Top 4.5' was fill
					4.5 and down was native
					Waste Found:
					Small amts. of glass and wood
					One chunk of metal.

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER

LOCATION S5-5 W.O. NUMBER N/A

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD Auger

DRILLER B. Stoudt LOG BY PDB DATE DRILLED 5/1/90

SKETCH MAP

Site 5

see Site Map

NOTES Start 11:05 Finish 11:25

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1			ND	ND	0-3' - Brown organic silt (OL)
2			ND	ND	3'-4.5' Lt. Brown fine silt (ML)
3			ND	ND	4.5'-6' Red-brown fine silt (ML)
4			ND	ND	6'-8' Maroon-red silt (ML)
5			ND	ND	8'-10' Orange-olive silt (ML)
6			ND	ND	
7			5-15	ND	
8			↓	1	
9				1	
10				8-10	
					Material appeared to be fill. Had hits from HNU and OVA
					NO Waste found

PAGE OF

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER

LOCATION SS-6 W.O. NUMBER N/A

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD Auger

DRILLER B. Stordt LOG BY PDB DATE DRILLED 5/1/90

SKETCH MAP

Site 5

See Site map

NOTES Start 1:40
Finish 2:00

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	~~SAMPLE NUMBER~~ HNU	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1			ND		0 – 2' Brown organic silt (OL)
2			ND		2' – 4' Orange-brown silty clay (CL)
3			ND		4' – 7' Red m-grained silt (ML)
4			ND		7' – 10' Maroon-Brown silty clay (CL)
5			ND		
6			ND		
7			ND		
8			ND		
9			ND		
10			ND		
					Material is probably native
					Waste Found: Nail
					beer can tab
					Screw
					Candy Wrapper

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER

LOCATION SS-7 W.O. NUMBER N/A

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber Sons DRILLING METHOD Auger

DRILLER B. Stovall LOG BY PDB DATE DRILLED 5/1/90

SKETCH MAP

Site 5

See Site Map

NOTES Started 1:00 Finished 1:15

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	HNU SAMPLE NUMBER	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1	OL		ND		0-2' Brown- organic silt (OL)
2			ND		2'-5' Orange-brown silty clay (CL)
3			ND		found metal screw
4	CL		ND		5'-6.5' Red-brown silty clay (CL)
5			ND		6.5'-8' Maroon-red silt (ML)
6	CL		ND		8'-10' Weathered bedrock
7			ND		
8	ML		ND		
9			ND		
10	WB		ND		

Material looks native

Waste Found:
Several glass fragments
One metal screw

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER

LOCATION SS-8 W.O. NUMBER N/A

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber/Sun DRILLING METHOD Auger

DRILLER B. Stoudt LOG BY PDB DATE DRILLED 5/1/90

SKETCH MAP

Site 5

See Site Map

NOTES Started 1:20
Finished 1:40

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	~~SAMPLE NUMBER~~ HNU	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
	OL				0 - 6" Brown organic silt (OL)
1					
2	ML + CL				6" - 5' Yellow-brown silt (ML) with clay.
3					
4					5' - 6' Red-brown silt (ML)
5					6' - 8' Brown silt with fr pebbles (ML)
6	ML				8' - 9' Red silt and clay (ML + CL)
7	ML				9' - Bedrock
8					
9	ML+CL				
10	Bed				
					Material appeared to be mostly fill
					NO WASTE Found

PAGE ____ OF ____

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT _____ OWNER _____

LOCATION SS-9 W.O. NUMBER N/A

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. _____ 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD Auger

DRILLER B. Stoudt LOG BY PDB DATE DRILLED 5/1/90

SKETCH MAP

Site 5

See Site Map

NOTES Start 3:10
Finish 3:30

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	~~SAMPLE NUMBER~~ HNU	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1			ND		0-6" Brown organic silt (OL)
2			ND		6"-2' Red m-grained silt (ML)
3			ND		2'-6 Gray-black clay (CL)
4			ND		Hit water at 4.5'
5			ND		6'-8' Red-brown clay (CL)
6			ND		8' - Refusal and gushing
7			ND		groundwater
8			ND		
9					
10					Boring depth → 8'
					Material looks like fill
					metal pieces were noticed
					while backfilling the borehole
					pieces in 2'-6'
					Interval?
					Waste found:
					1 piece of wood
					1 " " metal

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER

LOCATION SS-10 W.O. NUMBER N/A

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD Auger

DRILLER B. Stoudt LOG BY PDB DATE DRILLED 5/1/90

SKETCH MAP

Site 5
See Site Map

NOTES Start 2:30
Finish 3:00

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER (HNU)	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
	Fill		ND		0-6" Soil & gravel fill
1	ML		ND		6" - 2' Olive silt (ML)
2			ND		2' - 4.5' Lt. brown m-grained silt (ML)
3	ML		ND		4.5 - 6' Red-maroon silty clay (CL)
4			ND		6' - 7' Lt. Brown coarse silt (ML)
5	CL		ND		7' - 10' Maroon-red medium silt (ML)
6	ML		ND		
7			ND		
8	ML		ND		
9			ND		
10					
					Material appears to be all fill with the exception of 7-10' which looks native.
					NO Waste Found

PAGE ___ OF ___

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER NAVY

LOCATION S7-1 W.O. NUMBER ~~NA~~ 9522-20005

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD Auger

DRILLER B. Stoudt LOG BY PDB DATE DRILLED 5/2/90

SKETCH MAP

Site 7

See Site map

NOTES Start 1:40 Finish 1:55

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER HNU	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1			ND		0-4" Brown organic silt (OL)
2			ND		4"-4.5' ~~Orange~~ Yellow-brown silty clay (CL)
3			ND		4.5'-7 Red-brown medium grained silt (ML)
4			ND		7' Bedrock
5			ND		
6			ND		
7			ND		
8			ND		
9			ND		
10			ND		Material was baseball fill
					and native stockton soil
					No waste found

PAGE ___ OF ___

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NAD 6 OWNER NAVY

LOCATION S7-2 W.O. NUMBER ~~HA~~ 9522-20005

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD Auger

DRILLER B. Stoudt LOG BY PDB DATE DRILLED 5/12/90

SKETCH MAP

Site 7

See Site Map

NOTES Start 2:00
Finish 2:15

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	~~SAMPLE~~ NUMBER	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1	OL		ND		0-1.5' Brown organic silt (OL)
2			ND		1.5' - 6' Red-brown Sandy silt (ML)
3			ND		with fragments of red
4	ML		ND		siltstone
5			ND		6'- Bedrock
6			ND		
7			ND		
8	Bed rock		ND		
9			ND		Material appears to be
10			ND		native stockpile
					Auger Refusal at 6'
					NO Waste Found

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER NAVY

LOCATION S7-3 W.O. NUMBER 9522-20005

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. 8' 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD Auger

DRILLER B. Stoudt LOG BY PDB DATE DRILLED 5/2/90

SKETCH MAP

Site 7
See Site Map

NOTES Start 1:05
Finish 1:35

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	~~SAMPLE NUMBER~~ HNU	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
	OL		ND		0 - 4" Brown organic silt (OL)
1			ND		4" - 4' Orange-brown sandy silt (ML)
2	ML		ND		4' - 10' Red brown medium grained silt (ML)
3			ND		and clayey silt
4			ND		Hit GW at 8'
5			ND		
6			ND		
7	ML		ND		
8			ND		
9			ND		
10			ND		
					Boring depth → 10'
					Material appeared to be native Stockton
					No waste found

013 9018 86001

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NTDC OWNER NAVY

LOCATION S7-4 W.O. NUMBER 9522-20005

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER ~~8~~ 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garbert & Sons DRILLING METHOD Auger

DRILLER B. Stoudt LOG BY PDB DATE DRILLED 5/2/90

SKETCH MAP

Site 7

See Site Map

NOTES Start 2:15 Finished 2:40

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	~~SAMPLE NUMBER~~ HNU	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1	OL		ND		0-3" Baseball Fill
2			ND		3"-1' Olive clayey silt (OL)
3	CL		ND		1'-5' Yellow-brown silty clay (CL)
4			ND		5'-10' Red silty clay (CL)
5			ND		
6	CL		ND		
7			ND		
8			ND		Boring depth → 10'
9			ND		
10			ND		
					Material is native stockton
					NO Waste Found

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER NAVY

LOCATION S7-5 W.O. NUMBER ~~[illegible]~~ 9522-20005

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. 8' 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD Auger

DRILLER B. Stoudt LOG BY PDB DATE DRILLED 5/2/90

SKETCH MAP

Site 7

see Site Map

NOTES Started 2:40 Finished 2:55

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER (HNU)	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1	OL		ND		0 - 4" Brown organic silt (OL)
2	CL		ND		4" - 4' Yellow-brown silty clay (CL)
3			ND		appears mottled at ground 4'
4			ND		4' - 8' Yellow fine sand (SM)
5	SM		ND		8' - 9' Olive-yellow sandy silt (LM)
6			ND		9' - 10' Weathered arkose
7			ND		
8			ND		
9	LM		ND		
10			ND		Boring depth → 10'

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER NAVY

LOCATION S7-6 W.O. NUMBER 9522-20005

WELL NUMBER N/A TOTAL DEPTH 10 DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. NONE 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY CS GARBER DRILLING METHOD AUGER

DRILLER BARRY STOUDT / KEVIN NUZER LOG BY JETI WARSI DATE DRILLED 5/3/90

SKETCH MAP

SITE SEVEN (SEE MAP) BACKYARD OF INERTIAL REFER. BUILDING

NOTES 10:40 START 10:55 FINISH

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER (HW)	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING) Unified Soil classif system
1			ND		0'-3 DARK BROWN SILT (ML) (DAMP)
2					
3					3'-7' LIGHTER BROWN FINE SAND AND SILT WITH PEBBLE SIZED PIECES OF WEATHERED ARKOSIC GRAVEL (SC w/ gravel) DAMP
4					
5					
6					
7					
8					
9			ND		7'-10 MAROON - RED SAND, WET (SM/SP)
10					

NO WASTE ENCOUNTERED

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LO

PROJECT: NADC | OWNER: NAVY

LOCATION: S7-7 | W.O. NUMBER: 9522-20005

WELL NUMBER: N/A | TOTAL DEPTH: 10' | DIAMETER: 8"

SURFACE ELEV.: N/A | WAT. LEV.: INIT.: NONE | 24-HRS: N/A

SCREEN: DIA.: N/A | LENGTH: N/A | SLOT SIZE: N/A

CASING: DIA.: N/A | LENGTH: N/A | TYPE: N/A

DRILLING COMPANY: C.S. GARBER | DRILLING METHOD: AUGER

DRILLER: BARRY STOUT KEVIN KUZER | LOG BY: JEFF WALSH | DATE DRILLED: 5/3/90

SKETCH MAP

SEE SITE 7 MAP

IN BACKYARD OF INERTIAL REF BUILDING

NOTES: START 11:15 FINISH ~11:35

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER (HNu)	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
					Unified Soil classif system ( )
1			ND		0'-2½' DARK BROWN SILT (ML).
2					2½'-7 LIGHT BROWN FINE SAND AND SILT (SC).
3					
4					5'-7' SAME WITH PIECES OF weathered ARKOSE PEBBLE SIZED
5					
6					
7					
8					7'-10' BROWN SAND WITH SOME SILT (SM)
9			ND		
10					
					NO WASTE DETECTED

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER NAVY

LOCATION S7-8 W.O. NUMBER 9522-20005

WELL NUMBER N/A TOTAL DEPTH 10' DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. NONE 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY CS GARBER DRILLING METHOD AUGER

DRILLER ~~CS GAR~~ LOG BY JEFF WASIL DATE DRILLED 5/3/90

SKETCH MAP

SEE SITE #7 MAP

IN BACKYARD OF INERTIAL REFERENCE BUILDING

NOTES START 10:50 FINISH ~11:15

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1			ND		0'-1' DARK BROWN SILT (OL)
2					1'-5' ORANGE/BROWN SILT AND CLAY (ML).
3					
4					@ 5' A GRADATIONAL BOUNDARY
5					
6					5.0 - 6.0' MODERATELY BROWN SILT AND CLAY (ML).
7					
8					6.0 - 10.0' MODERATELY BROWN SAND WITH SILT. (SM)
9					
10			ND		
					NO WASTE DETECTED. Bottom of Boring = 10'

PAGE ___ OF ___

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER NAVY

LOCATION S7-9 W.O. NUMBER 9522-20005

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD Auger

DRILLER B. Stoudt LOG BY PDB DATE DRILLED 5/2/90

SKETCH MAP

Site 7

See Site Map

NOTES Started 11:15
Finished 11:30

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	~~SAMPLE NUMBER~~ HNU	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1	OL		ND		0-4" Brown organic silt (OL)
2			ND		4'-4.5' Orange-brown clayey silt (ML)
3	ML		ND		4.5-10' Maroon-red sandy silt (ML)
4			ND		
5			ND		
6			ND		
7			ND		
8	ML		ND		
9			ND		
10			ND		Boring depth → 10'

Material appeared to be native Stockton.

Possible waste: Several blain-red rock fragments were seen. These may be weathered bedrock fragments or some waste.

(-Subsequent drilling in this locale failed to identify a similar occurrence. 5/4/90

PAGE ___ OF ___

013 9018 86001

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER NAVY

LOCATION S7-10 W.O. NUMBER ~~N/A~~ 9522-20005

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Garber & Sons DRILLING METHOD Auger

DRILLER B. Stoudt LOG BY PDB DATE DRILLED 5/2/90

SKETCH MAP

Site 7

See Site Map

NOTES Start 10:50 Finish 11:15

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	HNU SAMPLE NUMBER	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1	OL		ND		0-4" Brown organic silt (OL)
2	ML		ND		4"-4' Orange-brown m-grained silt (ML)
3			ND		4'-7' Maroon red sandy silt (ML)
4			ND		Fragments of what may be weathered bedrock.
5			ND		
6	ML		ND		7'-8' Red-brown clayey silt (ML)
7			ND		8'-9' Maroon-red m silt (ML)
8	ML		ND		
9	ML		ND		Boring depth → 9'
10			ND		
					Material appeared to be native stockpiled soil
					PDB 5/9/90
					No Waste Found
					PDB 5/9/90
					Some white rock-like ~~(cement?)~~ fragments. Possibly could be weathered arkosic SS bedrock
					(White fragments were arkosic SS. 5/9/90)

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER NAVY

LOCATION 97-11 W.O. NUMBER ~~N/A~~ 9522-20005

WELL NUMBER N/A TOTAL DEPTH N/A DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. None 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY Gariboldi Sons DRILLING METHOD Auger

DRILLER B. Houdt LOG BY PDB DATE DRILLED 5/2/90

SKETCH MAP

Site 7

See Site Map

NOTES Start 10:35 Fin. 10:50

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER HNU	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1	OL		ND		0 - 1' Brown organic silt (OL)
2	ML		ND		1' - 3' Lt. brown clayey silt (ML)
3			ND		3' - 6' Maroon-red medium grained silt (ML)
4	ML		ND		Many weathered bedrock (red siltstone) fragments
5			ND		
6			ND		6' - 10' Maroon-red silty clay (CL)
7	CL		ND		
8			ND		
9			ND		
10			ND		Boring depth → 10'

Material appeared to be native Stockton

NO Waste Found

PAGE ___ OF

013 9018 86001

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NMOC OWNER NAVY

LOCATION S7-12 W.O. NUMBER 9522-20005

WELL NUMBER N/A TOTAL DEPTH 10' DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. NONE 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY CS GARBER DRILLING METHOD AUGER

DRILLER ~~JEFF~~ BARRY STANDI / KEVIN KUZER LOG BY JEFF WARSH DATE DRILLED 5/3/90

SKETCH MAP SEE SITE MAP SEVEN NEXT TO S7-9 20' SW from S7-9

NOTES 12 30 start 12 50 finish

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER	BLOW COUNT/ RQD/% REC.	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
					Unified Soil class. syst. ( )
1			ND		0' - 1½' DARK BROWN SILT (OL)
2					
3					1½ - 4' LIGHT BROWN SILT AND CLAY (ML)
4					4' - 10' BROWN SAND (SM) (DAMP)
5					
6					
7					
8					
9					
10			ND		
					NO WASTE DETECTED
					NO BLACK SOIL

PAGE 1 OF 1

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER NAVY

LOCATION S7-13 W.O. NUMBER 9522-20005

WELL NUMBER N/A TOTAL DEPTH _____ DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. _____ 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

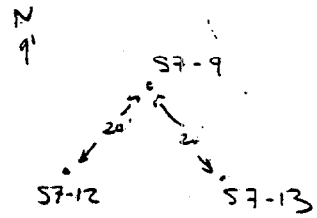
CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY CS GARBER DRILLING METHOD AUGER

DRILLER Barry STOUDT Kevin Kuzer LOG BY JEFF WALSH DATE DRILLED 5/3/90

SKETCH MAP

SEE SITE 7 map.



NOTES START - 12:50

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER (HNU)	BLOW COUNT/ RQD/% REC.	Unified Soil classif system ( ) DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1			ND		0'-1' DARK BROWN SILT (ML)
2					1'-6' GRADATIONAL change
3					TO Light BROWN SILT
4					AND CLAY; MICACEOUS (ML)
5					6'-9 DARK MAROON-BROWN SAND
6					AND SILT w/
7					PEBBLE SIZED PIECES
8					OF DARK PURPLE siltstone
9					9'-10' weathered dark purple
10			ND		siltstone
					NO waste material
					NO "Black" soil.

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NAVOC OWNER NAVY

LOCATION S7-14 W.O. NUMBER 9522-20005

WELL NUMBER N/A TOTAL DEPTH 10' DIAMETER 8"

SURFACE ELEV. N/A WAT. LEV.: INIT. NONE 24-HRS N/A

SCREEN: DIA. N/A LENGTH N/A SLOT SIZE N/A

CASING: DIA. N/A LENGTH N/A TYPE N/A

DRILLING COMPANY C.S GARBER DRILLING METHOD AUGER

DRILLER BARRY STOUT / Kevin Luzer LOG BY JEFF WALSH DATE DRILLED 5/3/90

SKETCH MAP

DIRECTLY ADJACENT TO S7-9

NOTES Felt natural "Black" soils This boring will reconfirm this

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER	BLOW COUNT/ RQD/% REC.	Unified Soil Classif. system DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1			ND		0'-2' DARK BROWN SILT
2					
3					2'-5' LIGHT BROWN SILT
4					& CLAY w/ DK PURPLE SILTSTONE GRAVEL
5					@ 5' gradational
6					Boundary.
7					
8					5'-10' DARK BROWN fine sand
9					and SILT w/
10			ND		PIECES OF DARK
					PURPLE SILTSTONE
					NO WASTE detected
					NO "Black" soils
					DETECTED

PAGE 1 OF 1

APPENDIX B-2

SUMMARY OF CONFIRMATION BORING RESULTS

TABLE 5-4

CONFIRMATION SOIL BORING SUMMARY
RI STAGE I

NADC WARMINSTER, PA

Abbreviations:
F = Suspected Fill
GL = Glass
CI = Cinders
T = Trash
W = Wood Fragments
M = Pieces of Metal
C = Pieces of Ceramics
B = Brick Fragments

Boring #	Location	Depth	Waste Encountered	PID (ppm)	Observations
S1-1	Site 1	0-10'	None	ND	Soil slightly damp
S1-2	Site 1	0-10'	None	ND	
S1-3	Site 1	0-10'	None	ND	
S1-4	Site 1	0-10'	None	ND	
S1-5	Site 1	0-7.5'	None	ND	Hit competent bedrock at 7.5'
S1-6	Site 1	0-6.5'	F	ND	
S1-7	Site 1	0-3'	None	ND	
		3-5'	F	ND	
		5-9'	None	ND	Hit competent bedrock at 9'
S1-8	Site 1	0-6.5'	None	ND	
		6.5-7'	CI	ND	
		7-10'	None	ND	
S1-9	Site 1	0-8'	None	ND	Hit competent bedrock at 8'
S1-10	Site 1	0-8'	None	ND	Hit competent bedrock at 8'
S1-11	Site 1	0-5'	F, CI	ND	
		5-10'	None	ND	
S1-12	Site 1	0-6'	F, CI	ND	
		6-10'	None	ND	
S1-13	Site 1	0-2'	F, GL, CI	ND	
		2-10'	GL, CI	ND	
S1-14	Site 2	0-5'	CI	ND	Hit competent bedrock at 7'
		5-7'	None	ND	
S1-15	Site 2	0-4.5'	F, CI, GL	ND	
		4.5-8'	CI, C	ND	
		8-10'	None	ND	
S1-16	Site 2	0-5'	F	ND	
		5-10'	C, CI, F	ND	
S1-17	Site 2	0-6'	F, GL, CI	ND	Abundant glass
		6-10'	None	ND	
S1-18	Site 2	0-7'	I, M	ND	Hit competent bedrock at 7'

TABLE 5-4 (CONT.)

CONFIRMATION SOIL BORING SUMMARY
RI STAGE I

NADC WARMINSTER, PA

Boring #	Location	Depth	Waste Encountered	PID (ppm)	Observations
S1-19	Site 2	0-2'	W	ND	Hit competent bedrock at 9'
		2-6'	F	ND	
		6-9'	None	ND	
S1-20	Site 2	0-10'	CI	ND	
S1-21	Site 2	0-7'	None	ND	
		7-10'	CI, B	ND	
S1-22	Site 2	0-3'	None	ND	
		3-5'	F, GL	ND	
		5-6'	M	ND	
		6-10'	F, CI	ND	
S1-23	Site 2	0-4"	GL	ND	Soil was damp at 9'
		4"-7'	CI	ND	
		7-9'	F, CI, M	ND	
		9-10'	F	ND	
S1-24	Site 2	0-6'	F	ND	Soil was damp at 9'
		6-8'	CI	ND	
		8-10'	W, C, GL	ND	
S1-25	Site 2	0-7'	F	2-5	
		7-10'	CI, W	ND	
S1-26	Site 2	0-4'	F, M	ND	Soil was wet below 7'
		4-7'	F, CI	1-10	
		7-10'	F,	4	
S1-27	Site 1	0-3'	CI	ND	Soils were damp
		3-10'	None	ND	
S1-28	Site 2	0-10'	None	ND	
S2-1	Site 2	0-2'	F	ND	
		2-7'	CI, M, B, GL	ND	
		7-10'	None	ND	
S2-2	Site 2	0-1'	F	ND	Fill from 0-1' is part
		1-6'	None	ND	of the parking lot
S3-1	Site 3	0-8'	F, CI, C, B, M	1-2	Auger refusal at 8.5'
		8-8.5'	M	ND	
S3-2	Site 3	0-10'	F	ND	
S3-3	Site 3	0-5'	F	2-15	
		5-10'	F, W, GL	5-20	

TABLE 5-4 (CONT.)

CONFIRMATION SOIL BORING SUMMARY
RI STAGE I

NADC WARMINSTER, PA

Boring #	Location	Depth	Waste Encountered	PID (ppm)	Observations
S3-4	Site 3	0-3'	F	ND	Soil was wet at 9'
		3-6'	F, W, CI, GL	ND	
		6-10'	F, CI	ND	
S3-5	Site 3	0-6'	F	1	
		6-10'	F, W	ND	
S3-6	Site 3	0-9'	F	ND	
		9-10'	None	ND	
S3-7	Site 3	0-7'	F	ND	
		7-10'	None	ND	
S4-1	Site 4	0-9'	F	ND	One plastic bag at 5'
		9-10'	None	ND	
S4-2	Site 4	0-7'	None	ND	Hit competent bedrock at 7'
S4-3	Site 4	0-3'	F	ND	
		3-10'	None	ND	
S4-4	Site 4	0-6'	F	ND	
		6-10'	None	ND	
S4-5	Site 4	0-8'	None	ND	Hit competent bedrock at 8'
S4-6	Site 4	0-5'	None	ND	Hit competent bedrock at 5'
S4-7	Site 4	0-3'	F	ND	
		3-5'	W	ND	
S4-8	Site 4	0-6"	F	ND	
		6"-10'	None	ND	
S4-9	Site 4	0-10'	None	ND	
S4-10	Site 4	0-10'	None	ND	
S4-11	Site 4	0-5'	F	ND	
		5-6'	None	ND	
S4-12	Site 4	0-3'	F	ND	
		3-5'	M, T	ND	
S4-13	Site 4	0-3'	F	ND	
		3-5'	W, M, GL, T	ND	
S5-1	Site 5	0-3'	F	ND	Hit water at 4'
		3-6'	F, M	1-10	Auger refusal at 6'
S5-2	Site 5	0-4'	None	ND	Auger refusal at 4'
S5-3	Site 5	0-5'	F	ND	
		5-10'	None	ND	

TABLE 5-4 (CONT.)

CONFIRMATION SOIL BORING SUMMARY
RI STAGE I

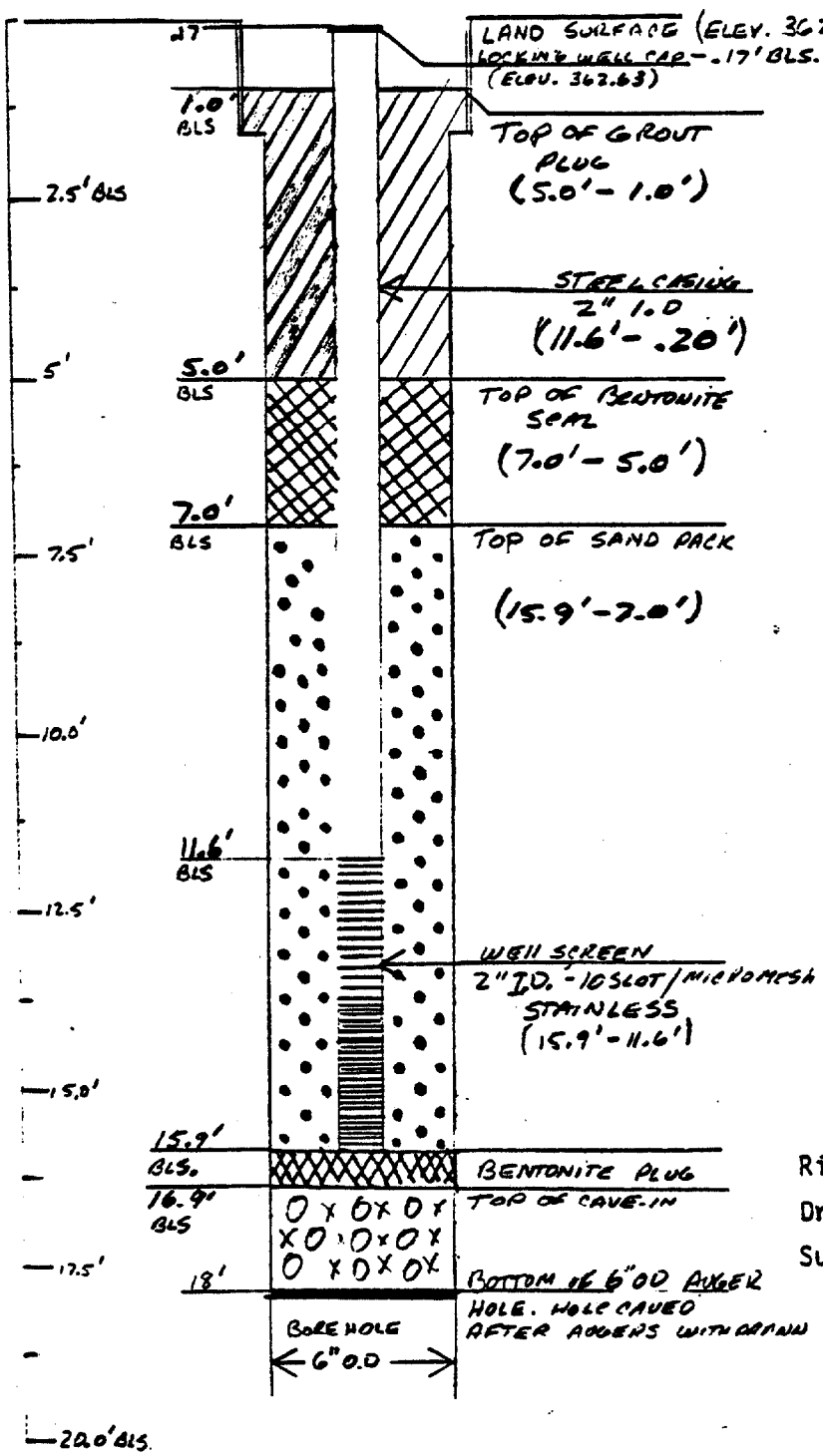
NADC WARMINSTER, PA

Boring #	Location	Depth	Waste Encountered	PID (ppm)	Observations
S5-4	Site 5	0-1'	GL	ND	Auger refusal at 7'
		1-4'	W, GL	ND	
		4-7'	None	ND	
S5-5	Site 5	0-6'	F	ND	
		6-8'	None	ND	
		8-10'	F	1-15	
S5-6	Site 5	0-4'	F, M	ND	
		4-10'	None	ND	
S5-7	Site 5	0-5'	F, GL, M	ND	
		5-10'	None	ND	
S5-8	Site 5	0-5'	F	ND	
		5-10'	None	ND	
S5-9	Site 5	0-6'	F, M, W	ND	Hit water at 4.5'
		6-10'	None	ND	
S5-10	Site 5	0-7'	F	ND	
		7-10'	None	ND	
S7-1	Site 7	0-4'	F	ND	
		4-7'	None	ND	Hit competent bedrock at 7'
S7-2	Site 7	0-6'	None	ND	Hit competent bedrock at 6'
S7-3	Site 7	0-10'	None	ND	
S7-4	Site 7	0-10'	None	ND	
S7-5	Site 7	0-10'	None	ND	
S7-6	Site 7	0-10'	None	ND	
S7-7	Site 7	0-10'	None	ND	
S7-8	Site 7	0-10'	None	ND	
S7-9	Site 7	0-10'	None	ND	
S7-10	Site 7	0-9'	None	ND	Hit competent bedrock at 9'
S7-11	Site 7	0-10'	None	ND	
S7-12	Site 7	0-10'	None	ND	
S7-13	Site 7	0-10'	None	ND	
S7-14	Site 7	0-10'	None	ND	

APPENDIX B-3

PREVIOUS INVESTIGATION MONITORING WELL BORINGS

AS-BUILT DRAWING



CHECKLIST

Land Surface Elevation 362.8'

Casing Height Above L-S -.17'

Total Depth BORE HOLE (OPEN) 15.9

Borehole Diameter 6" OD

Casing Diameter 2" ID

Casing Thickness N/A

Casing Lengths 8.4'

Screen Data

- Material STAINLESS
- Diameter 2" ID
- Slot Openings 10 SLOT/MM.
- Settings 11.6' - 15.9' BLS

Centralizers NONE

Grout Type PORTLAND

Gravel Pack [illegible]

K-Fittings NONE

Packers NONE

Cement Baskets NONE

Rig Type MOBILE B-56.

Driller LARRY CISLER - SCI

Supervisory Geologist ED TOKARSKI - JRB.

Well No. BG-1

Project NADC - WARMINSTER

Location SOUTH OF AIRFIELD - UPGRAD. OF SITE #6.

Date DRILLED 7/17/82

Prepared By: E. TOKARSKI 10/4/82

Scale: 1 INCH = 2.5 FEET

JRB-600/03-6

JRB ASSOCIATES, INC.
8400 Westpark Drive, McLean, Virginia 22102

WELL LOG

PROFILE	DESCRIPTION
0	LAND SURFACE
	TOP SOIL / VEGETATION
1	
2	
3	YELLOW BROWN - STIFF LOAM TO SANDY LOAM MOIST
4	
5	
6	SPLIT SPOON 5'-6.5' 6" = 5/8/9
7	
8	COLOR CHANGE 7' BLS. RED-BROWN TO DARK BROWN - SANDY LOAM.
9	
10	
11	SPLIT SPOON 10'-11.5' 6" = 12/21/30
12	
13	RED-BROWN HARD WEATHERED SHALE. SHALE FRAGMENTS IN CUTTINGS.
14	
15	SPLIT SPOON 15'-15.25' 45/25'
16	
17	
18	AUGER REFUSAL.
19	
20	

PROJECT NADC WARMINSTER, PA

OWNER NAVAL AIR DEVELOPMENT CENTER

WELL NO. BG-1

LOCATION SOUTH OF AIRFIELD UPGRADIENT SITE NO. 6

	Date	Time
DRILLING STARTED	7/17/82	~~0710~~ 0925
DRILLING COMPLETED	7/17/82	~~0820~~ 1115

DRILLER LARRY CISLER

GEOLOGIST ED TOKARSKI JRB

RIG TYPE MOBILE B-56.

REFERENCE POINT LAND SURFACE

R.P. ELEVATION 362.8 (SURVEYED)

TOPO POSITION FLAT LYING

PROFILE BY ED TOKARSKI

FIELD BOOK NO. 1 PAGES 42-43

WELL DATA

HOLE DIAMETER 6" O.D.

HOLE DEPTH 18'

CASING DIAMETER 2" I.D.

CASING LENGTH 8.4'

SCREEN DIAMETER 2" I.D.

SCREEN SETTING 11.6' - 15.9' BLS.

SCREEN SLOT/TYPE 10-SLOT / MICROMESH (2.15'/2..
STAINLESS STEEL - (JOHNSON)

PUMP TEST DATA

STATIC DEPTH TO WATER DRY HOLE

DATE MEASURED 7/25/82 // 9/8/82

PUMPING DEPTH TO WATER —

TEST DURATION —

PUMPING RATE —

TEST DATE —

TEST TYPE —

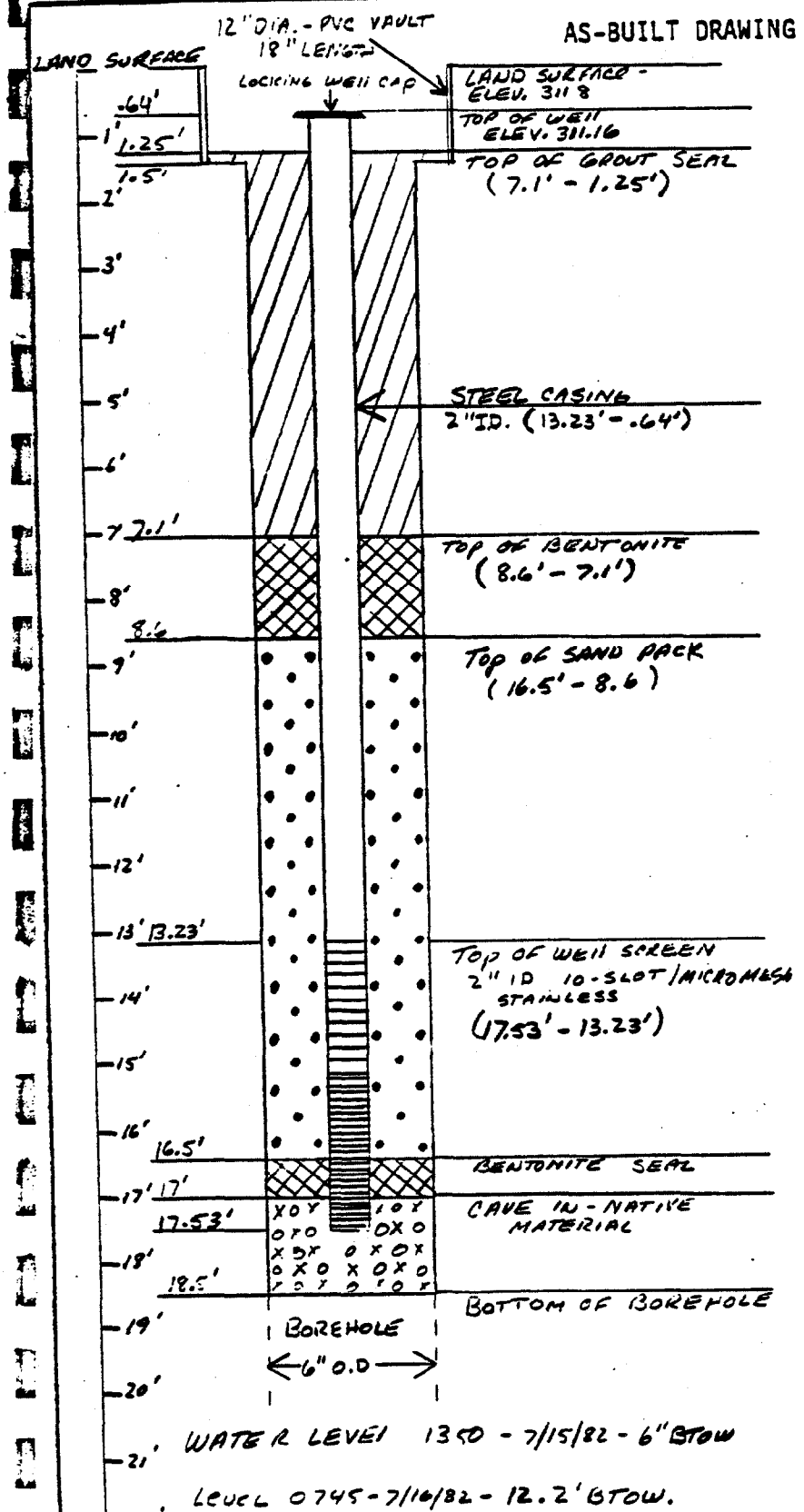
PUMP SETTING —

SPECIFIC CAPACITY —

REMARKS

MOTTLING IN SECTIONS OF SPLIT SPOON SHOW EVIDENCE OF WATER DURING WETTER PERIODS

AS-BUILT DRAWING



CHECKLIST

Land Surface Elevation 311.8

Casing Height Above L-S -.64'

Total Depth Borehole (open) - (18.0')

Borehole Diameter 6" O.D.

Casing Diameter 2" I.D.

~~Casing Thickness~~

Casing Lengths 12.59'

Screen Data

- Material STAINLESS
- Diameter 2" I.D.
- Slot Openings 10 SLOT/MM
- Settings 17.53' - 13.23

~~Centralizers~~

Grout Type PORTLAND

Gravel Pack SILICA.

~~K-Fittings~~

~~Packers~~

~~Cement Baskets~~

Rig Type MOBILE B-56

Driller LARRY CISLER - SCI

Supervisory Geologist ED TOKARSKI - JRB

Prepared By: ED TOKARSKI 10/5/82

Scale: AS SHOWN

Well No. BG-3

Project NADC - WARMINSTER, PA

Location NE CORNER PARKING LOT NO. 2. UPGRAD SITES #1, 2, 3.

Date Drilled 7/14 - [redacted].

JRB-600/03-b

JRB ASSOCIATES, INC.
8400 Westpark Drive, McLean, Virginia 22102

WELL LOG

PROFILE	DESCRIPTION
0–1	LITTLE VEGETATION SOME FILL AT TOP 6" RED BROWN STIFF SILTY CLAY SOME HARD SANDSTONE FRAGMENTS. DRY.
2–3	
4–5	VERY HARD SANDSTONE DRY-
6	SPLIT SPOON 5'-6.5' 6"=25/17/11
7–8	VERY HARD BROWN SANDSTONE RED WITH CHANGE TO GRAY BETWEEN 7'-8' BLS. SOME SILTY CLAY
9–10	
11	SPLIT SPOON 10'-11.5' 6"= 50/72/71
12	WATER 12' BLS
13	SPLIT SPOON 12.5'-14' 6"= 15/50/60
14–15	RED BROWN VERY HARD SANDSTONE. COARSE TO FINE GRAINED. SOME SILT AND LITTLE CLAY. WET.
16	
17	VERY HARD SANDSTONE LITTLE SAND - MANY FRAGMENTS
18	SPLIT SPOON 18' 50/0
	AUGER REFUSAL
19–20	

PROJECT NADC WARMINSTER, PA

OWNER NAVAL AIR DEVELOPMENT CENTER

WELL NO. BG-3

LOCATION NE CORNER PARKING LOT #2. UPGRADIENT SITES ~~#~~ #'s 1, 2, 3

	Date	Time
DRILLING STARTED	7/14/82	0805
DRILLING COMPLETED	7/14/82	1557

DRILLER LARRY CISLER SCI

GEOLOGIST ED TOKARSKI JRB

RIG TYPE MOBILE B-56.

REFERENCE POINT LAND SURFACE

R.P. ELEVATION ~~LAND~~ 311.8

TOPO POSITION FLAT LYING - CORNER PARKING LO

PROFILE BY ED TOKARSKI

FIELD BOOK NO. 1 PAGES 31-35.

WELL DATA

HOLE DIAMETER 6" O.D.

HOLE DEPTH 18.5'

CASING DIAMETER 2" I.D.

CASING LENGTH 12.59'

SCREEN DIAMETER 2" I.D.

SCREEN SETTING 17.53'-13.23'

SCREEN SLOT/TYPE 10-SLOT/MICROMESH (2.15/2.1

STAINLESS STEEL - (JOHNSON)

PUMP TEST DATA

STATIC DEPTH TO WATER 12.2' BTOW.

DATE MEASURED 7/10/82

PUMPING DEPTH TO WATER 12.2' BTOW

TEST DURATION —

PUMPING RATE —

TEST DATE ~~SEE BELOW~~ BAIL TEST. 9/9/82

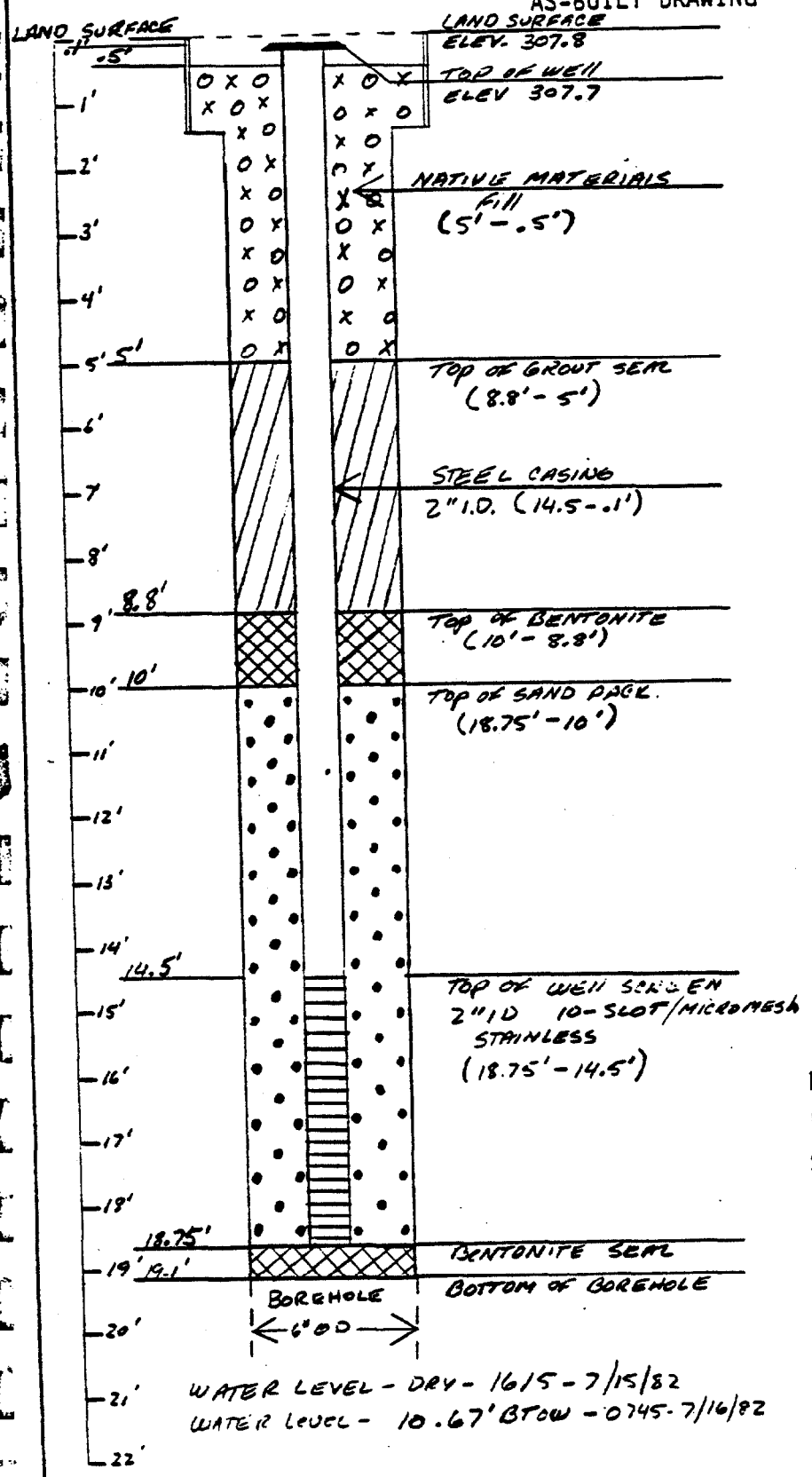
TEST TYPE BAIL

PUMP SETTING 16.5' BTOW

SPECIFIC CAPACITY — SEE BELOW.

REMARKS

AS-BUILT DRAWING



WATER LEVEL - DRY - 1615 - 7/15/82
WATER LEVEL - 10.67' BTOW - 0745 - 7/16/82

Prepared By: ED TOKARSKI 10/5/82

Scale: AS SHOWN

CHECKLIST

Land Surface Elevation 307.8

Casing Height Above L-S -.1

Total Depth 19.1'

Borehole Diameter 6" O.D.

Casing Diameter 2" I.D.

~~Casing Thickness~~ ~~[illegible]~~

Casing Lengths 14.4'

Screen Data

- Material STAINLESS
- Diameter 2" I.D.
- Slot Openings 10 SLOT/MM
- Settings 18.75' - 14.5'

~~Centralizers~~

Grout Type PORTLAND

Gravel Pack SILICA.

~~K-Fittings~~

~~Packers~~

~~Cement Baskets~~

Rig Type MOBILE B-56

Driller LARRY CISLER - SCI

Supervisory Geologist ED TOKARSKI - JRB

Well No. DG-1

Project NADC - WARMINSTER, PA

Location NW. CORNER OF BASE.
~~[illegible]~~ NE OF WATER TREAT. PLANT. DOWNGRAD #1

Date Drilled 7/14 - 7/15/82

JRB ASSOCIATES, INC.
8400 Westpark Drive, McLean, Virginia 22102

WELL LOG

PROFILE	DESCRIPTION
0	GRASS/VEGETATION - TOPSOIL.
1	
2	RED BROWN SILTY CLAY. DRY. FEW SANDSTONE FRAGMENTS.
3	
4	
5	
6	SPLIT SPOON 5'-6.5' 6"= 7/11/34
7	
8	ALMOST CONTINUOUS SANDSTONE. WEATHERED. ALTERNATING HARD TO SOFT LAYERS. RED BROWN VERY DRY TO MOIST AT 12'
9	
10	SPLIT SPOON 10'-10.3' 87/.3'
11	
12	SPLIT SPOON 12.5'-12.6' 30/.1'
13	
14	
15	
16	
17	
18	
19	AUGER REFUSAL.
20	

PROJECT NADC WARMINSTER, PA

OWNER NAVAL AIR DEVELOPMENT CENTER

WELL NO. DG-1

LOCATION NW CORNER BASE. NE WATER TREATMENT PLANT. DOWNGRADIENT SITE #1

	Date	Time
DRILLING STARTED	7/14/82	1205-1500.
DRILLING COMPLETED	7/15/82	1335-1630.

DRILLER LARRY CISLER.

GEOLOGIST ED TOKARSKI JRB

RIG TYPE MOBILE B-56.

REFERENCE POINT LAND SURFACE

R.P. ELEVATION 307.8

TOPO POSITION FLAT LYING

PROFILE BY ED TOKARSKI

FIELD BOOK NO. 1 PAGES 32-39

WELL DATA

HOLE DIAMETER 6" O.D.

HOLE DEPTH 19.1'

CASING DIAMETER 2" I.D.

CASING LENGTH 14.6'

SCREEN DIAMETER 2" I.D.

SCREEN SETTING 18.75'-14.5'

SCREEN SLOT/TYPE 10-SLOT/MICROMESH (2.15/2.1
STAINLESS STEEL - (JOHNSON)

PUMP TEST DATA

STATIC DEPTH TO WATER 10.67' BGW 7/16/82

DATE MEASURED 7/16/82.

PUMPING DEPTH TO WATER 10.67' BGW.

TEST DURATION —

PUMPING RATE —

TEST DATE 9/9/82

TEST TYPE BAIL TEST

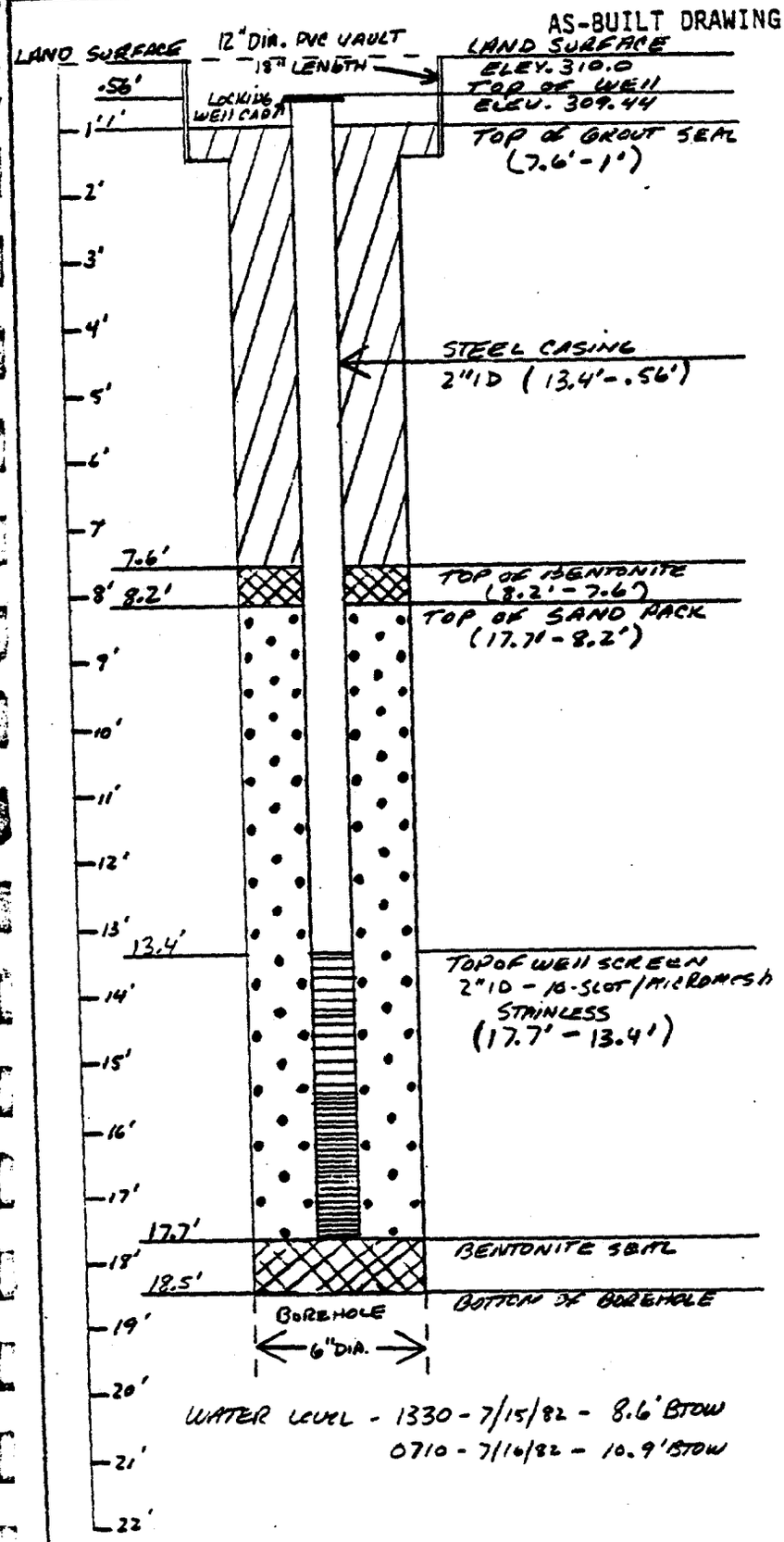
PUMP SETTING 18.5'

SPECIFIC CAPACITY — SEE ~~BAIL~~ REPO

REMARKS

ORIGINAL DG-1 BOREHOLE GROUTED UP AFTER CONSTANT CAVE IN AT 12.5'. PIPE WRENCH LOST IN HOLE WHILE GROUTING. NEW DG-1 BOREHOLE 10 FT WEST OF OLD BOREHOLE - SAME PROFILE.

AS-BUILT DRAWING



WATER LEVEL - 1330 - 7/15/82 - 8.6' BTOW
0710 - 7/16/82 - 10.9' BTOW

Prepared By: ED TOKARSKI 10/5/82

Scale: AS SHOWN

CHECKLIST

Land Surface Elevation 310.0

Casing Height Above L-S (-.56)

Total Depth 18.5'

Borehole Diameter 6" O.D.

Casing Diameter 2" I.D.

~~Casing Thickness~~

Casing Lengths 12.84'

Screen Data

Material STAINLESS
Diameter 2" I.D.
Slot Openings 10 SLOT/MM
Settings 17.7'-13.4'

~~Centralizers~~

Grout Type PORTLAND

Gravel Pack SILICA.

~~K-Fittings~~

~~Packers~~

~~Cement Baskets~~

Rig Type MOBILE B-56

Driller LARRY CISLER - SCI

Supervisory Geologist ED TOKARSKI - JRB

Well No. DG-2

Project NADC - WARMINSTER, PA

Location ~~NW~~ NE OF PARKING LOT #4 ALONG STREAM - DOWNGRADIENT SITE

Date Drilled 7/15/82

JRB ASSOCIATES, INC.
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WELL LOG

PROFILE	DESCRIPTION
0	GRASS/VEGETATION - TOPSOIL
1	ASPHALT FILL W GRAVEL
2	
3	
4	SOME FILL MATERIAL STIFF BROWN SANDY CLAY NO ODOR DRY
5	
6	SPLIT SPOON 5'-6.5' 6"=4/12/11
7	
8	BROWN SILTY CLAY - DRY TO MOIST
9	WATER 9'
10	RED - BROWN SANDY LOAM MOIST TO WET SOME GRAY SOME ORGANIC
11	SPLIT SPOON 10'-11.5' 6"=1/5/1
12	
13	
14	DARK GRAY SANDY LOAM WITH FILL SPLIT SPOON (NOT KEPT) BROUGHT UP WOOD FROM 13.5' BLS NO METAL
15	SPLIT SPOON. 15'-15.15' 50/.15'
16	
17	
18	SPLIT SPOON 18'-18.5' 72/.5'
19	AUGER REFUSAL
20	

PROJECT NADC WARMINSTER, PA

OWNER NAVAL AIR DEVELOPMENT CENTER

WELL NO. DG-2

LOCATION NE OF PARKING LOT #2 AROUND. STREAM DOWNGRADIENT SITE #2

	Date	Time
DRILLING STARTED	7/15/82	0930
DRILLING COMPLETED	7/15/82	1300

DRILLER LARRY CISLER SCI.

GEOLOGIST ED TOKARSKI JRB

RIG TYPE MOBILE B-56.

REFERENCE POINT LAND SURFACE

R.P. ELEVATION 310.0 SURVEYED

TOPO POSITION FLAT LYING AT EDGE OF SLOPE

PROFILE BY E TOKARSKI

FIELD BOOK NO. 1 PAGES 36 - 37

WELL DATA

HOLE DIAMETER 6" O.D.

HOLE DEPTH 18.5'

CASING DIAMETER 2" I.D.

CASING LENGTH 12.84'

SCREEN DIAMETER 2" I.D.

SCREEN SETTING 17.7' - 13.4'

SCREEN SLOT/TYPE 10-SLOT / MICROMESH (2.15/2.15 STAINLESS STEEL - (JOHNSON)

PUMP TEST DATA

STATIC DEPTH TO WATER	9.95	10.27
DATE MEASURED	7/25/82	9/9/82
PUMPING DEPTH TO WATER	SAME	
TEST DURATION	—	
PUMPING RATE	—	
TEST DATE	7/26/82 -	9/9/82

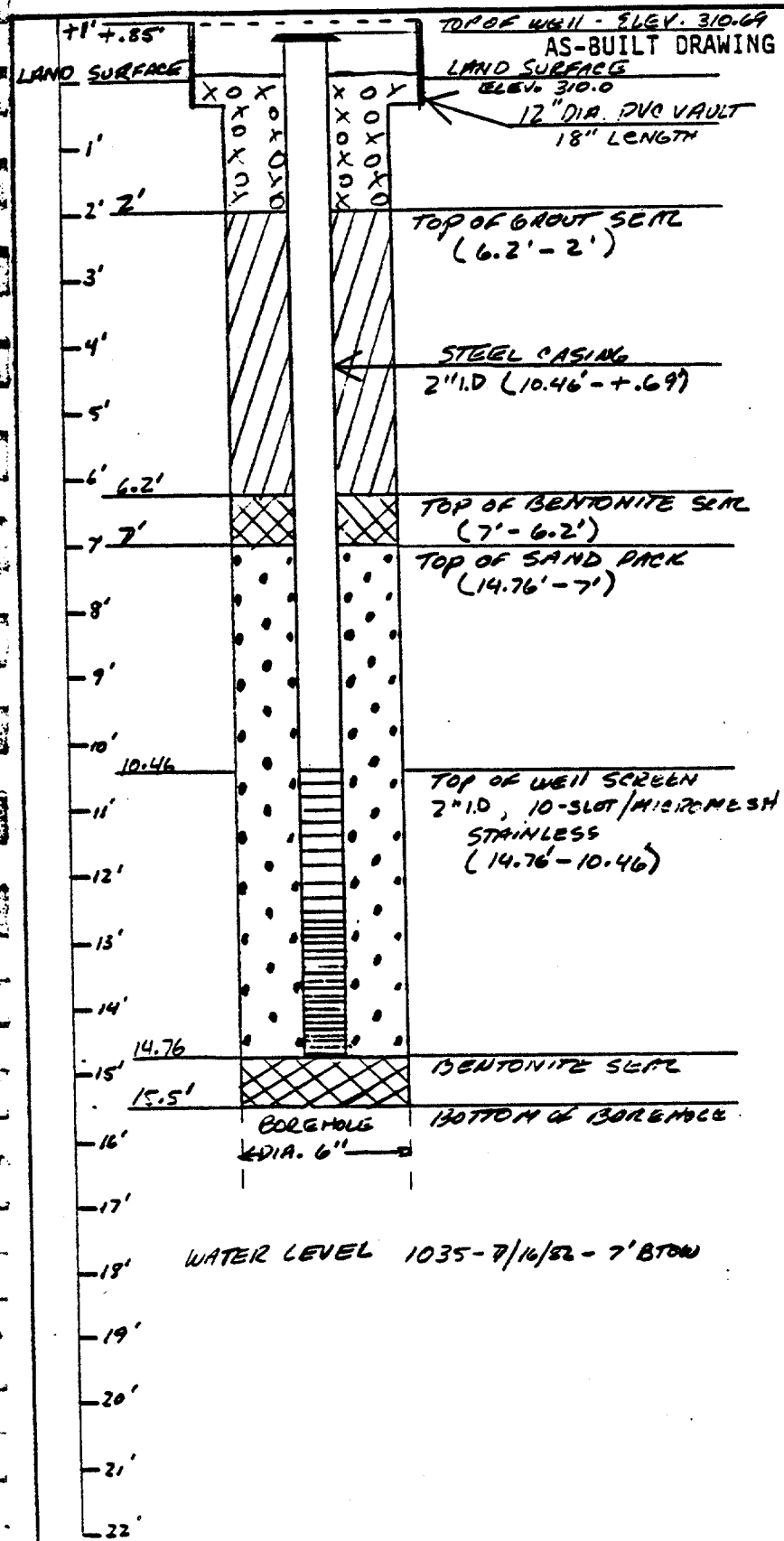
TEST TYPE BAIL TEST

PUMP SETTING 17'

SPECIFIC CAPACITY SEE REPORT

REMARKS

ALTERNATING LAYERS OF GRAY / MOIST FILL MATERIAL WITH WOOD FRAGMENTS NO METAL NO ODOR. START AT 6'. OCCUR AT IRREGULAR INTERVALS TO



CHECKLIST

Land Surface Elevation 310.0

Casing Height Above L-S +.69

Total Depth 15.5'

Borehole Diameter 6" O.D.

Casing Diameter 2" I.D.

~~Casing Thickness~~

Casing Lengths 9.77

Screen Data

- Material STAINLESS
- Diameter 2" I.D.
- Slot Openings 10 SLOT/MM.
- Settings 14.76' - 10.46'

~~Centralizers~~

Grout Type PORTLAND

Gravel Pack SILICA.

~~K-Fittings~~

~~Packers~~

~~Cement Baskets~~

Rig Type MOBILE B-56

Driller LARRY CISLER - SCI

Supervisory Geologist ED TOKARSKI - JRB

Well No. DG-3

Project NADC - WARMINSTER, PA

Location ~~TOP~~ NE OF PARKING LOT #2 - ALONG STREAM - DOWNGRADIENT SITE #3.

Date DRILLED 7/16/82.

Prepared By: ED TOKARSKI 10/5/82

Scale: AS SHOWN

JRB ASSOCIATES, INC.
8400 Westpark Drive, McLean, Virginia 22102

WELL LOG

PROFILE	DESCRIPTION
0	VEGETATION / TOPSOIL
1	
2	FILL MATERIAL - SOME ORGANIC MATERIAL - GRAY - WET
3	
4	
5	
6	SPLIT SPOON 5'-6.5' 6" = 14/14/8
7	MOSTLY GRAY NON-SOIL MATERIAL. NO ODOR - APPEARS TO BE CHEMICAL OR SEWAGE MATERIAL. VERY WET WATER 9'
8	
9	
10	SPLIT SPOON 10'-10.15' 50/.15
11	
12	MOSTLY HARD, RED BROWN SHALE VERY MOIST SOME LAYERS OF VERY WET GRAY MATERIAL.
13	
14	
15	SPLIT SPOON 15' 50/0. AUGER REFUSAL
16	
17	
18	
19	
20	

PROJECT NADC WARMINSTER, PA

OWNER NAVAL AIR DEVELOPMENT CENTER

WELL NO. DG-3

LOCATION NE PARKING LOT #2. ALONG STREAM DOWNGRADIENT OF #3

	Date	Time
DRILLING STARTED	7/16/82	0810
DRILLING COMPLETED	7/16/82	1030

DRILLER LARRY CISLER SCI

GEOLOGIST ED TOLARSIK JRB

RIG TYPE MOBILE B-56.

REFERENCE POINT LAND SURFACE

R.P. ELEVATION 310.0 SURVEYED

TOPO POSITION FLAT LYING

PROFILE BY ED TOLARSIK

FIELD BOOK NO. 2 PAGES 7-41

WELL DATA

HOLE DIAMETER 6" O.D.

HOLE DEPTH 15.5'

CASING DIAMETER 2" I.D.

CASING LENGTH 9.77'

SCREEN DIAMETER 2" I.D.

SCREEN SETTING 14.76' - 10.46'

SCREEN SLOT/TYPE 10-SLOT / MICROMESH (2.15/2.1

STAINLESS STEEL - (JOHNSON)

PUMP TEST DATA

STATIC DEPTH TO WATER 6.93 // 7.13

DATE MEASURED 7/25/82 // 9/9/82

PUMPING DEPTH TO WATER SAME.

TEST DURATION —

PUMPING RATE —

TEST DATE 9/9/82

TEST TYPE BAIL

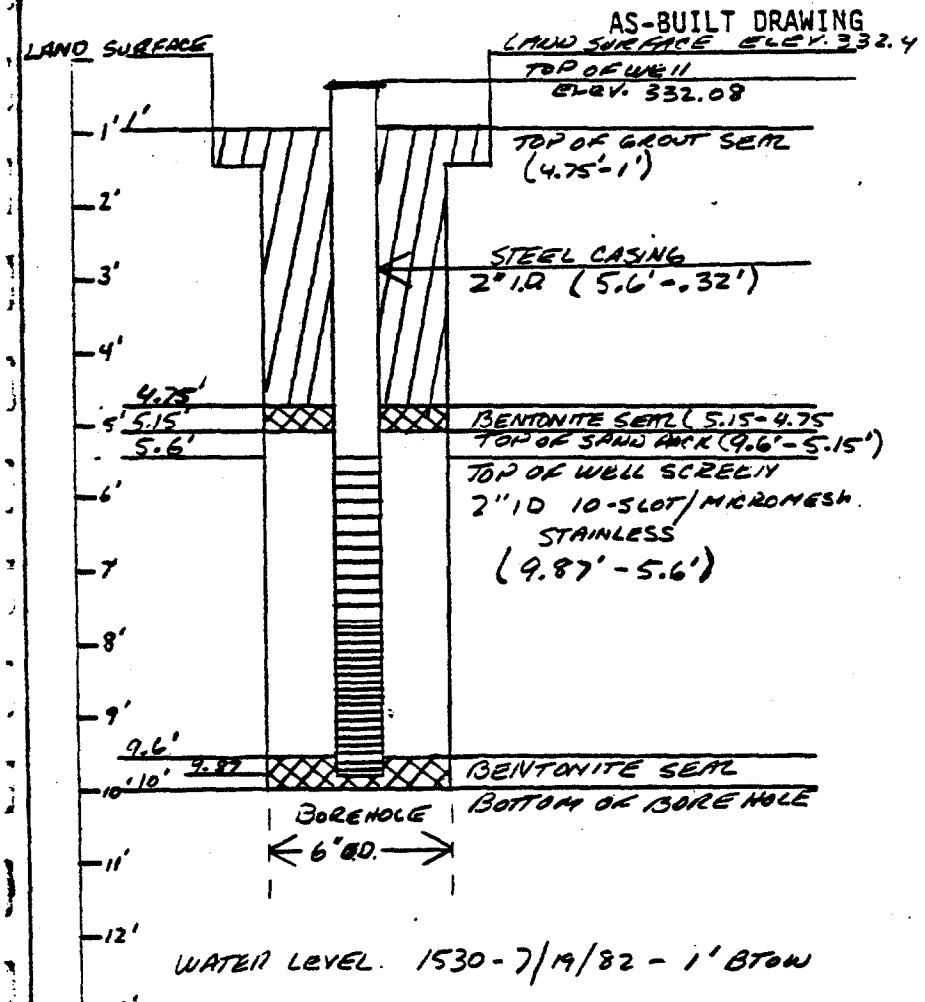
PUMP SETTING 14'

SPECIFIC CAPACITY SEE REPORT

REMARKS

ORGANIC MATERIAL BETWEEN 4'-10'. LOSS WITH WEIGHT 10'-15 MOSTLY SAPROLITIC CLAY

AS-BUILT DRAWING



CHECKLIST

Land Surface Elevation 332.4

Casing Height Above L-S -.32'

Total Depth 10'

Borehole Diameter 6" O.D.

Casing Diameter 2" I.D.

~~Casing Thickness~~

Casing Lengths 5.28'

Screen Data

- Material STAINLESS
- Diameter 2" I.D.
- Slot Openings 10 SLOT/MM
- Settings 9.87-5.6.

~~Centralizers~~

Grout Type PORTLAND

Gravel Pack SILICA.

~~K-Fittings~~

~~Packers~~

~~Cement Baskets~~

Rig Type MOBILE B-56

Driller LARRY CISLER - SCI

Supervisory Geologist ED TOKARSKI - JRB

Well No. DG-8

Project NADC-WARMINSTER, PA

Location ACROSS FROM HOUSING SOUTH OF BATTFIELD + N. OF DRAINAGE DITCH DOWN GRAD #5

Date Drilled 7/19/82

Prepared By: ED TOKARSKI 10/6/82

Scale: AS SHOWN

JRB-600/03-b

JRB ASSOCIATES, INC.
8400 Westpark Drive, McLean, Virginia 22102

WELL LOG

PROFILE	DESCRIPTION
0	TOPSOIL/VEGETATION
1	YELLOW TAN SANDY LOAM. STIFF. DRY. SOME SANDSTONE FRAGMENTS
2	
3	VERY HARD SANDSTONE LAYER
4	BROWN SANDY LOAM HARD DRY
5	SPLIT SPOON 5'-5.1' 50/.1'
6	
7	VERY HARD BROWN SANDSTONE. ALTERNATING HARD AND SOFT LAYERS. LARGE ROCK FRAGMENTS IN CUTTINGS. WATER.
8	
9	
10	AUGER REFUSAL.
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

PROJECT NADC WARMINSTER, PA

OWNER NAVAL AIR DEVELOPMENT CENTER

WELL NO. DG-8

LOCATION ACROSS FROM NALC HOUSING SOUTH OF BATFIELD & NORTH OF DRAINAGE DITCH. DOWNGRADIENT SITE #5

	Date	Time
DRILLING STARTED	7/19/82	[illegible]
DRILLING COMPLETED	7/19/82	[illegible]

DRILLER [illegible] CISLER

GEOLOGIST ED TOKARSKI JRB

RIG TYPE MOBILE B-56

REFERENCE POINT LAND SURFACE

R.P. ELEVATION 332.4

TOPO POSITION FLAT LANDS

PROFILE BY [illegible]

FIELD BOOK NO. 1 PAGES 44-45

WELL DATA

HOLE DIAMETER 6" O.D.

HOLE DEPTH 10'

CASING DIAMETER 2" I.D.

CASING LENGTH 5.28'

SCREEN DIAMETER 2" I.D.

SCREEN SETTING 9.87' - 5.6'

SCREEN SLOT/TYPE 10-SLOT / MICROMESH (2.15/2.15) STAINLESS STEEL - (JOHNSON)

PUMP TEST DATA

STATIC DEPTH TO WATER 2.39 // 4.94

DATE MEASURED 7/25/82 // 9/9/82

PUMPING DEPTH TO WATER SAME

TEST DURATION —

PUMPING RATE —

TEST DATE 9/9/82

TEST TYPE BAIL TEST

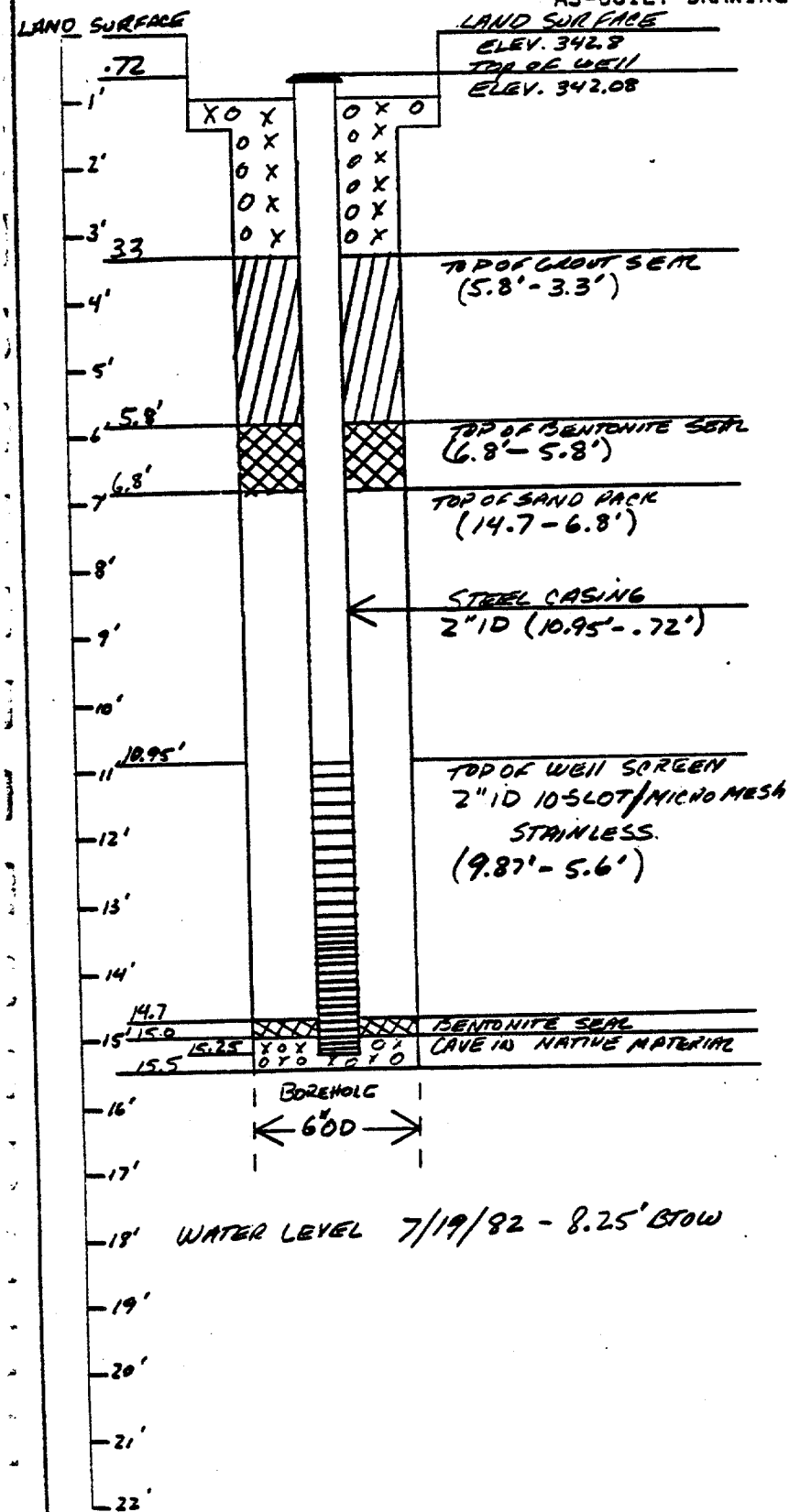
PUMP SETTING —

SPECIFIC CAPACITY SEE REPORT

REMARKS

UNABLE TO PENETRATE VERY HARD SS LAYER AT 10' WITH 2 AUGER TEETH. NO PENETRATION

AS-BUILT DRAWING



CHECKLIST

Land Surface Elevation 342.8

Casing Height Above L-S -.72'

Total Depth 15.5'

Borehole Diameter 6" O.D.

Casing Diameter 2" I.D.

~~Casing Thickness~~

Casing Lengths 10.23'

Screen Data

- Material STAINLESS
- Diameter 2" I.D.
- Slot Openings 10 SLOT/MM
- Settings 15.25'-10.95'

~~Centralizers~~

Grout Type PORTLAND

Gravel Pack SILICA.

~~K-Fittings~~

~~Packers~~

~~Cement Baskets~~

Rig Type MOBILE B-56

Driller LARRY CISLER - SCI

Supervisory Geologist ED TOKARSKI - JRB

Well No. DG-9

Project NADC-WARMINSTER, PA

Location N. OF HOUSING ALONG FENCE. S. OF SITE #6. DOWNGRAD. SITE #6.

Date Drilled 7/19/82

Prepared By: ED TOKARSKI 10/6/82

Scale: AS SHOWN

188-600/03-b

JRB ASSOCIATES, INC.
8400 Westpark Drive, McLean, Virginia 22102

WELL LOG

PROFILE	DESCRIPTION
0	TOPSOIL/VEGETATION
1	
2	
3	BROWN SANDY LOAM - DRY. STIFF
4	
5	SPLIT SPOON 5'-5.7' 35-50/.1
6	
7	
8	
9	BROWN SANDY LOAM - MOIST. WITH MANY SANDSTONE FRAGMENTS.
10	SPLIT SPOON 10'-10.1' 50/.1
11	
12	BROWN TO GRAY SANDSTONE. ALTERNATING HARD AND SOFT LAYERS.
13	
14	
15	AUGER REFUSAL
16	
17	
18	
19	
20	

PROJECT NADC WARMINSTER, PA

OWNER NAVAL AIR DEVELOPMENT CENTER

WELL NO. D6-9

LOCATION N. OF WATER HOUSING ACROSS FENCE
S. OF SITE #6

	Date	Time
DRILLING STARTED	7/19/82	0820
DRILLING COMPLETED	7/19/82	1035

DRILLER LARRY CISLER SR.
GEOLOGIST ED TOKARSKI JRB
RIG TYPE MOBILE B-56.
REFERENCE POINT LAND SURFACE
R.P. ELEVATION 342.8
TOPO POSITION FLAT LYING
PROFILE BY ED TOKARSKI
FIELD BOOK NO. 1 PAGES 44

WELL DATA

HOLE DIAMETER 6" O.D.
HOLE DEPTH 15.5'
CASING DIAMETER 2" I.D.
CASING LENGTH 10.23'
SCREEN DIAMETER 2" I.D.
SCREEN SETTING 15.25' - 10.95'
SCREEN SLOT/TYPE 10-SLOT / MICROMESH (2.15/2.15'
STAINLESS STEEL - (JOHNSON)

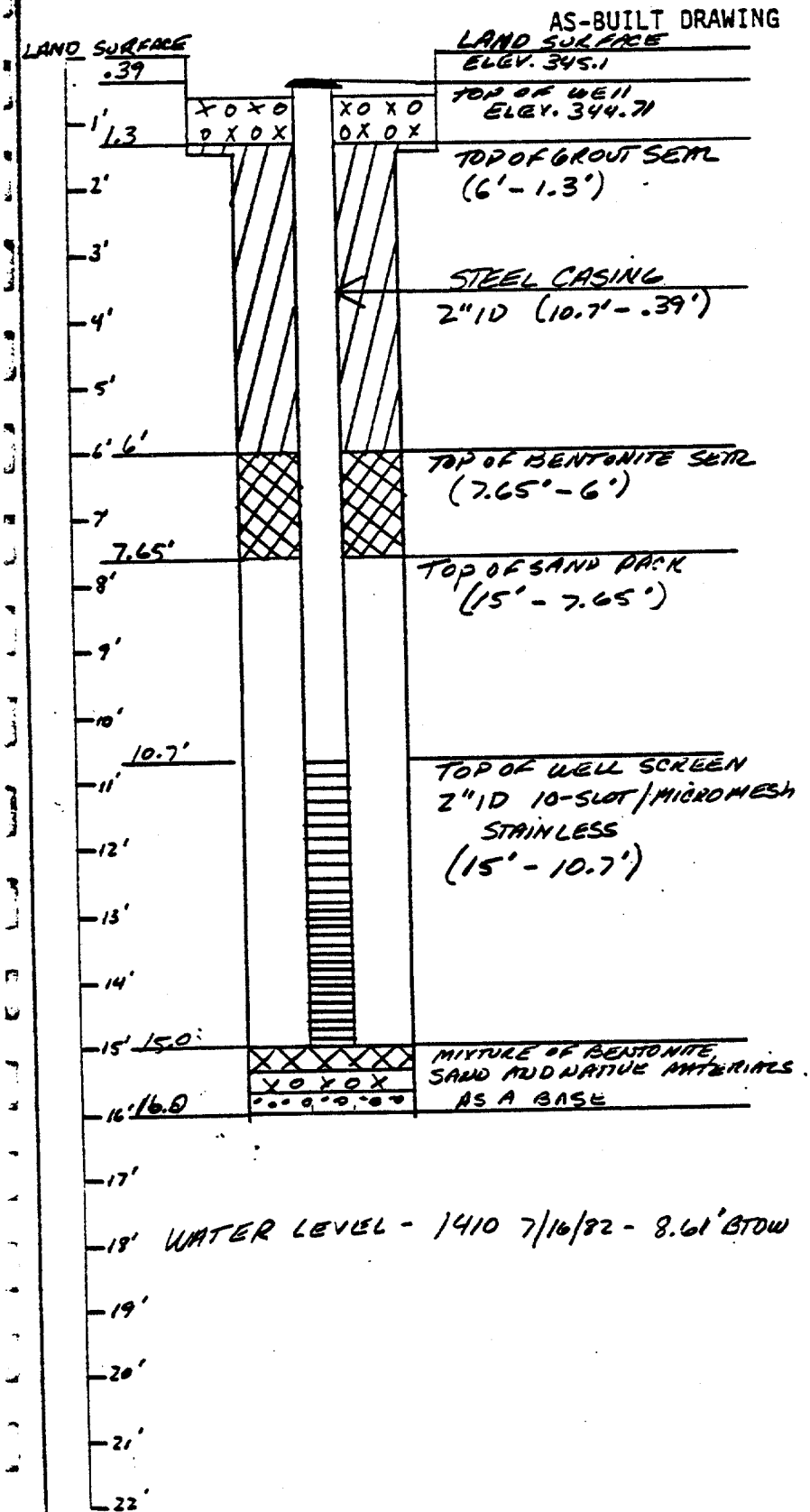
PUMP TEST DATA

STATIC DEPTH TO WATER 7.68 // 9.53
DATE MEASURED 7/25/82 // 9/9/82
PUMPING DEPTH TO WATER SPOKE
TEST DURATION —
PUMPING RATE —
TEST DATE 9/9/82
TEST TYPE BAIL TEST
PUMP SETTING 14'
SPECIFIC CAPACITY SEE REPORT

REMARKS

WET FROM APP 8' ON. DRILLING DID NOT DETECT WATER UNTIL 14'.

AS-BUILT DRAWING



CHECKLIST

Land Surface Elevation 345.1

Casing Height Above L-S -.39

Total Depth 16.1'

Borehole Diameter 6" O.D.

Casing Diameter 2" I.D.

~~Casing Thickness~~

Casing Lengths 10.31'

Screen Data

- Material STAINLESS
- Diameter 2" I.D.
- Slot Openings 10 SLOT/MM
- Settings 15'-10.7'

~~Centralizers~~

Grout Type PORTLAND

Gravel Pack SILICA.

~~K-Fittings~~

~~Packers~~

~~Cement Baskets~~

Rig Type MOBILE B-56

Driller LARRY CISLER - SCI

Supervisory Geologist ED TOKARSKI - JRB.

Well No. DG-10

Project NADC - WARMINSTER, PA

Location EAST WELL DG-9. N. OF HOUSING DOWNGRADIENT OF SITE #6.

Date Drilled 7/16/82

Prepared By: ED TOKARSKI 10/6/82

Scale: AS SHOWN

JRB-600/03-b

JRB ASSOCIATES, INC.
8400 Westpark Drive, McLean, Virginia 22102

WELL LOG

PROFILE	DESCRIPTION
0–1	TOPSOIL / VEGETATION / FILL
2–3	SANDY-LOAM to SILT DRY. RED-BROWN.
4–5	RED BROWN SILT-CLAY-HARD. DRY WITH ANDY FRAGMENTS.
5–6	SPLIT SPOON 5'-6.5' 6" = 10/13/25
7–8	
9–10	
10–11	SPLIT SPOON 10'-10.75' 41/50/1
11–12	SANDSTONE WITH HARD AND SOFT LAYERS. WET FROM 10'
13–14	
15–16	HOLED IN ROCK
17–18	
19–20	

PROJECT NADC WARMINSTER, PA

OWNER NAVAL AIR DEVELOPMENT CENTER

WELL NO. DG-10

LOCATION EAST WELL DG-9. N OF HOUSING DEVELOPMENT. DOWN-GRADIENT OF SITE FG

	Date	Time
DRILLING STARTED	7/16/82	1315
DRILLING COMPLETED	7/16/82	1410

DRILLER LARRY MISLER SCI

GEOLOGIST ED TOKARSKI JRB

RIG TYPE MOBILE B-56.

REFERENCE POINT LAND SURFACE

R.P. ELEVATION 345.1

TOPO POSITION FLAT LYING

PROFILE BY ED TOKARSKI

FIELD BOOK NO. 1 PAGES 40-41

WELL DATA

HOLE DIAMETER 6" O.D.

HOLE DEPTH 16'

CASING DIAMETER 2" I.D.

CASING LENGTH 10.31'

SCREEN DIAMETER 2" I.D.

SCREEN SETTING 15'-10.7'

SCREEN SLOT/TYPE 10-SLOT / MICROMESH (2.15/2.15' STAINLESS STEEL - (JOHNSON)

PUMP TEST DATA

STATIC DEPTH TO WATER 5.13 // 8.46

DATE MEASURED 7/25/82 // 9/9/82

PUMPING DEPTH TO WATER SAME

TEST DURATION —

PUMPING RATE —

TEST DATE 9/9/82

TEST TYPE BAIL TEST

PUMP SETTING 15'

SPECIFIC CAPACITY SEE REPORT

REMARKS

TABLE F-1

DRILLING ADMINISTRATION

Project: Naval Air Development Center
Project No. 214-83B

Well SMP#1 (WELL D)

Well Contractor: Rollin Raab & Son

Address: Warwick, PA **Phone:** 343-1277

Name of Driller: Dick Raab **Helper(s)** Harry Zimmerman

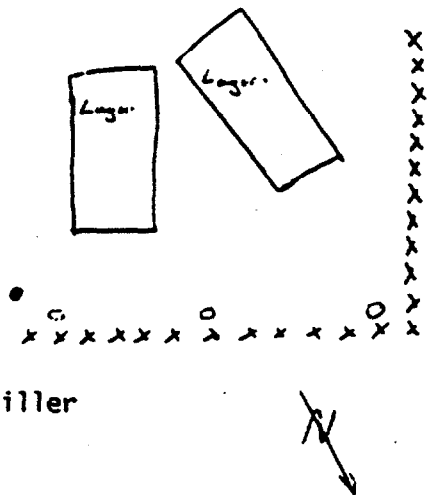
Rig: **Number** **Make** Denver-Gardner **Model** **Bar Length:** 20'

Reference Point: Top of Outer Casing = 311.11 MSL

Casing & Grouting Summary (Amounts, Lengths, diameters) 5" of sand at bottom of hole, 5' of 4" Johnson stainless steel #15 well screen threaded to 35' of 4" threaded steel casing. Top of casing is 2' above ground level.

Diary of Drilling

Date	Time	What Was Done & (Problems if Any)	Weather
2/23	10:30am	Drilling started.	45°, hazy
2/23	11:25am	Hole completed at driller's 40'. Drilling produced no flow when blown. Allowed well to stand for one hour. Static water level was then about 10' below top of casing.	
2/23	12:30pm	Four bags of sand used to pack bottom 10' of casing and screening. 2.5 gals. (25 lbs.) bentonite used to make a 50" seal (Volclay Tablets). Four bags of sand and 4 bags of cement used to grout hole to the surface.	
2/23	2:30 pm	4.5' of 6" protective steel casing set 1.5' into concrete around 4" steel casing.	
2/23	3 pm	temperature = 13.75°C specific conductivity = 1000 mmhos	



Cuttings:

Geologist: J. Roberts
Other Persons on Site: C. Miller

WALTER B. SATTERTHWAITE ASSOCIATES, INC.

TABLE F-2

Well No.: SMP-1 (WELL D)
Drilled: 2/23/84

DEPTH	DESCRIPTION
0-6	Brown to yellow clay, red silty soil.
6-7	Fine-grained brown to red sandstone.
7-10	Purple to brown, fine-grained sandstone to siltstone, highly weathered.
10-17	Reddish-brown to purple, medium- to fine-grained sandstone, darkening downward, biotite present. Moist zone at 15'.
17-22	Red to brown, medium-grained sandstone, purple medium-grained sandstone. Moist zones at 20 and 22 ft.
22-27	Same as above with little brown to buff, medium-grained sandstone.
27-31	Medium-grained, purple sandstone, some medium-grained white to buff sandstone, little fine-grained dark purple sandstone.
31-35	Same as above with little brown to yellow, medium-grained sandstone.

SMP-1
(WELL D)

FIGURE F-2

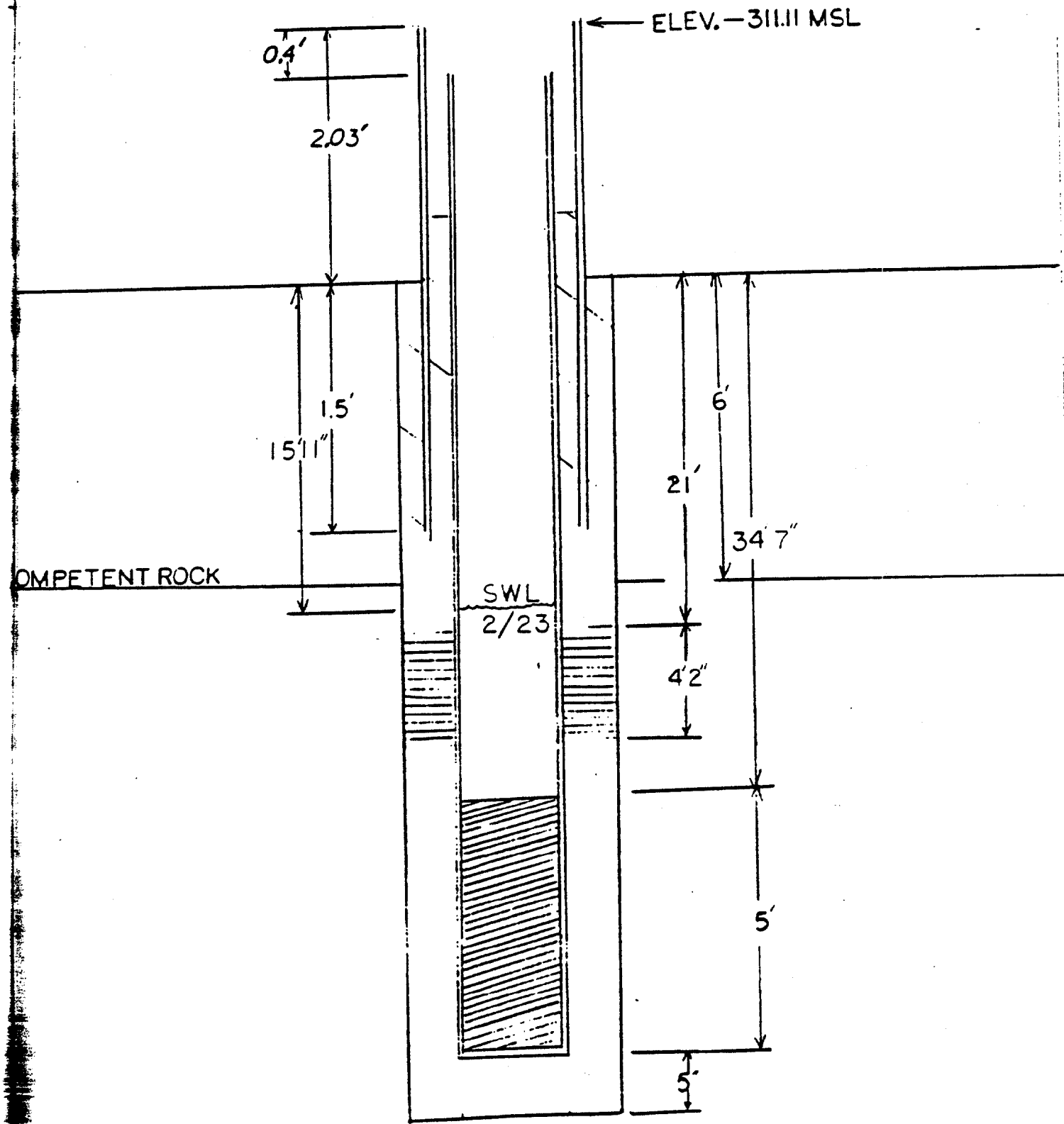


TABLE F-3

DRILLING ADMINISTRATION

Project: Naval Air Development Center
Project No. 214-838

Well SMP#2

Well Contractor: Rollin Raab & Son

Address: Warwick, PA **Phone:** 343-1277

Name of Driller: Dick Raab **Helper(s)** Harry Zimmerman

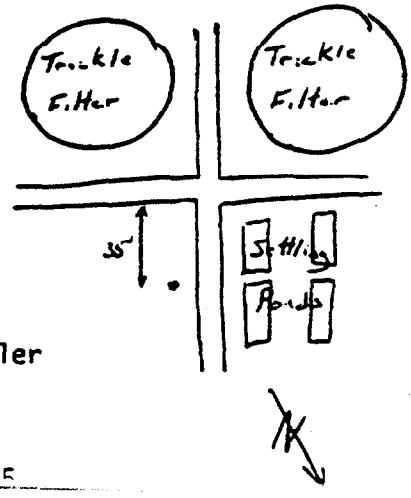
Rig: **Number** **Make** Denver-Gardner **Model** **Bar Length:** 20'

Reference Point: Top of Outer Casing = 317.30'MSL

Casing & Grouting Summary (Amounts, Lengths, diameters) 5' of #15 stainless steel Johnson well screen (4" dia.) set 6" off bottom of hole. Threaded to 36' of 4" steel casing 2.5' above ground level. Eight bags of sand used to pack hole up to 20'. 2.5 gals. bentonite made 50" seal.

Diary of Drilling

Date	Time	What Was Done & (Problems if Any)	Weather
2/23	3:30 pm	Drilling began.	
2/23	4:15 pm	Drilling completed to 40'. No water standing in bore hole. Driller decided to let hole sit overnight.	
2/24	10 am	Driller arrives	45°, rain tapering off.
2/24	11 am	Began blowing well. Much water produced at first. Well developed for 30 mins. producing roughly 3 gpm.	
2/24	11:30am	Well standing for one hour.	
2/24	11:45 am	temperature = 15°C specific conductivity = 340 mmhos	
2/24	12:30 pm	2.5 bags of cement used to grout hole to the surface. 5' of 6" protective steel casing set at 2.5'. Locking cap installed	



Cuttings:

Geologist: J. Roberts
Other Persons on Site: C. Miller

WALTER B. SATTERTHWAITE ASSOCIATES, INC.

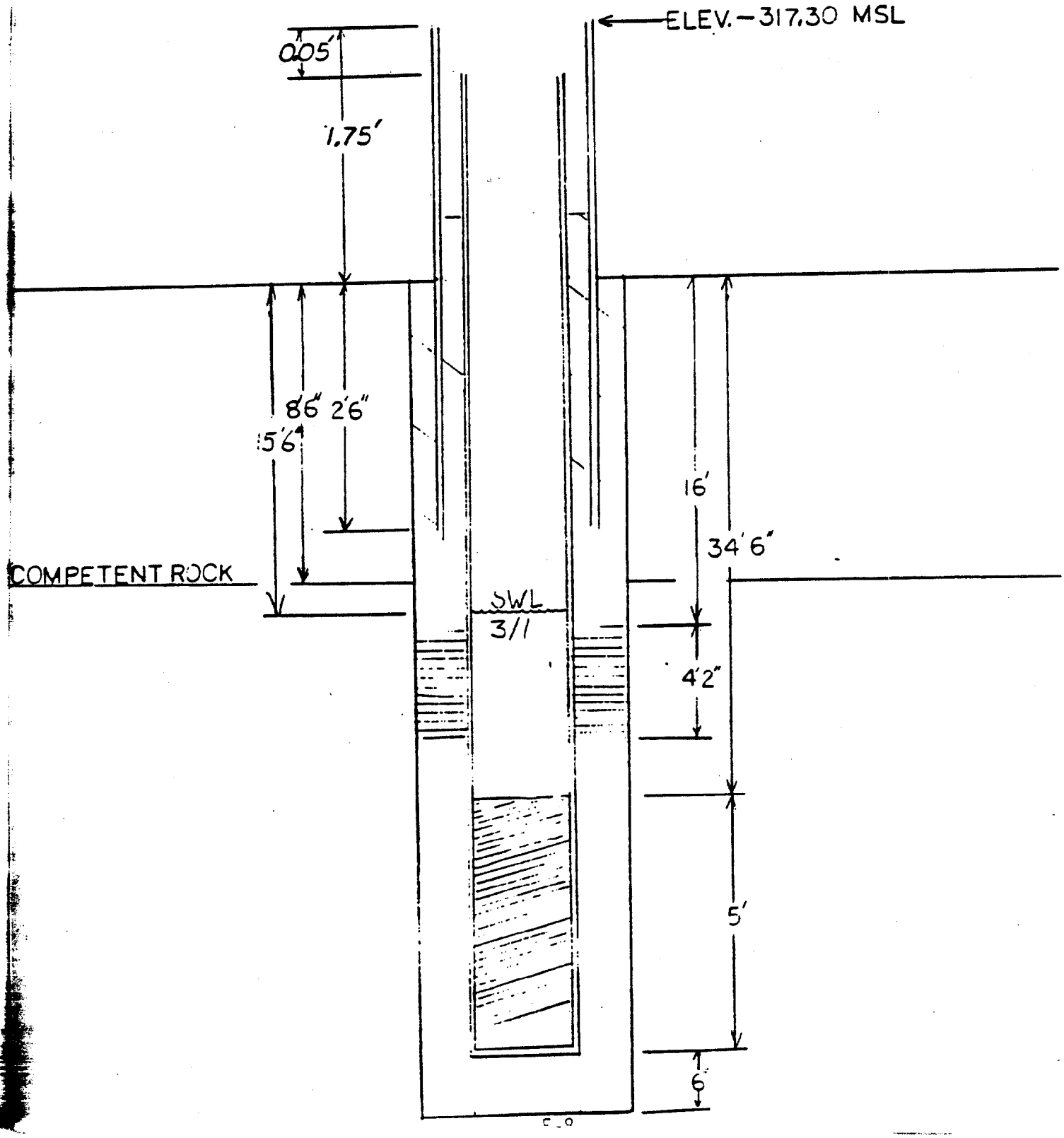
TABLE F-4

Well No.: SMP-2
Drilled: 2/23/84

DEPTH	DESCRIPTION
0-2	Yellow to brown clayey soil
2-6	Dark red clayey soil
6-8.5	Same as above with highly weathered red siltstone fragments.
8.5-16	Reddish brown to purple fine-grained, weathered sandstone to siltstone.
16-20	Red siltstone, some medium-grained purple sandstone and fine-grained dark gray sandstone.
20-23	Reddish-brown fine-grained sandstone, some purple to brown medium-grained sandstone.
23-30	Purple, fine-grained sandstones to siltstones.
30-33	Same as above with little medium-grained brown to yellow sandstone.
33-37	Brown to purple, medium-grained sandstone darker with depth.
37-39	Light purple to gray medium-grained sandstone.

SMP-2

FIGURE F-3



SMC-MARTIN Geologist's Log

Test Well #1 - Drilled 10/16/80
(SMC-1)

Depth	Description
0- 10	Reddish-brown silt, minor clay (soil).
10- 15	Fine-grained reddish-brown weathered sandstone.
15- 25	Brownish-red, fine-grained micaceous sandstone, minor calcite.
25- 35	Reddish-brown micaceous siltstone.
35- 45	Reddish-brown shale.
45- 55	Fine-grained reddish-brown to gray sandstone, minor feldspar.
55- 60	Fine-grained reddish-brown to gray sandstone, arkose.

CASING DEPTH = 20 FT.

Test Well #2 - Drilled 10/16/80, 10/17/80
(SMC-2)

Depth	Description
0- 10	Reddish-brown silty clay soil, some weathered shale fragments.
10- 25	Very fine-grained reddish-brown shaley sandstone with some mica.
25- 35	Reddish-brown siltstone, some mica.
35- 45	Reddish-brown shale with some fine-grained sandstone, minor mica.
55- 60	Fine-grained reddish-brown shaley micaceous sandstone.
60- 65	Fine to medium-grained gray to reddish-brown sandstone with minor calcite.
65- 75	Medium-grained brownish-red arkosic sandstone, some larger quartz and feldspar grains.
75- 85	Medium-grained brown arkosic sandstone.
85- 95	Fine-grained gray to brown sandstone, some feldspar, some brown siltstone.
95-105	Gray shale, some brown micaceous shale.
105-120	Fine-grained, brown arkosic sandstone.
120-125	Fine-grained, grayish-brown arkosic sandstone.
125-135	Reddish-brown micaceous shale.
135-155	Fine-grained brown arkosic sandstone, minor mica.
155-165	Fine to medium-grained arkosic sandstone, minor mica, minor calcite.
165-180	Medium-grained brown to gray arkosic sandstone, minor biotite.
180-185	Reddish-brown shale.
185-195	Brown to gray medium-grained arkosic sandstone.
195-205	Medium-grained gray quartzose sandstone, minor calcite.
205-210	Medium-grained gray to brown sandstone, minor gray shale, minor calcite.
210-215	Medium-grained gray quartzose sandstone, minor calcite.
215-225	Red-brown shale, minor calcite, some gray quartzose sandstone.
225-245	Medium-grained gray quartzose sandstone, minor feldspar, some gray and red-brown shale.
245-255	Dark reddish-brown shale, some gray sandstone, minor calcite.
255-265	Dark reddish-brown to gray fine-grained sandstone, some feldspar, mica.
265-275	Reddish-brown shale, minor calcite. some fine-grained sandstone.
275-285	Medium-grained gray quartzose sandstone, minor feldspar, minor biotite.

CASING DEPTH = 60 FT.

APPENDIX B-4

PHASE I RI MONITORING WELL BORINGS

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER Navy

LOCATION Site 2 W.O. NUMBER 9710-4.0001

WELL NUMBER BG-4 TOTAL DEPTH 47' DIAMETER 6"

SURFACE ELEV. / WAT. LEV.: INIT. 45' ~~24 HRS~~ 11/13/90 20.03'

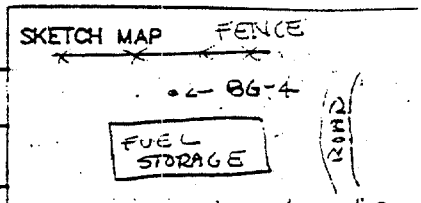
Open Hole: DIA. 6" LENGTH 17-47' SLOT SIZE NA

CASING: DIA. 6" LENGTH 0-17.05' TYPE PVC

DRILLING COMPANY C. S. Garber DRILLING METHOD Air Rotary

DRILLER E. Williams LOG BY PDB DATE DRILLED 10/24/90 10/25/90

SKETCH MAP



- water levels were measured from top of inner casing

NOTES
SHALLOW BEDROCK WELL

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	PID SAMPLE NUMBER	FID	DESCRIPTION / SOIL CLASSIFICATION (U.S.C.S.) (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
	Soil	17.05' CASING	ND	ND	0-10' Maroon-red silty sand (ML)
					10-12' Saprolite
					12-25' Maroon-red micaceous siltstone. Dry. Came to surface as sand-cobble size fragments
	12				25-38' Light red siltstone. Moist towards bottom of layer
	BEDROCK				38-44' Light red very fine arkosic sandstone. Dry. Came to surface as sand
47					44-47' Grayish-white quartzitic medium grained sandstone. Dry
		OPEN HOLE			* Casing was set at 17.05'.
		2' BENT. SEAL W/ B/C GROUT PROTECT. CASING W/ LOCKING CAP. SEE WORK PLAN well specs.			Hydrogeology
					- No water detected at soil/bedrock interface
					- Water was hit at 33'
					- The yield is less than ½ gpm
					- Water was run down the well during development to purge the well of sediment.

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DRILLING LOG

PROJECT NADC OWNER Navy

LOCATION Site 6 W.O. NUMBER 9710-40001

WELL NUMBER BG-7 TOTAL DEPTH 37' DIAMETER 6"

SURFACE ELEV. / WAT. LEV.: INIT. 28.65' 11/13/90 ~~24 HRS~~ 24.40'

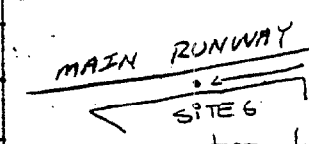
Open Hole: DIA. 6" LENGTH 18.15'-37' SLOT SIZE NA

CASING: DIA. 6" LENGTH 0-18.15' TYPE PVC

DRILLING COMPANY C.S. Garber DRILLING METHOD Air Rotary

DRILLER K. Levan LOG BY PDB DATE DRILLED 11/1/90 11/2/90

SKETCH MAP



-water levels were measured from top of inner casing.

NOTES

SHALLOW BEDROCK WELL

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	PID SAMPLE NUMBER	FID	DESCRIPTION / SOIL CLASSIFICATION (U.S.C.S) (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
			ND	ND	0-1' Brown organic silt (OL)
	SOIL				1-7' Orange-brown sandy silt. Dry
7					7-11' Light tan medium grained arkosic sandstone. Dry.
		18.15' CASING			11-13' Orange-tan fine grained arkosic sandstone. Dry. Came to surface as sand-granule sized particles
	BEDROCK				13-16' Light tan medium grained quartzitic sandstone. Came to surface as sand-granule sized particles
		OPEN HOLE			16-24' Light pink sandy shale. Dry. Friable.
					24-25' Grayish brown medium grained arkosic sandstone. Dry.
37					25-37' Brownish-red sandy siltstone. Came to surface as granule particle
		2' BENT. SEAL; B/C GROUT. PROTECT. CASING & LOCK CAP SEE work plan for specs.			* Casing set at 18.15'

Hydrogeology

- No water detected at soil / bedrock interface
- Water hit at approximately 30'
- Yield is < 1/2 gpm
- Two feet of water collected in hole in three minutes

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DRILLING LO

PROJECT NADC OWNER Navy

LOCATION Site 2 W.O. NUMBER 9710-40001

WELL NUMBER DG-12 TOTAL DEPTH 75' DIAMETER 6"

SURFACE ELEV. / WAT. LEV.: INIT. 45' 11/13/90 ~~24 HRS~~ 10.41'

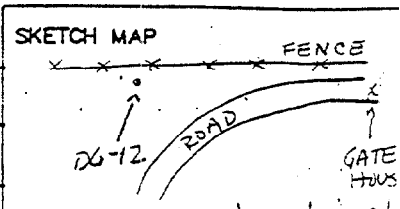
Open Hole: DIA. 6" LENGTH 18-75' SLOT SIZE NA

CASING: DIA. 6" LENGTH 0-18' TYPE PVC

DRILLING COMPANY C.S. Garber DRILLING METHOD Air Rotary

DRILLER K. Levan LOG BY PDB DATE DRILLED 10/24/90 10/26/90

SKETCH MAP



- water level were measured from top of inner casing

NOTES

SHALLOW BEDROCK WELL

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	PID SAMPLE NUMBER	FID	DESCRIPTION / SOIL CLASSIFICATION (U.S.C.S.) (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
			ND	ND	0-4' Maroon-red silt (ML). Dry
	SOIL				4-8' Brown-orange silty sand (SM). Dam near bottom
13					8-12' Maroon-red silt (ML). Moist.
		18' CASING			12-13' Whitish-gray clay (CL). Wet
					13-18' Very light brown fine to medium grained micaceous sandstone. Dry.
	BEDROCK				18-22' Light brown medium grained quartzitic sandstone. Dry
					22-34 White medium grained quartz arenite sandstone. Dry
					34-40' Maroon-red micaceous siltstone. Dry
		OPEN HOLE			40-43' Light brown fine grained silty sandstone
					43-52' Light red fine grained micaceous sandstone. Dry
					52-53' Yellow brown very fine grained sandst
					53-72' Light gray micaceous siltstone. Dr
75					72-75' Reddish brown micaceous siltstone. Mo
		2' BENT. SEAL PAT. CASING & LOCK. CAP. SEE WORK plan FOR SPECS.			* Casing set at 18'
					Hydrogeology
					- Soil bedrock interface was wet
					- Hit water at 72'
					- Yield is ½ gpm
					- Two feet of water collected in well overnigh

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DRILLING LOG

PROJECT NADC OWNER Navy

LOCATION Site 3 W.O. NUMBER 9710-40001

WELL NUMBER DG-13 TOTAL DEPTH 22' DIAMETER 6"

SURFACE ELEV. / WAT. LEV.: INIT. 14' 11/13/90 ~~24 HRS~~ 8.15'

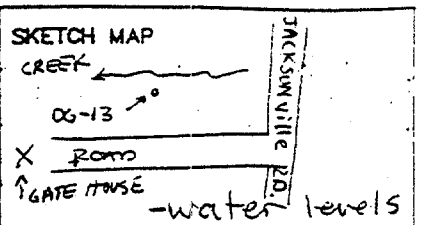
Open Hole: DIA. 6" LENGTH 18-22' SLOT SIZE NA

CASING: DIA. 6" LENGTH 0-18' TYPE PVC

DRILLING COMPANY C.S. Garber DRILLING METHOD Air Rotary

DRILLER E. Williams LOG BY PDB DATE DRILLED 10/24/90 10/25/90

SKETCH MAP



-water levels were measured from top of inner casing

NOTES

SHALLOW BEDROCK WELL

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER (PID)	FID	DESCRIPTION / SOIL CLASSIFICATION (U.S.C.S.) (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
	SOIL	18'	ND	ND	0-4' Dark brown-black gravel and asphalt
					4-11' Brownish-grey wet sandy clay (CL
22	BEDROCK				11-22' Maroon-red micaceous siltstone. Moist. Came to surface in sand-granule sized particles
		OPEN HOLE			* Casing set at 18'
		CASING			
		2' BENT. SEAL, PROTECT. CASING & LOCKIN WELL CAP BENT./CEM. GROUT SEE WORK PLAN SPECS			Hydrogeology
					- Water was hit at 18'
					- Soil / bedrock interface was wet
					- well yield is 1-2 gpm
					- 7-10' of water collected in well overnight.

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT: NADC OWNER: Navy

LOCATION: Site 6 W.O. NUMBER: 9710-40001

WELL NUMBER: DG-17 TOTAL DEPTH: 38' DIAMETER: 6"

SURFACE ELEV.: / WAT. LEV.: INIT. 37.5' 11/13/90 ~~24 HRS~~ 16.70'

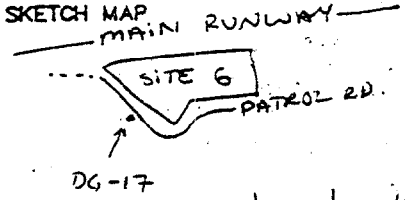
Open Hole: DIA. 6" LENGTH 16.5 - 38' SLOT SIZE NA

CASING: DIA. 6" LENGTH 0 - 16.5' TYPE PVC

DRILLING COMPANY C.S. Garber DRILLING METHOD Air Rotary

DRILLER E. Williams LOG BY PDB DATE DRILLED 10/31/90 11/1/90

SKETCH MAP



- water levels were measured from top of inner casing

NOTES

SHALLOW BEDROCK WELL

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER (FID)	PID	DESCRIPTION / SOIL CLASSIFICATION (U.S.C.S.) (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
	SOIL		ND	ND	0-5' Orange-red organic silt (OL). Dry
11					5-7' Brown quartzitic medium grained Sand. Dry
					7-11' Brown quartzo-feldspathic medium grained sand
		16.5 CASING			11-16' Brown and white medium grained arkosic sandstone. Dry
					16-20' Maroon-brown siltstone with medium grained sand inclusions. Quartz + feldspar. Dry
					20-23' Olive-brown fine to medium grained arkosic sandstone. Dry
	BEDROCK	OPEN HOLE			23-30' Dark red micaceous siltstone. Dry.
					30-37' Maroon brown very fine silty sandstone. Moist near bottom
38					37-38' Maroon-brown fine to medium grained quartzo-feldspathic sandstone.
		2" BENT. SEAL / BC GROUT PROTECT. CAS. w/ locking cap SEE work plan specs.			* Set Casing at 16.5'

Hydrogeology

- Hit water at 37'
- Well yield is < ½ gpm
- Bedrock / soil interface was dry
- Well recharged 1' in 2 minutes

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER Navy

LOCATION Site 6 W.O. NUMBER 9710-40001

WELL NUMBER DG-18 TOTAL DEPTH 27' DIAMETER 6"

SURFACE ELEV. / WAT. LEV.: INIT. 26.20' 11/13/90 ~~24 HRS~~ 15.70'

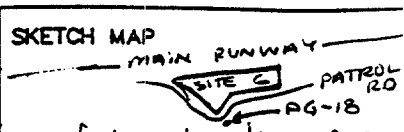
Open Hole: DIA. 6" LENGTH 22-27' SLOT SIZE NA

CASING: DIA. 6" LENGTH 0-22' TYPE PVC

DRILLING COMPANY C.S. Garber DRILLING METHOD Air Rotary

DRILLER E. Williams LOG BY PDB DATE DRILLED 11/2/90 11/5/90

SKETCH MAP



- Water levels were measured from top of inner casing.

NOTES

SHALLOW BEDROCK WELL

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	PID SAMPLE NUMBER	FID	DESCRIPTION / SOIL CLASSIFICATION (U.S.C.S.) (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
	SOIL	22' CASING	ND	ND	0-10' Brown organic silty sand (SM). Moist at bottom
17	BEDROCK				10-17' Dark brown medium grained arkosic sandstone. Dry. Comes to surface as granule sized particles.
27		OPEN HOLE			17-27' Gray very fine silty sandstone interbedded with olive medium to fine grained sandstone.
		2' BENT. SEAL. BENTICEM. GROUT PROTECT. CASING w/ locking well cap. SEE WORK PLAN SPECS.			* Casing set at 22'

Hydrogeology

- Bedrock / soil interface noticeably wet
- Well yield is approximately 1 gpm
- Well recovers 2-3 feet in 2 minutes
- Hit water around 23'
- There was 8 feet of water in the well when drilling resumed on 11/5.

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER Navy

LOCATION Site 6 W.O. NUMBER 9710-40001

WELL NUMBER DG-19 TOTAL DEPTH 47' DIAMETER 6"

SURFACE ELEV. / WAT. LEV.: INIT. 45' 11/13 ~~24-HRS~~ 17.05'

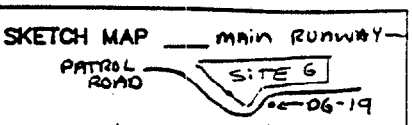
Open Hole: DIA. 6" LENGTH 21.75-4' SLOT SIZE NA

CASING: DIA. 6" LENGTH 0-21.75' TYPE PVC

DRILLING COMPANY C.S. Garber DRILLING METHOD Air Rotary

DRILLER E. Williams LOG BY PDB DATE DRILLED 11/2/90 11/5/90

SKETCH MAP



- Water levels were measured from top of inner casing

NOTES

SHALLOW BEDROCK WELL

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	PID SAMPLE NUMBER	FID	DESCRIPTION / SOIL CLASSIFICATION (U.S.C.S.) (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
	SOIL		ND	ND	0-6' Orange brown silty sand (SM)
7		21.75' CASING			6-7' Dk. maroon-red clayey silt (ML). Slightly moist.
	BEDROCK				7-28' Dark maroon red micaceous siltstone. Dry.
					28-46' Olive gray fine grained arkosic sandstone. Moist around 40-42'
47					46-47' Light green very fine grained arkosic sandstone.
		OPEN HOLE			
		2' BENT. SEAL; BENT./CEM. GROUT. PROTECT. CASING W/LOCKING CAP. SEE WORK PLAN SPECS.			

Hydrogeology

- Hit water at 42'
- Yield is ½ gpm
- Soil / bedrock interface slightly moist.
- 1.7-2 ppm hit on development water. This water was containerized.

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LO

PROJECT NADC OWNER Navy

LOCATION Site 5 W.O. NUMBER 9710-40001

WELL NUMBER DG-20 TOTAL DEPTH 32' DIAMETER 6"

SURFACE ELEV. / WAT. LEV.: INIT. 30.1' 11/13/90 ~~24 HRS~~ 7.13

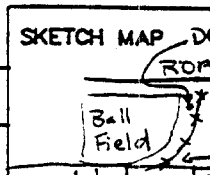
Open Hole: DIA. 6" LENGTH 17.6 - 32' SLOT SIZE NA

CASING: DIA. 6" LENGTH 0 - 17.6' TYPE PVC

DRILLING COMPANY C.S. Garber DRILLING METHOD Air Rotary

DRILLER E. Williams LOG BY PDB DATE DRILLED 11/6/90 11/7/90

SKETCH MAP



- Water levels were measured from top of inner casing

NOTES

SHALLOW BEDROCK WELL

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER (PID)	FID	DESCRIPTION / SOIL CLASSIFICATION (U.S.C.S.) (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
	SOIL		ND	ND	0-3' Yellow-tan silty sand (SM)
4					3-4' Dark brown clayey silt (ML). Slight moist.
					4-8' Light brown fine to medium grained arkosic sandstone. Dry
		17.6' CASING	.5		8-13' Light brown medium to coarse grained arkosic sandstone. Dry
	BEDROCK		1.5		13-17' Olive-tan medium grained arkosic sandstone. Iron rich grains are oxidized. Dry
			ND		17-19' Grayish-white fine to medium grained arkosic sandstone. Dr
					19-28' Brownish-red micaceous siltsto Wet at 27'.
					28-29' Buff medium grained quartzit sandstone. Dry
					29-30' Dark red coarse grained arkos sandstone.
32					30-32' Dark red micaceous siltstone. Dr
		OPEN HOLE			* Casing set at 17.6'
		SEE work plan specs.			Hydrogeology
					- Soil / bedrock interface was moist
					- Well yield = 1 gpm
					- Water was hit at 27'

013 9018 86001

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER Navy

LOCATION Site 5 W.O. NUMBER 9710-40001

WELL NUMBER DG-21 TOTAL DEPTH 33' DIAMETER 6"

SURFACE ELEV. / WAT. LEV.: INIT. 11.51 11/13/90 ~~24 HRS~~ 10.47'

Open Hole: DIA. 6" LENGTH 15-33' SLOT SIZE NA

CASING: DIA. 6" LENGTH 0-15' TYPE PVC

DRILLING COMPANY C.S. Garber DRILLING METHOD Air Rotary

DRILLER E. Williams LOG BY PDB DATE DRILLED 11/6/90 11/7/90

SKETCH MAP

see DG-27 sketch map.

-Water levels were measured from top of inner casing.

NOTES

SHALLOW BEDROCK WELL

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER	PID	FID	DESCRIPTION / SOIL CLASSIFICATION (U.S.C.S) (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
	SOIL 6	15' CASING		ND	ND	0-3' Brown organic silt (OL). Dry
						3-6' Maroon red sandy silt (ML). Dry
	BEDROCK					6-11' Saprolitic purple-brown arkosic sandstone. Moist at 11'
						11-31' Purple-brown medium grained arkosic sandstone. Wet at 28'
33		OPEN HOLE				31-33' Dark gray fine-medium grained arkosic sandstone. Dry
						* Casing set at 15'
		2' BENT. SEAL W/ GROUT + WELL COLLAR PROTECT. CASING w/ LOCKING CAP. SEE WORK PLAN WELL SPECS.				Hydrogeology
						- Water detected at saprolite / competent bedrock interface
						- Hit water at 28'
						- Well yield = < ½ gpm
						- 3' of water collected in 4 minutes
						- Water was run down the well during development to purge the well of sediment.

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER Navy

LOCATION Site 2 W.O. NUMBER 9710-40001

WELL NUMBER DG-23 TOTAL DEPTH 47' DIAMETER 6"

SURFACE ELEV. / WAT. LEV.: INIT. 37' 11-28-90 ~~24 HRS~~ 31'

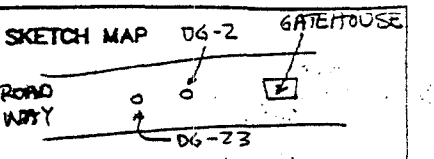
Open Hole: DIA. 6" LENGTH 23.5-47' SLOT SIZE NA

CASING: DIA. 6" LENGTH 0-23.5' TYPE PVC

DRILLING COMPANY C.S. Garber DRILLING METHOD Air Rotary

DRILLER E. Williams LOG BY PDB DATE DRILLED 11/8/90 11/9/90

SKETCH MAP



-Water levels were measured from top of inner casing

NOTES FLUSH MOUNT well in ROADWAY

SHALLOW BEDROCK WELL

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION (FLUSH Mount)	SAMPLE NUMBER	PID	FID	DESCRIPTION / SOIL CLASSIFICATION (U.S.C.S.) (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
	SOIL FILL		ND		ND	0-2' Asphalt and gravel fill
			↓		↓	2-4' Brownish red micaceous silt (OL) Soil was moist.
16		23.5' CASING	0.7			4-16' Dark brown organic silt (OL). Numerous glass and metal fragments were encountered. Water was encountered at 10'. This water registered 1.1 ppm on the PID.
	BEDROCK		ND			16-27' Dark reddish-brown medium grained arkosic sandstone. Dry
						27-34' Light tan medium grained quartzitic sandstone. Dry.
						34-40' Dark red micaceous siltstone. Dry
47			↓	↓		40-47' Brownish-red sandy siltstone. Water was hit at 45'.
		OPEN HOLE				* Casing set at 23.5'
		FLUSH MOUNT in PD. 2' Bent. seal w/ grout. SEE WORK P. SPECS.				Hydrogeology
						-Water was found in the overburden
						- Bedrock water was hit at 45'
						- Well yield = ½-1 gpm
						- Development water, which contained water run down from the rig, contained 0.9 ppm of volatiles as recorded by the PID. This water was containerized.

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER Navy

LOCATION Site 7 W.O. NUMBER 9710-40001

WELL NUMBER DG-25 TOTAL DEPTH 41' DIAMETER 6"

SURFACE ELEV. / WAT. LEV.: INIT. 40.2' 11/13/90 ~~24 HRS~~ 12.10'

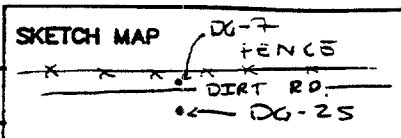
Open Hole: DIA. 6" LENGTH 21-41' SLOT SIZE NA

CASING: DIA. 6" LENGTH 0-21' TYPE PVC

DRILLING COMPANY C.S. Garber DRILLING METHOD Air Rotary

DRILLER E. Williams LOG BY PDB DATE DRILLED 11/9/90 11/13/90

SKETCH MAP



- Water level was measured from top of inner casing.

NOTES

SHALLOW BEDROCK WELL

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER (PID/FID)		DESCRIPTION / SOIL CLASSIFICATION (U.S.C.S.) (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
	SOIL		ND		0-2' Orange-red sandy silt (SM). Dry
11		21' CASING			2-11' Brownish-red medium grained Sand. Dry
	BEDROCK				11-16' Dark brown medium grained arkosic Sandstone. Dry
					16-29' Brown sandy siltstone. Dry
41		OPEN HOLE			29-41' Maroon-brown medium grained Sandstone. Sandstone contained equal amounts of quartz and feldspar with minor micaceous elements. Quartz grains were very coarse to granule sized.
		2' BENT. SEAL. BENTICEM. GROUT TO SURFACE. PROT. CASING w/ LOCKING CAP. SEE WORK PLAN SPECS.			* Set casing at 21'
					Hydrogeology
					- Overburden appeared dry
					- Water was hit at 36'
					- Well yield = 1 gpm
					- 5' of water collected inside the well in five minutes.

SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LO

PROJECT NADC OWNER Navy

LOCATION Site 2 W.O. NUMBER 9710-40001

WELL NUMBER DG-26 TOTAL DEPTH 15.25' DIAMETER 4"

SURFACE ELEV. / WAT. LEV.: INIT. 10.70' 24-HRS 10.80'

SCREEN: DIA. 4" LENGTH 10-15.25' SLOT SIZE 0.020

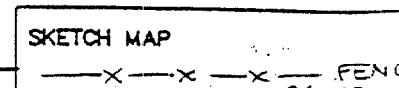
CASING: DIA. 4" LENGTH 0-10' TYPE PVC

ID = 6.25"

DRILLING COMPANY C.S. Garber DRILLING METHOD Auger OD = 11.50"

DRILLER B. Stoudt LOG BY PDB DATE DRILLED 11/14/90

SKETCH MAP



- Water levels measured from top of inner casing.

NOTES
OVERBURDEN WELL

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	PID SAMPLE NUMBER	BLOW COUNT	DESCRIPTION / SOIL CLASSIFICATION (U.S.C.S.) (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
	Cuttings		ND	16	0-1.4' Reddish-brown micaceous very fine
1	GROUT			20	fine grained sand
2.25 2	Bent.			18	1.4-1.7' Black cinder material
3.25 3				21	1.7-2.0' Brownish-red micaceous silt.
4	#1 SAND PACK			4	Portions of the soil contained
5.25 5				4	orange mottling. Dry
6				5	2.0-2.9' Brown organic sandy silt
7				7	containing roots and wood fragmen
8				21	2.9-3.2' Cement fragments. Dry
9				50+	3.2-3.6' Orange mottled micaceous
10.25 10	OVERBURDEN			50+	clay and silt. Dry.
11				50+	3.6-8.9' Reddish-brown mottled micaceou
12				40	silt loam. Orange mottling was
13				50+	heavy in spots. Soil was dam
14				Refusal	between 5 and 6 feet.
15					8.9-10.7' Grayish-red medium to coarse
15.25					grained quartz and feldspar
					rich sand. Became wet at 10
					10.7-13.0' No soil returns
					13.0-14.0' Light reddish-brown fine to
					medium grained feldspathic sand
					Contained minor quartz. Wet.
			✓		14.0-15.0' No soil returns

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SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

DG-26 Continued

PROJECT NADC OWNER NAVY

LOCATION SEE FIRST PAGE W.O. NUMBER 9710.-40001

WELL NUMBER ____ TOTAL DEPTH ____ DIAMETER ____

SURFACE ELEV. ____ WAT. LEV.: INIT. ____ 24-HRS ____

SCREEN: DIA. ____ LENGTH ____ SLOT SIZE ____

CASING: DIA. ____ LENGTH ____ TYPE ____

DRILLING COMPANY ____ DRILLING METHOD ____

DRILLER ____ LOG BY ____ DATE DRILLED ____

SKETCH MAP

NOTES 2ND PAGE FOR DG-26

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	SAMPLE NUMBER	BLOW COUNT	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
					Hydrogeology
					- Water was hit at 10'
					- Well yield = 2 gpm
					- Well was developed with a 4" Submersible pump.

SMC ENVIRONMENTAL SERVICES GROUP — DRILLING LO

PROJECT NADC OWNER Navy

LOCATION Site 5 W.O. NUMBER 9710-40001

WELL NUMBER DG-27 TOTAL DEPTH 13.8' DIAMETER 4"

SURFACE ELEV. / WAT. LEV.: INIT. 13.2' 24-HRS 9.75

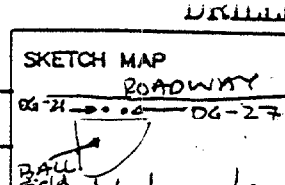
SCREEN: DIA. 4" LENGTH 8.2-13.2' SLOT SIZE 0.020

CASING: DIA. 4" LENGTH 0-8.2' TYPE PVC

DRILLING COMPANY C.S. Garber DRILLING METHOD Auger

DRILLER B. Stoudt LOG BY PDB DATE DRILLED 11/14/90

SKETCH MAP



Water levels measured from top of inner casing

NOTES

OVER BURDEN WELL

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	PID SAMPLE NUMBER	BLOW COUNT/	DESCRIPTION / SOIL CLASSIFICATION (U.S.C.S) (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
1	Collar		ND	10	0-0.5' Dark brown clayey silt loam
2	Grout			14	0.5-1.0' Orange-tan clay and silt, moist
3				15	1.0-2.9' Gleyed and mottled clayey silt
4 (4.2)	Bent.			26	Moist.
5				9	2.9-4.0' Orange-tan silt. Compact, wi
6 (6.2)	#1 SAND PACK			34	thin organic layers.
7				50+	4.0-5.2' Dark brown quartz sand with
8 (8.2)	OVERBURDEN			45	silt matrix. Dry.
9				50+	5.2-6.8' Dark purple micaceous sandy
10				26	silt. Dry
11				50+	6.8-9.0' Dull purple compact, dry
12				50+	arkosic sand.
13				Refusal	9.0-10.5' Brown medium-coarse grained
14 (13.2)					weathered sandstone. Gravel
					also present. Wet.
					11.0-11.8' Dull purple coarse grained
					arkosic sand. Wet
					13.0-13.8' Semi-Lithified dull purple
					coarse grained arkosic sand. Dry

Hydrogeology

- Hit water at 9'
- Well yield = ½ gpm
- Well was developed with a 4" submersible pump.

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APPENDIX B-5

PHASE II RI MONITORING WELL BORINGS

BORING LOG — **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER — BORING NO.: MW-02
PROJECT NO.: 3933 (CTO-0022) — DATE: 6-9-92 & 6-10-92 — DRILLER: DON McMASTER
ELEVATION: — FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA: 21.35' TOC, 7/7/92
(Date, Time & Conditions)

	SAMPLE NO. & TYPE TIME	DEPTH (Ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, Ft.)	MATERIAL DESCRIPTION* SOIL DENSITY: CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
	0945	0.0					RED	CLAY & SILTY CLAY	ML/CL	DAMP TO MOIST
	0947	5.0					RED	SILTY CLAY W/ TR RK. FRAGS	ML	MOIST
	0952	10.0			TOP BEDROCK	MED SOFT	REDDISH GRAY	FGR SANDSTONE & SILTSTONE (MICACEOUS)		DRY
	0956	15.0				MED. HARD	REDDISH GRAY	VERY FGR SANDSTONE & SILTSTONE		
6/9	0958	18.0			6" PVC CSG		RED	SILTSTONE & SHALE		DRY
6/10	0937	20.0					REDDISH GRAY	FGR. SANDSTONE		
	0940	25.0					REDDISH GRAY	FGR. SANDSTONE		DRY
	0942	30.0					REDDISH GRAY	FGR. SANDSTONE		
	0943	35.0				MED HARD	RED	FGR SANDSTONE		
						MED. SOFT		37' - THIN SOFT LYRS - SHALE ?		
	0945	40.0					RED	FGR SANDSTONE - HARD		
								42' - SOFT ZONE - SHALE ?		
	0949	45.0					RED	FGR. SANDSTONE		
								46'-47' SOFTER		
	0950	50.0				MED. HARD	GRAY	FGR SANDSTONE		DRY TO MOIST

REMARKS INGERSOLL-RAND T-4 DRILL RIG. 10" AIR HAMMER BOREHOLE & 6" ID PVC CSG TO APPX 18'. 6" AIR HAMMER OPEN BOREHOLE TO TOTAL DEPTH.

BORING MW-02

PAGE 1 OF 2

* See Legend on back

BORING LOG **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER BORING NO.: MW-02
PROJECT NO.: 3933 (CTO-0022) DATE: 6-9-92 & 6-10-92 DRILLER: DON McMASTER
ELEVATION: FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA:
(Date, Time & Conditions)

SAMPLE NO. & TYPE Time	DEPTH (Ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY/ CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
0952	50.0				MED. HARD	GRAY	FGR SANDSTONE		
					TO HARD	REDDISH GRAY	FGR SANDSTONE, HARDER		
0954	55.0								
0956	60.0					REDDISH GRAY	FGR SANDSTONE		
							63' SOFTER LYR.		
0958	65.0								
						BRN/TAN	FGR SANDSTONE		
0959	70.0					LT. GRAY	FGR SANDSTONE		
					MED HARD	BRN.	FGR SANDSTONE		
					TO HARD				
1000	75.0					BRN.	SANDSTONE, HARDER		
1004	80.0								
									STOP DRILLING APPX 10
1006 TO 20	85.0								MIN. - WELL MAKING SLIGHT AMOUNT OF WATER
					MED. SOFT	RED	SHALE & SILTSTONE		
1021	90.0								TOTAL DEPTH = 90'
				TOTAL DEPTH					FLUSH BOREHOLE WITH POTABLE WATER AND
									COMPRESSED AIR TO REMOVE CUTTINGS.
									EST. YIELD <.1 GPM

REMARKS

BORING MW-02

PAGE 2 OF 2

* See Legend on Back

BORING LOG — HALLIBURTON NUS

PROJECT: NAWC WARMINSTER — BORING NO.: MW-03
PROJECT NO.: 3933 (CTO-0022) — DATE: 6-9-92 & 6-10-92 — DRILLER: DON McMASTER
ELEVATION: — FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA: 21.76' TOC, 7/7/92
(Date, Time & Conditions)

SAMPLE NO. & TYPE / TIME	DEPTH (Ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY: CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
1050	0.0					ORANGE & RED	CLAY & SILTY CLAY w/ TRACES OF SILTSTONE FRAGS	CL/ML	DAMP TO MOIST
1053	5.0					BRN & REDDISH	SILTY CLAY w/ TRACE FRAGS	ML	MOIST
						BRN	OF WEATH. SILTSTONE		
1054	10.0								
				TOP BEDROCK	MED. SOFT	RED	SHALE / MUDSTONE		DRY
1055	15.0					RED	SHALE & SILTSTONE		DRY
6/9 1058	18.0			6" PVC CSG		REDDISH GRAY	VERY FGR SANDSTONE & SILTSTONE		DRY, HARDER
6/10 1133	20.0					RED	SHALE, SILTSTONE & SANDSTONE		
							INCREASING SANDSTONE CONTENT		
1135	25.0				MED. HARD	REDDISH GRAY	FGR. SANDSTONE		DRY
1139	30.0								
1141	35.0								
					MED. SOFT	RED	SHALE & SILTSTONE		
1143	40.0					REDDISH GRAY	FGR SANDSTONE		
						RED	SHALE, SOFT		DRY
1144	45.0								
						RED	SHALE, SOFT.		
1145	50.0								

REMARKS INGERSOLL-RAND T-4 DRILL RIG. 10" AIR HAMMER BOREHOLE & 6" I.D. PVC CSG. TO APPX 18'. 6" DIA. AIR HAMMER OPEN BOREHOLE TO TOTAL DEPTH.

BORING MW-03

PAGE 1 OF 2

* See Legend on Back

BORING LOG **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER BORING NO.: MW-03
PROJECT NO.: 3933 (CTO-0022) DATE: 6-9-92 & 6-10-92 DRILLER: DON MCMASTER
ELEVATION: FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA :
(Date, Time & Conditions)

SAMPLE NO. & TYPE TIME	DEPTH (Ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY/ CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
1147	50.0				MED. HARD	LIGHT REDDISH GRAY	FGR. SANDSTONE		DRY
1149	55.0					REDDISH GRAY	FGR. SANDSTONE		
1150	60.0								
1152	65.0					LIGHT REDDISH GRAY	FGR. SANDSTONE		DRY
1154	70.0								
1157	75.0								
1201	80.0					LIGHT REDDISH GRAY	FGR. SANDSTONE		DRY
1204 / 1217	85.0								STOP DRILLING; WAIT >10 MIN., NO WATER RECHARGE.
1220	90.0								
1221	95.0								
1225	100.0			TOTAL DEPTH		LIGHT REDDISH GRAY	FGR SANDSTONE		NO SIGNIFICANT WATER BEARING ZONES NOTED DURING DRILLING.

REMARKS

BORING MW-03

PAGE 2 OF 2

* See Legend on Back

BORING LOG — HALLIBURTON NUS

PROJECT: NAWC WARMINSTER — BORING NO.: MW-04
PROJECT NO.: 3933 (CTO-0022) — DATE: 6-9-92 & 6-11-92 — DRILLER: DON MCMASTER
ELEVATION: — FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA: 8.07' TOC 7/7/92
(Date, Time & Conditions)

SAMPLE NO. & TYPE TIME	DEPTH (Ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, Ft.)	MATERIAL DESCRIPTION* SOIL DENSITY: CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
1148	0.0					ORANGE RED	SILTY CLAY W/ RK. FRAGS	ML	DAMP
1151	5.0					BLK & RED	CRUSHED STONE GRAVEL W/ SILTY CLAY		FILL
1156	10.0					GRAY BRN.	CLAY W/ RK. FRAGS.	CL	MOIST
						BRN & GRAY	CLAY W/ TRACES RK FRAGS		MOIST
						RED	SANDY SILTY CLAY	ML/SM	
1200	15.0			TOP BEDROCK		BRN.	FGR - MGR ARKOSIC SANDSTONE		WET
					MED. HARD		WEATHERED. TO CONSOLIDATED		
1203	20.0					BRN	MGR - CGR ARKOSIC SANDSTONE		WET
6/9				6" PVC CSG.			& CONGLOMERATE		
6/11					MED. SOFT	RED	SHALE		
1613	25.0					BRN	FGR SANDSTONE		
					MED. HARD				
1616	30.0								
1617	35.0								WATER BEARING ZONE AT APPX 35'
					MED. SOFT	RED	SHALE & SILTSTONE		
1620	40.0				MED	REDDISH	FGR SANDSTONE, HARD		
					HARD TO	GRAY			
					HARD	BRN	FGR SANDSTONE		WATER BEARING ZONE
1622	45.0						SHALE LYR APPX 45'		APPX 43' - 45'
1624	50.0					REDDISH GRAY	FGR SANDSTONE		

REMARKS INGERSOLL-RAND T-4 DRILL RIG. 10" AIR HAMMER BOREHOLE & 6" I.D. PVC CSG. TO APPX 22'. 6" DIA. AIR HAMMER OPEN BOREHOLE TO TOTAL DEPTH.

BORING MW-04

PAGE 1 OF 2

* See Legend on Back

BORING LOG

HALLIBURTON NUS

PROJECT: NAWC WARMINSTER
BORING NO.: MW-04
PROJECT NO.: 3933 (CTO-0022)
DATE: 6-9-92 & 6-11-92
DRILLER: DON MC MASTER
ELEVATION:
FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA :
(Date, Time & Conditions)

SAMPLE NO. & TYPE TIME	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY/ CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
1624	50.0				MED. HARD	REDDISH GRAY	FGR SANDSTONE, HARD		
					TO HARD				
1629	55.0								INCREASED WATER PRODUCTION
					M. SOFT	RED	SHALE		
1631	60.0				MED. HARD	REDDISH GRAY	FGR SANDSTONE		
				TOTAL DEPTH					TOTAL DEPTH APPX 60' DEVELOP W/ AIR 5 MIN. EST YIELD ≥ 2-3 GPM

REMARKS

BORING MW-04

PAGE 2 OF 2

* See Legend on Back

BORING LOG — **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER — BORING NO.: MW-05

PROJECT NO.: 3933 (CTO-0022) — DATE: 6-9-92 & 6-10-92 — DRILLER: DON MC MASTER

ELEVATION: — FIELD GEOLOGIST: R. GOOD

WATER LEVEL DATA: 8.73' TOC 7/7/92

(Date, Time & Conditions)

	SAMPLE NO. & TYPE / TIME	DEPTH (Ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY / SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY/ CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
	1428	0.0					BRN.	SILTY CLAY & CLAY	ML/CL	
	1432	5.0					REDDISH BRN.	SILTY CLAY w/ SILTSTONE & SANDSTONE FRAGS.	ML	
	1435	10.0								
					TOP BEDROCK	MED. HARD	REDDISH GRAY	WEATHERED FGR. SANDSTONE		
	1439	15.0								
										BEDROCK STILL WEATHERE
	1443	20.0				MED SOFT	RED	SHALE & SILTSTONE		NOT WELL CONSOLIDATED.
					6" PVC CSG.	MED.	LIGHT	FGR SANDSTONE, HARD &	V. BR	WATER BEARING ZONE,
6/9	1448	25.0				HARD TO	GRAY	VERY FRACTURED		≈ 5GPM EST.
6/10	1634					HARD				
	1639	30.0					LIGHT GRAY	FGR SANDSTONE, HARD & VERY FRACTURED.		
									V. BR	
	1643	35.0			TOTAL DEPTH					TOTAL DEPTH APPX 35' SANDSTONE FRACTURED INTO LARGE FRAGS (UP TO 1" OR MORE) SOME DAMAGE TO LWR PART OF PVC CSG. EST. YIELD = SEVERAL GPM.

REMARKS INGERSOLL-RAND T-4 DRILL RIG. 10" AIR HAMMER BOREHOLE & 6" ID. PVC CSG TO APPX 25'. 6" DIA. AIR HAMMER OPEN BOREHOLE TO TOTAL DEPTH.

BORING MW-05

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* See Legend on Back

BORING LOG — **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER — BORING NO.: MW-06
PROJECT NO.: 3933 (CTO-0022) — DATE: 6-9-92 & 6-11-92 — DRILLER: DON McMASTER
ELEVATION: — FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA: 10.86' TOC, 7/7/92
(Date, Time & Conditions)

SAMPLE NO. & TYPE / TIME	DEPTH (Ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY/ CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
1613	0.0					BRN	SILTY CLAY	ML	MOIST
1616	5.0				MED	RED	WEATH. SHALE & SILTSTONE		SAPROLITE
					SOFT	RED	SHALE & SILTSTONE		TOP OF BEDROCK APPX 6' TO 7'
1620	10.0					REDDISH GRAY	FGR. SANDSTONE, SLIGHTLY WEATH.		WET
					MED HARD		9'-11' FRACTURED INTO LG. FRAGS	V.BR	WATER BEARING AT SEVERAL GPM
					TO HARD				
1623	15.0								
6/9 1625	18.0			6" PVC CSG		REDDISH GRAY	FGR SANDSTONE, HARD.		
6/11 1454	20.0								
					MED. SOFT	RED	SHALE & SILTSTONE		
					MED HARD	REDDISH GRAY	FGR SANDSTONE		SOME WATER FROM ZONE AT 24'-25'
1449 / 1501	25.0								
1503	30.0								
						BRN.	FGR SANDSTONE		
1504 / 1507	35.0								STOP TO CHECK WATER EST. ≤ 1 GPM
1509	40.0								
					MED. HARD	BRN & RED	FGR SANDSTONE INTERBEDDED W/ SHALE & SILTSTONE		
					MED SOFT		LAYERS		
1511	45.0								
									TOTAL DEPTH APPX 50'
1513	50.0								EST. YIELD ~2 GPM.

REMARKS INGERSOLL-RAND T-4 DRILL RIG. 10" AIR HAMMER BOREHOLE & 6" I.D. PVC CSG TO APPX 18'. 6" AIR HAMMER BOREHOLE OPEN TO TOTAL DEPTH.

BORING MW-06

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* See Legend on Back

BORING LOG — **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER — BORING NO.: MW-07
PROJECT NO.: 3933 (CTO-0022) — DATE: 6-11-92 — DRILLER: DON McMASTER
ELEVATION: — FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA: 9.73' TOC, 7/7/92
(Date, Time & Conditions)

SAMPLE NO. & TYPE	DEPTH (Ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, Ft.)	MATERIAL DESCRIPTION* SOIL DENSITY: CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
S-1 @	0.0	4 / 6				BRN &	6" SILTY CLAY w/ ROOTS		0 PPM, DAMP, FILL
0841	2.0	8 / 11	12"/24"		STIFF	LT. BRN.	6" SANDY SILTY CLAY w/ RK. FRAGS	ML	
S-2 @		3 / 8				RED-BRN BLK-BRN	7" SILTY CLAY w/ TRACE RK FRAGS		0 PPM, DAMP, FILL
0850	4.0	5 / 18	15"/24"		STIFF		3" SANDY SI/CL w/ RK. FRAGS 5" RK. FRAGS w/ SI/CL	ML	
S-3 @		6 / 6				RED-BRN	4" SI/CL w/ RK FRAGS 5" SI/CL w/ LARGER RK FRAGS		0 PPM, DAMP, FILL
0857	6.0	5 / 12	11"/24"		STIFF	& BLK.	2" BLACK TAR OR ASPHALT-LIKE MAT'L w/ RK FRAGS		NON-NATIVE RK FRAGS. 7 PPM FR/ BLK MAT'L
S-4 @		21 / 8				WHITE & BLK	2" TAR OR ASPHALT-LIKE MAT'L w/ RK. FRAGS		4 PPM, MOIST, FILL
0913	8.0	4 / 5	11"/24"		STIFF	REDDISH BRN	6" SILTY CLAY	ML	
S-5 @		2 / 2				BRN. TO	CLAY & SILTY CLAY w/ SMALL RK		0 PPM, DAMP TO MOIST
0924	10.0	6 / 10	17"/24"		STIFF	LT. GRAY	FRAGS & TRACES OF ORGANIC MATTER	CL	FILL
S-6 @		2 / 2				LT. BRN.	CLAY & SILTY CLAY w/ TRACES OF		0 PPM, DAMP, FILL ?
0932	12.0	9 / 15	13"/24"		STIFF	& LT. GRAY	RK. FRAGS & SAND	CL	
S-7 @	13.0	30 / 30			HARD	BRN.	SILTY SAND, TRACE QTZ PEBBLE 3"	SM	0.4 PPM, WET TO
0954		60+	11"/14"				WEATHERED FGR SANDSTONE 7" HARDER FGR-MGR SANDSTONE 1"		SATURATED, WATER AT APPX 12 FT.
									SAMPLE & AUGER REF. @ APPX 13' 2"

REMARKS H.S.A. - 7½" I.D. 12" O.D. - 24" x 2" DIA. SPLIT BARRELL SAMPLE SPOONS. FAILING F-10 DRILL RIG. INSTALL 4" I.D. PVC WELL.

BORING MW-07

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* See Legend on Back

BORING LOG

HALLIBURTON NUS

PROJECT: NAWC WARMINSTER
BORING NO.: MW-08
PROJECT NO.: 3933 (CTO-0022)
DATE: 6-11-92
DRILLER: DON McMASTER
ELEVATION:
FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA: DRY, 7/7/92
(Date, Time & Conditions)

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth ft.)	MATERIAL DESCRIPTION* SOIL DENSITY: CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
S-1 @	0.0	2 / 2				BRN.	SILTY CLAY w/ ROOTS		0 PPM, DAMP
1208	2.0	3 / 3	15"/24"		MED. STIFF			ML	
S-2 @		6 / 16				BRN TO LT. GRAY	6" CLAY & SILTY CLAY		0 PPM, DAMP
1214	4.0	10 / 9	16"/24"		STIFF	ORANGE BRN.	10" SILTY CLAY w/ WEATHERED RED-GRAY, FGR SS FRAGS	ML	
S-3 @		5 / 6				REDDISH	10" SILTY CLAY w/ SMALL SS FRAGS 3" SAND & WEATH. SS FRAGS		0 PPM, DAMP TO
1222	6.0	38 / 29	18"/24"		HARD	BRN	5" SILTY CLAY w/ SS FRAGS	ML	SLIGHTLY MOIST
S-4 @	7.0	20 / 50+	7"/12"		HARD	BRN - GRAY	FGR SAND, WEATH. SS FRAGS, SOME SILT & CLAY	SM	0 PPM, DAMP TO
1230							CONSOL. SS AT 7 FT APPR.		SLIGHTLY MOIST
									SAMPLE REF & AUGER
									REF @ 7'

REMARKS HSA - 7½" I.D. 12" O.D - 24" x 2" SPLIT BARREL SAMPLE SPOONS. FAILING F-10 DRILL RIG. INSTALL 4" I.D. PVC WELL.

BORING MW-08

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* See Legend on Back

BORING LOG **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER BORING NO.: MW-09
PROJECT NO.: 3933 (CTO-0022) DATE: 6-15-92 DRILLER: DON McMASTER
ELEVATION: FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA: 7.90' TOC, 7/7/92
(Date, Time & Conditions)

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY: CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
S-1 @	0.0	5 / 3				BRN.	SILTY CLAY w/ ROOTS & TRACES		0 PPM, DAMP
1041	2.0	4 / 3	15"/24"		MED STIFF		OF SM. RK. FRAGS	ML	
S-2 @		2 / 2				BRN	10" SILTY CLAY 6" SILTY SD. & WEATHERED		0 PPM, DAMP TO WET
1045	4.0	2 / 5	16"/24"		MED. STIFF		SANDSTONE 1" CLAY LAYER	ML	IN LWR. 4"
S-3 @		4 / 4				BRN &	WEATHERED SANDSTONE &		0 PPM MOIST TO WET
1048	6.0	10 / 13	13"/24"		STIFF	REDDISH BRN	SILTSTONE	SM	SAPROLITE
S-4 @	7.0	15 / 50+	6"/8"		HARD	REDDISH GRAY &	WEATHERED TO CONSOLIDATED SANDSTONE		0 PPM, MOIST TO WET
1101						BRN			SAPROLITE / BEDROCK
									SAMPLE REF @ 6'8"
									AUGER REF @ ~7'

REMARKS HSA 7½" I.D., 12" O.D. - 24" x 2" DIAM. SPLIT BARREL SAMPLE SPOONS. FAILING F-10 DRILL RIG. INSTALL 4" I.D. PVC WELL.

BORING MW-09

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BORING LOG **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER BORING NO.: MW-10
PROJECT NO.: 3933 (CTO-0022) DATE: 6-15-92 DRILLER: DON McMASTER
ELEVATION: FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA: DRY, 7/7/92
(Date, Time & Conditions)

SAMPLE NO. & TYPE	DEPTH (Ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, Ft.)	MATERIAL DESCRIPTION* SOIL DENSITY: CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
S-1 @	0.0	5 / 6				BRN.	SILTY CLAY w/ ROOTS & SMALL		0 PPM, DRY TO DAMP
1259	2.0	9 / 9	16"/24"		STIFF		WEATHERED SHALE, SILTSTONE & SANDSTONE FRAGS	ML	
S-2 @		4 / 5				RED BRN. TO	SILTY CLAY w/ WEATHERED SHALE & SILTSTONE FRAGS. 18"		0 PPM, DRY TO DAMP
1305	4.0	10 / 28	17"/24"		HARD	DK. RED BRN.	SANDY SILTY CLAY w/ WEATHERED SANDSTONE FRAGS 4"	SM	- SAPROLITE ?
S-3 @		12 / 24				RED BRN TO	SANDY SILTY CLAY w/ NUMEROUS		0 PPM DAMP
1311	6.0	24 / 25	13"/24"		HARD	REDDISH GRAY	WEATHERED SANDSTONE FRAGS	SM	- SAPROLITE
S-4 @	7.0	50+	2"/5"			REDDISH GRAY	SLIGHTLY WEATHERED TO CONSOLIDATED FGR SANDSTONE		0 PPM, DAMP
1316				REFUSAL					SAMPLE REF. @ 6'5"
									AUGER REF @ ~7'
									ON BEDROCK

REMARKS HSA - 7½" I.D. 12" O.D. - 24" x 2" SPLIT BARREL SAMPLE SPOONS. FAILING F-10 DRILL RIG. INSTALL 4" I.D. PVC WELL.

BORING MW-10

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* See Legend on Back

BORING LOG **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER BORING NO.: MW-11
PROJECT NO.: 3933 (CTO-0022) DATE: 6-15-92 DRILLER: DON McMASTER
ELEVATION: FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA: 8.91' TOC, 7/7/92
(Date, Time & Conditions)

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY/ CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
S-1 @	0.0	5 / 5				BRN.	SILTY CLAY w/ SOME WEATH.		0 PPM DAMP
1434	2.0	6 / 6	13"/24"		STIFF		SHALE & SILTSTONE FRAGS.	ML	
S-2 @		2 / 2				BRN.	SILTY CLAY w/ SOME WEATH.		0 PPM, DAMP
1439	4.0	2 / 4	8"/24"		MED STIFF		SHALE & SILTSTONE FRAGS.	ML	
S-3 @		2 / 2				ORANGE	SILTY CLAY TO CLAY w/ TRACES		0 PPM, DAMP TO MOIST
1446	6.0	2 / 3	12"/24"		MED. STIFF	BRN.	WEATH. SILTSTONE & SHALE	ML/CL	
S-4 @		12 / 12				ORANGE BRN TO	3" SAME AS ABOVE 14" WEATH. SANDSTONE w/ SANDY		0 PPM, DAMP TO WET
1458	8.0	12 / 14	19"/24"		VERY STIFF	DK. RED BRN.	SILTY CLAY 2" WEATH. SHALE	SM/ML	MUD & WATER ON LWR ½ OF SPOON
S-5 @		6 / 10				REDDISH BRN, LT.	7" WEATH. SHALE	ML/SM	0 PPM, MOIST
1508	10.0	72	12"/18"		HARD	GRAY & REDDISH GRAY	5" WEATH. FGR SANDSTONE		SAPROLITE
									REF @ 9'6"

REMARKS HSA 7½" I.D., 12" O.D. 24" x 2" DIA. SPLIT BARREL SAMPLE SPOONS, FAILING F-10 DRILL RIG. INSTALL 4" PVC WELL.

BORING MW-11

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APPENDIX B-6

SURFACE SOIL SAMPLE BORINGS

BORING LOG **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER BORING NO.: SB-01
PROJECT NO.: 3933 (CTO-0022) DATE: 6-16-92 DRILLER: DON MCMASTER
ELEVATION: FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA :
(Date, Time & Conditions)

SAMPLE NO. & TYPE	DEPTH (Ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY: CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
S-1 @	0.0	3 / 6				BRN	SILTY CLAY w/ ROOTS & WEATH.		0 ppm, DAMP
1503	2.0	6 / 7	18"/24"		STIFF		SHALE FRAGS.	ML	POSS. FILL
S-2 @		5 / 7				REDDISH	SILTY CLAY & SANDY SILTY CLAY		0 ppm, DAMP
1507	4.0	10 / 10	19"/24"		STIFF	BRN.	w/ RK. FRAGS.	ML	PROB. NATIVE SOIL
S-3 @		2 / 5				REDDISH	SILTY CLAY w/ SANDSTONE &		0 ppm, DAMP
1512	6.0	8 / 8	16"/24"		STIFF	BRN	SHALE FRAGS.	ML	PROB. SAPROLITE
S-4 @	7.0	10 / 27	12"/12"		HARD	REDDISH BRN.	WEATH. SANDSTONE w/ SILTY CLAY	SM	0 ppm, DAMP SAPROLITE.
1519									REF @ APPX 7.0'

REMARKS 4¼" I.D. HSA ; 24" x 3" DIA SPLIT BARREL SAMPLE SPOONS ;
FAILING F-10 DRILL RIG.
W-SB-01 FOR ANALYSIS FR/ S-1.

BORING SB-01

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* See Legend on Back

BORING LOG **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER BORING NO.: SB-02
PROJECT NO.: 3933 (CTO-0022) DATE: 6-16-92 DRILLER: DON MCMASTER
ELEVATION: FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA:
(Date, Time & Conditions)

SAMPLE NO. & TYPE	DEPTH (Ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY/ CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
S-1 @	0.0	7 / 7				BRN	SILTY CLAY w/ SAND & NON-NATIVE		1.5 ppm FR/ 1.5'-2.0'
1613	2.0	7 / 7	18"/24"		STIFF		RK. FRAGS.	ML	DRY TO DAMP, FILL
S-2 @		3 / 4				BRN	SANDY SILTY CLAY w/ SMALL	ML/	2.0 ppm FR/ 3.0'-4.0'
1617	4.0	5 / 7	16"/24"		STIFF		SANDSTONE FRAGS.	SM	DAMP, FILL
S-3 @		5 / 6				BRN. &	SANDY SILTY CLAY w/ NON-	ML	50.0 ppm MAX FR/ 5'-6
1621	6.0	8 / 7	21"/24"		STIFF	BLK.	NATIVE RK FRAGS, GRAVEL & POSS. ASPHALT	SM	MOIST, FILL
S-4 @		6 / 5			MED.	BRN,	SAND, SILTY CLAY, SMALL FRAGS OF BRICK, POSS COAL, CINDERS		5.0 ppm MAX.
1628	8.0	4 / 4	11"/24"		DENSE	BLK & ORANGE	OR ASHY MAT'L, GLASS, METAL, PLASTIC DEBRIS, ETC.		MOIST, FILL
S-5 @		2 / 2			LOOSE	BRN,	SAME AS ABOVE w/ SMALL LIGHT		1.0 ppm
1633	10.0	4 / 5	9"/24"			BLK & ORANGE	GREENISH WHITE, SOFT CRYSTALLINE FRAGS.		MOIST, FILL
S-6 @		3 / 2				BRN, BLK,	SAND SILT, CLAY, GLASS		3.0 ppm
1636	12.0	4 / 4	12"/24"		LOOSE	ORANGE, TAN	BRICK, ASH, ETC...		SATURATED FR/ APPX 11' TO 12', FILL
									COMPLETE BORING AT 12' DUE TO SATURATED CONDITIONS

REMARKS 4¼" I.D. HSA ; 24" x 3" DIA SPLIT BARREL SAMPLE SPOONS ;
FAILING F-10 DRILL RIG
W-SB-02 FOR ANALYSIS FR/ S-3, S-4, S-5 & S-6

BORING SB-02

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* See Legend on back

OBTAINED SHELBY TUBE SAMPLES FROM 6'-8' AND 8'-10' IMMED. ADJACENT TO SB-02. TUBE FROM 6'-8' DEFORMED & CLOGGED w/ WIRE - POOR REC., TUBE FROM 8'-10' HAD 15" REC.

BORING LOG **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER BORING NO.: SB-03
PROJECT NO.: 3933 (CTO-0022) DATE: 6-16-92 DRILLER: DON McMASTER
ELEVATION: FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA :
(Date, Time & Conditions)

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth ft.)	MATERIAL DESCRIPTION* SOIL DENSITY: CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
	0.0					GRAY &	LG CRUSHED STONE W/ FINES	GM	AUGER TO 2' - NOT POS-
	2.0					BRN	OF PARKING AREA COVER		TO OBTAIN SAMPLE
S-1 @		5 / 5				BRN TO REDDISH	SILTY CLAY W/ TRACE SAND 2" LYR OF BLACK ASPHALT -	ML	1.0 PPM FR/ BLK LYR.
1835	4.0	6 / 8	17"/24"		STIFF	BRN.	LIKE MAT'L W/ CRUSHED STONE AT 2½ FT		DAMP, FILL.
S-2 @		2 / 2				REDDISH BRN TO	SILTY CLAY W/ SMALL WEATH SHALE, SILTSTONE	ML	0 PPM, DAMP TO MOIST
1839	6.0	2 / 3	15"/24"		MED. STIFF	ORANGE BRN.	& SANDSTONE FRAGS.		APPEARS TO BE NATIVE SUBSOIL OR SAPROLITE
S-3 @		2 / 3				ORANGE BRN, BLK	CLAY & SILTY CLAY W/ BLK	CL	0 PPM, MOIST TO WE
1844	8.0	2 / 3	12"/24"		MED. STIFF	& DK. BRN.	LYR OF DECAYED PLANT MAT'L AT APPX 7 FT.		POSS. NATIVE MAT'L
S-4 @		5 / 12			STIFF TO	ORANGE BRN &	SILTY CLAY & CLAY 3" DK. GRAY SOFT CLAY W/ BLK &	CL/ML	0 PPM, MOIST TO SAT.
1854	10.0	12 / 10	20"/24"		VERY STIFF	DK. GRAY	GREEN SMALL FRAGS ~~10"~~ 7" WEATH. SANDSTONE & SHALE 10"		PROB. NATIVE MAT'L
									GREEN & BLK FRAGS MAY
									BE WEATH CLAY MINERAL
									& NAT. ORGANIC MATTER.
									INTERVAL FR 6-10 FT
									HAS THE APPEARANCE OF
									NATURAL WETLAND DEPOSI
									OVERLYING SAPROLITE
									- IF SO THE INTERVAL
									FR 4-6 FT WOULD THEN
									REPRESENT CLEAN FILL

REMARKS 4¼" I.D. HSA ; 24" x 3" DIA. SPLIT BARREL SAMPLE SPOONS ; FAILING F-10 DRILL RIG.
W-SB-03 FOR ANALYSIS FR/ S-1

BORING SB-03

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* See Legend on Back

BORING LOG **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER BORING NO.: SB-04
PROJECT NO.: 3933 (CTO-0022) DATE: 6-16-92 DRILLER: DON McMASTER
ELEVATION: FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA :
(Date, Time & Conditions)

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY/ CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
	0.0					GRAY &	LG. CRUSHED STONE W/ FINES	GM	AUGER TO 2', NOT POS
	2.0					BRN.	OF PARKING LOT COVER.		TO SAMPLE.
S-1 @		2 / 5			MED	BLK	APPX 2" CINDER-ASH-ASPHALT LIKE MAT'L W/ RK FRAGS.	GM	4 ppm FR BLK LYR
1935	4.0	3 / 6	19"/24"		STIFF	ORANGE BRN	SILTY CLAY W/ WEATH SHALE & SANDSTONE FRAGS	ML	0 ppm, DAMP, FILL
S-2 @		2 / 4			TO	GRAY TO RED-BRN	DECAYED ORGANIC MATTER & CLAY NEAR TOP, THIN SAND	CL/OL	0 ppm, DAMP
1939	6.0	8 / 9	20"/24"		STIFF	TO ORANGE BRN	SILT & CLAY W/ NUMEROUS WEATH RK FRAGS.	ML	PROB FILL AT TOP
S-3 @		5 / 7			MED STIFF	REDDISH	SILTY CLAY, WEATH SANDSTONE,	ML	0 ppm, DAMP TO
1944	8.0	9 / 11	22"/24"		TO V. STIFF	BRN	SILTSTONE & SHALE FRAGS. SOME GRAY & ORANGE CLAYS	CL	MOIST. SAPROLITE
							NEAR BASE		

REMARKS 4¼" I.D. HSA ; 24" x 3" SPLIT BARREL SAMPLE SPOONS ; FAILING F-10 DRILL RIG.
'U-SB-04 FOR ANALYSIS FR/ S-1 & S-2

BORING SB-04

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* See Legend on back

BORING LOG **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER BORING NO.: SB-05
PROJECT NO.: 3933 (CTO-0022) DATE: 6-17-92 DRILLER: DON McMASTER
ELEVATION: FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA:
(Date, Time & Conditions)

SAMPLE NO. & TYPE	DEPTH (Ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, Ft.)	MATERIAL DESCRIPTION* SOIL DENSITY/ CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
S-1 @	0.0	4 / 4				ORANGE	SILTY CLAY w/ ROOTS & SMALL		0 ppm, DAMP
0826	2.0	4 / 4	18"/24"		STIFF	BRN.	WEATH SANDSTONE & SHALE FRAGS.	ML	NATIVE SOIL OR CLEAN FILL
S-2 @		3 / 2				REDDISH	SANDY SILTY CLAY w/ SMALL		0 ppm, DAMP
0830	4.0	6 / 6	17"/24"		STIFF	BRN.	SANDSTONE & SHALE FRAGS	ML	NATIVE SOIL OR CLEAN FILL
S-3 @		4 / 8				REDDISH	WEATHERED F/GR. SANDSTONE		0 ppm, SATURATED
0833	6.0	8 / 8	18"/24"		STIFF	GRAY		SM	SAPROLITE.

REMARKS 4¼" I.D. HSA; 24" x 3" DIA. SPLIT BARREL SAMPLE SPOONS:
FAILING F-10 DRILL RIG
W-SB-05 FOR ANALYSIS FR/ S-7

BORING SB-05

PAGE 1 OF 1

* See Legend on Back

BORING LOG **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER BORING NO.: SB-06
PROJECT NO.: 3933 (CRO-0022) DATE: 6-17-92 DRILLER: DON McMASTER
ELEVATION: FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA :
(Date, Time & Conditions)

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth ft.)	MATERIAL DESCRIPTION* SOIL DENSITY/ CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
S-1 @	0.0	3 / 3				REDDISH BRN,	SILTY CLAY W/ ROOTS & SMALL RK FRAGS OVERLYING ASHY OR		0 ppm, DAMP
0916	2.0	6 / 8	18"/24"		STIFF	BLK & LT. GRAY	CINDER MAT'L W/ GLASS FRAGS & SMALL SOFT WHITE FRAGS.	ML	FILL/WASTE
S-2 @		2 / 4				BRN	2" SILTY CLAY		0 ppm, DAMP TO WET
0919	4.0	6 / 5	5"/24"		STIFF	BLK	ASH & MISC. DEBRIS (METAL, GLASS, PLASTIC, ETC. .)	ML	FILL/WASTE
S-3 @		2 / 3				GRAY	4" ASHY MAT'L AS ABOVE		0 ppm, WET TO MOIST
0923	6.0	5 / 5	18"/24"		STIFF	ORANGE	SILTY CLAY & CLAY W/ SMALL SANDSTONE & SHALE FRAGS.	ML	WASTE/SAPROLITE

REMARKS 4¼" I.D. HSA ; 24" x 3" DIA SPLIT BARREL SAMPLE SPOONS ;
FAILING F-10 DRILL RIG
W-SB-06 FOR ANALYSIS FR/ S-2 & S-3

BORING SB-06

PAGE 1 OF 1

* See Legend on back

BORING LOG **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER BORING NO.: SB-07
PROJECT NO.: 3933 (CTO-0022) DATE: 6-17-92 DRILLER: DON McMASTER
ELEVATION: FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA :
(Date, Time & Conditions)

SAMPLE NO. & TYPE	DEPTH (Ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, Ft.)	MATERIAL DESCRIPTION* SOIL DENSITY/ CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
S-1 @	0.0	3 / 4				REDDISH BRN &	SILTY CLAY & CLAY w/ ROOTS & SMALL SANDSTONE &		0 PPM, DRY TO DAMP
1002	2.0	5 / 6	19"/24"		STIFF	ORANGE BRN	SHALE FRAGMENTS	ML	FILL?
S-2 @		3 / 4				REDDISH BRN &	SILTY CLAY & CLAY w/ SOME SMALL RK FRAGS		0 PPM, DAMP
1006	4.0	6 / 9	20"/24"		STIFF	ORANGE BRN		ML	FILL?
S-3 @		3 / 6				RED &	SILTY CLAY, CLAY & SANDY SILTY CLAY w/ SMALL SHALE		0 PPM, DAMP
1010	6.0	9 / 12	19"/24"		MED. STIFF	REDDISH BRN	SILTSTONE & SANDSTONE FRAGS	ML/SM	POSS. SAPROLITE
S-4 @		4 / 10			TO HARD	RED &	CLAY, SILTY CLAY & WEATH.	ML	0 PPM, DAMP
1017	8.0	25 / 50+	14"/18"			REDDISH BRN.	SHALE		SAPROLITE
									REF. @ 7.5 FT

REMARKS 4¼" I.D. HSA ; 24" x 3" DIA. SPLIT BARREL SAMPLE SPOONS ;
FAILING F-10 DRILL RIG
W-SB-07 FOR ANALYSIS FR/ S-2

BORING SB-07

PAGE 1 OF 1

* See Legend on Back

BORING LOG **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER BORING NO.: SB-08
PROJECT NO.: 3933 (CTO-0022) DATE: 6-17-92 DRILLER: DON MC MASTER
ELEVATION: FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA :
(Date, Time & Conditions)

SAMPLE NO. & TYPE	DEPTH (Ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, Ft.)	MATERIAL DESCRIPTION* SOIL DENSITY: CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
S-1 @	0.0	2 / 3			MED	BRN	SANDY SILTY CLAY W/ ROOTS		1.0 PPM. DAMP
1143	2.0	4 / 6	19"/24"		STIFF			ML	FILL
S-2 @		2 / 2			MED	BRN	SANDY SILTY CLAY W/ ROOTS	ML	0 PPM, DAMP
1146	4.0	3 / 6	16"/24"		STIFF		MORTAR & BRICK FRAGS NEAR BASE		FILL
S-3 @	5.0	4 / 50+	8"/12"		HARD	BRN TO BLK.	SANDY SILTY CLAY W/ BRICK, MORTAR, CONCRETE & POSS.		0.6 PPM, DAMP
1150							ASPHALT FRAGS.		FILL
									REF. @ APPX 5 FT. ON CONCRETE.
									MOVE RIG APPX 8 FT EAST & TRY AGAIN
	0.0								
	2.0								
S-4 @		4 / 4			MED	BRN	SILTY CLAY W/ SOME SAND &	ML	0 PPM. DAMP
1203	4.0	3 / 4	16"/24"		STIFF		SANDSTONE FRAGS.		FILL
S-5 @		4 / 5				TAN RED	MORTAR, SAND, CONCRETE FRAGS BRICK SILTY CLAY, BLK ASH		0 PPM, DAMP
1206	6.0	6 / 3	17"/24"		STIFF TO	BRN & BLK	OR CINDER MAT'L, POSS ASPHALT.		FILL
S-6 @		14 / 50+	6"/6"		HARD	BRN & WHITE	SANDY SILTY CLAY W/ BRICK FRAGS — CONCRETE		0 PPM, DAMP
1213									REF @ 6'8" ON CONCRETE

REMARKS 4¼" I.D. HSA ; 24" x 3" DIA SPLIT BARREL SAMPLE SPOONS ;
FAILING E-10 DRILL RIG
W-SB-08 FOR ANALYSIS FR/ S-1, S-2, S-3 OF 1ST BORING

BORING SB-08

PAGE 1 OF 1

* See Legend on Back

BORING LOG **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER BORING NO.: SB-09
PROJECT NO.: 3933 (CTO-0022) DATE: 6-17-92 DRILLER: DON McMASTER
ELEVATION: FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA:
(Date, Time & Conditions)

SAMPLE NO. & TYPE	DEPTH (Ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, Ft.)	MATERIAL DESCRIPTION* SOIL DENSITY: CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
S-1 @	0.0	3 / 5				BRN. BLK &	SILTY CLAY W/ ROOTS GRAVEL & SANDY SILTY CLAY	ML / GM	3.0 ppm, DAMP
1306	2.0	5 / 7	15"/24"		STIFF	GRAY	SANDY SILTY CLAY W/ RK. FRAGS.		FILL
S-2 @		2 / 4				BRN	SILTY CLAY, UPR ½	ML	0 ppm, DAMP
1310	4.0	8 / 15	20"/24"		VERY STIFF		SAND & SANDY SILTY CLAY LWR ½	SM	
S-3 @		12 / 16				BRN TO REDDISH	SILTY CLAY W/ SAND & WEATH. SANDSTONE FRAGS.	ML	0 ppm. MOIST
1315	6.0	10 / 9	24"/24"		VERY STIFF	BRN.	WEATH. SHALE W/ SANDSTONE IN LWR PART.	SM	SAPROLITE

REMARKS 4¼" I.D. HSA; 24" x 3" DIA SPLIT BARREL SAMPLE SPOONS; FAILING F-10 DRILL RIG.
W-SB-09 FOR ANALYSIS FR/ S-1 & S-2

* See Legend on Back

SHELBY TUBE FROM 0.5 - 2.5 FT AT THIS LOC'N, REC. = 16.5"

BORING SB-09

PAGE 1 OF 1

BORING LOG **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER BORING NO.: SB-10
PROJECT NO.: 3933 (CTO-0022) DATE: 6-17-92 DRILLER: DON McMASTER
ELEVATION: FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA:
(Date, Time & Conditions)

SAMPLE NO. & TYPE	DEPTH (Ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY/ CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
S-1 @	0.0	3 / 3				ORANGE BRN &	SILTY CLAY w/ SANDSTONE &	ML	0 ppm, DRY TO DAMP
1412	2.0	4 / 5	16"/24"		STIFF	REDDISH BRN	SILTSTONE FRAGS.		FILL
S-2 @		5 / 6			TO	BRN	SILTY CLAY ~13"	ML	0 ppm, DAMP
1415	4.0	9 / 12	21"/24"		VERY STIFF		WEATH. MGR SANDSTONE ~8"	SM	SUBSOIL & SAPROLITE ?
S-3 @		5 / 6				BRN	SILTY CLAY w/ NUMEROUS	ML	0 ppm, MOIST
1420	6.0	12 / 8	22"/24"				WEATH. SANDSTONE FRAGS & SAND LAYERS	SM	SAPROLITE.

REMARKS 4¼" I.D. HSA ; 24" x 3" DIA. SPLIT BARREL SAMPLE SPOONS ;
FAILING F-10 DRILL RIG.
W-SB-10 FOR ANALYSIS FR/ S-1

BORING SB-10

PAGE 1 OF 1

* See Legend on Back

BORING LOG **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER BORING NO.: SB - 11
PROJECT NO.: 3933 (CTO - 0022) DATE: 6-17-92 DRILLER: DON MC MASTER
ELEVATION: FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA :
(Date, Time & Conditions)

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth ft.)	MATERIAL DESCRIPTION* SOIL DENSITY: CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
	0.0 / 1.0								
S-1 @		2 / 2			MED. STIFF	ORANGE BRN &	SILTY CLAY & CLAY w/	ML	0 ppm, DAMP
1504	3.0	4 / 6	21"/24"		TO STIFF	LT. GRAY	ROOTS		NATURAL SOIL ?
									BACKGROUND SOIL SAMPLE - AUGER TO 1 FT & SAMPLE TO 3 FT.

REMARKS 4½" I.D. HSA ; 24" x 3" DIA SPLIT BARREL SAMPLE SPOONS ;
FAILING F-10 DRILL RIG.
W - SB - 11 FOR ANALYSIS FR/ S-1

BORING SB - 11

PAGE 1 OF 1

* See Legend on Back

BORING LOG **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER BORING NO.: SB-12
PROJECT NO.: 3933 (CTO-0022) DATE: 6-17-92 DRILLER: DON McMASTER
ELEVATION: FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA:
(Date, Time & Conditions)

SAMPLE NO. & TYPE	DEPTH (Ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY/ CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
	0.0								
	2.0								
S-1 @		2 / 4			MED STIFF TO	REDDISH	SILTY CLAY W/ NUMEROUS	ML	0 PPM DAMP
1550	4.0	8 / 11	22"/24"		VERY STIFF	BRN.	WEATH. SANDSTONE, SILTSTONE & SHALE FRAGS.	SM	NATURAL SOIL OR SAPROLITE ?
									BACKGROUND SOIL SAMPLE
									AUGER TO 2 FT SAMPLE TO 4 FT.

REMARKS 4¼" I.D. HSA ; 24" x 3" DIA SPLIT BARREL SAMPLE SPOONS ;
FAILING F-10 DRILL RIG
W-SB-12 FOR ANALYSIS FR/ S-1

BORING SB-12

PAGE 1 OF 1

* See Legend on Back

APPENDIX C

TEST PIT INFORMATION

APPENDIX C-1

TEST PIT LOGS

completed 5-1-90

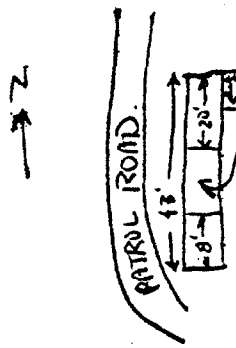
BY JKW DATE 5/2/90 **SMC Martin Inc.** SHEET 1 OF 1

CHKD. BY _____ DATE _____ W. O. NO. 9522-20005

PROJECT NAOC

SUBJECT TEST PITS: TEST PIT S6 - PIT-1

(1.) WASTE WAS DISCOVERED IN 2½' - 3' DEEP HORIZON. PID = NON-DETECTED.
WASTE = WIRES, BROKEN glass, ROOTS, ELECTRONIC PARTS. 0' - 2½' within the 10' MOST NORTHERN HAS PIECES of concrete.



concrete 0' - 2½' feet.

waste detected here. (2½ - 3' DEEP) water leaks into pit from this zone.

(2.) DIMENSIONS

WIDTH: ~3 FEET (one BUCKET width)
Length: 43' FEET
DEPTH: 6' FEET (BEDROCK) maroon red sandstone

(3) SOIL STRATIGRAPHY SUMMARY

DEPTH	DESCRIPTION	PID
0' - 2½'	LIGHT BROWN SILT AND FINE SAND (SM) AND CONCRETE IN 10' OF NORTHERN END OF TRENCH.	ND
2½' - 3'	"WASTE" WIRES, ELECTRONIC PARTS, GLASS, ROOTS. WATER leaks into pit from this zone.	ND
3' - 6'	MAROON RED SAND	ND
	WATER ENCOUNTERED 2½' - 3'	ND

completed 5-1-90

BY JKW DATE 5-9-90 **SMC Martin Inc.** SHEET 1 OF 1

CHKD. BY _____ DATE _____ W. O. NO. 9522-20005

PROJECT NADC

SUBJECT TEST PITS: TEST PIT SG-PIT-2

(1.) ONLY WASTE DETECTED WAS TWO SMALL STRIPS OF SHEET METAL DISCOVERED AT 5.5' DEEP ON THE EASTERN END OF THE PIT. AIR MONITORING INSTRUMENTS = NON-DETECTED.

(2.) DIMENSIONS

WIDTH: ~3 FEET (ONE BUCKET WIDTH)
LENGTH: 52 FEET
DEPTH 9½ FEET (BEDROCK & GROUNDWATER.)

(3.) SOIL STRATIGRAPHY SUMMARY

DEPTH	DESCRIPTION	PID
0'-1'	BROWN SILT & FINE SAND (OL/sm).	ND
1'-2½'	ORANGE AND GRAY MOTTLED SILT AND CLAY. (ML)	ND
2½'-9½'	MAROON-RED SAND AND SILT LOAM (sm). @ 5½ – sheet metal	ND
@ 9½	weathered maroon-red sandstone and groundwater.	ND

completed 5-1-90

BY JKW DATE 5-9-90 **SMC Martin Inc.** SHEET 1 OF 1

CHKD. BY _____ DATE _____ W. O. NO. 9522-20005

PROJECT NADC

SUBJECT TEST PITS: TEST PIT S6-PIT-3

(1.) NO WASTE DETECTED. AIR MONITORING INSTRUMENTS < NOTV - DETECTED.

(2.) DIMENSIONS

WIDTH: ~3 FEET (ONE BUCKET WIDTH)

LENGTH: 42 FEET

DEPTH: 10 FEET (BEDROCK & GROUNDWATER)

(3.) SOIL STRATIGRAPHY SUMMARY

DEPTH	DESCRIPTION	PID
0' - 1/2'	LIGHT BROWN SILT (OL)	ND
@ 1/2'	OLD TOP SOIL HORIZON ~~at~~ DARKER BROWN SILT, with humus (OL).	ND
1/2' - 4.0'	BROWN SANDY LOAM (SM).	ND
4.0' - 9.0'	MAROON RED SAND AND SILT LOAM WITH PIECES OF BUFF COLORED/WEATHERED ARKOSE.	ND
@ 9.0'	GROUNDWATER	ND
9.0' - 10.0'	WEATHERED MAROON RED SHALE (BEDROCK).	ND

completed 5-1-90

BY JKW DATE 5-9-90 **SMC Martin Inc.** SHEET 1 OF 1

CHKD. BY _____ DATE _____ W. O. NO. 9522-20005

PROJECT NADC

SUBJECT TEST PITS: TEST PIT S6-PIT-4

(1.) WASTE DETECTED ON SOUTHERN END OF TEST PIT WHERE MOUND IS BISECTED. WASTE IN MOUND = ASPHALT. ASPHALT YIELDS ~~A~~ 0.1 PPM FROM THE PID.

(2.) DIMENSIONS:

WIDTH: ~ 3 FEET (ONE BUCKET WIDTH)
LENGTH: 43 FEET
DEPTH: 4 FEET (BEDROCK)

(3.) SOIL STRATIGRAPHY SUMMARY:

DEPTH	DESCRIPTION	PID
6' ABOVE GROUND - GROUND SURFACE (0')	BROWN SANDY LOAM AND ASPHALT (SM)	ND
0' - 1/2'	LIGHT BROWN SANDY LOAM (OL).	ND
1/2' - 1'	BROWN SANDY LOAM (SM).	ND
1' - 4'	BROWN SANDY LOAM (SM) WITH PIECES OF WEATHERED/BUFF COLORED ARKOSE. SOME PIECES ARE AS LARGE AS COBBLES	ND
@ 4'	WEATHERED ARKOSE (BEDROCK)	

NO WATER ENCOUNTERED

completed 5-1-90

BY JKW DATE 5-9-90 **SMC Martin Inc.** SHEET 1 OF 1

CHKD. BY _____ DATE _____ W. O. NO. 9522-20005

PROJECT NAOC

SUBJECT TEST PITS : TEST PIT SG-PIT - 5

(1.) AT NORTH EAST END A SMALL AMOUNT OF SCRAP METAL AND AN EMPTY DRUM IS UNCOVERED AT ~3 FEET DEEP. DRUM APPEARS TO HAVE CONTAINED SILVER PAINT ~~WHICH~~ NOW (has) dried. PID INSTRUMENT = NON-DETECTED.

(2) DIMENSIONS:

WIDTH: ~3 FEET (ONE Bucket width)
LENGTH: 25 FEET
DEPTH: 10 FEET (BED ROCK)

(3.) SOIL STRATIGRAPHY SUMMARY:

DEPTH	DESCRIPTION	PID
0'-3'	ORANGE-BROWN SANDY LOAM (sm). AT NORTHEAST END SCRAP metal and empty drum.	ND
3'-9'	maroon-red sand (sp).	ND
9'-10'	weathered maroon-red sandstone	ND

NO WATER ENCOUNTERED.

complete 1 5-1-90

BY JKW DATE 5-9-90 **SMC Martin Inc.** SHEET 1 OF 1

CHKD. BY _____ DATE _____ W. O. NO. 9522-20005

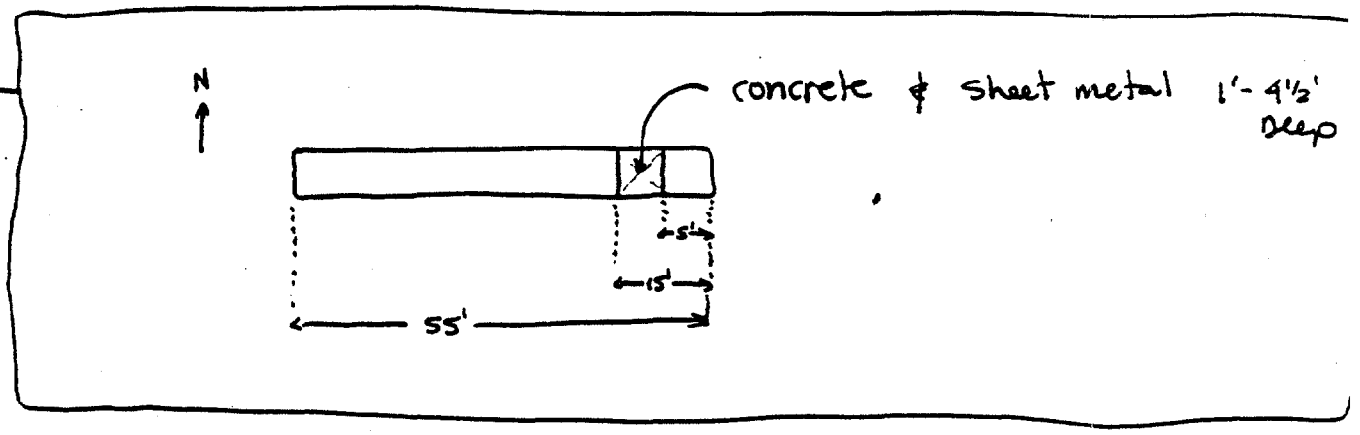
PROJECT NAPC

SUBJECT TEST PITS: TEST PIT S6 - PIT - 6

(1.) WITHIN A PORTION OF THE EASTERN PART OF THE PIT: concrete and small strips of sheet metal were encountered from 1.0' → 4½' Deep.

(2.) DIMENSIONS

WIDTH: ~3 FEET (one bucket width)
LENGTH: 55 FEET
DEPTH: 6 FEET (BEDROCK)



(3.) SOIL STRATIGRAPHY SUMMARY

DEPTH	DESCRIPTION	PID
0'-1½'	DARK BROWN SILT WITH FINE SAND (SM).	ND
@ 1½'	GRADATIONAL BOUNDARY	
1½'-3¼'	LIGHT BROWN SANDY LOAM (SM).	ND
3¼'-6'	MAROON RED SAND (SP).	ND
6'	maroon red sandstone	
(1.0'-4.5')	concrete & sheet metal as indicated above	ND

NO WATER ENCOUNTERED

BY JKW DATE 5/2/90 **SMC Martin Inc.** SHEET 1 OF 1

CHKD. BY _____ DATE _____ W. O. NO. 9522-22005

PROJECT NAOC

SUBJECT TEST PIT LOG: TEST PIT S7-PIT-1

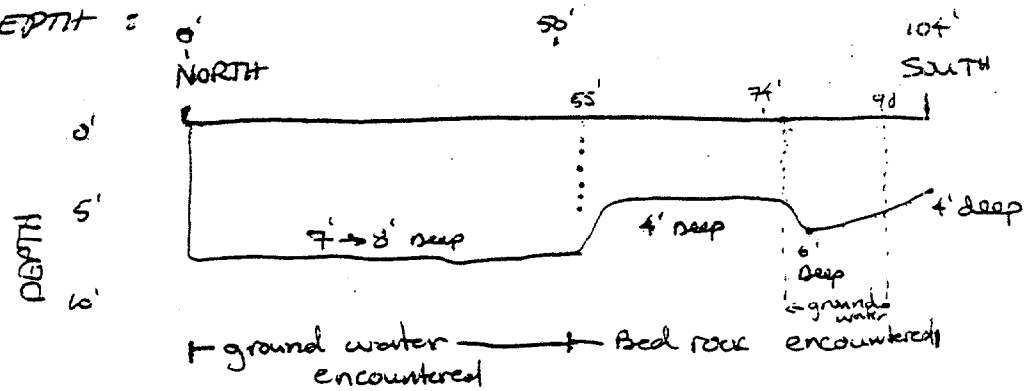
(1.) NO WASTE DETECTED. AIR MONITORING EQUIPMENT REMAINED NON-DETECTED.

(2.) DIMENSIONS

WIDTH: ~3 FEET (one bucket width)

LENGTH: 104 FEET

DEPTH:



(3.) soil stratigraphy summary

DEPTH (ft)	DESCRIPTION	PID
(0'-0.5')	BROWN SILT w/ GRASS & GRASS ROOTS (OL).	ND
(0.5'-1.25')	~~ORANGE AND GRAY~~ LIGHT BROWN SILT AND FINE SAND (SM).	ND
(1.25'-3.25')	ORANGE AND GRAY MOTTLED SILT WITH SOME CLAY (ML).	ND
(3.25'-4.0')	ORANGE AND GRAY MOTTLED FINE SAND AND SILT (SM)	ND
(4.0'-7.0')	MAROON RED MICACEOUS SAND (SP).	ND
(7.0'-8.0')	maroon RED OR GRAY CLAY (CL)	ND
8.0'	BEDROCK - maroon RED SILTSTONE	ND

BY: JKW DATE 5/2/90 **SMC Martin Inc.** SHEET 1 OF 1

CHKD. BY _____ DATE _____ W. O. NO. 9522-20005

PROJECT NADC

SUBJECT TEST PIT LOG: TEST PIT S7-PIT-2

(1.) NO WASTE DETECTED. AIR MONITORING EQUIPMENT REMAINED NON-DETECTED.

(2.) DIMENSIONS:

WIDTH: ~ 3 Feet (one bucket width)
Length: 62 ft. long
DEPTH: From 4.75' TO 6.0' (BED ROCK)

(3.) SOIL STRATIGRAPHY SUMMARY

DEPTH	DESCRIPTION	PID
(0'-0.75')	LIGHT BROWN SILT AND FINE SAND WITH GRASS (OL).	ND
(0.75'-3.0'/3.75')	GRAY AND ORANGE MOTTLED SILT AND CLAY (ML).	ND
(3.0'/3.75'-4.75'/5.0')	MAROON RED CLAY AND SILT (ML). WITH SOME GRAY CLAY.	ND
(4.75'/5.0'-6.0')	SLIGHTLY WEATHERED RED SILTSTONE, BEDROCK -	ND

Fragments of conglomeratic sandstone found on northern side of test pit

BY JKW DATE 5/2/90 **SMC Martin Inc.** SHEET 1 OF 1

CHKD. BY _____ DATE _____ W. O. NO. 9522-20005

PROJECT NADC

SUBJECT TEST PIT LOG: TEST PIT S7-3

1. NO WASTE DETECTED. AIR MONITORING EQUIPMENT REMAINED NON-DETECTED.

2. DIMENSIONS:

WIDTH: ~3 FEET (one bucket width)
Length: 50 FEET
Depth: 8.25 FEET, (BEDROCK)

3. SOIL STRATIGRAPHY SUMMARY

DEPTH	DESCRIPTION	RID/FID
(0'-0.80')	LIGHT BROWN SILT WITH FINE SAND (OL).	ND
(0.80'-3.25')	ORANGE AND GRAY MOTTLED SILT AND CLAY (ML).	ND
(3.25'-7.0')	MAROON RED SAND (SP).	ND
(7.0-8.25')	MAROON RED SANDSTONE (MICACEOUS)	ND

APPENDIX C-2

SUMMARY OF TEST PIT RESULTS

TABLE 5-5
TEST PIT SUMMARY
RI STAGE I
NADC WARMINSTER, PA

Test Pit #	Location	Length	Depth	Waste[1] Encountered	PID/FID (ppm)	Observations
S7-PIT-1	Site 7	104'	0-8'	None	ND	Hit bedrock at 4 to 8'
S7-PIT-2	Site 7	62'	0-6'	None	ND	Hit bedrock at 6'
S7-PIT-3	Site 7	50'	0-8.25'	None	ND	Hit bedrock at 7 to 8.25'
S6-PIT-1	Site 6	43'	0-2.5'	F,C	ND	
			2.5-3'	WI,GL	ND	Water encountered
			3-6'	None	ND	Hit bedrock at 6'
S6-PIT-2	Site 6	52'	0-5.5'	F,None	ND	
			at 5.5'	M	ND	
			5.5-9.5	None	ND	Hit bedrock and water at 9.5'
S6-PIT-3	Site 6	42'	0-9.5'	None	ND	Hit bedrock at 9-10'and water at 9'

NOTE:
1 - Abbreviations explained on next page.

9710:JWTBJ.WP

TABLE 5-5 - CONTINUED

Test Pit #	Location	Length	Depth	Waste Encountered	PID/FID (ppm)	Observations
S6-PIT-4	Site 6	43'	0-6'	F,AS	0.1 (PID)	Mound 6' above surrounding grade
			6-10'	None	ND	Pit 4' below surrounding grade Hit bedrock at 10'
S6-PIT-5	Site 6	25'	0-3'	F,D,M	ND	
			3-10'	None	ND	Hit bedrock at 9-10'
S6-PIT-6	Site 6	55'	0-1'	F,None	ND	
			1-4.5'	C,M	ND	
			4.5-6'	None	ND	Hit bedrock at 6'

Waste Abbreviations:

F= Miscellaneous Clean Fill
C= Cement
AS= Asphalt
WI= Wires and Electronic Parts
M= Scrap Metal
D= Empty Drum
GL= Glass

TABLE 5-6

SEDIMENT
TCL VOLATILES
DECEMBER 1990 RESULTS

NADC RI STAGE .I
WARMINSTER, PA

CONCENTRATIONS ARE IN UG/KG

LAB ID.	8797	8799	8810	8801	8802	8804	8806	8794
FIELD ID.	SED-1	SED-2	SED-2(DUP)	SED-3	SED-4	SED-5	SED-6	SED-8
COMPOUNDS								
CHLOROMETHANE	21 J	-	-	-	-	-	-	-
METHYLENE CHLORIDE	14 JB	41 B	12 JB	13 JB	23 JB	12 JB	15 JB	16 JB
ACETONE	280 B	170 B	200 B	66 B	-	150 B	340 B	670 B
1,2-DICHLOROETHENE(TOTAL)	2 J	-	-	-	-	-	-	-
CHLOROFORM	-	17 J	-	-	2 J	-	-	-
TRICHLOROETHENE	5 J	-	-	-	-	-	-	-
TETRACHLOROETHENE	6 J	-	-	-	-	-	-	-
TOLUENE	82	-	2 J	-	-	7 J	13 J	-
ETHYLBENZENE	4 J	-	-	-	-	-	-	-
m-XYLENE	8 J	-	-	-	-	-	-	-
o & p-XYLENE	11 J	-	-	-	-	-	-	-
VOLATILES - TENTATIVELY IDENTIFIED COMPOUNDS								
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHENE (FREON)	330 B	-	200 B	35 B	30 B	230 B	170 B	35 B
ALPHA-PINENE	30	-	-	-	-	-	-	-

EXPLANATION: J - INDICATES DETECTED BELOW CONTRACT REQUIRED QUANTITATION LIMIT
B - INDICATES COMPOUND FOUND IN BLANK
"-" NOT DETECTED

APPENDIX D

MONITORING WELL CONSTRUCTION INFORMATION

Well Construction Specifications for NAWC Wells, Warminster, Pennsylvania

Well Identification	Total Depth (ft.)	Depth to Bottom of Casing (ft.)	Length of Screen or Open Interval (ft.)	Well Diameter (in.)	Reported Well Yield (gpm)	Well Type	General Status or Conditions of the Well
Phase II RI Wells							
MW-01	85	18	67	6	2	Monitoring	Operational
MW-02	90	18	72	6	2	Monitoring	Operational
MW-03	100	18	82	6	1.5	Monitoring	Operational
MW-04	60	22	38	6	>5	Monitoring	Operational
MW-05	35	25	10	6	>7	Monitoring	Operational
MW-06	50	18	32	6	>5	Monitoring	Operational
MW-07	13	8	5	4	<0.5	Monitoring	Operational
MW-08	7	2	5	4	---	Monitoring	Often Dry
MW-09	7	2	5	4	<0.5	Monitoring	Operational
MW-10	7	2	5	4	---	Monitoring	Often Dry
MW-11	9.5	4.5	5	4	<0.5	Monitoring	Operational

NOTE:

--- indicates information is unavailable

Well Construction Specifications for
NAWC Wells, Warminster, Pennsylvania
Page two

Well Identification	Total Depth (ft.)	Depth to Bottom of Casing (ft.)	Length of Screen or Open Interval (ft.)	Well Diameter (in.)	Reported Well Yield (gpm)	Well Type	General Status or Conditions of the Well
Phase I RI Wells							
BG-4	47	17.05	29.95	6	<0.5	Monitoring	Operational
BG-5	47	17	30	6	2	Monitoring	Operational
BG-6	22	15	7	6	1	Monitoring	Operational
BG-7	37	18.15	18.75	6	<0.5	Monitoring	Operational
DG-12	75	18	57	6	0.5	Monitoring	Operational
DG-13	22	18	4	6	1-2	Monitoring	Operational
DG-14	46	18	28	6	0.5	Monitoring	Operational
DG-15	22	18	4	6	0.5	Monitoring	Operational
DG-16	38	18	20	6	1	Monitoring	Operational
DG-17	38	16.5	21.5	6	<0.5	Monitoring	Operational
DG-18	27	22	5	6	1	Monitoring	Operational
DG-19	47	21.75	25.25	6	0.5	Monitoring	Operational
DG-20	32	17.6	14.4	6	1	Monitoring	Operational
DG-21	33	15	18	6	<0.5	Monitoring	Operational
DG-22	61	20	41	6	0.5	Monitoring	Operational
DG-23	47	23.5	23.5	6	0.5-1	Monitoring	Operational
DG-24	43	22	21	6	0.5	Monitoring	Operational
DG-25	41	21	20	6	1	Monitoring	Operational
DG-26	15.25	10	5.25	4	2	Monitoring	Operational
DG-27	13.8	8.2	5.6	4	0.5	Monitoring	Operational
DG-28	10	5	5	4	<0.5	Monitoring	Operational

NOTE:

--- indicates information is unavailable

Well Construction Specifications for
NAWC Wells, Warminster, Pennsylvania
Page three

Well Identification	Total Depth (ft.)	Depth to Bottom of Casing (ft.)	Length of Screen or Open Interval (ft.)	Well Diameter (in.)	Reported Well Yield (gpm)	Well Type	General Status or Conditions of the Well
Existing Wells							
RCRA A (SMC-2)	285	60	225	6	80	Monitoring	Operational
RCRA B (SMC-1)	60	20	40	6	20.5	Monitoring	Operational
RCRA C	40	34.50	5.50	4	---	Monitoring	Operational
RCRA D (SMP-1)	35	34.50	5.50	4	---	Monitoring	Operational
RCRA E	40	30	10	4	---	Monitoring	Operational
SMP-2	40	34.50	5.50	4	3	Monitoring	Operational
BG-1	15.90	11.60	4.30	2	---	Monitoring	Operational
BG-2	14.70	10.40	4.30	2	---	Monitoring	Operational
BG-3	17.35	13.23	4.30	2	---	Monitoring	Location paved over
DG-1	18.75	14.50	4.25	2	---	Monitoring	Operational
DG-2	17.70	13.50	4.30	2	---	Monitoring	Operational
DG-3	14.75	10.46	4.30	2	---	Monitoring	Operational
DG-4	14.04	9.75	4.29	2	---	Monitoring	Operational
DG-5	16.75	12.45	4.30	2	---	Monitoring	Operational
DG-6	17.10	12.75	4.35	2	---	Monitoring	Operational
DG-7	15.05	10.75	4.30	2	---	Monitoring	Operational
DG-8	9.87	5.60	4.27	2	---	Monitoring	Operational
DG-9	15.75	10.95	4.80	2	---	Monitoring	Operational
DG-10	15.00	10.70	4.30	2	---	Monitoring	Operational
DG-11	16.85	12.56	4.29	2	---	Monitoring	Obstructed at approx. 13 ft.

Well Construction Specifications for
NAWC Wells, Warminster, Pennsylvania
Page four

Well Identification	Total Depth (ft.)	Depth to Bottom of Casing (ft.)	Length of Screen or Open Interval (ft.)	Well Diameter (in.)	Reported Well Yield (gpm)	Well Type	General Status or Conditions of the Well
Existing Wells							
MP-1	101	18	83	6	20	Monitoring	Operational
MP-2	101	19	82	6	20	Monitoring	Operational
MP-3	132	38.5	93.5	6	5	Monitoring	Operational
SW-1	247	26	221	8.75	117	Supply	Provides water to the NAWC fire protection system
SW-2	246	30	216	8.75	120	Supply	Provides water to the NAWC fire protection system
SW-3	570	30	540	8	160	Supply	Provides water to the main NAWC supply system
SW-4	584	29	555	8	160	Supply	Provides water to the main NAWC supply system
SW-5	341	62	279	8	76	Supply	Out of service because of VOC contamination, reportedly borehole has collapsed
SW-6	560	---	---	8	35	Supply	Not in use, formerly provided water to Building No. 80
SW-7	400	---	---	8	20	Supply	Not in use, formerly provided water to quarters "A".
SW-8	200	---	---	8	---	Supply	Provides water to quarters "B"
SW-9	385	---	---	8	135	Supply	Provides water to the one NAWC building
SW-10	400	---	---	8	400	Supply	Provides water to the main NAWC supply system
SW-11	400	57	343	10 inner casing 6 borehole in bedrock	90	Oberservation	Bucks Co. Planning Commission/United States Geological Survey continuously monitors water level

NOTE:

--- indicates information is unavailable

APPENDIX E

MONITORING WELL CASING AND GROUNDWATER ELEVATIONS

NAWC OVERBURDEN MONITORING WELLS
CASING ELEVATIONS AND GROUNDWATER ELEVATION
MEASUREMENTS, PHASE I AND II RI INVESTIGATION

Well I.D.	Casing Elevation (feet MSL)	December 1990		January 22, 24, 1990		July 7, 1992		August 13, 1992	
		Depth to Groundwater (feet TOC)	Groundwater Elevation (feet MSL)	Depth to Groundwater (feet TOC)	Groundwater Elevation (feet TOC)	Depth to Groundwater (feet TOC)	Groundwater Elevation (feet MSL)	Depth to Groundwater (feet TOC)	Groundwater Elevation (feet MSL)
BG-1	362.63	15.08	347.55	(1)	-	15.42	37.21	(1)	-
BG-2	351.04	9.08	341.96	5.65	345.39	6.14	344.90	6.93	344.11
BG-3	311.65	6.22	305.43	4.95	306.70	(2)	-	(2)	-
DG-1	308.19	12.27	295.42	10.10	298.09	12.16	296.03	13.12	295.07
DG-2	309.93	9.10	300.83	8.22	301.71	8.94	300.99	9.40	300.53
DG-3	311.18	8.00	303.18	5.04	306.14	9.14	302.04	9.70	301.48
DG-4	330.17	2.35	327.82	1.71	328.46	3.59	326.58	4.40	325.77
DG-5	336.76	6.98	329.78	6.35	330.41	7.52	329.24	8.25	328.51
DG-6	335.10	7.90	327.20	7.18	327.92	8.70	326.40	9.30	325.80
DG-7	338.29	8.04	330.25	0.70	337.59	(3)	-	(3)	-
DG-8	332.08	3.60	328.48	0.50	331.58	2.07	330.01	4.14	327.94
DG-9	342.08	8.85	333.23	3.01	339.07	7.90	334.18	9.47	332.61
DG-10	344.71	8.95	335.76	1.12	343.59	4.90	339.81	8.48	336.23
DG-11	321.57	(3)	-	(3)	-	(3)	-	(3)	-
DG-26	308.58	10.61	297.97	9.62	298.96	10.25	298.33	10.79	297.79
DG-27	338.38	8.29	330.09	1.18	337.20	5.75	332.63	8.73	329.65
DG-28	334.25	7.29	323.96	5.51	328.74	8.08	326.17	9.22	325.03
MW-07	313.32	(4)	-	(4)	-	9.73	303.59	10.13	303.19
MW-08	328.30	(4)	-	(4)	-	(1)	-	(1)	-
MW-09	327.81	(4)	-	(4)	-	7.90	319.91	(1)	-
MW-10	310.34	(4)	-	(4)	-	(1)	-	(1)	-
MW-11	309.86	(4)	-	(4)	-	8.91	300.95	9.13	300.73

(1) Well dry at time of measurement
(2) Well location paved over
(3) Well obstructed
(4) Well not installed during Phase I
MSL= Referenced to U.S.G.S. mean Sea Level Elevation
TOC= Referenced to top of casing

NAWC BEDROCK MONITORING WELLS
CASING ELEVATIONS AND GROUNDWATER ELEVATION
MEASUREMENTS, PHASE I AND II RI INVESTIGATION

Well I.D.	Casing Elevation (feet MSL)	December 1990		January 22, 24, 1990		July 7, 1992		August 13, 1992	
		Depth to Groundwater (feet TOC)	Groundwater Elevation (feet MSL)	Depth to Groundwater (feet TOC)	Groundwater Elevation (feet TOC)	Depth to Groundwater (feet TOC)	Groundwater Elevation (feet MSL)	Depth to Groundwater (feet TOC)	Groundwater Elevation (feet MSL)
BG-4	315.62	19.64	295.98	17.62	298.00	18.88	276.74	20.00	295.62
BG-5	335.53	15.48	320.05	11.33	324.20	15.66	319.87	18.07	317.46
BG-6	351.76	8.47	343.29	6.42	345.34	6.84	344.92	7.09	344.07
BG-7	368.11	21.99	346.12	18.37	349.74	22.09	346.02	24.59	343.52
DG-12	308.59	10.22	298.37	9.60	298.99	8.73	299.86	9.32	299.27
DG-13	313.16	8.07	305.09	7.49	305.67	8.35	304.81	8.92	304.27
DG-14	327.11	18.65	308.46	14.33	312.78	18.62	308.49	22.95	304.16
DG-15	339.13	7.78	331.35	7.10	332.03	8.80	330.33	9.40	329.73
DG-16	334.59	6.00	328.59	4.83	329.76	7.72	326.87	8.84	325.75
DG-17	347.64	15.06	332.58	8.82	338.82	14.03	333.61	16.73	330.91
DG-18	343.99	13.78	330.21	7.78	336.21	12.12	331.87	14.55	329.44
DG-19	346.25	16.24	330.01	10.25	336.00	13.67	332.58	16.72	329.53
DG-20	333.20	6.63	326.57	4.00	329.20	5.76	327.44	7.42	325.78
DG-21	338.90	9.24	329.66	2.71	336.19	6.78	332.12	9.54	329.36
DG-22	331.57	2.81	328.76	1.88	329.69	3.67	327.90	4.76	326.81
DG-23	310.14	8.90	301.24	8.21	301.93	9.13	301.01	9.65	300.49
DG-24	336.84	8.20	328.64	7.52	329.32	8.75	328.09	9.43	327.41
DG-25	338.17	9.09	329.08	3.42	334.75	7.11	331.06	9.59	328.58
SMC-1	313.91	(1)	-	(1)	-	19.11	294.80	18.89	295.02
SMP-2	317.16	(1)	-	(1)	-	17.87	299.29	19.18	297.98
C	309.63	(1)	-	(1)	-	19.41	290.22	21.01	288.62
D	310.13	(1)	-	(1)	-	16.73	293.40	17.66	292.47
E	310.64	(1)	-	(1)	-	15.35	295.29	16.52	294.12
MW-01	326.65	(2)	-	(2)	-	16.65	310.00	20.27	306.38
MW-02	317.43	(2)	-	(2)	-	21.35	296.08	23.13	294.30
MW-03	313.36	(2)	-	(2)	-	21.76	291.60	25.36	288.00
MW-04	312.68	(2)	-	(2)	-	8.07	304.61	8.67	304.01
MW-05	328.53	(2)	-	(2)	-	8.73	319.80	9.68	318.85
MW-06	331.84	(2)	-	(2)	-	10.86	320.98	11.80	320.04
SMC-2*	313.01	(1)	-	(1)	-	8.05	304.96	10.35	302.66

1. Wells not measured during Phase I.
2. Wells not installed during Phase I.
* Deep Bedrock Well
MSL= Referenced to U.S.G.S. mean Sea Level Elevation
TOC= Referenced to top of casing

APPENDIX F

GROUNDWATER VELOCITY CALCULATIONS

CALCULATION OF GROUNDWATER VELOCITY
DECEMBER 1989

NAWC Phase I RI

Formula Used:

$$V = \frac{k(dh/dl)}{n}$$

where:

k = hydraulic conductivity

$\frac{dh}{dl}$ = hydraulic gradient as measured at site

n = % effective porosity

k = 0.1 ft/day for overburden
1.5 ft/day for bedrock
(from Satterthwaite, 1984)

OPTION 1

silty overburden = 46%
fine-medium sandstone = 41% (from Todd, 1980)

OPTION 2

overburden and bedrock = 15% (from Satterthwaite, 1984)

1. Sites 1, 2, and 3

A. Overburden dh/dl = 0.01

Option 1

$$V = \frac{(0.1)\ (0.01)}{0.46} = 2.17 \times 10^{-3} \text{ ft/day} = 0.792 \text{ ft/yr}$$

Option 2

$$V = \frac{(0.1)\ (0.01)}{(0.15)} = 6.67 \times 10^{-3} \text{ ft/day} = 2.43 \text{ ft/yr}$$

B. Bedrock dh/dl = 0.015

Option 1

$$V = \frac{(1.5)\ (0.015)}{0.41} = 5.49 \times 10^{-2} \text{ ft/day} = 20.04 \text{ ft/yr}$$

Option 2

$$V = \frac{(1.5)\ (0.015)}{(0.15)} = 1.5 \times 10^{-1} \text{ ft/day} = 54.75 \text{ ft/yr}$$

2. <u>Site 4</u>

A. Overburden dh/dl = 0.034

Option 1

$$V = \frac{(0.1)\ (0.01)}{0.46} = 7.39 \times 10^{-3} \text{ ft/day} = 2.70 \text{ ft/yr}$$

Option 2

$$V = \frac{(.1)\ (0.034)}{(0.15)} = 2.3 \times 10^{-2} \text{ ft/day} = 8.27 \text{ ft/yr}$$

B. Bedrock dh/dl = 0.035

Option 1

$$V = \frac{(1.5)\ (0.035)}{0.41} = 1.28 \times 10^{-1} \text{ ft/day} = 46.72 \text{ ft/yr}$$

Option 2

$$V = \frac{(1.5)\ (0.035)}{(0.15)} = 3.5 \times 10^{-1} \text{ ft/day} = 127.75 \text{ ft/yr}$$

3. <u>Sites 5, 6, and 7</u>

A. Overburden dh/dl = 0.018

Option 1

$$V = \frac{(0.1)\ (0.01)}{0.46} = 3.91 \times 10^{-3} \text{ ft/day} = 1.43 \text{ ft/yr}$$

Option 2

$$V = \frac{(.1)\ (0.018)}{(0.15)} = 1.2 \times 10^{-2} \text{ ft/day} = 4.38 \text{ ft/yr}$$

B. Bedrock dh/dl = 0.012

Option 1

$$V = \frac{(1.5)\ (0.012)}{0.41} = 4.39 \times 10^{-2} \text{ ft/day} = 16.02 \text{ ft/yr}$$

Option 2

$$V = \frac{(1.5)\ (0.012)}{(0.15)} = 1.2 \times 10^{-1} \text{ ft/day} = 43.8 \text{ ft/yr}$$

C. Bedrock dh/dl = 0.033

Option 1

$$V = \frac{(1.5)\ (0.033)}{0.41} = 1.21 \times 10^{-1} \text{ ft/day} = 44.17 \text{ ft/yr}$$

Option 2

$$V = \frac{(1.5)\ (0.033)}{(0.15)} = 3.3 \times 10^{-1} \text{ ft/day} = 120.45 \text{ ft/yr}$$

4. <u>Site 8</u>

A. Bedrock dh/dl = 0.030

Option 1

$$V = \frac{(1.5)\ (0.030)}{0.41} = 1.1 \times 10^{-1} \text{ ft/day} = 40.15 \text{ ft/yr}$$

Option 2

$$V = \frac{(1.5)\ (0.030)}{(0.15)} = 3.0 \times 10^{-1} \text{ ft/day} = 109.5 \text{ ft/yr}$$

SUMMARY OF
GROUNDWATER WATER VELOCITY ESTIMATES
NAWC PHASE I RI
WARMINSTER, PENNSYLVANIA

Sites 1, 2, and 3

Overburden Aquifer	0.79 ft/yr to 2.4 ft/yr
Shallow Bedrock Aquifer	20 ft/yr to 54 ft/yr

Site 4

Overburden Aquifer	2.7 ft/yr to 8.3 ft/yr
Shallow Bedrock Aquifer	46 ft/yr to 130 ft/yr

Sites 5, 6, 7

Overburden Aquifer	1.4 ft/yr to 4.4 ft/yr
Shallow Bedrock Aquifer	16 ft/yr to 44 ft/yr (dh/dl=0.012) 44 ft/yr to 120 ft/yr (dh/dl=0.033)

Site 8

Bedrock Aquifer	40 ft/yr to 110 ft/yr

CALCULATIONS OF GROUNDWATER VELOCITY
SEPTEMBER 1992

NAWC PHASE II RI
WARMINSTER, PENNSYLVANIA

HALLIBURTON NUS Environmental Corporation and Subsidiaries		STANDARD CALCULATION SHEET	
CLIENT: NAWC WARMINSTER	FILE NO.: 3933	BY: R. GOOD	PAGE 1 OF 1
SUBJECT: SITES 1, 2 AND 3 : HORIZONTAL GROUNDWATER VELOCITIES (OVERBURDEN AQUIFER)		CHECKED BY: TRA	DATE: 10 Nov 92

$$V = \frac{(I)(k)}{n} = \text{HORIZONTAL GROUNDWATER VELOCITY}$$

I = HORIZONTAL GRADIENT

= 0.015 (PHASE II GROUNDWATER ELEVATIONS, 8-13-92) ✓

k = HYDRAULIC CONDUCTIVITY

= 0.016 TO 1.83 FT/DAY (PHASE II SLUG TEST RESULTS) ✓

n = POROSITY

= 0.46 (TODD, 1980) AND 0.15 (SATTERTHWAITE, 1984) ✓

$$V = \frac{(0.015)(0.016\ \text{FT/DAY})}{(0.46)} = 0.00052\ \text{FT/DAY} = 0.2\ \text{FT/YR}$$ ✓

FOR 0.016 FT/DAY HYDRAULIC CONDUCTIVITY AND 46 % POROSITY

$$V = \frac{(0.015)(0.016\ \text{FT/DAY})}{(0.15)} = 0.0016\ \text{FT/DAY} = 0.6\ \text{FT/YR}$$ ✓

FOR 0.016 FT/DAY HYDRAULIC CONDUCTIVITY AND 15 % POROSITY

$$V = \frac{(0.015)(1.83\ \text{FT/DAY})}{(0.46)} = 0.06\ \text{FT/DAY} = 22\ \text{FT/YR}$$ ✓

FOR 1.83 FT/DAY HYDRAULIC CONDUCTIVITY AND 46 % POROSITY

$$V = \frac{(0.015)(1.83\ \text{FT/DAY})}{(0.15)} = 0.183\ \text{FT/DAY} = 67\ \text{FT/YR}$$ ✓

FOR 1.83 FT/DAY HYDRAULIC CONDUCTIVITY AND 15 % POROSITY

HALLIBURTON NUS Environmental Corporation and Subsidiaries — **STANDARD CALCULATION SHEET**

CLIENT: NAWC WARMINSTER	FILE NO.: 3933	BY: R. GOOD	PAGE 1 OF 1
SUBJECT: SITES 1, 2 AND 3 : HORIZONTAL GROUNDWATER VELOCITIES (SHALLOW BEDROCK AQUIFER)		CHECKED BY: TKA	DATE: 10 Nov 92

$$V = \frac{(I)(k)}{n} = \text{HORIZONTAL GROUNDWATER VELOCITY}$$

I = HORIZONTAL GRADIENT
= 0.025 (PHASE II GROUNDWATER ELEVATIONS, 8-13-92)

k = HYDRAULIC CONDUCTIVITY
= 0.992 FT/DAY (PHASE II SLUG TEST RESULTS)

n = POROSITY
= 0.10 AND 0.25 (RANGE FROM RIMA, ET AL., 1962)

$$V = \frac{(0.025)(0.992\ \text{FT/DAY})}{(0.25)} = 0.0992\ \text{FT/DAY} = 36\ \text{FT/YR} \quad ✓$$

FOR 25 % POROSITY

$$V = \frac{(0.025)(0.992\ \text{FT/DAY})}{(0.10)} = 0.248\ \text{FT/DAY} = 91\ \text{FT/YR} \quad ✓$$

FOR 10 % POROSITY

HALLIBURTON NUS Environmental Corporation and Subsidiaries — **STANDARD CALCULATION SHEET**

CLIENT:	FILE NO.:	BY:	PAGE 1 OF 1
NAWC WARMINSTER	3933	R. GOOD	
SUBJECT: SITE 4: HORIZONTAL GROUNDWATER VELOCITY (OVERBURDEN AQUIFER)		CHECKED BY: TRA	DATE: 10 Nov 92

$V = \frac{(I)(k)}{n}$ = HORIZONTAL GROUNDWATER VELOCITY

I = HORIZONTAL GRADIENT

= 0.04 (PHASE II GROUNDWATER ELEVATIONS, 8-13-92)

k = HYDRAULIC CONDUCTIVITY

= 0.1 FT/DAY (SATTERTHWAITE, 1984)

n = POROSITY

= 0.46 (TODD, 1980) AND 0.15 (SATTERTHWAITE, 1984)

$V = \frac{(0.04)(0.1\ FT/DAY)}{(0.46)}$ = 0.0087 FT/DAY = 3.2 FT/YR. ✓

FOR 46 % POROSITY

$V = \frac{(0.04)(0.10\ FT/DAY)}{(0.15)}$ = 0.0267 FT/DAY = 9.7 FT/YR ✓

FOR 15 % POROSITY

HALLIBURTON NUS Environmental Corporation and Subsidiaries	STANDARD CALCULATION SHEET

CLIENT: NAWC WARMINSTER	FILE NO.: 3933	BY: R. GOOD	PAGE 1 OF 1
SUBJECT: SITE 4: HORIZONTAL GROUNDWATER VELOCITY (SHALLOW BEDROCK AQUIFER)		CHECKED BY: PER	DATE: 10 Nov 92

$$V = \frac{(I)(k)}{n} = \text{HORIZONTAL GROUNDWATER VELOCITY}$$

I = HORIZONTAL GRADIENT
= 0.04 (PHASE II GROUNDWATER ELEVATIONS, 8-13-92)

K = HYDRAULIC CONDUCTIVITY
= 1.5 FT/DAY (SATTERTHWAITE, 1984)

n = POROSITY
= 0.10 AND 0.25 (RANGE FROM RIMA, ET AL., 1962)

$$V = \frac{(0.04)(1.5\ \text{FT/DAY})}{(0.25)} = 0.24\ \text{FT/DAY} = 88\ \text{FT/YR.}$$ ✓

FOR 25 % POROSITY

$$V = \frac{(0.04)(1.5\ \text{FT/DAY})}{(0.10)} = 0.60\ \text{FT/DAY} = 219\ \text{FT/YR}$$ ✓

FOR 10 % POROSITY

HALLIBURTON NUS Environmental Corporation and Subsidiaries — **STANDARD CALCULATION SHEET**

CLIENT: NAWC WARMINSTER	FILE NO.: 3933	BY: R. GOOD	PAGE 1 OF 1
SUBJECT: SITES 5, 6 AND 7 : HORIZONTAL GROUND WATER VELOCITIES (OVERBURDEN AQUIFER)		CHECKED BY: TRA	DATE: 10 Nov 92

$$V = \frac{(I)(k)}{n} = \text{HORIZONTAL GROUNDWATER VELOCITY}$$

I = HORIZONTAL GRADIENT
= 0.025 (PHASE II GROUNDWATER ELEVATIONS, 7-7-92)

k = HYDRAULIC CONDUCTIVITY
= 0.1 FT/DAY (SATTERTHWAITE, 1984)

n = POROSITY
= 0.46 (TODD, 1980) AND 0.15 (SATTERTHWAITE, 1984)

$$V = \frac{(0.025)(0.1\ \text{FT/DAY})}{(0.46)} = 0.0054\ \text{FT/DAY} = 1.98\ \text{FT/YR.}$$

FOR 46 % POROSITY

$$V = \frac{(0.025)(0.1\ \text{FT/DAY})}{(0.15)} = 0.0167\ \text{FT/DAY} = 6.08\ \text{FT/YR}$$

HALLIBURTON NUS Environmental Corporation and Subsidiaries	STANDARD CALCULATION SHEET

CLIENT: NAWC WARMINSTER	FILE NO.: 3933	BY: R. GOOD	PAGE 1 OF 1
SUBJECT: SITES 5, 6 AND 7 : HORIZONTAL GROUND WATER VELOCITY (BEDROCK AQUIFER)		CHECKED BY: TRR	DATE: 10 Nov 92

$V = \frac{(I)(k)}{n}$ = HORIZONTAL GROUNDWATER VELOCITY

I = HORIZONTAL GRADIENT
= 0.01 TO 0.025 (PHASE II GROUNDWATER ELEVATIONS, 8-13-92)

k = HYDRAULIC CONDUCTIVITY
= 31.2 FT/DAY (PHASE II SLUG TEST RESULTS)

n = POROSITY
= 0.10 AND 0.25 (RANGE FROM RIMA, ET AL., 1962)

$V = \frac{(0.01)(31.2\ FT/DAY)}{(0.25)} = 1.25\ FT/DAY = 455\ FT/YR$ ✓

FOR 1% HORIZONTAL GRADIENT & 25% POROSITY

$V = \frac{(0.01)(31.2\ FT/DAY)}{(0.10)} = 3.12\ FT/DAY = 1140\ FT/YR$ ✓

FOR 1% HORIZONTAL GRADIENT & 10% POROSITY

$V = \frac{(0.025)(31.2\ FT/DAY)}{(0.25)} = 3.12\ FT/DAY = 1140\ FT/YR$ ✓

FOR 2.5% HORIZONTAL GRADIENT & 25% POROSITY

$V = \frac{(0.025)(31.2\ FT/DAY)}{(0.10)} = 7.8\ FT/DAY = 2850\ FT/YR$ ✓

FOR 2.5% HORIZONTAL GRADIENT & 10% POROSITY

HALLIBURTON NUS Environmental Corporation and Subsidiaries	STANDARD CALCULATION SHEET

CLIENT: NAWC WARMINSTER	FILE NO.: 3933	BY: R. GOOD	PAGE 1 OF 1
SUBJECT: SITE 8 : HORIZONTAL GROUNDWATER VELOCITY (SHALLOW BEDROCK AQUIFER)		CHECKED BY: RCR	DATE: 10 Nov 92

$$V = \frac{(I)(k)}{n}$$

V = HORIZONTAL GROUNDWATER VELOCITY

I = HORIZONTAL GRADIENT
= 0.035 (PHASE II GROUNDWATER ELEVATIONS, 8-13-92)

K = HYDRAULIC CONDUCTIVITY
= 0.53 FT/DAY (PHASE II SLUG TEST RESULTS)

n = POROSITY
= 0.10 AND 0.25 (RANGE FROM RIMA, ET AL., 1962)

$$V = \frac{(0.035)(0.53\ FT/DAY)}{(0.25)} = 0.074\ FT/DAY = 27\ FT/YR.$$

FOR 25% POROSITY

$$V = \frac{(0.035)(0.53\ FT/DAY)}{(0.10)} = 0.186\ FT/DAY = 68\ FT/YR.$$

FOR 10% POROSITY

SUMMARY OF
GROUNDWATER WATER VELOCITY ESTIMATES
NAWC PHASE II RI
WARMINSTER, PENNSYLVANIA

Sites 1, 2, and 3

Overburden Aquifer	0.2 ft/yr to 0.6 ft/yr (K = 0.0016 ft/day) 22 ft/day to 67 ft/yr (K = 1.83 ft/day)
Shallow Bedrock Aquifer	36 ft/yr to 91 ft/yr

Site 4

Overburden Aquifer	3.2 ft/yr to 9.7 ft/yr
Shallow Bedrock Aquifer	88 ft/yr to 219 ft/yr

Sites 5, 6, 7

Overburden Aquifer	1.98 ft/yr to 6.1 ft/yr
Shallow Bedrock Aquifer	455 ft/yr to 1140 ft/yr (I=0.01) 1140 ft/yr to 2850 ft/yr (I=0.025)

Site 8

Bedrock Aquifer	27 ft/yr to 68 ft/yr

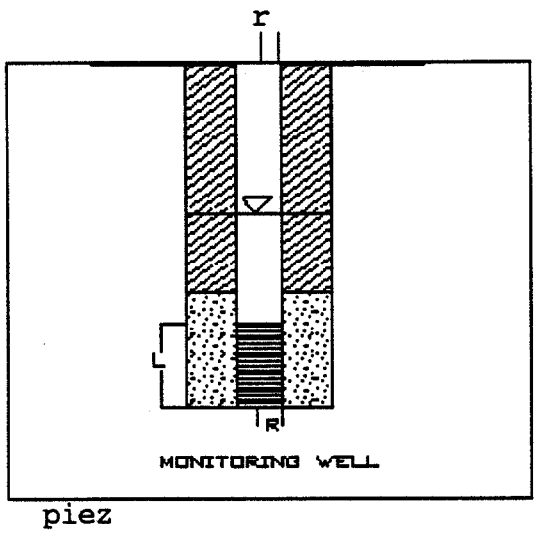
APPENDIX G

SLUG TEST DATA AND CALCULATIONS

SLUG TEST CALCULATION - HVORSLEV METHOD

HNUS CORPORATION
July 15, 1992

NAWC WARMINSTER
MW-01 FALLING HEAD



$r := .25$ = well casing radius (ft.)
$R := .25$ = effective well radius (ft.)
$L := 64$ = effective well length (ft.)
$T := 6.3$ = time (min.) to 37% of change in head ratio (from semi-log plot)

R = Well screen radius if K(Aq) > sand
or - Sand pack radius if K(Aq) < sand
L = Height of water in screened section
or - Height of water in sand pack
ln = natural log (e)
k = hydraulic conductivity (ft./min.)

Hvorslev's Equation ->

$$k := \frac{r^2 \cdot \left[\ln\left[\frac{L}{R}\right]\right]}{2 \cdot L \cdot T}$$

$k = 4.3 \cdot 10^{-4}$ <- ft./min.

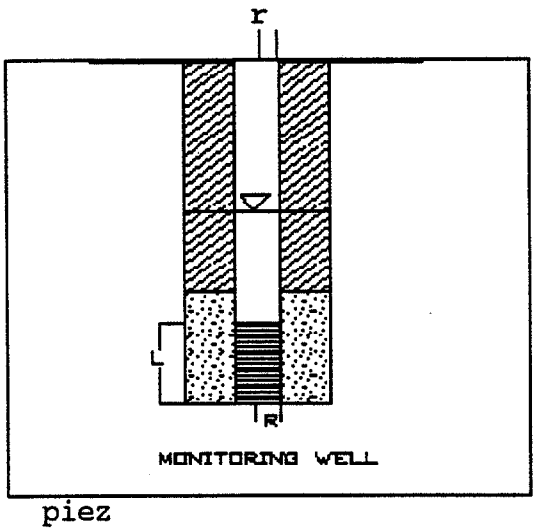
$k \cdot 1440 = 0.62$ <- ft./day

$k \cdot .508 = 2.18 \cdot 10^{-4}$ <- cm./sec.

SLUG TEST CALCULATION - HVORSLEV METHOD

HNUS CORPORATION
July 15, 1992

NAWC WARMINSTER
MW-01 RISING HEAD



$r := .25$ = well casing radius (ft.)
$R := .25$ = effective well radius (ft.)
$L := 64$ = effective well length (ft.)
$T := 8.7$ = time (min.) to 37% of change in head ratio (from semi-log plot)

R = Well screen radius if K(Aq) > sand
or - Sand pack radius if K(Aq) < sand
L = Height of water in screened section
or - Height of water in sand pack
ln = natural log (e)
k = hydraulic conductivity (ft./min.)

Hvorslev's Equation ->

$$k := \frac{r^2 \cdot \left[\ln\left[\frac{L}{R}\right]\right]}{2 \cdot L \cdot T}$$

$k = 3.11 \cdot 10^{-4}$ <- ft./min.

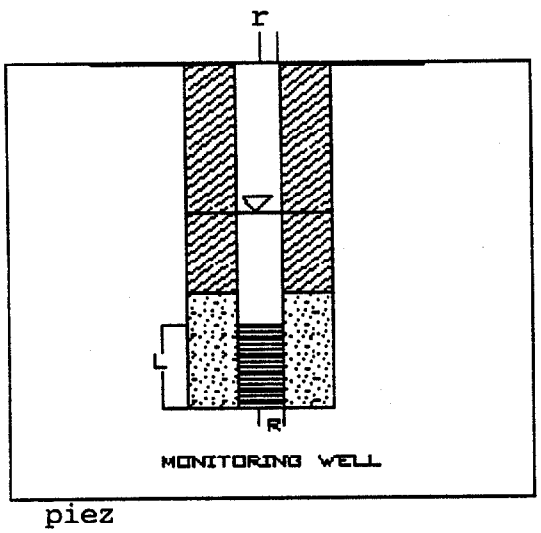
$k \cdot 1440 = 0.45$ <- ft./day

$k \cdot .508 = 1.58 \cdot 10^{-4}$ <- cm./sec.

SLUG TEST CALCULATION - HVORSLEV METHOD

HNUS CORPORATION
July 15, 1992

NAWC WARMINSTER
MW-02 RISING HEAD



$r := .25$ = well casing radius (ft.)
$R := .25$ = effective well radius (ft.)
$L := 61.28$ = effective well length (ft.)
$T := 6.95$ = time (min.) to 37% of change in head ratio (from semi-log plot)

R = Well screen radius if K(Aq) > sand
or - Sand pack radius if K(Aq) < sand
L = Height of water in screened section
or - Height of water in sand pack
ln = natural log (e)
k = hydraulic conductivity (ft./min.)

Hvorslev's Equation ->

$$k := \frac{r^2 \cdot \left[\ln\left[\frac{L}{R}\right]\right]}{2 \cdot L \cdot T}$$

$k = 4.04 \cdot 10^{-4}$ <- ft./min.

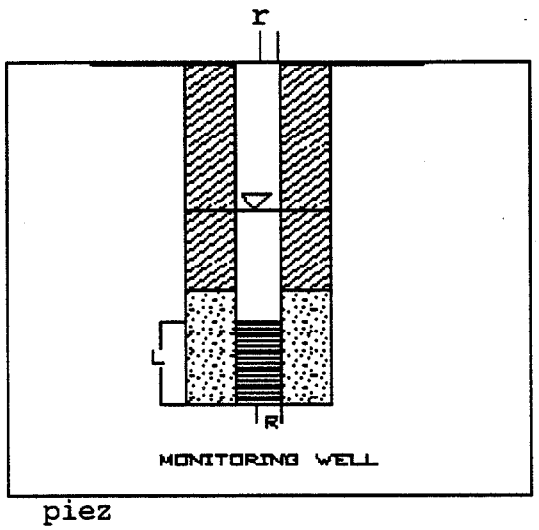
$k \cdot 1440 = 0.58$ <- ft./day

$k \cdot .508 = 2.05 \cdot 10^{-4}$ <- cm./sec.

SLUG TEST CALCULATION - HVORSLEV METHOD

HNUS CORPORATION
July 15, 1992

NAWC WARMINSTER
MW-03 RISING HEAD



$r := .25$ = well casing radius (ft.)
$R := .25$ = effective well radius (ft.)
$L := 64.53$ = effective well length (ft.)
$T := 10.15$ = time (min.) to 37% of change in head ratio (from semi-log plot)

R = Well screen radius if K(Aq) > sand
or - Sand pack radius if K(Aq) < sand
L = Height of water in screened section
or - Height of water in sand pack
ln = natural log (e)
k = hydraulic conductivity (ft./min.)

Hvorslev's Equation ->

$$k := \frac{r^2 \cdot \left[\ln\left[\frac{L}{R}\right]\right]}{2 \cdot L \cdot T}$$

$k = 2.65 \cdot 10^{-4}$ <- ft./min.

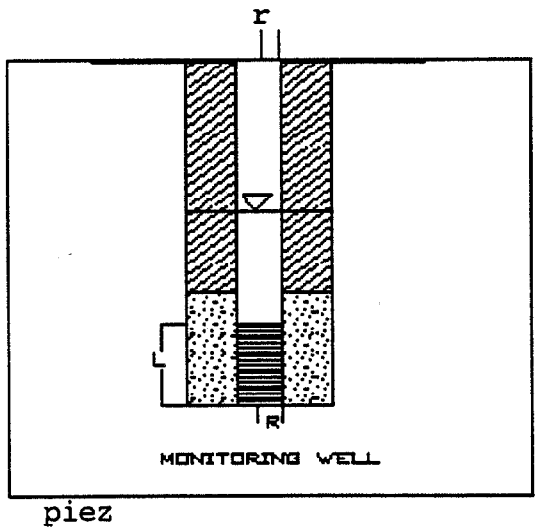
$k \cdot 1440 = 0.38$ <- ft./day

$k \cdot .508 = 1.35 \cdot 10^{-4}$ <- cm./sec.

SLUG TEST CALCULATION - HVORSLEV METHOD

HNUS CORPORATION
July 15, 1992

NAWC WARMINSTER
MW-04 FALLING HEAD



$r := .25$ = well casing radius (ft.)
$R := .25$ = effective well radius (ft.)
$L := 34.9$ = effective well length (ft.)
$T := 3.25$ = time (min.) to 37% of change in head ratio (from semi-log plot)

R = Well screen radius if K(Aq) > sand
or - Sand pack radius if K(Aq) < sand
L = Height of water in screened section
or - Height of water in sand pack
ln = natural log (e)
k = hydraulic conductivity (ft./min.)

Hvorslev's Equation ->

$$k := \frac{r^2 \cdot \left[\ln\left[\frac{L}{R}\right]\right]}{2 \cdot L \cdot T}$$

$k = 1.36 \cdot 10^{-3}$ <- ft./min.

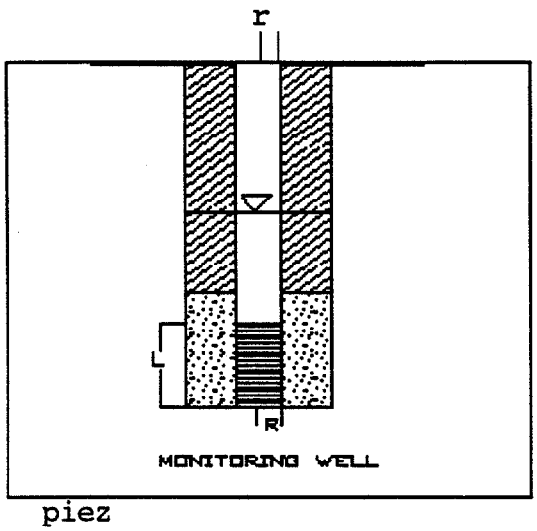
$k \cdot 1440 = 1.96$ <- ft./day

$k \cdot .508 = 6.91 \cdot 10^{-4}$ <- cm./sec.

SLUG TEST CALCULATION - HVORSLEV METHOD

HNUS CORPORATION
July 15, 1992

NAWC WARMINSTER
MW-04 RISING HEAD



$r := .25$ = well casing radius (ft.)
$R := .25$ = effective well radius (ft.)
$L := 34.9$ = effective well length (ft.)
$T := 3.08$ = time (min.) to 37% of change in head ratio (from semi-log plot)

R = Well screen radius if K(Aq) > sand
or - Sand pack radius if K(Aq) < sand
L = Height of water in screened section
or - Height of water in sand pack
ln = natural log (e)
k = hydraulic conductivity (ft./min.)

Hvorslev's Equation ->

$$k := \frac{r^2 \cdot \left[\ln\left[\frac{L}{R}\right]\right]}{2 \cdot L \cdot T}$$

$k = 1.44 \cdot 10^{-3}$ <- ft./min.

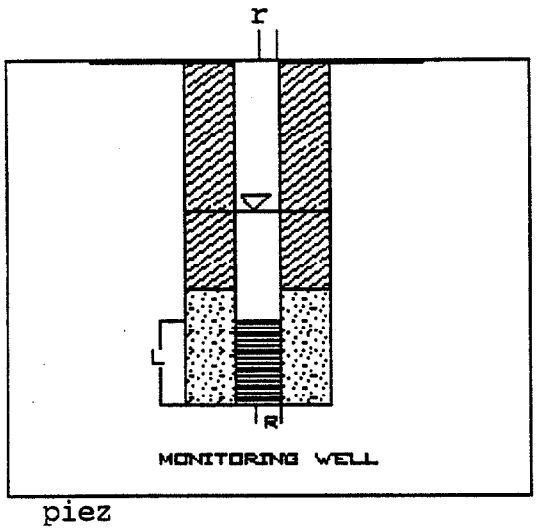
$k \cdot 1440 = 2.07$ <- ft./day

$k \cdot .508 = 7.29 \cdot 10^{-4}$ <- cm./sec.

SLUG TEST CALCULATION - HVORSLEV METHOD

HNUS CORPORATION
July 15, 1992

NAWC WARMINSTER
MW-05 FALLING HEAD



$r := .25$ = well casing radius (ft.)
$R := .25$ = effective well radius (ft.)
$L := 8.1$ = effective well length (ft.)
$T := .48$ = time (min.) to 37% of change in head ratio (from semi-log plot)

R = Well screen radius if K(Aq) > sand
or - Sand pack radius if K(Aq) < sand
L = Height of water in screened section
or - Height of water in sand pack
ln = natural log (e)
k = hydraulic conductivity (ft./min.)

Hvorslev's Equation ->

$$k := \frac{r^2 \cdot \left[\ln\left[\frac{L}{R}\right]\right]}{2 \cdot L \cdot T}$$

$k = 0.03$ <- ft./min.

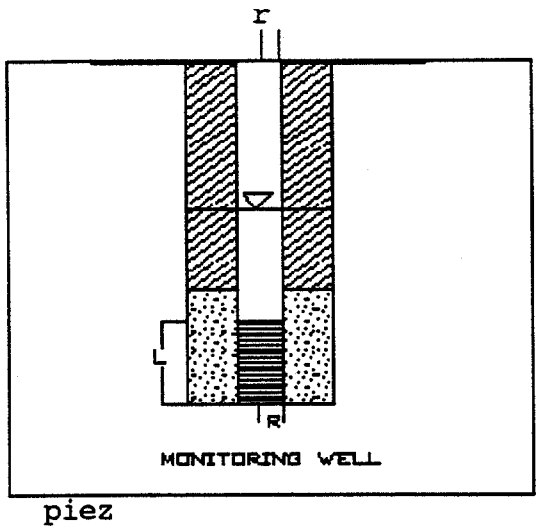
$k \cdot 1440 = 40.26$ <- ft./day

$k \cdot .508 = 0.01$ <- cm./sec.

SLUG TEST CALCULATION - HVORSLEV METHOD

HNUS CORPORATION
July 15, 1992

NAWC WARMINSTER
MW-05 RISING HEAD



$r := .25$ = well casing radius (ft.)
$R := .25$ = effective well radius (ft.)
$L := 8.1$ = effective well length (ft.)
$T := .244$ = time (min.) to 37% of change in head ratio (from semi-log plot)

R = Well screen radius if K(Aq) > sand
or - Sand pack radius if K(Aq) < sand
L = Height of water in screened section
or - Height of water in sand pack
ln = natural log (e)
k = hydraulic conductivity (ft./min.)

Hvorslev's Equation ->

$$k := \frac{r^2 \cdot \left[\ln\left[\frac{L}{R}\right]\right]}{2 \cdot L \cdot T}$$

$k = 0.05$ <- ft./min.

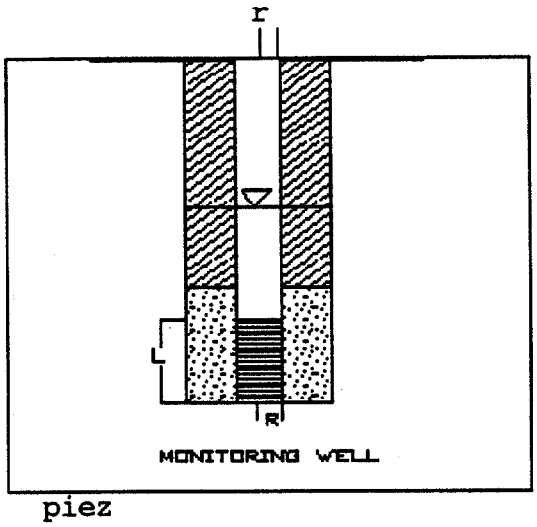
$k \cdot 1440 = 79.19$ <- ft./day

$k \cdot .508 = 0.03$ <- cm./sec.

SLUG TEST CALCULATION - HVORSLEV METHOD

HNUS CORPORATION
July 15, 1992

NAWC WARMINSTER
MW-06 FALLING HEAD



$r := .25$ = well casing radius (ft.)
$R := .25$ = effective well radius (ft.)
$L := 28.0$ = effective well length (ft.)
$T := 1.14$ = time (min.) to 37% of change in head ratio (from semi-log plot)

R = Well screen radius if K(Aq) > sand
or - Sand pack radius if K(Aq) < sand
L = Height of water in screened section
or - Height of water in sand pack
ln = natural log (e)
k = hydraulic conductivity (ft./min.)

Hvorslev's Equation ->

$$k := \frac{r^2 \cdot \left[\ln\left[\frac{L}{R}\right]\right]}{2 \cdot L \cdot T}$$

$k = 4.62 \cdot 10^{-3}$ <- ft./min.

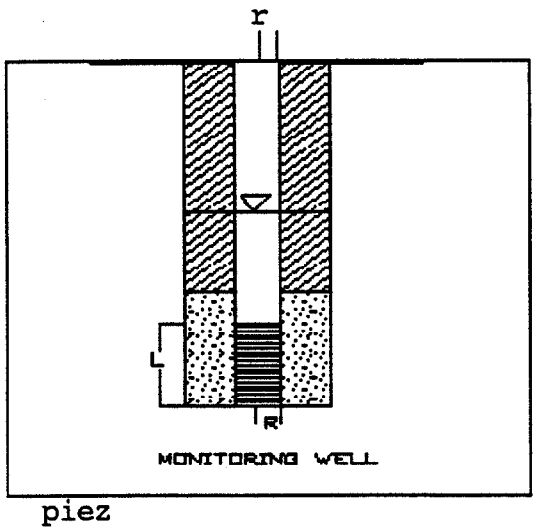
$k \cdot 1440 = 6.65$ <- ft./day

$k \cdot .508 = 2.35 \cdot 10^{-3}$ <- cm./sec.

SLUG TEST CALCULATION - HVORSLEV METHOD

HNUS CORPORATION
July 15, 1992

NAWC WARMINSTER
MW-06 RISING HEAD



$r := .25$ = well casing radius (ft.)
$R := .25$ = effective well radius (ft.)
$L := 28.0$ = effective well length (ft.)
$T := 1.34$ = time (min.) to 37% of change in head ratio (from semi-log plot)

R = Well screen radius if K(Aq) > sand
or - Sand pack radius if K(Aq) < sand
L = Height of water in screened section
or - Height of water in sand pack
ln = natural log (e)
k = hydraulic conductivity (ft./min.)

Hvorslev's Equation ->

$$k := \frac{r^2 \cdot \left[\ln\left[\frac{L}{R}\right]\right]}{2 \cdot L \cdot T}$$

$k = 3.93 \cdot 10^{-3}$ <- ft./min.

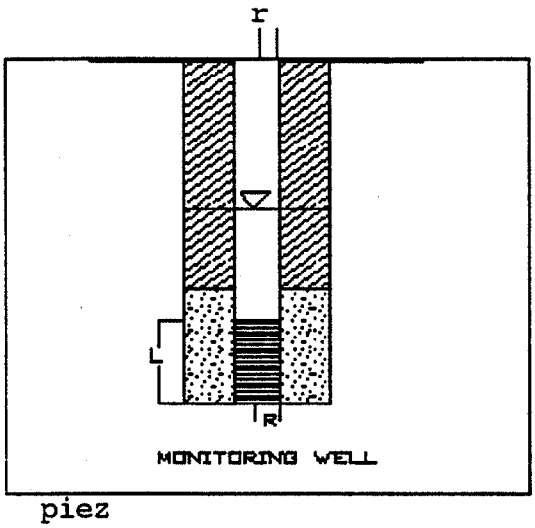
$k \cdot 1440 = 5.66$ <- ft./day

$k \cdot .508 = 2 \cdot 10^{-3}$ <- cm./sec.

SLUG TEST CALCULATION - HVORSLEV METHOD

HNUS CORPORATION
July 15, 1992

NAWC WARMINSTER
MW-07 FALLING HEAD



$r := .1667$ = well casing radius (ft.)
$R := .5$ = effective well radius (ft.)
$L := 5.0$ = effective well length (ft.)
$T := 4.0$ = time (min.) to 37% of change in head ratio (from semi-log plot)

R = Well screen radius if K(Aq) > sand
or - Sand pack radius if K(Aq) < sand
L = Height of water in screened section
or - Height of water in sand pack
ln = natural log (e)
k = hydraulic conductivity (ft./min.)

Hvorslev's Equation ->

$$k := \frac{r^2 \cdot \left[\ln\left[\frac{L}{R}\right]\right]}{2 \cdot L \cdot T}$$

$k = 1.6 \cdot 10^{-3}$ <- ft./min.

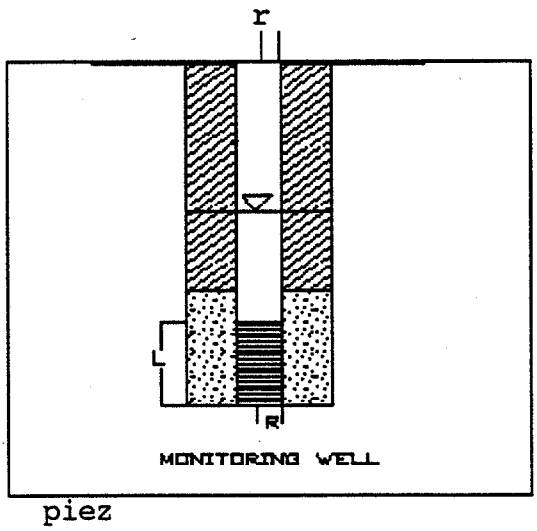
$k \cdot 1440 = 2.3$ <- ft./day

$k \cdot .508 = 8.13 \cdot 10^{-4}$ <- cm./sec.

SLUG TEST CALCULATION - HVORSLEV METHOD

HNUS CORPORATION
July 15, 1992

NAWC WARMINSTER
MW-07 RISING HEAD



$r := .1667$ = well casing radius (ft.)
$R := .5$ = effective well radius (ft.)
$L := 5.0$ = effective well length (ft.)
$T := 6.8$ = time (min.) to 37% of change in head ratio (from semi-log plot)

R = Well screen radius if K(Aq) > sand
or - Sand pack radius if K(Aq) < sand
L = Height of water in screened section
or - Height of water in sand pack
ln = natural log (e)
k = hydraulic conductivity (ft./min.)

Hvorslev's Equation ->

$$k := \frac{r^2 \cdot \left[\ln\left[\frac{L}{R}\right]\right]}{2 \cdot L \cdot T}$$

$k = 9.41 \cdot 10^{-4}$ <- ft./min.

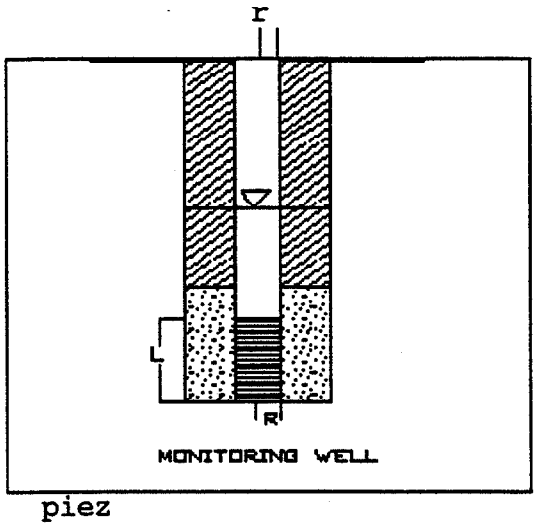
$k \cdot 1440 = 1.36$ <- ft./day

$k \cdot .508 = 4.78 \cdot 10^{-4}$ <- cm./sec.

SLUG TEST CALCULATION - HVORSLEV METHOD

HNUS CORPORATION
July 15, 1992

NAWC WARMINSTER
MW-11 RISING HEAD



$r := .1667$ = well casing radius (ft.)
$R := .5$ = effective well radius (ft.)
$L := 5.0$ = effective well length (ft.)
$T := 584$ = time (min.) to 37% of change in head ratio (from semi-log plot)

R = Well screen radius if K(Aq) > sand
or - Sand pack radius if K(Aq) < sand
L = Height of water in screened section
or - Height of water in sand pack
ln = natural log (e)
k = hydraulic conductivity (ft./min.)

Hvorslev's Equation ->

$$k := \frac{r^2 \cdot \left[\ln\left[\frac{L}{R}\right]\right]}{2 \cdot L \cdot T}$$

$k = 1.1 \cdot 10^{-5}$ <- ft./min.

$k \cdot 1440 = 0.02$ <- ft./day

$k \cdot .508 = 5.57 \cdot 10^{-6}$ <- cm./sec.

NAWC WARMINSTER
SLUG TEST RESULTS

WELL NUMBER	TEST TYPE	WELL TYPE	HYDRAULIC CONDUCTIVITY (k)
MW-01	FALLING	BEDROCK	2.18E-04
MW-01	RISING	BEDROCK	1.58E-04
MW-02	RISING	BEDROCK	2.05E-04
MW-03	RISING	BEDROCK	1.35E-04
MW-04	FALLING	BEDROCK	6.91E-04
MW-04	RISING	BEDROCK	7.29E-04
MW-05	FALLING	BEDROCK	0.01
MW-05	RISING	BEDROCK	3.00E-02
MW-06	FALLING	BEDROCK	2.35E-03
MW-06	RISING	BEDROCK	2.00E-03
MW-07	FALLING	OVERBURDEN	8.13E-04
MW-07	RISING	OVERBURDEN	4.78E-04

* All values in cm/sec

TABLE 1
NAWC WARMINSTER

SPREADSHEET TO CALCULATE GEOMETRIC MEAN
USING LOTUS-123

WELL NUMBER	TEST TYPE	HYDRAULIC CONDUCTIVITY (k)	NATURAL LOG (ln)
MW-01	FALLING	2.18E-04	-8.4310
MW-01	RISING	1.58E-04	-8.7529
MW-02	RISING	2.05E-04	-8.4925
MW-03	RISING	1.35E-04	-8.9102
MW-04	FALLING	6.91E-04	-7.2774
MW-04	RISING	7.29E-04	-7.2238
MW-05	FALLING	0.01	-4.6052
MW-05	RISING	3.00E-02	-3.5066
MW-06	FALLING	2.35E-03	-6.0533
MW-06	RISING	2.00E-03	-6.2146
MW-07	FALLING	8.13E-04	-7.1148
MW-07	RISING	4.78E-04	-7.6459

* All values in cm/sec

-7.0190 <- AVG Nat. Log

8.95E-04 <- GEOMETRIC MEAN

HYDRAULIC CONDUCTIVITY TESTING DATA SHEET — HALLIBURTON NUS CORPORATION

PROJECT NAME: NAWC WARMINSTER WELL/BORING NO.: MW-01

PROJECT NO.: 3933-0306 GEOLOGIST: A. Kendrick / R. Good

WELL DIAMETER: 6" ID PVC SCREEN LENGTH/DEPTH: Open Hole/Case @ 20.0 TEST NO.: 001

STATIC WATER LEVEL (Depth/Elevation): 18.09 Tot. Depth 82.0 DATE: 7-20-92

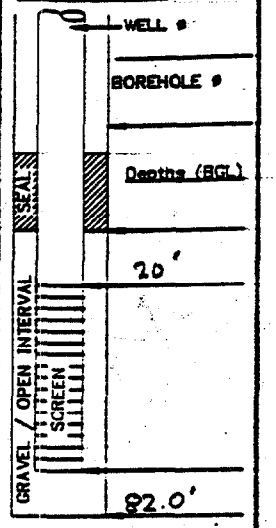
TEST TYPE (Rising/Falling/Constant Head): Falling head. CHECKED:

METHOD OF INDUCING WATER LEVEL CHANGE: 4" ID PVC Sling X 3.5' PAGE 1 OF

REFERENCE PT. FOR WL MEAS. (Top of Casing, Transducer, etc.): TOC

ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)	ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)
0.00	.000	Head Ratio	9.84 *	.422	.22
0.15	1.909 (ho)		11.84 *	.300	.16
0.47	1.800	.94	13.84	.209	.11
.84 *	1.706	.89	15.84	.143	.07
1.84 *	1.440	.75	19.84	.062	.03
2.84 *	1.242	.63	27.84	.003	.00
3.84 *	1.070	.56			
4.84 *	.923	.48			
5.84 *	.795	.42			
6.84 *	.682	.36			
7.84 *	.582	.30			
8.84 *	.497	.26			

WELL SCHEMATIC



▽ Indicate SWL Depth on Drawing

REMARKS:

@ T.63 = 6.3 min.

r = .25 ft.

R = ~~.5 ft.~~ .25 ft

L = 64.0 ft.

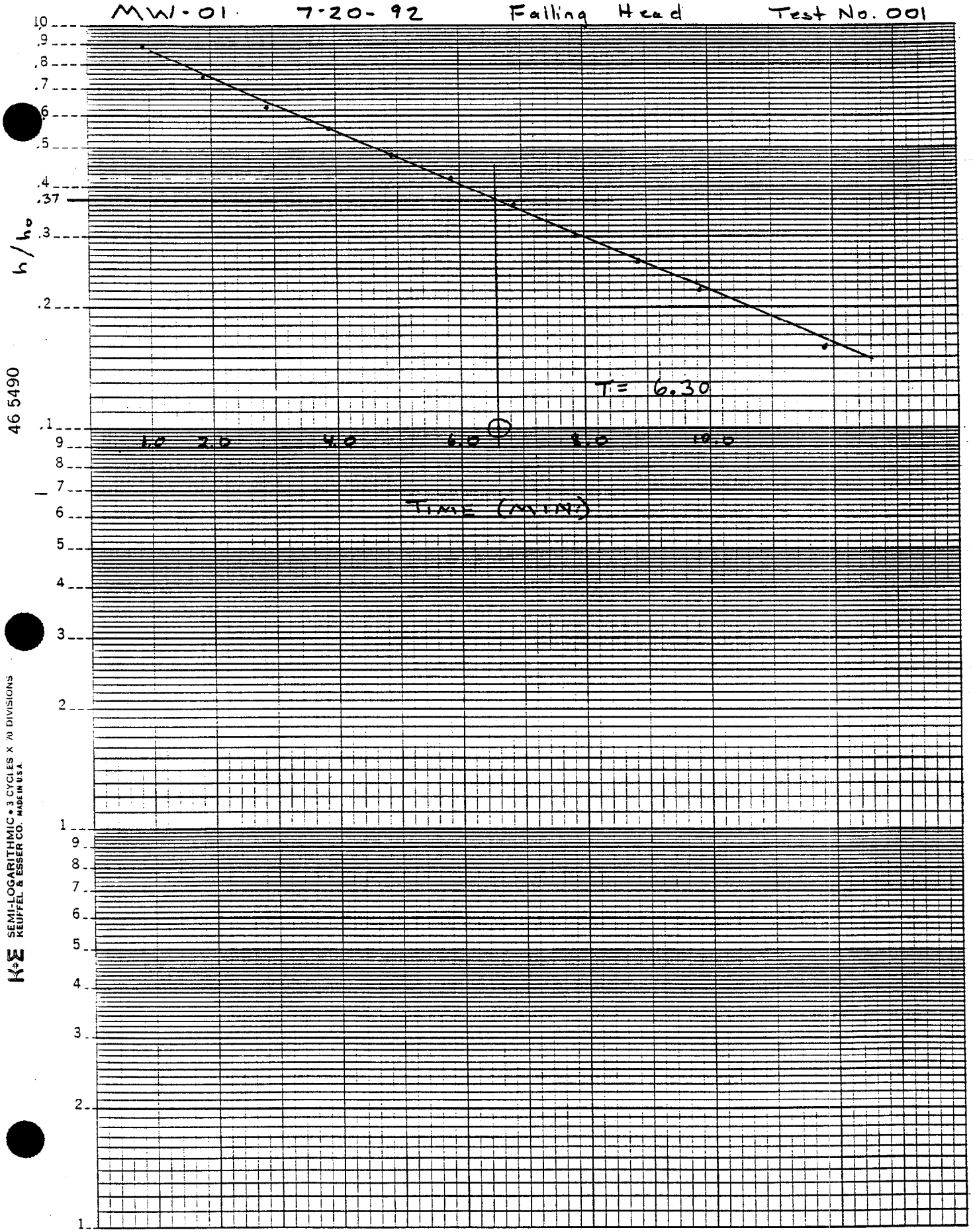
K = 4.3 x 10^-4 ft/min

K = 2.18 x 10^-4 cm/sec

MW-01fh.MLD

CALCS, SKETCH MAPS, ETC.:

MW-01 7-20-92 Falling Head Test No. 001



HALLIBURTON NUS Environmental Corporation and Subsidiaries — **STANDARD CALCULATION SHEET**

CLIENT: NAWC	FILE NO.: 3933	BY:	PAGE OF
SUBJECT: MW-01, Falling Head Slug Test		CHECKED BY:	DATE:

MW-01
Test 001
Falling Head
READY 7-20-92

SE1000C
Environmental Logger
07/21 07:08

Unit# 00731 Test 1

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00001
Reference	0.000
Linearity	0.010
Scale factor	9.900
Offset	0.030
Delay mSEC	50.000

Step 0 07/20 18:15:51

Elapsed Time	INPUT 1
0.0000	0.015
0.0033	0.015
0.0066	0.015
0.0100	0.015
0.0133	0.015
0.0166	0.015
0.0200	0.009
0.0233	0.009
0.0266	0.366
0.0300	-0.432
0.0333	-1.602
0.0366	-1.136
0.0400	-1.756
0.0433	-1.699
0.0466	-2.028
0.0500	-2.031
0.0533	-2.388
0.0566	0.979
0.0600	-3.797
0.0633	-2.445
0.0666	-2.635
0.0700	-2.679
0.0733	-2.651
0.0766	-2.507
0.0800	-2.645
0.0833	-2.595
0.0866	-2.589
0.0900	-2.548
0.0933	-1.778
0.0966	-2.573
0.1000	-1.756
0.1033	-2.213
0.1066	-1.806
0.1100	-1.549
0.1133	-1.790
0.1166	-2.225
0.1200	-2.128
0.1233	-1.928
0.1266	-1.890
0.1300	-1.944
0.1333	-1.991
0.1366	-1.950
0.1400	-1.962
0.1433	-1.972
0.1466	-1.966
0.1500	-1.966
T=0 0.1533	-1.962
0.00 0.1566	-1.966
0.1600	-1.966
0.1633	-1.962
0.1666	-1.959
0.1700	-1.956
0.1733	-1.953
0.1766	-1.953
0.1800	-1.953
0.1833	-1.953
0.1866	-1.953
0.1900	-1.953
0.1933	-1.950
0.1966	-1.950
0.2000	-1.947
0.2033	-1.947
0.2066	-1.944
0.2100	-1.944
0.2133	-1.944
0.2166	-1.944
0.2200	-1.941
0.2233	-1.941
0.2266	-1.937
0.2300	-1.937
0.2333	-1.937
0.2366	-1.934
0.2400	-1.931
0.2433	-1.931
0.2466	-1.931
0.2500	-1.931
0.2533	-1.928
0.2566	-1.928
0.2600	-1.925
0.2633	-1.925
0.2666	-1.922
0.2700	-1.922
0.2733	-1.922
0.2766	-1.919
0.2800	-1.919
0.2833	-1.919
0.2866	-1.915
0.2900	-1.915
0.2933	-1.912
0.2966	-1.912
0.3000	-1.912
0.3033	-1.912
0.3066	-1.909
0.3100	-1.906
0.3133	-1.906
0.3166	-1.906
0.3200	-1.906
0.3233	-1.903
0.3266	-1.903
0.3300	-1.900
0.3333	-1.900
0.3500	-1.893
0.3666	-1.890
0.3833	-1.881
0.4000	-1.878
0.4166	-1.872
0.4333	-1.865
0.4500	-1.859
0.4666	-1.853
0.4833	-1.847
0.5000	-1.843
0.5166	-1.837
0.5333	-1.831
0.5500	-1.828
0.5666	-1.822
0.5833	-1.815
0.6000	-1.809
0.6166	-1.803
0.6333	-1.800
0.6500	-1.793
0.6666	-1.787
0.6833	-1.784
0.7000	-1.778
0.7166	-1.771
0.7333	-1.768
0.7500	-1.759
0.7666	-1.756
0.7833	-1.756
0.8000	-1.746
0.8166	-1.743
0.8333	-1.737
0.8500	-1.731
0.8666	-1.728
0.8833	-1.721
0.9000	-1.715
0.9166	-1.712
0.9333	-1.709
0.9500	-1.703
0.9666	-1.699
0.9833	-1.693
1.0000	-1.706
1.2000	-1.627
1.4000	-1.577
1.6000	-1.530
1.8000	-1.483
2.0000	-1.440
2.2000	-1.396
2.4000	-1.355
2.6000	-1.314
2.8000	-1.277
3.0000	-1.242
3.2000	-1.205
3.4000	-1.170
3.6000	-1.136
3.8000	-1.105
4.0000	-1.070
4.2000	-1.042
4.4000	-1.011
4.6000	-0.976
4.8000	-0.951
5.0000	-0.923
5.2000	-0.898
5.4000	-0.870
5.6000	-0.845

HALLIBURTON NUS Environmental Corporation and Subsidiaries — **STANDARD CALCULATION SHEET**

CLIENT: NAWC	FILE NO.: 3933	BY:	PAGE OF
SUBJECT: MW-01, Falling Head Slug Test (cont.)		CHECKED BY:	DATE:

5.8000	-0.820
6.0000	-0.795
6.2000	-0.773
6.4000	-0.748
6.6000	-0.726
6.8000	-0.704
7.0000	-0.682
7.2000	-0.660
7.4000	-0.641
7.6000	-0.619
7.8000	-0.601
8.0000	-0.582
8.2000	-0.566
8.4000	-0.547
8.6000	-0.532
8.8000	-0.513
9.0000	-0.497
9.2000	-0.482
9.4000	-0.466
9.6000	-0.450
9.8000	-0.435
10.0000	-0.422
12.0000	-0.300
14.0000	-0.209
16.0000	-0.143
18.0000	-0.093
20.0000	-0.062
22.0000	-0.037
24.0000	-0.021
26.0000	-0.015
28.0000	-0.003

END

HYDRAULIC CONDUCTIVITY TESTING DATA SHEET — HALLIBURTON NUS CORPORATION

PROJECT NAME: NAWC WARMINSTER WELL/BORING NO.: MW-01

PROJECT NO.: 3933-0306 GEOLOGIST:

WELL DIAMETER: 6" ID PVC SCREEN LENGTH/DEPTH: Open Hole/Case @ 20.0 TEST NO.: 002

STATIC WATER LEVEL (Depth/Elevation): 18.09 Tot. Depth = 82.0 DATE: 7-20-92

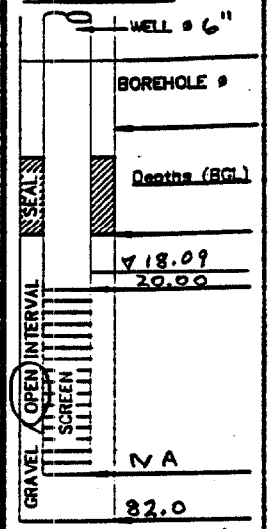
TEST TYPE (Rising/Falling/Constant Head): Rising Head CHECKED:

METHOD OF INDUCING WATER LEVEL CHANGE: 4" ID PVC Slug X 3.5' PAGE 2 OF

REFERENCE PT. FOR WL MEAS. (Top of Casing, Transducer, etc.): TOC

ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)	ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)
0.00	1.76	Head Ratio	11.71	.43	.24
0.24	1.73	.98	13.71	.33	.19
.91	1.67	.95	15.71	.24	.14
1.71	1.57	.89	17.77	.18	.10
2.71	1.42	.81	19.77	.14	.08
3.71	1.25	.71			
4.71	1.10	.63			
5.71	.97	.55			
6.71	.85	.48			
7.71	.75	.43			
8.71	.65	.37			
9.71	.57	.32			

WELL SCHEMATIC



▽ Indicate SWL Depth on Drawing

REMARKS:

@ $T_{.63}$ = 8.7 min.

@ r = .25 ft.

@ R = ~~.5 ft.~~ .25 ft

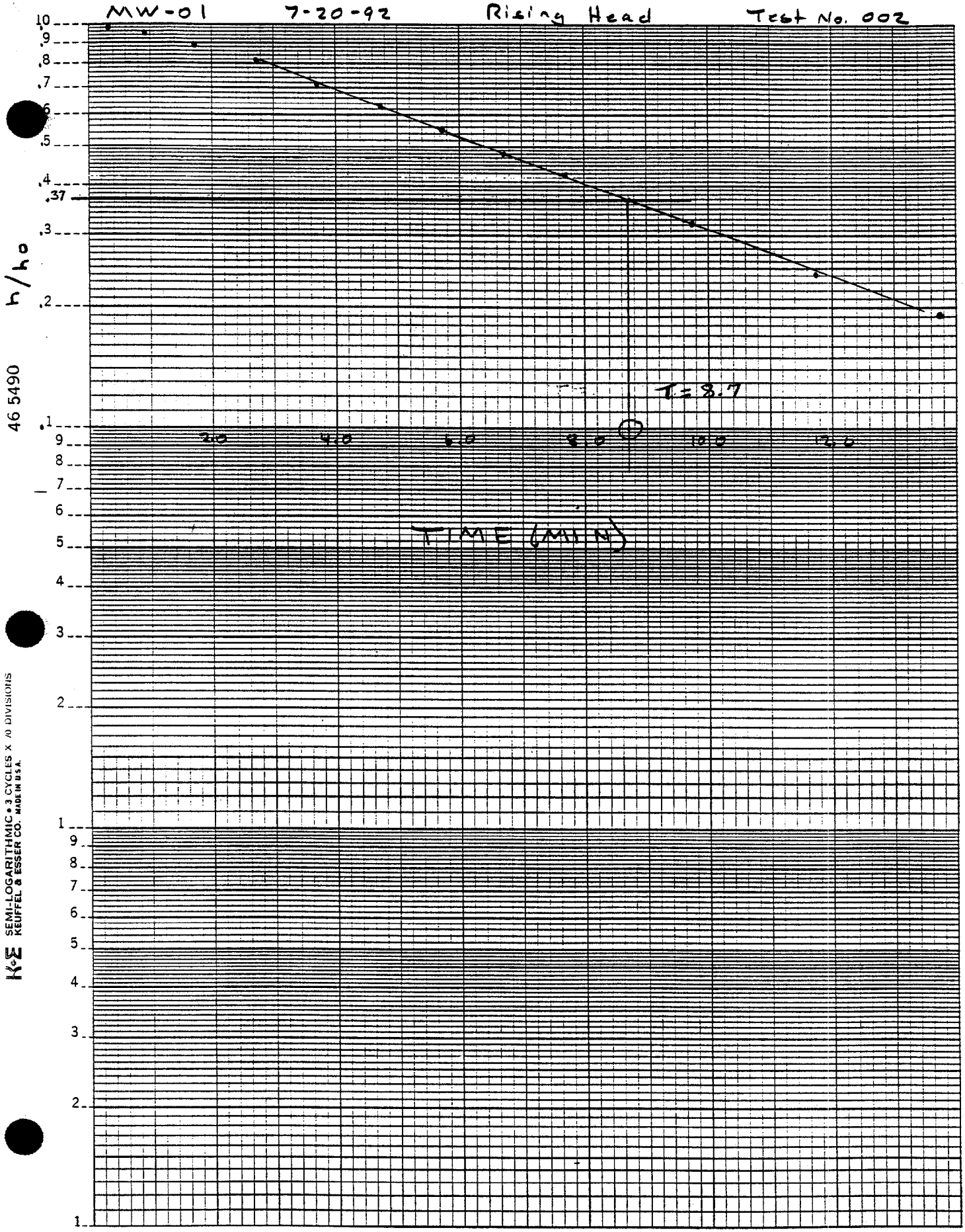
@ L = 64.0 ft.

~~K = 1.38 x 10^-4~~

K = 3.11 x 10^-4 ft/min

K = 1.58 x 10^-4 cm/sec

CALCS, SKETCH MAPS, ETC.: MW-01rh.mch


MW-01 7-20-92 Rising Head Test No. 002
h/ho
.37
T = 8.7
2.0
4.0
6.0
8.0
10.0
12.0
TIME (MIN)
46 5490
K&E SEMI-LOGARITHMIC • 3 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

HALLIBURTON NUS Environmental Corporation and Subsidiaries — **STANDARD CALCULATION SHEET**

CLIENT: NAWC	FILE NO.: 3933	BY:	PAGE OF
SUBJECT: MW-01, Rising Head Slug Test		CHECKED BY:	DATE:

MW-01
Test 002
READY Rising Head
7-20-92

SE1000C
Environmental Logger
07/20 20:20

Unit# 00731 Test 2

INPUT 1: Level (F) TOC

Reference	0.000
Linearity	0.010
Scale factor	9.900
Offset	0.030
Delay mSEC	50.000

Step 0 07/20 18:53:15

Elapsed Time	INPUT 1
0.0000	0.009
0.0033	0.006
0.0066	0.006
0.0100	0.006
0.0133	1.392
0.0166	1.605
0.0200	2.951
0.0233	3.461
0.0266	2.626
0.0300	2.516
0.0333	2.397
0.0366	1.803
0.0400	1.890
0.0433	1.824
0.0466	1.818
0.0500	1.806
0.0533	1.787
0.0566	1.821
0.0600	1.777
0.0633	1.780
0.0666	1.793
0.0700	1.780
0.0733	1.780
0.0766	1.793
0.0800	1.780
0.0833	1.777
0.0866	1.790
0.0900	1.774
0.0933	1.774
0.0966	1.784
0.1000	1.777
0.1033	1.771
0.1066	1.777
0.1100	1.777
0.1133	1.774
0.1166	1.774
0.1200	1.777
0.1233	1.768
0.1266	1.771
0.1300	1.771
0.1333	1.768
0.1366	1.774
0.1400	1.774
0.1433	1.768
0.1466	1.771
0.1500	1.771
0.1533	1.765
0.1566	1.765
0.1600	1.771
0.1633	1.762
0.1666	1.768
0.1700	1.765
0.1733	1.759
0.1766	1.765
0.1800	1.765
0.1833	1.759
0.1866	1.759
0.1900	1.765
0.1933	1.762
0.1966	1.759
0.2000	1.762
0.2033	1.762
0.2066	1.759
0.2100	1.762
0.2133	1.762
0.2166	1.759
0.2200	1.759
0.2233	1.755
0.2266	1.755
0.2300	1.759
0.2333	1.755
0.2366	1.755
0.2400	1.759
0.2433	1.755
0.2466	1.752
0.2500	1.765
0.2533	1.759
0.2566	1.755
0.2600	1.759
0.2633	1.759
0.2666	1.755
0.2700	1.759
0.2733	1.755
0.2766	1.755
0.2800	1.755
0.2833	1.755
T=0 Time 0.2866	1.755
0.2900	1.752
0.0 0.2933	1.755
0.2966	1.752
0.3000	1.752
0.3033	1.752
0.3066	1.749
0.3100	1.752
0.3133	1.752
0.3166	1.749
0.3200	1.749
0.3233	1.749
0.3266	1.749
0.3300	1.749
0.3333	1.749
0.3500	1.746
0.3666	1.746
0.3833	1.743
0.4000	1.743
0.4166	1.743
0.4333	1.740
0.4500	1.740
0.4666	1.737
0.4833	1.737
0.5000	1.734
0.5166	1.734
.24 0.5333	1.730
0.5500	1.730
0.5666	1.727
0.5833	1.727
0.6000	1.724
0.6166	1.724
0.6333	1.721
0.6500	1.721
0.6666	1.718
0.6833	1.715
0.7000	1.715
0.7166	1.715
0.7333	1.712
0.7500	1.709
0.7666	1.709
0.7833	1.705
0.8000	1.705
0.8166	1.702
0.8333	1.702
0.8500	1.699
0.8666	1.699
0.8833	1.696
0.9000	1.696
0.9166	1.693
0.9333	1.693
0.9500	1.690
0.9666	1.690
0.9833	1.687
1.0000	1.687
.907 1.2000	1.665
1.4000	1.646
1.6000	1.630
1.8000	1.605
1.71 2.0000	1.568
2.2000	1.530
2.4000	1.496
2.6000	1.468
2.8000	1.446
2.71 3.0000	1.421
3.2000	1.386
3.4000	1.352
3.6000	1.317
3.8000	1.286
3.71 4.0000	1.252
4.2000	1.223
4.4000	1.192
4.6000	1.161
4.8000	1.133
4.71 5.0000	1.104
5.2000	1.076
5.4000	1.048
5.6000	1.023
5.8000	0.995
5.71 6.0000	0.973
6.2000	0.948
6.4000	0.923
6.6000	0.898
6.8000	0.876

HALLIBURTON NUS Environmental Corporation and Subsidiaries — **STANDARD CALCULATION SHEET**

CLIENT: NAWC	FILE NO.: 3933	BY:	PAGE OF
SUBJECT: MW-01, Rising Head Slug Test (cont.)		CHECKED BY:	DATE:

6.7)	7.0000	0.854
	7.2000	0.832
	7.4000	0.810
	7.6000	0.788
	7.8000	0.770
7.7)	8.0000	0.748
	8.2000	0.729
	8.4000	0.707
	8.6000	0.691
	8.8000	0.673
8.7)	9.0000	0.654
	9.2000	0.638
	9.4000	0.619
	9.6000	0.604
	9.8000	0.588
9.7)	10.0000	0.572
11.7)	12.0000	0.432
13.7)	14.0000	0.325
	16.0000	0.244
	18.0000	0.176
	20.0000	0.141

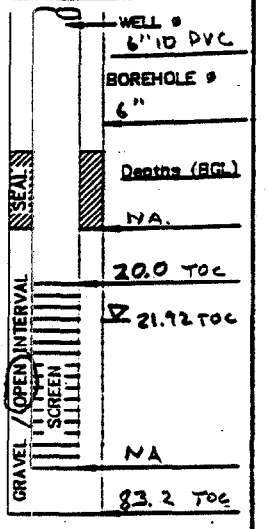
END

HYDRAULIC CONDUCTIVITY TESTING DATA SHEET — HALLIBURTON NUS CORPORATION

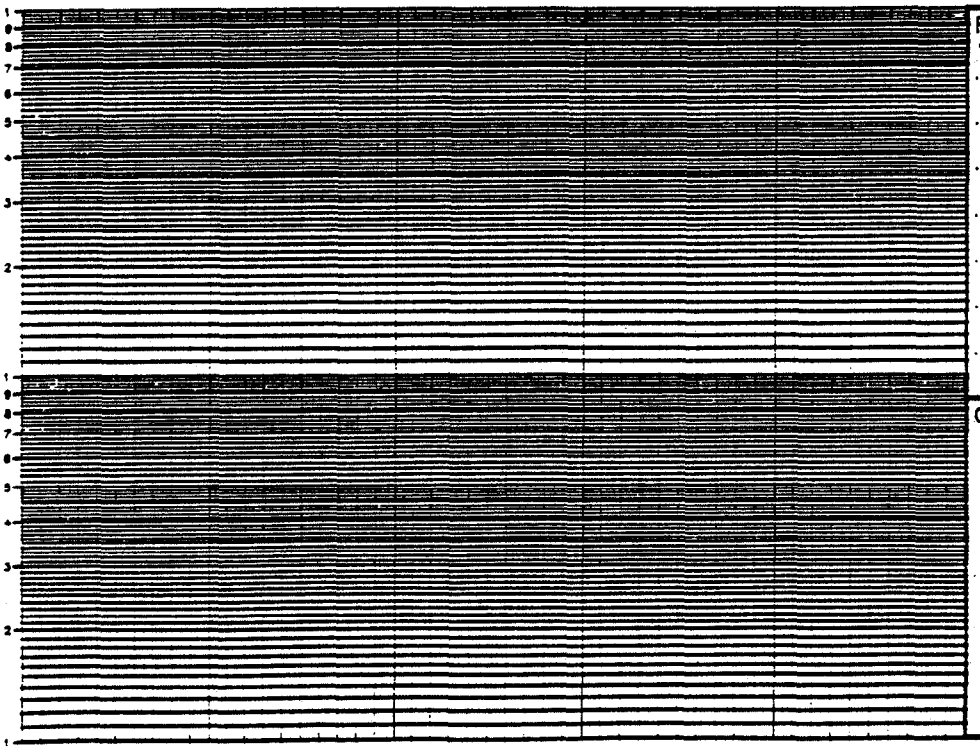
PROJECT NAME: NAWC Warminster WELL/BORING NO.: MW-02
PROJECT NO.: 3933 GEOLOGIST: A. Kendrick / R. Good
WELL DIAMETER: 6" ID PVC SCREEN LENGTH/DEPTH: Open: Tot. 83.2 TEST NO.: 001
STATIC WATER LEVEL (Depth/Elevation): 21.92 (TOC) DATE: 7-21-92
TEST TYPE (Rising/Falling/Constant Head): Rising Head only CHECKED:
METHOD OF INDUCING WATER LEVEL CHANGE: 4" PVC Sing. x 3.5' PAGE ... OF ...
REFERENCE PT. FOR WL MEAS. (Top of Casing, Transducer, etc.): TOC: 1.0'

ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)	ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)
10.83' : 0.0 0.0	HEAD RATIO $\Delta H/H_0$ = 1 *	H_0 = 2.089			
0.2	.96 *	2.011			
0.3	.95	1.989			
0.7	.90 *	1.880			
1.15	.83 *	1.739			
2.95	.65 *	1.348			
4.95	.49 *	1.026			
6.95	.37 *	0.766			
8.95	.27 *	0.578			
13.95	.16	0.334			

WELL SCHEMATIC



Indicate SWL Depth on Drawing

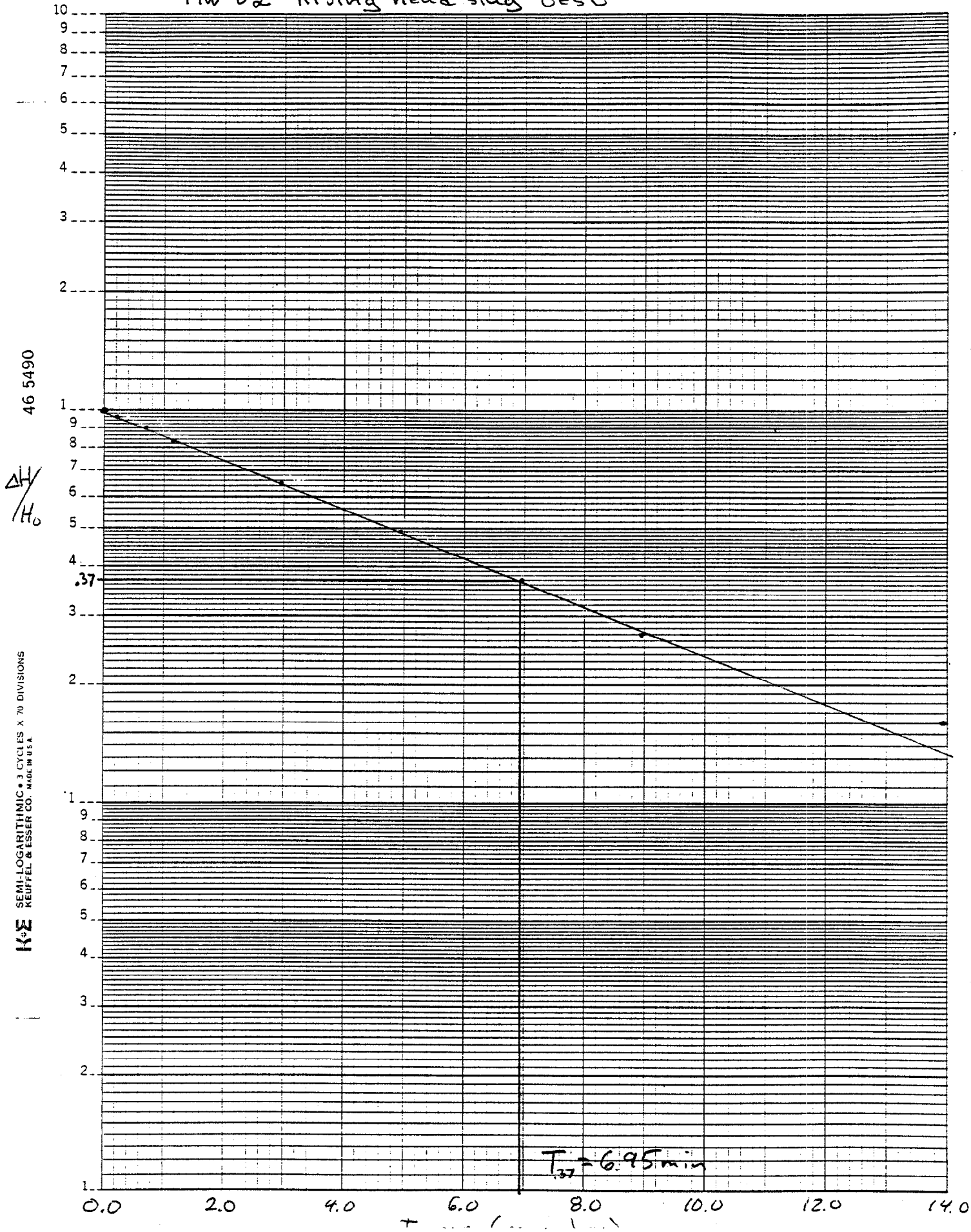


REMARKS: parameters
T_{37} = 6.95 min
r = .25'
R = .25'
L = 61.28'
K = 4.04×10^{-4} ft/min
205×10^{-4} cm/sec

MW-02. MCD

CALCS, SKETCH MAPS, ETC.:

MW-02 Rising head slug test



HALLIBURTON NUS Environmental Corporation and Subsidiaries

STANDARD CALCULATION SHEET

CLIENT:	FILE NO.:	BY:	PAGE 1 OF
SUBJECT: MW-02 Risinghead slugtest data		CHECKED BY:	DATE:

001

(3) MW-02
7-21-92
Rising head only

READY

SE1000C
Environmental Logger
07/21 14:33

Unit# 00731 Test 2

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00002
Reference	0.000
Linearity	0.010
Scale factor	9.900
Offset	0.030
Delay mSEC	50.000

Step 0 07/21 12:53:23

Elapsed Time	INPUT 1
0.0000	0.053
0.0033	0.053
0.0066	0.319
0.0100	0.854
0.0133	0.619
0.0166	0.547
0.0200	0.979
0.0233	1.041
0.0266	1.288
0.0300	1.113
0.0333	1.789
0.0366	1.745
0.0400	1.939
0.0433	2.145
0.0466	2.086
* 0.0500 t_0=0.00	1.089: H_0
0.0533	2.089
0.0566	2.098
* 0.0600	2.089
0.0633	2.080
0.0666	2.083
* 0.0700	2.080
0.0733	2.070
0.0766	2.073
* 0.0800	2.073
0.0833	2.070
0.0866	2.055
0.0900	2.014
0.0933	2.045
0.0966	2.015
0.1000	2.064
0.1033	2.052
0.1066	2.055
0.1100	2.055
[illegible]	2.052
[illegible]	2.042
0.1166	2.042
[illegible]	2.042
[illegible]	2.042
0.1233	2.052
0.1266	2.042
0.1300	2.045
0.1333	2.036
0.1366	2.042
0.1400	2.039
0.1433	2.048
0.1466	2.045
0.1500	2.042
0.1533	2.045
0.1566	2.039
0.1600	2.039
0.1633	2.036
0.1666	2.033
0.1700	2.033
0.1733	2.036
0.1766	2.033
0.1800	2.030
0.1833	2.030
0.1866	2.027
0.1900	2.027
0.1933	2.023
0.1966	2.027
0.2000	2.027
0.2033	2.020
0.2066	2.023
0.2100	2.020
0.2133	2.020
0.2166	2.017
0.2200	2.020
0.2233	2.017
0.2266	2.014
0.2300	2.017
0.2333	2.014
0.2366	2.014
0.2400	2.011
0.2433	2.011
0.2466	2.011
0.2500	2.011
0.2533	2.008
0.2566	2.008
0.2600	2.008
0.2633	2.008
0.2666	2.005
0.2700	2.008
0.2733	2.005
0.2766	2.002
0.2800	2.005
0.2833	2.002
0.2866	1.992
0.2900	2.002
0.2933	2.000
0.2966	1.998
? 0.3000	1.995
0.00 [illegible]	[illegible]
0.3066	1.995
[illegible]	[illegible]
[illegible]	1.995
[illegible]	1.995
[illegible]	1.992
[illegible]	1.992
[illegible]	1.989
[illegible]	1.992
[illegible]	1.989
[illegible]	1.989
[illegible]	[illegible]
0.3666	1.980
0.3833	1.976
0.4000	1.970
0.4166	1.967
0.4333	1.961
0.4500	1.958
0.4666	1.951
0.4833	1.948
0.5000	1.942
0.5166	1.939
0.5333	1.933
0.5500	1.930
0.5666	1.923
0.5833	1.920
0.6000	1.914
0.6166	1.911
0.6333	1.905
0.6500	1.898
0.6666	1.898
0.6833	1.892
0.7000	1.892
0.7166	1.886
0.7333	1.880
0.7500	1.880
0.7666	1.870
0.7833	1.864
0.8000	1.861
0.8166	1.855
0.8333	1.851
0.8500	1.845
0.8666	1.842
0.8833	1.836
0.9000	1.833
0.9166	1.829
0.9333	1.823
0.9500	1.817
0.9666	1.814
0.9833	1.808
1.0000	1.804
1.2000	1.729
1.4000	1.689
1.6000	1.642
1.8000	1.595
2.0000	1.551
2.2000	1.507
2.4000	1.467
2.6000	1.423
2.8000	1.382
3.0000	1.348
3.2000	1.304
3.4000	1.273
3.6000	1.238
3.8000	1.201
4.0000	1.173
4.2000	1.141
4.4000	1.110
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

HALLIBURTON NUS Environmental Corporation and Subsidiaries

STANDARD CALCULATION SHEET

CLIENT:	FILE NO.:	BY:	PAGE 2 OF
SUBJECT: MW-02 Rising head slug test data		CHECKED BY:	DATE:

6.2000	0.860
6.4000	0.835
6.6000	0.813
6.8000	0.788
7.0000	0.766
7.2000	0.744
7.4000	0.725
7.6000	0.703
7.8000	0.682
8.0000	0.663
8.2000	0.647
8.4000	0.628
8.6000	0.616
8.8000	0.597
9.0000	0.578
9.2000	0.566
9.4000	0.550
9.6000	0.541
9.8000	0.528
10.0000	0.516
12.0000	0.409
14.0000	0.334
16.0000	0.287
18.0000	0.253
20.0000	0.237
22.0000	0.219
24.0000	0.212
26.0000	0.206
28.0000	0.200
30.0000	0.203
32.0000	0.190
34.0000	0.194
36.0000	0.187
38.0000	0.194
40.0000	0.190
42.0000	0.187
44.0000	0.181
46.0000	0.194
48.0000	0.197
50.0000	0.184
52.0000	0.194
54.0000	0.197
56.0000	0.194
58.0000	0.197
60.0000	0.197
62.0000	0.206
64.0000	0.200
66.0000	0.209
68.0000	0.209
70.0000	0.212
72.0000	0.215
74.0000	0.222
76.0000	0.225
[illegible]	[illegible]

READY

HYDRAULIC CONDUCTIVITY TESTING DATA SHEET — HALLIBURTON NUS CORPORATION

PROJECT NAME: NAWC Warminster WELL/BORING NO.: MW-03

PROJECT NO.: 3933 GEOLOGIST: A. Kendrick / R. Good

WELL DIAMETER: 6" SCREEN LENGTH/DEPTH: open Cased : 20 (TOC) TEST NO.: 001

STATIC WATER LEVEL (Depth/Elevation): 23.17 (TOC) Total : 87.7' TOC DATE: 7-21-92

TEST TYPE (Rising/Falling/Constant Head): Rising head only CHECKED:

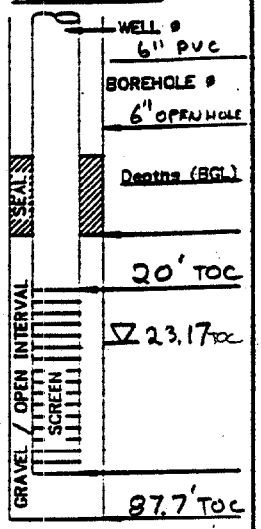
METHOD OF INDUCING WATER LEVEL CHANGE: 4" PVC Slug x 3.5' PAGE ... OF ...

REFERENCE PT. FOR WL MEAS. (Top of Casing, Transducer, etc.): TOC = 1.5'

ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)	ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)
0.00	Head Ratio 1.0	2.004	5.85	.493	0.987
0.05	0.992	1.987	6.85	.449	0.899
0.1	.984	1.972	7.85	.411	0.823
0.13	.981	1.965	8.85	.382	0.766
0.2	.970	1.943	9.85	.355	0.712
0.45	.932	1.867	15.85	.248	0.497
0.65	.910	1.817	19.85	.202	0.405
0.85	.883	1.769	29.85	.151	0.303
1.85	.766	1.535			
2.85	.681	1.364			
3.85	.605	1.212			
4.85	.548	1.098			

9.21:0.00

WELL SCHEMATIC

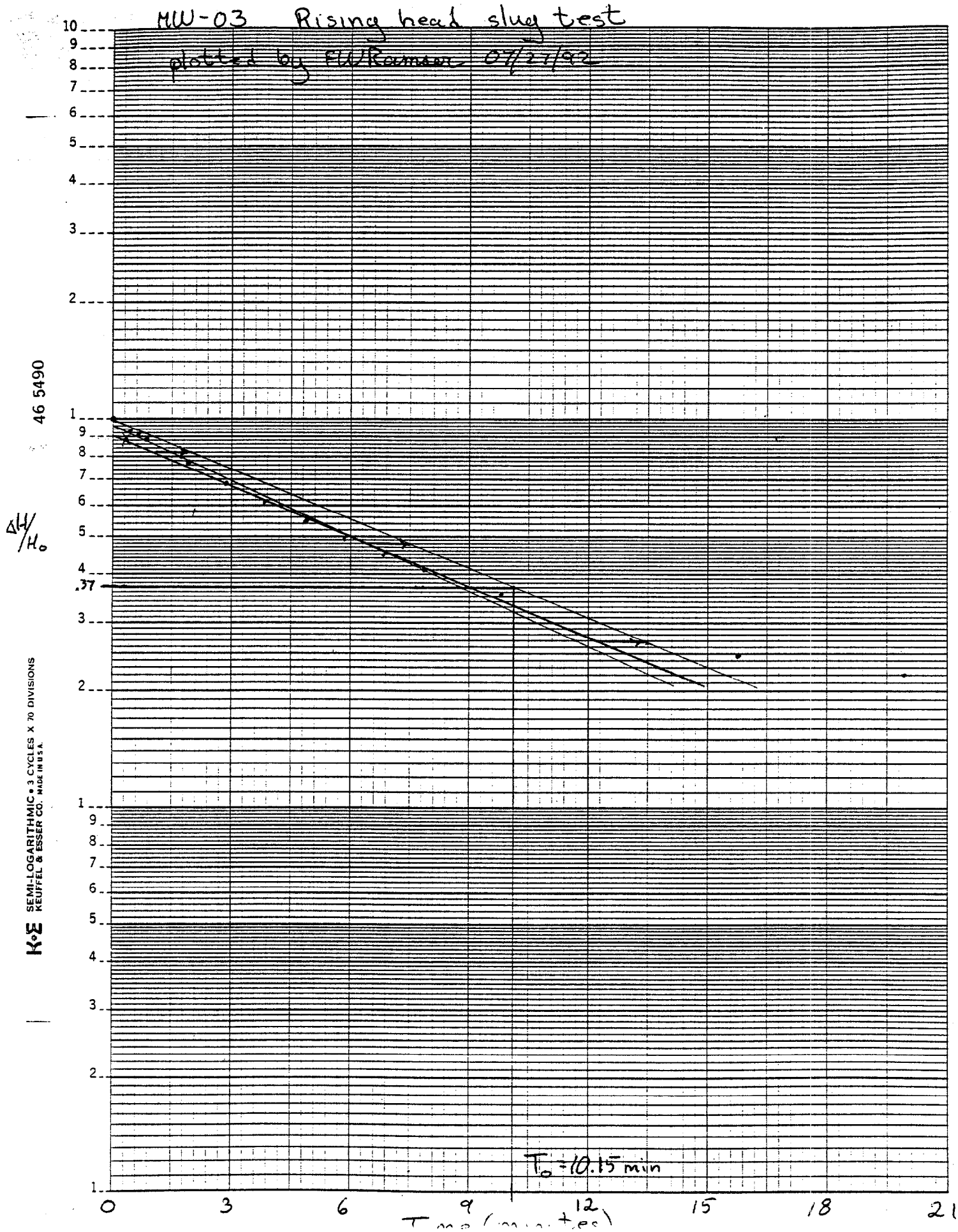


▽ Indicate SWL Depth on Drawing

REMARKS:
parameters:

T_0 = 10.15 min
r = .25'
R = .25'
L = 64.53'
K = 2.65 × 10^{-4} ft/min
K = 1.35 × 10^{-4} cm/sec
MW-03.MCD

CALCS, SKETCH MAPS, ETC.:


MW-03 Rising head slug test
plotted by FWRamsey 07/27/92
46 5490
ΔH/H₀
.37
T₀ = 10.15 min
0
3
6
9
12
15
18
21
Time (minutes)
K+E SEMI-LOGARITHMIC • 3 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

HALLIBURTON NUS Environmental Corporation and Subsidiaries	STANDARD CALCULATION SHEET

CLIENT:	FILE NO.:	BY:	PAGE 1 OF
SUBJECT: MW-03 Rising head slug test data		CHECKED BY:	DATE:

READY 001

(A) MW-03
Rising head only
7-21-92

SE1000C
Environmental Logger
07/21 16:44

Unit# 00765 Test 2

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00003
Reference	4.000
Linearity	0.000
Scale factor	10.020
Offset	0.000
Delay mSEC	50.000

Step 0 07/21 15:39:52

Elapsed Time	INPUT 1
0.0000	0.053
0.0033	0.053
0.0066	4.050
0.0100	0.066 ×
0.0133	1.107
0.0166	1.082
0.0200	0.474
0.0233	0.189
0.0266	0.348
0.0300	0.702
0.0333	0.873
0.0366	1.120
0.0400	1.449
0.0433	1.582
0.0466	1.649
0.0500	[illegible] *
0.0533	2.139
0.0566	2.038
0.0600	2.029 *
0.0633	2.044
0.0666	2.057
0.0700	2.051 ×
0.0733	2.032
0.0766	2.006
0.0800	2.016 *
0.0833	2.038
[illegible]	[illegible]
0.0900	2.075 ×
0.0933	[illegible]
0.0966	2.019
[illegible]	[illegible] ×
0.1033	[illegible]
[illegible]	[illegible]
[illegible]	2.029
0.1133	2.022
0.1166	2.017
[illegible]	[illegible] ×
[illegible]	[illegible]
[illegible]	[illegible]

Elapsed Time	INPUT 1
[illegible]	1.015
0.1333	2.006
0.1366	2.003
0.1400	2.003 ×
0.1433	1.997
0.1466	2.003
t=0.00 0.1500	2.003
0.1533	2.003
0.1566	2.000
0.1600	2.000
0.1633	1.997
0.1666	1.981
0.1700	2.000
0.1733	1.997
0.1766	[illegible]
0.1800	1.994
0.1833	[illegible]
0.1866	1.987
0.1900	1.987
0.1933	1.987
0.1966	1.984
0.2000	1.987
0.2033	1.987
0.2066	1.984
0.2100	1.981
0.2133	1.975
0.2166	1.978
0.2200	1.978
0.2233	1.984
0.2266	1.975
0.2300	1.975
0.2333	1.978
0.2366	1.979
0.2400	1.972
0.2433	1.972
0.2466	1.972
0.2500	1.972
0.2533	[illegible]
0.2566	1.968
0.2600	[illegible]
0.2633	1.968
[illegible]	[illegible]
0.2700	1.965
0.2733	1.965
0.2766	1.962
0.2800	1.965
0.2833	1.962
0.2866	1.959
0.2900	1.965
2.00 [illegible]	[illegible]
0.2966	1.956
0.3000	1.956
0.3033	1.956
[illegible]	1.953
0.3100	1.953
0.3133	1.953
0.3166	1.953
[illegible]	[illegible]
0.3233	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

Elapsed Time	INPUT 1
0.4166	1.921
0.4333	[illegible]
0.4500	1.911
0.4666	1.905
0.4833	1.902
0.5000	1.896
0.5166	1.892
0.5333	1.886
0.5500	1.880
0.5666	1.877
0.5833	1.870
0.6000	1.867
0.6166	1.864
0.6333	1.858
0.6500	1.854
0.6666	1.851
0.6833	[illegible]
0.7000	1.842
0.7166	1.839
0.7333	1.832
0.7500	1.829
0.7666	1.826
0.7833	1.820
0.8000	1.817
0.8166	1.813
0.8333	1.813
0.8500	1.807
0.8666	1.801
0.8833	1.798
0.9000	1.791
0.9166	1.788
0.9333	1.785
0.9500	1.782
0.9666	1.775
0.9833	1.772
1.0000	1.769
1.2000	1.772
1.4000	1.666
1.6000	1.627
1.8000	1.579
2.0000	[illegible]
[illegible]	[illegible]
2.4000	1.465
[illegible]	1.427
[illegible]	1.395
[illegible]	1.364
[illegible]	1.332
[illegible]	1.304
[illegible]	1.275
[illegible]	1.244
4.0000	1.212
4.2000	1.179
4.4000	[illegible]
[illegible]	1.142
[illegible]	[illegible]
5.0000	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	0.999

HALLIBURTON NUS Environmental Corporation and Subsidiaries

STANDARD CALCULATION SHEET

CLIENT:	FILE NO.:	BY:	PAGE 2 OF
SUBJECT: MW-03 Rising head slug test data		CHECKED BY:	DATE:

7.2000	0.883
7.4000	0.864
7.6000	0.851
7.8000	0.835
8.0000	0.823
8.2000	0.810
8.4000	0.797
8.6000	0.788
8.8000	0.778
9.0000	0.766
9.2000	0.756
9.4000	0.747
9.6000	0.734
9.8000	0.721
10.0000	0.712
12.0000	0.636
14.0000	0.553
16.0000	0.497
18.0000	0.446
20.0000	0.405
22.0000	0.367
24.0000	0.338
26.0000	0.322
28.0000	0.310
30.0000	0.303
32.0000	0.316
34.0000	0.313
36.0000	0.310
38.0000	0.307
40.0000	0.307
42.0000	0.307
44.0000	0.297
46.0000	0.297
48.0000	0.303
50.0000	0.303
52.0000	0.300
54.0000	0.300
56.0000	0.300

END

HYDRAULIC CONDUCTIVITY TESTING DATA SHEET — HALLIBURTON NUS CORPORATION

PROJECT NAME: NAWC Warminster — WELL/BORING NO.: MW-04

PROJECT NO.: 3933 — GEOLOGIST: A. Kendrick / R. Good

WELL DIAMETER: 6" ID PVC — SCREEN LENGTH/DEPTH: Open Hole Tot. 55.9 TOC — TEST NO.:

STATIC WATER LEVEL (Depth/Elevation): 8.22 TOC — DATE:

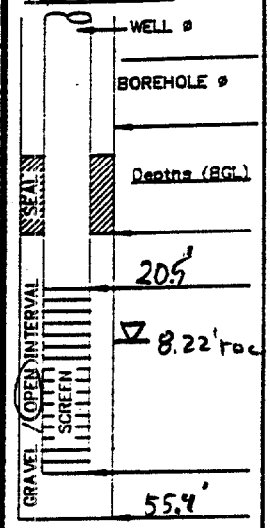
TEST TYPE (Rising/Falling/Constant Head): Falling head — CHECKED:

METHOD OF INDUCING WATER LEVEL CHANGE: 4.5" OD PVC x 3.5' — PAGE ... OF

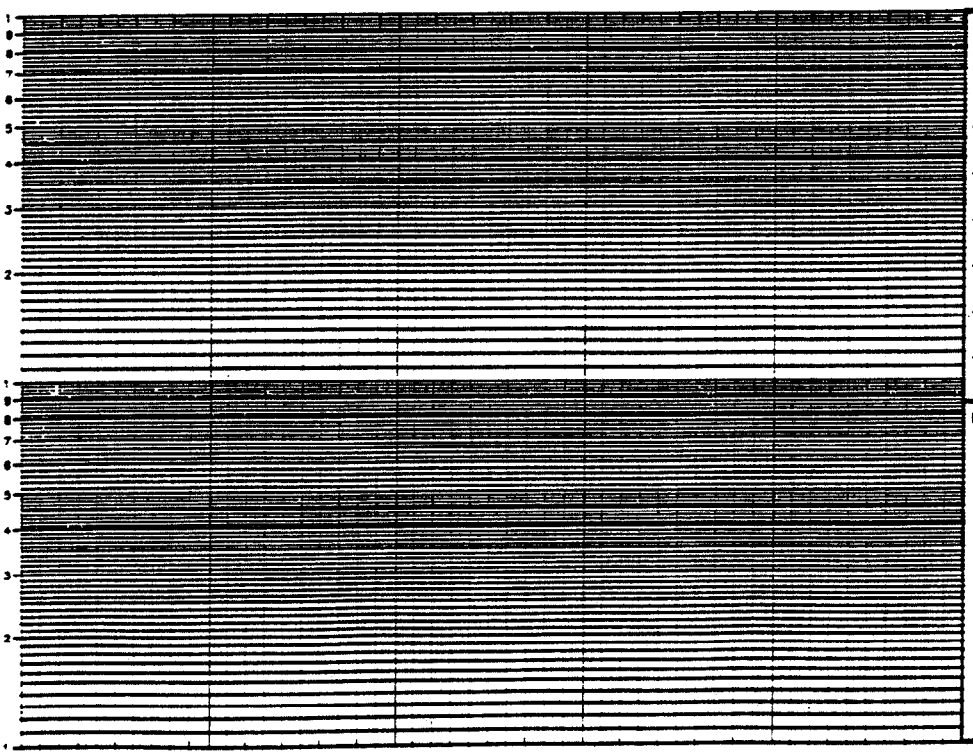
REFERENCE PT. FOR WL MEAS. (Top of Casing, Transducer, etc.): TOC = 0.5'

ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)	ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)
0.0	H_o = 1.620	HEAD RATIO H_t/H_o = 1.0 *	5.8534	.284	.18
0.0234	1.589	.98			
0.0534	1.555	.96			
0.1034	1.502	.93 *			
0.2034	1.411	.87 *			
0.3534	1.301	.80			
0.5534	1.182	.73 *			
0.8534	1.045	.65 *			
1.8534	.732	.45 *			
2.8534	.553	.34 *			
3.8534	.438	.27 *			
4.8534	.356	.22			

WELL SCHEMATIC



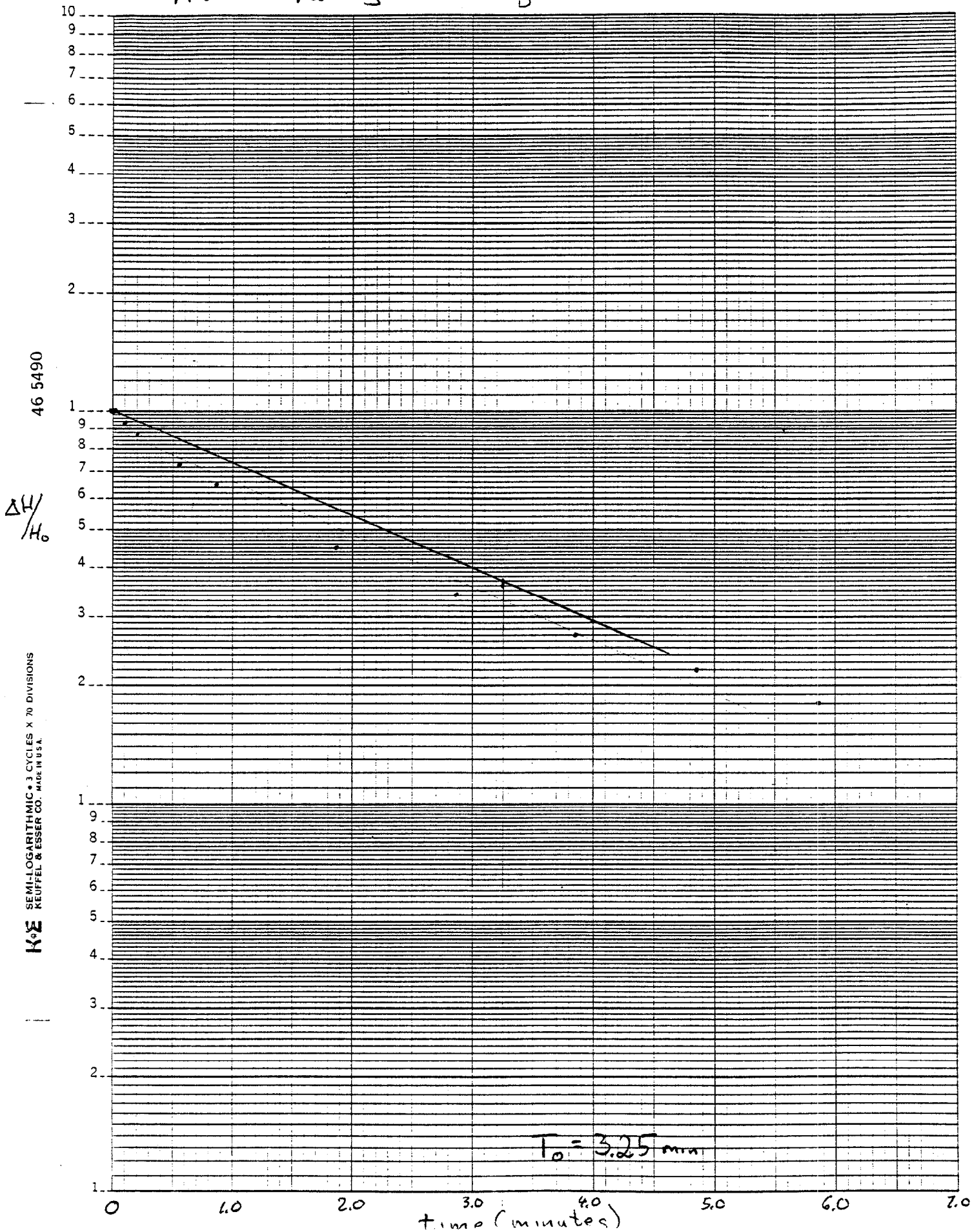
▽ Indicate SWL Depth on Drawing



REMARKS:
parameters:
T_o = 3.25 min
r = .25
R = .25
L = 34.9'
K = 1.36×10^{-3} ft/min
K = 691×10^{-4} cm/sec
MW-04 fh mcd

CALCS, SKETCH MAPS, ETC.:

MW-04 Falling head slug test



HALLIBURTON NUS Environmental Corporation and Subsidiaries — **STANDARD CALCULATION SHEET**

CLIENT:	FILE NO.:	BY:	PAGE 1 OF
SUBJECT: MW-04 Falling head slug test data		CHECKED BY:	DATE:

(B) MW-04
001
Falling head
7-21-92

READY

SE1000C
Environmental Logger
07/21 11:50

Unit# 00731 Test 0

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00004
Reference	0.000
Linearity	0.010
Scale factor	9.900
Offset	0.030
Delay mSEC	50.000

Step 0 07/21 10:18:38

Elapsed Time	INPUT 1
0.0000	0.031
0.0033	0.031
0.0066	0.031
0.0100	0.028
0.0133	-0.143
0.0166	-0.231
0.0200	-0.525
0.0233	-0.522
0.0266	-0.963
0.0300	-1.317
0.0333	-1.401
0.0366	-1.689
0.0400	-1.652
0.0433	-2.105
0.0466	-2.275
0.0500	-2.215
0.0533	-2.318
0.0566	-2.271
0.0600	-2.409
0.0633	-2.375
0.0666	-2.115
0.0700	-2.052
0.0733	-2.005
0.0766	-1.865
0.0800	-1.721
0.0833	-1.962
0.0866	-1.883
0.0900	-1.542
0.0933	-1.248
0.0966	-1.721
0.1000	-1.685
0.1033	-1.548
0.1066	-1.761
0.1100	-1.592
0.1133	-1.721
0.1166	-1.673
0.1200	-1.667
0.1233	-1.649
0.1266	-1.645
0.1300	-1.639
0.1333	-1.636
0.1366	-1.633
0.1400	-1.658
0.1433	-1.580
0.00 0.1466	-1.620 •
0.1500	-1.608
0.1533	-1.605
0.1566	-1.605
0.1600	-1.595
0.1633	-1.595
0.1666	-1.589
0.1700	-1.589 •
0.1733	-1.583
0.1766	-1.580
0.1800	-1.573
0.1833	-1.570
0.1866	-1.567
0.1900	-1.561
0.1933	-1.558
0.1966	-1.555
0.2000	-1.555 •
0.2033	-1.548
0.2066	-1.542
0.2100	-1.539
0.2133	-1.536
0.2166	-1.533
0.2200	-1.530
0.2233	-1.527
0.2266	-1.523
0.2300	-1.520
0.2333	-1.517
0.2366	-1.514
0.2400	-1.511
0.2433	-1.508
0.2466	-1.502
0.2500	-1.502 •
0.2533	-1.498
0.2566	-1.495
0.2600	-1.492
0.2633	-1.489
0.2666	-1.483
0.2700	-1.483
0.2733	-1.476
0.2766	-1.473
0.2800	-1.473
0.2833	-1.470
0.2866	-1.467
0.2900	-1.464
0.2933	-1.461
0.2966	-1.458
0.3000	-1.455
0.3033	-1.451
0.3066	-1.448
0.3100	-1.445
0.3133	-1.442
0.3166	-1.442
0.3200	-1.439
0.3233	-1.436
0.3266	-1.433
0.3300	-1.430
0.3333	-1.426
0.3366	-1.411 •
0.3666	-1.398
0.3833	-1.386
0.4000	-1.370
0.4166	-1.361
0.4333	-1.348
0.4500	-1.336
0.4666	-1.323
0.4833	-1.314
0.5000	-1.301 •
0.5166	-1.289
0.5333	-1.279
0.5500	-1.270
0.5666	-1.257
0.5833	-1.248
0.6000	-1.239
0.6166	-1.229
0.6333	-1.220
0.6500	-1.210
0.6666	-1.201
0.6833	-1.192
0.7000	-1.182 •
0.7166	-1.173
0.7333	-1.164
0.7500	-1.157
0.7666	-1.148
0.7833	-1.142
0.8000	-1.132
0.8166	-1.123
0.8333	-1.117
0.8500	-1.110
0.8666	-1.101
0.8833	-1.095
0.9000	-1.085
0.9166	-1.079
0.9333	-1.073
0.9500	-1.063
0.9666	-1.057
0.9833	-1.051
1.0000	-1.045 •
1.2000	-0.948
1.4000	-0.885
1.6000	-0.829
1.8000	-0.779
2.0000	-0.732 •
2.2000	-0.691
2.4000	-0.653
2.6000	-0.619
2.8000	-0.588
3.0000	-0.553 •
3.2000	-0.525
3.4000	-0.503
3.6000	-0.478
3.8000	-0.456
4.0000	-0.438 •
4.2000	-0.416
4.4000	-0.400
4.6000	-0.384
4.8000	-0.372
5.0000	-0.356 •

HALLIBURTON NUS Environmental Corporation and Subsidiaries — *STANDARD CALCULATION SHEET*

CLIENT:	FILE NO.:	BY:	PAGE 2 OF
SUBJECT: MW-04 Falling head slug test data		CHECKED BY:	DATE:

5.2000	-0.341
5.4000	-0.328
5.6000	-0.309
5.8000	-0.297
6.0000	-0.284
6.2000	-0.275
6.4000	-0.269
6.6000	-0.262
6.8000	-0.253
7.0000	-0.240
7.2000	-0.228
7.4000	-0.215
7.6000	-0.206
7.8000	-0.197
8.0000	-0.187
8.2000	-0.181
8.4000	-0.172
8.6000	-0.168
8.8000	-0.162
9.0000	-0.159
9.2000	-0.156
9.4000	-0.153
9.6000	-0.147
9.8000	-0.143
10.0000	-0.137
12.0000	-0.109
14.0000	-0.090
16.0000	-0.068
18.0000	-0.056
20.0000	-0.050
22.0000	-0.034
24.0000	-0.025
26.0000	-0.021
28.0000	-0.015
30.0000	-0.009

END

HYDRAULIC CONDUCTIVITY TESTING DATA SHEET — HALLIBURTON NUS CORPORATION

PROJECT NAME: NAWC Warminster WELL/BORING NO.: MW-04

PROJECT NO.: 3933 GEOLOGIST: A. Kendrick / R. Good

WELL DIAMETER: 6" ID PVC SCREEN LENGTH/DEPTH: Open Hole Tot=55.9 TOC TEST NO.: 001

STATIC WATER LEVEL (Depth/Elevation): 8.22 DATE: 7-21-92

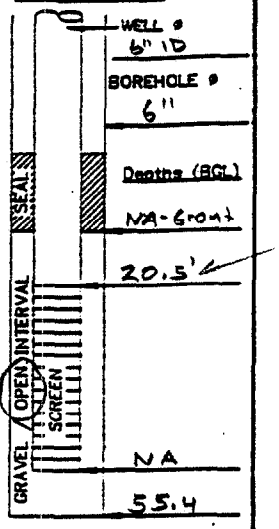
TEST TYPE (Rising/Falling/Constant Head): Rising Head CHECKED:

METHOD OF INDUCING WATER LEVEL CHANGE: 4.5" OD PVC x 3.5' PAGE ___ OF ___

REFERENCE PT. FOR WL MEAS. (Top of Casing, Transducer, etc.): TOC = 0.5'

ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)	ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)
0919 0.0	Head Ratio 1.0 ΔH/H₀	H₀ = 1.918	0.75	.603	1.157
0.02	0.944	1.811	0.85	.579	1.11
0.05	0.912	1.749	0.95	.556	1.067
0.09	0.877	1.683	1.95	.385	.738
0.13	0.843	1.617	2.95	.295	.566
0.15	0.832	1.595	3.95	.239	.46
0.2	.802	1.539	4.95	.200	.384
0.25	.778	1.492	5.95	.168	.322
0.35	.734	1.408	6.95	.150	.287
0.45	.694	1.332	8.95	.120	.231
0.55	.661	1.267			
0.65	.631	1.21			

WELL SCHEMATIC



Indicate SWL Depth on Drawing

REMARKS:
parameters:

T_0 = 3.08 min

r = .25'

R = .25'

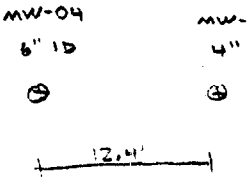
L = 34.9'

K = 1.44×10^{-3} ft/min

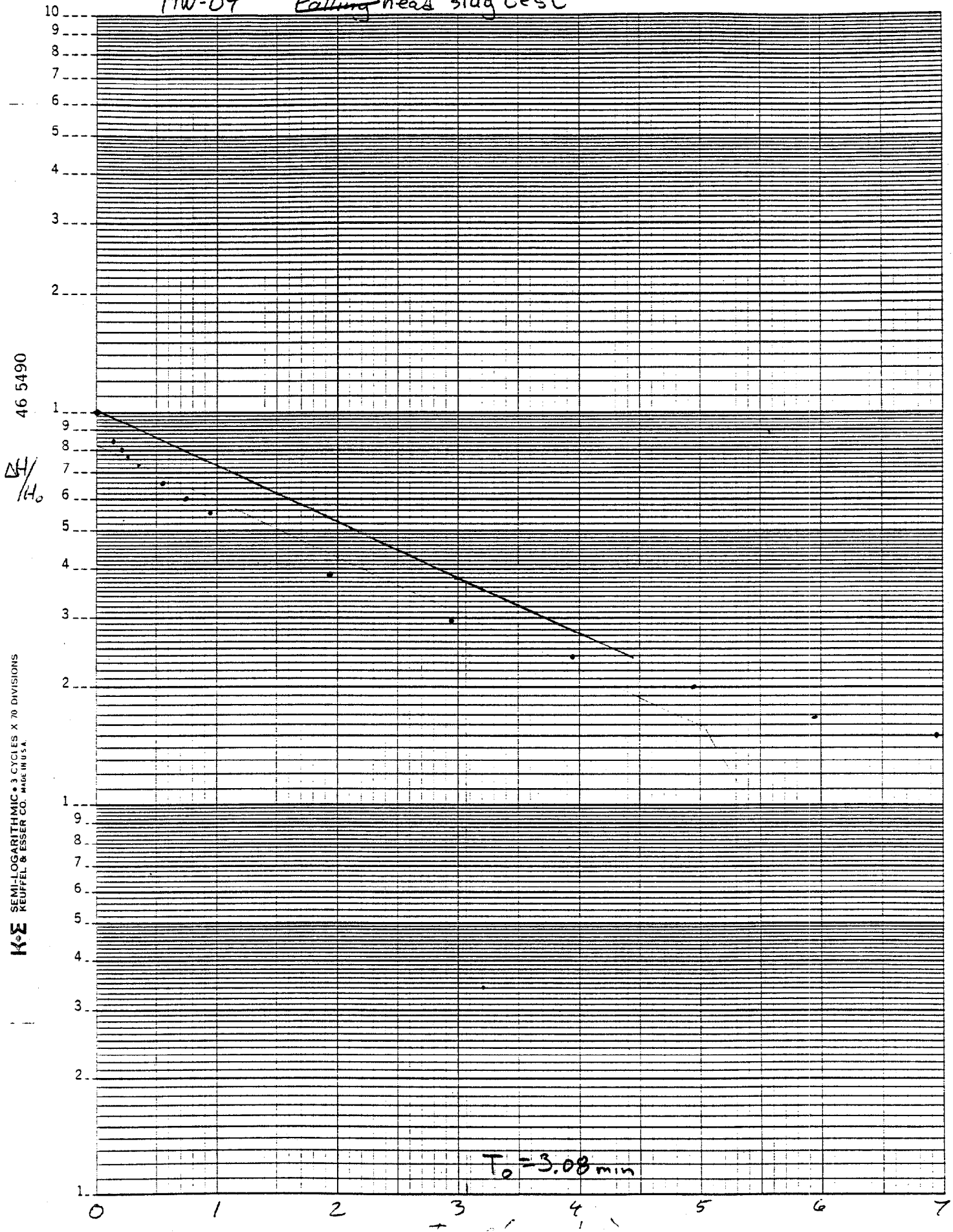
K = 7.29×10^{-4} cm/sec

MW-04rh.mcd

CALCS, SKETCH MAPS, ETC.:



MW-04 Rising ~~Falling~~ head slug test



HALLIBURTON NUS Environmental Corporation and Subsidiaries

STANDARD CALCULATION SHEET

CLIENT:	FILE NO.:	BY:	PAGE 1 OF
SUBJECT: MW-04 Rising head slugtest data		CHECKED BY:	DATE:

(B) MW-04 002
Rising Head
7-21-97

SE1000C
Environmental Logger
07/21 12:02

Unit# 00731 Test 1

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00004
Reference	0.000
Linearity	0.010
Scale factor	9.900
Offset	0.030
Delay mSEC	50.000

Step 0 07/21 10:59:05

Elapsed Time	INPUT 1
0.0000	0.043
0.0033	0.597
0.0066	0.951
0.0100	0.682
0.0133	0.644
0.0166	0.838
0.0200	0.378
0.0233	0.519
0.0266	0.675
0.0300	1.004
0.0333	1.020
0.0366	1.476
0.0400	1.586
0.0433	1.814
0.0466 - Too high	1.990
0.00 0.0500	1.918 •
0.0533	1.911
0.0566	1.896
0.0600	1.877
0.0633	1.849
0.0666	1.833
0.0700	1.811 •
0.0733	1.802
0.0766	1.802
0.0800	1.799
0.0833	1.786
0.0866	1.767
0.0900	1.758
0.0933	1.758
0.0966	1.758
0.1000	1.749 •
0.1033	1.745
0.1066	1.727
0.1100	1.717
0.1133	1.714
0.1166	1.714
0.1200	1.714
0.1233	1.695
0.1266	1.695
0.1300	1.689
0.1333	1.680
0.1366	1.677
0.1400	1.683 •
0.1433	1.667
0.1466	1.658
0.1500	1.658
0.1533	1.655
0.1566	1.648
0.1600	1.645
0.1633	1.642
0.1666	1.642
0.1700	1.623
0.1733	1.627
0.1766	1.623
0.1800	1.617 •
0.1833	1.617
0.1866	1.608
0.1900	1.602
0.1933	1.602
0.1966	1.595
0.2000	1.595 •
0.2033	1.592
0.2066	1.586
0.2100	1.580
0.2133	1.580
0.2166	1.576
0.2200	1.570
0.2233	1.567
0.2266	1.567
0.2300	1.561
0.2333	1.555
0.2366	1.558
0.2400	1.551
0.2433	1.548
0.2466	1.548
0.2500	1.539 •
0.2533	1.536
0.2566	1.536
0.2600	1.530
0.2633	1.526
0.2666	1.523
0.2700	1.520
0.2733	1.517
0.2766	1.514
0.2800	1.511
0.2833	1.508
0.2866	1.508
0.2900	1.501
0.2933	1.498
0.2966	1.498
0.3000	1.492 •
0.3033	1.489
0.3066	1.489
0.3100	1.486
0.3133	1.483
0.3166	1.476
0.3200	1.476
0.3233	1.473
0.3266	1.470
0.3300	1.467
0.3333	1.464
0.3500	1.448
0.3666	1.436
0.3833	1.420
0.4000	1.408 •
0.4166	1.395
0.4333	1.379
0.4500	1.367
0.4666	1.354
0.4833	1.342
0.5000	1.332 •
0.5166	1.320
0.5333	1.311
0.5500	1.298
0.5666	1.289
0.5833	1.276
0.6000	1.267 •
0.6166	1.254
0.6333	1.242
0.6500	1.235
0.6666	1.226
0.6833	1.220
0.7000	1.210 •
0.7166	1.201
0.7333	1.192
0.7500	1.182
0.7666	1.173
0.7833	1.164
0.8000	1.157 •
0.8166	1.148
0.8333	1.142
0.8500	1.135
0.8666	1.126
0.8833	1.117
0.9000	1.110 •
0.9166	1.101
0.9333	1.095
0.9500	1.088
0.9666	1.079
0.9833	1.073
1.0000	1.067 •
1.2000	0.966
1.4000	0.901
1.6000	0.838
1.8000	0.788
2.0000	0.738 •
2.2000	0.697
2.4000	0.660
2.6000	0.628
2.8000	0.594
3.0000	0.566 •
3.2000	0.541
3.4000	0.519
3.6000	0.497
3.8000	0.478
4.0000	0.460 •
4.2000	0.444
4.4000	0.425
4.6000	0.410
4.8000	0.397
5.0000	0.384 •
5.2000	0.372
5.4000	0.356
5.6000	0.341
5.8000	0.328
6.0000	0.322 •

HALLIBURTON NUS Environmental Corporation and Subsidiaries — **STANDARD CALCULATION SHEET**

CLIENT:	FILE NO.:	BY:	PAGE 2 OF
SUBJECT: MW-04 Rising head slug test data		CHECKED BY:	DATE:

6.2000	0.316
6.4000	0.309
6.6000	0.303
6.8000	0.297
7.0000	0.287
7.2000	0.278
7.4000	0.272
7.6000	0.266
7.8000	0.259
8.0000	0.253
8.2000	0.247
8.4000	0.244
8.6000	0.237
8.8000	0.234
9.0000	0.231
9.2000	0.225
9.4000	0.222
9.6000	0.219
9.8000	0.216
10.0000	0.209
12.0000	0.181
14.0000	0.165
16.0000	0.150
18.0000	0.134
20.0000	0.122
22.0000	0.112
24.0000	0.106
26.0000	0.103
28.0000	0.090
30.0000	0.087
32.0000	0.084
34.0000	0.081
36.0000	0.075
38.0000	0.081
40.0000	0.081
42.0000	0.078
44.0000	0.068
46.0000	0.072

END

Trial (3)

HYDRAULIC CONDUCTIVITY TESTING DATA SHEET — HALLIBURTON NUS CORPORATION

PROJECT NAME: NAWC Warminster — WELL/BORING NO.: MW-05

PROJECT NO.: 3933 — GEOLOGIST: A. Kendrick

WELL DIAMETER: 6" ID PVC — SCREEN LENGTH/DEPTH: Cas=? TD=33.1 TOC — TEST NO.: 001

STATIC WATER LEVEL (Depth/Elevation): 9.16 TOC — DATE: 7-22-92

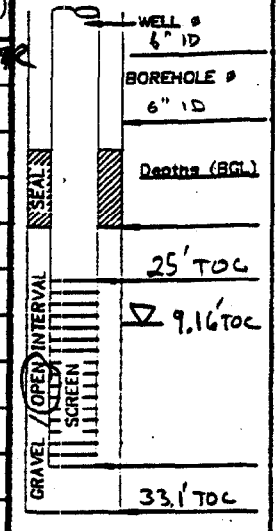
TEST TYPE (Rising/Falling/Constant Head): Falling — CHECKED:

METHOD OF INDUCING WATER LEVEL CHANGE: 2" PVC x 3.5' + 3 Sect. 1½" slug (2.5' x 3 Sect.) — PAGE ___ OF ___

REFERENCE PT. FOR WL MEAS. (Top of Casing, Transducer, etc.): TOC = 1.5'

ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)	ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)
10:16 0.0	Head Ratio 1.0	H_o = 0.685	~~0.56~~	~~.269~~	
0.02	.876	0.6	0.71	.232	.159
.04	.785	.538	0.86	.209	.143
.06	.717	.491	1.86	.127	0.087
.08	.657	.45	2.86	.123	.084
.11	.584	0.4	3.86	.114	.078
0.16	.507	0.347			
0.21	.447	.306			
0.26	.406	.278			
0.36	.346	.237			
0.46	.301	.206			
0.56	.269	.184			

WELL SCHEMATIC



▽ Indicate SWL Depth on Drawing

REMARKS:

Rising = 10:33

(II) Falling = 10:51 (4" slug)

(II) Rising = 11:07 (4" slug)

T_o = 0.48 min

r = .25

R = .25

L = 8.1'

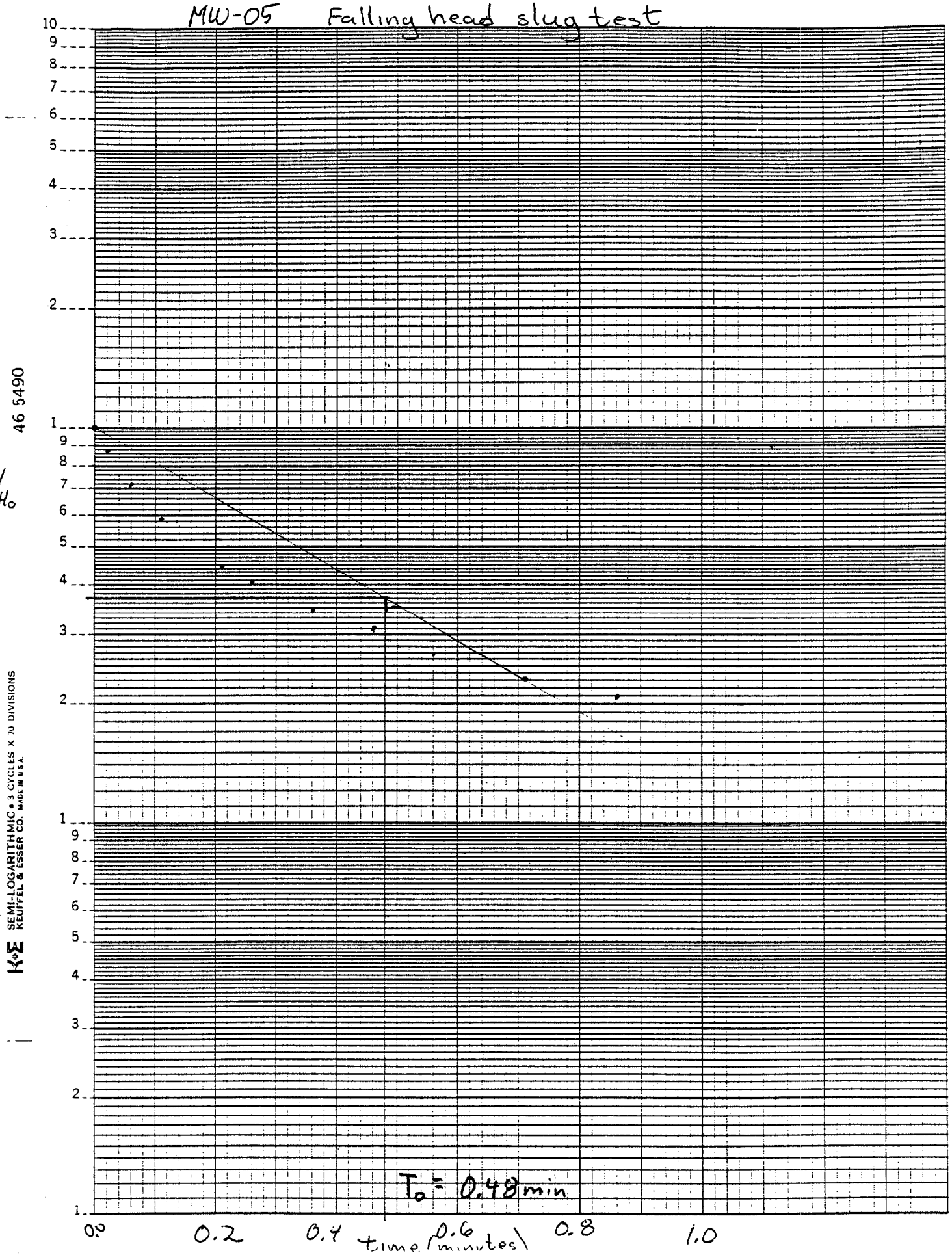
K = 0.03 ft/min

CALCS, SKETCH MAPS, ETC.:

K = .01 cm/sec

MW-05fh.mcd

MW-05 Falling head slug test



HALLIBURTON NUS Environmental Corporation and Subsidiaries — **STANDARD CALCULATION SHEET**

CLIENT:	FILE NO.:	BY:	PAGE / OF
SUBJECT: MW-05 Falling head slug test		CHECKED BY:	DATE:

MW-05 003
7-22-92
Fall No. 2

SE1000C
Environmental Logger
07/22 14:09

Unit# 00927 Test 2

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00005
Reference	0.000
Linearity	0.010
Scale factor	9.910
Offset	-0.030
Delay mSEC	50.000

Step 0 07/22 10:52:04

Elapsed Time	INPUT 1
0.0000	-0.725
0.0033	-1.611
0.0066	-1.016
0.0100	-1.251
0.0133	-1.645
0.0166	-1.945
0.0200	-1.664
0.0233	-1.867
0.0266	-2.092
0.0300	-2.086
0.0333	-2.158
0.0366	-2.105
0.0400	-2.168
0.0433	-2.080
0.0466	-1.895
0.0500	-1.883
0.0533	-1.714
0.0566	-1.586
0.0600	-1.592
0.0633	-1.404
0.0666	-1.198
0.0700	-0.857
0.0733	-0.606
0.0766	-0.763
0.0800	-1.060
0.0833	-0.976
0.0866	-0.854
0.0900	-0.929
0.0933	-0.900
0.0966	-0.885
0.1000	-0.866
0.1033	-0.847
0.1066	-0.832
0.1100	-0.747
0.1133	-0.531
0.1166	-0.944
0.1200	-0.994
0.1233	-0.610
0.1266	-0.722
0.1300	-0.769
0.1333	-0.663
0.1366	-0.681
0.000 0.1400	-0.685 •
0.1433	-0.656
0.1466	-0.644
0.1500	-0.631
0.1533	-0.622
0.1566	-0.610
0.1600	-0.600 •
0.1633	-0.588
0.1666	-0.575
0.1700	-0.569
0.1733	-0.559
0.1766	-0.550
0.1800	-0.538 •
0.1833	-0.531
0.1866	-0.522
0.1900	-0.513
0.1933	-0.506
0.1966	-0.497
0.2000	-0.491 •
0.2033	-0.481
0.2066	-0.475
0.2100	-0.469
0.2133	-0.462
0.2166	-0.456
0.2200	-0.450 •
0.2233	-0.444
0.2266	-0.437
0.2300	-0.434
0.2333	-0.428
0.2366	-0.422
0.2400	-0.419
0.2433	-0.412
0.2466	-0.406
0.2500	-0.400 •
0.2533	-0.397
0.2566	-0.394
0.2600	-0.391
0.2633	-0.384
0.2666	-0.381
0.2700	-0.378
0.2733	-0.375
0.2766	-0.369
0.2800	-0.366
0.2833	-0.362
0.2866	-0.359
0.2900	-0.356
0.2933	-0.353
0.2966	-0.350
0.3000	-0.347 •
0.3033	-0.344
0.3066	-0.341
0.3100	-0.337
0.3133	-0.334
0.3166	-0.331
0.3200	-0.331
0.3233	-0.328
0.3266	-0.325
0.3300	-0.322
0.3333	-0.319
0.3500	-0.306 •
0.3666	-0.297
0.3833	-0.287
0.4000	-0.278 •
0.4166	-0.269
0.4333	-0.262
0.4500	-0.256
0.4666	-0.250
0.4833	-0.240
0.5000	-0.237 •
0.5166	-0.231
0.5333	-0.225
0.5500	-0.222
0.5666	-0.215
0.5833	-0.212
0.6000	-0.206 •
0.6166	-0.203 X
0.6333	-0.200
0.6500	-0.197
0.6666	-0.190
0.6833	-0.187
0.7000	-0.184 •
0.7166	-0.181
0.7333	-0.178
0.7500	-0.175
0.7666	-0.172
0.7833	-0.168
0.8000	-0.168
0.8166	-0.165
0.8333	-0.162
0.8500	-0.159 •
0.8666	-0.159
0.8833	-0.156
0.9000	-0.156
0.9166	-0.153
0.9333	-0.150
0.9500	-0.150
0.9666	-0.147
0.9833	-0.143
1.0000	-0.143 •
1.2000	-0.122
1.4000	-0.109
1.6000	-0.100
1.8000	-0.090
2.0000	-0.087 •
2.2000	-0.084
2.4000	-0.081
2.6000	-0.084
2.8000	-0.087
3.0000	-0.084 •
3.2000	-0.081
3.4000	-0.081
3.6000	-0.078
3.8000	-0.078
4.0000	-0.078 •
4.2000	-0.081
4.4000	-0.081
4.6000	-0.081
4.8000	-0.081
5.0000	-0.081

HALLIBURTON NUS Environmental Corporation and Subsidiaries

STANDARD CALCULATION SHEET

CLIENT:	FILE NO.:	BY:	PAGE 2 OF
SUBJECT: MW-05 Falling head slug test		CHECKED BY:	DATE:

5.2000	-0.081
5.4000	-0.078
5.6000	-0.075
5.8000	-0.075
6.0000	-0.078
6.2000	-0.078
6.4000	-0.075
6.6000	-0.075
6.8000	-0.075
7.0000	-0.071
7.2000	-0.071
7.4000	-0.075
7.6000	-0.075
7.8000	-0.071
8.0000	-0.071
8.2000	-0.068
8.4000	-0.065
8.6000	-0.065
8.8000	-0.065
9.0000	-0.062
9.2000	-0.062
9.4000	-0.059
9.6000	-0.059
9.8000	-0.062
10.0000	-0.062
12.0000	-0.056

END

HYDRAULIC CONDUCTIVITY TESTING DATA SHEET — HALLIBURTON NUS CORPORATION

PROJECT NAME: NAWC Warminster WELL/BORING NO.: MW-05

PROJECT NO.: 3933 GEOLOGIST: A. Kendrick

WELL DIAMETER: 6" ID PVC SCREEN LENGTH/DEPTH: Cas=? TD=33.1 TOC TEST NO.: 002

STATIC WATER LEVEL (Depth/Elevation): 9.16' TOC DATE: 7-22-92

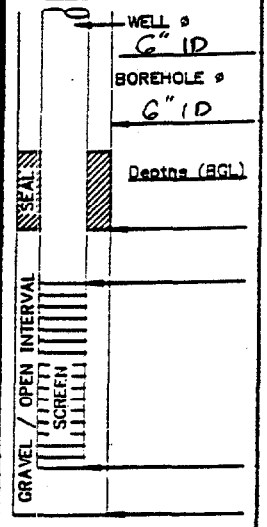
TEST TYPE (Rising/Falling/Constant Head): Rising CHECKED:

METHOD OF INDUCING WATER LEVEL CHANGE: 2" PVC x 35' + 3 sect. 1½ slug PAGE ___ OF ___

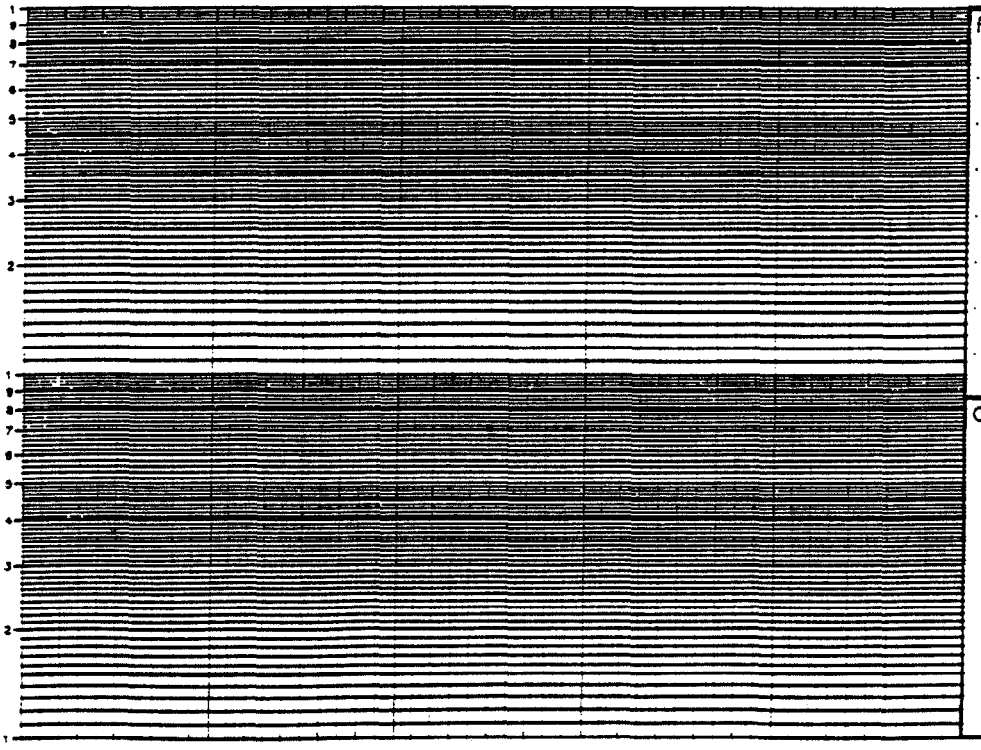
REFERENCE PT. FOR WL MEAS. (Top of Casing, Transducer, etc.): TOC = 1.5'

ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)	ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)
0.0	Head Ratio ΔH/H₀ = 1	H₀ = 1.044	0.82	.16	.165
0.02	.88	0.916	0.92	.15	.156
0.05	.71	0.744			
0.08	.60	0.625			
0.12	.48	0.503			
0.16	.41	0.431			
0.20	.36	0.378			
0.27	.30	0.315			
0.42	.23	0.244			
0.52	.21	0.215			
0.62	.19	0.193			
0.72	.17	0.178			

WELL SCHEMATIC



▽ Indicate SWL Depth on Drawing



REMARKS:

(II) Rising = 11:07 (4" slug)

T_o = .244 min

r = .25'

R = .25'

L = 8.1'

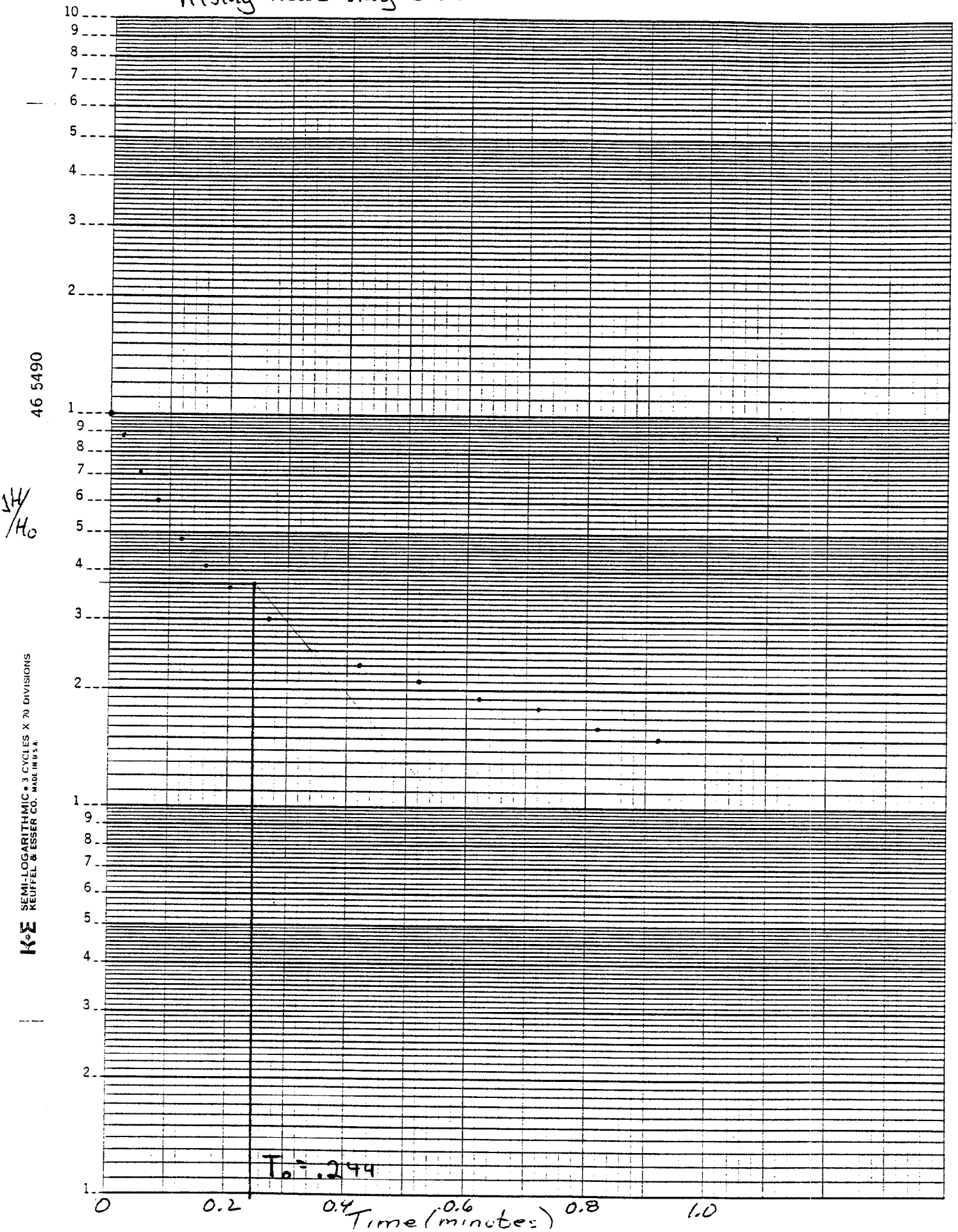
K = 0.05 ft/min

k = 0.03 cm/sec

MW-05rh.wcd

CALCS, SKETCH MAPS, ETC.:

MW-05 Rising head slug test



HALLIBURTON NUS Environmental Corporation and Subsidiaries

STANDARD CALCULATION SHEET

CLIENT:	FILE NO.:	BY:	PAGE / OF /
SUBJECT: MW-05 Risinghead slugtest data		CHECKED BY:	DATE:

MW 05
7-22-92
004 Rise #2

SE1000C
Environmental Logger
07/22 14:18

Unit# 00927 Test 3

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00005
Reference	0.000
Linearity	0.010
Scale factor	9.910
Offset	-0.030
Delay mSEC	50.000

Step 0 07/22 11:08:01

Elapsed Time	INPUT 1
0.0000	0.006
0.0033	1.041
0.0066	1.113
0.0100	1.811
0.0133	2.211
0.0166	2.349
0.0200	1.051
0.0233	1.341
0.0266	1.748
0.0300	1.839
0.0333	1.592
0.0366	1.598
0.0400	1.532
0.0433	1.467
0.0466	1.429
0.0500	1.366
0.0533	1.345
0.0566	1.301
0.0600	1.266
0.0633	1.241
0.0666	1.198
0.0700	1.169
0.0733	1.119
0.0766	1.094
0.0800	1.041
0.00 0.0833	1.044 •
0.0866	1.016
0.0900	0.991
0.0933	0.960
0.0966	0.929
0.1000	0.916 •
0.1033	0.897
0.1066	0.879
0.1100	0.850
0.1133	0.838
0.1166	0.816
0.1200	0.794
0.1233	0.775
0.1266	0.760
0.1300	0.744 •
0.1333	0.722
0.1366	0.713
0.1400	0.697
0.1433	0.678
0.1466	0.669
0.1500	0.656
0.1533	0.641
0.1566	0.635
0.1600	0.625 •
0.1633	0.613
0.1666	0.597
0.1700	0.588
0.1733	0.575
0.1766	0.566
0.1800	0.556
0.1833	0.541
0.1866	0.541
0.1900	0.525
0.1933	0.522
0.1966	0.513
0.2000	0.503 •
0.2033	0.497
0.2066	0.491
0.2100	0.484
0.2133	0.478
0.2166	0.472
0.2200	0.462
0.2233	0.456
0.2266	0.453
0.2300	0.444
0.2333	0.441
0.2366	0.434
0.2400	0.431 •
0.2433	0.425
0.2466	0.419
0.2500	0.412
0.2533	0.409
0.2566	0.403
0.2600	0.400
0.2633	0.397
0.2666	0.394
0.2700	0.387
0.2733	0.384
0.2766	0.381
0.2800	0.378 •
0.2833	0.372
0.2866	0.369
0.2900	0.366
0.2933	0.366
0.2966	0.362
0.3000	0.356
0.3033	0.356
0.3066	0.350
0.3100	0.347
0.3133	0.347
0.3166	0.344
0.3200	0.340
0.3233	0.337
0.3266	0.334
0.3300	0.331
0.3333	0.331
0.3500	0.315 •
0.3666	0.306
0.3833	0.297
0.4000	0.287
0.4166	0.278
0.4333	0.272
0.4500	0.262
0.4666	0.256
0.4833	0.250
0.5000	0.244 •
0.5166	0.240
0.5333	0.234
0.5500	0.228
0.5666	0.225
0.5833	0.218
0.6000	0.215 •
0.6166	0.212
0.6333	0.209
0.6500	0.203
0.6666	0.200
0.6833	0.197
0.7000	0.193 •
0.7166	0.190
0.7333	0.190
0.7500	0.187
0.7666	0.184
0.7833	0.181
0.8000	0.178 •
0.8166	0.175
0.8333	0.172
0.8500	0.172
0.8666	0.168
0.8833	0.165
0.9000	0.165 •
0.9166	0.162
0.9333	0.162
0.9500	0.159
0.9666	0.159
0.9833	0.156
1.0000	0.156
1.2000	0.134
1.4000	0.125
1.6000	0.115
1.8000	0.106
2.0000	0.096
2.2000	0.090
2.4000	0.087
2.6000	0.084
2.8000	0.084
3.0000	0.081
3.2000	0.075
3.4000	0.075
3.6000	0.075
3.8000	0.071
4.0000	0.071
4.2000	0.071
4.4000	0.068
4.6000	0.065
4.8000	0.062

END

HYDRAULIC CONDUCTIVITY TESTING DATA SHEET — HALLIBURTON NUS CORPORATION

PROJECT NAME: NAWC Warminster — WELL/BORING NO.: MW-06

PROJECT NO.: 3933 — GEOLOGIST: A. Kendrick

WELL DIAMETER: 6" ID PVC — SCREEN LENGTH/DEPTH: Open Case @ 20.0 TOC — TEST NO.: 001

STATIC WATER LEVEL (Depth/Elevation): 11.26 — TD = 48.0 TOC — DATE: 7-22-92

TEST TYPE (Rising/Falling/Constant Head): Falling — CHECKED:

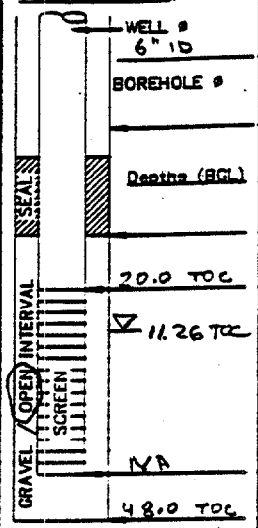
METHOD OF INDUCING WATER LEVEL CHANGE: 4" PVC Slug x 3.5' — PAGE ... OF ...

REFERENCE PT. FOR WL MEAS. (Top of Casing, Transducer, etc.): TOC = 1.8'

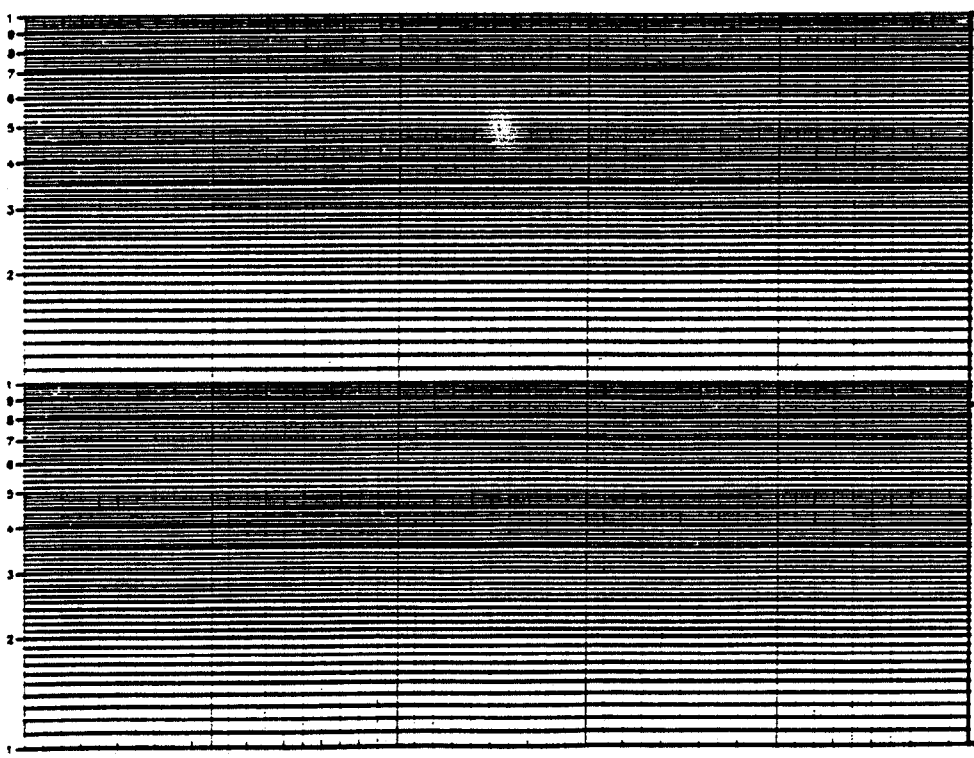
9:33

ELAPSED* TIME (min or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)	ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)
0.00	Head Ratio $\Delta H/H_0 = 1.0$	2.443 (H_0)	1.93	0.172	0.421
0.01	0.908	2.219			
0.03	0.668	1.633			
0.08	0.635	1.551			
0.13	0.600	1.468			
0.18	0.571	1.396			
0.23	0.549	1.342			
0.28	0.521	1.272			
0.43	0.456	1.11			
0.63	0.387	0.946			
0.83	0.333	0.813			
0.93	0.311	0.759			

WELL SCHEMATIC



▽ Indicate SWL Depth on Drawing



REMARKS:

*ELAPSED TIME ADJ. TO ZERO

T_0 = 1.14 min

r = .25'

R = .25'

L = 28.0'

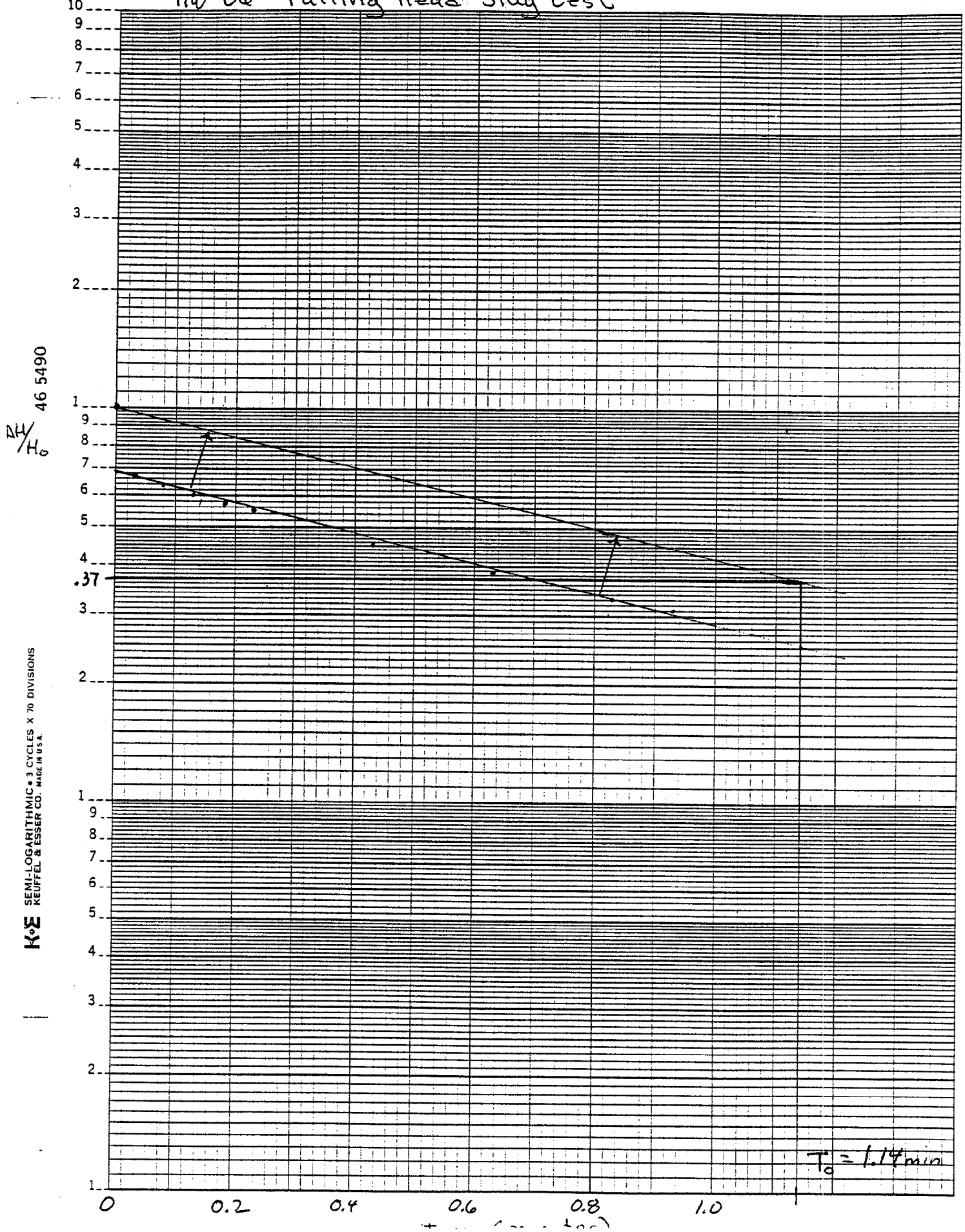
K = 4.62×10^{-3} ft/min

K = 2.35×10^{-3} cm/sec

MW-06th.mcd

CALCS, SKETCH MAPS, ETC.:

MW-06 Falling head Slug test



HALLIBURTON NUS Environmental Corporation and Subsidiaries

STANDARD CALCULATION SHEET

CLIENT:	FILE NO.:	BY:	PAGE 1 OF
SUBJECT: Falling head Slug test data, MW-06		CHECKED BY:	DATE:

MW-06
Falling Head
READY 7/22/92

001

SE1000C
Environmental Logger
07/22 11:52

Unit# 00765 Test 0

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00006
Reference	0.000
Linearity	0.000
Scale factor	10.020
Offset	0.000
Delay mSEC	50.000

Step 0 07/22 09:34:20

Elapsed Time	INPUT 1
0.0000	-0.012
0.0033	-0.705
0.0066	-0.724
0.0100	-1.069
0.0133	-1.332
0.0166	-1.646
0.0200	-1.737
0.0233	-1.892
0.0266	-2.051
0.0300	-2.105
0.0333	-2.193
0.0366	-2.288
0.0400	-2.386
0.0433	-2.329
0.0466	-2.352
0.0500	-2.421
0.0533	-2.393
0.0566	-2.282
0.0600	-2.336
0.0633	-2.383
0.00 0.0666	-2.443
0.0700	-2.336
0.0733	-2.231
0.0766	-2.219
0.0800	-1.968
0.0833	-1.646
0.0866	-1.231
0.0900	-1.139
0.0933	-1.617
0.0966	-1.788
0.1000	-1.633
0.1033	-1.620
0.1066	-1.665
0.1100	-1.627
0.1133	-1.608
0.1166	-1.620
0.1200	-1.608
0.1233	-1.592
0.1266	-1.595
0.1300	-1.585
0.1333	-1.576
0.1366	-1.576
0.1400	-1.566
0.1433	-1.560
0.1466	-1.563
0.1500	-1.551
0.1533	-1.547
0.1566	-1.538
0.1600	-1.535
0.1633	-1.528
0.1666	-1.522
0.1700	-1.516
0.1733	-1.513
0.1766	-1.506
0.1800	-1.500
0.1833	-1.497
0.1866	-1.490
0.1900	-1.484
0.1933	-1.481
0.1966	-1.475
0.2000	-1.468
0.2033	-1.465
0.2066	-1.459
0.2100	-1.456
0.2133	-1.449
0.2166	-1.446
0.2200	-1.440
0.2233	-1.437
0.2266	-1.430
0.2300	-1.424
0.2333	-1.421
0.2366	-1.418
0.2400	-1.411
0.2433	-1.411
0.2466	-1.399
0.2500	-1.396
0.2533	-1.396
0.2566	-1.377
0.2600	-1.313
0.2633	-1.342
0.2666	-1.386
0.2700	-1.427
0.2733	-1.446
0.2766	-1.383
0.2800	-1.320
0.2833	-1.358
0.2866	-1.345
0.2900	-1.348
0.2933	-1.326
0.2966	-1.313
0.3000	-1.342
0.3033	-1.370
0.3066	-1.361
0.3100	-1.288
0.3133	-1.304
0.3166	-1.316
0.3200	-1.310
0.3233	-1.307
0.3266	-1.310
0.3300	-1.304
0.3333	-1.282
0.3500	-1.272
0.3666	-1.253
0.3833	-1.234
0.4000	-1.215
0.4166	-1.199
0.4333	-1.180
0.4500	-1.164
0.4666	-1.145
0.4833	-1.130
0.5000	-1.114
0.5166	-1.098
0.5333	-1.082
0.5500	-1.066
0.5666	-1.054
0.5833	-1.038
0.6000	-1.025
0.6166	-1.009
0.6333	-0.997
0.6500	-0.984
0.6666	-0.971
0.6833	-0.959
0.7000	-0.946
0.7166	-0.933
0.7333	-0.921
0.7500	-0.911
0.7666	-0.899
0.7833	-0.886
0.8000	-0.876
0.8166	-0.864
0.8333	-0.854
0.8500	-0.845
0.8666	-0.835
0.8833	-0.823
0.9000	-0.813
0.9166	-0.804
0.9333	-0.794
0.9500	-0.788
0.9666	-0.775
0.9833	-0.769
1.0000	-0.759
1.2000	-0.648
1.4000	-0.576
1.6000	-0.512
1.8000	-0.462
2.0000	-0.421
2.2000	-0.386
2.4000	-0.354
2.6000	-0.326
2.8000	-0.303
3.0000	-0.284
3.2000	-0.265
3.4000	-0.253
3.6000	-0.237
3.8000	-0.221
4.0000	-0.212
4.2000	-0.202
4.4000	-0.196
4.6000	-0.189
4.8000	-0.180
5.0000	-0.174
5.2000	-0.167
5.4000	-0.161
5.6000	-0.155
5.8000	-0.155
6.0000	-0.148

HALLIBURTON NUS Environmental Corporation and Subsidiaries — *STANDARD CALCULATION SHEET*

CLIENT:	FILE NO.:	BY:	PAGE 2 OF
SUBJECT: Falling head slug test data, MW-06		CHECKED BY:	DATE:

6.2000	-0.145
6.4000	-0.142
6.6000	-0.139
6.8000	-0.139
7.0000	-0.136
7.2000	-0.129
7.4000	-0.126
7.6000	-0.126
7.8000	-0.123
8.0000	-0.123
8.2000	-0.120
8.4000	-0.120
8.6000	-0.120
8.8000	-0.117
9.0000	-0.117
9.2000	-0.113
9.4000	-0.110
9.6000	-0.110
9.8000	-0.110
10.0000	-0.107
12.0000	-0.107
14.0000	-0.098
16.0000	-0.094
18.0000	-0.094
20.0000	-0.098

END

HYDRAULIC CONDUCTIVITY TESTING DATA SHEET — HALLIBURTON NUS CORPORATION

PROJECT NAME: NAWC Warminster WELL/BORING NO.: MW-06

PROJECT NO.: 3933 GEOLOGIST: A. Kendrick

WELL DIAMETER: 6" ID PVC SCREEN LENGTH/DEPTH: Open, Case to 20.0 TOC TEST NO.: 002

STATIC WATER LEVEL (Depth/Elevation): 11.26 TD = 48.0 TOC DATE: 7-22-93

TEST TYPE (Rising/Falling/Constant Head): Rising CHECKED:

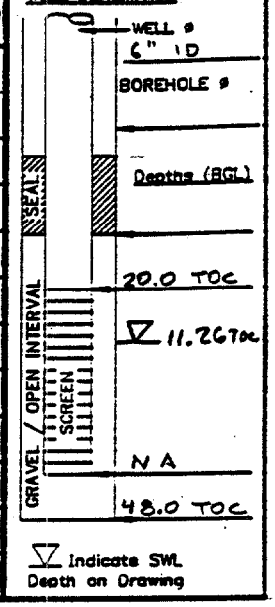
METHOD OF INDUCING WATER LEVEL CHANGE: 4" PVC Slug x 3.5' PAGE ..... OF .....

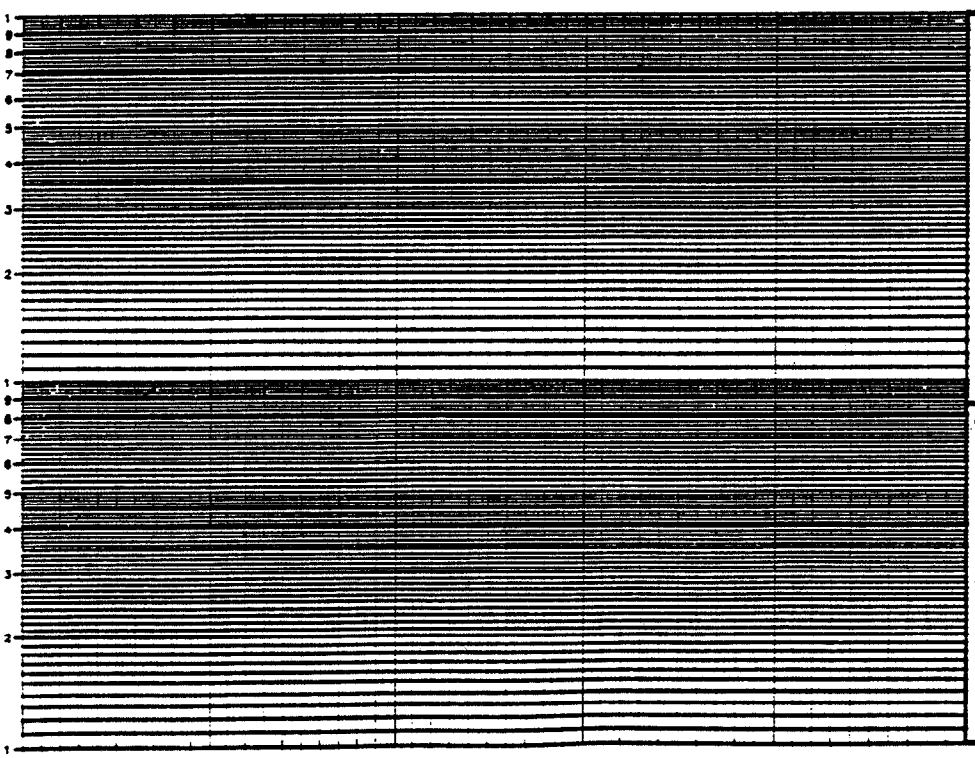
REFERENCE PT. FOR WL MEAS. (Top of Casing, Transducer, etc.): TOC = 1.8'

9:56

ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)	ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)
0.00	Head Ratio ΔH/H₀ = 1.0*	H₀ = 1.826	0.75	.495*	.905
.03	.95	1.737	0.95	.431*	.788
.05	.91*	1.665	1.95	.241	.44
08	.88	1.608	2.95	.161	.294
0.1	.86*	1.563	3.95	.119	0.218
.14	.82	1.5			
.16	.80	1.465			
0.2	.77*	1.411			
0.23	.75	1.37			
.35	.67*	1.231			
.45	.62	1.133			
.6	.55*	1.009			

WELL SCHEMATIC

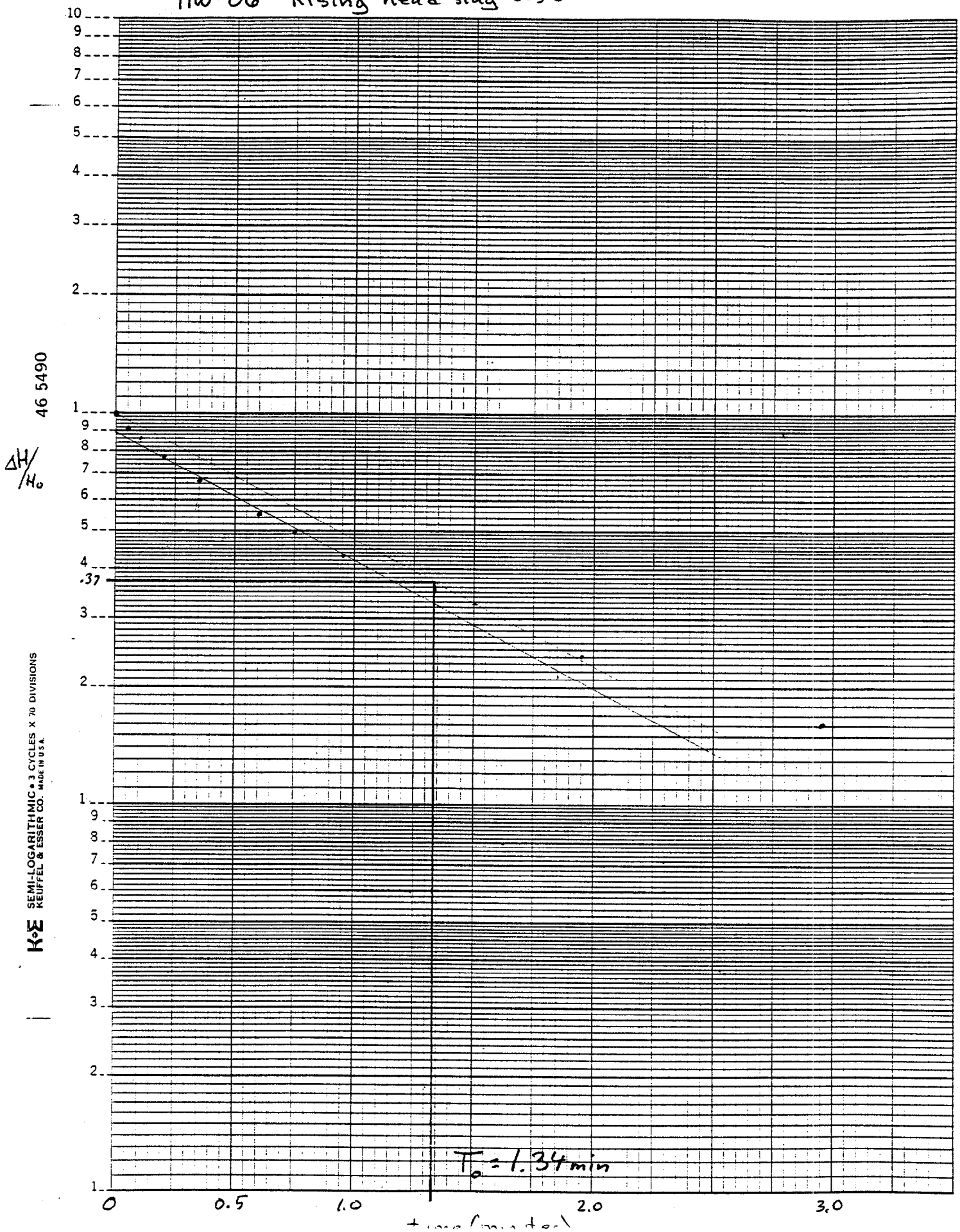




REMARKS:
parameters:
T_0 = 1.34 min
r = .25'
R = .25'
L = 28'
K = 3.93×10^{-3} ft/min
K = 2×10^{-3} cm/sec
MW-06rh.mcd

CALCS, SKETCH MAPS, ETC.:

MW-06 Rising head slug test



HALLIBURTON NUS Environmental Corporation and Subsidiaries

STANDARD CALCULATION SHEET

CLIENT:	FILE NO.:	BY:	PAGE / OF
SUBJECT: MW-06 Rising head slug test data		CHECKED BY:	DATE:

MW-06 7/22/92

Rising Head 002

SE1000C
Environmental Logger
07/22 12:02

Unit# 00765 Test 1

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00006
Reference	0.000
Linearity	0.000
Scale factor	10.020
Offset	0.000
Delay mSEC	50.000

Step 0 07/22 09:57:11

Elapsed Time	INPUT 1
0.0000	0.000
0.0033	0.446
0.0066	2.456
0.0100	2.792
0.0133	2.871
0.0166	3.099
0.0200	2.184
0.0233	2.712
0.0266	2.845
0.0300	2.082
0.0333	1.848
0.0366	1.874
0.0400	1.874
0.0433	1.848
0.0466	1.842
t=0.0 0.0500	1.826
0.0533	1.801
0.0566	1.798
0.0600	1.791
0.0633	1.791
0.0666	1.760
0.0700	1.750
0.0733	1.734
0.0766	1.722
0.0800	1.737
0.0833	1.715
0.0866	1.709
0.0900	1.680
0.0933	1.677
0.0966	1.671
0.1000	1.665
0.1033	1.665
0.1066	1.658
0.1100	1.646
0.1133	1.642
0.1166	1.633
0.1200	1.620
0.1233	1.620
0.1266	1.611
0.1300	1.608
0.1333	1.604
0.1366	1.589
0.1400	1.595
0.1433	1.579
0.1466	1.576
0.1500	1.570
0.1533	1.563
0.1566	1.557
0.1600	1.547
0.1633	1.544
0.1666	1.538
0.1700	1.532
0.1733	1.525
0.1766	1.522
0.1800	1.516
0.1833	1.509
0.1866	1.503
0.1900	1.500
0.1933	1.497
0.1966	1.490
0.2000	1.484
0.2033	1.478
0.2066	1.472
0.2100	1.465
0.2133	1.462
0.2166	1.459
0.2200	1.453
0.2233	1.446
0.2266	1.443
0.2300	1.440
0.2333	1.433
0.2366	1.427
0.2400	1.424
0.2433	1.418
0.2466	1.415
0.2500	1.411
0.2533	1.405
0.2566	1.402
0.2600	1.396
0.2633	1.392
0.2666	1.389
0.2700	1.383
0.2733	1.380
0.2766	1.377
0.2800	1.370
0.2833	1.367
0.2866	1.364
0.2900	1.358
0.2933	1.354
0.2966	1.351
0.3000	1.345
0.3033	1.345
0.3066	1.339
0.3100	1.335
0.3133	1.332
0.3166	1.326
0.3200	1.323
0.3233	1.320
0.3266	1.313
0.3300	1.310
0.3333	1.307
0.3500	1.288
0.3666	1.269
0.3833	1.250
0.4000	1.231
0.4166	1.212
0.4333	1.196
0.4500	1.180
0.4666	1.161
0.4833	1.145
0.5000	1.133
0.5166	1.117
0.5333	1.101
0.5500	1.085
0.5666	1.073
0.5833	1.060
0.6000	1.047
0.6166	1.031
0.6333	1.019
0.6500	1.009
0.6666	0.997
0.6833	0.984
0.7000	0.971
0.7166	0.962
0.7333	0.949
0.7500	0.936
0.7666	0.924
0.7833	0.914
0.8000	0.905
0.8166	0.895
0.8333	0.883
0.8500	0.873
0.8666	0.864
0.8833	0.851
0.9000	0.842
0.9166	0.832
0.9333	0.823
0.9500	0.813
0.9666	0.804
0.9833	0.797
1.0000	0.788
1.2000	0.671
1.4000	0.595
1.6000	0.534
1.8000	0.484
2.0000	0.440
2.2000	0.398
2.4000	0.364
2.6000	0.338
2.8000	0.316
3.0000	0.294
3.2000	0.275
3.4000	0.259
3.6000	0.243
3.8000	0.231
4.0000	0.218
4.2000	0.208
4.4000	0.199
4.6000	0.186
4.8000	0.177
5.0000	0.170

5.2000	0.164
5.4000	0.158
5.6000	0.148
5.8000	0.145
6.0000	0.142
6.2000	0.139
6.4000	0.136
6.6000	0.132
6.8000	0.129
7.0000	0.126
7.2000	0.123
7.4000	0.123
7.6000	0.120
7.8000	0.117
8.0000	0.110
8.2000	0.110
8.4000	0.110
8.6000	0.107
8.8000	0.107
9.0000	0.104
9.2000	0.101
9.4000	0.101
9.6000	0.101
9.8000	0.101
10.0000	0.101
12.0000	0.094
14.0000	0.091
16.0000	0.085
18.0000	0.091
20.0000	0.082
22.0000	0.079
24.0000	0.082
26.0000	0.085
28.0000	0.079

END

HYDRAULIC CONDUCTIVITY TESTING DATA SHEET — HALLIBURTON NUS CORPORATION

PROJECT NAME: NAWC Warminster — WELL/BORING NO.: MW-07

PROJECT NO.: 3933 — GEOLOGIST: A. Kendrick / R. Good

WELL DIAMETER: 4" ID PVC — SCREEN LENGTH/DEPTH: 5' (10.1'-15.1') — TEST NO.: 001

STATIC WATER LEVEL (Depth/Elevation): 9.79 Total 15.1 TOC — DATE: 7-21-92

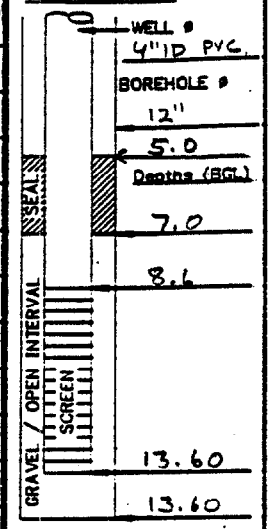
TEST TYPE (Rising/Falling/Constant Head): Falling Head — CHECKED:

METHOD OF INDUCING WATER LEVEL CHANGE: 2.5" OD PVC x 3.5' — PAGE ... OF ...

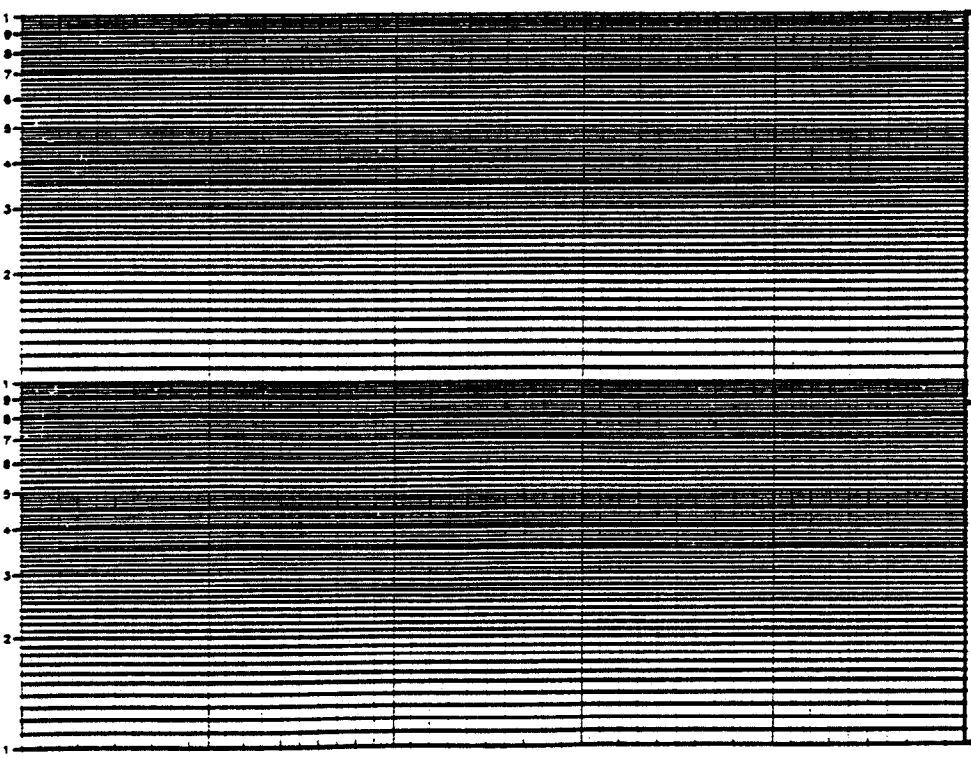
REFERENCE PT. FOR WL MEAS. (Top of Casing, Transducer, etc.): TOC = 1.5'

ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)	ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)
1020 0.0	Head Ratio ΔH/H₀ ~1	1.003	3.9	.38 *	.383
.04	.984	.987	4.9	.32 *	.316
.08	.975	.978	5.9	.27	.269
0.13	.962 *	.965	7.9	.22	.221
0.2	.946	.949	9.9	.19	.193
0.3	.924 *	.927			
0.4	.899	.902			
0.5	.877 *	0.88			
0.7	.833	.835			
0.9	.792 *	.794			
1.9	.61 *	.61			
29	.48 *	.481			

WELL SCHEMATIC



▽ Indicate SWL Depth on Drawing



REMARKS:

Parameters:

T_o = 4.0 min

r = .1667'

R = .5'

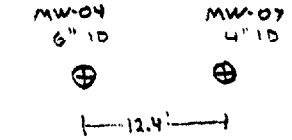
L = 5.0

K = 1.6×10^{-3} ft/min

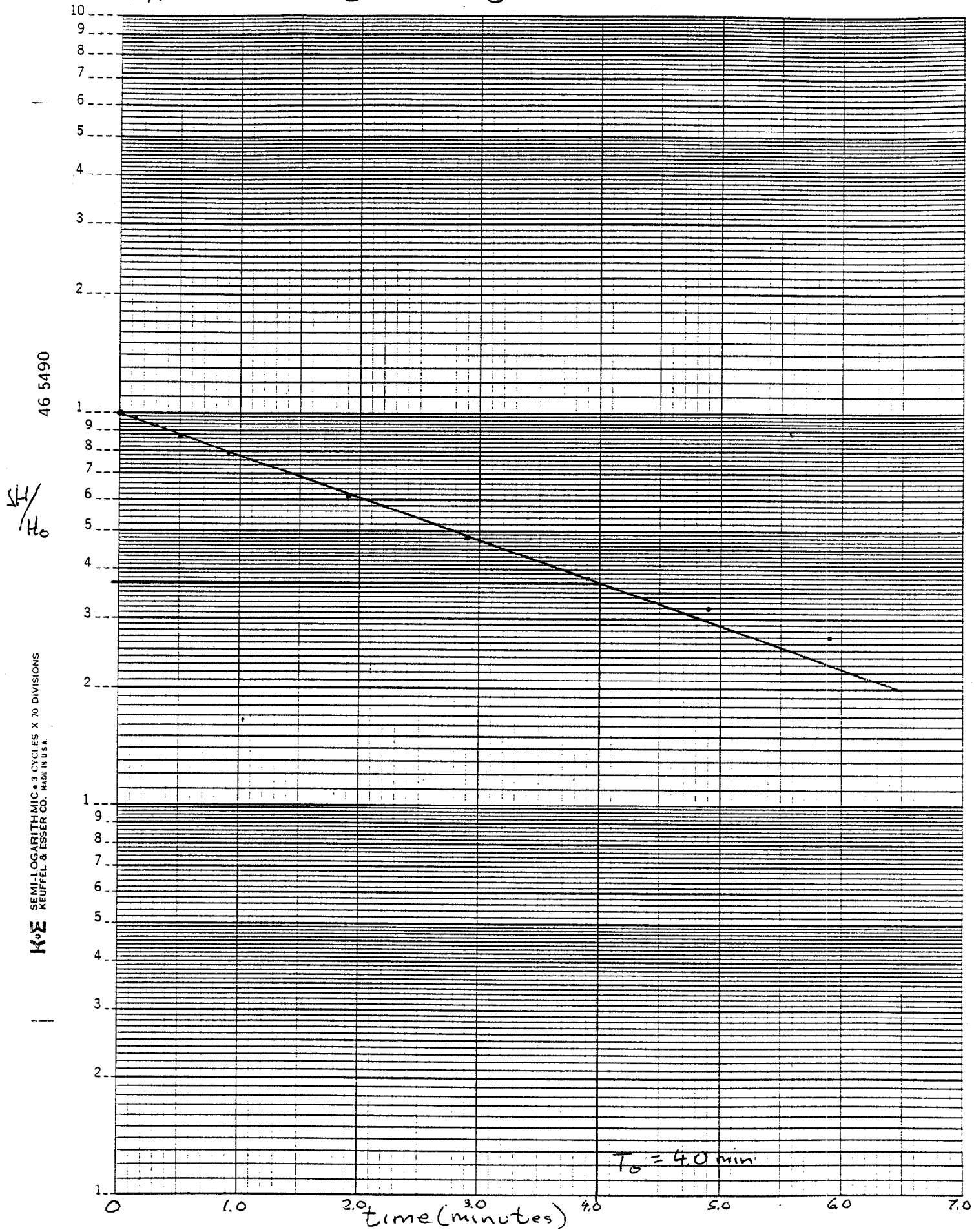
K = 8.13×10^{-4} cm/sec

MW-07ch.mcd

CALCS, SKETCH MAPS, ETC.:



MW-07 Falling head slug test



HALLIBURTON NUS Environmental Corporation and Subsidiaries

STANDARD CALCULATION SHEET

CLIENT:	FILE NO.:	BY:	PAGE 1 OF
SUBJECT: MW-07 Falling head slug test data		CHECKED BY:	DATE:

(A) MW-07 001
Falling head

READY 7-21-92

SE1000C
Environmental Logger
07/21 12:46

Unit# 00765 Test 0

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00007
Reference	0.000
Linearity	0.000
Scale factor	10.020
Offset	0.000
Delay mSEC	50.000

Step 0 07/21 09:18:39

Elapsed Time	INPUT 1
0.0000	0.142
0.0033	0.139
0.0066	-0.218
0.0100	-0.484
0.0133	-0.471
0.0166	-0.626
0.0200	-0.943
0.0233	-1.164
0.0266	-1.228
0.0300	-1.180
0.0333	-1.345
0.0366	-1.225
0.0400	-1.035
0.0433	-0.937
0.0466	-0.886
0.0500	-1.047
0.0533	-0.835
0.0566	-0.952
0.0600	-1.123
0.0633	-0.975
0.0666	-0.997
0.0700	-1.031
0.0733	-0.993
0.0766	-1.000
0.0800	-1.019
0.0833	-0.997
0.0866	-1.000
0.0900	-1.009
0.0933	-0.997
0.0966	-1.000
0.00 0.1000	-1.003
0.1033	-0.997
0.1066	-0.997
0.1100	-0.997
0.1133	-0.993
0.1166	-0.993
0.1200	-0.993
0.1233	-0.990
0.1266	-0.990
0.1300	-0.990
0.1333	-0.990
0.1366	-0.987
0.1400	-0.987
0.1433	-0.987
0.1466	-0.984
0.1500	-0.984
0.1533	-0.984
0.1566	-0.984
0.1600	-0.984
0.1633	-0.981
0.1666	-0.981
0.1700	-0.981
0.1733	-0.981
0.1766	-0.978
0.1800	-0.978
0.1833	-0.978
0.1866	-0.978
0.1900	-0.975
0.1933	-0.975
0.1966	-0.975
0.2000	-0.975
0.2033	-0.975
0.2066	-0.971
0.2100	-0.971
0.2133	-0.971
0.2166	-0.968
0.2200	-0.968
0.2233	-0.968
0.2266	-0.968
0.2300	-0.965
0.2333	-0.965
0.2366	-0.965
0.2400	-0.965
0.2433	-0.965
0.2466	-0.962
0.2500	-0.962
0.2533	-0.962
0.2566	-0.962
0.2600	-0.959
0.2633	-0.959
0.2666	-0.959
0.2700	-0.959
0.2733	-0.956
0.2766	-0.956
0.2800	-0.956
0.2833	-0.956
0.2866	-0.952
0.2900	-0.952
0.2933	-0.952
0.2966	-0.952
0.3000	-0.949
0.3033	-0.949
0.3066	-0.949
0.3100	-0.949
0.3133	-0.946
0.3166	-0.946
0.3200	-0.946
0.3233	-0.946
0.3266	-0.943
0.3300	-0.943
0.3333	-0.943
0.3500	-0.940
0.3666	-0.933
0.3833	-0.930
0.4000	-0.927
0.4166	-0.921
0.4333	-0.918
0.4500	-0.914
0.4666	-0.911
0.4833	-0.911
0.5000	-0.902
0.5166	-0.886
0.5333	-0.881
0.5500	-0.886
0.5666	-0.886
0.5833	-0.883
0.6000	-0.880
0.6166	-0.876
0.6333	-0.873
0.6500	-0.867
0.6666	-0.864
0.6833	-0.861
0.7000	-0.857
0.7166	-0.854
0.7333	-0.851
0.7500	-0.848
0.7666	-0.845
0.7833	-0.838
0.8000	-0.835
0.8166	-0.832
0.8333	-0.829
0.8500	-0.826
0.8666	-0.823
0.8833	-0.819
0.9000	-0.816
0.9166	-0.813
0.9333	-0.807
0.9500	-0.804
0.9666	-0.800
0.9833	-0.797
1.0000	-0.794
1.2000	-0.750
1.4000	-0.712
1.6000	-0.674
1.8000	-0.642
2.0000	-0.610
2.2000	-0.582
2.4000	-0.553
2.6000	-0.528
2.8000	-0.503
3.0000	-0.481
3.2000	-0.459
3.4000	-0.436
3.6000	-0.417
3.8000	-0.398
4.0000	-0.383
4.2000	-0.367
4.4000	-0.354
4.6000	-0.338
4.8000	-0.325
5.0000	-0.316
5.2000	-0.303
5.4000	-0.294
5.6000	-0.288
5.8000	-0.278
6.0000	-0.269

HALLIBURTON NUS Environmental Corporation and Subsidiaries

STANDARD CALCULATION SHEET

CLIENT:	FILE NO.:	BY:	PAGE 2 OF
SUBJECT: MW-07 Falling head slug test data		CHECKED BY:	DATE:

6.2000	-0.262
6.4000	-0.256
6.6000	-0.253
6.8000	-0.246
7.0000	-0.240
7.2000	-0.237
7.4000	-0.231
7.6000	-0.227
7.8000	-0.224
8.0000	-0.221 •
8.2000	-0.218
8.4000	-0.215
8.6000	-0.212
8.8000	-0.208
9.0000	-0.208
9.2000	-0.208
9.4000	-0.205
9.6000	-0.199
9.8000	-0.196
10.0000	-0.193 •
12.0000	-0.167
14.0000	-0.145
16.0000	-0.126
18.0000	-0.126
20.0000	-0.104
22.0000	-0.088
24.0000	-0.079
26.0000	-0.072
28.0000	-0.060
30.0000	-0.053
32.0000	-0.047
34.0000	-0.053
36.0000	-0.041
38.0000	-0.034
40.0000	-0.028
42.0000	-0.022
44.0000	-0.015
46.0000	-0.009
48.0000	-0.006
50.0000	-0.003
52.0000	0.003
54.0000	0.003

END

HYDRAULIC CONDUCTIVITY TESTING DATA SHEET — HALLIBURTON NUS CORPORATION

PROJECT NAME: NAWC Warminster WELL/BORING NO.: MW-07

PROJECT NO.: 3933 GEOLOGIST: A. Kendrick / R. Good

WELL DIAMETER: 4" I.D. PVC SCREEN LENGTH/DEPTH: 5' (10.1'-15.1') TEST NO.: 002

STATIC WATER LEVEL (Depth/Elevation): 9.79 Total 15.1 TOC DATE: 7-21-92

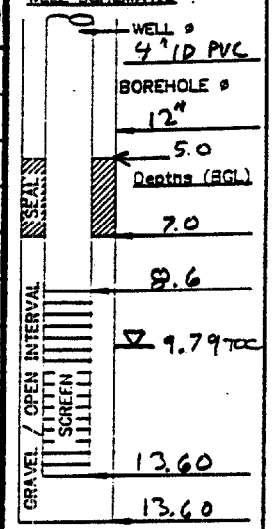
TEST TYPE (Rising/Falling/Constant Head): Rising head CHECKED:

METHOD OF INDUCING WATER LEVEL CHANGE: 2.5" OD PVC x 3.5' PAGE ... OF ...

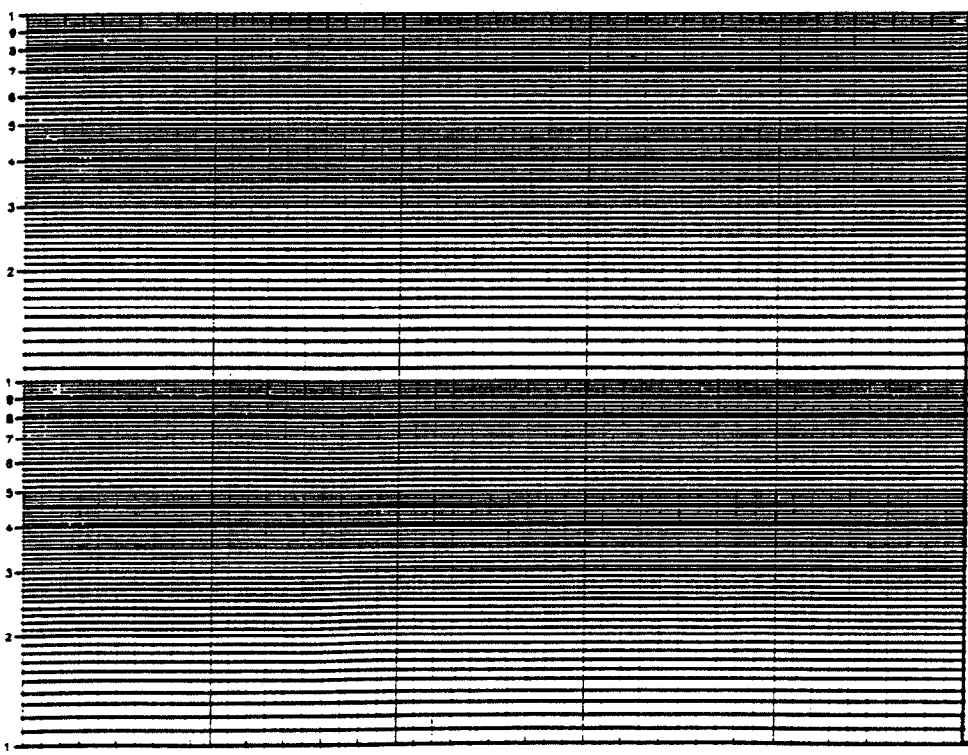
REFERENCE PT. FOR WL MEAS. (Top of Casing, Transducer, etc.): TOC = 1.5'

ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)	ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)
0.0	Head Ratio ΔH/H₀ = 1.0	H₀ = 1.202	4.95	✓.36 *	.430
0.05	.92	1.107	5.95	✓.33 *	.398
0.10	.87 *	1.041	6.95	✓.31	.376
0.15	.81	.984	8.95	✓.29	.345
0.25	.77 *	.930	19.95	✓.23	.275
0.30	.76	.918	39.95	.19	.231
0.40	.74 *	.892			
0.65	✓.71 *	.851			
0.90	.68 *	.813			
1.95	.55 *	.661			
2.95	.48 *	.563			
3.95	✓.41 *	.487			

WELL SCHEMATIC



▽ Indicate SWL Depth on Drawing



REMARKS: parameters:

$T_0 = 6.8$ min

$r = .1667'$

$R = .5'$

$L = 5.0'$

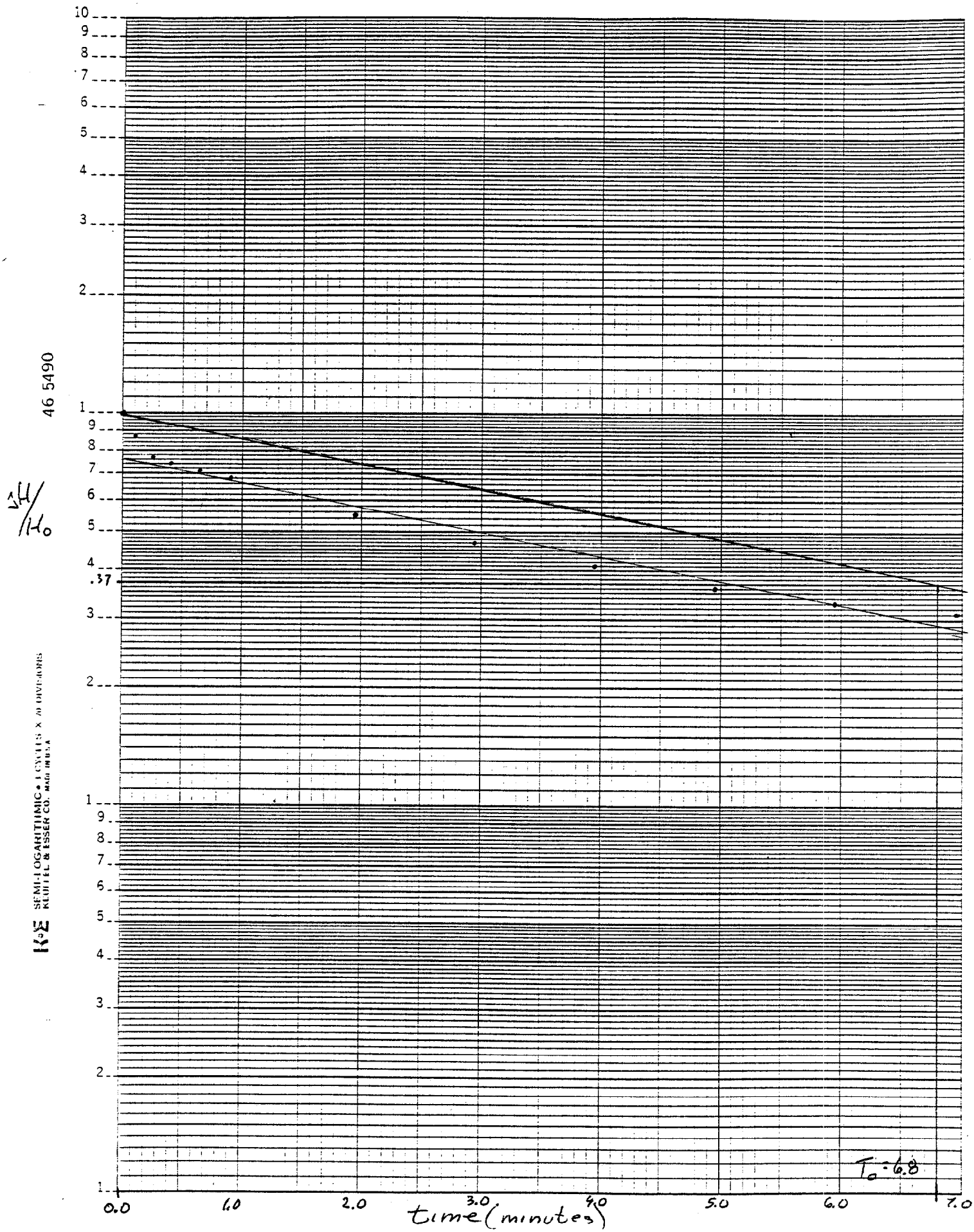
$K = 9.41 \times 10^{-4}$ ft/min

$K = 4.78 \times 10^{-4}$ cm/sec

MW-07rh.mcd

CALCS, SKETCH MAPS, ETC.:

MW-07 Rising head slug test



HALLIBURTON NUS Environmental Corporation and Subsidiaries

STANDARD CALCULATION SHEET

CLIENT:	FILE NO.:	BY:	PAGE 1 OF
SUBJECT: MW-07 Rising head slug test data		CHECKED BY:	DATE:

7-21-92 002
MW-07
Rising Head

SE1000C
Environmental Logger
07/21 12:57

Unit# 00765 Test 1

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00007
Reference	0.000
Linearity	0.000
Scale factor	10.020
Offset	0.000
Delay mSEC	50.000

Step 0 07/21 10:17:19

Elapsed Time	INPUT 1
0.0000	0.006
0.0033	0.018
0.0066	0.538
0.0100	0.762
0.0133	0.813
0.0166	0.850
0.0200	0.783
0.0233	0.557
0.0266	1.395
0.0300	1.054
0.0333	1.247
0.0366	1.098
0.0400	1.215
0.0433	1.212
0.0466	1.174
0.0500	1.202
0.0533	1.130
0.0566	1.183
0.0600	1.183
0.0633	1.174
0.0666	1.168
0.0700	1.164
0.0733	1.155
0.0766	1.142
0.0800	1.133
0.0833	1.130
0.0866	1.127
0.0900	1.120
[illegible]	[illegible]
[illegible]	1.114
0.1000	1.107
[illegible]	1.104
0.1066	1.098
[illegible]	1.095
[illegible]	1.088
[illegible]	1.082
[illegible]	1.077
0.1233	1.076
0.1266	1.073
0.1300	1.066
0.1333	1.063
0.1366	1.057
0.1400	1.054
0.1433	1.050
0.1466	1.044
0.1500	1.041
0.1533	1.035
0.1566	1.031
0.1600	1.025
0.1633	1.025
0.1666	1.019
0.1700	1.016
0.1733	1.009
0.1766	1.006
0.1800	1.003
0.1833	1.000
0.1866	0.997
0.1900	0.993
0.1933	0.990
0.1966	0.987
0.2000	0.984
0.2033	0.981
0.2066	0.978
0.2100	0.978
0.2133	0.974
0.2166	0.971
0.2200	0.968
0.2233	0.965
0.2266	0.965
0.2300	0.962
0.2333	0.959
0.2366	0.959
0.2400	0.955
0.2433	0.955
0.2466	0.952
0.2500	0.952
0.2533	0.949
0.2566	0.949
0.2600	0.946
0.2633	0.946
0.2666	0.943
0.2700	0.943
0.2733	0.940
0.2766	0.940
0.2800	0.936
0.2833	0.936
0.2866	0.933
0.2900	0.933
0.2933	0.933
0.2966	0.930
[illegible]	0.930
[illegible]	[illegible]
[illegible]	[illegible]
0.3133	0.927
0.3166	0.924
0.3200	0.924
0.3233	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
0.3366	0.918
[illegible]	0.918
[illegible]	0.908
[illegible]	0.908
0.4300	0.902
0.4166	0.902
0.4333	0.895
0.4500	0.892
0.4666	0.889
0.4833	0.889
0.5000	0.883
0.5166	0.883
0.5333	0.876
0.5500	0.873
0.5666	0.870
0.5833	0.870
0.6000	0.867
0.6166	0.861
[illegible]	[illegible]
0.6500	0.857
[illegible]	0.854
0.6833	0.851
0.7000	0.851
0.7166	0.848
0.7333	0.845
0.7500	0.842
0.7666	0.838
0.7833	0.838
0.8000	0.835
0.8166	0.832
0.8333	0.829
[illegible]	0.826
0.8666	0.826
0.8833	0.823
0.9000	0.823
0.9166	0.816
0.9333	0.816
0.9500	0.813
0.9666	0.810
0.9833	0.807
1.0000	0.804
1.2000	0.766
1.4000	0.731
1.6000	0.712
1.8000	0.696
2.0000	0.681
2.2000	0.639
2.4000	0.617
2.6000	0.598
2.8000	0.579
3.0000	0.563
3.1000	0.547
[illegible]	0.531
3.6000	0.515
3.8000	0.500
4.0000	0.487
[illegible]	0.471
4.4000	0.465
[illegible]	[illegible]
[illegible]	[illegible]
5.0000	0.438
5.2000	0.427
5.4000	0.420
[illegible]	0.414
[illegible]	[illegible]
[illegible]	0.395

HALLIBURTON NUS Environmental Corporation and Subsidiaries

STANDARD CALCULATION SHEET

CLIENT:	FILE NO.:	BY:	PAGE 2 OF
SUBJECT: MW-07 Rising head slug test data		CHECKED BY:	DATE:

6.2000	0.385	42.0000	0.224
6.4000	0.389	44.0000	0.224
6.6000	0.386	46.0000	0.215
6.8000	0.383	48.0000	0.221
7.0000	0.376	50.0000	[illegible]
7.2000	[illegible]	52.0000	0.215
7.4000	0.367	54.0000	0.209
7.6000	0.364	56.0000	0.215
7.8000	0.360	58.0000	0.212
8.0000	0.360	60.0000	0.212
8.2000	0.360	62.0000	0.208
8.4000	0.360	64.0000	0.199
8.6000	0.357	66.0000	0.202
8.8000	0.351	68.0000	0.195
9.0000	0.347	70.0000	0.192
9.2000	0.341	72.0000	0.196
9.4000	0.341	74.0000	0.186
9.6000	0.345	76.0000	0.186
9.8000	0.345	78.0000	[illegible]
10.0000	0.343	80.0000	0.185
12.0000	0.329	82.0000	0.181
14.0000	[illegible]	84.0000	0.183
16.0000	0.306	86.0000	0.184
18.0000	[illegible]	88.0000	0.182
20.0000	0.275	90.0000	0.183
22.0000	[illegible]	92.0000	[illegible]
24.0000	0.262	94.0000	0.177
26.0000	0.259	96.0000	[illegible]
28.0000	0.256	98.0000	0.170
30.0000	0.246	100.000	[illegible]
32.0000	0.240	110.000	[illegible]
34.0000	0.243	120.000	0.170
36.0000	0.240	130.000	0.150
38.0000	0.234	140.000	[illegible]
40.0000	0.231	END	

HYDRAULIC CONDUCTIVITY TESTING DATA SHEET — HALLIBURTON NUS CORPORATION

PROJECT NAME: NAWC Warminster WELL/BORING NO.: MW-11

PROJECT NO.: 3933 GEOLOGIST: A. Kendrick / R. Good

WELL DIAMETER: 4" ID SCREEN LENGTH/DEPTH: 5' (5.7-10.7') TOC TEST NO.: 001

STATIC WATER LEVEL (Depth/Elevation): 8.80 (TOC) DATE: 7-21-92

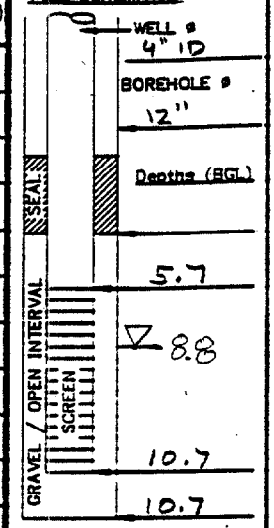
TEST TYPE (Rising/Falling/Constant Head): Rising head only CHECKED:

METHOD OF INDUCING WATER LEVEL CHANGE: 3" Bailer - Sing H_2O removed. PAGE ___ OF ___

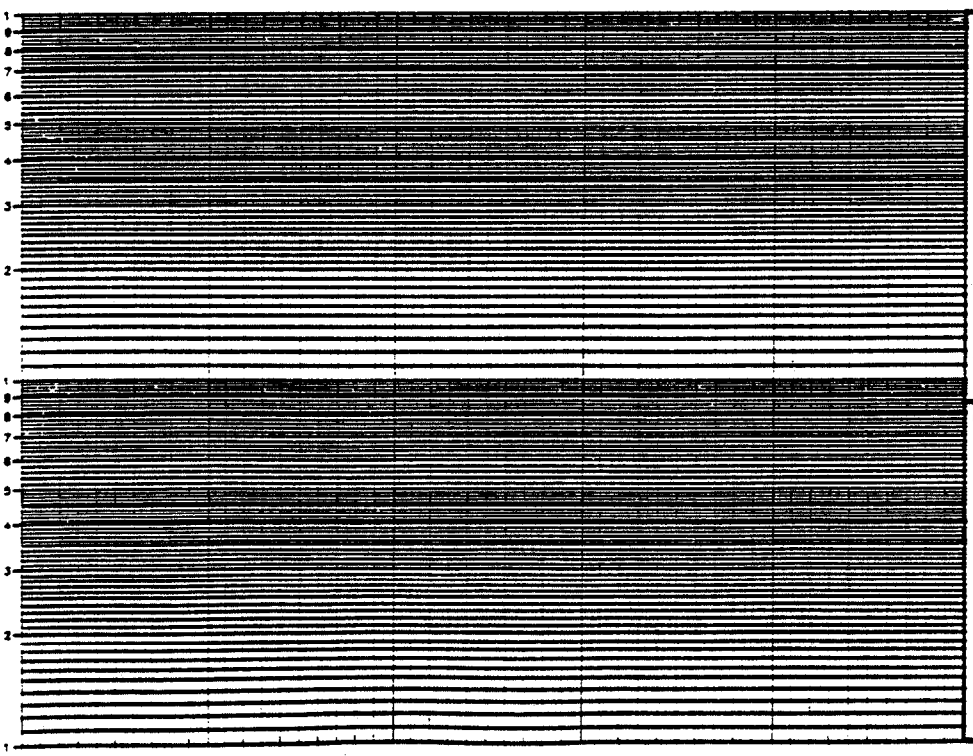
REFERENCE PT. FOR WL MEAS. (Top of Casing, Transducer, etc.): TOC = 1.4'

ELAPSED TIME (min. or sec.)	~~MEASURED WATER LEVEL~~ (feet)	DRAWDOWN OR HEAD (ΔH) (feet)	ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)
11:35 0.0	Head Ratio $\Delta H/H_0 = 1.0$	$H_0 = .453$	0.0	Head Ratio $\Delta H/H_0 = 1.0$	$H_0 = .519$
0.02	.88	.400	0.1	.69	.356
0.04	.83	.375	0.64	.45	.231
0.09	.71 *	.322	2.99	.40	.206
0.12	.66 *	.300	17.99	.39	.200
0.16	.62	.281	49.99	.36	.187
0.23	.57 *	.259	99.99	.34	.178
0.43	.52 *	.237	139.99	.32	.165
0.93	.49 *	.221			
1.95	.46	.209			
2.75	.455	.206			

WELL SCHEMATIC



▽ Indicate SWL Depth on Drawing



REMARKS:

Ver low K.

Set bailer in well and let eq.

$T_0 = 584$ min

$r = .1667$

$R = .5'$

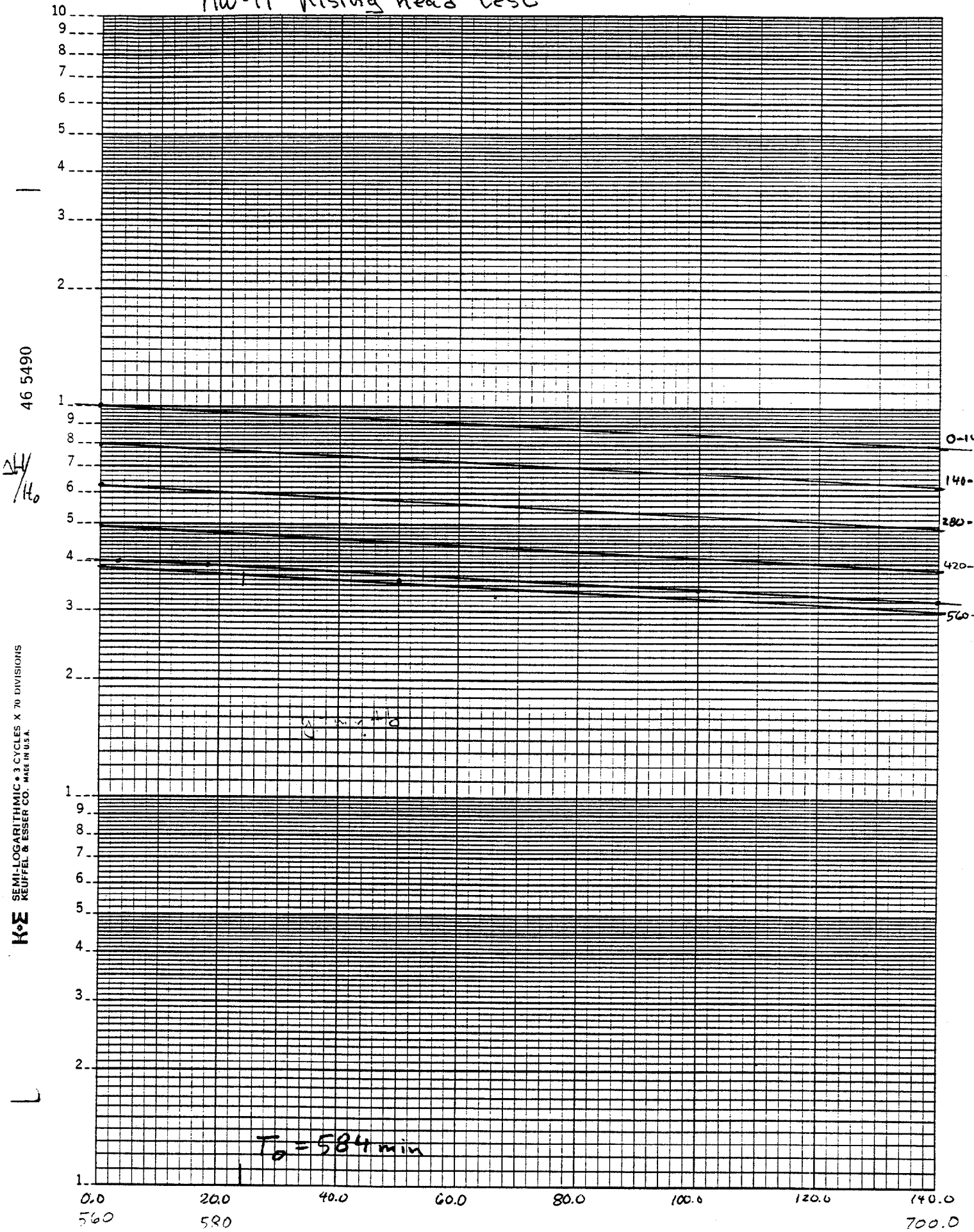
$L = \cancel{5.0}$ (1.9')

$K = 1.1 \times 10^{-5}$ ft/min

CALCS, SKETCH MAPS, ETC.:

$K = 5.57 \times 10^{-6}$ cm/sec.

MW-11 Rising head test



HALLIBURTON NUS Environmental Corporation and Subsidiaries

STANDARD CALCULATION SHEET

CLIENT:	FILE NO.:	BY:	PAGE 1 OF
SUBJECT: MW-11 Rising head slug test data		CHECKED BY:	DATE:

MW-11
Rising Head
001
7-21-92

READY

SE1000C
Environmental Logger
07/21 18:26

Unit# 00927 Test 0

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	0001
Reference	0.000
Linearity	0.010
Scale factor	9.910
Offset	-0.030
Delay mSEC	50.000

Step 0 07/21 15:32:02

Elapsed Time	INPUT 1
0.0000	-0.006
0.0033	0.153
0.0066	0.474
t_0 = 0.0100	H_0 = 0.519
0.0133	0.515
0.0166	0.506
0.0200	0.506
0.0233	0.506
0.0266	0.493
0.0300	0.493
0.0333	0.490
0.0366	0.465
0.0400	0.472
0.0433	0.468
0.0466	0.462
0.0500	0.447
0.00 — 0.0533	0.453
0.0566	0.440
0.0600	0.425
0.0633	0.418
0.0666	0.409
0.0700	0.409
0.0733	0.403
0.0766	0.400
0.0800	0.393
0.0833	0.390
0.0866	0.384
0.0900	0.378
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

Elapsed Time	INPUT 1
0.1[illegible]	0.340
0.1266	0.337
0.1300	0.334
0.1333	0.331
0.1366	0.328
0.1400	0.325
0.1433	0.322
0.1466	0.319
0.1500	0.315
0.1533	0.315
0.1566	0.312
0.1600	0.309
0.1633	0.306
0.1666	0.306
0.1700	0.303
[illegible]	0.303
0.1766	0.300
0.1800	0.297
0.1833	0.293
0.1866	0.293
0.1900	0.290
0.1933	0.290
0.1966	0.287
0.2000	0.287
0.2033	0.284
0.2066	0.284
0.2100	0.281
0.2133	0.281
0.2166	0.278
0.2200	0.278
0.2233	0.275
0.2266	0.275
0.2300	0.275
0.2333	0.272
0.2366	0.272
0.2400	0.272
0.2433	0.268
0.2466	0.268
0.2500	0.268
0.2533	0.265
0.2566	0.267
0.2600	0.265
0.2633	0.262
0.2666	0.262
0.2700	0.262
0.2733	0.262
0.2766	0.259
0.2800	0.259
0.2833	0.259
0.2866	0.259
0.2900	0.259
0.2933	0.256
0.2966	0.256
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

Elapsed Time	INPUT 1
0.3333	0.250
0.3500	0.250
0.3666	0.247
0.3833	0.243
0.4000	0.243
0.4166	0.243
0.4333	0.240
0.4500	0.240
0.4666	0.237
0.4833	0.237
0.5000	0.237
0.5166	0.234
0.5333	0.234
0.5500	0.234
0.5666	[illegible]
0.5833	0.234
0.6000	0.231
0.6166	0.231
0.6333	0.231
0.6500	0.231
0.6666	0.231
0.6833	0.231
0.7000	0.228
0.7166	0.228
0.7333	0.228
0.7500	0.228
0.7666	0.228
0.7833	0.228
0.8000	0.225
0.8166	0.225
0.8333	0.225
0.8500	0.225
0.8666	0.225
0.8833	0.225
0.9000	0.225
0.9166	[illegible]
0.9333	0.225
0.9500	0.225
0.9666	0.225
[illegible]	[illegible]
1.0000	[illegible]
[illegible]	[illegible]
[illegible]	0.218
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	0.209
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

HALLIBURTON NUS Environmental Corporation and Subsidiaries

STANDARD CALCULATION SHEET

CLIENT:	FILE NO.:	BY:	PAGE 2 OF
SUBJECT: MW-11 Rising head slug test data		CHECKED BY:	DATE:

5.2000	0.196
5.4000	0.196
5.6000	0.196
5.8000	0.196
6.0000	0.196
6.2000	0.196
6.4000	0.196
6.6000	0.196
6.8000	0.197
7.0000	0.197
7.2000	0.197
7.4000	0.197
7.6000	0.197
7.8000	0.197
8.0000	0.198
8.2000	0.198
8.4000	0.198
8.6000	0.198
8.8000	0.198
9.0000	0.198
9.2000	0.198
9.4000	0.198
9.6000	0.198
9.8000	0.198
10.0000	0.198
12.0000	0.198
14.0000	0.198
16.0000	0.198
18.0000	0.198
20.0000	0.198
22.0000	0.198
24.0000	0.198
26.0000	0.198
28.0000	0.198
30.0000	0.198
32.0000	0.198
34.0000	0.197
36.0000	0.197
38.0000	0.197
40.0000	0.197

42.0000	0.197
44.0000	0.197
46.0000	0.197
48.0000	0.197
50.0000	0.197
52.0000	0.197
54.0000	0.197
56.0000	0.197
58.0000	0.194
60.0000	0.194
62.0000	0.194
64.0000	0.194
66.0000	0.194
68.0000	0.194
70.0000	0.194
72.0000	0.194
74.0000	0.191
76.0000	0.191
78.0000	0.191
80.0000	0.191
82.0000	0.191
84.0000	0.191
86.0000	0.191
88.0000	0.191
90.0000	0.191
92.0000	0.191
94.0000	0.191
96.0000	0.191
98.0000	0.191
100.000	0.191
110.000	0.191
120.000	0.191
130.000	0.188
140.000	0.188
150.000	0.188
160.000	0.188
170.000	0.188

END

APPENDIX H

PUMPING TEST DATA AND CALCULATIONS

WELL E

PUMPING WELL

HALLIBURTON NUS
Environmental Corporation

Page _____

AQUIFER TEST DATA

Owner NAWC Warminster Address _____ County Bucks State P

Date 8/11/92 Company performing test H. NUS Measured by AWK/RWG

Well No. E Distance from pumping well 0.00 Type of test Single Well (E) pump Test No. 0

Measuring equipment Hermit (1) and 50 psi transducer (Input 2)

Time Data
Pump on: Date 8/11 Time 1345 (t_0)
Pump off: Date 8/11 Time 2252 (t'_0)
Duration of aquifer test:
Pumping 9H 7M Recovery 9H

Water Level Data
Static water level 16.43
Measuring point TOC
Elevation of measuring point _____

Discharge Data
How Q measured 5 gal. bucket
Depth of pump/air line 33.9 TOC
Previous pumping? Yes ____ No X
Duration _____ End _____

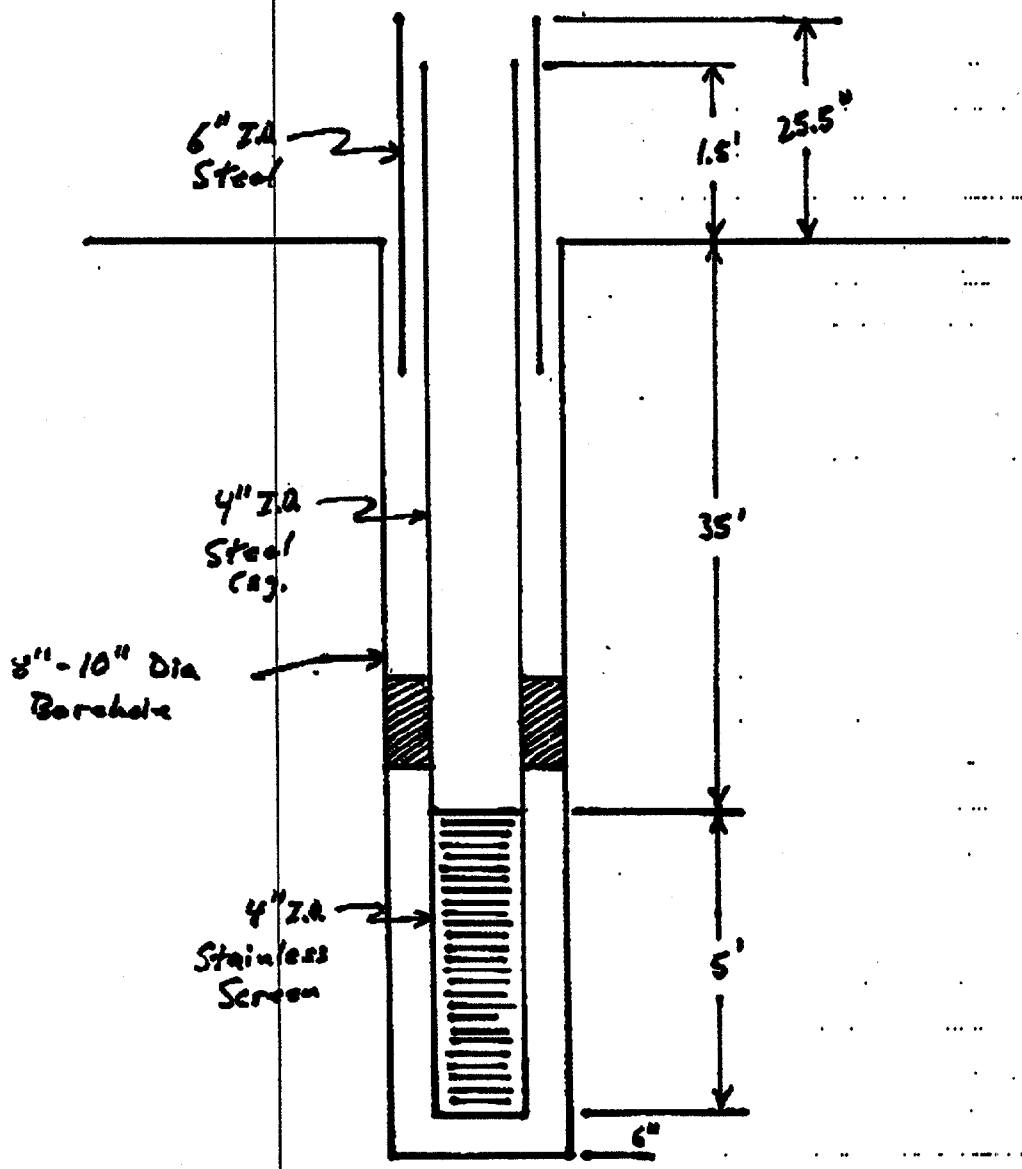
Comments on factors affecting test data: Pumping Well

Date	Clock time	Time since pump started t	Time since pump stopped t'	t/t'		Water level measurement	Correction or Conversion	Ref to 0.00 Water level	Water level change s or s'		Discharge measurement	Rate		Comments
8/11	1417							-15.02				4 GPM		
	1438							-15.57				3.9 GPM		
	1521							-15.97				"		
	1612							-15.91				"		
	1645							-15.84				"		
	1742							-16.00				"		
	1840							-16.37				"		
	1945							-16.31				"		
	2045							-16.37				"		2103 pump fail 1 min.
	2145							-16.21				"		Stop pumping and
	2245							-16.26				"		begin Step 1 @ 225
	2252													Begin Recovery
			.5					-14.03						
			1.0					-12.52						
			2.0					-10.33						
			3.0					-8.74						
			4.0					-7.50						
			5.0					-6.45						
			8.0					-4.63						
			10.0					-3.88						
			14.0					-2.89						
			20.0					-2.10						
			30.0					-1.44						
			40.0					-1.14						
			50.0					-.95						

HALLIBURTON NUS Environmental Corporation and Subsidiaries — **STANDARD CALCULATION SHEET**

CLIENT:	FILE NO.:	BY:	PAGE OF
SUBJECT:		CHECKED BY:	DATE:

WELL E



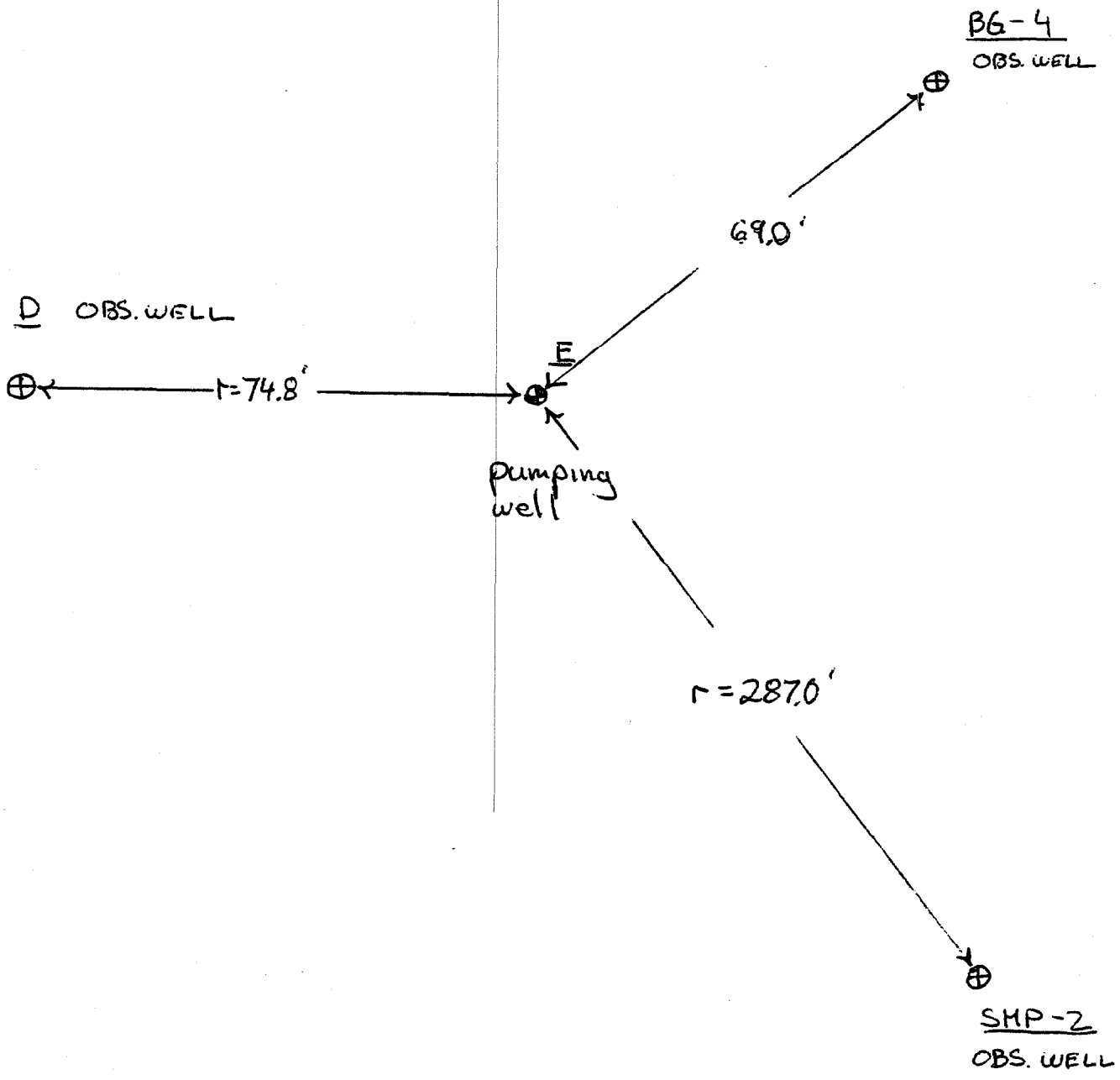
KNOWN: 4" I.D. Steel casing, 18" stick-up, Total depth = 41' 6" TOC.

ASSUMED: 5' of 4" I.D. screen, borehole diam. 8"-10", other construction details similar to SMP-1 (Well D) and SMP-2

HALLIBURTON NUS Environmental Corporation and Subsidiaries	STANDARD CALCULATION SHEET

CLIENT: NAWC WARMINSTER	FILE NO.: 3933-0306	BY: FURAMSER	PAGE OF
SUBJECT: PUMP TEST DATA EVALUATION		CHECKED BY:	DATE:

Radial Distance Schematic



HALLIBURTON NUS Environmental Corporation and Subsidiaries — **STANDARD CALCULATION SHEET**

CLIENT: Warminster	FILE NO.: 3933-0302	BY: FWRamsey ✓	PAGE 1 OF
SUBJECT: Warminster pumptest Pumping well-E		CHECKED BY: gR	DATE: 9/28/92

Objective: Use recovery data to determine transmissivity "T". Method found in Groundwater + Wells, Driscoll pg 252-257

where t = total time pumped @ Q stopped
t' = time after pumping has ended

$s'(h_0 - h)$ residual draw down

(maxium draw down @ t = when pump is stopped)

pump duration = 540 min

recovery time = 140 (required to return to zero)

$s_1' = 15.881$ ft

use the eq. $T = \frac{264\,Q}{\Delta s'}$, in ft^2/day

where Q in gpm

$\Delta s'$ in feet

Procedure: Plot residual draw down vs t/t' ratio on semi-log paper to determine $\Delta s'$ for one log cycle.

Calculations: From field data $Q = 3.9$ gpm

From plot $\Delta s' = 9.6$ feet

HALLIBURTON NUS Environmental Corporation and Subsidiaries			STANDARD CALCULATION SHEET
CLIENT: NAWC Warminster	FILE NO.: 3933-0302	BY: FLRamsey	PAGE 2 OF
SUBJECT: Warminster pumptest, Pumping well-E		CHECKED BY: EJR	DATE: 9/28/92

Calculations (continued)

1) $T = \frac{264\,Q}{\Delta s'}$

sub. $T = \frac{(264)(3.9\ gpm)}{9.6\ feet}$

$T = 107.25\ ft^2/day$

$T = 107.25\ ft^2/day \times \frac{1\ day \cdot hr}{1{,}440.0\ hr \cdot min} = 0.0745\ ft^2/min$

$\boxed{T = 1.15\ cm/sec}$

2) $K = T/b$ $\quad b = 63\ ft.$

sub. $K = \frac{.0745\ ft^2/min}{63\ ft}$

$K = 1.2 \times 10^{-3}\ ft/min$

$K = 1.2 \times 10^{-3}\ \frac{ft}{min} \times \frac{1\ min}{60\ sec} \times \frac{12\ in}{1\ ft} \times \frac{2.54\ cm}{1\ in}$

$\boxed{K = 6.0 \times 10^{-4}\ cm/sec}$

warminster pumptest pump well-e recovery data

Time t	Time t′	t/t′	s′
540.05	0.05	10801	15.9
540.1	0.1	5401	15.7
540.2	0.2	2701	15.2
540.5	0.5	1081	14
540.75	0.75	721	13.2
541	1	541	12.5
542	2	271	10.3
543	3	181	8.7
544	4	136	7.5
545	5	109	6.4
546	6	91	5.7
547	7	78.14286	5.1
548	8	68.5	4.6
550	10	55	3.9
560	20	28	2.1
570	30	19	1.5
580	40	14.5	1.2
590	50	11.8	1
600	60	10	0.8
620	80	7.75	0.6
640	100	6.4	0.5
740	200	3.7	0.2
840	300	2.8	0.1
940	400	2.35	0

warminster pumptest pump well e reco

Time t	Time t′	t/t′	s′
540.05	0.05	10801	15.9
540.1	0.1	5401	15.7
540.2	0.2	2701	15.2
540.5	0.5	1081	14
540.75	0.75	721	13.2
541	1	541	12.5
542	2	271	10.3
543	3	181	8.7
544	4	136	7.5
545	5	109	6.4
546	6	91	5.7
547	7	78.14286	5.1
548	8	68.5	4.6
550	10	55	3.9
560	20	28	2.1
570	30	19	1.5
580	40	14.5	1.2
590	50	11.8	1
600	60	10	0.8
620	80	7.75	0.6
640	100	6.4	0.5
740	200	3.7	0.2
840	300	2.8	0.1
940	400	2.35	0

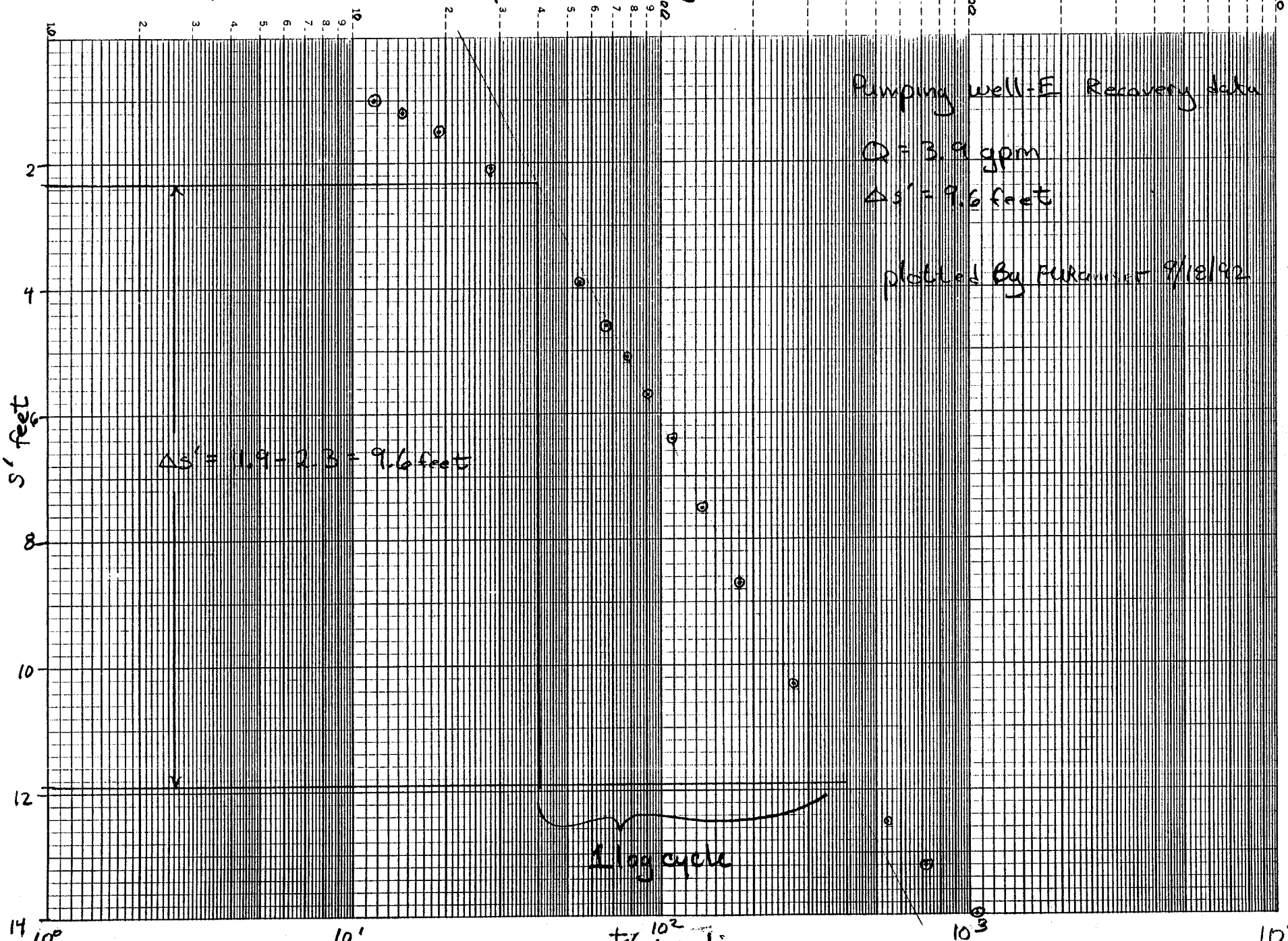
warminster pumptest pump well e reco

Time t	Time t′	t/t′	s′
540.05	0.05	10801	15.9

K+E SEMI-LOGARITHMIC 4 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 6010

NAWC Warminster Pump test, Pumping well-E Recovery Data

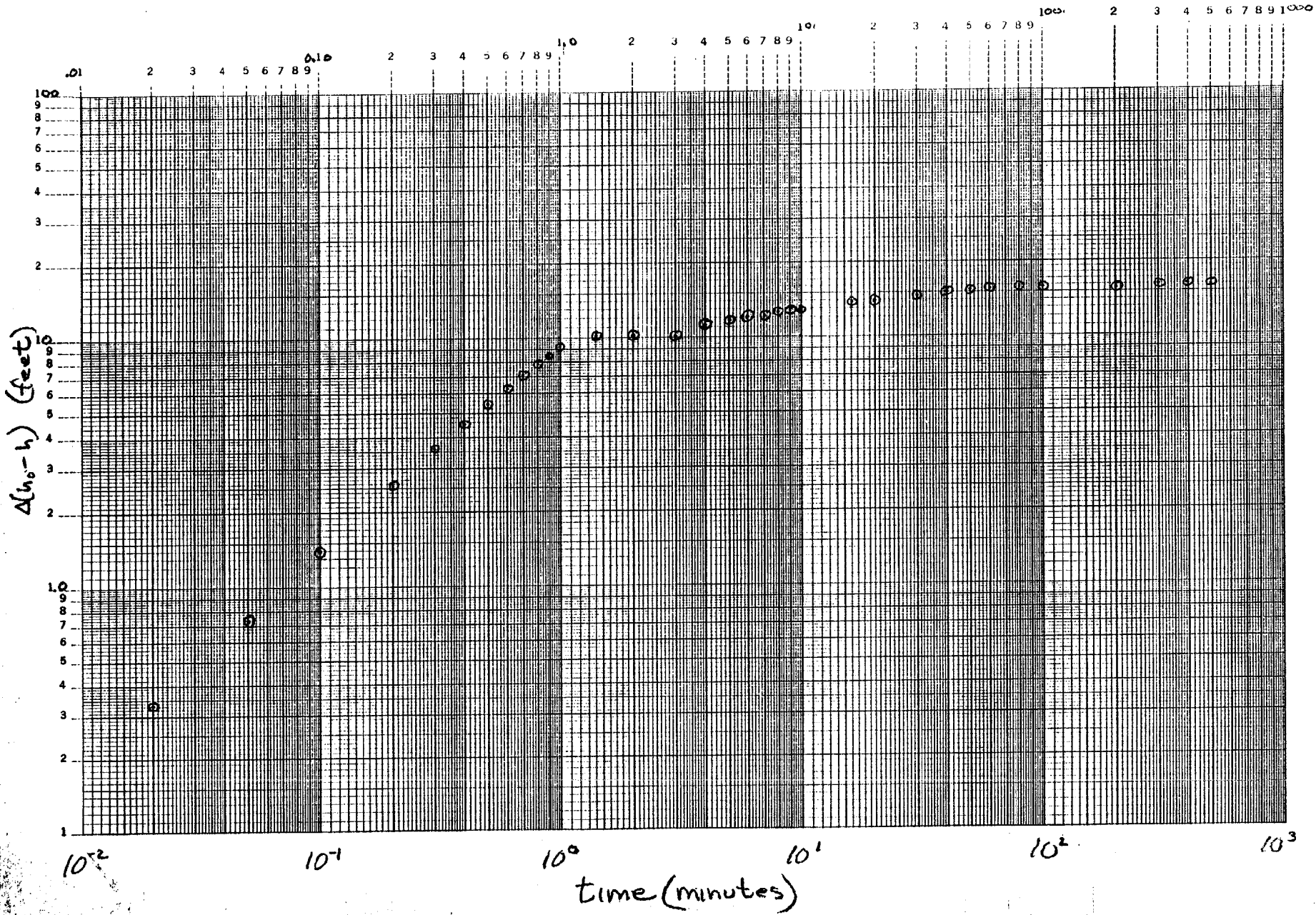


Pg 4

K+E LOGARITHMIC 3 x 5 CYCLES
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 7522

NAWC Warminster Pump test, Pumping well-E; Pumping well-E graph



NAWC Warminster Pump test
Pumping Well - E
Recovery Data

SE1000C
Environmental Logger
08/12 09:06

Unit# 00765 Test 0

Setups:	INPUT 2
Type	Level (F)
Mode	Surface
I.D.	00500
Reference	0.000
Linearity	0.000
Scale factor	50.420
Offset	-0.090
Delay mSEC	50.000

Step 1 08/11 22:53:07

Elapsed Time	INPUT 2
0.0000	-16.215 ✓
0.0033	-16.088
0.0066	-16.119
0.0100	-16.072
0.0133	-16.056
0.0166	-16.024
0.0200	-16.024
0.0233	-16.008
0.0266	-16.008
0.0300	-15.976
0.0333	-15.960
0.0366	-15.960
0.0400	-15.944
0.0433	-15.912
0.0466	-15.912
0.0500	-15.896 ✓
0.0533	-15.865
0.0566	-15.865
0.0600	-15.849
0.0633	-15.833
0.0666	-15.817
0.0700	-15.801
0.0733	-15.785
0.0766	-15.769
0.0800	-15.769
0.0833	-15.737
0.0866	-15.737
0.0900	-15.721
0.0933	-15.705
0.0966	-15.689
0.1000	-15.673 ✓
0.1033	-15.657
0.1066	-15.642
0.1100	-15.642
0.1133	-15.626
0.1166	-15.610
0.1200	-15.594
0.1233	-15.578
0.1266	-15.562
0.1300	-15.546
0.1333	-15.530
0.1366	-15.530
0.1400	-15.498
0.1433	-15.498
0.1466	-15.466
0.1500	-15.466
0.1533	-15.434
0.1566	-15.419
0.1600	-15.419
0.1633	-15.387
0.1666	-15.371
0.1700	-15.355
0.1733	-15.355
0.1766	-15.339
0.1800	-15.323
0.1833	-15.307
0.1866	-15.291
0.1900	-15.275
0.1933	-15.259
0.1966	-15.243
0.2000	-15.243 ✓
0.2033	-15.227
0.2066	-15.211
0.2100	-15.196
0.2133	-15.180

well - E
recovery

0.2166	-15.164
0.2200	-15.148
0.2233	-15.132
0.2266	-15.116
0.2300	-15.100
0.2333	-15.100
0.2366	-15.068
0.2400	-15.068
0.2433	-15.036
0.2466	-15.036
0.2500	-15.020
0.2533	-15.004
0.2566	-14.988
0.2600	-14.973
0.2633	-14.957
0.2666	-14.941
0.2700	-14.925
0.2733	-14.909
0.2766	-14.909
0.2800	-14.893
0.2833	-14.877
0.2866	-14.861
0.2900	-14.845
0.2933	-14.829
0.2966	-14.829
0.3000	-14.797
0.3033	-14.781
0.3066	-14.781
0.3100	-14.765
0.3133	-14.750
0.3166	-14.734
0.3200	-14.718
0.3233	-14.702
0.3266	-14.702
0.3300	-14.686
0.3333	-14.670
0.3500	-14.590
0.3666	-14.527
0.3833	-14.463
0.4000	-14.399
0.4166	-14.335
0.4333	-14.272
0.4500	-14.208
0.4666	-14.144
0.4833	-14.081
0.5000	-14.033 ✓
0.5166	-13.969
0.5333	-13.921
0.5500	-13.858
0.5666	-13.794
0.5833	-13.746
0.6000	-13.682
0.6166	-13.635
0.6333	-13.587
0.6500	-13.523
0.6666	-13.475
0.6833	-13.427
0.7000	-13.380
0.7166	-13.316
0.7333	-13.268
0.7500	-13.220 ✓
0.7666	-13.173
0.7833	-13.125
0.8000	-13.077
0.8166	-13.029
0.8333	-12.966
0.8500	-12.934
0.8666	-12.886
0.8833	-12.822
0.9000	-12.790
0.9166	-12.743
0.9333	-12.695
0.9500	-12.647
0.9666	-12.599
0.9833	-12.567
1.0000	-12.520 ✓
1.2000	-12.010
1.4000	-11.548 ✓
1.6000	-11.118
1.8000	-10.720
2.0000	-10.337 ✓
2.2000	-9.987
2.4000	-9.652
2.6000	-9.334
2.8000	-9.031
3.0000	-8.744 ✓
3.2000	-8.474
3.4000	-8.219

well-E
Recovery

3.6000	-7.964
3.8000	-7.725
4.0000	-7.502
4.2000	-7.263
4.4000	-7.040
4.6000	-6.849
4.8000	-6.642
5.0000	-6.451
5.2000	-6.275
5.4000	-6.100
5.6000	-5.941
5.8000	-5.782
6.0000	-5.654
6.2000	-5.527
6.4000	-5.399
6.6000	-5.288
6.8000	-5.176
7.0000	-5.081
7.2000	-4.985
7.4000	-4.890
7.6000	-4.794
7.8000	-4.714
8.0000	-4.635
8.2000	-4.539
8.4000	-4.460
8.6000	-4.380
8.8000	-4.300
9.0000	-4.221
9.2000	-4.157
9.4000	-4.077
9.6000	-4.014
9.8000	-3.950
10.0000	-3.886
12.0000	-3.329
14.0000	-2.899
16.0000	-2.564
18.0000	-2.309
20.0000	-2.102
22.0000	-1.911
24.0000	-1.768
26.0000	-1.656
28.0000	-1.545
30.0000	-1.449
32.0000	-1.369
34.0000	-1.322
36.0000	-1.258
38.0000	-1.194
40.0000	-1.146
42.0000	-1.083
44.0000	-1.051
46.0000	-1.019
48.0000	-0.987
50.0000	-0.955
52.0000	-0.907
54.0000	-0.892
56.0000	-0.876
58.0000	-0.844
60.0000	-0.828
62.0000	-0.796
64.0000	-0.780
66.0000	-0.748
68.0000	-0.732
70.0000	-0.716
72.0000	-0.700
74.0000	-0.684
76.0000	-0.668
78.0000	-0.653
80.0000	-0.637
82.0000	-0.621
84.0000	-0.605
86.0000	-0.589
88.0000	-0.573
90.0000	-0.557
92.0000	-0.541
94.0000	-0.541
96.0000	-0.525
98.0000	-0.509
100.000	-0.493
110.000	-0.445
120.000	-0.398
130.000	-0.366
140.000	-0.334
150.000	-0.302
160.000	-0.270
170.000	-0.238
180.000	-0.222
190.000	-0.206
200.000	-0.191

well-E
Recovery

210.000	-0.159
220.000	-0.143
230.000	-0.127
240.000	-0.127
250.000	-0.111
260.000	-0.095
270.000	-0.079
280.000	-0.063
290.000	-0.063
300.000	-0.047 ✓
310.000	-0.031
320.000	-0.031
330.000	-0.015
340.000	-0.015
350.000	-0.015
360.000	0.000
370.000	0.000
380.000	0.000
390.000	0.015
400.000	0.015 ✓
410.000	0.031
420.000	0.031
430.000	0.031
440.000	0.031
450.000	0.031
460.000	0.047
470.000	0.031
480.000	0.031
490.000	0.015
500.000	0.015
510.000	0.000
520.000	0.000
530.000	-0.015
540.000	-0.015

SE1000C
Environmental Logger
08/12 09:02

Unit# 00765 Test 0

Setups:	INPUT 2
Type	Level (F)
Mode	Surface
I.D.	00500
Reference	0.000
Linearity	0.000
Scale factor	50.420
Offset	-0.090
Delay mSEC	50.000

Step 0 08/11 13:45:39

NAWC Warminster Pump test

Pumping Well - E

Drawdown data

Q = 3.9 gpm

Elapsed Time	INPUT 2
0.0000	-0.334 *
0.0033	-0.382
0.0066	-0.445
0.0100	-0.573
0.0133	-0.525
0.0166	-0.621
0.0200	-0.668 ✓
0.0233	-0.684
0.0266	-0.780
0.0300	-0.812
0.0333	-0.828
0.0366	-0.923
0.0400	-0.939
0.0433	-0.987
0.0466	-1.051
0.0500	-1.067 ✓
0.0533	-1.130
0.0566	-1.194
0.0600	-1.194
0.0633	-1.290
0.0666	-1.306
0.0700	-1.353
0.0733	-1.401
0.0766	-1.401
0.0800	-1.497
0.0833	-1.529
0.0866	-1.561
0.0900	-1.640
0.0933	-1.640
0.0966	-1.704
0.1000	-1.736 ✓
0.1033	-1.752
0.1066	-1.831
0.1100	-1.863
0.1133	-1.879
0.1166	-1.975
0.1200	-1.975
0.1233	-2.022
0.1266	-2.070
0.1300	-2.086
0.1333	-2.134
0.1366	-2.182
0.1400	-2.214
0.1433	-2.261
0.1466	-2.277
0.1500	-2.325
0.1533	-2.389
0.1566	-2.389
0.1600	-2.468
0.1633	-2.468
0.1666	-2.532
0.1700	-2.580
0.1733	-2.564
0.1766	-2.644
0.1800	-2.691
0.1833	-2.691
0.1866	-2.771
0.1900	-2.771
0.1933	-2.819
0.1966	-2.867
0.2000	-2.883 ✓
0.2033	-2.915
0.2066	-2.978
0.2100	-2.978
0.2133	-3.058

Adjust all drawdown values by 0.334 ft to plot.

W-11-E
Pump data

0.2166	-3.058
0.2200	-3.122
0.2233	-3.137
0.2266	-3.169
0.2300	-3.217
0.2333	-3.265
0.2366	-3.281
0.2400	-3.329
0.2433	-3.345
0.2466	-3.408
0.2500	-3.424
0.2533	-3.456
0.2566	-3.520
0.2600	-3.520
0.2633	-3.552
0.2666	-3.631
0.2700	-3.631
0.2733	-3.663
0.2766	-3.711
0.2800	-3.727
0.2833	-3.791
0.2866	-3.791
0.2900	-3.854
0.2933	-3.870
0.2966	-3.886
0.3000	-3.934 ✓
0.3033	-3.982
0.3066	-3.982
0.3100	-4.061
0.3133	-4.045
0.3166	-4.109
0.3200	-4.157
0.3233	-4.157
0.3266	-4.189
0.3300	-4.253
0.3333	-4.253
0.3500	-4.412
0.3666	-4.587
0.3833	-4.698
0.4000	-4.890 ✓
0.4166	-5.049
0.4333	-5.176
0.4500	-5.336
0.4666	-5.511
0.4833	-5.654
0.5000	-5.782 ✓
0.5166	-5.941
0.5333	-6.084
0.5500	-6.212
0.5666	-6.371
0.5833	-6.498
0.6000	-6.626 ✓
0.6166	-6.769
0.6333	-6.881
0.6500	-7.024
0.6666	-7.152
0.6833	-7.295
0.7000	-7.422 ✓
0.7166	-7.550
0.7333	-7.677
0.7500	-7.805
0.7666	-7.932
0.7833	-8.044
0.8000	-8.187 ✓
0.8166	-8.298
0.8333	-8.426
0.8500	-8.553
0.8666	-8.681
0.8833	-8.792
0.9000	-8.904 ✓
0.9166	-9.031
0.9333	-9.143
0.9500	-9.270
0.9666	-9.381
0.9833	-9.493
1.0000	-9.605 ✓
1.2000	-10.656
1.4000	-10.497 ✓
1.6000	-10.449
1.8000	-10.481
2.0000	-10.544 ✓
2.2000	-10.640
2.4000	-10.656
2.6000	-10.528
2.8000	-10.449
3.0000	-10.401 ✓
3.2000	-10.385
3.4000	-10.369

well - E
Pump - data

3.6000	-10.640
3.8000	-11.022
4.0000	-11.405
4.2000	-11.691
4.4000	-11.978
4.6000	-12.058
4.8000	-12.105
5.0000	-12.169
5.2000	-12.265
5.4000	-12.360
5.6000	-12.472
5.8000	-12.408
6.0000	-12.344
6.2000	-12.312
6.4000	-12.296
6.6000	-12.296
6.8000	-12.281
7.0000	-12.440
7.2000	-12.551
7.4000	-12.647
7.6000	-12.758
7.8000	-12.838
8.0000	-12.950
8.2000	-12.934
8.4000	-12.966
8.6000	-12.966
8.8000	-12.966
9.0000	-13.013
9.2000	-13.013
9.4000	-13.045
9.6000	-13.093
9.8000	-13.077
10.0000	-13.125
12.0000	-13.412
14.0000	-13.666
16.0000	-13.858
18.0000	-14.112
20.0000	-14.240
22.0000	-14.399
24.0000	-14.558
26.0000	-14.718
28.0000	-14.781
30.0000	-14.893
32.0000	-14.988
34.0000	-15.068
36.0000	-15.196
38.0000	-15.243
40.0000	-15.307
42.0000	-15.371
44.0000	-15.403
46.0000	-15.466
48.0000	-15.466
50.0000	-15.498
52.0000	-15.530
54.0000	-15.610
56.0000	-15.642
58.0000	-15.657
60.0000	-15.689
62.0000	-15.721
64.0000	-15.673
66.0000	-15.769
68.0000	-15.737
70.0000	-15.785
72.0000	-15.801
74.0000	-15.817
76.0000	-15.817
78.0000	-15.817
80.0000	-15.833
82.0000	-15.849
84.0000	-15.865
86.0000	-15.865
88.0000	-15.849
90.0000	-15.849
92.0000	-15.849
94.0000	-15.912
96.0000	-15.976
98.0000	-16.040
100.000	-16.072
110.000	-15.960
120.000	-15.896
130.000	-15.976
140.000	-15.992
150.000	-15.944
160.000	-15.976
170.000	-16.008
180.000	-15.865
190.000	-15.880
200.000	-15.992

well-E
Pump data

210.000	-16.056
220.000	-16.072
230.000	-16.072
240.000	-16.024
250.000	-16.008
260.000	-16.024
270.000	-15.992
280.000	-16.008
290.000	-16.279
300.000	-16.374
310.000	-16.247
320.000	-16.247
330.000	-16.231
340.000	-16.327
350.000	-16.358
360.000	-16.327
370.000	-16.358
380.000	-16.390
390.000	-16.406
400.000	-16.422
410.000	-16.374
420.000	-16.390
430.000	-16.374
440.000	-14.606
450.000	-16.040
460.000	-16.151
470.000	-16.199
480.000	-16.199
490.000	-16.279
500.000	-16.311
510.000	-16.295
520.000	-16.327
530.000	-16.342
540.000	-16.263

WELL BG-4

OBSERVATION WELL

HALLIBURTON NUS
Environmental Corporation

Page _____

AQUIFER TEST DATA

Owner NAWC Warminster Address _____ County Bucks State PA

Date 8/11/92 Company performing test H.NUS Measured by AWK/RWG

Well No. BG-4 Distance from pumping well 69.0' Type of test Single Well (E) Pump Test No. 0

Measuring equipment Hermit (4) and 10 psi transducer (Input 1)

Time Data
Pump on: Date 8/11 Time 1345 (t_0)
Pump off: Date 8/11 Time 2252 (t_0')
Duration of aquifer test:
Pumping 4H 7M Recovery 9H

Water Level Data
Static water level 19.82
Measuring point TOC
Elevation of measuring point _____

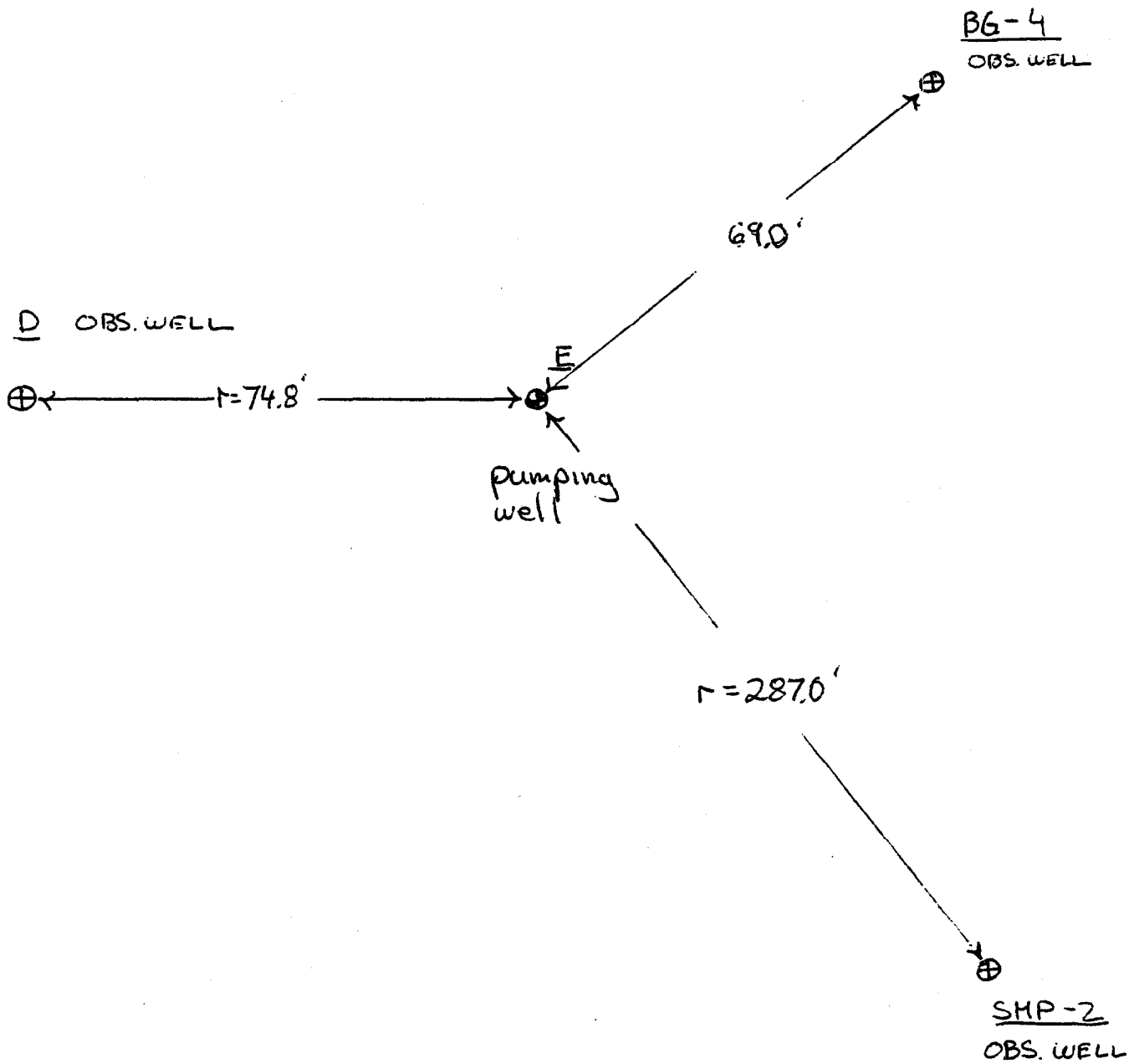
Discharge Data
How Q measured 5 gal. bucket
Depth of pump/air line 33.9 TOC
Previous pumping? Yes ____ No X
Duration _____ End _____

Comments on factors affecting test data

Date	Clock time	Time since pump started t	Time since pump stopped t'	t/t'		Water level measurement	Correction or Conversion	Ref to 0.00 Water level	Water level change s or s'		Discharge measurement	Rate		
8/11	1416							-.30				4 GPM		
	1438							-.56				3.9 GPM		
	1521							-1.03				"		
	1611							-1.36				"		
	1647							-1.45				"		
	1742							-1.52				"		
	1840							-1.55				"		
	1945							-1.58				"		
	2045							-1.60				"		2103 Pump fail 1 min.
	2145							-1.59				"		Stop Test @ 2248
	2245							-1.60				"		Start recovery (log)
	2252													@ 2252 (Test 1)
			10					-1.59						Begin Recovery
			14					-1.56						
			16					-1.54						
			20					-1.50						
			26					-1.43						
			36					-1.29						
			42					-1.21						
			52					-1.08						

HALLIBURTON NUS Environmental Corporation and Subsidiaries			STANDARD CALCULATION SHEET
CLIENT: NAWC WARMINSTER	FILE NO.: 3933-0306	BY: FURAMSER	PAGE OF
SUBJECT: PUMP TEST DATA EVALUATION		CHECKED BY:	DATE:

Radial Distance Schematic



SMC ENVIRONMENTAL SERVICES GROUP

DRILLING LOG

PROJECT NADC OWNER Navy

LOCATION Site 2 W.O. NUMBER 9710-40001

WELL NUMBER BG-4 TOTAL DEPTH 47' DIAMETER 6"

SURFACE ELEV. / WAT. LEV.: INIT. 45' ~~24-HRS~~ 11/13/90 20.03'

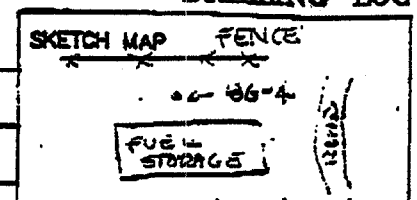
Open Hole: DIA. 6" LENGTH 17-47' SLOT SIZE NA

CASING: DIA. 6" LENGTH 0-17.05' TYPE PVC

DRILLING COMPANY C. S. Garber DRILLING METHOD Air Rotary

DRILLER E. Williams LOG BY PDB DATE DRILLED 10/24/90 10/25/90

SKETCH MAP



— water levels were measured from top of inner casing

NOTES
SHALLOW BEDROCK WELL

DEPTH (FEET)	GRAPHIC LOG	WELL CONSTRUCTION	PID SAMPLE NUMBER	PID	DESCRIPTION / SOIL CLASSIFICATION (U.S.C.S.) (COLOR, TEXTURE, STRUCTURES, MOISTURE, OVA READING)
			ND	ND	0-10' Maroon-red silty sand (ML)
					10-12' Saprolite
					12-25' Maroon-red micaceous siltstone. Dry. Came to surface as sand-cobble size fragments
					25-38' Light red siltstone. Moist towards bottom of layer
					38-44' Light red very fine arkosic sandstone. Dry. Came to surface as sand
47					44-47' Grayish-white quartzitic medium grained sandstone. Dry
					* Casing was set at 17.05'.
					Hydrogeology
					- No water detected at soil/bedrock interface
					- Water was hit at 33'
					- The yield is less than ½ gpm
					- Water was run down the well during development to purge the well of sediment

49'
17.05'
CASING
17.52 (9/92)
BEDROCK
OPEN HOLE
2" MONT. SCHL. W/ BENT. GROUT PACKER: CASING W/ BENTONITE CHIP. SEE WORK PLAN WELL SPECS.

013 9018 86001

Top at 12'
Bottom of aquifer at 55'

HALLIBURTON NUS Environmental Corporation and Subsidiaries			STANDARD CALCULATION SHEET
CLIENT: NAWC Warminster	FILE NO.: 3933-0306	BY: [illegible]	PAGE 1 OF
SUBJECT: Pump test Data evaluation, Obs well BG-4		CHECKED BY: [illegible] 2/23/92	DATE:

I. Objective: To calculate transmissivity 'T' and storativity 'S" and hydraulic conductivity, using the W.C. Walton method of curve matching overlay procedures for a semi-confined aquifer. This procedure allows for the determination of formation constants for both the aquifer and the semi-pervious layer. Fetter pg 182, 183 (1988).

II Procedure: Drawdown vs time data are plotted on log-Log paper. Matched to Type curves for a leaky confined aquifer with no storage in the confining Layer (after Hantush + Jacob. 1955).

$$W(u, r/B) = \frac{4\pi T \Delta(h_o - h)}{Q}, \quad \frac{1}{u} = \frac{4Tt}{r^2 S}$$

$$K' = \frac{T b' (r/B)^2}{r^2}$$ where K' = vertical conductivity of semipervious layer ~~feet~~ FR

b' = thickness of semipervious layer (feet)

III Calculations:

From field data: $Q = 3.9$ gpm $\quad r = 69.0$ ft

From overlay plot: $t = 56$ min $\quad \Delta(h_o - h) = 3.6$ feet

$r/B = 1.5$

$$W(u, r/B) = 1 = \frac{4\pi T(\Delta(h_o - h))}{Q} \qquad \frac{1}{u} = 1 = \frac{4Tt}{r^2 S}$$

HALLIBURTON NUS Environmental Corporation and Subsidiaries — **STANDARD CALCULATION SHEET**

CLIENT: NAWC Warminster	FILE NO.: 3933-0306	BY: [illegible]	PAGE 2 OF
SUBJECT: Pumptest Data evaluation, Obs. well BG-4		CHECKED BY: EJR 9/28/92	DATE:

III Calculations (continued)

$Q = 3.9\ gpm \times .1337\ ft^3/gal = 0.5214\ ft^3/min$ $\quad r/B = 1.5$

$r = 69.0\ ft$ $\quad t = 56\ min$ $\quad \Delta(h_o - h) = 3.6\ ft$

1)

$$W(u, r/B) = 1 = \frac{4\pi T \Delta(h_o - h)}{Q}$$

$$W(u, r/B)\frac{Q}{4\pi \Delta(h_o - h)} = T$$

sub.

$$(1)\ \frac{0.5214\ ft^3/min}{4\pi(3.6\ ft)} = T$$

$$0.0115\ ft^2/min = T$$

$$T = 0.0115\ ft^2/min \times \frac{1\ min}{60\ sec} \times \left(\frac{12\ in}{1\ ft}\right)^2 \times \left(\frac{2.54\ cm}{1\ in}\right)^2$$

$$T = 1.78 \times 10^{-1}\ cm^2/sec$$

2)

$$\frac{4Tt}{r^2 S} = 1 = \frac{1}{u}$$

$$S = \frac{4Tt(u)}{r^2}$$

sub. $$S = \frac{4(.0115\ ft^2/min)(56\ min)(1)}{(69\ ft)^2}$$

$$S = 0.0005$$

3)

$$K' = \frac{T b' (r/B)^2}{r^2}$$

$b' = 2\ ft$

sub. $$K' = \frac{(.0115\ ft^2/min)(2\ ft)(1.5)^2}{(69\ ft)^2}$$

$$K' = 1.1 \times 10^{-5}\ ft/min$$

$$K' = 1.1 \times 10^{-5}\ ft/min \times$$

$$K' = 5.5 \times 10^{-6}\ cm/sec$$

4) $K = T/b$ $\quad b = 63\ ft$

$$K = \frac{.0115\ ft^2/min}{63\ ft}$$

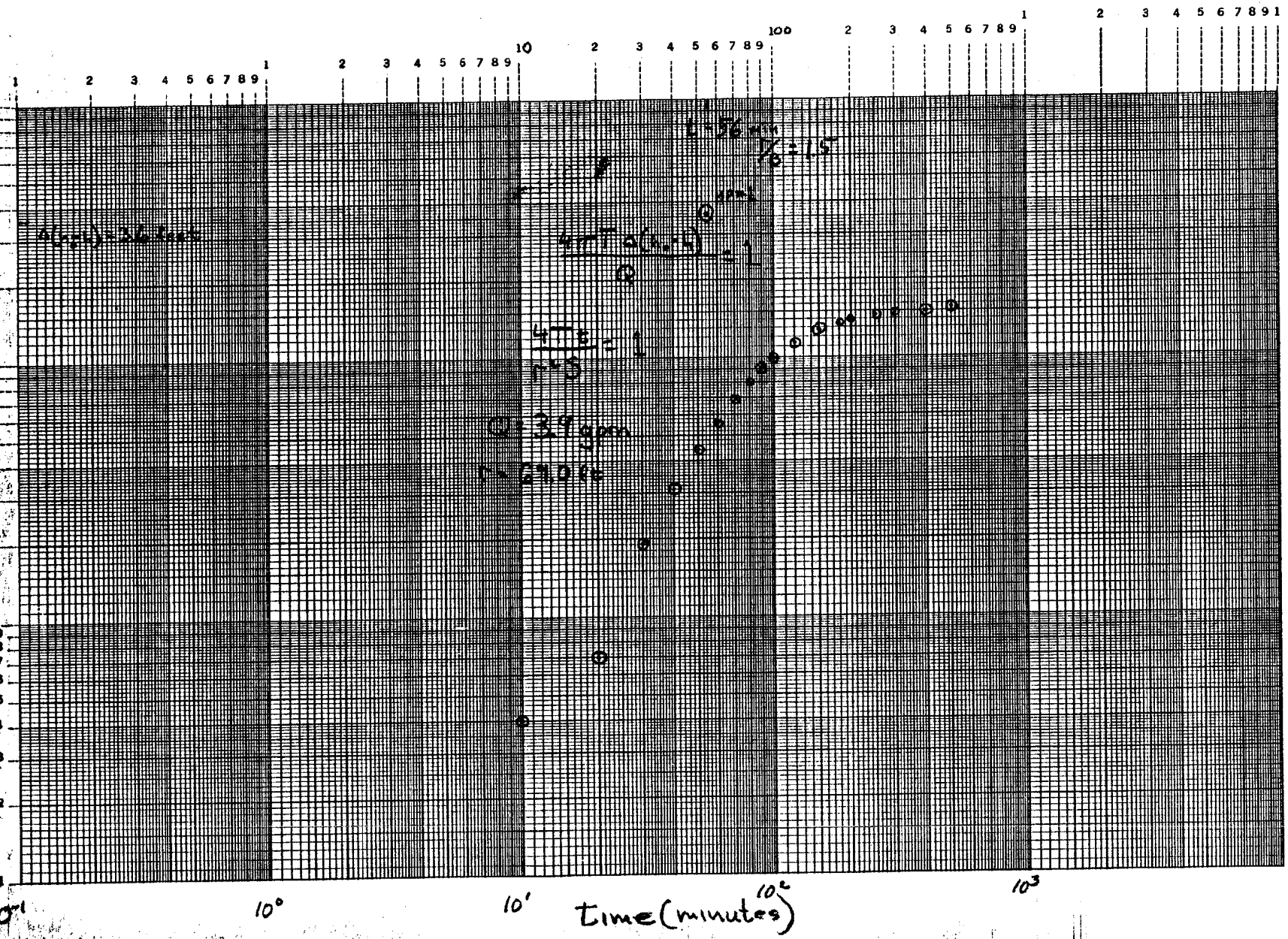
$$K = 1.8 \times 10^{-4}\ ft/min$$

$$\boxed{K = 9.3 \times 10^{-5}\ cm/sec}$$

K+E LOGARITHMIC 3 x 5 CYCLES
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 7522

NAWC Warminster Pump test Pumping well-E; Observation well BG-4 Graph



Plotted by FWRamser 9/14/92

Pg. 3

HALLIBURTON NUS Environmental Corporation and Subsidiaries — **STANDARD CALCULATION SHEET**

CLIENT:	FILE NO.:	BY:	PAGE 4 OF
NAWC Warminster	2933-0306	RWarner	
SUBJECT: Pumptest Data Evaluation (obs. well - BG 4)		CHECKED BY: EJR 9/28/92	DATE:

I Objective: To calculate transmissivity "T", storativity "S" and Hydraulic conductivity "K" using the Cooper-Jacob straight line method* (from Fetter 1988, pg 170)

II Procedure: Observation well-BG 4 data plotted on Semi-log paper to derive values for "t_o" and $\Delta(h_o - h)$

III Calculations:

Known field data: $Q = 3.9$ gpm, $r = 69.0$ feet

from plot: $t_o = 30.0$ min $\Delta(h_o - h) = 1.87$ feet

Eq. $T = \frac{2.3Q}{4\pi\Delta(h_o - h)}$ $S = \frac{2.25 T t_o}{r^2}$ $K = T/b$

where $Q = 3.9 \frac{gal}{min} \times \frac{.1337 ft^3}{gal} = 0.5214 \, ft^3/min$

$r = 69.0$ ft, $t_o = 30.0$ min, $\Delta(h_o - h) = 1.87$ ft

1) $T = \frac{2.3Q}{4\pi\Delta(h_o - h)}$

sub. $T = \frac{2.3(0.5214 \, ft^3/min)}{4\pi(1.87 ft)}$

$T = 0.051 \, ft^2/min$

2) $S = \frac{2.25 T t_o}{r^2}$

sub. $S = \frac{2.25(0.051 \, ft^2/min)(30.0 \, min)}{(69.0 ft)^2}$

$S = 0.0007$

3) Check t (time required for adequate pumptest based on assumptions for Cooper-Jacob straight line)

where $t = \frac{r^2 S}{4Tu}$ let $u = 0.1$

continue →

3) (continued) Checking t

$$t = \frac{r^2 S}{4Tu} \qquad \text{let } u = 0.1$$

sub.

$$t = \frac{(69\,ft)^2(0.0007)}{4(0.051\,ft^2/min)(0.1)}$$

$$\boxed{t = 163.4\ min}$$

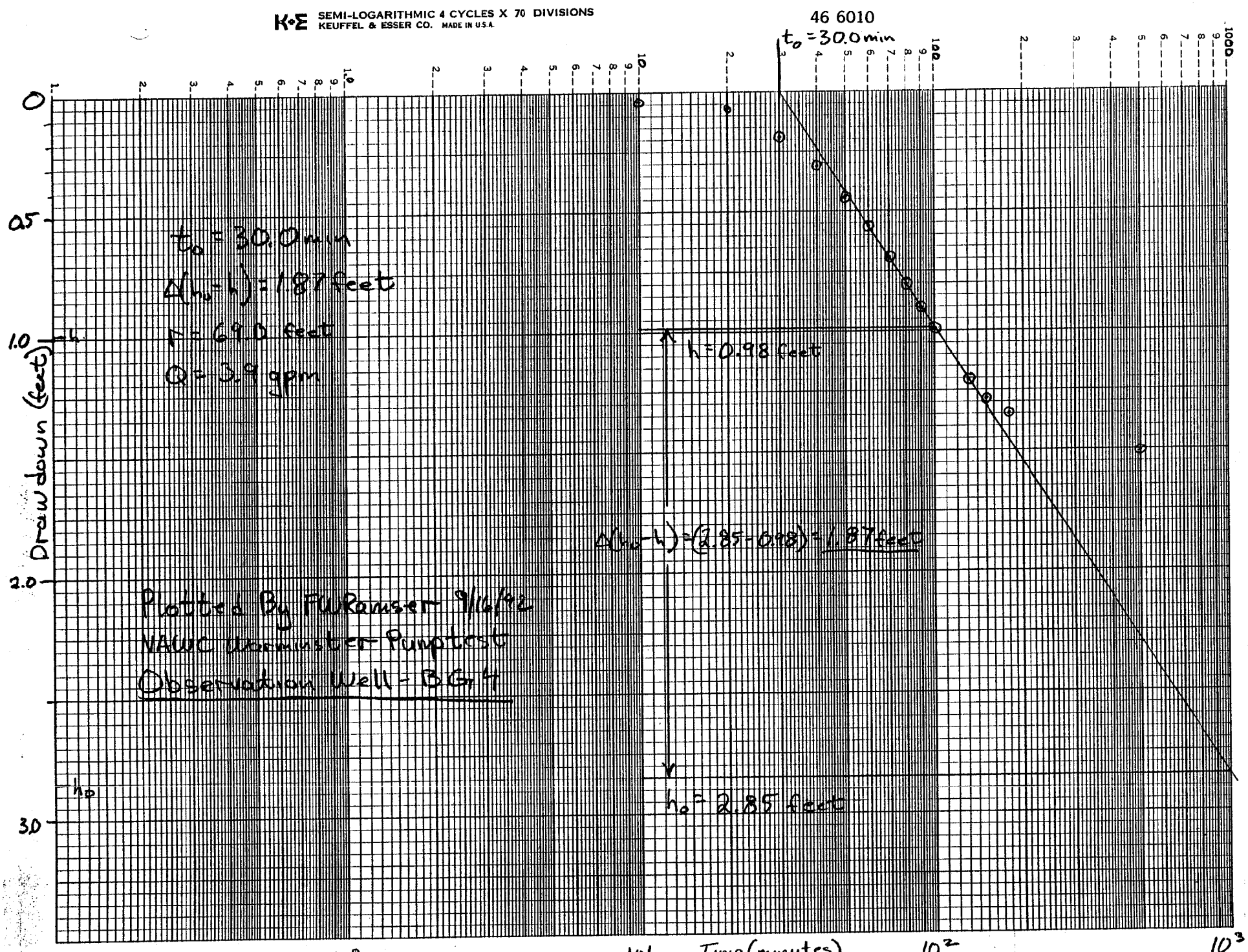
4) $K = T/b \qquad b = 63\,ft$

sub.

$$K = \frac{.051\,ft^2/min}{63\,ft}$$

$$K = 8.1 \times 10^{-4}\ ft/min$$

$$K = 4.1 \times 10^{-4}\ cm/sec$$


K+E SEMI-LOGARITHMIC 4 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 6010
t_o = 30.0 min
t_o = 30.0 min
$\Delta(h_o - h)$ = 1.87 feet
r = 69.0 feet
Q = 3.9 gpm
h = 0.98 feet
$\Delta(h_o - h)$ = (2.85 - 0.98) = 1.87 feet
h_o = 2.85 feet
Plotted By FWRamsey 9/16/92
NAWC Warminster Pumptest
Observation Well - BG4
Drawdown (feet)
Time (minutes)
0
0.5
1.0
2.0
3.0
10^2
10^3

Pg 6

Pg 6

SE1000B
Environmental Logger
08/12 09:12

Unit# 40020 Test# 0

INPUT 1: Level (F)

Reference 0.00
Scale factor 10.02
Offset - 0.01

Step# 0 08/11 13:45

NAWC Warminster Pumptest
Observation Well BG4
Drawdown Data

Q = 3.9 gpm
r = 69.0 feet

Elapsed Time	Value	
0.0000	-0.09 *	
10.0000	-0.13	(.13-.09 = .04)
20.0000	-0.16	(.16-.09 = .07)
30.0000	-0.28	(.28-.09 = .19
40.0000	-0.40	.31
50.0000	-0.53	.44
60.0000	-0.65	.56
70.0000	-0.78	.69
80.0000	-0.89	
90.0000	-0.99	
100.000	-1.08	
110.000	-1.15	
120.000	-1.23	1.14
130.000	-1.30	
140.000	-1.34	
150.000	-1.37	
160.000	-1.39	
170.000	-1.42	
180.000	-1.44	
190.000	-1.46	
200.000	-1.48	
210.000	-1.49	
220.000	-1.50	
230.000	-1.51	
240.000	-1.53	
250.000	-1.53	
260.000	-1.54	
270.000	-1.54	
280.000	-1.55	
290.000	-1.55	
300.000	-1.56	
310.000	-1.56	
320.000	-1.57	
330.000	-1.57	
340.000	-1.58	
350.000	-1.58	
360.000	-1.58	
370.000	-1.58	
380.000	-1.58	
390.000	-1.59	
400.000	-1.59	
410.000	-1.59	
420.000	-1.60	
430.000	-1.60	
440.000	-1.60	
450.000	-1.60	
460.000	-1.60	
470.000	-1.59	
480.000	-1.60	
490.000	-1.60	
500.000	-1.60	
510.000	-1.60	
520.000	-1.60	
530.000	-1.60	
540.000	-1.60	

* adj all values by .09 @ t = 0 to be plotted.

NAWC Warminster Pump test

Observation Well BG4

Recovery Data

SE1000B
Environmental Logger
08/12 09:13

Unit# 40020 Test# 1

INPUT 1: Level (F)

Reference	0.00
Scale factor	10.02
Offset	- 0.01

Step# 0 08/11 22:52

Elapsed Time	Value
0.0000	-1.61
0.0033	-1.61
0.0066	-1.61
0.0099	-1.61
0.0133	-1.61
0.0166	-1.61
0.0200	-1.61
0.0233	-1.61
0.0266	-1.61
0.0300	-1.61
0.0333	-1.61
0.0500	-1.61
0.0666	-1.61
0.0833	-1.61
0.1000	-1.61
0.1166	-1.61
0.1333	-1.61
0.1500	-1.61
0.1666	-1.61
0.1833	-1.61
0.2000	-1.61
0.2166	-1.61
0.2333	-1.61
0.2500	-1.61
0.2666	-1.61
0.2833	-1.61
0.3000	-1.61
0.3166	-1.61
0.3333	-1.61
0.4167	-1.61
0.5000	-1.61
0.5833	-1.61
0.6667	-1.61
0.7500	-1.61
0.8333	-1.61
0.9167	-1.61
1.0000	-1.61
1.0833	-1.61
1.1667	-1.61
1.2500	-1.61
1.3333	-1.61
1.4166	-1.61
1.5000	-1.61
1.5833	-1.61
1.6667	-1.61
1.7500	-1.61
1.8333	-1.61
1.9167	-1.61
2.0000	-1.61
2.5000	-1.61
3.0000	-1.61
3.5000	-1.61
4.0000	-1.61
4.5000	-1.61
5.0000	-1.61
5.5000	-1.61
6.0000	-1.61
6.5000	-1.60
7.0000	-1.60
7.5000	-1.60
8.0000	-1.60
8.5000	-1.60
9.0000	-1.59
9.5000	-1.59
10.0000	-1.59
12.0000	-1.57
14.0000	-1.56
16.0000	-1.54
18.0000	-1.52
20.0000	-1.50
22.0000	-1.48

24.0000	-1.45
26.0000	-1.43
28.0000	-1.40
30.0000	-1.37
32.0000	-1.35
34.0000	-1.32
36.0000	-1.29
38.0000	-1.26
40.0000	-1.24
42.0000	-1.21
44.0000	-1.18
46.0000	-1.16
48.0000	-1.13
50.0000	-1.10
52.0000	-1.08
54.0000	-1.05
56.0000	-1.03
58.0000	-1.00
60.0000	-0.98
62.0000	-0.96
64.0000	-0.93
66.0000	-0.91
68.0000	-0.89
70.0000	-0.87
72.0000	-0.85
74.0000	-0.83
76.0000	-0.80
78.0000	-0.79
80.0000	-0.77
82.0000	-0.75
84.0000	-0.73
86.0000	-0.71
88.0000	-0.70
90.0000	-0.68
92.0000	-0.66
94.0000	-0.65
96.0000	-0.63
98.0000	-0.62
100.000	-0.61
110.000	-0.55
120.000	-0.49
130.000	-0.43
140.000	-0.39
150.000	-0.35
160.000	-0.31
170.000	-0.28
180.000	-0.24
190.000	-0.22
200.000	-0.19
210.000	-0.17
220.000	-0.15
230.000	-0.13
240.000	-0.11
250.000	-0.09
260.000	-0.07
270.000	-0.06
280.000	-0.05
290.000	-0.04
300.000	-0.03
310.000	-0.01
320.000	-0.00
330.000	0.00
340.000	0.00
350.000	0.01
360.000	0.02
370.000	0.03
380.000	0.03
390.000	0.04
400.000	0.05
410.000	0.05
420.000	0.06
430.000	0.06
440.000	0.07
450.000	0.07
460.000	0.08
470.000	0.08
480.000	0.08
490.000	0.07
500.000	0.07
510.000	0.06
520.000	0.04
530.000	0.01
540.000	-0.04

WELL D

OBSERVATION WELL

HALLIBURTON NUS
Environmental Corporation

Page _____

AQUIFER TEST DATA

Owner NAWC Warminster Address _____ County Bucks State P

Date 8/11/92 Company performing test H. NUS Measured by AWK/RWG

Well No. D Distance from pumping well 74.8' Type of test Single Well (E) Pump Test No. 0

Measuring equipment Hermit (1) and 10 psi transducer (Input 1)

Time Data
Pump on: Date 8/11 Time 1345 (t_0)
Pump off: Date 8/11 Time 2252 (t'_0)
Duration of aquifer test:
Pumping 9H 7M Recovery 9H

Water Level Data
Static water level 17.56
Measuring point TOC
Elevation of measuring point _____

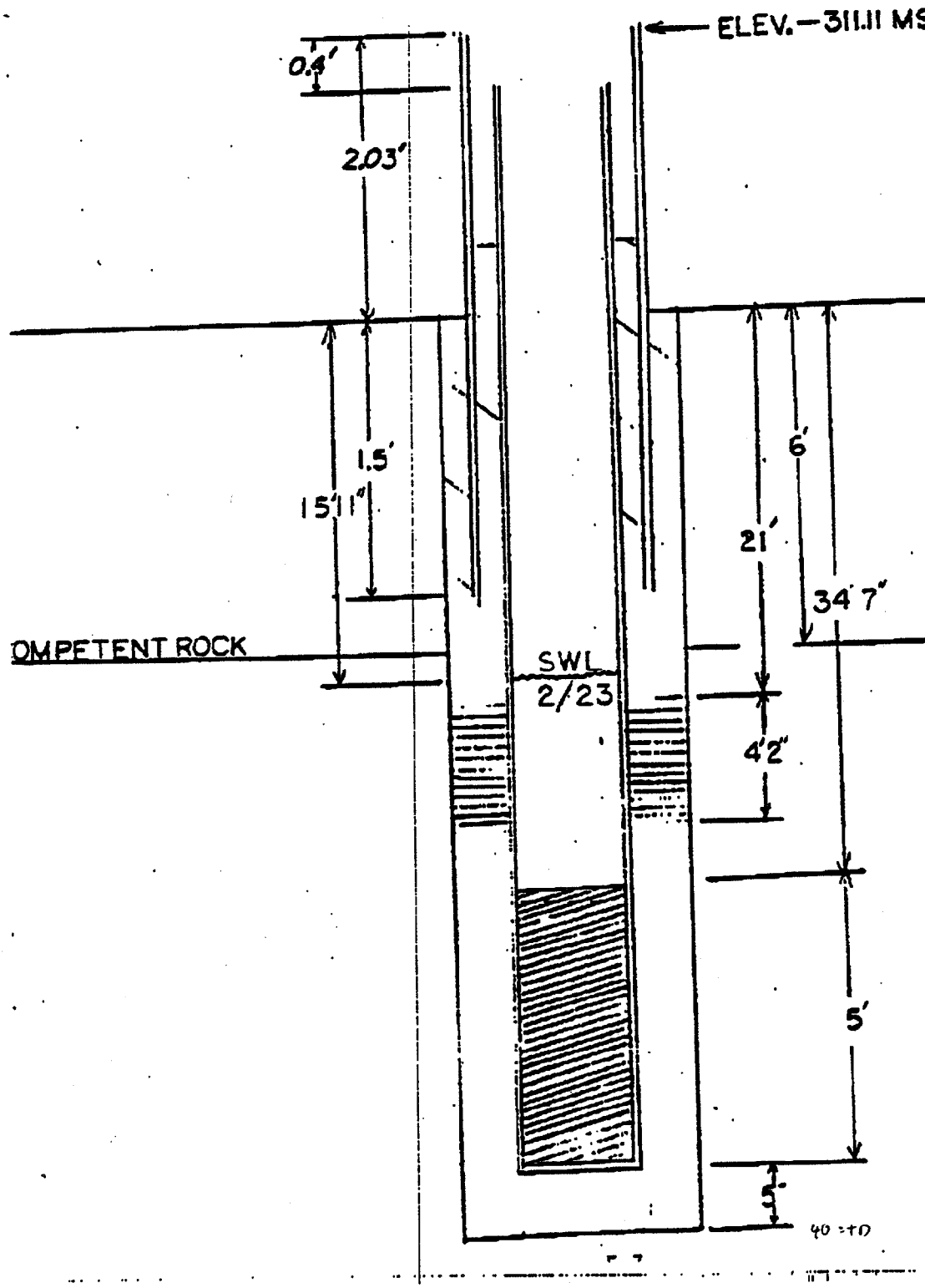
Discharge Data
How Q measured 5 gal. bucket
Depth of pump/air line 33.9 TOC
Previous pumping? Yes ____ No X
Duration _____ End _____

Comments on factors affecting test data

Date	Clock time	Time since pump started t	Time since pump stopped t'	t/t'		Water level measurement	Correction or Conversion	Ref. to 0.00 Water level	Water level change s or s'		Discharge measurement	Rate		Comments
8/11	1417							-1.28				4 GPM		
	1433							-1.68				3.9 GPM		
	1521							-1.99				"		
	1612							-2.12				"		
	1645							-2.15				"		
	1742							-2.21				"		
	1840							-2.25				"		
	1945							-2.29				"		
	2045							-2.32				"		2103 Pump fail 1 min.
	2145							-2.31				"		Stop Pumping and
	2245							-2.34				"		begin Step 1 @ 2252
	2252													Begin Recovery
			4					-2.31						
			5					-2.29						
			6					-2.26						
			7					-2.23						
			8					-2.19						
			9					-2.15						
			10					-2.11						
			12					-2.02						
			14					-1.93						
			20					-1.63						
			26					-1.38						
			30					-1.23						
			40					-0.94						
			50					-0.75						

SMP-1 (D)

FIGURE F-2



WALTER B. SATTERTHWAITE ASSOCIATES, INC.

TABLE F-2

Well No.: SMP-1 (D)
Drilled: 2/23/84

DEPTH	DESCRIPTION
0-6	Brown to yellow clay, red silty soil.
6-7	Fine-grained brown to red sandstone.
7-10	Purple to brown, fine-grained sandstone to siltstone, highly weathered.
10-17	Reddish-brown to purple, medium- to fine-grained sandstone, darkening downward, biotite present. Moist zone at 15'.
17-22	Red to brown, medium-grained sandstone, purple medium-grained sandstone. Moist zones at 20 and 22 ft.
22-27	Same as above with little brown to buff, medium-grained sandstone.
27-31	Medium-grained, purple sandstone, some medium-grained white to buff sandstone, little fine-grained dark purple sandstone.
31-35	Same as above with little brown to yellow, medium-grained sandstone.

screened interval 35-40

effective thickness of aquifer is from 10-55 = 45' = b @ SMP-1

TABLE F-1
DRILLING ADMINISTRATION

Project: Naval Air Development Center
Project No. 214-83B

Well SMP#1 (D)

Well Contractor: Rollin Raab & Son

Address: Warwick, PA **Phone:** 343-1277

Name of Driller: Dick Raab **Helper(s)** Harry Zimmerman

Rig: Number **Make** Denver-Gardner **Model** **Bar Length:** 20'

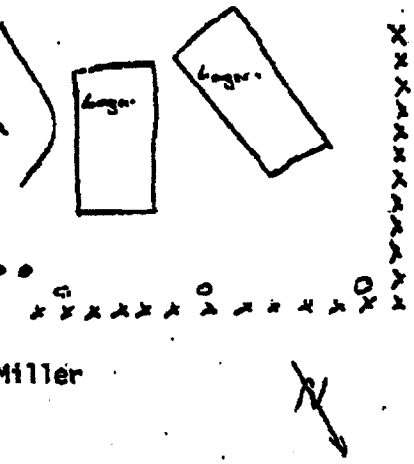
Reference Point: Top of Outer Casing = 311.11 MSL

Casing & Grouting Summary (Amounts, Lengths, diameters) 5" of sand at bottom of hole, 5' of 4" Johnson stainless steel #15 well screen threaded to 35' of 4" threaded steel casing. Top of casing is 2' above ground level.

Diary of Drilling

Date	Time	What Was Done & (Problems if Any)	Weather
2/23	10:30am	Drilling started.	45°, hazy
2/23	11:25am	Hole completed at driller's 40'. Drilling produced no flow when blown. Allowed well to stand for one hour. Static water level was then about 10' below top of casing.	
2/23	12:30pm	Four bags of sand used to pack bottom 10' of casing and screening. 2.5 gals. (25 lbs.) bentonite used to make a 50" seal (Volclay Tablets). Four bags of sand and 4 bags of cement used to grout hole to the surface.	
2/23	2:30 pm	4.5' of 6" protective steel casing set 1.5' into concrete around 4" steel casing.	
2/23	3 pm	temperature = 13.75°C specific conductivity = 1000 mmhos	

(Assume SMP #1 is well D based on depth & loc'n)



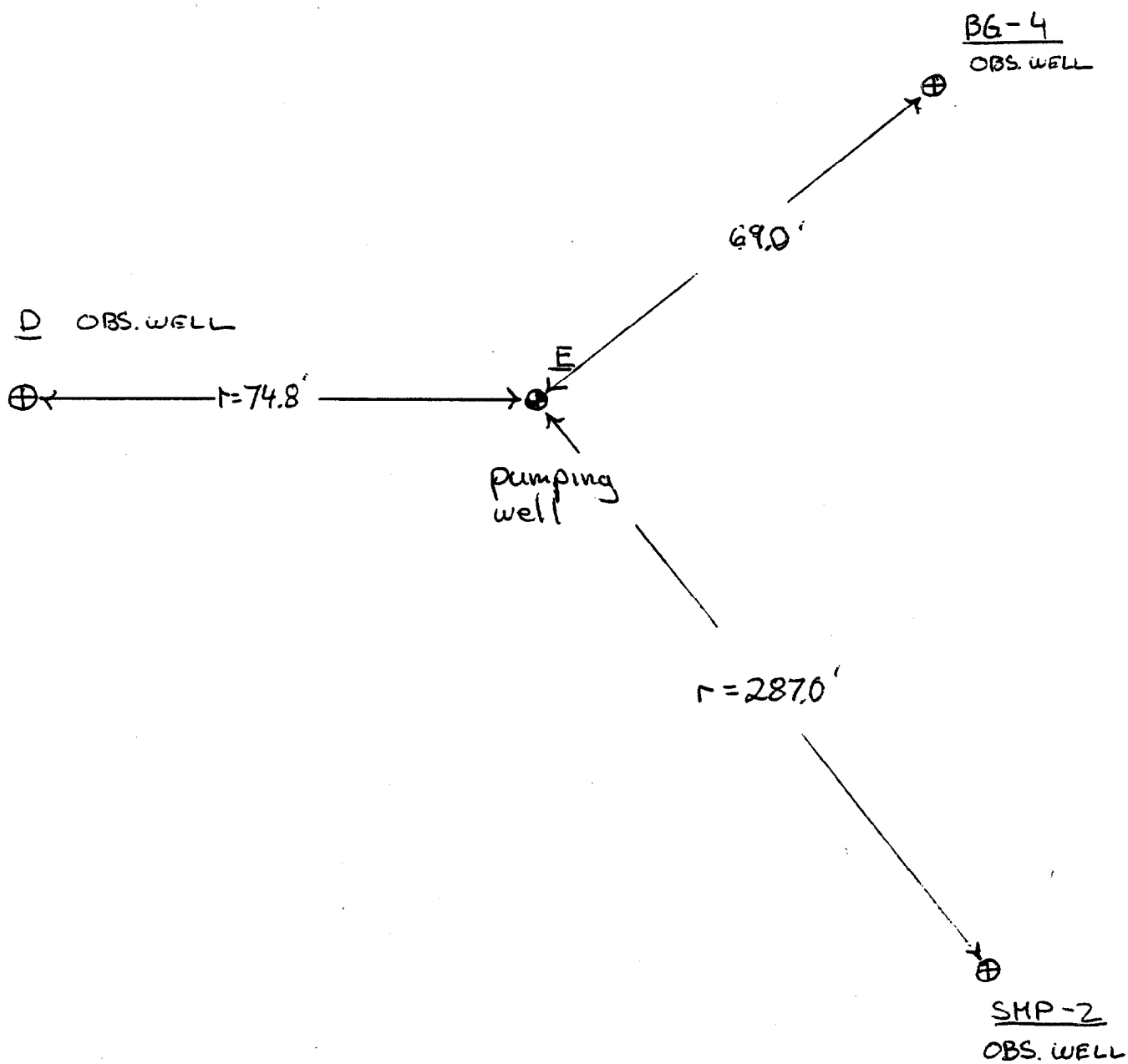
Cuttings:

Geologist: J. Roberts
Other Persons on Site: C. Miller

HALLIBURTON NUS Environmental Corporation and Subsidiaries	STANDARD CALCULATION SHEET

CLIENT: NAWC WARMINSTER	FILE NO.: 3933-0306	BY: FURAMSER	PAGE OF
SUBJECT: PUMP TEST DATA EVALUATION		CHECKED BY:	DATE:

Radial Distance Schematic



HALLIBURTON NUS Environmental Corporation and Subsidiaries			STANDARD CALCULATION SHEET
CLIENT: NAWC Warminster	FILE NO.: 3933-0306	BY: S Ramser	PAGE / OF
SUBJECT: Pump test Data evaluation, Obs well-D		CHECKED BY: EJR	DATE: 9/28/92

I. Objective: To calculate transmissivity "T" and storativity "S" and hydraulic conductivity using the W. C. Walton method of curve matching overlay procedures for a semi-confined aquifer. This procedure allows for the determination of formation constants for both the aquifer and the semi-pervious layer. Fetter pg 182, 183 (1988)

II Procedure: Drawdown vs time data Plotted on log-log paper Matched to Type curves for a Leaky Confined Aquifer with no storage in the confining Layer (after Hantush + Jacob, 1955 Using the following eq.

$$W(u, r/B) = \frac{4\pi T \Delta(h_o - h)}{Q}, \quad \frac{1}{u} = \frac{4Tt}{r^2 S}$$

$$K' = \frac{Tb'(r/B)^2}{r^2} \qquad K = T/b$$

K': vertical conductivity of semipervious layer

b': thickness of semipervious layer

III Calculations:

From field Data: $r = 74.8$ ft $\quad Q = 3.9$ gpm

$b = 65$ ft $\quad b' = 3$ ft

From plot overlay: $t = 8.6$ min $\quad \Delta(h_o - h) = 1.4$ feet

$1/u = 1 \quad W(u, r/B) = 1 \quad r/B = 0.6$

HALLIBURTON NUS Environmental Corporation and Subsidiaries	STANDARD CALCULATION SHEET

CLIENT: NAWC Warminster	FILE NO.: 3933-0306	BY: JLRamsor	PAGE 2 OF
SUBJECT: Pump test Data Evaluation, Obs well - D		CHECKED BY: JR	DATE: 9/28/92

III Calculations (continued)

1)

$$W(u, r/B) = \frac{4\pi T \Delta(h_o - h)}{Q}$$

$$T = \frac{Q}{4\pi \Delta(h_o - h)} W(u, r/B)$$

$$Q = 3.9 \frac{gal}{min} \times .1337 \, ft^3/gal = 0.5214 \, ft^3/min$$

sub

$$T = \frac{0.5214 \, ft^3/min}{4\pi(1.4 \, ft)}(1)$$

$$\boxed{T = 0.0296 \, ft^2/min}$$

$$T = .0296 \, ft^2/min \times \frac{1 \, min}{60 \, sec} \times \left(\frac{12 \, in}{1 \, ft}\right)^2 \times \left(\frac{2.54 \, cm}{1 \, in}\right)^2$$

$$T = 4.6 \times 10^{-1} \, cm^2/sec$$

2)

$$1/u = \frac{4Tt}{r^2 S}$$

$$S = \frac{4Tt}{r^2} u$$

sub.

$$S = \frac{4(0.0296 \, ft^2/min)(8.6 \, min)}{(74.8 \, ft)^2}(1)$$

$$\boxed{S = 0.0002}$$

3) $K = T/b$ where $b = 65 \, ft$

sub. $K = \frac{.0296 \, ft^2/min}{65 \, ft}$

$$K = 4.6 \times 10^{-4} \, ft/min$$

$$K = 2.3 \times 10^{-4} \, cm/sec$$

4) $K' = \dfrac{Tb'(T/B)^2}{r^2}$ $\qquad b' = 3\,ft'$

sub. $K' = \dfrac{(0.0296\,ft^2/min)(3\,ft)(0.6)^2}{(74.8\,ft)^2}$

$K' = \cancel{6.4 \times 10^{-5}\,ft/min}$ $\quad 5.7 \times 10^{-6}\,ft/min$

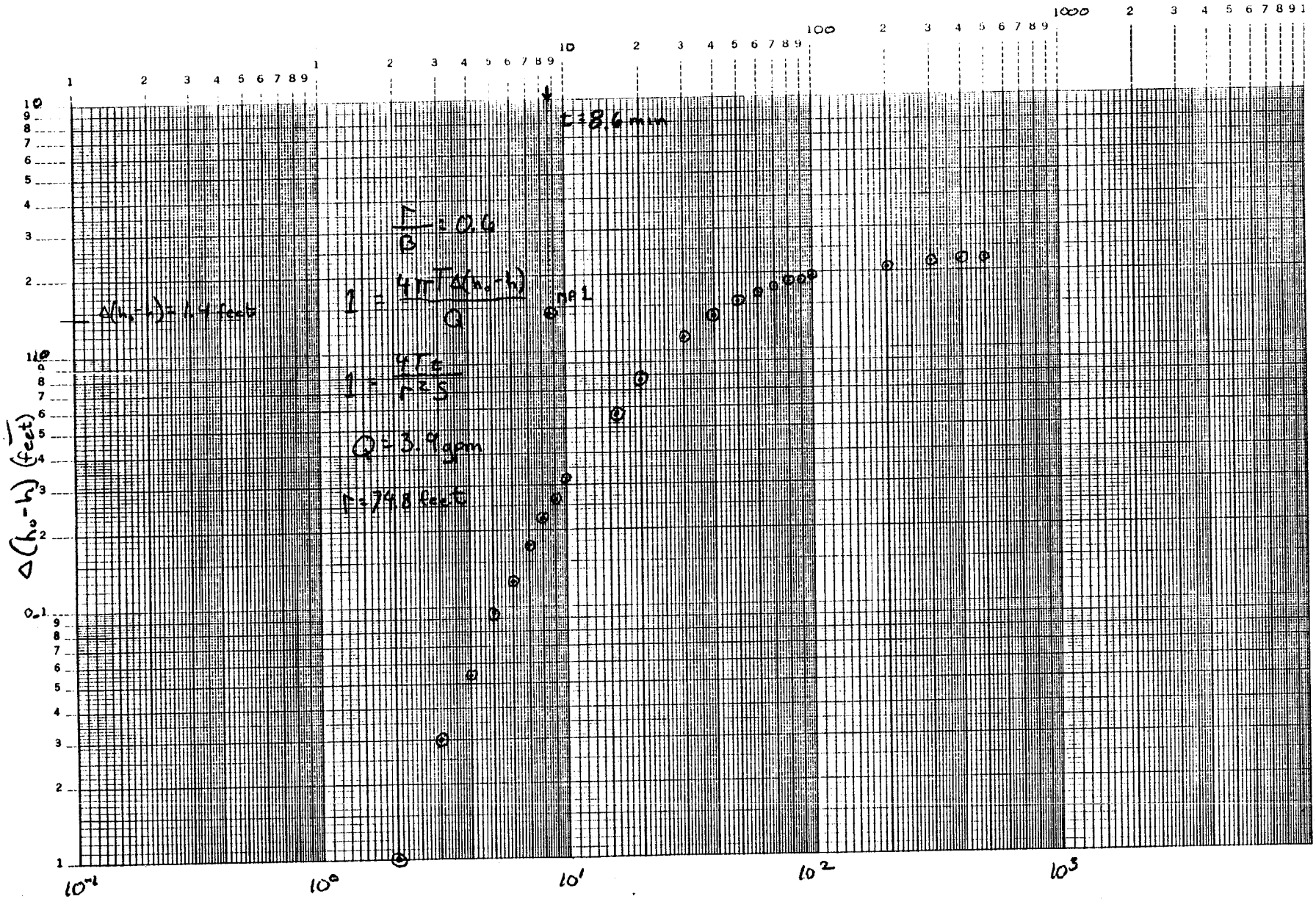
$K' = 6.43 \times 10^{-5}\,ft/min \times \dfrac{1\,min}{60\,sec} \times \dfrac{12\,in}{1\,ft} \times \dfrac{2.54\,cm}{1\,in}$

$K' = \cancel{3.27 \times 10^{-5}\,cm/sec}$ $\quad 2.90 \times 10^{-6}\,cm/sec$

K+E LOGARITHMIC 3 x 5 CYCLES
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 7522

NAWC WARMINSTER PUMP TEST PUMPING WELL E, OBSERVATION WELL "D" GRAPH.



PLOTTED BY F.W. RAMSER 9/16/92

Pg 4

HALLIBURTON NUS Environmental Corporation and Subsidiaries	STANDARD CALCULATION SHEET

CLIENT: NAWC Warminster	FILE NO.: 2933-0306	BY: FURamser	PAGE 5 OF
SUBJECT: Pump test Data Evaluation (OBSWELL-D)		CHECKED BY: EP 3/28/92	DATE: 9/16/92

I. Objective: To calculate transmissivity "T", Storativity "S" and Hydraulic conductivity "K" using the Cooper-Jacob straight line method.* (From Fetter 1988 pg 170)

II Procedure: Observation well-D data plotted on semi-log paper to derive values for "t_o" and "$\Delta(h_o - h)$".

III calculations:

Known field data: $Q = 3.9$ gpm, $r = 74.8$ ft

* eq. $T = \frac{2.3Q}{4\pi\Delta(h_o - h)}$ $S = \frac{2.25 T t_o}{r^2}$ $K = T/b$

where: $Q = 3.9 \frac{gal}{min} \times \frac{.1337 ft^3}{gal} = \underline{0.5214 \ ft^3/min}$

$r = \underline{74.8 \ ft}$ $b = 65$ ft

$\Delta(h_o - h) = \underline{1.97 \ ft}$

$t_o = \underline{8.1 \ min}$

1) $T = \frac{2.3Q}{4\pi\Delta(h_o - h)}$

sub. $T = \frac{2.3(.5214 \ ft^3/min)}{4\pi(1.97 \ ft)}$ *

$\boxed{T = 0.0484 \ ft^2/min}$

2) $S = \frac{2.25 T t_o}{r^2}$

$S = \frac{2.25(0.0484 \ ft^2/min)(8.1 \ min)}{(74.8 \ ft)^2}$

$\boxed{S = 0.0002}$

HALLIBURTON NUS Environmental Corporation and Subsidiaries			STANDARD CALCULATION SHEET
CLIENT: NAWC Warminster	FILE NO.: 2933-0306	BY: PLRanuser	PAGE 6 OF
SUBJECT: Pump test Data Evaluation (Obs well-D)		CHECKED BY: EJR 9/28/92	DATE: 9/16/92

III calculations (continued)

3) Check t (time required for adaquate pump test based on assumptions for Cooper-Jacob straight line)

where $t = \frac{r^2 S}{4 T u}$ let $u = 0.1$

sub. $t = \frac{(74.8\,ft)^2 (0.0002)}{4(0.0484\,ft^2/min)(0.1)}$

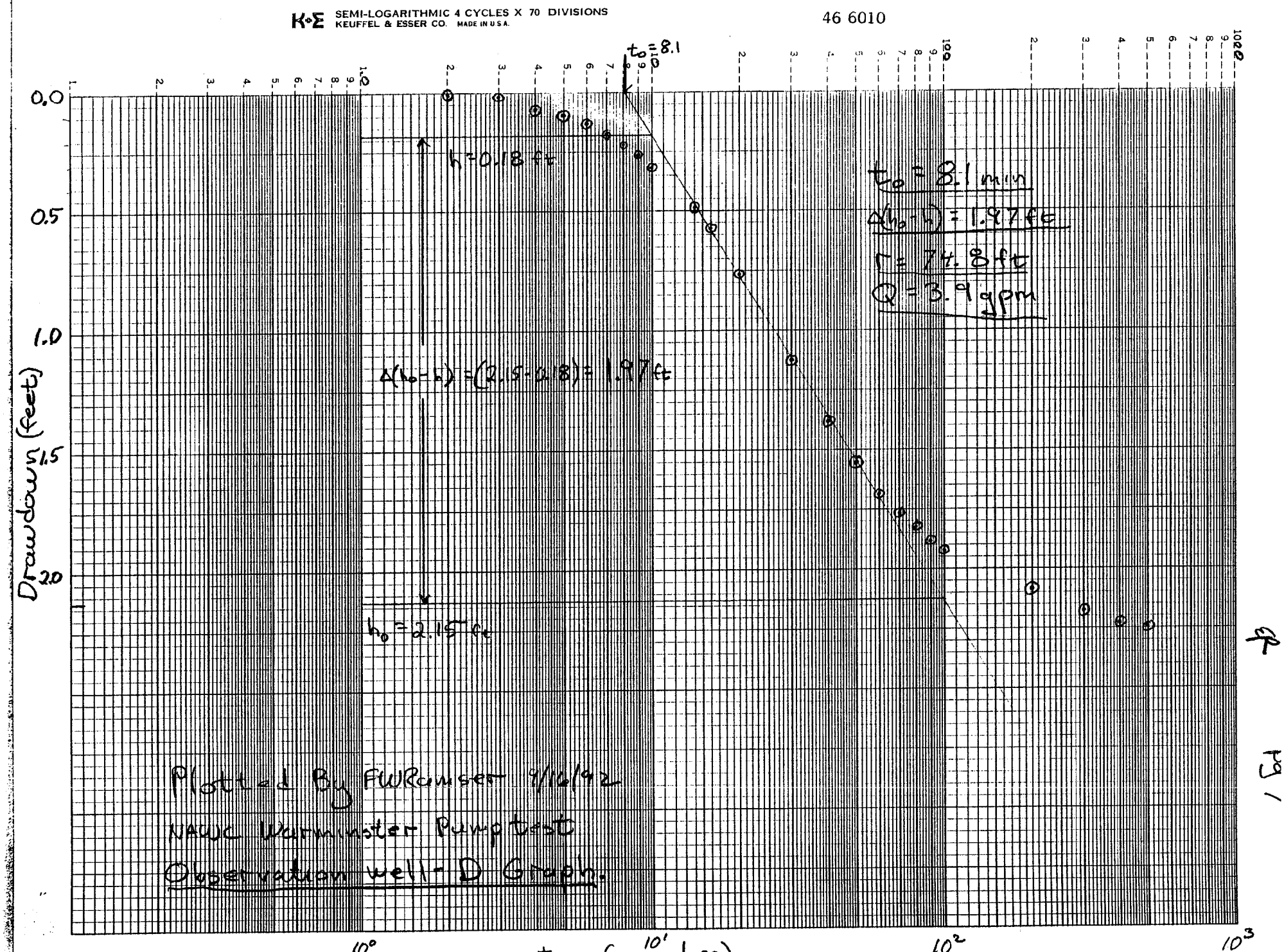
$t = 57.8$ min

4) ~~T = 1 HR~~ $K = T/b$ $b = 65$ ft

sub. $K = \frac{.0484\,ft^2/min}{65\,ft}$

$K = 7.5 \times 10^{-4}$ ft/min

$K = 3.8 \times 10^{-4}$ cm/sec


K+E SEMI-LOGARITHMIC 4 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 6010
Drawdown (feet)
0.0
0.5
1.0
1.5
2.0
10^0
10^1
10^2
10^3
t_0 = 8.1
h = 0.18 ft
$\Delta(h_0 - h)$ = (2.15 - 0.18) = 1.97 ft
h_0 = 2.15 ft
t_0 = 8.1 min
$\Delta(h_0 - h)$ = 1.97 ft
T = 74.8 ft
Q = 3.9 gpm
Plotted By FWRamsey 9/16/92
NAWC Warminster Pump Test
Observation Well - D Graph.

Pg 1

SE1000C
Environmental Logger
08/12 08:52

Observation Well - D
r = 74.8
pumping data
Q = 3.9 gpm

Unit# 00765 Test 0

Setups:	INPUT 1
Type	Level (F)
Mode	Surface
I.D.	00400
Reference	0.000
Linearity	0.000
Scale factor	10.000
Offset	-0.040
Delay mSEC	50.000

Step 0 08/11 13:45:39

Elapsed Time	INPUT 1	
0.0000	-0.085	(.085 - .085)
0.0033	-0.085	
0.0066	-0.085	
0.0100	-0.085	
0.0133	-0.085	
0.0166	-0.085	
0.0200	-0.085	
0.0233	-0.085	
0.0266	-0.085	
0.0300	-0.085	
0.0333	-0.085	
0.0366	-0.085	
0.0400	-0.085	
0.0433	-0.085	
0.0466	-0.085	
0.0500	-0.085	
0.0533	-0.085	
0.0566	-0.085	
0.0600	-0.085	
0.0633	-0.085	
0.0666	-0.085	
0.0700	-0.085	
0.0733	-0.085	
0.0766	-0.085	
0.0800	-0.085	
0.0833	-0.085	
0.0866	-0.085	
0.0900	-0.085	
0.0933	-0.085	
0.0966	-0.085	
0.1000	-0.085	
0.1033	-0.085	
0.1066	-0.085	
0.1100	-0.085	
0.1133	-0.085	
0.1166	-0.085	
0.1200	-0.085	

0.1233	-0.085
0.1266	-0.085
0.1300	-0.085
0.1333	-0.085
0.1366	-0.085
0.1400	-0.085
0.1433	-0.085
0.1466	-0.085
0.1500	-0.085
0.1533	-0.085
0.1566	-0.085
0.1600	-0.085
0.1633	-0.085
0.1666	-0.085
0.1700	-0.085
0.1733	-0.085
0.1766	-0.085
0.1800	-0.085
0.1833	-0.085
0.1866	-0.085
0.1900	-0.085
0.1933	-0.085
0.1966	-0.085
0.2000	-0.085
0.2033	-0.085
0.2066	-0.085
0.2100	-0.085
0.2133	-0.085
0.2166	-0.085
0.2200	-0.085
0.2233	-0.085
0.2266	-0.085
0.2300	-0.085
0.2333	-0.085
0.2366	-0.085
0.2400	-0.085
0.2433	-0.085
0.2466	-0.085
0.2500	-0.085
0.2533	-0.085
0.2566	-0.085
0.2600	-0.085
0.2633	-0.085
0.2666	-0.085
0.2700	-0.085
0.2733	-0.085
0.2766	-0.085
0.2800	-0.085
0.2833	-0.085
0.2866	-0.085
0.2900	-0.085
0.2933	-0.085
0.2966	-0.085
0.3000	-0.085
0.3033	-0.085
0.3066	-0.085
0.3100	-0.085
0.3133	-0.085
0.3166	-0.085
0.3200	-0.085

0.3233	-0.085	
0.3266	-0.085	
0.3300	-0.085	
0.3333	-0.085	
0.3500	-0.085	
0.3666	-0.085	
0.3833	-0.085	
0.4000	-0.088	
0.4166	-0.085	
0.4333	-0.088	
0.4500	-0.085	
0.4666	-0.085	
0.4833	-0.085	
0.5000	-0.085	
0.5166	-0.085	
0.5333	-0.085	
0.5500	-0.082	
0.5666	-0.085	
0.5833	-0.082	
0.6000	-0.082	
0.6166	-0.082	
0.6333	-0.082	
0.6500	-0.082	
0.6666	-0.082	
0.6833	-0.082	
0.7000	-0.082	
0.7166	-0.078	
0.7333	-0.078	
0.7500	-0.078	
0.7666	-0.078	
0.7833	-0.078	
0.8000	-0.078	
0.8166	-0.078	
0.8333	-0.078	
0.8500	-0.078	
0.8666	-0.078	
0.8833	-0.078	
0.9000	-0.082	
0.9166	-0.082	
0.9333	-0.082	
0.9500	-0.082	
0.9666	-0.082	
0.9833	-0.082	
1.0000	-0.082	
1.2000	-0.082	
1.4000	-0.082	
1.6000	-0.085	
1.8000	-0.088	
2.0000	-0.094	(.094 - .085 = .01)
2.2000	-0.104	
2.4000	-0.107	
2.6000	-0.110	
2.8000	-0.113	
3.0000	-0.116	(.116 - .085 = .03)
3.2000	-0.126	
3.4000	-0.129	
3.6000	-0.132	
3.8000	-0.132	
4.0000	-0.139	(.139 - .085 = .054)
4.2000	-0.148	

4.4000	-0.154	
4.6000	-0.157	
4.8000	-0.167	
5.0000	-0.180	(180 - .085 = .095)
5.2000	-0.186	
5.4000	-0.192	
5.6000	-0.199	
5.8000	-0.202	
6.0000	-0.211	(.211 - .085 = .126)
6.2000	-0.224	
6.4000	-0.230	
6.6000	-0.240	
6.8000	-0.252	
7.0000	-0.259	(.259 - .085 = .174)
7.2000	-0.265	
7.4000	-0.274	
7.6000	-0.284	
7.8000	-0.296	
8.0000	-0.306	(.306 - .085 = .221)
8.2000	-0.312	
8.4000	-0.315	
8.6000	-0.325	
8.8000	-0.338	
9.0000	-0.347	(.347 - .085 = .262)
9.2000	-0.356	
9.4000	-0.366	
9.6000	-0.379	
9.8000	-0.391	
10.0000	-0.404	(.404 - .085 = .319)
12.0000	-0.495	
14.0000	-0.578	(.578 - .085 = .493)
16.0000	-0.657	(.657 - .085 = .572)
18.0000	-0.761	
20.0000	-0.849	(.849 - .085 = .764)
22.0000	-0.938	
24.0000	-1.007	
26.0000	-1.080	
28.0000	-1.140	
30.0000	-1.209	(1.209 - .085 = 1.124)
32.0000	-1.270	
34.0000	-1.317	
36.0000	-1.367	
38.0000	-1.418	
40.0000	-1.462	(1.462 - .085 = 1.377)
42.0000	-1.503	
44.0000	-1.538	
46.0000	-1.573	
48.0000	-1.604	
50.0000	-1.636	(1.636 - .085 = 1.551)
52.0000	-1.664	
54.0000	-1.693	
56.0000	-1.718	
58.0000	-1.740	
60.0000	-1.765	(1.765 - .085 = 1.68)
62.0000	-1.784	
64.0000	-1.797	
66.0000	-1.819	
68.0000	-1.838	
70.0000	-1.851	(1.851 - .085 = 1.766)
72.0000	-1.867	

74.0000	-1.879	
76.0000	-1.892	
78.0000	-1.901	
80.0000	-1.911	(1.911 - .085 = 1.826)
82.0000	-1.920	
84.0000	-1.933	
86.0000	-1.946	
88.0000	-1.958	
90.0000	-1.968	(1.968 - .085 = 1.883)
92.0000	-1.977	
94.0000	-1.983	
96.0000	-1.987	
98.0000	-1.996	
100.000	-2.009	(2.009 - .085 = 1.924)
110.000	-2.044	
120.000	-2.072	
130.000	-2.097	
140.000	-2.116	
150.000	-2.126	
160.000	-2.135	
170.000	-2.148	
180.000	-2.160	
190.000	-2.167	
200.000	-2.173	(2.173 - .085 = 2.088)
210.000	-2.183	
220.000	-2.195	
230.000	-2.205	
240.000	-2.214	
250.000	-2.220	
260.000	-2.227	
270.000	-2.233	
280.000	-2.239	
290.000	-2.249	
300.000	-2.258	(2.258 - .085 = 2.173)
310.000	-2.274	
320.000	-2.277	
330.000	-2.284	
340.000	-2.287	
350.000	-2.296	
360.000	-2.299	
370.000	-2.299	
380.000	-2.306	
390.000	-2.312	
400.000	-2.318	(2.318 - .085 = 2.233)
410.000	-2.325	
420.000	-2.328	
430.000	-2.331	
440.000	-2.331	
450.000	-2.315	
460.000	-2.312	
470.000	-2.318	
480.000	-2.322	
490.000	-2.325	
500.000	-2.331	(2.331 - .085 = 2.246)
510.000	-2.331	
520.000	-2.344	
530.000	-2.347	
540.000	-2.347	

SE1000C
Environmental Logger
08/12 08:57

Unit# 00765 Test 0

Setups:	INPUT 1
Type	Level (F)
Mode	Surface
I.D.	00400
Reference	0.000
Linearity	0.000
Scale factor	10.000
Offset	-0.040
Delay mSEC	50.000

Well-D
Obs well
r= 74.8'
recovery Data

Step 1 08/11 22:53:07

Elapsed Time	INPUT 1
0.0000	-2.344
0.0033	-2.344
0.0066	-2.344
0.0100	-2.344
0.0133	-2.344
0.0166	-2.344
0.0200	-2.344
0.0233	-2.344
0.0266	-2.344
0.0300	-2.344
0.0333	-2.344
0.0366	-2.344
0.0400	-2.344
0.0433	-2.344
0.0466	-2.344
0.0500	-2.344
0.0533	-2.344
0.0566	-2.344
0.0600	-2.344
0.0633	-2.344
0.0666	-2.344
0.0700	-2.344
0.0733	-2.344
0.0766	-2.344
0.0800	-2.344
0.0833	-2.344
0.0866	-2.344
0.0900	-2.344
0.0933	-2.344
0.0966	-2.344
0.1000	-2.344
0.1033	-2.344
0.1066	-2.344
0.1100	-2.344
0.1133	-2.344
0.1166	-2.344
0.1200	-2.344

well - D
Recovery

0.1233	-2.344
0.1266	-2.344
0.1300	-2.344
0.1333	-2.344
0.1366	-2.344
0.1400	-2.344
0.1433	-2.344
0.1466	-2.344
0.1500	-2.344
0.1533	-2.344
0.1566	-2.344
0.1600	-2.344
0.1633	-2.344
0.1666	-2.344
0.1700	-2.344
0.1733	-2.344
0.1766	-2.344
0.1800	-2.344
0.1833	-2.344
0.1866	-2.344
0.1900	-2.344
0.1933	-2.344
0.1966	-2.344
0.2000	-2.344
0.2033	-2.344
0.2066	-2.344
0.2100	-2.344
0.2133	-2.344
0.2166	-2.344
0.2200	-2.344
0.2233	-2.344
0.2266	-2.344
0.2300	-2.344
0.2333	-2.344
0.2366	-2.344
0.2400	-2.344
0.2433	-2.344
0.2466	-2.344
0.2500	-2.344
0.2533	-2.344
0.2566	-2.344
0.2600	-2.344
0.2633	-2.344
0.2666	-2.344
0.2700	-2.344
0.2733	-2.344
0.2766	-2.344
0.2800	-2.344
0.2833	-2.344
0.2866	-2.344
0.2900	-2.344
0.2933	-2.344
0.2966	-2.344
0.3000	-2.344
0.3033	-2.344
0.3066	-2.344
0.3100	-2.344
0.3133	-2.344
0.3166	-2.344
0.3200	-2.344

well-D
recovery

0.3233	-2.344
0.3266	-2.344
0.3300	-2.344
0.3333	-2.344
0.3500	-2.344
0.3666	-2.344
0.3833	-2.344
0.4000	-2.344
0.4166	-2.344
0.4333	-2.344
0.4500	-2.344
0.4666	-2.344
0.4833	-2.344
0.5000	-2.344
0.5166	-2.344
0.5333	-2.344
0.5500	-2.344
0.5666	-2.344
0.5833	-2.344
0.6000	-2.344
0.6166	-2.344
0.6333	-2.344
0.6500	-2.347
0.6666	-2.344
0.6833	-2.344
0.7000	-2.344
0.7166	-2.344
0.7333	-2.344
0.7500	-2.344
0.7666	-2.344
0.7833	-2.344
0.8000	-2.344
0.8166	-2.344
0.8333	-2.344
0.8500	-2.344
0.8666	-2.344
0.8833	-2.344
0.9000	-2.344
0.9166	-2.344
0.9333	-2.344
0.9500	-2.344
0.9666	-2.344
0.9833	-2.344
1.0000	-2.344
1.2000	-2.344
1.4000	-2.344
1.6000	-2.344
1.8000	-2.340
2.0000	-2.340
2.2000	-2.337
2.4000	-2.337
2.6000	-2.334
2.8000	-2.331
3.0000	-2.331
3.2000	-2.328
3.4000	-2.325
3.6000	-2.322
3.8000	-2.318
4.0000	-2.315
4.2000	-2.312

well-D
recovery

4.4000	-2.306
4.6000	-2.303
4.8000	-2.299
5.0000	-2.293
5.2000	-2.290
5.4000	-2.284
5.6000	-2.277
5.8000	-2.274
6.0000	-2.268
6.2000	-2.261
6.4000	-2.255
6.6000	-2.249
6.8000	-2.243
7.0000	-2.236
7.2000	-2.227
7.4000	-2.220
7.6000	-2.214
7.8000	-2.205
8.0000	-2.198
8.2000	-2.189
8.4000	-2.183
8.6000	-2.176
8.8000	-2.167
9.0000	-2.157
9.2000	-2.151
9.4000	-2.141
9.6000	-2.135
9.8000	-2.126
10.0000	-2.116
12.0000	-2.028
14.0000	-1.930
16.0000	-1.832
18.0000	-1.734
20.0000	-1.639
22.0000	-1.548
24.0000	-1.462
26.0000	-1.380
28.0000	-1.301
30.0000	-1.232
32.0000	-1.165
34.0000	-1.105
36.0000	-1.048
38.0000	-0.998
40.0000	-0.947
42.0000	-0.903
44.0000	-0.862
46.0000	-0.824
48.0000	-0.789
50.0000	-0.758
52.0000	-0.726
54.0000	-0.701
56.0000	-0.676
58.0000	-0.650
60.0000	-0.628
62.0000	-0.606
64.0000	-0.587
66.0000	-0.568
68.0000	-0.552
70.0000	-0.537
72.0000	-0.521

Sheet #5 of 5

well-D
recovery

74.0000	-0.505
76.0000	-0.492
78.0000	-0.480
80.0000	-0.467
82.0000	-0.458
84.0000	-0.445
86.0000	-0.435
88.0000	-0.423
90.0000	-0.417
92.0000	-0.404
94.0000	-0.398
96.0000	-0.385
98.0000	-0.379
100.000	-0.369
110.000	-0.338
120.000	-0.309
130.000	-0.281
140.000	-0.255
150.000	-0.236
160.000	-0.217
170.000	-0.199
180.000	-0.183
190.000	-0.170
200.000	-0.154
210.000	-0.142
220.000	-0.129
230.000	-0.123
240.000	-0.113
250.000	-0.101
260.000	-0.091
270.000	-0.085 ← RECOVERED.
280.000	-0.075
290.000	-0.069
300.000	-0.063
310.000	-0.053
320.000	-0.050
330.000	-0.047
340.000	-0.044
350.000	-0.037
360.000	-0.031
370.000	-0.028
380.000	-0.025
390.000	-0.018
400.000	-0.015
410.000	-0.012
420.000	-0.009
430.000	-0.006
440.000	-0.003
450.000	-0.003
460.000	-0.003
470.000	0.000
480.000	0.000
490.000	-0.003
500.000	-0.006
510.000	-0.006
520.000	-0.009
530.000	-0.009
540.000	-0.009

WELL SMP-2

OBSERVATION WELL

HALLIBURTON NUS
Environmental Corporation

Page _____

AQUIFER TEST DATA

Owner NAWC Warminster Address _____ County Bucks State P

Date 8/11/ Company performing test H.NUS Measured by AWK/RWG

Well No. SMP-2 Distance from pumping well _____ Type of test Single Well (E) Pump Test No. 0

Measuring equipment Hermit (4) and 10 psi transducer (Input 2)

Time Data
Pump on: Date 8/11 Time 1345 (t_0)
Pump off: Date 8/11 Time 2252 (t'_0)
Duration of aquifer test:
Pumping 9H7M Recovery 9H

Water Level Data
Static water level 18.96
Measuring point TOC
Elevation of measuring point _____

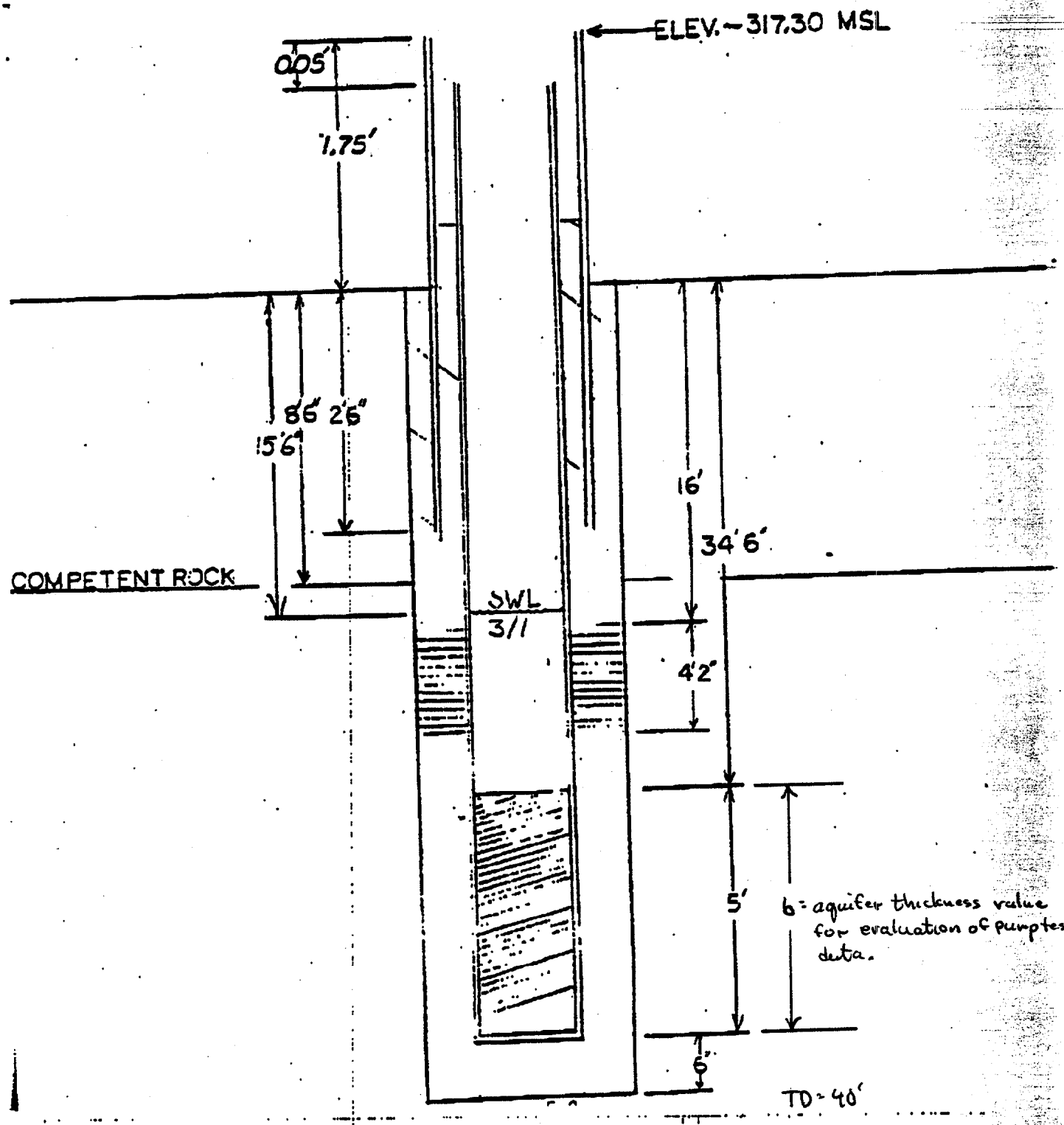
Discharge Data
How Q measured 5 gal. bucket
Depth of pump/air line 33.9 TOC
Previous pumping? Yes ____ No X
Duration _____ End _____

Comments on factors affecting test data

Date	Clock time	Time since pump started t	Time since pump stopped t'	t/t'		Water level measurement	Correction or Conversion	Ref. to 0.00 Water level	Water level change s or s'		Discharge measurement	Rate		Comments
8/11	1416							-.07				4 GPM		
	1438							-.11				3.9 GPM		
	1521							-.15				"		
	1611							-.29				"		
	1647							-.36				"		
	1742							-.48				"		
	1840							-.58				"		
	1945							-.67				"		
	2045							-.74				"		2103 Pump fail 1 min
	2145							-.79				"		Stop Test @ 2248
	2245							-.84				"		Start recovery (lo
	2252													@ 2252 (Test 1)
			39					-.85						
			42					-.85						
			52					-.85						

SMP-2

FIGURE F-3



WALTER B. SATTERTHWAITE ASSOCIATES, INC.

TABLE F-4

Well No.: SMP-2
Drilled: 2/23/84

DEPTH	DESCRIPTION
0-2	Yellow to brown clayey soil
2-6	Dark red clayey soil
6-8.5	Same as above with highly weathered red siltstone fragments.
8.5-16	Reddish brown to purple fine-grained, weathered sandstone to siltstone.
16-20	Red siltstone, some medium-grained purple sandstone and fine-grained dark gray sandstone.
20-23	Reddish-brown fine-grained sandstone, some purple to brown medium-grained sandstone.
23-30	Purple, fine-grained sandstones to siltstones.
30-33	Same as above with little medium-grained brown to yellow sandstone.
33-37	Brown to purple, medium-grained sandstone darker with depth.
37-39	Light purple to gray medium-grained sandstone.

TABLE F-3

DRILLING ADMINISTRATION

Project: Naval Air Development Center
Project No. 214-83B

Well SMP#2

Well Contractor: Rollin Raab & Son

Address: Warwick, PA **Phone:** 343-1277

Name of Driller: Dick Raab **Helper(s)** Harry Zimmerman

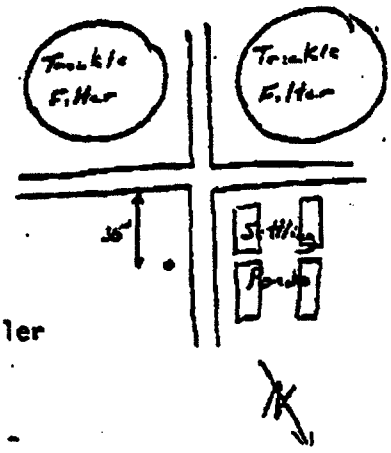
Rig: Number **Make** Denver-Gardner **Model** **Bar Length:** 20'

Reference Point: Top of Outer Casing = 317.30'MSL

Casing & Grouting Summary (Amounts, Lengths, diameters) 5' of #15 stainless steel Johnson well screen (4" dia.) set 6" off bottom of hole. Threaded to 36' of 4" steel casing 2.5' above ground level. Eight bags of sand used to pack hole up to 20'. 2.5 gals. bentonite made 50" seal.

Diary of Drilling

Date	Time	What Was Done & (Problems if Any)	Weather
2/23	3:30 pm	Drilling began.	
2/23	4:15 pm	Drilling completed to 40'. No water standing in bore hole. Driller decided to let hole sit overnight.	
2/24	10 am	Driller arrives	45°, rain tapering off.
2/24	11 am	Began blowing well. Much water produced at first. Well developed for 30 mins. producing roughly 3 gpm.	
2/24	11:30am	Well standing for one hour.	
2/24	11:45 am	temperature = 15°C specific conductivity = 340 mmhos	
2/24	12:30 pm	2.5 bags of cement used to grout hole to the surface. 5' of 6" protective steel casing set at 2.5'. Locking cap installed	



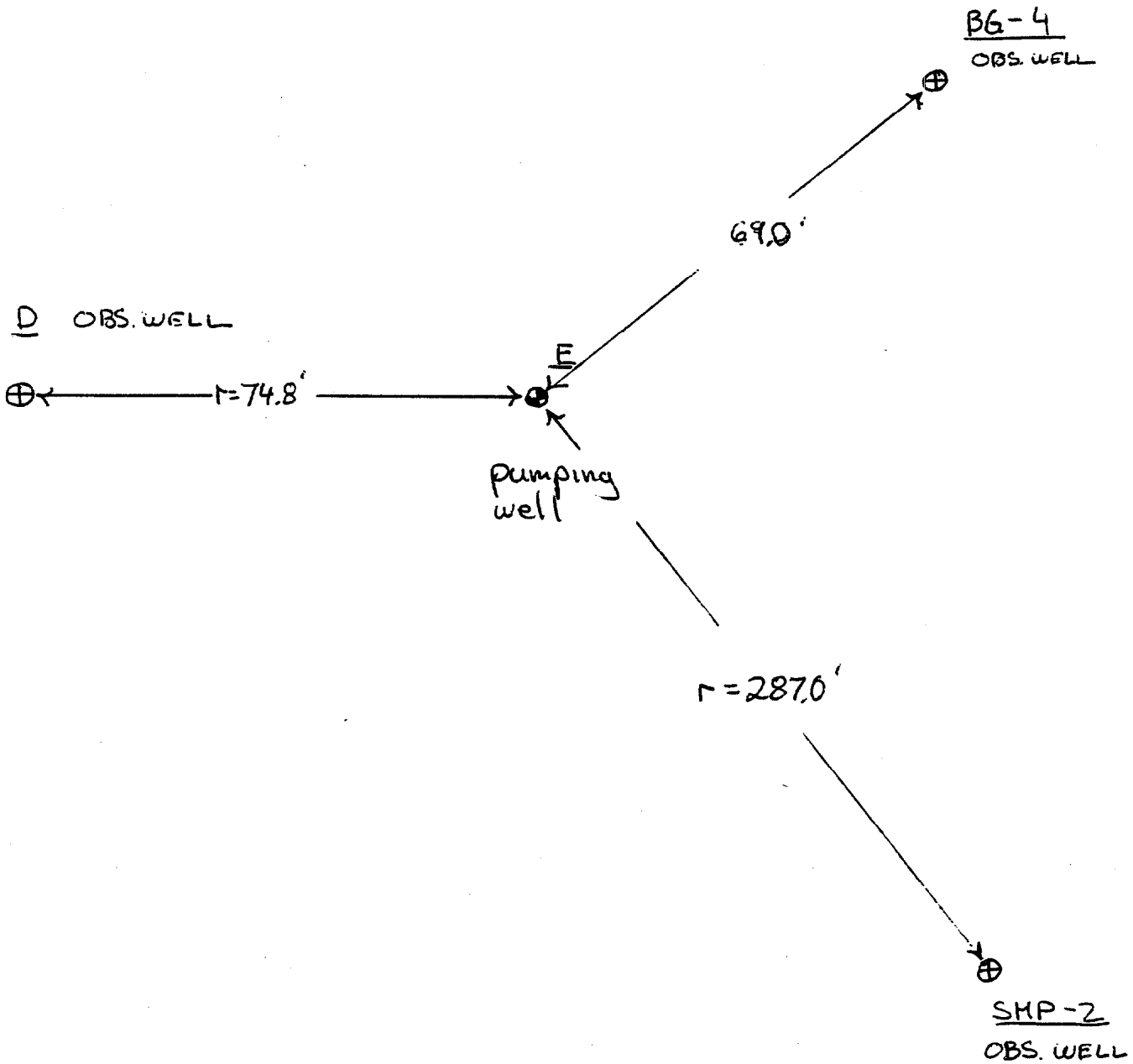
Cuttings:

Geologist: J. Roberts
Other Persons on Site: C. Miller

HALLIBURTON NUS Environmental Corporation and Subsidiaries	STANDARD CALCULATION SHEET

CLIENT: NAWC WARMINSTER	FILE NO.: 3933-0306	BY: FURAMSER	PAGE OF
SUBJECT: PUMP TEST DATA EVALUATION		CHECKED BY:	DATE:

Radial Distance Schematic



HALLIBURTON NUS Environmental Corporation and Subsidiaries	STANDARD CALCULATION SHEET

CLIENT:	FILE NO.:	BY:	PAGE / OF
INWC Warminster	3933-0306 ~~3933-0306~~ FR2	JWRamsey	
SUBJECT: Pump test Data evaluation (obs well SMP-2)		CHECKED BY: Eje 9/28/92	DATE: 9-17-92

I Objective: To calculate transmissivity "T", Storativity "S" and hydraulic conductivity "K" using the W. C. Walton method of curve matching overlay procedures for a semi-confined aquifer. This procedure allows for the determination of formation constants for both the aquifer and the semi pervious layer. Fetter pg 182, 183 (1988).

II Procedure: Drawdown vs time data are plotted on log-log paper. Overlay matched to type curves for leaky confined aquifer with no storage in the confining layer (after Hantush + Jacob, 1955

$$W(u, r/B) = \frac{4\pi T \Delta(h_0 - h)}{Q} \quad , \quad \frac{1}{u} = \frac{4Tt}{r^2 S}$$

$$K' = \frac{T b' (r/B)^2}{r^2}$$

where, K' = vertical conductivity of semi pervious layer

b' = thickness of semi pervious layer

$$K = T/b$$

III calculations:

From field data: $Q = 3.9$ gpm, $r = 287$ feet

From Overlay plot: $t = 141$ min, $\Delta(h_0 - h) = .82$ feet

$W(u, r/B) = 1$, $1/u = 1$

r/B is not determined due to a lack of datum points.

HALLIBURTON NUS Environmental Corporation and Subsidiaries			STANDARD CALCULATION SHEET
CLIENT: UAVC Warminster	FILE NO.: ~~2933-0306~~ 3933-0306	BY: JRamos	PAGE 2 OF
SUBJECT: Pumptest data evaluation, obs well SMP-2		CHECKED BY: 9/28/92	DATE: 9-17-92

III calculations (continued)

1) $W(u, r/B) = \frac{4\pi T \Delta(h_o - h)}{Q}$ $\qquad Q = 3.9 \frac{gal}{min} \times .1337 \frac{ft^3}{gal} = .5214 \frac{ft^3}{min}$

$T = \frac{Q}{4\pi \Delta(h_o - h)} W(u, r/B)$

sub. $T = \frac{.5214\ ft^3/min}{4\pi(.82\ ft)}$

$\boxed{T = 0.0506 \frac{ft^2}{min}}$ $\qquad T = 7.8 \times 10^{-1} \frac{cm^2}{sec}$

2) $\frac{1}{u} = \frac{4Tt}{r^2 S}$

$S = \frac{4Tt}{r^2}(u)$

sub. $S = \frac{4(0.0506 \frac{ft^2}{min})(14\ min)}{(287\ ft)^2}$

$\boxed{S = 0.0003}$

3) $K = T/b$ $\qquad b = 59\ ft$

$K = \frac{.0506\ ft^2/min}{59\ ft}$

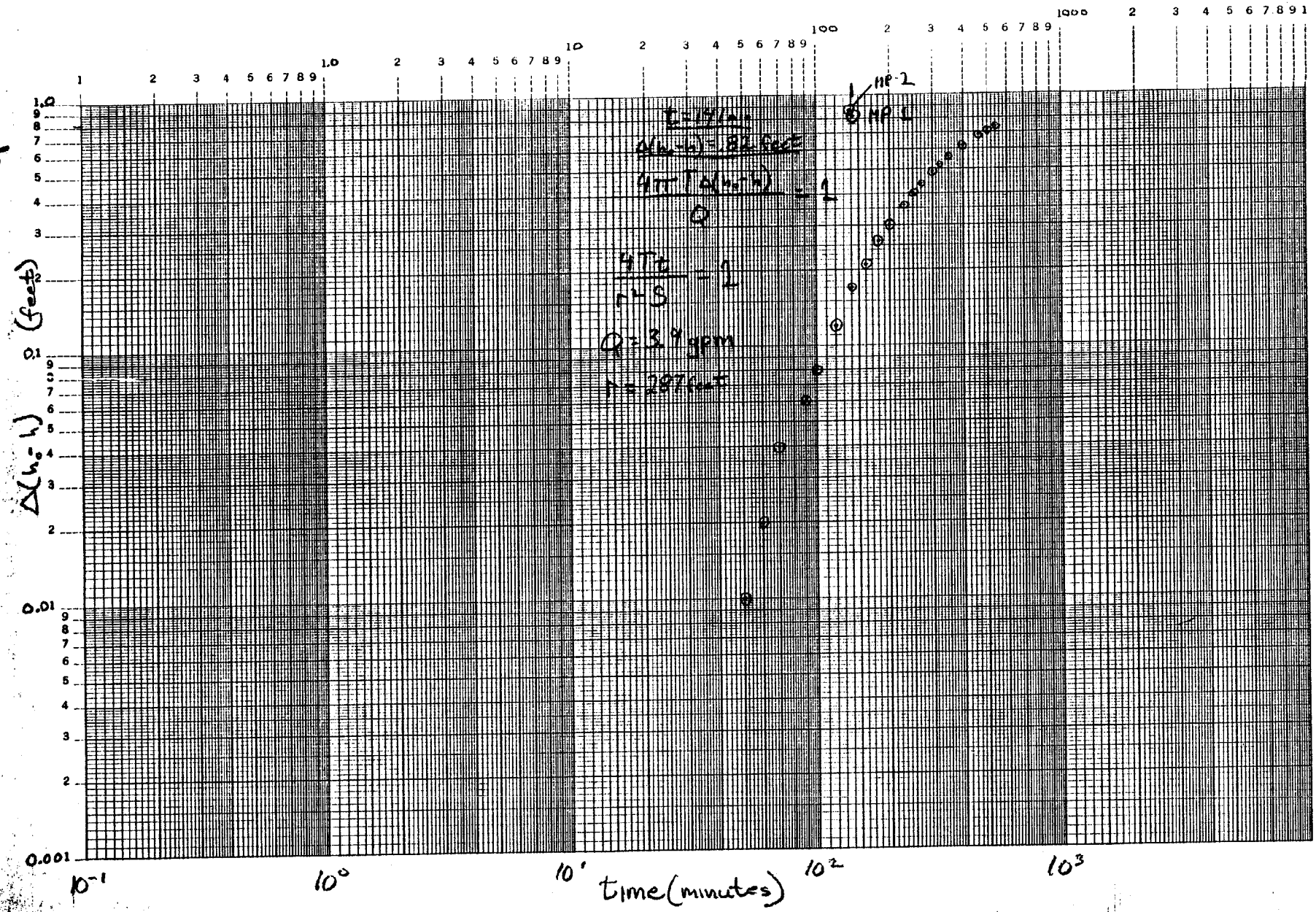
$K = 8.6 \times 10^{-4}\ ft/min$

$K = 4.4 \times 10^{-4}\ cm/sec$

K+E LOGARITHMIC 3 x 5 CYCLES
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 7522

NAWC Warminster Pump test Pumping well E; Observation well · SMP-2 Graph



Plotted By FWRamser

HALLIBURTON NUS Environmental Corporation and Subsidiaries			STANDARD CALCULATION SHEET
CLIENT: NAWC Warminster	FILE NO.: 3933-0306 ~~2933-0306~~	BY: FURamser	PAGE 4 OF
SUBJECT: Pump test Data Evaluation (Obs well SMP-2)		CHECKED BY: Eye 9/29/92	DATE: 9-17-92

I Objective: To calculate transmissivity "T", storativity "S" and Hydraulic conductivity "K" using the Cooper-Jacob straight line method.* (from Fetter 1988 pg 170)

II Procedure: Observation well SMP-2 data plotted on semi-log paper to derive values for "t_o" and $\Delta(h_o - h)$

III Calculations:

Known field data: $Q = 3.9$ gpm, $r = 287$ feet

* Eq. $T = \frac{2.3Q}{4\pi\Delta(h_o - h)}$ $S = \frac{2.25 T t_o}{r^2}$ $K = T/b$

where $Q = 3.9 \frac{gal}{min} \times \frac{.1337 ft^3}{gal} = 0.5214 \, ft^3/min$

$r = 287$ ft

from plot: $\Delta(h_o - h) = 1.055$ ft $t_o = 105$ min

1) $T = \frac{2.3Q}{4\pi\Delta(h_o - h)}$ 2) $S = \frac{2.25 T t_o}{r^2}$

sub. $T = \frac{2.3(.5214 \, ft^3/min)}{4\pi(1.055 \, ft)}$ sub. $S = \frac{2.25(0.0905 \, ft^2/min)(105 \, min)}{(287)^2}$

$\boxed{T = 0.0905 \, ft^2/min}$ $T = 1.4 \frac{cm^2}{sec}$ $\boxed{S = 0.0003}$

3) Check t (time required for adaquate pump test based on assumptions for Cooper-Jacob straight line)

where $t = \frac{r^2 S}{4Tu}$ let $u = 0.1$

HALLIBURTON NUS Environmental Corporation and Subsidiaries	STANDARD CALCULATION SHEET

CLIENT: NAVY Warminster	FILE NO.: 3933-0306	BY: JRanson	PAGE 5 OF
SUBJECT: Pumptest Data Evaluation (Obs well STP-2)		CHECKED BY: GJK 9/28/92	DATE: 9-17-92

3) Check t (continued)

$$t = \frac{r^2 S}{4Tu} \quad \text{let } u = 0.1$$

sub.

$$t = \frac{(287\,ft)^2(0.0003)}{4(0.0905\,ft^2/min)(0.1)}$$

$$t = 682.6 \text{ min}$$

4) $K = T/b$ where $b = 59\,ft$

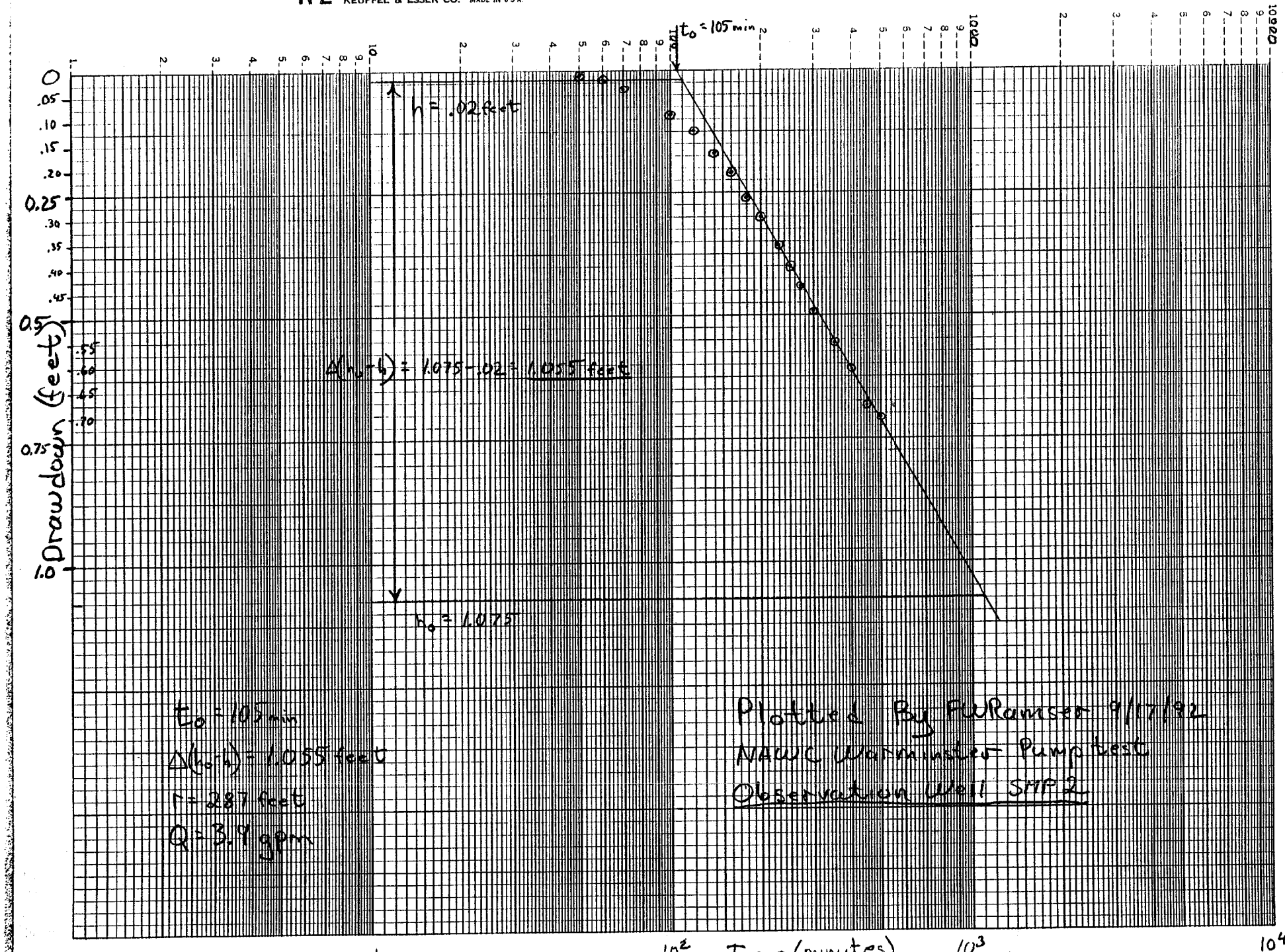
sub $K = \frac{.0905\,ft^2/min}{59\,ft} =$

$$K = 1.5 \times 10^{-3}\,ft/min$$

$$K = 7.8 \times 10^{-4}\,cm/sec$$

K+E SEMI-LOGARITHMIC 4 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 6010



pg 6

SE1000B
Environmental Logger
08/12 09:44

Unit# 40020 Test# 0

INPUT 2: Level (F)

Reference 0.00
Scale factor 10.01
Offset - 0.04

Step# 0 08/11 13:45

Obs. well SMP-2 Drawdown data

Elapsed Time	Value
0.0000	-0.10
10.0000	-0.12
20.0000	-0.04
30.0000	-0.07
40.0000	-0.09
50.0000	* -0.11
60.0000	-0.12
70.0000	-0.14
80.0000	-0.13
90.0000	-0.16
100.000	-0.18
110.000	-0.17
120.000	-0.22
130.000	-0.25
140.000	-0.27
150.000	-0.29
160.000	-0.31
170.000	-0.34
180.000	-0.36
190.000	-0.38
200.000	-0.40
210.000	-0.42
220.000	-0.44
230.000	-0.46
240.000	-0.48
250.000	-0.50
260.000	-0.52
270.000	-0.54
280.000	-0.55
290.000	-0.57
300.000	-0.59
310.000	-0.60
320.000	-0.62
330.000	-0.63
340.000	-0.65
350.000	-0.66
360.000	-0.67
370.000	-0.69
380.000	-0.70
390.000	-0.71
400.000	-0.72
410.000	-0.73
420.000	-0.74
430.000	-0.75
440.000	-0.76
450.000	-0.77
460.000	-0.78
470.000	-0.79
480.000	-0.80
490.000	-0.80
500.000	-0.81
510.000	-0.82
520.000	-0.83
530.000	-0.83
540.000	-0.84

* All values adjusted by subtracting .10 for plots from absolute values of drawdown.

OBS. well SMP-2
Recovery Data

SE1000B
Environmental Logger
08/12 09:18

Unit# 40020 Test# 1

INPUT 2: Level (F)

Reference 0.00
Scale factor 10.01
Offset - 0.04

Step# 0 08/11 22:52

Elapsed Time	Value
0.0000	-0.84
0.0033	-0.84
0.0066	-0.84
0.0099	-0.84
0.0133	-0.84
0.0166	-0.84
0.0200	-0.84
0.0233	-0.84
0.0266	-0.84
0.0300	-0.84
0.0333	-0.84
0.0500	-0.84
0.0666	-0.84
0.0833	-0.84
0.1000	-0.84
0.1166	-0.84
0.1333	-0.84
0.1500	-0.84
0.1666	-0.84
0.1833	-0.84
0.2000	-0.84
0.2166	-0.84
0.2333	-0.84
0.2500	-0.84
0.2666	-0.84
0.2833	-0.84
0.3000	-0.84
0.3166	-0.84
0.3333	-0.84
0.4167	-0.84
0.5000	-0.84
0.5833	-0.84
0.6667	-0.84
0.7500	-0.84
0.8333	-0.84
0.9167	-0.84
1.0000	-0.84
1.0833	-0.84
1.1667	-0.84
1.2500	-0.84
1.3333	-0.84
1.4166	-0.84
1.5000	-0.84
1.5833	-0.84
1.6667	-0.84
1.7500	-0.84
1.8333	-0.84
1.9167	-0.84
2.0000	-0.84
2.5000	-0.85
3.0000	-0.84
3.5000	-0.84
4.0000	-0.84
4.5000	-0.84
5.0000	-0.85
5.5000	-0.84
6.0000	-0.84
6.5000	-0.84
7.0000	-0.84
7.5000	-0.84
8.0000	-0.84
8.5000	-0.84
9.0000	-0.84
9.5000	-0.85
10.0000	-0.84
12.0000	-0.85
14.0000	-0.85
16.0000	-0.85
18.0000	-0.85
20.0000	-0.85
22.0000	-0.85

SMP-2
Recovery data

24.0000	-0.85
26.0000	-0.85
28.0000	-0.85
30.0000	-0.85
32.0000	-0.85
34.0000	-0.85
36.0000	-0.85
38.0000	-0.85
40.0000	-0.85
42.0000	-0.85
44.0000	-0.85
46.0000	-0.85
48.0000	-0.85
50.0000	-0.85
52.0000	-0.85
54.0000	-0.85
56.0000	-0.85
58.0000	-0.85
60.0000	-0.85
62.0000	-0.85
64.0000	-0.85
66.0000	-0.85
68.0000	-0.85
70.0000	-0.85
72.0000	-0.85
74.0000	-0.84
76.0000	-0.84
78.0000	-0.84
80.0000	-0.84
82.0000	-0.84
84.0000	-0.84
86.0000	-0.83
88.0000	-0.83
90.0000	-0.83
92.0000	-0.83
94.0000	-0.83
96.0000	-0.82
98.0000	-0.82
100.000	-0.82
110.000	-0.81
120.000	-0.80
130.000	-0.78
140.000	-0.77
150.000	-0.75
160.000	-0.74
170.000	-0.72
180.000	-0.70
190.000	-0.69
200.000	-0.67
210.000	-0.65
220.000	-0.63
230.000	-0.62
240.000	-0.60
250.000	-0.58
260.000	-0.55
270.000	-0.54
280.000	-0.52
290.000	-0.51
300.000	-0.49
310.000	-0.47
320.000	-0.46
330.000	-0.44
340.000	-0.43
350.000	-0.41
360.000	-0.39
370.000	-0.38
380.000	-0.38
390.000	-0.36
400.000	-0.34
410.000	-0.33
420.000	-0.31
430.000	-0.31
440.000	-0.30
450.000	-0.29
460.000	-0.27
470.000	-0.26
480.000	-0.26
490.000	-0.25
500.000	-0.24
510.000	-0.22
520.000	-0.18
530.000	-0.13
540.000	-0.06

WELL C

OBSERVATION WELL

PUMP TEST H_2O LEVELS/PLOTS
(ADDRESSES COMMENT # 2)

WELL-C PUMPING PHASE
SE1000C
Environmental Logger
08/12 08:40

Unit# 00731 Test 0

Setups: INPUT 2

Type	Level (F)
Mode	Surface
I.D.	00300

Reference	0.000
Linearity	0.000
Scale factor	10.020
Offset	0.000
Delay mSEC	50.000

Step 0 08/11 13:45:20

Elapsed Time INPUT 2 (continued)

0.0000	-0.123	270.000	-0.259
10.0000	-0.120	280.000	-0.259
20.0000	-0.053	290.000	-0.265
30.0000	-0.085	300.000	-0.265
40.0000	-0.104	310.000	-0.268
50.0000	-0.120	320.000	-0.272
60.0000	-0.132	330.000	-0.272
70.0000	-0.142	340.000	-0.275
80.0000	-0.142	350.000	-0.275
90.0000	-0.155	360.000	-0.278
100.000	-0.164	370.000	-0.278
110.000	-0.158	380.000	-0.278
120.000	-0.180	390.000	-0.281
130.000	-0.196	400.000	-0.284
140.000	-0.205	410.000	-0.281
150.000	-0.205	420.000	-0.284
160.000	-0.215	430.000	-0.284
170.000	-0.221	440.000	-0.287
180.000	-0.227	450.000	-0.287
190.000	-0.230	460.000	-0.287
200.000	-0.237	470.000	-0.287
210.000	-0.240	480.000	-0.291
220.000	-0.243	490.000	-0.291
230.000	-0.249	500.000	-0.291
240.000	-0.253	510.000	-0.291
250.000	-0.253	520.000	-0.291
260.000	-0.259	530.000	-0.291
		540.000	-0.291

WELL-C RECOVERY PHASE
SE1000C
Environmental Logger
08/12 08:41

Unit# 00731 Test 1

Setups: INPUT 2
--- ---
Type Level (F)
Mode Surface
I.D. 00300

Reference 0.000
Linearity 0.000
Scale factor 10.020
Offset 0.000
Delay mSEC 50.000

Step 0 08/11 22:52:38

Elapsed Time INPUT 2
--- ---

0.0000	-0.294
0.0033	-0.294
0.0066	-0.294
0.0100	-0.294
0.0133	-0.294
0.0166	-0.294
0.0200	-0.294
0.0233	-0.294
0.0266	-0.294
0.0300	-0.294
0.0333	-0.294
0.0366	-0.294
0.0400	-0.294
0.0433	-0.294
0.0466	-0.294
0.0500	-0.294
0.0533	-0.294
0.0566	-0.294
0.0600	-0.294
0.0633	-0.294
0.0666	-0.294
0.0700	-0.294
0.0733	-0.294
0.0766	-0.294
0.0800	-0.294
0.0833	-0.294
0.0866	-0.294

(cont.)

0.0900	-0.294
0.0933	-0.294
0.0966	-0.294
0.1000	-0.294
0.1033	-0.294
0.1066	-0.294
0.1100	-0.294
0.1133	-0.294
0.1166	-0.294
0.1200	-0.294
0.1233	-0.294
0.1266	-0.294
0.1300	-0.294
0.1333	-0.294
0.1366	-0.294
0.1400	-0.294
0.1433	-0.294
0.1466	-0.294
0.1500	-0.294
0.1533	-0.294
0.1566	-0.294
0.1600	-0.294
0.1633	-0.294
0.1666	-0.294
0.1700	-0.294
0.1733	-0.294
0.1766	-0.294
0.1800	-0.294
0.1833	-0.294
0.1866	-0.294
0.1900	-0.294
0.1933	-0.294
0.1966	-0.294
0.2000	-0.294
0.2033	-0.294
0.2066	-0.294
0.2100	-0.294
0.2133	-0.294
0.2166	-0.294
0.2200	-0.294
0.2233	-0.294
0.2266	-0.294
0.2300	-0.294
0.2333	-0.294
0.2366	-0.294
0.2400	-0.294
0.2433	-0.294
0.2466	-0.294
0.2500	-0.294

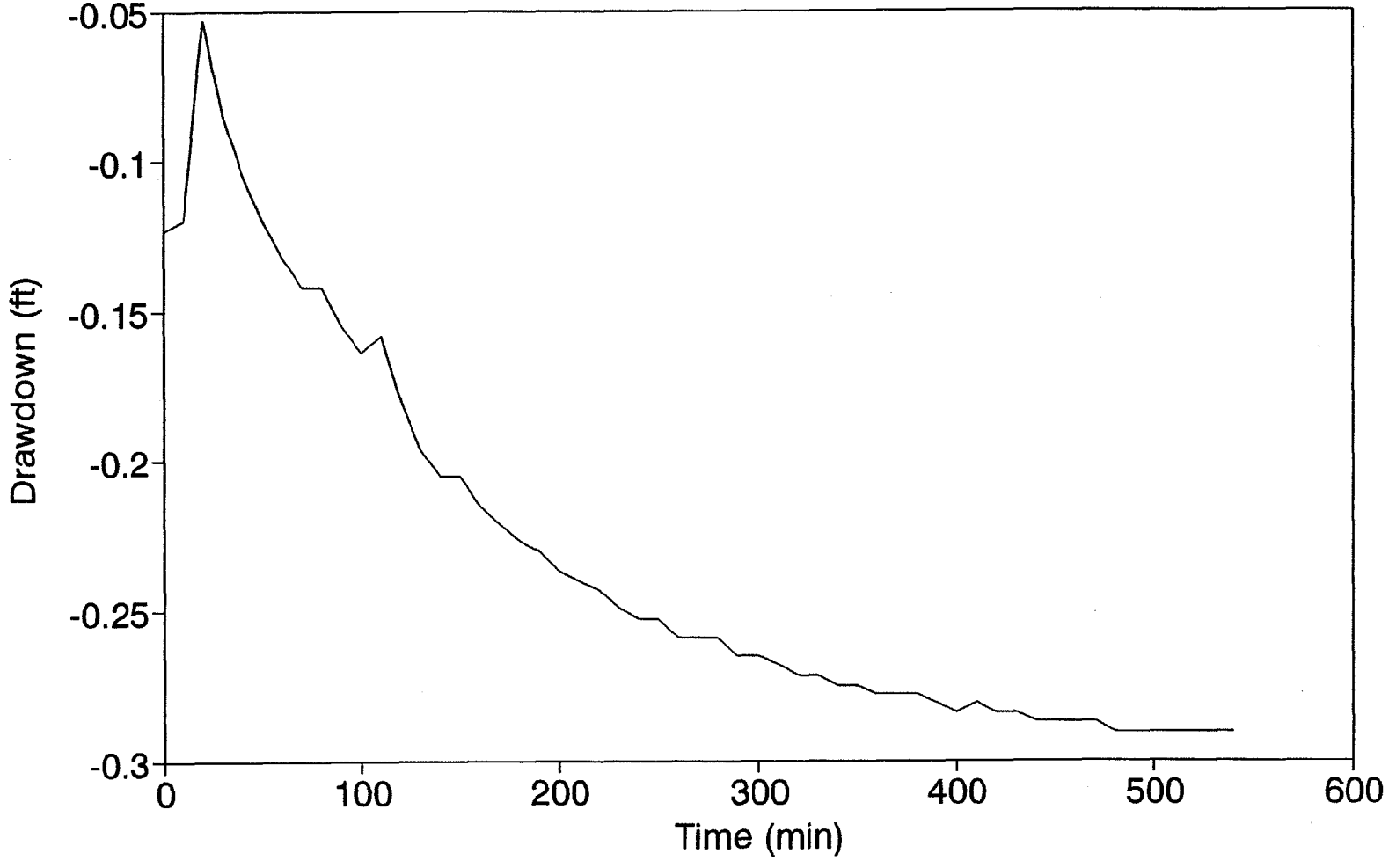
(cont.)

0.2533	-0.294
0.2566	-0.294
0.2600	-0.294
0.2633	-0.294
0.2666	-0.294
0.2700	-0.294
0.2733	-0.294
0.2766	-0.294
0.2800	-0.294
0.2833	-0.294
0.2866	-0.294
0.2900	-0.294
0.2933	-0.294
0.2966	-0.294
0.3000	-0.294
0.3033	-0.294
0.3066	-0.294
0.3100	-0.294
0.3133	-0.294
0.3166	-0.294
0.3200	-0.294
0.3233	-0.294
0.3266	-0.294
0.3300	-0.294
0.3333	-0.294
0.3500	-0.294
0.3666	-0.294
0.3833	-0.294
0.4000	-0.294
0.4166	-0.294
0.4333	-0.294
0.4500	-0.294
0.4666	-0.294
0.4833	-0.294
0.5000	-0.294
0.5166	-0.294
0.5333	-0.294
0.5500	-0.294
0.5666	-0.294
0.5833	-0.294
0.6000	-0.294
0.6166	-0.294
0.6333	-0.294
0.6500	-0.294
0.6666	-0.294
0.6833	-0.294
0.7000	-0.294
0.7166	-0.294
0.7333	-0.294

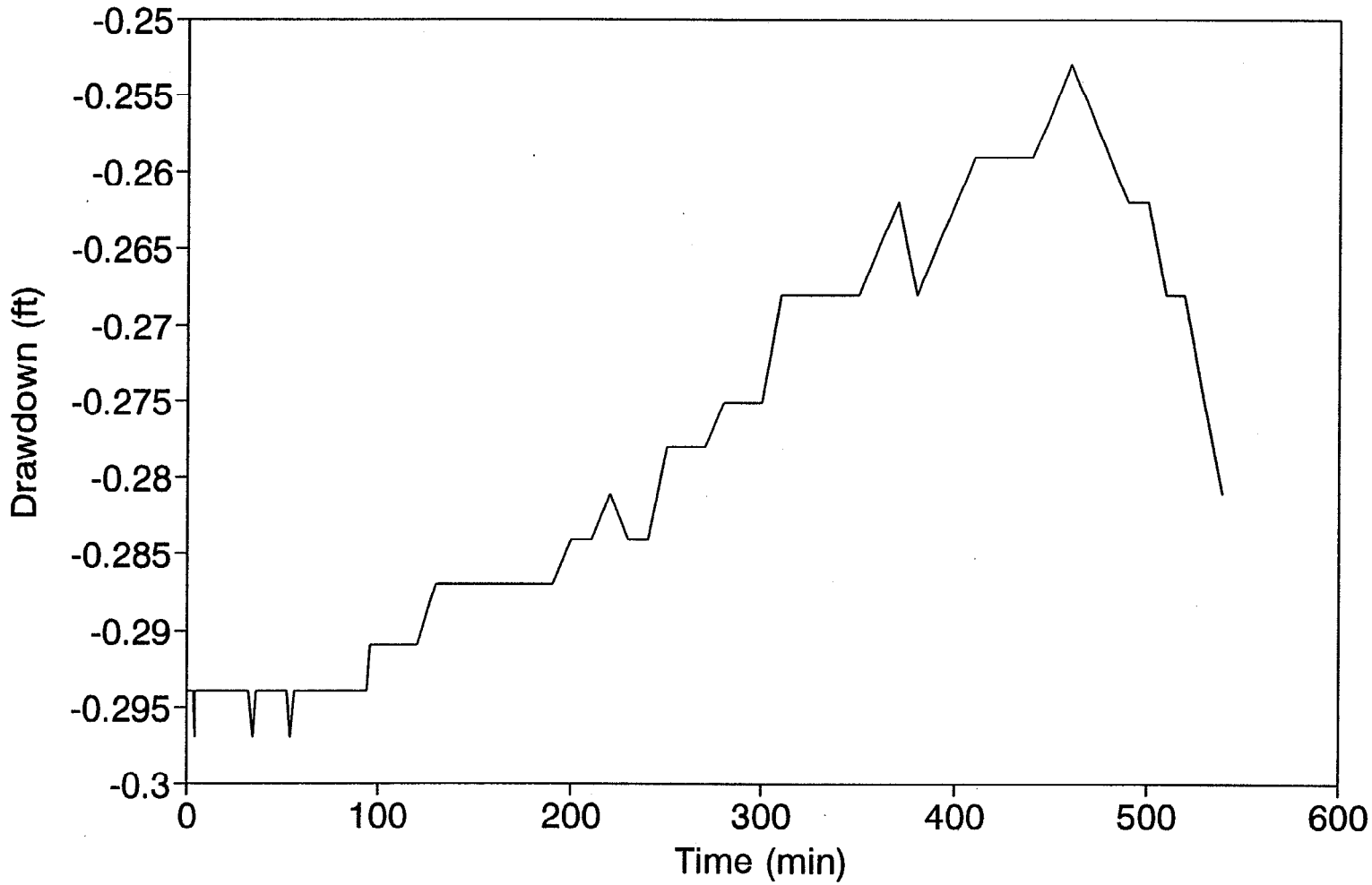
WELL-C RECOVERY PHASE

		(cont.)		(cont.)		(cont.)	
0.7500	-0.294	7.8000	-0.294	86.0000	-0.294	520.000	-0.268
0.7666	-0.294	8.0000	-0.294	88.0000	-0.294	530.000	-0.275
0.7833	-0.294	8.2000	-0.294	90.0000	-0.294	540.000	-0.281
0.8000	-0.294	8.4000	-0.294	92.0000	-0.294		
0.8166	-0.294	8.6000	-0.294	94.0000	-0.294		
0.8333	-0.294	8.8000	-0.294	96.0000	-0.291		
0.8500	-0.294	9.0000	-0.294	98.0000	-0.291		
0.8666	-0.294	9.2000	-0.294	100.000	-0.291		
0.8833	-0.294	9.4000	-0.294	110.000	-0.291		
0.9000	-0.294	9.6000	-0.294	120.000	-0.291		
0.9166	-0.294	9.8000	-0.294	130.000	-0.287		
0.9333	-0.294	10.0000	-0.294	140.000	-0.287		
0.9500	-0.294	12.0000	-0.294	150.000	-0.287		
0.9666	-0.294	14.0000	-0.294	160.000	-0.287		
0.9833	-0.294	16.0000	-0.294	170.000	-0.287		
1.0000	-0.294	18.0000	-0.294	180.000	-0.287		
1.2000	-0.294	20.0000	-0.294	190.000	-0.287		
1.4000	-0.294	22.0000	-0.294	200.000	-0.284		
1.6000	-0.294	24.0000	-0.294	210.000	-0.284		
1.8000	-0.294	26.0000	-0.294	220.000	-0.281		
2.0000	-0.294	28.0000	-0.294	230.000	-0.284		
2.2000	-0.294	30.0000	-0.294	240.000	-0.284		
2.4000	-0.294	32.0000	-0.294	250.000	-0.278		
2.6000	-0.294	34.0000	-0.297	260.000	-0.278		
2.8000	-0.294	36.0000	-0.294	270.000	-0.278		
3.0000	-0.294	38.0000	-0.294	280.000	-0.275		
3.2000	-0.294	40.0000	-0.294	290.000	-0.275		
3.4000	-0.294	42.0000	-0.294	300.000	-0.275		
3.6000	-0.294	44.0000	-0.294	310.000	-0.268		
3.8000	-0.294	46.0000	-0.294	320.000	-0.268		
4.0000	-0.294	48.0000	-0.294	330.000	-0.268		
4.2000	-0.297	50.0000	-0.294	340.000	-0.268		
4.4000	-0.294	52.0000	-0.294	350.000	-0.268		
4.6000	-0.297	54.0000	-0.297	360.000	-0.265		
4.8000	-0.294	56.0000	-0.294	370.000	-0.262		
5.0000	-0.294	58.0000	-0.294	380.000	-0.268		
5.2000	-0.294	60.0000	-0.294	390.000	-0.265		
5.4000	-0.294	62.0000	-0.294	400.000	-0.262		
5.6000	-0.294	64.0000	-0.294	410.000	-0.259		
5.8000	-0.294	66.0000	-0.294	420.000	-0.259		
6.0000	-0.294	68.0000	-0.294	430.000	-0.259		
6.2000	-0.294	70.0000	-0.294	440.000	-0.259		
6.4000	-0.294	72.0000	-0.294	450.000	-0.256		
6.6000	-0.294	74.0000	-0.294	460.000	-0.253		
6.8000	-0.294	76.0000	-0.294	470.000	-0.256		
7.0000	-0.294	78.0000	-0.294	480.000	-0.259		
7.2000	-0.294	80.0000	-0.294	490.000	-0.262		
7.4000	-0.294	82.0000	-0.294	500.000	-0.262		
7.6000	-0.294	84.0000	-0.294	510.000	-0.268		

Well C - Pumping Data



Well C - Recovery Data



WELL DG-1 PUMPING PHASE
SE1000C
Environmental Logger
08/12 08:34

Unit# 00731 Test 0

Setups: INPUT 1

Type	Level (F)
Mode	Surface
I.D.	00010

Reference	0.000
Linearity	0.000
Scale factor	10.010
Offset	-0.130
Delay mSEC	50.000

Step 0 08/11 13:45:20

Elapsed Time INPUT 1 (continued)

0.0000	-0.006	270.000	-0.006
10.0000	-0.009	280.000	-0.006
20.0000	0.028	290.000	-0.009
30.0000	0.015	300.000	-0.009
40.0000	0.009	310.000	-0.009
50.0000	0.003	320.000	-0.009
60.0000	0.000	330.000	-0.009
70.0000	0.003	340.000	-0.009
80.0000	0.009	350.000	-0.009
90.0000	0.003	360.000	-0.006
100.000	0.000	370.000	-0.009
110.000	0.009	380.000	-0.009
120.000	-0.006	390.000	-0.009
130.000	-0.003	400.000	-0.012
140.000	-0.006	410.000	-0.012
150.000	0.003	420.000	-0.012
160.000	0.000	430.000	-0.012
170.000	-0.003	440.000	-0.012
180.000	-0.003	450.000	-0.012
190.000	-0.006	460.000	-0.012
200.000	-0.006	470.000	-0.015
210.000	-0.003	480.000	-0.009
220.000	-0.006	490.000	-0.015
230.000	-0.003	500.000	-0.015
240.000	-0.006	510.000	-0.009
250.000	-0.003	520.000	-0.009
260.000	-0.006	530.000	-0.009
		540.000	-0.006

WELL DG-1

OBSERVATION WELL

WELL DG-1 RECOVERY PHASE (cont.)

SE1000C

Environmental Logger

08/12 08:36

Unit# 00731 Test 1

Setups: INPUT 1

--- ---

Type Level (F)

Mode Surface

I.D. 00010

Reference 0.000

Linearity 0.000

Scale factor 10.010

Offset -0.130

Delay mSEC 50.000

Step 0 08/11 22:52:38

Elapsed Time INPUT 1

--- ---

0.0000	0.000
0.0033	0.000
0.0066	0.000
0.0100	0.000
0.0133	0.000
0.0166	0.000
0.0200	0.000
0.0233	0.000
0.0266	0.000
0.0300	0.000
0.0333	0.000
0.0366	0.000
0.0400	0.000
0.0433	0.000
0.0466	0.000
0.0500	0.000
0.0533	0.000
0.0566	0.000
0.0600	0.000
0.0633	0.000
0.0666	-0.003
0.0700	0.000
0.0733	0.000
0.0766	-0.003
0.0800	0.000
0.0833	0.000
0.0866	0.000

(cont.)

0.0900	0.000
0.0933	-0.003
0.0966	0.000
0.1000	-0.003
0.1033	-0.003
0.1066	0.000
0.1100	-0.003
0.1133	0.000
0.1166	0.000
0.1200	0.000
0.1233	0.000
0.1266	0.000
0.1300	0.000
0.1333	-0.003
0.1366	0.000
0.1400	0.000
0.1433	0.000
0.1466	-0.003
0.1500	-0.003
0.1533	-0.003
0.1566	-0.003
0.1600	-0.003
0.1633	0.000
0.1666	-0.003
0.1700	-0.003
0.1733	-0.003
0.1766	-0.003
0.1800	-0.003
0.1833	-0.003
0.1866	-0.003
0.1900	-0.003
0.1933	-0.003
0.1966	0.000
0.2000	-0.003
0.2033	-0.003
0.2066	-0.003
0.2100	-0.003
0.2133	-0.003
0.2166	-0.003
0.2200	-0.003
0.2233	-0.003
0.2266	-0.003
0.2300	-0.003
0.2333	-0.003
0.2366	-0.003
0.2400	-0.003
0.2433	0.000
0.2466	-0.003
0.2500	0.000

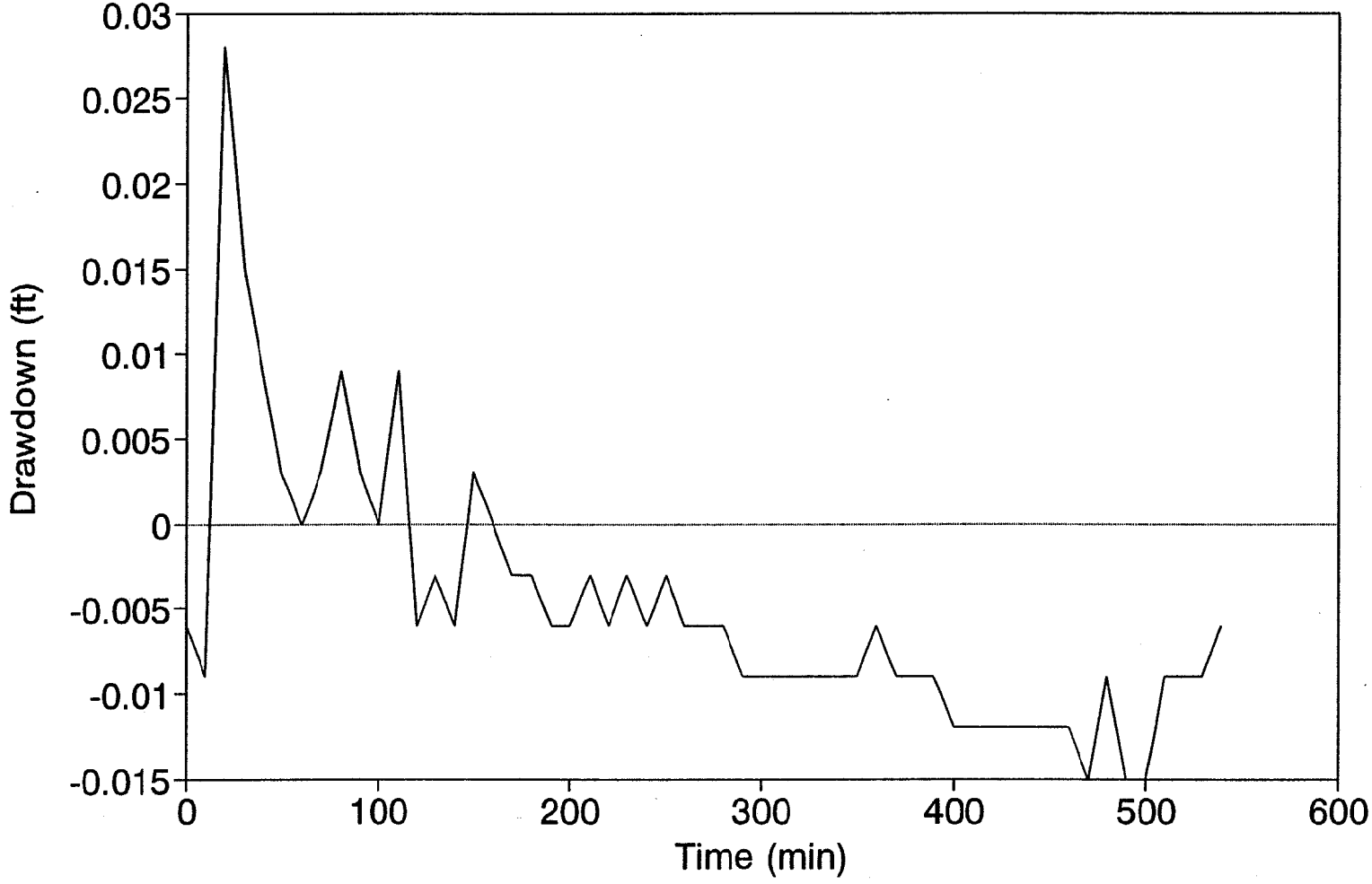
(cont.)

0.2533	-0.003
0.2566	-0.003
0.2600	-0.003
0.2633	-0.003
0.2666	-0.003
0.2700	-0.003
0.2733	-0.003
0.2766	-0.003
0.2800	-0.003
0.2833	-0.003
0.2866	-0.003
0.2900	-0.003
0.2933	-0.003
0.2966	-0.003
0.3000	-0.003
0.3033	-0.003
0.3066	-0.003
0.3100	-0.003
0.3133	-0.003
0.3166	-0.003
0.3200	-0.003
0.3233	-0.003
0.3266	-0.003
0.3300	-0.003
0.3333	-0.003
0.3500	-0.003
0.3666	-0.003
0.3833	-0.003
0.4000	-0.003
0.4166	-0.003
0.4333	-0.003
0.4500	-0.003
0.4666	-0.003
0.4833	-0.003
0.5000	-0.003
0.5166	-0.003
0.5333	-0.003
0.5500	-0.003
0.5666	-0.003
0.5833	-0.003
0.6000	-0.003
0.6166	-0.003
0.6333	-0.003
0.6500	-0.003
0.6666	-0.003
0.6833	-0.003
0.7000	-0.003
0.7166	-0.003
0.7333	-0.003

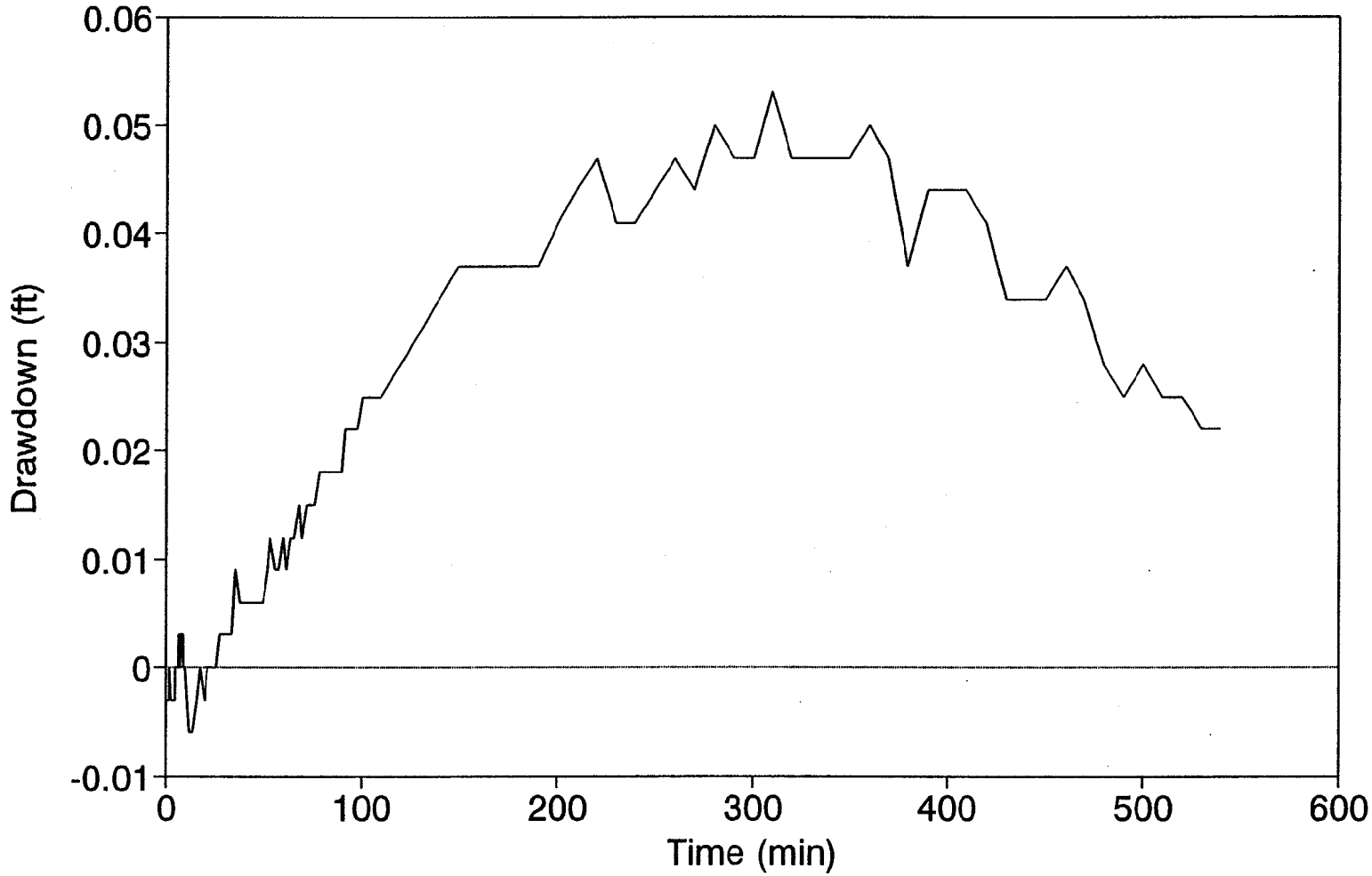
WELL DG-1 RECOVERY PHASE (cont.) (cont.) (cont.)

0.7500	-0.003	7.8000	0.003	86.0000	0.018	520.000	0.025
0.7666	-0.003	8.0000	0.003	88.0000	0.018	530.000	0.022
0.7833	-0.003	8.2000	0.003	90.0000	0.018	540.000	0.022
0.8000	-0.003	8.4000	0.003	92.0000	0.022		
0.8166	-0.003	8.6000	0.003	94.0000	0.022		
0.8333	-0.003	8.8000	0.000	96.0000	0.022		
0.8500	-0.003	9.0000	0.003	98.0000	0.022		
0.8666	-0.003	9.2000	0.000	100.000	0.025		
0.8833	-0.003	9.4000	0.000	110.000	0.025		
0.9000	-0.003	9.6000	0.000	120.000	0.028		
0.9166	-0.003	9.8000	0.000	130.000	0.031		
0.9333	-0.003	10.0000	0.000	140.000	0.034		
0.9500	-0.003	12.0000	-0.006	150.000	0.037		
0.9666	-0.003	14.0000	-0.006	160.000	0.037		
0.9833	-0.003	16.0000	-0.003	170.000	0.037		
1.0000	-0.003	18.0000	0.000	180.000	0.037		
1.2000	-0.003	20.0000	-0.003	190.000	0.037		
1.4000	-0.003	22.0000	0.000	200.000	0.041		
1.6000	-0.003	24.0000	0.000	210.000	0.044		
1.8000	0.000	26.0000	0.000	220.000	0.047		
2.0000	-0.003	28.0000	0.003	230.000	0.041		
2.2000	0.000	30.0000	0.003	240.000	0.041		
2.4000	-0.003	32.0000	0.003	250.000	0.044		
2.6000	-0.003	34.0000	0.003	260.000	0.047		
2.8000	-0.003	36.0000	0.009	270.000	0.044		
3.0000	-0.003	38.0000	0.006	280.000	0.050		
3.2000	-0.003	40.0000	0.006	290.000	0.047		
3.4000	-0.003	42.0000	0.006	300.000	0.047		
3.6000	-0.003	44.0000	0.006	310.000	0.053		
3.8000	-0.003	46.0000	0.006	320.000	0.047		
4.0000	-0.003	48.0000	0.006	330.000	0.047		
4.2000	-0.003	50.0000	0.006	340.000	0.047		
4.4000	-0.003	52.0000	0.009	350.000	0.047		
4.6000	-0.003	54.0000	0.012	360.000	0.050		
4.8000	-0.003	56.0000	0.009	370.000	0.047		
5.0000	-0.003	58.0000	0.009	380.000	0.037		
5.2000	0.000	60.0000	0.012	390.000	0.044		
5.4000	0.000	62.0000	0.009	400.000	0.044		
5.6000	0.000	64.0000	0.012	410.000	0.044		
5.8000	0.000	66.0000	0.012	420.000	0.041		
6.0000	0.000	68.0000	0.015	430.000	0.034		
6.2000	0.000	70.0000	0.012	440.000	0.034		
6.4000	0.000	72.0000	0.015	450.000	0.034		
6.6000	0.000	74.0000	0.015	460.000	0.037		
6.8000	0.000	76.0000	0.015	470.000	0.034		
7.0000	0.003	78.0000	0.018	480.000	0.028		
7.2000	0.000	80.0000	0.018	490.000	0.025		
7.4000	0.003	82.0000	0.018	500.000	0.028		
7.6000	0.003	84.0000	0.018	510.000	0.025		

Well DG-1 - Pumping Data



Well DG-1 Recovery Data



WELL DG-12

OBSERVATION WELL

WELL DG-12 PUMPING PHASE
SE1000C
Environmental Logger
08/12 09:25

Unit# 00764 Test 0

Setups: INPUT 2

Type	Level (F)
Mode	Surface
I.D.	00120

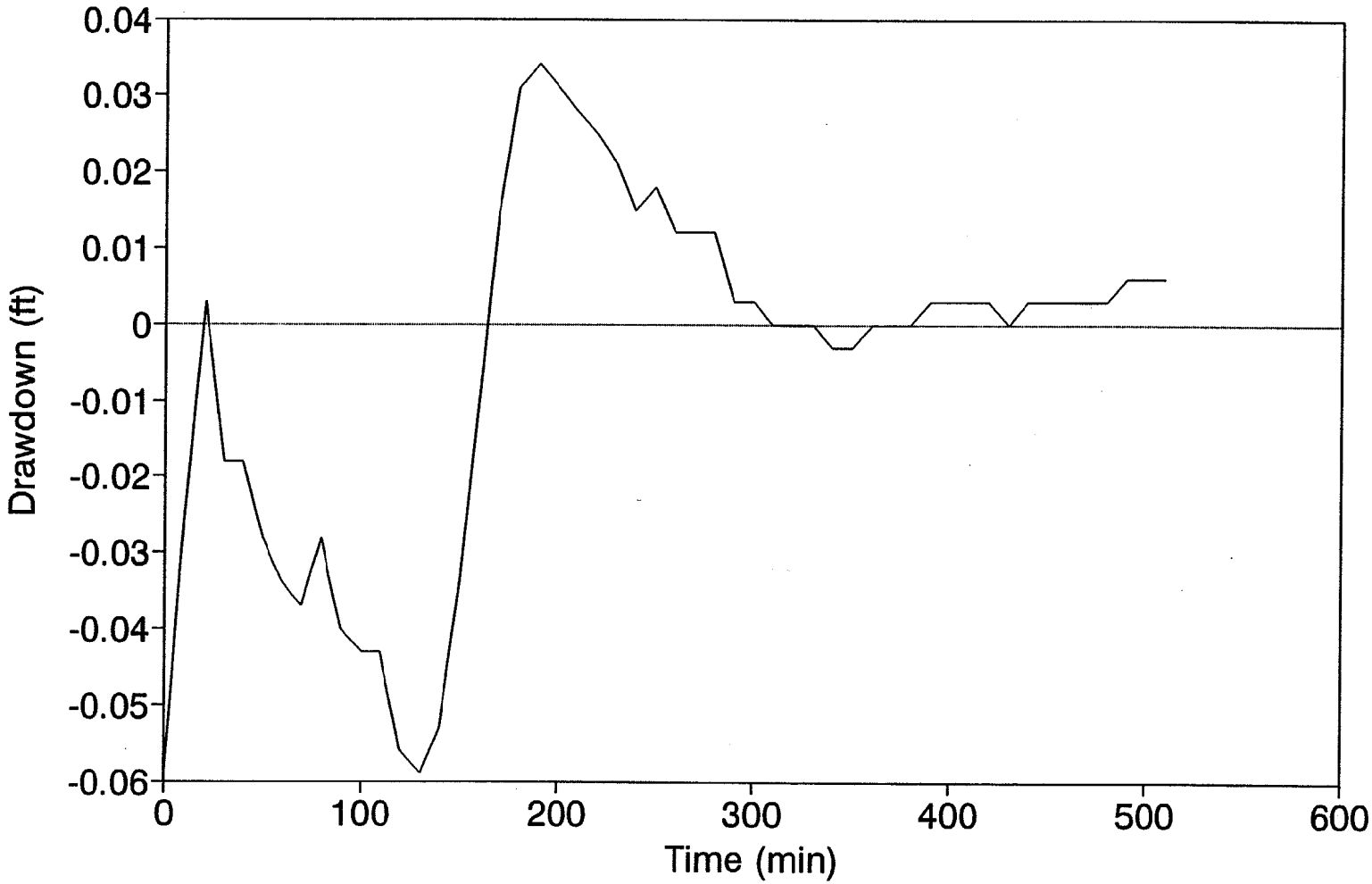
Reference	0.000
Linearity	0.010
Scale factor	9.900
Offset	0.030
Delay mSEC	50.000

Step 0 08/11 13:45:43

Elapsed Time INPUT 2 (continued)

0.0000	-0.059	270.000	0.012
10.0000	-0.025	280.000	0.012
20.0000	0.003	290.000	0.003
30.0000	-0.018	300.000	0.003
40.0000	-0.018	310.000	0.000
50.0000	-0.028	320.000	0.000
60.0000	-0.034	330.000	0.000
70.0000	-0.037	340.000	-0.003
80.0000	-0.028	350.000	-0.003
90.0000	-0.040	360.000	0.000
100.000	-0.043	370.000	0.000
110.000	-0.043	380.000	0.000
120.000	-0.056	390.000	0.003
130.000	-0.059	400.000	0.003
140.000	-0.053	410.000	0.003
150.000	-0.034	420.000	0.003
160.000	-0.009	430.000	0.000
170.000	0.015	440.000	0.003
180.000	0.031	450.000	0.003
190.000	0.034	460.000	0.003
200.000	0.031	470.000	0.003
210.000	0.028	480.000	0.003
220.000	0.025	490.000	0.006
230.000	0.021	500.000	0.006
240.000	0.015	510.000	0.006
250.000	0.018		
260.000	0.012		

Well DG-12 Pumping Data



WELL DG-26

OBSERVATION WELL

WELL DG-26 PUMPING PHASE
SE1000C
Environmental Logger
08/12 09:23

Unit# 00764 Test 0

Setups: INPUT 1

Type	Level (F)
Mode	Surface
I.D.	00260

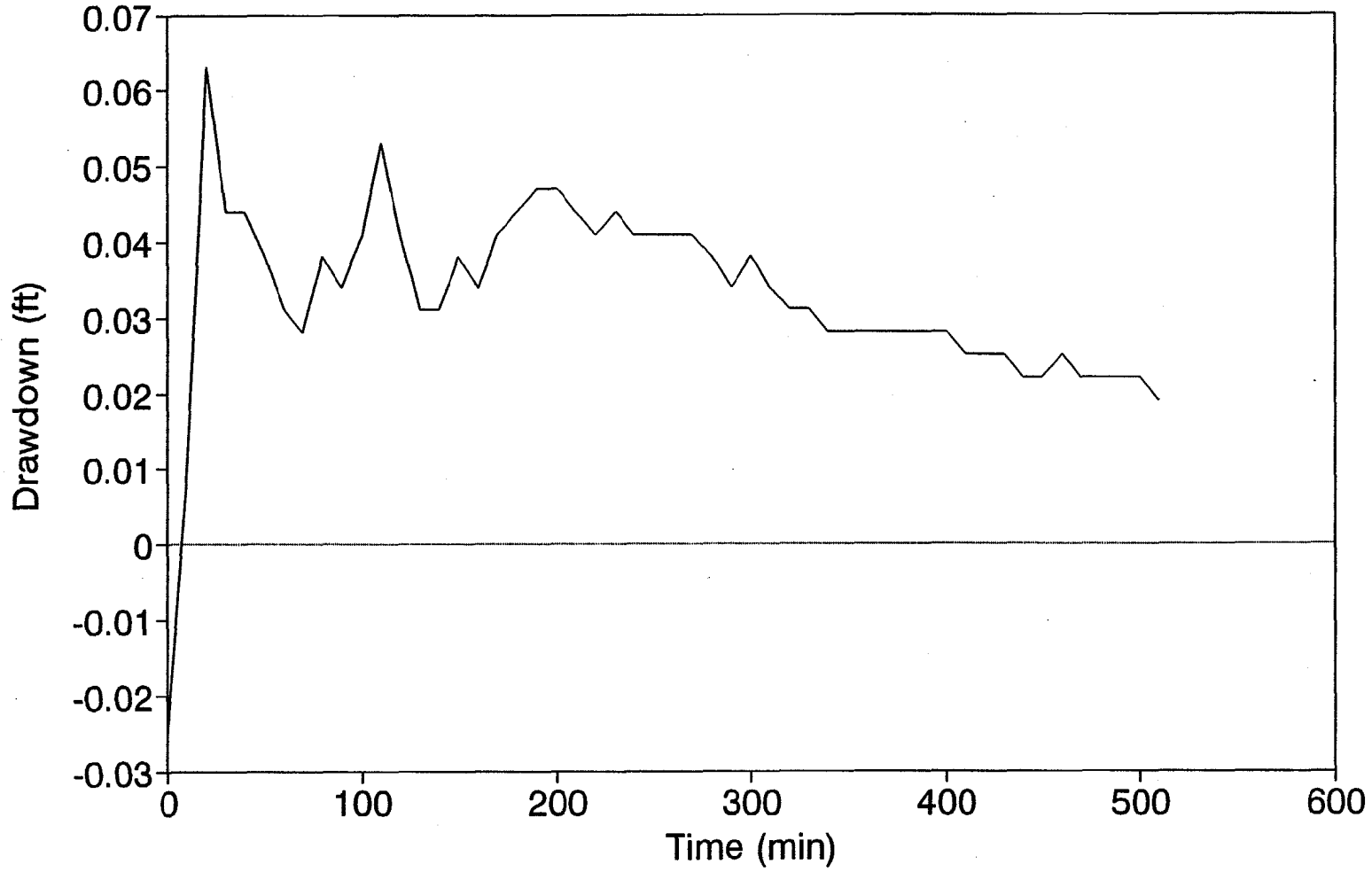
Reference	0.000
Linearity	0.000
Scale factor	10.010
Offset	0.040
Delay mSEC	50.000

Step 0 08/11 13:45:43

Elapsed Time INPUT 1 (continued)

0.0000	-0.025	270.000	0.041
10.0000	0.009	280.000	0.038
20.0000	0.063	290.000	0.034
30.0000	0.044	300.000	0.038
40.0000	0.044	310.000	0.034
50.0000	0.038	320.000	0.031
60.0000	0.031	330.000	0.031
70.0000	0.028	340.000	0.028
80.0000	0.038	350.000	0.028
90.0000	0.034	360.000	0.028
100.000	0.041	370.000	0.028
110.000	0.053	380.000	0.028
120.000	0.041	390.000	0.028
130.000	0.031	400.000	0.028
140.000	0.031	410.000	0.025
150.000	0.038	420.000	0.025
160.000	0.034	430.000	0.025
170.000	0.041	440.000	0.022
180.000	0.044	450.000	0.022
190.000	0.047	460.000	0.025
200.000	0.047	470.000	0.022
210.000	0.044	480.000	0.022
220.000	0.041	490.000	0.022
230.000	0.044	500.000	0.022
240.000	0.041	510.000	0.019
250.000	0.041		
260.000	0.041		

Well DG-26 Pumping Data



WELL SMC-1

OBSERVATION WELL

WELL SMC-1 PUMPING PHASE
SE1000C
Environmental Logger
08/12 08:48

Unit# 00927 Test 0

Setups: INPUT 2

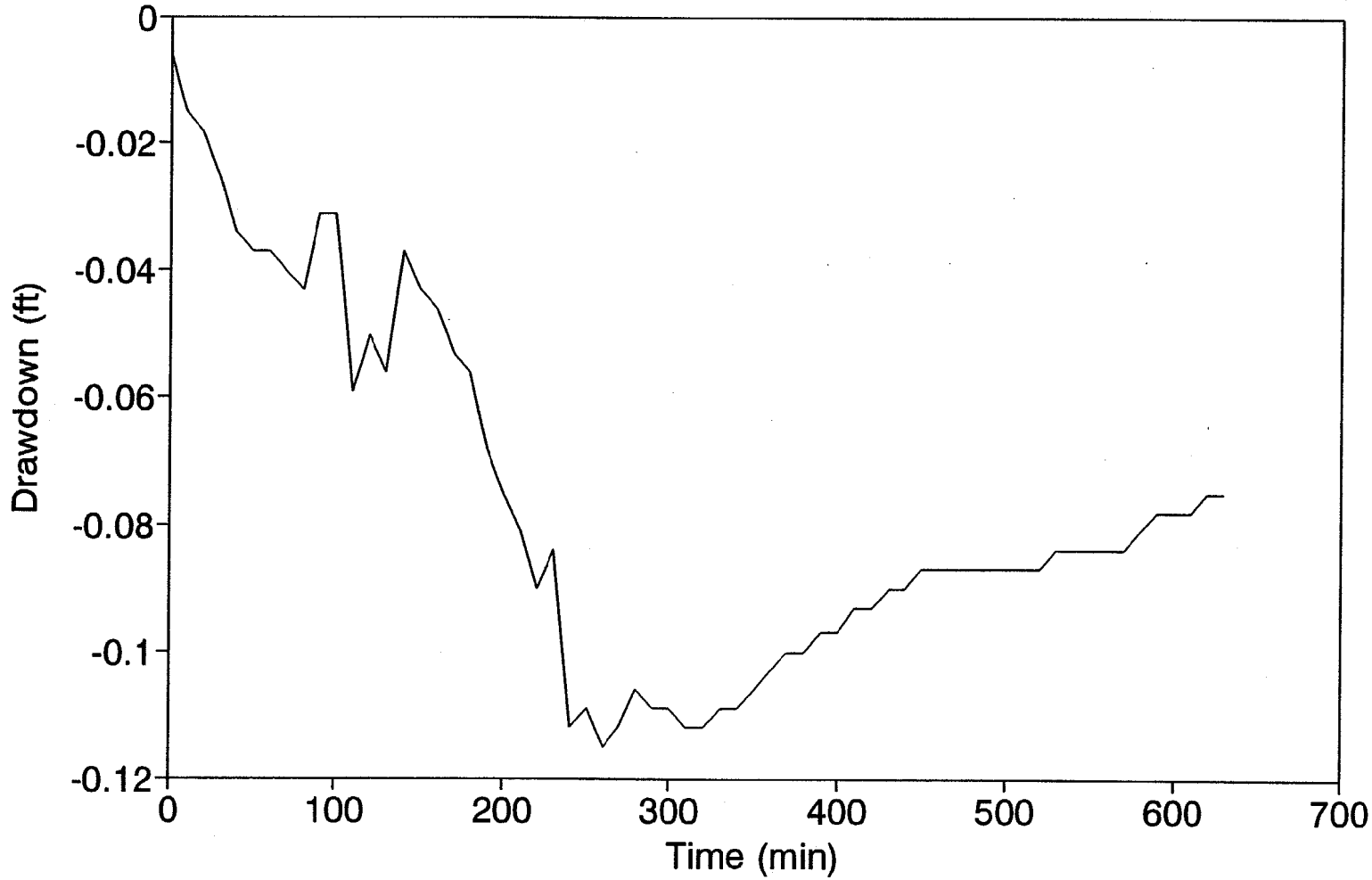
Type	Level (F)
Mode	Surface
I.D.	00200

Reference	0.000
Linearity	0.010
Scale factor	9.910
Offset	-0.030
Delay mSEC	50.000

Step 0 08/11 11:41:52

Elapsed Time	INPUT 2	(continued)		(continued)	
0.0000	-0.006	270.000	-0.112	540.000	-0.084
10.0000	-0.015	280.000	-0.106	550.000	-0.084
20.0000	-0.018	290.000	-0.109	560.000	-0.084
30.0000	-0.025	300.000	-0.109	570.000	-0.084
40.0000	-0.034	310.000	-0.112	580.000	-0.081
50.0000	-0.037	320.000	-0.112	590.000	-0.078
60.0000	-0.037	330.000	-0.109	600.000	-0.078
70.0000	-0.040	340.000	-0.109	610.000	-0.078
80.0000	-0.043	350.000	-0.106	620.000	-0.075
90.0000	-0.031	360.000	-0.103	630.000	-0.075
100.000	-0.031	370.000	-0.100		
110.000	-0.059	380.000	-0.100		
120.000	-0.050	390.000	-0.097		
130.000	-0.056	400.000	-0.097		
140.000	-0.037	410.000	-0.093		
150.000	-0.043	420.000	-0.093		
160.000	-0.046	430.000	-0.090		
170.000	-0.053	440.000	-0.090		
180.000	-0.056	450.000	-0.087		
190.000	-0.068	460.000	-0.087		
200.000	-0.075	470.000	-0.087		
210.000	-0.081	480.000	-0.087		
220.000	-0.090	490.000	-0.087		
230.000	-0.084	500.000	-0.087		
240.000	-0.112	510.000	-0.087		
250.000	-0.109	520.000	-0.087		
260.000	-0.115	530.000	-0.084		

Well SMC-1 Pumping Data



WELL SMC-2

OBSERVATION WELL

WELL SMC-2 PUMPING PHASE
SE1000C
Environmental Logger
08/12 08:46

Unit# 00927 Test 0

Setups: INPUT 1

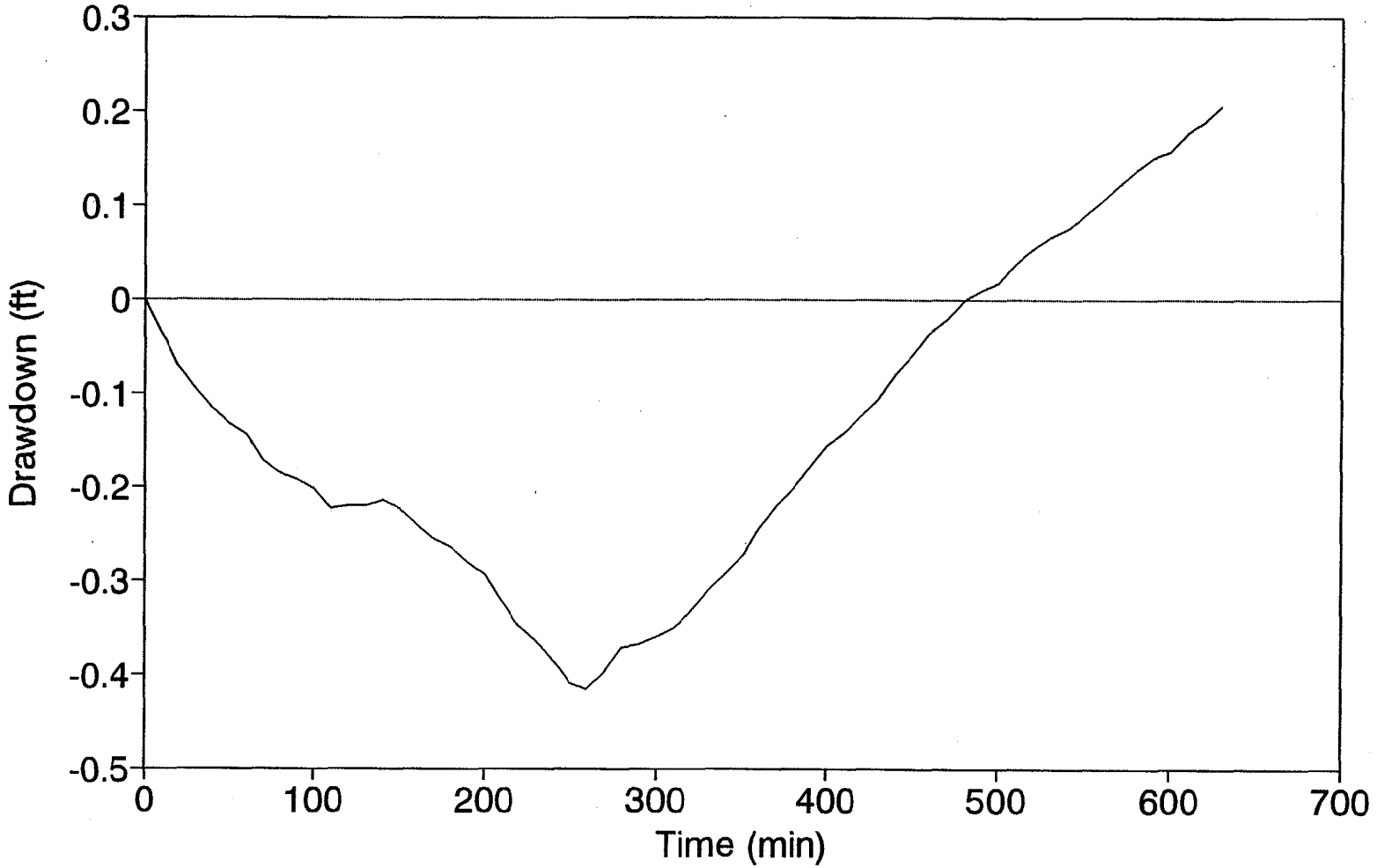
Type	Level (F)
Mode	Surface
I.D.	00100

Reference	0.000
Linearity	0.000
Scale factor	10.010
Offset	-0.030
Delay mSEC	50.000

Step 0 08/11 11:41:52

Elapsed Time	INPUT 1	(continued)		(continued)	
0.0000	0.000	270.000	-0.397	540.000	0.075
10.0000	-0.037	280.000	-0.372	550.000	0.088
20.0000	-0.072	290.000	-0.369	560.000	0.104
30.0000	-0.094	300.000	-0.360	570.000	0.120
40.0000	-0.116	310.000	-0.350	580.000	0.135
50.0000	-0.132	320.000	-0.334	590.000	0.151
60.0000	-0.145	330.000	-0.312	600.000	0.157
70.0000	-0.173	340.000	-0.293	610.000	0.176
80.0000	-0.186	350.000	-0.274	620.000	0.189
90.0000	-0.192	360.000	-0.243	630.000	0.205
100.000	-0.202	370.000	-0.221		
110.000	-0.224	380.000	-0.202		
120.000	-0.221	390.000	-0.180		
130.000	-0.221	400.000	-0.157		
140.000	-0.214	410.000	-0.142		
150.000	-0.224	420.000	-0.123		
160.000	-0.240	430.000	-0.107		
170.000	-0.255	440.000	-0.079		
180.000	-0.265	450.000	-0.060		
190.000	-0.281	460.000	-0.037		
200.000	-0.293	470.000	-0.022		
210.000	-0.322	480.000	-0.003		
220.000	-0.347	490.000	0.009		
230.000	-0.363	500.000	0.018		
240.000	-0.385	510.000	0.037		
250.000	-0.410	520.000	0.053		
260.000	-0.416	530.000	0.066		

Well SMC-2 Pumping Data



GROUNDWATER

VELOCITY

CALCULATIONS

HALLIBURTON NUS Environmental Corporation and Subsidiaries	STANDARD CALCULATION SHEET

CLIENT: NAWC Warminster	FILE NO.: 3933-0306	BY: [illegible]	PAGE OF
SUBJECT: RATE OF GROUNDWATER MIGRATION		CHECKED BY: EJR 9/28/92	DATE:

Objective: To determine the rate of groundwater migration in the shallow bedrock aquifer

Procedure: The rate of groundwater migration can be solved for by using the equation for average linear velocity; $V_x = -K \cdot \frac{1}{n_e} \cdot \frac{dh}{dl}$

where n_e = effective porosity

$\frac{dh}{dl}$ = average hydraulic gradient across the site

.0002
.0004

$n_e = n \times epf$

n for sandstones can range from 3 to 30 percent (.03 to .3)
.1

let $n_e = .1$

1) from pump test data the average value for K is 3.89×10^{-4} cm/sec

2) from a potentialmetric contour map fig — generated by Robert Good.

$\frac{dh_1}{dl_1} = \frac{5}{200} = 2.5 \times 10^{-2}$, $\frac{dh_2}{dl_2} = \frac{7}{200} = 3.5 \times 10^{-2}$ $\frac{dh_{ave}}{dl_{ave}} = 3.0 \times 10^{-2}$

3) $V_x = -K \frac{dh}{dl} \cdot \frac{1}{n_e}$

sub. $V_x = 3.89 \times 10^{-4}$ cm/sec $\cdot 3.0 \times 10^{-2} \cdot 1.0 \times 10^{1}$

V_x 1.17×10^{-4} cm/sec $\times \frac{2835 \text{ ft/day}}{1 \text{ cm/sec}}$

$$\boxed{V_x = 3.3 \times 10^{-1} \text{ ft/day}}$$

NUS CORPORATION AND SUBSIDIARIES			STANDARD CALCULATION SHEET
CLIENT: NAWC Warmin	FILE NO.: 3933-0306	BY: AW Kendrick	PAGE 1 OF 1
SUBJECT: GW Velocity		CHECKED BY: FJ Kemmerer 9/29/92	DATE: 9-29-92

Hydraulic Conductivity (K) = 3.89×10^{-4} cm/sec.
= 1.10 ft/day

Effective Porosity (n_e) = .1

Hydraulic Gradient $\left(\frac{dh}{dl}\right) = i = 3.0 \times 10^{-2}$

∴ Specific Discharge (v) = Ki = 1.17×10^{-5} cm/sec ✓
= .03 ft/day ✓

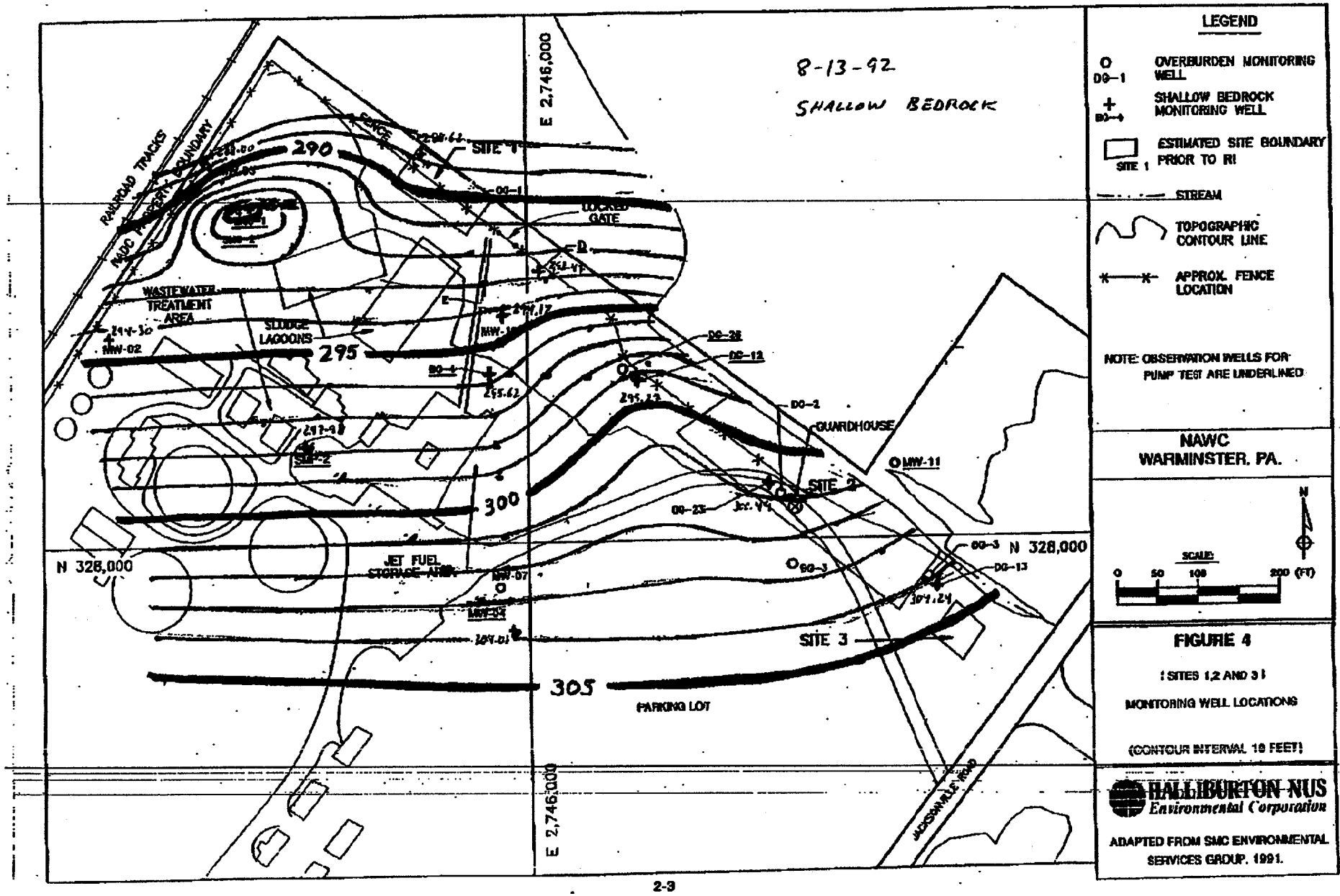
Avg. linear velocity (V_x) = $\frac{Ki}{n_e}$ = 1.17×10^{-4} cm/sec.
.33 ft/day

Avg. linear velocity of a solute front (V_s) = $\frac{Ki}{n_{ed}}$

where n_{ed} = n_e × Darcian pore factor (dpf)
dpf = .9 (Fetter, 1988) so: n_{ed} = .09

∴ $V_s = \frac{1.17 \times 10^{-5}}{.09} = 1.30 \times 10^{-4}$ cm/sec. ✓

= .37 ft/day


8-13-92
SHALLOW BEDROCK
LEGEND
OVERBURDEN MONITORING WELL
SHALLOW BEDROCK MONITORING WELL
ESTIMATED SITE BOUNDARY PRIOR TO RI
STREAM
TOPOGRAPHIC CONTOUR LINE
APPROX. FENCE LOCATION
NOTE: OBSERVATION WELLS FOR PUMP TEST ARE UNDERLINED
NAWC
WARMINSTER, PA.
SCALE:
0 50 100 200 (FT)
FIGURE 4
(SITES 1,2 AND 3)
MONITORING WELL LOCATIONS
(CONTOUR INTERVAL 10 FEET)
HALLIBURTON NUS
Environmental Corporation
ADAPTED FROM SMC ENVIRONMENTAL SERVICES GROUP, 1991.
E 2,746,000
E 2,746,000
N 328,000
N 328,000
290
295
300
305
SITE 1
SITE 2
SITE 3
RAILROAD TRACKS
NAWC PROPERTY BOUNDARY
WASTEWATER TREATMENT AREA
SLUDGE LAGOONS
JET FUEL STORAGE AREA
LOCKED GATE
GUARDHOUSE
PARKING LOT
JACKSONVILLE ROAD
MW-02
MW-11
DG-1
DG-2
DG-3
DG-12
DG-13
DG-23
DG-25

APPENDIX I

CHAIN OF CUSTODY RECORDS

RMC USE ONLY

CHAIN OF CUSTODY RECORD

Tri-County Business Campus
88 Robinson Street
Pottstown, PA 19464
(215) 327-4850
FAX (215) 327-4852

RMC ENVIRONMENTAL SERVICES

Client: SMC Environmental
Sampler (Initials): PDB-SSB
Job No.: 9710-40001
Client Contact: Jeff Walsh
Phone: 265-2700

Refrigerator #											
No./Type of Containers			5	2							
Volume of Containers											
Preservative											
General Analysis Group Requested →			Full TCL +30	Full TCL +30							
RMC Only Lab ID	Sample Identification	SMC-COC	Matrix Code	Date/Time Collected							
	8 - Surface Water	1	SW	11/28-10:30	✓						
	8 - Sediment	2	SE	11/28-10:30		✓					
	7 - Surface Water	3	SW	11/28-11:15	✓						
	1 - Surface Water	4	SW	11/28-12:30	✓						
	1 - Sediment	5	SE	11/28-12:30		✓					
	2 - Surface Water	6	SW	11/28-1:15	✓						
	2 - Sediment	7	SE	11/28-1:15		✓					
	3 - Surface Water	8	SW	11/28-2:45	✓						
	3 - Sediment	9	SE	11/28-2:45		✓					
	4 - Sediment	10	SE	11/28-3:15		✓					
	5 - Surface Water	11	SW	11/28-3:40	✓						
	5 - Sediment	12	SE	11/28-3:40		✓					
	6 - Surface Water	13	SW	11/28-4:00	✓						
	6 - Sediment	14	SE	11/28-4:00		✓					
	Field Rinsate Blank	15	SW	11/28-4:00	✓						

RMC Use Only

Samples Were:
1 Shipped or Hand-Delivered
NOTES:

2 Ambient or Chilled
NOTES:

3 Received Broken/Leaking (Improperly Sealed) Y N
NOTES:

4 Properly Preserved Y N
NOTES:

5 Received Within Holding Times Y N
NOTES:

COC Tape Was:
1 Present on Outer Package Y N
2 Unbroken on Outer Package Y N
3 Present on Sample Y N
4 Unbroken on Sample Y N
NOTES:

Discrepancies Between Sample Labels and COC Record? Y N
NOTES:

MATRIX CODES:
S — Soil; SE — Sediment; SO — Solid; SL — Sludge; WS — Solid Waste; DS — Drum Solids; GW — Groundwater; SW — Surface Water; WW — Waste Water; PW — Potable Water; DL — Drum Liquids; BI — Biological; O — Oil; A — Air; F — Fish; X — Other; G — Grab; C — Composite

BOTTLE CODES:
G — Glass
P — Plastic

Special Instructions:

Sample Containers Prepared By: L. Hetrick Total No. Containers: 76	Relinquished at Laboratory By: L. Hetrick	Date	Time	Received By	For (Company)
		11/26	4:30	Peter Beyer	SMC

Item/Reason	Relinquished by	Received by	Date	Time	Item/Reason	Relinquished by	Received by	Date	Time
To Courier	Peter Beyer	Bob Fillmore	11/29/90	10:30					

RMC reserves the right to charge $50.00 for unreturned preservative kits. Original: Laboratory Yellow: Client

RMC USE ONLY

CHAIN OF CUSTODY RECORD

Tri-County Business Campus
88 Robinson Street
Pottstown, PA 19464
(215) 327-4850
FAX (215) 327-4852

RMC ENVIRONMENTAL SERVICES

Client: SMC Environmental
Sampler (Initials): PDB - SSB
Job No.: 9710-40001
Client Contact: Jeff Walsh
Phone: 265-2700

Refrigerator #										
No./Type of Containers	5	2	2							
Volume of Containers		[illegible]								
Preservative										
General Analysis Group Requested →	Full TCL +30	Full TCL +30	TCL WL							

RMC Only Lab ID	Sample Identification	SMC-COC	Matrix Code	Date/Time Collected									
	Field Blank - TAP	16	PW	11/28 8:05	✓								
	2 - Surface Water Duplicate	17	SW	11/28 1:15	✓								
	2 - Sediment Duplicate	18	SE	11/28 1:15		✓							
	Field Blank - DI	19	PW	11/28 6:05	✓								
11/29/00 JKW	TRIP BLANK	29	PW	—			✓						

MATRIX CODES:
S — Soil; SE — Sediment; SO — Solid; SL — Sludge; WS — Solid Waste; DS — Drum Solids; GW — Groundwater; SW — Surface Water; WW — Waste Water; PW — Potable Water; DL — Drum Liquids; BI — Biological; O — Oil; A — Air; F — Fish; X — Other; G — Grab; C — Composite

BOTTLE CODES:
G — Glass
P — Plastic

Special Instructions:

Sample Containers Prepared By:	Relinquished at Laboratory By:	Date	Time	Received By	For (Company)
L. Hebrick Total No. Containers: 16	L. Hebrick	11/26/00	4:30	Peter Beyer	SMC

Item/Reason	Relinquished by	Received by	Date	Time	Item/Reason	Relinquished by	Received by	Date	Time
To Courier	Peter Beyer	[illegible]	11/29/00	10:30					

RMC Use Only

Samples Were:
1 Shipped or Hand-Delivered
NOTES:

2 Ambient or Chilled
NOTES:

3 Received Broken/Leaking (Improperly Sealed) Y N
NOTES:

4 Properly Preserved Y N
NOTES:

5 Received Within Holding Times Y N
NOTES:

COC Tape Was:
1 Present on Outer Package Y N
2 Unbroken on Outer Package Y N
3 Present on Sample Y N
4 Unbroken on Sample Y N
NOTES:

Discrepancies Between Sample Labels and COC Record? Y N
NOTES:

RMC reserves the right to charge $50.00 for unreturned preservative kits. Original: Laboratory Yellow: Client

RMC USE ONLY

CHAIN OF CUSTODY RECORD

Tri-County Business Campus
88 Robinson Street
Pottstown, PA 19464
(215) 327-4850
FAX (215) 327-4852

RMC ENVIRONMENTAL SERVICES

Client: NADC / SMC ENVIR.
Sampler (Initials): JKW
Job No.: 9710-40002
Client Contact: JEFF W. / ED TOKARSKI
Phone: (215) 265-27000

Refrigerator #										
No./Type of Containers	5	2								
Volume of Containers	/	/								
Preservative SEE PAGE 5	/	/								
General Analysis Group Requested →	FULL TCL TAL	TCL VOL								

RMC Only Lab ID	Sample Identification	Matrix Code	Date/Time Collected									
✓	NADC-S2-#20-RINSATE	PW	11-29-90/11:20	✓								
	NADC TRIP BLANK (#21)	PW	11-28-90/NA	[redacted]	✓							
	NADC-S2-#22-BG-4 (DUP)	GW	11-28-90/13:30	✓								
	NADC-S2 #23-BG-4	GW	11-28-90/13:30	✓								
	NADC-S2 #24-BG-3	GW	" /15:15	✓								
	NADC-S2 #25-D	GW	" /16:00	✓								
	NADC-S2-#26-DG-26	GW	" /16:30	✓								
	NADC-#27-FIELD BLANK-TAP	PW	11-30-90/#3	✓								
	NADC-#28-FIELD BLANK-DI	PW	" /10:50	✓								

MATRIX CODES:
S — Soil; SE — Sediment; SO — Solid; SL — Sludge; WS — Solid Waste; DS — Drum Solids; GW — Groundwater; SW — Surface Water; WW — Waste Water; PW — Potable Water; DL — Drum Liquids; BI — Biological; O — Oil; A — Air; F — Fish; X — Other; G — Grab; C — Composite

BOTTLE CODES:
G — Glass
P — Plastic

Special Instructions:

Sample Containers Prepared By: RELINQUISHED BY	Relinquished at Laboratory By:	Date	Time	Received By	For (Company)
Total No. Containers: /		11-28-90	9:35	JKW	SMC

Item/Reason	Relinquished by	Received by	Date	Time	Item/Reason	Relinquished by	Received by	Date	Time
TO LAB	JKW	M Bauman	11/30/90	12:30					

RMC Use Only

Samples Were:
1 Shipped or Hand-Delivered
NOTES:

2 Ambient or Chilled
NOTES:

3 Received Broken/Leaking (Improperly Sealed) Y N
NOTES:

4 Properly Preserved Y N
NOTES:

5 Received Within Holding Times Y N
NOTES:

COC Tape Was:

1 Present on Outer Package Y N
2 Unbroken on Outer Package Y N
3 Present on Sample Y N
4 Unbroken on Sample Y N
NOTES:

Discrepancies Between Sample Labels and COC Record? Y N
NOTES:

RMC reserves the right to charge $50.00 for unreturned preservative kits. Original: Laboratory Yellow: Client

RMC USE ONLY

CHAIN OF CUSTODY RECORD

Tri-County Business Campus
88 Robinson Street
Pottstown, PA 19464
(215) 327-4850
FAX (215) 327-4852

RMC ENVIRONMENTAL SERVICES

Client NADC - SMC ENV. SERV. GRP.
Sampler (Initials) JKW
Job No. 9710-40002
Client Contact JEFF WALSH
Phone 265-27000

Refrigerator #											
No./Type of Containers	5	2									
Volume of Containers	~~5~~	~~2~~									
Preservative SEE labels	—	—									
General Analysis Group Requested →	FULL TCL TAL	TCL VOL.									

RMC Only Lab ID	Sample Identification	Matrix Code	Date/Time Collected										
	NADC-30-RINSATE	PW	12-4-90/11:00	✓									
	NADC-31-TRIP BLANK	PW	11/30/90/—		✓								
	NADC-S2-32-DG-12	GW	12-4-90/11:30	✓									
	NADC-S4-33-DG-28	GW	"/14:45	✓									
	NADC-S4-34-DG-15	GW	"/15:30	✓									
	NADC-S4-35-DG-6	GW	"/16:00	✓									
	NADC-S4-36-DG-16	GW	"/16:40	✓									

MATRIX CODES:
S — Soil, SE — Sediment, SO — Solid, SL — Sludge, WS — Solid Waste, DS — Drum Solids
GW — Groundwater, SW — Surface Water, WW — Waste Water, PW — Potable Water, DL — Drum Liquids
BI — Biological, O — Oil, A — Air, F — Fish, X — Other
G — Grab, C — Composite

BOTTLE CODES:
G — Glass
P — Plastic

Special Instructions:

Sample Containers Prepared By: M. Brunner Total No. Containers: 49	Relinquished at Laboratory By: M. Brunner	Date	Time	Received By	For (Company)
		11-30-90	14:30	JKW	SMC

Item/Reason	Relinquished by	Received by	Date	Time	Item/Reason	Relinquished by	Received by	Date	Time
TRANS.	JKW	[illegible]	12/5/90						
	[illegible]	[illegible]	[illegible]						

RMC Use Only

Samples Were:
1 Shipped or Hand-Delivered
NOTES:

2 Ambient or Chilled
NOTES:

3 Received Broken/Leaking (Improperly Sealed)
Y N
NOTES:

4 Properly Preserved
Y N
NOTES:

5 Received Within Holding Times
Y N
NOTES:

COC Tape Was:

1 Present on Outer Package Y N
2 Unbroken on Outer Package Y N
3 Present on Sample Y N
4 Unbroken on Sample Y N
NOTES:

Discrepancies Between Sample Labels and COC Record? Y N
NOTES:

RMC reserves the right to charge $50.00 for unreturned preservative kits. Original: Laboratory Yellow: Client

RMC USE ONLY

CHAIN OF CUSTODY RECORD

Tri-County Business Campus
88 Robinson Street
Pottstown, PA 19464
(215) 327-4850
FAX (215) 327-4852

RMC ENVIRONMENTAL SERVICES

Client: NADC - SMC ENV. SERV. G
Sampler (Initials): JKW
Job No.: 9710-40002
Client Contact: JEFF WALSH/ED TOKARSKI
Phone: (215) 265-2700

Refrigerator #											
No./Type of Containers			5	2							
Volume of Containers			[redacted]	[redacted]							
Preservative			SEE TABLES								
General Analysis Group Requested →			FULL TCL TAL	TCL VOLS.							
RMC Only Lab ID	Sample Identification	Matrix Code	Date/Time Collected								
	NADC-S4-#37-DG-9	GW	12/5/90/10:00	✓							
	NADC-TRIP BLANK-#38	PW	12/4/—		✓						
2	NADC-S4-#39-DG-18	GW	12/5/9-11:00	✓							
	NADC-RINSATE-#40	PW	" 11:30	✓							
3	NADC S4-#41-DG-10	GW	"/12:45	✓							
4	NADC-S4 #42 DG-4	GW	"/14:00	✓							
5	NADC-S4-#43-DG-5	GW	"/14:40	✓							
6	NADC-S4-#44-DG-7	GW	"/15:30	✓							

MATRIX CODES:
S — Soil; SE — Sediment; SO — Solid; SL — Sludge; WS — Solid Waste; DS — Drum Solids; GW — Groundwater; SW — Surface Water; WW — Waste Water; PW — Potable Water; DL — Drum Liquids; BI — Biological; O — Oil; A — Air; F — Fish; X — Other; G — Grab; C — Composite

BOTTLE CODES:
G — Glass
P — Plastic

Special Instructions:

Sample Containers Prepared By:	Relinquished at Laboratory By:	Date	Time	Received By	For (Company)
L Hetrick Total No. Containers: 50	L Hetrick	12/4/90	16:30	B	SMC

Item/Reason	Relinquished by	Received by	Date	Time	Item/Reason	Relinquished by	Received by	Date	Time
TO JEFF	B	JKW	12/4/90	17:10	TO B	JKW		12/6	
	BRB								

RMC Use Only

Samples Were:
1 Shipped or Hand-Delivered
NOTES:

2 Ambient or Chilled
NOTES:

3 Received Broken/Leaking (Improperly Sealed)
Y N
NOTES:

4 Properly Preserved
Y N
NOTES:

5 Received Within Holding Times
Y N
NOTES:

COC Tape Was:

1 Present on Outer Package Y N

2 Unbroken on Outer Package Y N

3 Present on Sample Y N

4 Unbroken on Sample Y N

NOTES:

Discrepancies Between Sample Labels and COC Record? Y N
NOTES:

RMC reserves the right to charge $50.00 for unreturned preservative kits. Original: Laboratory Yellow: Client

Sheet 1 of 1

RMC USE ONLY

CHAIN OF CUSTODY RECORD

Tri-County Business Campus
88 Robinson Street
Pottstown, PA 19464
(215) 327-4850
FAX (215) 327-4852

RMC ENVIRONMENTAL SERVICES

Client: NADC/SMC ENVIR. SER. GRP.
Sampler (Initials): JKW
Job No.: 9710-40002
Client Contact: JEFF WALSH / ED TOKARSKI
Phone: (215) 265-27000

Refrigerator #											
No./Type of Containers	2	5									
Volume of Containers	—	—									
Preservative SEE LABELS	—										
General Analysis Group Requested →	TCL VOL.	FULL TCL TAL									

RMC Only Lab ID	Sample Identification	Matrix Code	Date/Time Collected		
	NADC-TRIP BLANK #45	PW	12/5/90/—	✓	
	NADC-RINSATE - #46	PW	12-6-90/9:30		✓
	NADC-S6-#47-DG-19	GW	"/11:15		✓
	NADC-S6-#48-DG-17	GW	"/15:00		✓
	NADC-S8-#49-DG-5	GW	"/15:15		✓

JKW 12/7/90

MATRIX CODES:
S — Soil; SE — Sediment; SO — Solid; SL — Sludge; WS — Solid Waste; DS — Drum Solids; GW — Groundwater; SW — Surface Water; WW — Waste Water; PW — Potable Water; DL — Drum Liquids; BI — Biological; O — Oil; A — Air; F — Fish; X — Other; G — Grab; C — Composite

BOTTLE CODES:
G — Glass
P — Plastic

Special Instructions:

Sample Containers Prepared By:	Relinquished at Laboratory By:	Date	Time	Received By	For (Company)
L. Hetrick	L. Hetrick	12-5-90	11:00	B. Bartwalter	SMC E.S.G.

Total No. Containers: 52

Item/Reason	Relinquished by	Received by	Date	Time	Item/Reason	Relinquished by	Received by	Date	Time
TO FIELD	BBB (SMC)	JKW	12/6/90	08:00	TO LAB	JKW	BBB (SMC)	12/7/90	10:30
	[illegible]								

RMC Use Only

Samples Were:
1 Shipped or Hand-Delivered
NOTES:

2 Ambient or Chilled
NOTES:

3 Received Broken/Leaking (Improperly Sealed) Y N
NOTES:

4 Properly Preserved Y N
NOTES:

5 Received Within Holding Times Y N
NOTES:

COC Tape Was:
1 Present on Outer Package Y N
2 Unbroken on Outer Package Y N
3 Present on Sample Y N
4 Unbroken on Sample Y N
NOTES:

Discrepancies Between Sample Labels and COC Record? Y N
NOTES:

RMC reserves the right to charge $50.00 for unreturned preservative kits. Original: Laboratory Yellow: Client

Sheet 1 of 1

RMC USE ONLY

CHAIN OF CUSTODY RECORD

Tri-County Business Campus
88 Robinson Street
Pottstown, PA 19464
(215) 327-4850
FAX (215) 327-4852

RMC ENVIRONMENTAL SERVICES

Client: SMC Environmental Services
Sampler (Initials): PDB
Job No.: 9710-40002
Client Contact: Jeff Walsh
Phone: 265-2700

Refrigerator #										
No./Type of Containers			53	1	1	2				
Volume of Containers			40ml	1 liter	1 gallon	40ml				
Preservative				HNO_3						
General Analysis Group Requested →			Full TCL +30	→	→	TCL VOL				
RMC Only Lab ID	Sample Identification	Matrix Code	Date/Time Collected							
	NADC-S5-50-DG 8	GW	12/10 11:00	✓	✓	✓				
	NADC-S5-51-DG 20	GW	12/10 12:30	✓	✓	✓				
	NADC-Trip Blank-52	PW	12/10	●			✓			
	NADC-Rinsate Blank-53	PW	12/10	✓	✓	✓				
	NADC-S5-54-DG-27	GW	12/10 2:50	✓	✓	✓				
	NADC-S5-55-DG 21	GW	12/10 4:00	✓	✓	✓				

MATRIX CODES:
SL — Soil; SE — Sediment; SO — Solid; SL — Sludge; WS — Solid Waste; DS — Drum Solids; GW — Groundwater; SW — Surface Water; WW — Waste Water; PW — Potable Water; DL — Drum Liquids; BI — Biological; O — Oil; A — Air; F — Fish; X — Other; G — Grab; C — Composite

BOTTLE CODES: G — Glass; P — Plastic

Special Instructions:

Sample Containers Prepared By: M. Brunner; Total No. Containers: 50	Relinquished at Laboratory By: M. Brunner	Date: 12-6-90	Time: ~~11:10~~ 17:15	Received By: JKW	For (Company): SMC

Item/Reason	Relinquished by	Received by	Date	Time	Item/Reason	Relinquished by	Received by	Date	Time
TO Field	JKW	[illegible]	12-7-90	08:00	TO LAB	PDB	[illegible]	12-11-90	08:00

RMC Use Only

Samples Were:
1 Shipped or Hand-Delivered
NOTES:
2 Ambient or Chilled
NOTES:
3 Received Broken/Leaking (Improperly Sealed) Y N
NOTES:
4 Properly Preserved Y N
NOTES:
5 Received Within Holding Times Y N
NOTES:

COC Tape Was:
1 Present on Outer Package Y N
2 Unbroken on Outer Package Y N
3 Present on Sample Y N
4 Unbroken on Sample Y N
NOTES:

Discrepancies Between Sample Labels and COC Record? Y N
NOTES:

RMC reserves the right to charge $50.00 for unreturned preservative kits. Original: Laboratory Yellow: Client

RMC USE ONLY

CHAIN OF CUSTODY RECORD

Tri-County Business Campus
88 Robinson Street
Pottstown, PA 19464
(215) 327-4850
FAX (215) 327-4852

RMC ENVIRONMENTAL SERVICES

Client: NADC / SMC ENVIR. SERV G.
Sampler (Initials): JKW
Job No.: 9710 - 40002
Client Contact: JEFF WALSH / PETE BEYER
Phone: (215) 265 - 2780

RMC Only Lab ID	Sample Identification	Matrix Code	Date/Time Collected									
Refrigerator #												
No./Type of Containers				5	2							
Volume of Containers												
Preservative				SEE PAGES								
General Analysis Group Requested				Full TCL/TAL	TCL VOL							
	NADC-S7-#58-DG-25	GW	12-4-90/10:30	✓								
	NADC-TRIP BLANK #57	PW	12-10-90/—		✓							
	NADC-S7-#58-DG-25 (DUPL.)	GW	12-4-90/10:30	✓								
	NADC-RINSATE-#59	PW	12-4-90/11:45	✓								
	NADC-S3-60-DG 13	GW	12-11-90/12:45	✓								
	NADC-S3-61-DG 13 (Dupl.)	GW	12-11-90/12:45	✓								
	NADC-S3-62-DG 3	GW	12-11-90/1:55	✓								
	NADC-S2-#63-WELL E	GW	"/15:00	✓								
	NADC-#S1-#64-DG-1	GW	"/16:00	✓								

MATRIX CODES:
S — Soil, SE — Sediment, SO — Solid, SL — Sludge, WS — Solid Waste, DS — Drum Solids, GW — Groundwater, SW — Surface Water, WW — Waste Water, PW — Potable Water, DL — Drum Liquids, BI — Biological, O — Oil, A — Air, F — Fish, X — Other, G — Grab, C — Composite

BOTTLE CODES: G — Glass, P — Plastic

Special Instructions:

Sample Containers Prepared By:	Relinquished at Laboratory By:	Date	Time	Received By	For (Company)
L. Hetrick	L. Hetrick	12/10/90	17:15	JKW	SMC

Total No. Containers: 50

Item/Reason	Relinquished by	Received by	Date	Time	Item/Reason	Relinquished by	Received by	Date	Time
TO LAB	JKW	Lisa Hetrick	12-12-90	13:15					

RMC Use Only

Samples Were:
1 Shipped or Hand Delivered
NOTES:
2 Ambient or Chilled
NOTES:
3 Received Broken/Leaking (Improperly Sealed) Y N
NOTES:
4 Properly Preserved Y N
NOTES: N/A
5 Received Within Holding Times Y N
NOTES:

COC Tape Was:
1 Present on Outer Package Y N
2 Unbroken on Outer Package Y N
3 Present on Sample Y N
4 Unbroken on Sample Y N
NOTES:

Discrepancies Between Sample Labels and COC Record? Y N
NOTES:

RMC reserves the right to charge $50.00 for unreturned preservative kits. Original: Laboratory Yellow: Client

Sheet 1 of 1

RMC USE ONLY

CHAIN OF CUSTODY RECORD

Tri-County Business Campus
88 Robinson Street
Pottstown, PA 19464
(215) 327-4850
FAX (215) 327-4852

RMC ENVIRONMENTAL SERVICES

Client: SMC Environmental Services
Sampler (Initials): PDB
Job No.: 9710-40002
Client Contact: Jeff Walsh/P. BEYER
Phone: (215) 265-2700

Refrigerator #					3					
No./Type of Containers		3/G	1/G	1/P	1/G					
Volume of Containers		40ml	1 gallon	1 liter	40ml					
Preservative		—	—	HNO3	—					
General Analysis Group Requested →										
RMC Only Lab ID	Sample Identification	Matrix Code	Date/Time Collected							
	NADC - Rinsate - 65	PW	12/12/90 9:30	✓	✓	✓				
	NADC - S1 - 66 Well C	GW	12/12/90 10:00	✓	✓	✓				
	NADC - S4 - 67 - BG 2	GW	12/12/90 12:30	✓	✓	✓				
	NADC - S4 - 68 - BG 6	GW	12/12/90 12:00	✓	✓	✓				
	NADC - S6 - 69 BG 7	GW	12/12/90 3:20	✓	✓	✓				
	NADC - Trip Blank - 70	PW	12/12/90				✓			

MATRIX CODES:
S — Soil; SE — Sediment; SO — Solid; SL — Sludge; WS — Solid Waste; DS — Drum Solids; GW — Groundwater; SW — Surface Water; WW — Waste Water; PW — Potable Water; DL — Drum Liquids; BI — Biological; O — Oil; A — Air; F — Fish; X — Other; G — Grab; C — Composite

BOTTLE CODES:
G — Glass
P — Plastic

Special Instructions:

Sample Containers Prepared By: L. Hetrick Total No. Containers: 5	Relinquished at Laboratory By: L. Hetrick	Date	Time	Received By	For (Company)
		12-11-90	1:00	BBB	SMC

Item/Reason	Relinquished by	Received by	Date	Time	Item/Reason	Relinquished by	Received by	Date	Time
TO FIELD	BBB	PDB	12-12-90	5:00	To Lab	PDB	THG	12-13	10:45
TO LAB	THG	Lisa Hetrick	12-13-90	11:45					

RMC Use Only

Samples Were:
1 Shipped or Hand-Delivered
NOTES:

2 Ambient or Chilled
NOTES:

3 Received Broken/Leaking (Improperly Sealed)
Y N
NOTES:

4 Properly Preserved
Y N
NOTES:

5 Received Within Holding Times
Y N
NOTES:

COC Tape Was:

1 Present on Outer Package Y N
2 Unbroken on Outer Package Y N
3 Present on Sample Y N
4 Unbroken on Sample Y N
NOTES:

Discrepancies Between Sample Labels and COC Record? Y N
NOTES:

RMC reserves the right to charge $50.00 for unreturned preservative kits. Original: Laboratory Yellow: Client

CHAIN OF CUSTODY RECORD

Tri-County Business Campus
88 Robinson Street
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(215) 327-4850
FAX (215) 327-4852

RMC ENVIRONMENTAL SERVICES

Client: NADC / SMC ENVIR. SERV.
Sampler (Initials): JKW
Job No.: 9710-40002
Client Contact: JEFF WALSH / PETE BEYER
Phone: (215) 265-2720

Refrigerator #									
No./Type of Containers	3	1	1	2					
Volume of Containers	40ml	1l	gall	40ml					
Preservative	—	HNO_3	—	—					
General Analysis Group Requested *	TCL VOL	TCL metals	TCL BNA +	TCL VOA					

RMC Only Lab ID	Sample Identification	Matrix Code	Date/Time Collected								
	NADC - TRIP BLANK - #71	PW	12/12/90	✓							
	NADC - RINSATE - #72	PW	12/13/90 10:00	✓	✓	✓					
	NADC-S8 - #75 - DG-14	GW	" / 11:30	✓	✓	✓					
	NADC-S4 - #73 - DG-22	GW	" / 13:15	✓	✓	✓					
	NADC-S4 - #78 - DG-22 (DUP.)	GW	" / 13:15		✓	✓	✓				
	NADC-S4 - #74 - DG-24	GW	" / 13:45	✓	✓	✓					
	NADC - S2 - #76 - DG-2	GW	" / 15:30	✓	✓	✓					
	NADC-S2 - #77 - DG-23	GW	" / 16:30	✓	✓	✓					

MATRIX CODES:
S — Soil; SE — Sediment; SO — Solid; SL — Sludge; WS — Solid Waste; DS — Drum Solids; GW — Groundwater; SW — Surface Water; WW — Waste Water; PW — Potable Water; DL — Drum Liquids; BI — Biological; O — Oil; A — Air; F — Fish; X — Other; G — Grab; C — Composite

BOTTLE CODES:
G — Glass
P — Plastic

Special Instructions: * FULL TCL + 30 ANALYSIS AS PER CONTRACT.

Sample Containers Prepared By: M. Brunner Total No. Containers: 18	Relinquished at Laboratory By: M. Brunner	Date	Time	Received By	For (Company)
		12/12/90	13:15	JKW	SMC

Item/Reason	Relinquished by	Received by	Date	Time	Item/Reason	Relinquished by	Received by	Date	Time
TO LAB	JKW	[illegible]	12/14/90	10:45					
	[illegible]	M. Brunner	12/14/90	11:10					

RMC Use Only

Samples Were:
1 Shipped or Hand-Delivered
NOTES:

2 Ambient or Chilled
NOTES:

3 Received Broken/Leaking (Improperly Sealed)
Y N
NOTES:

4 Properly Preserved
Y N
NOTES:

5 Received Within Holding Times
Y N
NOTES:

COC Tape Was:

1 Present on Outer Package Y N
2 Unbroken on Outer Package Y N
3 Present on Sample Y N
4 Unbroken on Sample Y N
NOTES:

Discrepancies Between Sample Labels and COC Record? Y N
NOTES:

RMC reserves the right to charge $50.00 for unreturned preservative kits. Original: Laboratory Yellow: Client

Sheet 1 of 1

SMC INTER OFFICE MEMORANDUM

Date: December 12, ~~1990~~

From: Jeff Walsh JKW

To: File

Subject: Chain of custody tape on coolers sent to RMC

As stated in the work plan, all coolers containing samples for shipment to RMC have been sealed with SMC's chain-of-custody tape. However, it has recently come to my attention that RMC has been indicating on the chain-of-custody forms that the coolers containing samples from the NADC have not been wrapped with chain-of-custody tape. RMC has been indicating this because SMC has not been using RMC's chain-of-custody tape on the coolers. It should be noted that all coolers shipped to RMC have been properly wrapped, but RMC's tape was not used.

cc: FILE 3.1
EFT
SLR
PDB

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3933

SITE NAME: NAWC - Warminster

SAMPLERS (SIGNATURE): [illegible] Scott Roth

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	60 ml VOA	8 ounce BNA/PCB/Pest.	8 ounce Metals/CN.	8 ounce BNA/PCB Pest/TPH/BTEX	32 ounce TCLP/WET CFC/pH/TOC/MC			REMARKS
S-1,2,3	6-16-92	1530		✓	W-SB-01	4	2	1	1					
S-1,2,3	6-16-92	1645		✓	W-SB-02	4	2	1	1					
S-1,2,3	6-16-92	1645		✓	W-SB-02-D	4	2	1	1					
S-1,2,3	6-16-92	1645		✓	W-SB-02-MS	4	2	1	1					DO MS
S-1,2,3	6-16-92	1645		✓	W-SB-02-MSD	4	2	1	1					DO MSD
S-1,2,3	6-16-92	1903		✓	W-SB-03	4	2	1	1					
S-1,2,3	6-16-92	1950		✓	W-SB-04	6	2		1	1	2			
S-1,2,3	6-16-92	1600		✓	W-616-TB	3	3							Trip Blank

RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):
[illegible]	6-17-92 0830				
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RELINQUISHED BY (SIGNATURE):	**DATE / TIME:**	**RECEIVED FOR LABORATORY BY (SIGNATURE):**	**DATE / TIME:**	**REMARKS:** Shipped Via Federal Express Airbill Number 4689021315	

NUS 440 REVISED 0891

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3933

SITE NAME: NAWC - Warminster

SAMPLERS (SIGNATURE): [illegible]

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	VOA / VOA TCLP	BNA / BNA TCLP	PCB/Pest / PCB/Pest TCLP	Metals / Metals TCLP	Cyanide	TOC / COD	REMARKS
S-1,2,3	6-16-92	1835		✓	W-616-RB	18	3/3	2/2	2/2	1/1	1	1	Analyze Rinsate

RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):
[illegible]	6-17-92 0830				
RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):
RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED FOR LABORATORY BY (SIGNATURE):	DATE / TIME:	REMARKS: Shipped Via Federal Express Airbill Number 4689021315	

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3933

SITE NAME: NAWC - Warminster

SAMPLERS (SIGNATURE): [signature] Paul [signature]

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	VOA	BNA/PCB/Pest TPH/BTEX	Metals	Cyanide TPH/WLT/CFC	pH/TOC/MC			REMARKS
05	6-17-92	0839		✓	W-SB-05	4	2	1	1					
06	6-17-92	0929		✓	W-SB-06	4	2	1	1					
07	6-17-92	1020		✓	W-SB-07	4	2	1	1					
08	6-17-92	1221		✓	W-SB-08	4	2	1	1					
09	6-17-92	1321		✓	W-SB-09	6	2	1	1	2				
10	6-17-92	1426		✓	W-SB-10	4	2	1	1					
11	6-17-92	1507		✓	W-SB-11	4	2	1	1					
12	6-17-92	1552		✓	W-SB-12	4	2	1	1					

RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):
[signature]	6-17-92 1730				
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RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED FOR LABORATORY BY (SIGNATURE):	DATE / TIME:	REMARKS: Shipped Via Federal Express Airbill No. 468 902 1326	

NUS 440 REVISED 0891

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3933

SITE NAME: NAWC- Warminster

SAMPLERS (SIGNATURE): [illegible] Paul Davis

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	VOA	BNA	PCB/PEST	Metals	Metals (dissolved)	Cyanide	Hard. Alk. TDS. TSS BOD. Sulf. Chlorides	TOC - COD	NH3 - NO3	REMARKS
617	6-17-92	0935		✓	W-617-FB	12	3	2	2	1	1	1	1	1		Field Blank
617	6-17-92	0928		✓	W-617-TB	3	3									Trip Blank

RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):
[illegible]	6-17-92 1730				
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RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED FOR LABORATORY BY (SIGNATURE):	DATE / TIME:	REMARKS: Shipped Via Federal Express Air bill # 4689021326	

NUS 440 REVISED 0891

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3933

SITE NAME: NAWC - Westminster

SAMPLERS (SIGNATURE): [illegible] Paul Davis

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	VOA / VOA TCLP	BNA / BNA TCLP	PCB/Pest/PCB/Pest TCLP	Metals/Metals TCLP	Cyanide	TOC/COD/NO3/NH3	REMARKS
617	6-17-92	1240		✓	W-617-RB	14	3/3	1/1	1/1	1/1	1	1	Rinsate Do not analyze - as per NEESA

RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):
[illegible]	6-17-92 1730				
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NUS 440 REVISED 0891

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3933

SITE NAME: NAWC - Warminster

SAMPLERS (SIGNATURE): VJASL Paul Davis R. O'Brien

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	VOA	BNA · PCB · Pest TPH · BTEX	Metals Cyanide	TCLP · WET · CEC pH · TOC · MC				REMARKS
13	6-18-92	0800		✓	W-SB-13	4	2	1	1					
14	6-18-92	0904		✓	W-SB-14	6	2	1	1	2				
15	6-18-92	0947		✓	W-SB-15	4	2	1	1					
15	6-18-92	0947		✓	W-SB-15-D	4	2	1	1					
15	6-18-92	0947		✓	W-SB-15-MS	4	2	1	1					Do MS
15	6-18-92	0947		✓	W-SB-15-MSD	4	2	1	1					Do MSD
16	6-18-92	1038		✓	W-SB-16	4	2	1	1					

RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):
VJASL	6-18-92 1430				
RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):
RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED FOR LABORATORY BY (SIGNATURE):	DATE / TIME:	REMARKS: Shipped via Federal Express Air Bill No. 4689021551	

NUS 440 REVISED 0891

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3933

SITE NAME: NAWC - Westminster

SAMPLERS (SIGNATURE): [signature] Paul Davor [signature]

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	VOA	BNA	PCB/Pest	Metals	Metals (dissolved)	Cyanide	Hard - Alk - TDS - TSS Bod - Sulf - Chlor TOC - COD NH3 - NO3			REMARKS
618	6-18-92	0900		✓	W - 618 - FB	10	3	1	1	1	1	1	1	1		Field Blank
618	6-18-92	0900		✓	W - 618 - TB	3	3									Trip Blank

RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):
[signature]	6-18-92 1430				
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RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED FOR LABORATORY BY (SIGNATURE):	DATE / TIME:	REMARKS: Shipped Via Federal Express Airbill Number 4689021551	

NUS 440 REVISED 0891

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3933

SITE NAME: NAWC - Warminster

SAMPLERS (SIGNATURE): [illegible] Paul Davis

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	VOA / VOA-TCLP	BNA / BNA TCLP	PCB Pest / PCB-Pest-TCLP	Metals / Metals TCLP	Cyanide	TOC - COD NO3 - NH3	REMARKS
618	6/18/92	0830		✓	W-618-RB	14	3/3	1/1	1/1	1/1	1	1	analyze Rinsate

RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):
[illegible]	6-18-92 1430				
RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):
RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED FOR LABORATORY BY (SIGNATURE):	DATE / TIME:	REMARKS: Shipped Via Federal Express Airbill Number 4689021551	

NUS 440 REVISED 0891

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3933

SITE NAME: NAWC Warminster

SAMPLERS (SIGNATURE): [illegible] Paul [illegible]

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	VOA	BNA, PCB/Pest, TPH, LEAD	Metals	Cyanide	TCLP, WET, CEC, pH, TOC, MC			REMARKS
17	6-19-92	1208		✓	W-SB-17	4	2	1	1					
18	6-19-92	1105		✓	W-SB-18	6	2	1	1	2				
01	6-19-92	1150		✓	W-SS-01	4	2	1	1					
02	6-19-92	1047		✓	W-SS-02	4	2	1	1					

RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):
[illegible]	6-19-92 1530				
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RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED FOR LABORATORY BY (SIGNATURE):	DATE / TIME:	REMARKS: Shipped via Federal Express Airbill No. 4689021540	

NUS 440 REVISED 0891

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3733

SITE NAME: NAWC - Warminster

SAMPLERS (SIGNATURE): [illegible] Paul [illegible]

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	VOA	BNA	PCB/Pest.	Metals	Cyanide	TOC - TOX - NO3 - NH3	REMARKS
619	6-19-92	1015		✓	W - 619 - RB	8	3	1	1	1	1	1	Hold Rinsate, [illegible] analyze as per NEESA
619	6-19-92	1015		✓	W - 619 - TB	3	3						Trip Blank

RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):
[illegible]	6-19-92 1530				
RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):
RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED FOR LABORATORY BY (SIGNATURE):	DATE / TIME:	REMARKS: Shipped via Federal Express Airbill No. 4689021540	

NUS 440 REVISED 0891

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3933

SITE NAME: NAWC WARMINSTER

SAMPLERS (SIGNATURE): [illegible]

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	VOA	BNA-PCB-PEST TPH-BTEX	BNA-PCB-PEST	METALS-CYANIDE	TCLP-INT. CEC PH-TOC-MC		REMARKS
03	6/22/92	0841		✓	W-SS-03	4	2	1		1			
19	6/22/92	0854		✓	W-SB-19	6	2	1		1	2		
19	6/22/92	0854		✓	W-SB-19-D	6	2	1		1	2		
19	6/22/92	0854		✓	W-SB-19-MS	6	2	1		1	2		Do MS
19	6/22/92	0854		✓	W-SB-19-MSD	9	2	1		1	5		Do MSD
01	6/22/92	1101		✓	W-SD-01	4	2		1	1			
02	6/22/92	1028		✓	W-SD-02	4	2		1	1			
03	6/22/92	1514		✓	W-SD-03	4	2		1	1			
04	6/22/92	1237		✓	W-SD-04	4	2		1	1			

RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):
[illegible]	6/22/92 17:04				
RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):
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NUS 440

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3933

SITE NAME: NAWC WARMINSTER

SAMPLERS (SIGNATURE): [illegible]

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	VOA	BNA	PCB-PEST.	METALS (TOTAL)	METALS (DISSOLVED)	CYANIDE	Hard, Alk, TDS, TSS, BOD, Sulf, Chl, TOC, COD, NH3, NO3			REMARKS
622	6/22/92	0833		✓	W-622-TB	3	3									TRIP BLANK
622	6/22/92	1010		✓	W-622-FB	10	3	1	1	1	1	1	1	1		FIELD BLANK
622	6/22/92	1547		✓	W-622-RB	8	3	1	1	1		1		1		Analyze Rinsate Blank
01	6/22/92	1056		✓	W-SW-01	7	3	1	1	1		1				
01	6/22/92	1056		✓	W-SW-F-01	1					1					
02	6/22/92	1022		✓	W-SW-02	7	3	1	1	1		1				
02	6/22/92	1022		✓	W-SW-F-02	1					1					
03	6/22/92	1510		✓	W-SW-03	7	3	1	1	1		1				
03	6/22/92	1510		✓	W-SW-F-03	1					1					
04	6/22/92	1230		✓	W-SW-04	7	3	1	1	1		1				
04	6/22/92	1230		✓	W-SW-F-04	1					1					

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[illegible]	6/22/92 17:04				
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RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED FOR LABORATORY BY (SIGNATURE):	DATE / TIME:	REMARKS: Shipped via Federal Express Airbill No. 4689021562	

NUS 440 REVISED 0891

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3933

SITE NAME: NAWC WARMINSTER

SAMPLERS (SIGNATURE): [illegible]

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	VOA	BNA-X3-PEST	METALS-CYANIDE				REMARKS
05	6/23/92	1103		✓	W-SD-05	4	2	1	1				
06	6/23/92	1106		✓	W-SD-06	4	2	1	1				
06	6/23/92	1106		✓	W-SD-06-D	4	2	1	1				
06	6/23/92	1106		✓	W-SD-06-MS	4	2	1	1				Do MS
06	6/23/92	1106		✓	W-SD-06-MSD	4	2	1	1				Do MSD
01	6/23/92	1133		✓	W-SD-W-01	4	2	1	1				

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[illegible]	6/23/92 1511				
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RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED FOR LABORATORY BY (SIGNATURE):	DATE / TIME:	REMARKS: Shipped via Federal Express Airbill No. 4689021536	

NUS 440 REVISED 0891

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3933

SITE NAME: NAWC WARMINSTER

SAMPLERS (SIGNATURE): Paul Davis, Robert J. Gerard, Scott D. Yolanc

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	VOA	BNA	PCB - PEST	METALS (TOTAL)	METALS (DISSOLVED)	CYANIDE	REMARKS
623	6/23/92	0850		✓	W - 623 - TB	3	3						TRIP BLANK
623	6/23/92	1404		✓	W - 623 - RB	7	3	1	1	1		1	RINSATE BLANK : Hold, but do not analyze as per NEESA.
05	6/23/92	1856		✓	W - SW - 05	7	3	1	1	1		1	
05	6/23/92	0856		✓	W - SW - F - 05	1					1		
06	6/23/92	1048		✓	W - SW - 06	7	3	1	1	1		1	
06	6/23/92	1048		✓	W - SW - F - 06	1					1		
06	6/23/92	1048		✓	W - SW - 06 - D	7	3	1	1	1		1	
06	6/23/92	1048		✓	W - SW - F - 06 - D	1					1		
06	6/23/92	1048		✓	W - SW - 06 - MS	7	3	1	1	1		1	Do MS
06	6/23/92	1048		✓	W - SW - F - 06 - MS	1					1		Do MS
06	6/23/92	1048		✓	W - SW - 06 - MSD	7	3	1	1	1		1	Do MSD
06	6/23/92	1048		✓	W - SW - F - 06 - MSD	1					1		Do MSD

RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):
Robert J. Gerard	6/23/92 1511				
RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):
RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED FOR LABORATORY BY (SIGNATURE):	DATE / TIME:	REMARKS: Shipped via Federal Express Airbill No. 4689021536	

NUS 440 REVISED 0891

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3933

SITE NAME: NAWC - Warminster

SAMPLERS (SIGNATURE): [illegible]

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	Low Conc. VOA	Metals	dissolved metals	Cyanide	Hetl, Alk, TDS, TSS	BOD, Sulf, Chlor	TOC, COD, Alk, Nitr	REMARKS
01	6-24-92	1310		✓	W MW-01	6	3	1	1	1				
02	6-24-92	1404		✓	W-MW-02	6	3	1	1	1				
03	6-24-92	1302		✓	W-MW-03	8	3	1	1	1	1	1		
04	6-24-92	1330		✓	W-MW-04	6	3	1	1	1				
624	[illegible]	1530		✓	W-~~MW~~ 624 - RB	8	3	1	1	1	1	1		

RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):
[illegible]	6-24-92 1700				
RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):
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HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3933

SITE NAME: NAWC WARMINSTER

SAMPLERS (SIGNATURE): [signature]

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	VOA	BNA	PCB/PEST	METALS	METALS (Dissolved)	CYANIDE	Hard, Alk, TDS, TSS, SO4, Sulf, Chlor.	TOC, COD, NH3, NO2	REMARKS
624	6/24/92	0814		✓	W-624-FB	10	3	1	1	1	1	1	1	1	
624	6/24/92	0840		✓	W-624-TB	3	3								

RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):
[signature]	6-24-92 1700				
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RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED FOR LABORATORY BY (SIGNATURE):	DATE / TIME:	REMARKS: Shipped via Federal Express Airbill No. 4685021330	

NUS 440 REVISED 0891

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3933

SITE NAME: NAWC - Westminster

SAMPLERS (SIGNATURE): Paul Davis

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	Low Concentration VOA	Metals	dissolved metals	Cyanide	Hard, Alk, TDS, TSS, BOD Sulf Chlor.	TOC COD NH3 NO3	BNA	PCB/Pest	REMARKS
05	6-25-92	0950		✓	W-MW-05	6	3	1	1	1					
06	6-25-92	1218		✓	W-MW-06	8	3	1	1	1	1	1			
07	6-25-92	1343		✓	W-MW-07	6	3	1	1	1					
08	6-25-92	0920		✓	W-MW-08	6	3	1	1	1					
08	6-25-92	0920		✓	W-MW-08-D	6	3	1	1	1					
08	6-25-92	0920		✓	W-MW-08-MS	6	3	1	1	1					Do MS
08	6-25-92	0920		✓	W-MW-08-MSD	6	3	1	1	1					Do MSD
09	6-25-92	1128		✓	W-MW-09	8	3	1	1	1			1	1	
10	6-25-92	1334		✓	W-MW-10	6	3	1	1	1					

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	6-25-92 / 1800				
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NUS 440 REVISED 0891

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3933

SITE NAME: NAWC - Westminster

SAMPLERS (SIGNATURE): [illegible]

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	VOA	BNA	PCB/Pest	metals	dissolved metals	Cyanide	Hard, Alk, TDS, TSS, BOD, SulF, Chlor.	TOC, COD, NH3, NO2	REMARKS
625	6-25-92	1415		✓	W-625-RB	10	3	1	1	1	1	1	1	1	Rinsate Blank - Hold, do not analyze as per DEESA
625	6-25-92	1425		✓	W-625-TB	3	3								Trip Blank

RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):
[illegible]	6-25-92 18:00				
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NUS 440 REVISED 0891

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3933

SITE NAME: NAWC - Warminster

SAMPLERS (SIGNATURE): [illegible]

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	Low Conc. VOA	Metals	dissolved Metals	Cyanide	Hard, Alk, TDS, TSS, BOD, Sulf, Chlor.	TOC, COD, NH3, NO3	REMARKS
11	6-26-92	0924		✓	W-MW-11	6	3	1	1	1			
12	6-26-92	0908		✓	W-MW-12	6	3	1	1	1			
13	6-26-92	1004		✓	W-MW-13	6	3	1	1	1			
14	6-26-92	0913		✓	W-MW-14	8	3	1	1	1	1	1	
15	6-26-92	1206		✓	W-MW-15	6	3	1	1	1			
16	6-26-92	1125		✓	W-MW-16	6	3	1	1	1			

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[illegible]	6-26-92 1400				
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NUS 440 REVISED 0891

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3933

SITE NAME: NAWC - Warminster

SAMPLERS (SIGNATURE): Vit A. Shi Paul Di R. Tomal

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	VOA	Metals	dissolved metals	Cyanide	Hard, Alk, TDS, TSS, BOD, Sulf, Chlor.	TOC, COD	NH_3, NO_3	REMARKS
626	6-26-92			✓	W-626-RB	8	3	1	1	1	1	1		Rinsate Blank - analyze
626	6-26-92	10		✓	W-626-TB	3	3							Trip Blank

RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):
Vit A. Shi	6-26-92 1600				
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NUS 440 REVISED 0891

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3933

SITE NAME: NAWC - Warminster

SAMPLERS (SIGNATURE): [illegible]

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	Low concentration VOA	Metals	dissolved Metals	Cyanide	BNA	PCB/Pest	Hard Alk, TDS, TSS BOD, Sulf, Chlor. TOC, COD NH3, NO2		REMARKS
17	6-29-92	0923		✓	W-MW-17	6	3	1	1	1					
22	6-29-92	0919		✓	W-MW-22	6	3	1	1	1					
23	6-29-92	0949		✓	W-MW-23	6	3	1	1	1					
23	6-29-92	0949		✓	W-MW-23-D	6	3	1	1	1					
23	6-29-92	0949		✓	W-MW-23-MS	6	3	1	1	1					Do MS
23	6-29-92	0949		✓	W-MW-23-MSD	6	3	1	1	1					Do MSD
21	6-29-92	1310		✓	W-MW-21	10	3	1	1	1	1	1	1	1	
24	6-29-92	1245		✓	W-MW-24	6	3	1	1	1					
629	6-29-92	0830		✓	W-629-RB	10	3	1	1	1	1	1	1	1	Rinsate Blank - Do not analyze as per NEESA
629	6-29-92	0845		✓	W-629-TB	3	3								Trip Blank
18	6-29-92	1553		✓	W-MW-18	6	3	1	1	1					
19	6-29-92	1552		✓	W-MW-19	6	3	1	1	1					

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[illegible]	6-29-92 1700				
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NUS 440 REVISED 0891

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3933

SITE NAME: NAWC - Warminster

SAMPLERS (SIGNATURE): [illegible] [illegible] Paul Davis [illegible] [illegible]

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	Low Concentration VOA	Metals	dissolved metals	Cyanide	BNA	PCB/Pest	H2SO4, HNO3, TDS, TSS 8000, SO4, chlor	TOC, COD NH3, NO3	REMARKS
20	6-30-92	0821		✓	W-MW-20	6	3	1	1	1					
630	6-30-92	0900		✓	W-630-TB	3	3								Trip Blank
25	6-30-92	1005		✓	W-MW-25	8	3	1	1	1			1	1	
26	6-30-92	1302		✓	W-MW-26	6	3	1	1	1					
27	6-30-92	1311		✓	W-MW-27	6	3	1	1	1					
28	6-30-92	1353		✓	W-MW-28	6	3	1	1	1					
29	6-30-92	1454		✓	W-MW-29	8	3	1	1	1	1	1			
630	6-30-92	1500		✓	W-630-RB	10	3	1	1	1	1	1	1	1	Analyze Rinsate Blank
30	6-30-92	1555		✓	W-MW-30	8	3	1	1	1			1	1	

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NUS 440 REVISED 0891

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3922

SITE NAME: NAWC WARMINSTER

SAMPLERS (SIGNATURE): [illegible]

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	Low Concentration VOA	Metals	Dissolved Metals	Cyanide	Hard, Alk, TDS, TSS, BOD, Sulf, Chlor, TOC, COD, NH3, NO3		REMARKS
701	7/1/92	0920		✓	W-701-TB	3	3						TRIP BLANK
701	7/1/92	0940		✓	W-701-RB	8	3	1	1	1	1	1	RINSATE BLANK - Do not analyze as per NESSA
32	7/1/92	0935		✓	W-MW-32	8	3	1	1	1	1	1	
33	7/1/92	1330		✓	W-MW-33	6	3	1	1	1			
36	7/1/92	1250		✓	W-MW-36	6	3	1	1	1			
34	7/1/92	1440		✓	W-MW-34	6	3	1	1	1			
31	7/1/92	1510		✓	W-MW-31	8	3	1	1	1	1	1	
31	7/1/92	1510		✓	W-MW-31-D	8	3	1	1	1	1	1	
31	7/1/92	1510		✓	W-MW-31-MS	8	3	1	1	1	1	1	Do MS
31	7/1/92	1510		✓	W-MW-31-MSD	8	3	1	1	1	1	1	Do MSD
35	7/1/92	1453		✓	W-MW-35	8	3	1	1	1	1	1	

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[illegible]	7-1-92 1530				
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NUS 440 REVISED 0891

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3933

SITE NAME: NAWC - Warminster

SAMPLERS (SIGNATURE): Paul D. [illegible] Paul D. Good

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	Low Concentration VOA	BNA	PCB/Pest	Metals	dissolved metals	Cyanide	REMARKS
702	7-2-92	0830		✓	W-702-RB	8	3	1	1	1	1	1	Analyze Rinsate Blank
37	7-2-92	0835		✓	W-MW-37	6	3			1	1	1	
38	7-2-92	0957		✓	W-MW-38	6	3			1	1	1	
39	7-2-92	1200		✓	W-MW-39	8	3	1	1	1	1	1	
39	7-2-92	1200		✓	W-MW-39-D	8	3	1	1	1	1	1	
39	7-2-92	1200		✓	W-MW-39-MS	8	3	1	1	1	1	1	Do MS
39	7-2-92	1200		✓	W-MW-39-MSD	8	3	1	1	1	1	1	Do MSD
40	7-2-92	1315		✓	W-MW-40	8	3	1	1	1	1	1	
702	7-2-92	0950		✓	W-702-TB	3	3						TRIP BLANK

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Paul D. Good	7-2-92 1500				
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NUS 440 REVISED 0891

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3933

SITE NAME: NAWC - Warminster

SAMPLERS (SIGNATURE): [illegible]

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	Low Concentration VOA	Metals dissolved metals	Cyanide Hera, Alk, TDS, TSS BOD, Sulf, Chlor TOC, COD NH3, NO3					REMARKS
706	7-6-92	0900		✓	W-706-TB	3	3							Trip Blank
706	7-6-92	0930		✓	W-706-RB	8	3	1	1	1	1	1		Rinsate Blank - Do not analyze as per NFESA
41	7-6-92	1231		✓	W-MW-41	6	3	1	1	1				
42	7-6-92	1210		✓	W-MW-42	6	3	1	1	1				
43	7-6-92	1427		✓	W-MW-43	6	3	1	1	1				
46	7-6-92	1547		✓	W-MW-46	8	3	1	1	1	1	1		
45	7-6-92	1620		✓	W-MW-45	6	3	1	1	1				
45	7-6-92	1620		✓	W-MW-45-D	6	3	1	1	1				
45	7-6-92	1620		✓	W-MW-45-MS	6	3	1	1	1				Do MS
45	7-6-92	1620		✓	W-MW-45-MSD	6	3	1	1	1				Do MSD
44	7-6-92	1710		✓	W-MW-44	6	3	1	1	1				

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[signature]	7-6-92 1815				
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NUS 440 REVISED 0891

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3933

SITE NAME: NAWC Warminster

SAMPLERS (SIGNATURE): R. T. Gorrel, Paul Davis

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	Low Concentration VOA	VOA	Total Metals	Dissolved Metals	Cyanide	BNA	PB - Pest	REMARKS
07	8/6/92	1350		✓	W-SW-07	8		3	1	1	1	1	1	
08	8/6/92	0920		✓	W-SW-08	8		3	1	1	1	1	1	
08	8/6/92	0920		✓	W-SW-08-D	8		3	1	1	1	1	1	
08	8/6/92	0920		✓	W-SW-08-MS	8		3	1	1	1	1	1	Do MS
08	8/6/92	0920		✓	W-SW-08-MSD	8		3	1	1	1	1	1	Do MSD
01	8/6/92	1130		✓	W-OS-01	8	3		1	1	1	1	1	
01	8/6/92	1130		✓	W-OS-01-D	8	3		1	1	1	1	1	
01	8/6/92	1130		✓	W-OS-01-MS	8	3		1	1	1	1	1	Do MS
01	8/6/92	1130		✓	W-OS-01-MSD	8	3		1	1	1	1	1	Do MSD
02	8/6/92	1300		✓	W-OS-02	6	3		1	1	1			
03	8/6/92	1320		✓	W-OS-03	6	3		1	1	1			
806	8/6/92	1520		✓	W-806-TB	3	3							Trip Blank
806	8/6/92	1705		✓	W-806-RB	7		3	1		1	1	1	Analyze Rinsate

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R. T. Gorrel	8/6/92 1930				
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NUS 440 REVISED 0891

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3933

SITE NAME: NAWC Warminster

SAMPLERS (SIGNATURE): [illegible] Paul [illegible]

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	VOA	BNA-PCB-Pest.	Metals-Cyanide				REMARKS
07	8/6/92	1355		✓	W-SD-07	4	2	1	1				
08	8/6/92	0920		✓	W-SD-08	4	2	1	1				
08	8/6/92	0920		✓	W-SD-08-D	4	2	1	1				
08	8/6/92	0920		✓	W-SD-08-MS	4	2	1	1				Do MS
08	8/6/92	0920		✓	W-SD-08-MSD	10	2	4	4				Do MSD

RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):
[illegible]	8/6/92 1930				
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NUS 440 REVISED 0891

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3733

SITE NAME: NAWC Warminster

SAMPLERS (SIGNATURE): [illegible] Paul [illegible]

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	VOA	Total Metals	Dissolved Metals	Cyanide	DNA	PCB - Pest	Hardness, Alkalinity, Tot. TSS, Sulf. Chlor	TOC, COD, NH3, NO3	REMARKS
806	8/6/92	1525		✓	W-806-FB	10	3	1	1	1	1	1	1	1	

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[illegible]	8/6/92 1930				
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NUS 440 REVISED 0891

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3933

SITE NAME: NAWC WARMINSTER

SAMPLERS (SIGNATURE): [signature]

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	VOA	Low Concentration VOA	Total Metals	Dissolved Metals	Cyanide		REMARKS
812	8/12/92	0856		✓	W-812-TB	3	3						TRIP BLANK
04	8/12/92	1100		✓	W-05-04	6		3	1	1	1		

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[signature]	8/12/92 1230				
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NUS 440 REVISED 0891

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.: 3933

SITE NAME: NAWC Warminster

SAMPLERS (SIGNATURE): Andy Kendall for Rob Good

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	Shelby Tube						REMARKS
W-SB-15	6/18/92	NA		X	W-SB-15	1	1						1.0' - 3.0' 21" Rec.
W-SB-02	6/16/92	NA		X	W-SB-02	1	1						8.0' - 10.0' 15" Rec.
W-SB-09	6/17/92	NA		X	W-SB-09	1	1						6" - 2' 6" 16.5" Rec.
W-SB-17	6/17/92	NA		X	W-SB-17	1	1						6" - 33" 15" Rec.
					Note: Talk to								
					Neil Teamerson								
					about required								
					analytical, Wayne, PA.								
					AK.								

RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):
Andy Kendall	3/14/92 1010				
RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):
RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED FOR LABORATORY BY (SIGNATURE):	DATE / TIME:	REMARKS: Driven from Warminster and hand delivered to Pitt. Lab.	

NUS 440 REVISED 0891

APPENDIX J

PHASE II SURVEY RESULTS

BOUCHER & JAMES, INC.

SITE COORDINATES AND ELEVATIONS

SEPTEMBER 10, 1992

SITES 1, 2 & 3

POINT NO.	COORDINATES		ELEVATIONS		
	NORTH	EAST	GROUND	TOP OF CASING	TOP OF PVC
MW 02	328,249.40	2,745,483.62	316.35	317.80	317.43
MW 03	328,468.16	2,745,607.35	311.73	313.65	313.36
MW 04	327,881.85	2,745,973.81	312.28	313.40	312.68
MW 07	327,891.13	2,745,981.95	311.80	313.60	313.32
MW 10	328,240.72	2,745,944.10	309.18	310.64	310.34
MW 11	328,095.88	2,746,497.69	308.43	310.46	309.86
SB 01	328,423.15	2,745,813.91	309.14		
SB 02	328,129.53	2,746,195.85	309.59		
SB 03	327,882.90	2,746,525.71	312.23		
SB 04	327,847.37	2,746,561.32	316.95		
SB 12	328,044.08	2,746,651.30	310.70		
SMC 01	328,412.04	2,745,667.22	312.66	313.91	
SMC 02	328,410.63	2,745,661.91	312.47	313.01	

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
Timothy D. Hydrusko
LAND SURVEYOR
31410-E

BOUCHER & JAMES, INC.

SITE COORDINATES AND ELEVATIONS

SEPTEMBER 10, 1992

SITES 1, 2 & 3

POINT	COORDINATES		ELEVATIONS		
	NORTH	EAST	GROUND	TOP OF CASING	TOP OF PVC
BG 4	328,201.66	2,745,950.81			315.63
C	328,465.79	2,745,868.56	307.71	310.10	309.63
D	328,326.21	2,746,015.15	308.99	310.99	310.13
E	328,269.04	2,745,966.85	309.13	311.19	310.64

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
Timothy D. Hvarasko
SURVEYOR
31410-E

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BOUCHER & JAMES, INC.

SITE COORDINATES AND ELEVATIONS

SEPTEMBER 10, 1992

SITE NO. 4

POINT NO.	COORDINATES		ELEVATIONS		
	NORTH	EAST	GROUND	TOP OF CASING	TOP OF PVC
SB 13	327,499.59	2,750,032.56	343.90		
SB 14	327,492.83	2,750,204.90	344.02		
SB 15	327,508.74	2,750,235.06	344.47		
SB 16	327,289.22	2,750,237.69	354.74		
DG 16	327,609.57	2,749,890.38			338.94
DG 28	327,609.30	2,749,876.66			338.61

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LAND SURVEYOR
31410-E

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Rev. 10/20/92

BOUCHER & JAMES, INC.

SITE COORDINATES AND ELEVATIONS

SEPTEMBER 10, 1992

SITES 5, 6 & 7

POINT NO.	COORDINATES		ELEVATIONS		
	NORTH	EAST	GROUND	TOP OF CASING	TOP OF PVC
MW 05	325,564.44	2,752,027.78	335.94	338.07	337.53
MW 06	325,632.22	2,751,660.32	338.90	340.96	340.68
MW 08	325,554.74	2,752,021.19	335.81	337.78	337.14
MW 09	325,539.20	2,751,614.37	334.85	336.95	336.65
SB 05	326,173.36	2,751,782.32	350.18		
SB 06	326,219.13	2,751,823.51	352.07		
SB 07	326,219.33	2,751,850.37	351.39		
SB 08	326,266.64	2,751,482.14	367.04		
SB 09	326,430.18	2,751,339.50	369.96		
SB 10	326,364.13	2,751,312.80	369.16		
SB 11	326,601.86	2,751,190.16	371.76		
DG 17	326,115.13	2,751,406.66			356.48
DG 25	325,971.52	2,751,650.20			347.00

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REGISTERED PROFESSIONAL
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BOUCHER & JAMES, INC.

SITE COORDINATES AND ELEVATIONS

SEPTEMBER 10, 1992

SITE NO. 8

POINT NO.	COORDINATES		ELEVATIONS		
	NORTH	EAST	GROUND	TOP OF CASING	TOP OF PVC
MW 01	328,261.61	2,748,264.73	325.35	327.04	326.58
SB 17	328,113.14	2,748,370.16	331.51		
SB 18	327,848.92	2,748,028.42	333.61		
SB 19	328,075.97	2,748,352.60	331.53		
BG 05	327,967.79	2,748,518.42			335.43
DG 14	328,344.66	2,748,445.44			327.07

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COMMONWEALTH OF PENNSYLVANIA
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LAND SURVEYOR
31410-E

45 v3

Phase II
Remedial Investigation Report
Volume III (Appendices K through O)

for

Operable Unit 1
Naval Air Warfare Center (NAWC)
Philadelphia Naval Shipyard

Warminster, Pennsylvania

Northern Division

Naval Facilities Engineering Command

Contract No. N62472-90-D-1298-0136

Contract Task Order 0022

April 1993

Halliburton NUS
CORPORATION

45v3

D-51-2-3-7

PHASE II
REMEDIAL INVESTIGATION REPORT
VOLUME III (APPENDICES K THROUGH O)
for
OPERABLE UNIT 1
NAVAL AIR WARFARE CENTER (NAWC)
WARMINSTER, PENNSYLVANIA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Northern Division
Environmental Branch, Code 18
Naval Facilities Engineering Command
10 Industrial Highway, Mail Stop No. 82
Lester, Pennsylvania 19113-2090

Submitted by:
Halliburton NUS Corporation
993 Old Eagle School Road, Suite 415
Wayne, Pennsylvania 19087-1710

Contract No. N62472-90-D-1298
Contract Task Order 0022

April 1993

PREPARED BY:

Neil Teamerson

NEIL TEAMERSON
PROJECT MANAGER
HALLIBURTON NUS CORPORATION
WAYNE, PENNSYLVANIA

APPROVED BY:

John Trepanowski

JOHN J. TREPANOWSKI, P.E.
PROGRAM MANAGER
HALLIBURTON NUS CORPORATION

NAWC WARMINSTER APPENDICES
VOLUME III

APPENDIX	TOPIC
K.	**ANALYTICAL DATABASE**
	K.1 Phase I - Organics
	K.2 Phase I - Inorganic
	K.3 Phase II - Miscellaneous Parameters
	K.4 Phase II - TCL Low-Concentration Volatile Organics
	K.5 Phase II - TCL Organic
	K.6 Phase II - TAL Inorganic and Cyanide
L.	**DATA VALIDATION SUMMARIES**
M.	**SAMPLE CALCULATIONS**
N.	**RISK ASSESSMENT SPREADSHEETS**
	N.1 Current Groundwater
	N.2 Upper Confidence Limits
O.	**TOXICITY PROFILES**

APPENDIX K

ANALYTICAL DATABASE

Groundwater Sample Identificaiton Numbers
NAWC Warminster Remedial Investigation

Phase II Sample Identification Number	Monitoring Well Number and Phase I Sample Identification Number	Sample/Well Location
W-MW-11	DG-18	Area B (Sites 5, 6, & 7)
W-MW-12	DG-9	Area B (Sites 5, 6, & 7)
W-MW-13	DG-10	Area B (Sites 5, 6, & 7)
W-MW-14	BG-7	Area B (Sites 5, 6, & 7)
W-MW-15	DG-19	Area B (Sites 5, 6, & 7)
W-MW-16	DG-17	Area B (Sites 5, 6, & 7)
W-MW-17	MW-05	Area B (Sites 5, 6, & 7)
W-MW-18	MW-06	Area B (Sites 5, 6, & 7)
W-MW-19	DG-25	Area B (Sites 5, 6, & 7)
W-MW-20	MW-09	Area B (Sites 5, 6, & 7)
W-MW-21	DG-21	Area B (Sites 5, 6, & 7)
W-MW-22	DG-8	Area B (Sites 5, 6, & 7)
W-MW-23	DG-20	Area B (Sites 5, 6, & 7)
W-MW-24	DG-27	Area B (Sites 5, 6, & 7)
W-MW-25	MW-02	Area A (Sites 1, 2, & 3)
W-MW-26	MW-03	Area A (Sites 1, 2, & 3)
W-MW-27	DG-13	Area A (Sites 1, 2, & 3)
W-MW-28	DG-3	Area A (Sites 1, 2, & 3)
W-MW-29	MW-04	Area A (Sites 1, 2, & 3)
W-MW-30	MW-07	Area A (Sites 1, 2, & 3)
W-MW-31	C	Area A (Sites 1, 2, & 3)
W-MW-32	DG-1	Area A (Sites 1, 2, & 3)
W-MW-33	E	Area A (Sites 1, 2, & 3)
W-MW-34	SMP-2	Area A (Sites 1, 2, & 3)
W-MW-35	DG-12	Area A (Sites 1, 2, & 3)
W-MW-36	DG-26	Area A (Sites 1, 2, & 3)
W-MW-37	MW-11	Area A (Sites 1, 2, & 3)
W-MW-38	BG-4	Area A (Sites 1, 2, & 3)
W-MW-39	D	Area A (Sites 1, 2, & 3)
W-MW-41	SMC-2	Area A (Sites 1, 2, & 3)
W-MW-42	DG-23	Area A (Sites 1, 2, & 3)
W-MW-43	SMC-1	Area A (Sites 1, 2, & 3)
W-MW-44	DG-2	Area A (Sites 1, 2, & 3)

APPENDIX K-1

PHASE I - ORGANICS

SITE: WARMINSTER NAVAL BASE
CASE NO. 3933
LABORATORY: CEIMIC

Total Organic Carbon Analyses (mg/L)

Client ID:		W-SB-04	W-SB-09	W-SB-14	W-SB-18	W-SB-19
LAB ID:		920317-04	920317-09	920323-02	920323-10	920328-01
ANALYTE	RL					
TOC	1	2600	23400	488	7180	3700
Dilution Factor:		1.0	1.0	1.0	1.0	1.0

SITE: WARMINSTER NAVAL BASE
CASE NO. 3933
LABORATORY: CEIMIC

Total Organic Carbon Analyses (mg/L)

Client ID:		W-SB-19D	W-MW-03	W-MW-06	W-MW-14	W-MW-21
LAB ID:		920328-02	920330-15	920323-02	920323-13	920336-02
ANALYTE	RL					
TOC	1	3400	1.4 B	8.4	2	7.3
Dilution Factor:		1.0	1.0	1.0	1.0	1.0

SITE: WARMINSTER NAVAL BASE
CASE NO. 3933
LABORATORY: CEIMIC

Total Organic Carbon Analyses (mg/L)

Client ID:		W-MW-25	W-MW-30	W-MW-31
LAB ID:		920336-03	920336-04	920343-01
ANALYTE	RL			
TOC	1	8.9	6	2.6
Dilution Factor:		1.0	1.0	1.0

SITE: WARMINSTER NAVAL BASE
CASE NO. 3933
LABORATORY: CEIMIC

Inorganic Analyses

Client ID:	W-SB-04	W-SB-09	W-SB-14	W-SB-18	W-616-RB	
LAB ID:	920317-04	920317-09	920323-02	920323-10	920317-13	
ANALYTE						
% Moisture	14.9	7.5	18.5	17.8	NA	
pH	6	7.4	7.9	6.7	NA	
Chemical Oxygen Demand	NA	NA	NA	NA	5	U
Alkalinity	NA	NA	NA	NA	NA	
Ammonia	NA	NA	NA	NA	NA	
Biological Oxygen Demand	NA	NA	NA	NA	NA	
Chloride	NA	NA	NA	NA	NA	
Hardness	NA	NA	NA	NA	NA	
Nitrate-Nitrite	NA	NA	NA	NA	NA	
Sulfate	NA	NA	NA	NA	NA	
Total Dissolved Solids	NA	NA	NA	NA	NA	
Total Suspended Solids	NA	NA	NA	NA	NA	
Dilution Factor:	1.0	1.0	1.0	1.0	1.0	

NA - Not Analyzed

SITE: WARMINSTER NAVAL BASE
CASE NO. 3933
LABORATORY: CEIMIC

Inorganic Analyses

Client ID:	W-617-FB		W-618-RB		W-618-FB		W-SB-19	W-SB-19-D
LAB ID:	920317-15		920323-07		920323-06		920328-01	920328-02
ANALYTE								
% Moisture	NA		NA		NA		16	15.7
pH	NA		NA		NA		7.6	7.1
Chemical Oxygen Demand	5	U	5	U	5	U	NA	NA
Alkalinity	133		NA		99		NA	NA
Ammonia	0.1		0.1	U	0.33		NA	NA
Biological Oxygen Demand	2	U	NA		NA		NA	NA
Chloride	12		NA		14		NA	NA
Hardness	146		NA		113		NA	NA
Nitrate-Nitrite	0.64		0.02	U	0.33		NA	NA
Sulfate	37		NA		31		NA	NA
Total Dissolved Solids	191		NA		190		NA	NA
Total Suspended Solids	5	U	NA		6		NA	NA
Dilution Factor:	1.0		1.0		1.0		1.0	1.0

NA - Not Analyzed

SITE: WARMINSTER NAVAL BASE
CASE NO. 3933
LABORATORY: CEIMIC

Inorganic Analyses

Client ID:	W-622-FB		W-622-RB		W-MW-03		W-624-FB		W-624-RB	
LAB ID:	920328-16		920328-17		920330-15		920330-17		920330-18	
ANALYTE										
% Moisture	NA		NA		NA		NA		NA	
pH	NA		NA		NA		NA		NA	
Chemical Oxygen Demand	5	U	5	U	2	U	2	U	2	U
Alkalinity	2	U	NA		99		2	U	2	U
Ammonia	0.1		0.1	U	0.2		0.1	U	0.1	U
Biological Oxygen Demand	2	U	NA		2	U	2	U	2	U
Chloride	2	U	NA		2		5	U	5	U
Hardness	2	U	NA		120		2	U	2	U
Nitrate-Nitrite	0.04		0.02	U	0.02	U	0.02	U	0.03	
Sulfate	5	U	NA		38		5	U	5	U
Total Dissolved Solids	39	B	NA		143		10		10	
Total Suspended Solids	5	U	NA		5	U	5	U	5	U
Dilution Factor:	1.0		1.0		1.0		1.0		1.0	

NA – Not Analyzed

SITE: WARMINSTER
CASE NO. 9710-40004

TABLE I - TENTATIVELY IDENTIFIED COMPOUNDS (TICs)*

CLIENT ID:	NADC - 1-SEDIMENT	2-SEDIMENT	2-SEDIMENT-D	5-SEDIMENT	8-SEDIMENT
TIC					
SULFUR, MOL(8)				x	x
TETRADECANOIC ACID					
DICHLOROFLUOROMETHANE					
1-METHYL PYRENE	X				
DIMETHYL-PHENANTHRENE ISOMER		X			
11H-BENZO(b)FLUORENE		X			
UNKNOWN PAH		X			
UNKNOWN PHTHALATE ESTER			X		

* This table presents the named TICs which remain after data validation qualification.

SITE: WARMINSTER
CASE NO. 9710-40004

TABLE I - TENTATIVELY IDENTIFIED COMPOUNDS (TICs)*

CLIENT ID:	NADC - S1-64-DG-1	S1-66-WELL-C	S2-22-BG-4-D	S2-23-BG-4	S2-25-D
TIC					
SULFUR, MOL(8)	X				x
TETRADECANOIC ACID					
DICHLOROFLUOROMETHANE			X	X	
1-METHYL PYRENE					
DIMETHYL-PHENANTHRENE ISOMER					
11H-BENZO(b)FLUORENE					
UNKNOWN PAH					
UNKNOWN PHTHALATE ESTER					

* This table presents the named TICs which remain after data validation qualification.

SITE: WARMINSTER
CASE NO. 9710-40004

TABLE I - TENTATIVELY IDENTIFIED COMPOUNDS (TICs)*

CLIENT ID:	NADC - S2-63-WELL-E	S2-76-DG-2	S3-62-DG-3	S4-37-DG-9	S4-67-BG-2
TIC					
SULFUR, MOL(8)	X	x	x	x	X
TETRADECANOIC ACID				x	
DICHLOROFLUOROMETHANE					
1-METHYL PYRENE					
DIMETHYL-PHENANTHRENE ISOMER					
11H-BENZO(b)FLUORENE					
UNKNOWN PAH					
UNKNOWN PHTHALATE ESTER					

* This table presents the named TICs which remain after data validation qualification.

SITE: WARMINSTER
CASE NO. 9710-40004

TABLE I - TENTATIVELY IDENTIFIED COMPOUNDS (TICs)*

CLIENT ID:	NADC - S5-50-DG-8
TIC	
SULFUR, MOL(8)	x
TETRADECANOIC ACID	
DICHLOROFLUOROMETHANE	
1-METHYL PYRENE	
DIMETHYL-PHENANTHRENE ISOMER	
11H-BENZO(b)FLUORENE	
UNKNOWN PAH	
UNKNOWN PHTHALATE ESTER	

* This table presents the named TICs which remain after data validation qualification.

Data Qualifier Key:

B	-	Positive result is considered to be a false positive attributable to blank contamination.
R (f)	-	Nondetect for 2-butanone is considered to be unreliable due to lack of instrumental sensitivity to this compound, as demonstrated by initial and continuing calibration response factors less than 0.050. Bias is very low.
R (x)	-	Nondetect for 4,4'-DDT is considered to be unreliable due to chromatographic interferences which hampered calibration of this compound. Bias cannot be determined.
R (s)	-	Nondetects for acid-fraction compounds are considered to be unreliable based on extremely low (< 10%) acid surrogate recovery. Bias is very low.
R (m)	-	Nondetects for specific pesticide/PCB fraction compounds are considered to be unreliable due to very low matrix spike recovery.
L (s)	-	Positive result is considered to be biased low based on pesticide surrogate recovery less than lower advisory limit.
J	-	Positive result is considered to be approximate because it is reported at a concentration below the Contract Required Quantitation Limit (CRQL). In addition, some results for 1,2-dichlorobenzene and diethylphthalate are also considered to be approximate because of continuing calibration %D greater than 25%.
J (c)	-	Positive result is considered to be approximate based on calibration inconsistences. Initial calibration %RSD and/or continuing calibration %D exceeded 50%. Bias cannot be determined.
J (s,i)	-	Positive result is considered to be estimated due to surrogate recoveries and internal standard responses outside of quality control limits. Bias cannot be determined.
J (i)	-	Positive result is considered to be estimated due to semivolatile internal standard response outside of quality control limits. Bias cannot be determined.

UL (s)	-	Nondetect is considered to be biased low based on pesticide surrogate recovery less than lower advisory limit.
UJ (c)	-	Nondetect is considered to be estimated based on calibration inconsistencies. Initial calibration %RSD and/or continuing calibration %D exceeded 50%. Additionally, some pesticide/PCB fraction results in some samples are affected by low DBC surrogate recovery. Bias cannot be determined.
UJ (s,i)	-	Nondetect is considered to be estimated due to surrogate recoveries and internal standard responses outside of quality control limits. Bias cannot be determined.
UJ (i)	-	Nondetect is considered to be estimated due to semivolatile internal standard response outside of quality control limits. Bias cannot be determined.

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

VOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - FIELD R. BLANK	FIELD BLK-TAP	FIELD BLK-DI	TRIP BLANK	S2-20-RINSATE
LAB ID:		8807	8808	8811	8820	8847
CHEMICAL	CRQL					
Chloromethane	10	10 U	10 U	10 U	10 U	10 U
Bromomethane	10	10 U	10 U	10 U	10 U	10 U
Vinyl Chloride	10	10 U	10 U	10 U	10 U	10 U
Chloroethane	10	10 U	10 U	10 U	10 U	10 U
Methylene Chloride	5	6 B	5 B	8 B	16 B	5 B
Acetone	10	10 UJ(c)	10 UJ(c)	2 B	10 UJ(c)	10 UJ(c)
Carbon Disulfide	5	5 U	5 U	5 U	5 U	5 U
Trichlorofluoromethane	5	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethene	5	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethane	5	5 U	5 U	5 U	5 U	5 U
1,2-Dichloroethene(total)	5	5 U	5 U	5 U	5 U	5 U
Chloroform	5	5 U	4 B	2 B	5 U	0.5 B
1,2-Dichloroethane	5	5 U	5 U	5 U	5 U	5 U
2-Butanone	10	R(f)	R(f)	R(f)	R(f)	R(f)
1,1,1-Trichloroethane	5	5 U	5 U	5 U	5 U	5 U
CarbonTetrachloride	5	5 U	5 U	5 U	5 U	5 U
VinylAcetate	10	10 U	10 U	10 U	10 U	10 U
Bromodichloromethane	5	5 U	1 J	5 U	5 U	5 U
1,2-Dichloropropane	5	5 U	5 U	5 U	5 U	5 U
cis-1,3-Dichloropropene	5	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5	5 U	5 U	5 U	5 U	5 U
Benzene	5	5 U	5 U	5 U	5 U	5 U
Dibromochloromethane	5	5 U	5 U	5 U	5 U	5 U
1,1,2-Trichloroethane	5	5 U	5 U	5 U	5 U	5 U
trans-1,3-Dichloropropene	5	5 U	5 U	5 U	5 U	5 U
2-chloroethylVinyl ether	10	10 U	10 U	10 U	10 U	10 U
Bromoform	5	5 U	5 U	5 U	5 U	5 U
4-Methyl-2-Pentanone	10	10 U	10 U	10 U	10 U	10 U
2-Hexanone	10	10 U	10 U	10 U	10 U	10 U
Tetrachloroethene	5	5 U	5 U	5 U	5 U	5 U
1,1,2,2-Tetrachloroethane	5	5 U	5 U	5 U	5 U	5 U
Toluene	5	5 U	5 U	5 U	5 U	5 U
Chlorobenzene	5	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	5	5 U	5 U	5 U	5 U	5 U
Styrene	5	5 U	5 U	5 U	5 U	5 U
Xylenes (total)	5	5 U	5 U	5 U	5 U	5 U
1,3-dichlorobenzene	5	5 U	5 U	5 U	5 U	5 U
1,2 & 1,4-dichlorobenzene	5	5 U	5 U	5 U	5 U	5 U

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

VOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - TRIP BLANK - 21	FIELD BLANK - 27	FIELD BLANK - 28	RINS. BLANK - 30	TRIP BLANK - 31
LAB ID:		8848	8854	8855	8901	8902
CHEMICAL	CRQL					
Chloromethane	10	10 U	10 U	10 U	10 U	10 U
Bromomethane	10	10 U	10 U	10 U	10 U	10 U
Vinyl Chloride	10	10 U	10 U	10 U	10 U	10 U
Chloroethane	10	10 U	10 U	10 U	10 U	10 U
Methylene Chloride	5	6 B	3 B	5 B	6 B	4 B
Acetone	10	4 B	2 B	10 UJ(c)	28 B	3 B
Carbon Disulfide	5	5 U	5 U	5 U	5 U	5 U
Trichlorofluoromethane	5	5 U	5 U	5 U	3 J	5 U
1,1-Dichloroethene	5	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethane	5	5 U	5 U	5 U	5 U	5 U
1,2-Dichloroethene(total)	5	5 U	5 U	5 U	5 U	5 U
Chloroform	5	5 U	8 B	2 B	5 U	5 U
1,2-Dichloroethane	5	5 U	5 U	5 U	5 U	5 U
2-Butanone	10	R(f)	R(f)	R(f)	R(f)	R(f)
1,1,1-Trichloroethane	5	5 U	5 U	5 U	0.6 J	0.4 J
CarbonTetrachloride	5	5 U	5 U	5 U	5 U	5 U
VinylAcetate	10	10 U	10 U	10 U	10 U	10 U
Bromodichloromethane	5	5 U	7	5 U	5 U	5 U
1,2-Dichloropropane	5	5 U	5 U	5 U	5 U	5 U
cis-1,3-Dichloropropene	5	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5	5 U	5 U	5 U	5 U	5 U
Benzene	5	5 U	5 U	5 U	5 U	5 U
Dibromochloromethane	5	5 U	6	5 U	5 U	5 U
1,1,2-Trichloroethane	5	5 U	5 U	5 U	5 U	5 U
trans-1,3-Dichloropropene	5	5 U	5 U	5 U	5 U	5 U
2-chloroethylVinyl ether	10	10 U	10 U	10 U	10 U	10 U
Bromoform	5	5 U	1 J	5 U	5 U	5 U
4-Methyl-2-Pentanone	10	10 U	10 U	10 U	10 U	10 U
2-Hexanone	10	10 U	10 U	10 U	10 U	10 U
Tetrachloroethene	5	5 U	2 J	5 U	5 U	5 U
1,1,2,2-Tetrachloroethane	5	5 U	5 U	5 U	5 U	5 U
Toluene	5	5 U	5 U	5 U	13	9
Chlorobenzene	5	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	5	5 U	5 U	5 U	5 U	5 U
Styrene	5	5 U	5 U	5 U	5 U	5 U
Xylenes (total)	5	5 U	5 U	5 U	5 U	5 U
1,3-dichlorobenzene	5	5 U	5 U	5 U	5 U	5 U
1,2 & 1,4-dichlorobenzene	5	5 U	5 U	5 U	5 U	5 U

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

VOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - TRIP BLANK - 38	RINS. BLANK - 40	TRIP BLANK - 45	RINS. BLANK - 46	TRIP BLANK - 52
LAB ID:		8975	8977	9019	9020	9103
CHEMICAL	CRQL					
Chloromethane	10	10 U	10 U	10 U	10 U	10 U
Bromomethane	10	10 U	10 U	10 U	10 U	10 U
Vinyl Chloride	10	10 U	10 U	10 U	10 U	10 U
Chloroethane	10	10 U	10 U	10 U	10 U	10 U
Methylene Chloride	5	74 B	68 B	5 B	5 B	30 B
Acetone	10	8 B	10 UJ(c)	10 UJ(c)	3 B	6 B
Carbon Disulfide	5	5 U	5 U	5 U	5 U	5 U
Trichlorofluoromethane	5	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethene	5	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethane	5	5 U	5 U	5 U	5 U	5 U
1,2-Dichloroethene (total)	5	5 U	5 U	5 U	5 U	5 U
Chloroform	5	5 U	5 U	5 U	5 U	5 U
1,2-Dichloroethane	5	5 U	5 U	5 U	5 U	5 U
2-Butanone	10	R(f)	R(f)	R(f)	R(f)	R(f)
1,1,1-Trichloroethane	5	5 U	5 U	5 U	5 U	5 U
CarbonTetrachloride	5	5 U	5 U	5 U	5 U	5 U
VinylAcetate	10	10 U	10 U	10 U	10 U	10 U
Bromodichloromethane	5	5 U	5 U	5 U	5 U	5 U
1,2-Dichloropropane	5	5 U	5 U	5 U	5 U	5 U
cis-1,3-Dichloropropene	5	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5	5 U	5 U	5 U	5 U	5 U
Benzene	5	5 U	5 U	5 U	5 U	5 U
Dibromochloromethane	5	5 U	5 U	5 U	5 U	5 U
1,1,2-Trichloroethane	5	5 U	5 U	5 U	5 U	5 U
trans-1,3-Dichloropropene	5	5 U	5 U	5 U	5 U	5 U
2-chloroethylvinyl ether	10	10 U	10 U	10 U	10 U	10 U
Bromoform	5	5 U	5 U	5 U	5 U	5 U
4-Methyl-2-Pentanone	10	10 U	10 U	10 U	10 U	10 U
2-Hexanone	10	10 U	10 U	10 U	10 U	10 U
Tetrachloroethene	5	5 U	5 U	5 U	5 U	5 U
1,1,2,2-Tetrachloroethane	5	5 U	5 U	5 U	5 U	5 U
Toluene	5	5 U	5 U	5 U	5 U	5 U
Chlorobenzene	5	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	5	5 U	5 U	5 U	5 U	5 U
Styrene	5	5 U	5 U	5 U	5 U	5 U
Xylenes (total)	5	5 U	5 U	5 U	5 U	5 U
1,3-dichlorobenzene	5	5 U	5 U	5 U	5 U	5 U
1,2 & 1,4-dichlorobenzene	5	5 U	5 U	5 U	5 U	5 U

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

VOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - RINS. BLANK-53	TRIP BLANK-57	RINS. BLANK-59	RINS. BLANK-65	TRIP BLANK-70
LAB ID:		9104	9154	9156	9236	9241
CHEMICAL	CRQL					
Chloromethane	10	10 U	10 U	10 U	10 U	10 U
Bromomethane	10	10 U	10 U	10 U	10 U	10 U
Vinyl Chloride	10	10 U	10 U	10 U	10 U	10 U
Chloroethane	10	10 U	10 U	10 U	10 U	10 U
Methylene Chloride	5	5 B	28 B	4 B	4 B	7 B
Acetone	10	4 B	10 UJ(c)	10 UJ(c)	2 B	9 B
Carbon Disulfide	5	5 U	5 U	5 U	5 U	5 U
Trichlorofluoromethane	5	5 U	3 J	5 U	3 J	5 U
1,1-Dichloroethene	5	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethane	5	5 U	5 U	5 U	5 U	5 U
1,2-Dichloroethene(total)	5	5 U	5 U	5 U	5 U	5 U
Chloroform	5	1 B	5 U	5 U	4 B	5 U
1,2-Dichloroethane	5	5 U	5 U	5 U	5 U	5 U
2-Butanone	10	R(f)	R(f)	R(f)	R(f)	R(f)
1,1,1-Trichloroethane	5	5 U	0.3 J	5 U	5 U	5 U
CarbonTetrachloride	5	5 U	5 U	5 U	5 U	5 U
VinylAcetate	10	10 U	10 U	10 U	10 U	10 U
Bromodichloromethane	5	5 U	5 U	5 U	5 U	5 U
1,2-Dichloropropane	5	5 U	5 U	5 U	5 U	5 U
cis-1,3-Dichloropropene	5	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5	5 U	5 U	0.4 J	5 U	5 U
Benzene	5	5 U	5 U	5 U	5 U	5 U
Dibromochloromethane	5	5 U	5 U	5 U	5 U	5 U
1,1,2-Trichloroethane	5	5 U	5 U	5 U	5 U	5 U
trans-1,3-Dichloropropene	5	5 U	5 U	5 U	5 U	5 U
2-chloroethylvinyl ether	10	10 U	10 U	10 U	10 U	10 U
Bromoform	5	5 U	5 U	5 U	5 U	5 U
4-Methyl-2-Pentanone	10	10 U	10 U	10 U	10 U	10 U
2-Hexanone	10	10 U	10 UJ(c)	10 UJ(c)	10 U	10 U
Tetrachloroethene	5	5 U	5 U	5 U	5 U	5 U
1,1,2,2-Tetrachloroethane	5	5 U	5 U	5 U	5 U	5 U
Toluene	5	5 U	5 U	5 U	5 U	5 U
Chlorobenzene	5	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	5	5 U	5 U	5 U	5 U	5 U
Styrene	5	5 U	5 U	5 U	5 U	5 U
Xylenes (total)	5	5 U	5 U	5 U	5 U	5 U
1,3-dichlorobenzene	5	5 U	5 U	5 U	5 U	5 U
1,2 & 1,4-dichlorobenzene	5	5 U	5 U	5 U	5 U	5 U

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

VOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - S1-64-DG-1	S1-66-WELL-C	S2-22-BG-4-D	S2-23-BG-4	S2-24-BG-3
LAB ID:		9161	9237	8849	8850	8851
CHEMICAL	CRQL					
Chloromethane	10	10 U	10 U	10 U	10 U	10 U
Bromomethane	10	10 U	10 U	10 U	10 U	10 U
Vinyl Chloride	10	10 U	10 U	10 U	2 J	10 U
Chloroethane	10	10 U	10 U	10 U	10 U	10 U
Methylene Chloride	5	4 B	5 B	6 B	5 B	5 B
Acetone	10	10 UJ(c)	10 UJ(c)	10 UJ(c)	10 UJ(c)	4 B
Carbon Disulfide	5	5 U	5 U	5 U	5 U	5 U
Trichlorofluoromethane	5	5 U	91	3 B	3 B	5 U
1,1-Dichloroethene	5	5 U	2 J	5 U	0.2 J	2 J
1,1-Dichloroethane	5	5 U	2 J	9	7	2 J
1,2-Dichloroethene (total)	5	5 U	3 J	67	57	5 U
Chloroform	5	3 B	15	27	23	0.5 B
1,2-Dichloroethane	5	5 U	3 J	4 J	3 J	5 U
2-Butanone	10	R(f)	R(f)	R(f)	R(f)	R(f)
1,1,1-Trichloroethane	5	5 U	0.5 B	3 B	3 B	6
CarbonTetrachloride	5	5 U	16	10	10	5 U
VinylAcetate	10	10 U	10 U	10 U	10 U	10 U
Bromodichloromethane	5	5 U	5 U	5 U	5 U	5 U
1,2-Dichloropropane	5	5 U	1 J	5 U	5 U	5 U
cis-1,3-Dichloropropene	5	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5	1 B	2100	160	150	1 B
Benzene	5	5 U	5 U	1 J	0.9 J	5 U
Dibromochloromethane	5	5 U	5 U	5 U	5 U	5 U
1,1,2-Trichloroethane	5	5 U	5 U	5 U	5 U	5 U
trans-1,3-Dichloropropene	5	5 U	5 U	5 U	5 U	5 U
2-chloroethylVinyl ether	10	10 U	10 U	10 U	10 U	10 U
Bromoform	5	5 U	5 U	5 U	5 U	5 U
4-Methyl-2-Pentanone	10	10 U	10 U	10 U	10 U	10 U
2-Hexanone	10	10 U	10 U	10 U	10 U	10 U
Tetrachloroethene	5	0.5 B	27	140	120	4 B
1,1,2,2-Tetrachloroethane	5	5 U	5 U	5 U	5 U	5 U
Toluene	5	5 U	5 U	5 U	5 U	5 U
Chlorobenzene	5	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	5	5 U	5 U	5 U	5 U	5 U
Styrene	5	5 U	5 U	5 U	5 U	5 U
Xylenes (total)	5	5 U	5 U	5 U	5 U	5 U
1,3-dichlorobenzene	5	5 U	5 U	5 U	5 U	5 U
1,2 & 1,4-dichlorobenzene	5	5 U	5 U	5 U	5 U	5 U

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

VOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - S2-25-D	S2-26-DG-26	S2-32-DG-12	S2-63-WELL-E	S2-76-DG-2
LAB ID:		8852	8853	8903	9160	9275
CHEMICAL	CRQL					
Chloromethane	10	10 U	10 U	10 U	10 U	10 U
Bromomethane	10	10 U	10 U	10 U	10 U	10 U
Vinyl Chloride	10	10 U	10 U	10 U	10 U	10 U
Chloroethane	10	10 U	10 U	10 U	10 U	10 U
Methylene Chloride	5	5 B	4 B	2 B	5 B	5 B
Acetone	10	2. B	0.3 B	10 UJ(c)	2 B	10 UJ(c)
Carbon Disulfide	5	5 U	5 U	5 U	5 U	5 U
Trichlorofluoromethane	5	10	5 U	5 U	12	5 U
1,1-Dichloroethene	5	2 J	1 J	5 U	2 J	0.6 J
1,1-Dichloroethane	5	5	2 J	1 J	5	2 J
1,2-Dichloroethene(total)	5	23	6	1 J	40	5 U
Chloroform	5	17	0.6 B	2 B	13	0.8 B
1,2-Dichloroethane	5	3 J	5 U	5 U	3 J	5 U
2-Butanone	10	R(f)	R(f)	R(f)	R(f)	R(f)
1,1,1-Trichloroethane	5	5	3 B	2 B	4 J	1 B
CarbonTetrachloride	5	44	5 U	5 U	13	5 U
VinylAcetate	10	10 U	10 U	10 U	10 U	10 UJ(c)
Bromodichloromethane	5	5 U	5 U	5 U	0.2 B	5 U
1,2-Dichloropropane	5	5 U	5 U	5 U	5 U	5 U
cis-1,3-Dichloropropene	5	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5	150	13	6	150	0.7 B
Benzene	5	5 U	2 J	5 U	1 J	5 U
Dibromochloromethane	5	5 U	5 U	5 U	5 U	5 U
1,1,2-Trichloroethane	5	5 U	5 U	5 U	5 U	5 U
trans-1,3-Dichloropropene	5	5 U	5 U	5 U	5 U	5 U
2-chloroethylvinyl ether	10	10 U	10 U	10 U	10 U	10 U
Bromoform	5	5 U	5 U	5 U	5 U	5 U
4-Methyl-2-Pentanone	10	10 U	10 U	10 U	10 U	10 U
2-Hexanone	10	10 U	10 U	10 U	10 U	10 U
Tetrachloroethene	5	440	5 B	4 B	130	1 B
1,1,2,2-Tetrachloroethane	5	5 U	5 U	5 U	5 U	5 U
Toluene	5	5 U	5 U	9 B	5 U	5 U
Chlorobenzene	5	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	5	0.2 J	5 U	5 U	5 U	5 U
Styrene	5	5 U	5 U	5 U	5 U	5 U
Xylenes (total)	5	2 J	5 U	5 U	5 U	5 U
1,3-dichlorobenzene	5	5 U	5 U	5 U	5 U	5 U
1,2 & 1,4-dichlorobenzene	5	5 U	5 U	5 U	5 U	5 U

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

VOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - S2-77-DG-23	S3-60-DG-13	S3-61-DG-13-D	S3-62-DG-3	S4-33-DG-28
LAB ID:		9276	9157	9158	9159	8904
CHEMICAL	CRQL					
Chloromethane	10	10 U	10 U	10 U	10 U	10 U
Bromomethane	10	10 U	10 U	10 U	10 U	10 U
Vinyl Chloride	10	10 U	10 U	10 U	10 U	10 U
Chloroethane	10	10 U	10 U	10 U	10 U	10 U
Methylene Chloride	5	6 B	3 B	3 B	4 B	6 B
Acetone	10	10 UJ(c)	10 UJ(c)	0.4 B	10 UJ(c)	97 B
Carbon Disulfide	5	5 U	5 U	5 U	5 U	5 U
Trichlorofluoromethane	5	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethene	5	2 J	3 J	3 J	2 J	5 U
1,1-Dichloroethane	5	5 J	3 J	3 J	3 J	5 U
1,2-Dichloroethene (total)	5	5 U	5 U	5 U	5 U	5 U
Chloroform	5	0.98 B	0.4 B	0.4 B	0.3 B	10 B
1,2-Dichloroethane	5	5 U	5 U	5 U	5 U	5 U
2-Butanone	10	R(f)	R(f)	R(f)	R(f)	R(f)
1,1,1-Trichloroethane	5	5	9	10	8	5 U
CarbonTetrachloride	5	5 U	5 U	5 U	5 U	5 U
VinylAcetate	10	10 UJ(c)	10 U	10 U	10 U	10 U
Bromodichloromethane	5	5 U	5 U	5 U	5 U	0.7 B
1,2-Dichloropropane	5	5 U	5 U	5 U	5 U	5 U
cis-1,3-Dichloropropene	5	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5	14	1 J	5 U	1 J	5 U
Benzene	5	5 U	5 U	5 U	5 U	5 U
Dibromochloromethane	5	5 U	5 U	5 U	5 U	5 U
1,1,2-Trichloroethane	5	5 U	5 U	5 U	5 U	5 U
trans-1,3-Dichloropropene	5	5 U	5 U	5 U	5 U	5 U
2-chloroethylVinyl ether	10	10 U	10 U	10 U	10 U	10 U
Bromoform	5	5 U	5 U	5 U	5 U	5 U
4-Methyl-2-Pentanone	10	10 U	10 U	10 U	10 U	10 U
2-Hexanone	10	10 U	10 UJ(c)	10 UJ(c)	10 UJ(c)	10 U
Tetrachloroethene	5	6 B	4 B	4 B	4 B	5 U
1,1,2,2-Tetrachloroethane	5	5 U	5 U	5 U	5 U	5 U
Toluene	5	5 U	5 U	5 U	5 U	5 U
Chlorobenzene	5	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	5	5 U	5 U	5 U	5 U	5 U
Styrene	5	5 U	5 U	5 U	5 U	5 U
Xylenes (total)	5	5 U	5 U	5 U	5 U	5 U
1,3-dichlorobenzene	5	5 U	5 U	5 U	5 U	5 U
1,2 & 1,4-dichlorobenzene	5	5 U	5 U	5 U	5 U	5 U

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

VOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - S4-34-DG-15	S4-35-DG-6	S4-36-DG-16	S4-37-DG-9	S4-39-DG-18
LAB ID:		8905	8906	8907	8974	8976
CHEMICAL	CRQL					
Chloromethane	10	10 U	10 U	10 U	10 U	10 U
Bromomethane	10	10 U	10 U	10 U	10 U	10 U
Vinyl Chloride	10	10 U	10 U	10 U	10 U	10 U
Chloroethane	10	10 U	10 U	10 U	10 U	10 U
Methylene Chloride	5	3 B	2 B	3 B	3 B	4 B
Acetone	10	10 UJ(c)	10 UJ(c)	1 B	10 UJ(c)	10 UJ(c)
Carbon Disulfide	5	5 U	5 U	5 U	5 U	5 U
Trichlorofluoromethane	5	5 U	5 U	3 B	5 U	5 U
1,1-Dichloroethene	5	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethane	5	5 U	5 U	5 U	5 U	5 U
1,2-Dichloroethene(total)	5	5 U	5 U	5 U	5 U	7
Chloroform	5	5 U	5 U	5 U	5 U	1 B
1,2-Dichloroethane	5	5 U	5 U	5 U	5 U	5 U
2-Butanone	10	R(f)	R(f)	R(f)	R(f)	R(f)
1,1,1-Trichloroethane	5	0.4 B	5 U	0.4 B	5 U	5 U
CarbonTetrachloride	5	5 U	5 U	5 U	5 U	0.3 J
VinylAcetate	10	10 U	10 U	10 U	10 U	10 U
Bromodichloromethane	5	5 U	5 U	5 U	5 U	5 U
1,2-Dichloropropane	5	5 U	5 U	5 U	5 U	5 U
cis-1,3-Dichloropropene	5	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5	5 U	5 U	5 U	5 U	8
Benzene	5	5 U	5 U	5 U	5 U	5 U
Dibromochloromethane	5	5 U	5 U	5 U	5 U	5 U
1,1,2-Trichloroethane	5	5 U	5 U	5 U	5 U	5 U
trans-1,3-Dichloropropene	5	5 U	5 U	5 U	5 U	5 U
2-chloroethylvinyl ether	10	10 U	10 U	10 U	10 U	10 U
Bromoform	5	5 U	5 U	5 U	5 U	5 U
4-Methyl-2-Pentanone	10	10 U	10 U	10 U	10 U	10 U
2-Hexanone	10	10 U	10 U	10 U	10 U	10 U
Tetrachloroethene	5	5 U	5 U	5 U	5 U	5 U
1,1,2,2-Tetrachloroethane	5	5 U	5 U	5 U	5 U	5 U
Toluene	5	9 B	8 B	9 B	5 U	5 U
Chlorobenzene	5	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	5	5 U	5 U	5 U	5 U	5 U
Styrene	5	5 U	5 U	5 U	5 U	5 U
Xylenes (total)	5	5 U	5 U	5 U	5 U	5 U
1,3-dichlorobenzene	5	5 U	5 U	5 U	5 U	5 U
1,2 & 1,4-dichlorobenzene	5	5 U	5 U	5 U	5 U	5 U

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

VOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - S4-42-DG-4	S4-43-DG-5	S4-44-DG-7	S4-67-BG-2	S4-68-BG-6
LAB ID:		8979	8980	8981	9238	9239
CHEMICAL	CRQL					
Chloromethane	10	10 U	10 U	10 U	10 U	10 U
Bromomethane	10	10 U	10 U	10 U	10 U	10 U
Vinyl Chloride	10	10 U	10 U	10 U	10 U	10 U
Chloroethane	10	10 U	10 U	10 U	10 U	10 U
Methylene Chloride	5	3 B	3 B	3 B	4 B	4 B
Acetone	10	1 B	3 B	10 UJ(c)	2 B	10 UJ(c)
Carbon Disulfide	5	5 U	5 U	5 U	5 U	5 U
Trichlorofluoromethane	5	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethene	5	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethane	5	5 U	5 U	5 U	5 U	5 U
1,2-Dichloroethene (total)	5	5 U	5 U	5 U	5 U	5 U
Chloroform	5	5 U	5 U	5 U	1 B	5 U
1,2-Dichloroethane	5	5 U	5 U	5 U	5 U	5 U
2-Butanone	10	R(f)	R(f)	R(f)	R(f)	R(f)
1,1,1-Trichloroethane	5	5 U	5 U	5 U	5 U	5 U
CarbonTetrachloride	5	5 U	5 U	5 U	5 U	5 U
VinylAcetate	10	10 U	10 U	10 U	10 UJ(c)	10 U
Bromodichloromethane	5	5 U	5 U	5 U	5 U	5 U
1,2-Dichloropropane	5	5 U	5 U	5 U	5 U	5 U
cis-1,3-Dichloropropene	5	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5	5 U	5 U	5 U	5 U	5 U
Benzene	5	5 U	5 U	5 U	5 U	5 U
Dibromochloromethane	5	5 U	5 U	5 U	5 U	5 U
1,1,2-Trichloroethane	5	5 U	5 U	5 U	5 U	5 U
trans-1,3-Dichloropropene	5	5 U	5 U	5 U	5 U	5 U
2-chloroethylvinyl ether	10	10 U	10 U	10 U	10 U	10 U
Bromoform	5	5 U	5 U	5 U	5 U	5 U
4-Methyl-2-Pentanone	10	10 U	10 U	10 U	10 U	10 U
2-Hexanone	10	10 U	10 U	10 U	10 U	10 U
Tetrachloroethene	5	5 U	5 U	5 U	5 U	5 U
1,1,2,2-Tetrachloroethane	5	5 U	5 U	5 U	5 U	5 U
Toluene	5	5 U	5 U	5 U	5 U	5 U
Chlorobenzene	5	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	5	5 U	5 U	5 U	5 U	5 U
Styrene	5	5 U	5 U	5 U	5 U	5 U
Xylenes (total)	5	5 U	5 U	5 U	5 U	5 U
1,3-dichlorobenzene	5	5 U	5 U	5 U	5 U	5 U
1,2 & 1,4-dichlorobenzene	5	5 U	5 U	5 U	5 U	5 U

SITE: WARMINSTER
CASE NO. 9210-40004
LABORATORY: RMC

VOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - S4-73-DG-22	S4-78-DG-22-D	S4-74-DG-24	S5-50-DG-8	S5-51-DG-20
LAB ID:		9272	9273	9274	9101	9102
CHEMICAL	CRQL					
Chloromethane	10	10 U	10 U	10 U	10 U	10 U
Bromomethane	10	10 U	10 U	10 U	10 U	10 U
Vinyl Chloride	10	10 U	10 U	10 U	10 U	10 U
Chloroethane	10	10 U	10 U	10 U	10 U	10 U
Methylene Chloride	5	7 B	6 B	6 B	4 B	5 B
Acetone	10	10 UJ(c)	10 UJ(c)	10 UJ(c)	10 UJ(c)	3 B
Carbon Disulfide	5	5 U	5 U	5 U	5 U	5 U
Trichlorofluoromethane	5	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethene	5	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethane	5	5 U	5 U	5 U	5 U	5 U
1,2-Dichloroethene (total)	5	5 U	5 U	5 U	5 U	2 J
Chloroform	5	5 U	1 B	0.8 B	5 U	1 B
1,2-Dichloroethane	5	5 U	5 U	5 U	5 U	5 U
2-Butanone	10	R(f)	R(f)	R(f)	R(f)	R(f)
1,1,1-Trichloroethane	5	5 U	5 U	5 U	5 U	5 U
CarbonTetrachloride	5	5 U	5 U	5 U	5 U	5 U
VinylAcetate	10	10 UJ(c)	10 UJ(c)	10 UJ(c)	10 U	10 U
Bromodichloromethane	5	5 U	5 U	5 U	5 U	5 U
1,2-Dichloropropane	5	5 U	5 U	5 U	5 U	5 U
cis-1,3-Dichloropropene	5	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5	5 U	5 U	5 U	5 U	6
Benzene	5	5 U	5 U	5 U	5 U	5 U
Dibromochloromethane	5	5 U	5 U	5 U	5 U	5 U
1,1,2-Trichloroethane	5	5 U	5 U	5 U	5 U	5 U
trans-1,3-Dichloropropene	5	5 U	5 U	5 U	5 U	5 U
2-chloroethylvinyl ether	10	10 U	10 U	10 U	10 U	10 U
Bromoform	5	5 U	5 U	5 U	5 U	5 U
4-Methyl-2-Pentanone	10	10 U	10 U	10 U	10 U	10 U
2-Hexanone	10	10 U	10 U	10 U	10 U	10 U
Tetrachloroethene	5	5 U	5 U	5 U	0.7 B	2 B
1,1,2,2-Tetrachloroethane	5	5 U	5 U	5 U	5 U	5 U
Toluene	5	5 U	5 U	5 U	5 U	5 U
Chlorobenzene	5	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	5	5 U	5 U	5 U	5 U	5 U
Styrene	5	5 U	5 U	5 U	5 U	5 U
Xylenes (total)	5	5 U	5 U	5 U	5 U	5 U
1,3-dichlorobenzene	5	5 U	5 U	5 U	5 U	5 U
1,2 & 1,4-dichlorobenzene	5	5 U	5 U	5 U	5 U	5 U

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

VOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - S5-54-DG-27	S5-55-DG-21	S6-47-DG-19	S6-48-DG-17	S6-41-DG-10
LAB ID:		9105	9106	9021	9022	8978
CHEMICAL	CRQL					
Chloromethane	10	10 U	10 U	10 U	10 U	10 U
Bromomethane	10	10 U	10 U	10 U	10 U	10 U
Vinyl Chloride	10	10 U	10 U	10 U	10 U	10 U
Chloroethane	10	10 U	10 U	10 U	10 U	10 U
Methylene Chloride	5	5 B	6 B	4 B	4 B	3 B
Acetone	10	2 B	2 B	10 UJ(c)	10 UJ(c)	1 B
Carbon Disulfide	5	5 U	5 U	5 U	5 U	5 U
Trichlorofluoromethane	5	5 U	2 B	5 U	5 U	5 U
1,1-Dichloroethene	5	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethane	5	5 U	5 U	5 U	5 U	5 U
1,2-Dichloroethene(total)	5	3 J	3 J	5 U	5 U	5 U
Chloroform	5	5 U	0.4 B	2 B	5 U	5 U
1,2-Dichloroethane	5	5 U	5 U	5 U	5 U	5 U
2-Butanone	10	R(f)	R(f)	R(f)	R(f)	R(f)
1,1,1-Trichloroethane	5	5 U	5 U	5 U	5 U	5 U
CarbonTetrachloride	5	5 U	5 U	1 J	5 U	5 U
VinylAcetate	10	10 U	10 U	10 U	10 U	10 U
Bromodichloromethane	5	5 U	5 U	5 U	5 U	5 U
1,2-Dichloropropane	5	5 U	5 U	5 U	5 U	5 U
cis-1,3-Dichloropropene	5	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5	5 U	1 B	2 B	5 U	5 U
Benzene	5	5 U	5 U	5 U	5 U	5 U
Dibromochloromethane	5	5 U	5 U	5 U	5 U	5 U
1,1,2-Trichloroethane	5	5 U	5 U	5 U	5 U	5 U
trans-1,3-Dichloropropene	5	5 U	5 U	5 U	5 U	5 U
2-chloroethylvinyl ether	10	10 U	10 U	10 U	10 U	10 U
Bromoform	5	5 U	5 U	5 U	5 U	5 U
4-Methyl-2-Pentanone	10	10 U	10 U	10 U	10 U	10 U
2-Hexanone	10	10 UJ(c)	10 UJ(c)	10 U	10 U	10 U
Tetrachloroethene	5	1 B	3 B	5 U	5 U	5 U
1,1,2,2-Tetrachloroethane	5	5 U	5 U	5 U	5 U	5 U
Toluene	5	5 U	5 U	5 U	5 U	5 U
Chlorobenzene	5	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	5	5 U	5 U	5 U	5 U	5 U
Styrene	5	5 U	5 U	5 U	5 U	5 U
Xylenes (total)	5	5 U	5 U	5 U	5 U	5 U
1,3-dichlorobenzene	5	5 U	5 U	5 U	5 U	5 U
1,2 & 1,4-dichlorobenzene	5	5 U	5 U	5 U	5 U	5 U

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

VOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - S6-69-BG-7	S7-56-DG-25	S7-58-DG-25-D	S8-75-DG-14	S8-49-BG-5
LAB ID:		9240	9153	9155	9271	9023
CHEMICAL	CRQL					
Chloromethane	10	10 U	10 U	10 U	10 U	10 U
Bromomethane	10	10 U	10 U	10 U	10 U	10 U
Vinyl Chloride	10	10 U	10 U	10 U	10 U	10 U
Chloroethane	10	10 U	10 U	10 U	10 U	10 U
Methylene Chloride	5	5 B	5 B	3 B	6 B	4 B
Acetone	10	10 UJ(c)	10 UJ(c)	10 UJ	10 UJ(c)	1 B
Carbon Disulfide	5	5 U	5 U	5 U	5 U	5 U
Trichlorofluoromethane	5	5 U	2 B	3 B	5 U	5 U
1,1-Dichloroethene	5	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethane	5	5 U	5 U	5 U	5 U	5 U
1,2-Dichloroethene(total)	5	5 U	2 J	2 J	5 U	5 U
Chloroform	5	1 B	0.6 B	0.6 B	5 U	5 U
1,2-Dichloroethane	5	5 U	5 U	5 U	5 U	5 U
2-Butanone	10	R(f)	R(f)	R(f)	R(f)	R(f)
1,1,1-Trichloroethane	5	5 U	5 U	5 U	5 U	5 U
CarbonTetrachloride	5	5 U	1 J	5 U	5 U	5 U
VinylAcetate	10	10 U	10 U	10 U	10 UJ(c)	10 U
Bromodichloromethane	5	5 U	5 U	5 U	5 U	5 U
1,2-Dichloropropane	5	5 U	5 U	5 U	5 U	5 U
cis-1,3-Dichloropropene	5	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5	5 U	6	8	5 U	5 U
Benzene	5	5 U	5 U	5 U	5 U	5 U
Dibromochloromethane	5	5 U	5 U	5 U	5 U	5 U
1,1,2-Trichloroethane	5	5 U	5 U	5 U	5 U	5 U
trans-1,3-Dichloropropene	5	5 U	5 U	5 U	5 U	5 U
2-chloroethylvinyl ether	10	10 U	10 U	10 U	10 U	10 U
Bromoform	5	5 U	5 U	5 U	5 U	5 U
4-Methyl-2-Pentanone	10	10 U	10 U	10 U	10 U	10 U
2-Hexanone	10	10 U	10 UJ(c)	10 UJ(c)	10 U	10 U
Tetrachloroethene	5	5 U	0.3 B	0.5 B	1 B	3 B
1,1,2,2-Tetrachloroethane	5	5 U	5 U	5 U	5 U	5 U
Toluene	5	5 U	5 U	5 U	5 U	5 U
Chlorobenzene	5	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	5	5 U	5 U	5 U	5 U	5 U
Styrene	5	5 U	5 U	5 U	5 U	5 U
Xylenes (total)	5	5 U	5 U	5 U	5 U	5 U
1,3-dichlorobenzene	5	5 U	5 U	5 U	5 U	5 U
1,2 & 1,4-dichlorobenzene	5	5 U	5 U	5 U	5 U	5 U

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

SEMIVOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC -	FIELD R. BLANK	FIELD BLK-TAP	FIELD BLK-DI	S2-20-RINSATE	FIELD BLANK-27
LAB ID:			8807	8808	8811	8847	8854
CHEMICAL	CRQL						
N-Nitrosodimethylamine	10		10 U	10 U	10 U	10 U	10 U
bis(2-Chloroethyl) ether	10		10 U	10 U	10 U	10 U	10 U
Phenol	10		10 U	10 U	10 U	10 U	R(s)
2-Chlorophenol	10		10 U	10 U	10 U	10 U	R(s)
1,3-Dichlorobenzene	10		10 U	10 U	10 U	10 U	10 U
1,4-Dichlorobenzene	10		10 U	10 U	10 U	10 U	10 U
Benzyl alcohol	10		10 U	10 U	10 U	10 U	10 U
1,2-Dichlorobenzene	10		10 U	10 U	10 U	10 U	10 U
2-Methylphenol	10		10 U	10 U	10 U	10 U	R(s)
bis(2-Chloroisopropyl) ether	10		10 U	10 U	10 U	10 U	10 U
4-Methylphenol	10		10 U	10 U	10 U	10 U	R(s)
N-Nitroso-di-n-dipropylamine	10		10 U	10 U	10 U	10 U	10 U
Hexachloroethane	10		10 U	10 U	10 U	10 U	10 U
Nitrobenzene	10		10 U	10 U	10 U	10 U	10 U
Isophorone	10		10 U	10 U	10 U	10 U	10 U
2-Nitrophenol	10		10 U	10 U	10 U	10 U	R(s)
2,4-Dimethylphenol	10		10 U	10 U	10 U	10 U	R(s)
Benzoic acid	50		50 U	50 U	50 U	50 U	R(s)
bis(2-Chloroethoxy) methane	10		10 U	10 U	10 U	10 U	10 U
2,4-Dichlorophenol	10		10 U	10 U	10 U	10 U	R(s)
1,2,4-Trichlorobenzene	10		10 U	10 U	10 U	10 U	10 U
Naphthalene	10		10 U	10 U	10 U	10 U	10 U
4-Chloroaniline	10		10 U	10 U	10 U	10 U	10 U
Hexachlorobutadiene	10		10 U	10 U	10 U	10 U	10 U
4-Chloro-3-methylphenol	10		10 U	10 U	10 U	10 U	R(s)
2-Methylnaphthalene	10		10 U	10 U	10 U	10 U	10 U
Hexachlorocyclopentadiene	10		10 U	10 U	10 U	10 U	10 U
2,4,6-Trichlorophenol	10		10 U	10 U	10 U	10 U	R(s)
2,4,5-Trichlorophenol	50		50 U	50 U	50 U	50 U	R(s)
2-Chloronaphthalene	10		10 U	10 U	10 U	10 U	10 U
2-Nitroaniline	50		50 U	50 U	50 U	50 U	50 U
Dimethylphthalate	10		10 U	10 U	10 U	10 U	10 U
Acenaphthylene	10		10 U	10 U	10 U	10 U	10 U
2,6-Dinitrotoluene	10		10 U	10 U	10 U	10 U	10 U

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

SEMIVOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - FIELD R. BLANK	FIELD BLK-TAP	FIELD BLK-DI	S2-20-RINSATE	FIELD BLANK-27
LAB ID:		8807	8808	8811	8847	8854
CHEMICAL	CRQL					
3-Nitroaniline	50	50 U	50 U	50 U	50 U	50 U
Acenaphthene	10	10 U	10 U	10 U	10 U	10 U
2,4-Dinitrophenol	50	50 U	50 U	50 U	50 U	R(s)
4-Nitrophenol	50	50 U	50 U	50 U	50 U	R(s)
Dibenzofuran	10	10 U	10 U	10 U	10 U	10 U
2,4-Dinitrotoluene	10	10 U	10 U	10 U	10 U	10 U
Diethylphthalate	10	10 U	10 U	10 U	10 U	10 U
4-Chlorophenyl-phenyl ether	10	10 U	10 U	10 U	10 U	10 U
Fluorene	10	10 U	10 U	10 U	10 U	10 U
4-Nitroaniline	50	50 U	50 U	50 U	50 U	50 U
4,6-Dinitro-2-methylphenol	50	50 U	50 U	50 U	50 U	R(s)
N-nitrosodiphenylamine	10	10 U	10 U	10 U	10 U	10 U
1,2-diphenyl hydrazine	10	10 U	10 U	10 U	10 U	10 U
4-Bromophenyl-phenylether	10	10 U	10 U	10 U	10 U	10 U
Hexachlorobenzene	10	10 U	10 U	10 U	10 U	10 U
Pentachlorophenol	50	50 U	50 U	50 U	50 U	R(s)
Phenanthrene	10	10 U	10 U	10 U	10 U	10 UJ(i)
Anthracene	10	10 U	10 U	10 U	10 U	10 UJ(i)
Di-n-butylphthalate	10	0.3 B	0.2 B	10 U	10 U	10 UJ(i)
Fluoranthene	10	10 U	10 U	10 U	10 U	10 UJ(i)
Pyrene	10	10 U	10 U	10 U	10 U	10 UJ(i)
Benzidine	80	80 U	80 U	80 UJ(c)	80 UJ(c)	10 UJ(c,i)
Butylbenzylphthalate	10	10 U	10 U	10 U	10 U	10 UJ(i)
3,3'-Dichlorobenzidine	20	20 U	20 U	20 U	20 U	10 UJ(i)
Benzo(a)anthracene	10	10 U	10 U	10 U	10 U	10 UJ(i)
Chrysene	10	10 U	10 U	10 U	10 U	10 U
bis(2-Ethylhexyl)phthalate	10	9 B	0.4 B	3 B	18 B	0.3 B
Di-n-octylphthalate	10	10 U	10 U	10 U	10 U	10 U
Benzo(b)fluoranthene	10	10 U	10 U	10 U	10 U	10 U
Benzo(k)fluoranthene	10	10 U	10 U	10 U	10 U	10 U
Benzo(a)pyrene	10	10 U	10 U	10 U	10 U	10 U
Indeno(1,2,3-cd)pyrene	10	10 U	10 U	10 U	10 U	10 U
Dibenz(a,h)anthracene	10	10 U	10 U	10 U	10 U	10 U
Benzo(g,h,i)perylene	10	10 U	10 U	10 U	10 U	10 U
Analysis Factor:		1.0	1.0	1.0	1.0	1.0

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

SEMIVOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - FIELD BLANK-28	RINS. BLANK-30	RINS. BLANK-40	RINS. BLANK-46	RINS. BLANK-53
LAB ID:		8855	8901	8977	9020	9104
CHEMICAL	CRQL					
N-Nitrosodimethylamine	10	10 U	10 U	10 U	10 U	10 U
bis(2-Chloroethyl) ether	10	10 U	10 U	10 U	10 U	10 U
Phenol	10	10 U	10 U	10 U	10 U	10 U
2-Chlorophenol	10	10 U	10 U	10 U	10 U	10 U
1,3-Dichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
1,4-Dichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
Benzyl alcohol	10	10 U	10 U	10 U	10 U	10 U
1,2-Dichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
2-Methylphenol	10	10 U	10 U	10 U	10 U	10 U
bis(2-Chloroisopropyl) ether	10	10 U	10 U	10 U	10 U	10 U
4-Methylphenol	10	10 U	10 U	10 U	10 U	10 U
N-Nitroso-di-n-dipropylamine	10	10 U	10 U	10 U	10 U	10 U
Hexachloroethane	10	10 U	10 U	10 U	10 U	10 U
Nitrobenzene	10	10 U	10 U	10 U	10 U	10 U
Isophorone	10	10 U	10 U	10 U	10 U	10 U
2-Nitrophenol	10	10 U	10 U	10 U	10 U	10 U
2,4-Dimethylphenol	10	10 U	10 U	10 U	10 U	10 U
Benzoic acid	50	50 U	50 U	50 U	50 U	50 U
bis(2-Chloroethoxy) methane	10	10 U	10 U	10 U	10 U	10 U
2,4-Dichlorophenol	10	10 U	10 U	10 U	10 U	10 U
1,2,4-Trichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
Naphthalene	10	10 U	10 U	10 U	10 U	10 U
4-Chloroaniline	10	10 U	10 U	10 U	10 U	10 U
Hexachlorobutadiene	10	10 U	10 U	10 U	10 U	10 U
4-Chloro-3-methylphenol	10	10 U	10 U	10 U	10 U	10 U
2-Methylnaphthalene	10	10 U	10 U	10 U	10 U	10 U
Hexachlorocyclopentadiene	10	10 U	10 U	10 U	10 U	10 U
2,4,6-Trichlorophenol	10	10 U	10 U	10 U	10 U	10 U
2,4,5-Trichlorophenol	50	50 U	50 U	50 U	50 U	50 U
2-Chloronaphthalene	10	10 U	10 U	10 U	10 U	10 U
2-Nitroaniline	50	50 U	50 U	50 U	50 U	50 U
Dimethylphthalate	10	10 U	10 U	10 U	10 U	10 U
Acenaphthylene	10	10 U	10 U	10 U	10 U	10 U
2,6-Dinitrotoluene	10	10 U	10 U	10 U	10 U	10 U

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

SEMIVOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC -	FIELD BLANK-28	RINS. BLANK-30	RINS. BLANK-40	RINS. BLANK-46	RINS. BLANK-53
LAB ID:			8855	8901	8977	9020	9104
CHEMICAL	CRQL						
3-Nitroaniline	50		50 U	50 U	50 U	50 U	50 U
Acenaphthene	10		10 U	10 U	10 U	10 U	10 U
2,4-Dinitrophenol	50		50 U	50 U	50 U	50 U	50 U
4-Nitrophenol	50		50 U	50 U	50 U	50 U	50 U
Dibenzofuran	10		10 U	10 U	10 U	10 U	10 U
2,4-Dinitrotoluene	10		10 U	10 U	10 U	10 U	10 U
Diethylphthalate	10		10 U	10 U	0.2 J	10 U	10 U
4-Chlorophenyl-phenyl ether	10		10 U	10 U	10 U	10 U	10 U
Fluorene	10		10 U	10 U	10 U	10 U	10 U
4-Nitroaniline	50		50 U	50 U	50 U	50 U	50 U
4,6-Dinitro-2-methylphenol	50		50 U	50 U	50 U	50 U	50 U
N-nitrosodiphenylamine	10		10 U	10 U	10 U	10 U	10 U
1,2-diphenyl hydrazine	10		10 U	10 U	10 U	10 U	10 U
4-Bromophenyl-phenylether	10		10 U	10 U	10 U	10 U	10 U
Hexachlorobenzene	10		10 U	10 U	10 U	10 U	10 U
Pentachlorophenol	50		50 U	50 U	50 U	50 U	50 U
Phenanthrene	10		10 U	10 U	10 U	10 U	10 U
Anthracene	10		10 U	10 U	10 U	10 U	10 U
Di-n-butylphthalate	10		10 U	0.2 B	0.2 B	0.5 B	10 U
Fluoranthene	10		10 U	10 U	10 U	10 U	10 U
Pyrene	10		10 U	10 U	10 U	10 U	10 U
Benzidine	80		80 UJ(c)	80 UJ(c)	80 UJ(c)	80 U	80 U
Butylbenzylphthalate	10		10 U	10 U	10 U	10 U	10 U
3,3'-Dichlorobenzidine	20		20 U	20 U	20 U	20 U	20 U
Benzo(a)anthracene	10		10 U	10 U	10 U	10 U	10 U
Chrysene	10		10 U	10 U	10 U	10 U	10 U
bis(2-Ethylhexyl)phthalate	10		4 B	17 B	7 B	5 B	41 B
Di-n-octylphthalate	10		10 U	10 U	10 U	10 U	10 U
Benzo(b)fluoranthene	10		10 U	10 U	10 U	10 U	10 U
Benzo(k)fluoranthene	10		10 U	10 U	10 U	10 U	10 U
Benzo(a)pyrene	10		10 U	10 U	10 U	10 U	10 U
Indeno(1,2,3-cd)pyrene	10		10 U	10 U	10 U	10 U	10 U
Dibenz(a,h)anthracene	10		10 U	10 U	10 U	10 U	10 U
Benzo(g,h,i)perylene	10		10 U	10 U	10 U	10 U	10 U
Analysis Factor:			1.0	1.0	1.0	1.0	1.0

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

SEMIVOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - 8-S. WATER	S1-64-DG-1	S1-66-WELL-C	S2-22-BG-4-D	S2-23-BG-4
LAB ID:		8793	9161	9237	8649	8650
CHEMICAL	CRQL					
N-Nitrosodimethylamine	10	10 U	10 U	10 U	10 U	10 U
bis(2-Chloroethyl) ether	10	10 U	10 U	10 U	10 U	10 U
Phenol	10	10 U	10 U	10 U	10 U	10 U
2-Chlorophenol	10	10 U	10 U	10 U	10 U	10 U
1,3-Dichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
1,4-Dichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
Benzyl alcohol	10	10 U	10 U	10 U	10 U	10 U
1,2-Dichlorobenzene	10	10 U	10 U	0.7 J	10 U	10 U
2-Methylphenol	10	10 U	10 U	10 U	10 U	10 U
bis(2-Chloroisopropyl) ether	10	10 U	10 U	10 U	10 U	10 U
4-Methylphenol	10	10 U	10 U	10 U	10 U	10 U
N-Nitroso-di-n-dipropylamine	10	10 U	10 U	10 U	10 U	10 U
Hexachloroethane	10	10 U	10 U	10 U	10 U	10 U
Nitrobenzene	10	10 U	10 U	10 U	10 U	10 U
Isophorone	10	10 U	10 U	10 U	10 U	10 U
2-Nitrophenol	10	10 U	10 U	10 U	10 U	10 U
2,4-Dimethylphenol	10	10 U	10 U	10 U	10 U	10 U
Benzoic acid	50	50 U	50 U	50 U	50 U	50 U
bis(2-Chloroethoxy) methane	10	10 U	10 U	10 U	10 U	10 U
2,4-Dichlorophenol	10	10 U	10 U	10 U	10 U	10 U
1,2,4-Trichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
Naphthalene	10	10 U	10 U	10 U	10 U	10 U
4-Chloroaniline	10	10 U	10 U	10 U	10 U	10 U
Hexachlorobutadiene	10	10 U	10 U	10 U	10 U	10 U
4-Chloro-3-methylphenol	10	10 U	10 U	10 U	10 U	10 U
2-Methylnaphthalene	10	10 U	10 U	10 U	10 U	10 U
Hexachlorocyclopentadiene	10	10 U	10 U	10 U	10 U	10 U
2,4,6-Trichlorophenol	10	10 U	10 U	10 U	10 U	10 U
2,4,5-Trichlorophenol	50	50 U	50 U	50 U	50 U	50 U
2-Chloronaphthalene	10	10 U	10 U	10 U	10 U	10 U
2-Nitroaniline	50	50 U	50 U	50 U	50 U	50 U
Dimethylphthalate	10	10 U	10 U	10 U	10 U	10 U
Acenaphthylene	10	10 U	10 U	10 U	10 U	10 U
2,6-Dinitrotoluene	10	10 U	10 U	10 U	10 U	10 U

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

SEMIVOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - 8-S. WATER	S1-64-DG-1	S1-66-WELL-C	S2-22-BG-4-D	S2-23-BG-4
LAB ID:		8793	9161	9237	8849	8850
CHEMICAL	CRQL					
3-Nitroaniline	50	50 U	50 U	50 U	50 U	50 U
Acenaphthene	10	10 U	10 U	10 U	10 U	10 U
2,4-Dinitrophenol	50	50 U	50 U	50 U	50 U	50 U
4-Nitrophenol	50	50 U	50 U	50 U	50 U	50 U
Dibenzofuran	10	10 U	10 U	10 U	10 U	10 U
2,4-Dinitrotoluene	10	10 U	10 U	10 U	10 U	10 U
Diethylphthalate	10	0.2 J	10 U	10 U	10 U	10 U
4-Chlorophenyl-phenyl ether	10	10 U	10 U	10 U	10 U	10 U
Fluorene	10	10 U	10 U	10 U	10 U	10 U
4-Nitroaniline	50	50 U	50 UJ(c)	50 U	50 UJ(c)	50 U
4,6-Dinitro-2-methylphenol	50	50 U	50 U	50 U	50 U	50 U
N-nitrosodiphenylamine	10	10 U	10 U	10 U	10 U	10 U
1,2-diphenyl hydrazine	10	10 U	10 U	10 U	10 U	10 U
4-Bromophenyl-phenylether	10	10 U	10 U	10 U	10 U	10 U
Hexachlorobenzene	10	10 U	10 U	10 U	10 U	10 U
Pentachlorophenol	50	50 U	50 U	50 U	50 U	50 U
Phenanthrene	10	10 U	10 U	10 U	10 U	10 U
Anthracene	10	10 U	10 U	10 U	10 U	10 U
Di-n-butylphthalate	10	0.7 B	10 U	1 B	10 U	10 U
Fluoranthene	10	10 U	10 U	10 U	10 U	10 U
Pyrene	10	10 U	10 U	10 U	10 U	10 U
Benzidine	80	80 U	80 U	80 U	80 U	80 UJ(c)
Butylbenzylphthalate	10	10 U	10 U	10 U	10 U	10 U
3,3'-Dichlorobenzidine	20	20 U	20 U	20 U	20 U	20 U
Benzo(a)anthracene	10	10 U	10 U	10 U	10 U	10 U
Chrysene	10	10 U	10 U	10 U	10 U	10 U
bis(2-Ethylhexyl)phthalate	10	0.3 B	9 B	2 B	6 B	4 B
Di-n-octylphthalate	10	10 U	1 J	10 U	10 U	0.3 J
Benzo(b)fluoranthene	10	10 U	10 U	10 U	10 U	10 U
Benzo(k)fluoranthene	10	10 U	10 U	10 U	10 U	10 U
Benzo(a)pyrene	10	10 U	10 U	10 U	10 U	10 U
Indeno(1,2,3-cd)pyrene	10	10 U	10 U	10 U	10 U	10 U
Dibenz(a,h)anthracene	10	10 U	10 U	10 U	10 U	10 U
Benzo(g,h,i)perylene	10	10 U	10 U	10 U	10 U	10 U
Analysis Factor:		1.0	1.0	1.0	1.0	1.0

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

SEMIVOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - S2-24-BG-3	S2-25-D	S2-26-DG-26	S2-63-WELL-E	S2-32-DG-12
LAB ID:		8851	8852	8853	9160	8903
CHEMICAL	CRQL					
N-Nitrosodimethylamine	10	10 U	10 U	10 U	10 U	10 U
bis(2-Chloroethyl) ether	10	10 U	10 U	10 U	10 U	10 U
Phenol	10	10 U	10 U	10 U	10 U	10 U
2-Chlorophenol	10	10 U	10 U	10 U	10 U	10 U
1,3-Dichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
1,4-Dichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
Benzyl alcohol	10	10 U	10 U	10 U	10 U	10 U
1,2-Dichlorobenzene	10	10 U	0.4 J	10 U	0.7 J	10 U
2-Methylphenol	10	10 U	10 U	10 U	10 U	10 U
bis(2-Chloroisopropyl) ether	10	10 U	10 U	10 U	10 U	10 U
4-Methylphenol	10	10 U	10 U	10 U	10 U	10 U
N-Nitroso-di-n-dipropylamine	10	10 U	10 U	10 U	10 U	10 U
Hexachloroethane	10	10 U	10 U	10 U	10 U	10 U
Nitrobenzene	10	10 U	10 U	10 U	10 U	10 U
Isophorone	10	10 U	10 U	10 U	10 U	10 U
2-Nitrophenol	10	10 U	10 U	10 U	10 U	10 U
2,4-Dimethylphenol	10	10 U	10 U	10 U	10 U	10 U
Benzoic acid	50	50 U	50 U	50 U	50 U	50 U
bis(2-Chloroethoxy) methane	10	10 U	10 U	10 U	10 U	10 U
2,4-Dichlorophenol	10	10 U	10 U	10 U	10 U	10 U
1,2,4-Trichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
Naphthalene	10	10 U	10 U	10 U	10 U	10 U
4-Chloroaniline	10	10 U	10 U	10 U	10 U	10 U
Hexachlorobutadiene	10	10 U	10 U	10 U	10 U	10 U
4-Chloro-3-methylphenol	10	10 U	10 U	10 U	10 U	10 U
2-Methylnaphthalene	10	10 U	10 U	10 U	10 U	10 U
Hexachlorocyclopentadiene	10	10 U	10 U	10 U	10 U	10 U
2,4,6-Trichlorophenol	10	10 U	10 U	10 U	10 U	10 U
2,4,5-Trichlorophenol	50	50 U	50 U	50 U	50 U	50 U
2-Chloronaphthalene	10	10 U	10 U	10 U	10 U	10 U
2-Nitroaniline	50	50 U	50 U	50 U	50 U	50 U
Dimethylphthalate	10	10 U	10 U	10 U	10 U	10 U
Acenaphthylene	10	10 U	10 U	10 U	10 U	10 U
2,6-Dinitrotoluene	10	10 U	10 U	10 U	10 U	10 U

SEMIVOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - S2-24-BG-3	S2-25-D	S2-26-DG-26	S2-63-WELL-E	S2-32-DG-12
LAB ID:		8851	8852	8853	9160	8903
CHEMICAL	CRQL					
3-Nitroaniline	50	50 U	50 U	50 U	50 U	50 U
Acenaphthene	10	10 U	10 U	10 U	10 U	10 U
2,4-Dinitrophenol	50	50 U	50 U	50 U	50 U	50 U
4-Nitrophenol	50	50 U	50 U	50 U	50 U	50 U
Dibenzofuran	10	10 U	10 U	10 U	10 U	10 U
2,4-Dinitrotoluene	10	10 U	10 U	10 U	10 U	10 U
Diethylphthalate	10	10 U	10 U	10 U	10 U	10 U
4-Chlorophenyl-phenyl ether	10	10 U	10 U	10 U	10 U	10 U
Fluorene	10	10 U	10 U	10 U	10 U	10 U
4-Nitroaniline	50	50 U	50 U	50 U	50 UJ(c)	50 U
4,6-Dinitro-2-methylphenol	50	50 U	50 U	50 U	50 U	50 U
N-nitrosodiphenylamine	10	10 U	10 U	10 U	10 U	10 U
1,2-diphenyl hydrazine	10	10 U	10 U	10 U	10 U	10 U
4-Bromophenyl-phenylether	10	10 U	10 U	10 U	10 U	10 U
Hexachlorobenzene	10	10 U	10 U	10 U	10 U	10 U
Pentachlorophenol	50	50 U	50 U	50 U	50 U	50 U
Phenanthrene	10	17	10 U	10 U	10 U	10 U
Anthracene	10	10 U	10 U	10 U	10 U	10 U
Di-n-butylphthalate	10	10 U	0.2 B	0.2 B	10 U	0.2 B
Fluoranthene	10	46	10 U	10 U	10 U	10 U
Pyrene	10	35	10 U	10 U	10 U	10 U
Benzidine	80	80 U	80 UJ(c)	80 UJ(c)	80 U	80 UJ(c)
Butylbenzylphthalate	10	10 U	10 U	10 U	10 U	10 U
3,3'-Dichlorobenzidine	20	20 U	20 U	20 U	20 U	20 U
Benzo(a)anthracene	10	17	10 U	10 U	10 U	10 U
Chrysene	10	30	10 U	10 U	10 U	10 U
bis(2-Ethylhexyl)phthalate	10	33 B	10 B	2 B	2 B	0.9 B
Di-n-octylphthalate	10	1 J	10 U	10 U	2 J	0.3 J
Benzo(b)fluoranthene	10	52	10 U	10 U	10 U	10 U
Benzo(k)fluoranthene	10	10 U	10 U	10 U	10 U	10 U
Benzo(a)pyrene	10	24	10 U	10 U	10 U	10 U
Indeno(1,2,3-cd)pyrene	10	20	10 U	10 U	10 U	10 U
Dibenz(a,h)anthracene	10	5 J	10 U	10 U	10 U	10 U
Benzo(g,h,i)perylene	10	20	10 U	10 U	10 U	10 U
Analysis Factor:		1.0	1.0	1.0	1.0	1.0

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

SEMIVOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - S2-76-DG-~~24~~ 2	S2-77-DG-23	S3-60-DG-13	S3-61-DG-13-D	S3-62-DG-3
LAB ID:		9275	9276	9157	9158	9159
CHEMICAL	CRQL					
N-Nitrosodimethylamine	10	10 U	10 U	10 U	10 U	10 U
bis(2-Chloroethyl) ether	10	10 U	10 U	10 U	10 U	10 U
Phenol	10	R(s)	10 U	10 U	10 U	10 U
2-Chlorophenol	10	R(s)	10 U	10 U	10 U	10 U
1,3-Dichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
1,4-Dichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
Benzyl alcohol	10	10 U	10 U	10 U	10 U	10 U
1,2-Dichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
2-Methylphenol	10	R(s)	10 U	10 U	10 U	10 U
bis(2-Chloroisopropyl) ether	10	R(s)	10 U	10 U	10 U	10 U
4-Methylphenol	10	10 U	10 U	10 U	10 U	10 U
N-Nitroso-di-n-dipropylamine	10	10 U	10 U	10 U	10 U	10 U
Hexachloroethane	10	10 U	10 U	10 U	10 U	10 U
Nitrobenzene	10	10 U	10 U	10 U	10 U	10 U
Isophorone	10	10 U	10 U	10 U	10 U	10 U
2-Nitrophenol	10	R(s)	10 U	10 U	10 U	10 U
2,4-Dimethylphenol	10	R(s)	10 U	10 U	10 U	10 U
Benzoic acid	50	R(s)	50 U	50 U	50 U	50 U
bis(2-Chloroethoxy) methane	10	10 U	10 U	10 U	10 U	10 U
2,4-Dichlorophenol	10	R(s)	10 U	10 U	10 U	10 U
1,2,4-Trichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
Naphthalene	10	10 U	10 U	10 U	10 U	10 U
4-Chloroaniline	10	10 U	10 U	10 U	10 U	10 U
Hexachlorobutadiene	10	10 U	10 U	10 U	10 U	10 U
4-Chloro-3-methylphenol	10	R(s)	10 U	10 U	10 U	10 U
2-Methylnaphthalene	10	10 U	10 U	10 U	10 U	10 U
Hexachlorocyclopentadiene	10	10 U	10 U	10 U	10 U	10 U
2,4,6-Trichlorophenol	10	R(s)	10 U	10 U	10 U	10 U
2,4,5-Trichlorophenol	50	R(s)	50 U	50 U	50 U	50 U
2-Chloronaphthalene	10	10 U	10 U	10 U	10 U	10 U
2-Nitroaniline	50	50 U	50 U	50 U	50 U	50 U
Dimethylphthalate	10	10 U	10 U	10 U	10 U	10 U
Acenaphthylene	10	10 U	10 U	10 U	10 U	10 U
2,6-Dinitrotoluene	10	10 U	10 U	10 U	10 U	10 U

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

SEMIVOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - S2-76-DG-~~24~~ 2	S2-77-DG-23	S3-60-DG-13	S3-61-DG-13-D	S3-62-DG-3
LAB ID:		9275	9276	9157	9158	9159
CHEMICAL	CRQL					
3-Nitroaniline	50	50 U	50 U	50 U	50 U	50 U
Acenaphthene	10	10 U	10 U	10 U	10 U	10 U
2,4-Dinitrophenol	50	R(s)	50 U	50 U	50 U	50 U
4-Nitrophenol	50	R(s)	50 U	50 U	50 U	50 U
Dibenzofuran	10	10 U	10 U	10 U	10 U	10 U
2,4-Dinitrotoluene	10	10 U	10 U	10 U	10 U	10 U
Diethylphthalate	10	0.2 J	10 U	10 U	0.5 J	0.2 J
4-Chlorophenyl-phenyl ether	10	10 U	10 U	10 U	10 U	10 U
Fluorene	10	10 U	10 U	10 U	10 U	10 U
4-Nitroaniline	50	50 UJ(c)	50 UJ(c)	50 UJ(c)	50 U	50 UJ(c)
4,6-Dinitro-2-methylphenol	50	R(s)	50 U	50 U	50 U	50 U
N-nitrosodiphenylamine	10	10 U	10 U	10 U	10 U	10 U
1,2-diphenyl hydrazine	10	10 U	10 U	10 U	10 U	10 U
4-Bromophenyl-phenylether	10	10 U	10 U	10 U	10 U	10 U
Hexachlorobenzene	10	10 U	10 U	10 U	10 U	10 U
Pentachlorophenol	50	R(s)	50 U	50 U	50 U	50 U
Phenanthrene	10	0.3 J	10 U	10 U	10 U	10 U
Anthracene	10	10 U	10 U	10 U	10 U	10 U
Di-n-butylphthalate	10	0.4 B	0.4 B	10 U	10 U	10 U
Fluoranthene	10	0.6 J	10 U	10 U	10 U	10 U
Pyrene	10	0.6 J	10 U	10 U	10 U	10 U
Benzidine	80	80 UJ(c)	80 U	80 U	80 U	80 U
Butylbenzylphthalate	10	10 U	10 U	10 U	10 U	10 U
3,3'-Dichlorobenzidine	20	20 U	20 U	20 U	20 U	20 U
Benzo(a)anthracene	10	10 U	10 U	10 U	10 U	10 U
Chrysene	10	10 U	10 U	10 U	10 U	10 U
bis(2-Ethylhexyl)phthalate	10	25 B	0.7 B	1 B	1 B	7 B
Di-n-octylphthalate	10	10 U	10 U	10 U	10 U	10 U
Benzo(b)fluoranthene	10	10 U	10 U	10 U	10 U	10 U
Benzo(k)fluoranthene	10	10 U	10 U	10 U	10 U	10 U
Benzo(a)pyrene	10	10 U	10 U	10 U	10 U	10 U
Indeno(1,2,3-cd)pyrene	10	10 U	10 U	10 U	10 U	10 U
Dibenz(a,h)anthracene	10	10 U	10 U	10 U	10 U	10 U
Benzo(g,h,i)perylene	10	10 U	10 U	10 U	10 U	10 U
Analysis Factor:		1.0	1.0	1.0	1.0	1.0

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

SEMIVOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - S4-33-DG-28	S4-34-DG-15	S4-35-DG-6	S4-36-DG-16	S4-37-DG-9
LAB ID:		8904	8905	8906	8907	8974
CHEMICAL	CRQL					
N-Nitrosodimethylamine	10	10 U	10 U	10 U	10 U	10 U
bis(2-Chloroethyl) ether	10	10 U	10 U	10 U	10 U	10 U
Phenol	10	10 U	10 U	10 U	10 U	10 U
2-Chlorophenol	10	10 U	10 U	10 U	10 U	10 U
1,3-Dichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
1,4-Dichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
Benzyl alcohol	10	10 U	10 U	10 U	10 U	10 U
1,2-Dichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
2-Methylphenol	10	10 U	10 U	10 U	10 U	10 U
bis(2-Chloroisopropyl) ether	10	10 U	10 U	10 U	10 U	10 U
4-Methylphenol	10	10 U	10 U	10 U	10 U	10 U
N-Nitroso-di-n-dipropylamine	10	10 U	10 U	10 U	10 U	10 U
Hexachloroethane	10	10 U	10 U	10 U	10 U	10 U
Nitrobenzene	10	10 U	10 U	10 U	10 U	10 U
Isophorone	10	10 U	10 U	10 U	10 U	10 U
2-Nitrophenol	10	10 U	10 U	10 U	10 U	10 U
2,4-Dimethylphenol	10	10 U	10 U	10 U	10 U	10 U
Benzoic acid	50	50 U	50 U	50 U	50 U	50 U
bis(2-Chloroethoxy) methane	10	10 U	10 U	10 U	10 U	10 U
2,4-Dichlorophenol	10	10 U	10 U	10 U	10 U	10 U
1,2,4-Trichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
Naphthalene	10	10 U	10 U	10 U	10 U	10 U
4-Chloroaniline	10	10 U	10 U	10 U	10 U	10 U
Hexachlorobutadiene	10	10 U	10 U	10 U	10 U	10 U
4-Chloro-3-methylphenol	10	10 U	10 U	10 U	10 U	10 U
2-Methylnaphthalene	10	10 U	10 U	10 U	10 U	10 U
Hexachlorocyclopentadiene	10	10 U	10 U	10 U	10 U	10 U
2,4,6-Trichlorophenol	10	10 U	10 U	10 U	10 U	10 U
2,4,5-Trichlorophenol	50	50 U	50 U	50 U	50 U	50 U
2-Chloronaphthalene	10	10 U	10 U	10 U	10 U	10 U
2-Nitroaniline	50	50 U	50 U	50 U	50 U	50 U
Dimethylphthalate	10	10 U	10 U	10 U	10 U	10 U
Acenaphthylene	10	10 U	10 U	10 U	10 U	10 U
2,6-Dinitrotoluene	10	10 U	10 U	10 U	10 U	10 U

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

SEMIVOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - S4-33-DG-28	S4-34-DG-15	S4-35-DG-6	S4-36-DG-16	S4-37-DG-9
LAB ID:		8904	8905	8906	8907	8974
CHEMICAL	CRQL					
3-Nitroaniline	50	50 U	50 U	50 U	50 U	50 U
Acenaphthene	10	10 U	10 U	10 U	10 U	10 U
2,4-Dinitrophenol	50	50 U	50 U	50 U	50 U	50 U
4-Nitrophenol	50	50 U	50 U	50 U	50 U	50 U
Dibenzofuran	10	10 U	10 U	10 U	10 U	10 U
2,4-Dinitrotoluene	10	10 U	10 U	10 U	10 U	10 U
Diethylphthalate	10	10 U	10 U	10 U	10 U	2 J
4-Chlorophenyl-phenyl ether	10	10 U	10 U	10 U	10 U	10 U
Fluorene	10	10 U	10 U	10 U	10 U	10 U
4-Nitroaniline	50	50 U	50 U	50 U	[illegible] U	50 UJ(c)
4,6-Dinitro-2-methylphenol	50	50 U	50 U	50 U	[illegible] U	50 U
N-nitrosodiphenylamine	10	10 U	10 U	10 U	10 U	10 U
1,2-diphenyl hydrazine	10	10 U	10 U	10 U	10 U	10 U
4-Bromophenyl-phenylether	10	10 U	10 U	10 U	10 U	10 U
Hexachlorobenzene	10	10 U	10 U	10 U	10 U	10 U
Pentachlorophenol	50	50 U	50 U	50 U	50 U	50 U
Phenanthrene	10	10 U	10 U	10 U	10 U	10 UJ(i)
Anthracene	10	10 U	10 U	10 U	10 U	10 UJ(i)
Di-n-butylphthalate	10	0.2 B	0.1 B	0.2 B	0.2 B	10 UJ(i)
Fluoranthene	10	10 U	10 U	10 U	10 U	10 UJ(i)
Pyrene	10	10 U	10 U	10 U	10 U	10 UJ(i)
Benzidine	80	80 UJ(c)	80 UJ(c)	80 UJ(c)	80 UJ(c)	80 UJ(i)
Butylbenzylphthalate	10	10 U	10 U	10 U	10 U	10 UJ(i)
3,3'-Dichlorobenzidine	20	20 U	20 U	20 U	20 U	20 UJ(i)
Benzo(a)anthracene	10	10 U	10 U	10 U	10 U	10 UJ(i)
Chrysene	10	10 U	10 U	10 U	10 U	10 UJ(i)
bis(2-Ethylhexyl)phthalate	10	0.6 B	2 B	8 B	2 B	3 B
Di-n-octylphthalate	10	0.3 J	0.3 J	10 U	0.2 J	10 UJ(i)
Benzo(b)fluoranthene	10	10 U	10 U	10 U	10 U	10 UJ(i)
Benzo(k)fluoranthene	10	10 U	10 U	10 U	10 U	10 UJ(i)
Benzo(a)pyrene	10	10 U	10 U	10 U	10 U	10 UJ(i)
Indeno(1,2,3-cd)pyrene	10	10 U	10 U	10 U	10 U	10 UJ(i)
Dibenz(a,h)anthracene	10	10 U	10 U	10 U	10 U	10 UJ(i)
Benzo(g,h,i)perylene	10	10 U	10 U	10 U	10 U	10 UJ(i)
Analysis Factor:		1.0	1.0	1.0	1.0	1.0

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

SEMIVOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - S4-39-DG-18	S4-42-DG-4	S4-43-DG-5	S4-44-DG-7	S4-67-BG-2
LAB ID:		8976	8979	8980	8981	9238
CHEMICAL	CRQL					
N-Nitrosodimethylamine	10	10 U	10 U	10 U	10 U	10 U
bis(2-Chloroethyl) ether	10	10 U	10 U	10 U	10 U	10 U
Phenol	10	10 U	10 U	10 U	10 U	10 U
2-Chlorophenol	10	10 U	10 U	10 U	10 U	10 U
1,3-Dichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
1,4-Dichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
Benzyl alcohol	10	10 U	10 U	10 U	10 U	10 U
1,2-Dichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
2-Methylphenol	10	10 U	10 U	10 U	10 U	10 U
bis(2-Chloroisopropyl) ether	10	10 U	10 U	10 U	10 U	10 U
4-Methylphenol	10	10 U	10 U	10 U	10 U	10 U
N-Nitroso-di-n-dipropylamine	10	10 U	10 U	10 U	10 U	10 U
Hexachloroethane	10	10 U	10 U	10 U	10 U	10 U
Nitrobenzene	10	10 U	10 U	10 U	10 U	10 U
Isophorone	10	10 U	10 U	10 U	10 U	10 U
2-Nitrophenol	10	10 U	10 U	10 U	10 U	10 U
2,4-Dimethylphenol	10	10 U	10 U	10 U	10 U	10 U
Benzoic acid	50	50 U	50 U	50 U	50 U	50 U
bis(2-Chloroethoxy) methane	10	10 U	10 U	10 U	10 U	10 U
2,4-Dichlorophenol	10	10 U	10 U	10 U	10 U	10 U
1,2,4-Trichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
Naphthalene	10	10 U	10 U	10 U	10 U	10 U
4-Chloroaniline	10	10 U	10 U	10 U	10 U	10 U
Hexachlorobutadiene	10	10 U	10 U	10 U	10 U	10 U
4-Chloro-3-methylphenol	10	10 U	10 U	10 U	10 U	10 U
2-Methylnaphthalene	10	10 U	10 U	10 U	10 U	10 U
Hexachlorocyclopentadiene	10	10 U	10 U	10 U	10 U	10 U
2,4,6-Trichlorophenol	10	10 U	10 U	10 U	10 U	10 U
2,4,5-Trichlorophenol	50	50 U	50 U	50 U	50 U	50 U
2-Chloronaphthalene	10	10 U	10 U	10 U	10 U	10 U
2-Nitroaniline	50	50 U	50 U	50 U	50 U	50 U
Dimethylphthalate	10	10 U	10 U	10 U	10 U	10 U
Acenaphthylene	10	10 U	10 U	10 U	10 U	10 U
2,6-Dinitrotoluene	10	10 U	10 U	10 U	10 U	10 U

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

SEMIVOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - S4-39-DG-18	S4-42-DG-4	S4-43-DG-5	S4-44-DG-7	S4-67-BG-2
LAB ID:		8976	8979	8980	8981	9238
CHEMICAL	CRQL					
3-Nitroaniline	50	50 U	50 U	50 U	50 U	50 U
Acenaphthene	10	10 U	10 U	10 U	10 U	10 U
2,4-Dinitrophenol	50	50 U	50 U	50 U	50 U	50 U
4-Nitrophenol	50	50 U	50 U	50 U	50 U	50 U
Dibenzofuran	10	10 U	10 U	10 U	10 U	10 U
2,4-Dinitrotoluene	10	10 U	10 U	10 U	10 U	10 U
Diethylphthalate	10	10 U	0.3 J	10 U	10 U	10 U
4-Chlorophenyl-phenyl ether	10	10 U	10 U	10 U	10 U	10 U
Fluorene	10	10 U	10 U	10 U	10 U	10 U
4-Nitroaniline	50	50 U	50 U	50 U	50 U	50 U
4,6-Dinitro-2-methylphenol	50	50 U	50 U	50 U	50 U	50 U
N-nitrosodiphenylamine	10	10 U	10 U	10 U	10 U	10 U
1,2-diphenyl hydrazine	10	10 U	10 U	10 U	10 U	10 U
4-Bromophenyl-phenylether	10	10 U	10 U	10 U	10 U	10 U
Hexachlorobenzene	10	10 U	10 U	10 U	10 U	10 U
Pentachlorophenol	50	50 U	50 U	50 U	50 U	50 U
Phenanthrene	10	10 U	10 U	10 U	10 U	10 U
Anthracene	10	10 U	10 U	10 U	10 U	10 U
Di-n-butylphthalate	10	0.3 B	0.3 B	10 U	0.3 B	10 U
Fluoranthene	10	10 U	10 U	10 U	10 U	10 U
Pyrene	10	10 U	10 U	10 U	10 U	10 U
Benzidine	80	80 UJ(c)	80 UJ(c)	80 U	80 U	80 U
Butylbenzylphthalate	10	10 U	0.3 J	10 U	10 U	0.4 J
3,3'-Dichlorobenzidine	20	20 U	20 U	20 U	20 U	20 U
Benzo(a)anthracene	10	10 U	10 U	10 U	10 U	10 U
Chrysene	10	10 U	10 U	10 U	10 U	10 U
bis(2-Ethylhexyl)phthalate	10	0.7 B	13 B	7 B	12 B	28 B
Di-n-octylphthalate	10	0.2 J	2 J	1 J	10 U	0.8 J
Benzo(b)fluoranthene	10	10 U	10 U	10 U	10 U	10 U
Benzo(k)fluoranthene	10	10 U	10 U	10 U	10 U	10 U
Benzo(a)pyrene	10	10 U	10 U	10 U	10 U	10 U
Indeno(1,2,3-cd)pyrene	10	10 U	10 U	10 U	10 U	10 U
Dibenz(a,h)anthracene	10	10 U	10 U	10 U	10 U	10 U
Benzo(g,h,i)perylene	10	10 U	10 U	10 U	10 U	10 U
Analysis Factor:		1.0	1.0	1.0	1.0	1.0

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

SEMIVOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - S4-68-BG-~~X~~ 6	S4-73-DG-22	S4-78-DG-22-D	S4-74-DG-24	S5-50-DG-8
LAB ID:		9239	9272	9273	9274	9101
CHEMICAL	CRQL					
N-Nitrosodimethylamine	10	10 U	10 U	10 U	10 U	10 U
bis(2-Chloroethyl) ether	10	10 U	10 U	10 U	10 U	10 U
Phenol	10	10 U	10 U	10 U	10 U	10 U
2-Chlorophenol	10	10 U	10 U	10 U	10 U	10 U
1,3-Dichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
1,4-Dichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
Benzyl alcohol	10	10 U	10 U	10 U	10 U	10 U
1,2-Dichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
2-Methylphenol	10	10 U	10 U	10 U	10 U	10 U
bis(2-Chloroisopropyl) ether	10	10 U	10 U	10 U	10 U	10 U
4-Methylphenol	10	10 U	10 U	10 U	10 U	10 U
N-Nitroso-di-n-dipropylamine	10	10 U	10 U	10 U	10 U	10 U
Hexachloroethane	10	10 U	10 U	10 U	10 U	10 U
Nitrobenzene	10	10 U	10 U	10 U	10 U	10 U
Isophorone	10	10 U	10 U	10 U	10 U	10 U
2-Nitrophenol	10	10 U	10 U	10 U	10 U	10 U
2,4-Dimethylphenol	10	10 U	10 U	10 U	10 U	10 U
Benzoic acid	50	50 U	50 U	50 U	50 U	50 U
bis(2-Chloroethoxy) methane	10	10 U	10 U	10 U	10 U	10 U
2,4-Dichlorophenol	10	10 U	10 U	10 U	10 U	10 U
1,2,4-Trichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
Naphthalene	10	10 U	10 U	10 U	10 U	10 U
4-Chloroaniline	10	10 U	10 U	10 U	10 U	10 U
Hexachlorobutadiene	10	10 U	10 U	10 U	10 U	10 U
4-Chloro-3-methylphenol	10	10 U	10 U	10 U	10 U	10 U
2-Methylnaphthalene	10	10 U	10 U	10 U	10 U	10 U
Hexachlorocyclopentadiene	10	10 U	10 U	10 U	10 U	10 U
2,4,6-Trichlorophenol	10	10 U	10 U	10 U	10 U	10 U
2,4,5-Trichlorophenol	50	50 U	50 U	50 U	50 U	50 U
2-Chloronaphthalene	10	10 U	10 U	10 U	10 U	10 U
2-Nitroaniline	50	50 U	50 U	50 U	50 U	50 U
Dimethylphthalate	10	10 U	10 U	10 U	10 U	10 U
Acenaphthylene	10	10 U	10 U	10 U	10 U	10 U
2,6-Dinitrotoluene	10	10 U	10 U	10 U	10 U	10 U

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SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

SEMIVOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - S4-68-BG-~~X~~ 6	S4-73-DG-22	S4-78-DG-22-D	S4-74-DG-24	S5-50-DG-8
LAB ID:		9239	9272	9273	9274	9101
CHEMICAL	CRQL					
3-Nitroaniline	50	50 U	50 U	50 U	50 U	50 U
Acenaphthene	10	10 U	10 U	10 U	10 U	10 U
2,4-Dinitrophenol	50	50 U	50 U	50 U	50 U	50 U
4-Nitrophenol	50	50 U	50 U	50 U	50 U	50 U
Dibenzofuran	10	10 U	10 U	10 U	10 U	10 U
2,4-Dinitrotoluene	10	10 U	10 U	10 U	10 U	10 U
Diethylphthalate	10	10 U	10 U	10 U	10 U	0.2 J
4-Chlorophenyl-phenyl ether	10	10 U	10 U	10 U	10 U	10 U
Fluorene	10	10 U	10 U	10 U	10 U	10 U
4-Nitroaniline	50	50 UJ(c)	50 U	50 U	50 U	50 U
4,6-Dinitro-2-methylphenol	50	50 U	50 U	50 U	50 U	50 U
N-nitrosodiphenylamine	10	10 U	10 U	10 U	10 U	10 U
1,2-diphenyl hydrazine	10	10 U	10 U	10 U	10 U	10 U
4-Bromophenyl-phenylether	10	10 U	10 U	10 U	10 U	10 U
Hexachlorobenzene	10	10 U	10 U	10 U	10 U	10 U
Pentachlorophenol	50	50 U	50 U	50 U	50 U	50 U
Phenanthrene	10	10 U	10 U	10 U	10 U	10 U
Anthracene	10	10 U	10 U	10 U	10 U	10 U
Di-n-butylphthalate	10	0.2 B	10 U	10 U	10 U	0.3 B
Fluoranthene	10	10 U	10 U	10 U	10 U	10 U
Pyrene	10	10 U	10 U	10 U	10 U	10 U
Benzidine	80	80 U	80 U	80 U	80 U	80 U
Butylbenzylphthalate	10	10 U	10 U	10 U	10 U	10 U
3,3'-Dichlorobenzidine	20	20 U	20 U	20 U	20 U	20 U
Benzo(a)anthracene	10	10 U	10 U	10 U	10 U	10 U
Chrysene	10	10 U	10 U	10 U	10 U	10 U
bis(2-Ethylhexyl)phthalate	10	1 B	0.4 B	0.8 B	0.9 B	10 B
Di-n-octylphthalate	10	10 U	10 U	10 U	10 U	0.6 J
Benzo(b)fluoranthene	10	10 U	10 U	10 U	10 U	10 U
Benzo(k)fluoranthene	10	10 U	10 U	10 U	10 U	10 U
Benzo(a)pyrene	10	10 U	10 U	10 U	10 U	10 U
Indeno(1,2,3-cd)pyrene	10	10 U	10 U	10 U	10 U	10 U
Dibenz(a,h)anthracene	10	10 U	10 U	10 U	10 U	10 U
Benzo(g,h,i)perylene	10	10 U	10 U	10 U	10 U	10 U
Analysis Factor:		1.0	1.0	1.0	1.0	1.0

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SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

SEMIVOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - S5-51-DG-20	S5-54-DG-27	S5-55-DG-21	S6-41-DG-10	S6-47-DG-19
LAB ID:		9102	9105	9106	8978	9021
CHEMICAL	CRQL					
N-Nitrosodimethylamine	10	10 U	10 U	10 U	10 U	10 U
bis(2-Chloroethyl) ether	10	10 U	10 U	10 U	10 U	10 U
Phenol	10	10 U	10 U	10 U	10 U	10 U
2-Chlorophenol	10	10 U	10 U	10 U	10 U	10 U
1,3-Dichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
1,4-Dichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
Benzyl alcohol	10	10 U	10 U	10 U	10 U	10 U
1,2-Dichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
2-Methylphenol	10	10 U	10 U	10 U	10 U	10 U
bis(2-Chloroisopropyl) ether	10	10 U	10 U	10 U	10 U	10 U
4-Methylphenol	10	10 U	10 U	10 U	10 U	10 U
N-Nitroso-di-n-dipropylamine	10	10 U	10 U	10 U	10 U	10 U
Hexachloroethane	10	10 U	10 U	10 U	10 U	10 U
Nitrobenzene	10	10 U	10 U	10 U	10 U	10 U
Isophorone	10	10 U	10 U	10 U	10 U	10 U
2-Nitrophenol	10	10 U	10 U	10 U	10 U	10 U
2,4-Dimethylphenol	10	10 U	10 U	10 U	10 U	10 U
Benzoic acid	50	50 U	50 U	50 U	50 U	50 U
bis(2-Chloroethoxy) methane	10	10 U	10 U	10 U	10 U	10 U
2,4-Dichlorophenol	10	10 U	10 U	10 U	10 U	10 U
1,2,4-Trichlorobenzene	10	10 U	10 U	10 U	10 U	10 U
Naphthalene	10	10 U	10 U	10 U	10 U	10 U
4-Chloroaniline	10	10 U	10 U	10 U	10 U	10 U
Hexachlorobutadiene	10	10 U	10 U	10 U	10 U	10 U
4-Chloro-3-methylphenol	10	10 U	10 U	10 U	10 U	10 U
2-Methylnaphthalene	10	10 U	10 U	10 U	10 U	10 U
Hexachlorocyclopentadiene	10	10 U	10 U	10 U	10 U	10 U
2,4,6-Trichlorophenol	10	10 U	10 U	10 U	10 U	10 U
2,4,5-Trichlorophenol	50	50 U	50 U	50 U	50 U	50 U
2-Chloronaphthalene	10	10 U	10 U	10 U	10 U	10 U
2-Nitroaniline	50	50 U	50 U	50 U	50 U	50 U
Dimethylphthalate	10	10 U	10 U	10 U	10 U	10 U
Acenaphthylene	10	10 U	10 U	10 U	10 U	10 U
2,6-Dinitrotoluene	10	10 U	10 U	10 U	10 U	10 U

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

SEMIVOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - S5-51-DG-20	S5-54-DG-27	S5-55-DG-21	S6-41-DG-10	S6-47-DG-19
LAB ID:		9102	9105	9106	8978	9021
CHEMICAL	CRQL					
3-Nitroaniline	50	50 U	50 U	50 U	50 U	50 U
Acenaphthene	10	10 U	10 U	10 U	10 U	10 U
2,4-Dinitrophenol	50	50 U	50 U	50 U	50 U	50 U
4-Nitrophenol	50	50 U	50 U	50 U	50 U	50 U
Dibenzofuran	10	10 U	10 U	10 U	10 U	10 U
2,4-Dinitrotoluene	10	10 U	10 U	10 U	10 U	10 U
Diethylphthalate	10	10 U	10 U	0.2 J	0.4 J	10 U
4-Chlorophenyl-phenyl ether	10	10 U	10 U	10 U	10 U	10 U
Fluorene	10	10 U	10 U	10 U	10 U	10 U
4-Nitroaniline	50	50 U	50 U	50 U	50 U	50 U
4,6-Dinitro-2-methylphenol	50	50 U	50 U	50 U	50 U	50 U
N-nitrosodiphenylamine	10	10 U	10 U	10 U	10 U	10 U
1,2-diphenyl hydrazine	10	10 U	10 U	10 U	10 U	10 U
4-Bromophenyl-phenylether	10	10 U	10 U	10 U	10 U	10 U
Hexachlorobenzene	10	10 U	10 U	10 U	10 U	10 U
Pentachlorophenol	50	50 U	50 U	50 U	50 U	50 U
Phenanthrene	10	10 U	10 U	10 U	10 U	10 U
Anthracene	10	10 U	10 U	10 U	10 U	10 U
Di-n-butylphthalate	10	10 U	10 U	10 U	0.7 B	10 U
Fluoranthene	10	10 U	10 U	10 U	10 U	10 U
Pyrene	10	10 U	10 U	10 U	10 U	10 U
Benzidine	80	80 U	80 U	80 U	80 UJ(c)	80 U
Butylbenzylphthalate	10	10 U	10 U	10 U	10 U	10 U
3,3'-Dichlorobenzidine	20	20 U	20 U	20 U	20 U	20 U
Benzo(a)anthracene	10	10 U	10 U	10 U	10 U	10 U
Chrysene	10	10 U	10 U	10 U	10 U	10 U
bis(2-Ethylhexyl)phthalate	10	3 B	2 B	4 B	5 B	1 B
Di-n-octylphthalate	10	10 U	10 U	0.9 J	0.3 J	10 U
Benzo(b)fluoranthene	10	10 U	10 U	10 U	10 U	10 U
Benzo(k)fluoranthene	10	10 U	10 U	10 U	10 U	10 U
Benzo(a)pyrene	10	10 U	10 U	10 U	10 U	10 U
Indeno(1,2,3-cd)pyrene	10	10 U	10 U	10 U	10 U	10 U
Dibenz(a,h)anthracene	10	10 U	10 U	10 U	10 U	10 U
Benzo(g,h,i)perylene	10	10 U	10 U	10 U	10 U	10 U
Analysis Factor:		1.0	1.0	1.0	1.0	1.0

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

SEMIVOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC -	S6-48-DG-17	S6-69-BG-7	S7-58-DG-25-D	S7-56-DG-25	S8-49-BG-5
LAB ID:			9022	9240	9155	9153	9023
CHEMICAL	CRQL						
N-Nitrosodimethylamine	10		10 U	10 U	10 U	10 U	10 U
bis(2-Chloroethyl) ether	10		10 U	10 U	10 U	10 U	10 U
Phenol	10		10 U	10 U	10 U	10 U	10 U
2-Chlorophenol	10		10 U	10 U	10 U	10 U	10 U
1,3-Dichlorobenzene	10		10 U	10 U	10 U	10 U	10 U
1,4-Dichlorobenzene	10		10 U	10 U	10 U	10 U	10 U
Benzyl alcohol	10		10 U	10 U	10 U	10 U	10 U
1,2-Dichlorobenzene	10		10 U	10 U	10 U	10 U	10 U
2-Methylphenol	10		10 U	10 U	10 U	10 U	10 U
bis(2-Chloroisopropyl) ether	10		10 U	10 U	10 U	10 U	10 U
4-Methylphenol	10		10 U	10 U	10 U	10 U	10 U
N-Nitroso-di-n-dipropylamine	10		10 U	10 U	10 U	10 U	10 U
Hexachloroethane	10		10 U	10 U	10 U	10 U	10 U
Nitrobenzene	10		10 U	10 U	10 U	10 U	10 U
Isophorone	10		10 U	10 U	10 U	10 U	10 U
2-Nitrophenol	10		10 U	10 U	10 U	10 U	10 U
2,4-Dimethylphenol	10		10 U	10 U	10 U	10 U	10 U
Benzoic acid	50		50 U	50 U	50 U	50 U	50 U
bis(2-Chloroethoxy) methane	10		10 U	10 U	10 U	10 U	10 U
2,4-Dichlorophenol	10		10 U	10 U	10 U	10 U	10 U
1,2,4-Trichlorobenzene	10		10 U	10 U	10 U	10 U	10 U
Naphthalene	10		10 U	10 U	10 U	10 U	10 U
4-Chloroaniline	10		10 U	10 U	10 U	10 U	10 U
Hexachlorobutadiene	10		10 U	10 U	10 U	10 U	10 U
4-Chloro-3-methylphenol	10		10 U	10 U	10 U	10 U	10 U
2-Methylnaphthalene	10		10 U	10 U	10 U	10 U	10 U
Hexachlorocyclopentadiene	10		10 U	10 U	10 U	10 U	10 U
2,4,6-Trichlorophenol	10		10 U	10 U	10 U	10 U	10 U
2,4,5-Trichlorophenol	50		50 U	50 U	50 U	50 U	50 U
2-Chloronaphthalene	10		10 U	10 U	10 U	10 U	10 U
2-Nitroaniline	50		50 U	50 U	50 U	50 U	50 U
Dimethylphthalate	10		10 U	10 U	10 U	10 U	10 U
Acenaphthylene	10		10 U	10 U	10 U	10 U	10 U
2,6-Dinitrotoluene	10		10 U	10 U	10 U	10 U	10 U

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

SEMIVOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - S6-48-DG-17	S6-69-BG-7	S7-58-DG-25-D	S7-56-DG-25	S8-49-BG-5
LAB ID:		9022	9240	9155	9153	9023
CHEMICAL	CRQL					
3-Nitroaniline	50	50 U	50 U	50 U	50 U	50 U
Acenaphthene	10	10 U	10 U	10 U	10 U	10 U
2,4-Dinitrophenol	50	50 U	50 U	50 U	50 U	50 U
4-Nitrophenol	50	50 U	50 U	50 U	50 U	50 U
Dibenzofuran	10	10 U	10 U	10 U	10 U	10 U
2,4-Dinitrotoluene	10	10 U	10 U	10 U	10 U	10 U
Diethylphthalate	10	0.2 J	10 U	10 U	10 U	0.2 J
4-Chlorophenyl-phenyl ether	10	10 U	10 U	10 U	10 U	10 U
Fluorene	10	10 U	10 U	10 U	10 U	10 U
4-Nitroaniline	50	50 U	50 UJ(c)	50 U	50 U	50 U
4,6-Dinitro-2-methylphenol	50	50 U	50 U	50 U	50 U	50 U
N-nitrosodiphenylamine	10	10 U	10 U	10 U	10 U	10 U
1,2-diphenyl hydrazine	10	10 U	10 U	10 U	10 U	10 U
4-Bromophenyl-phenylether	10	10 U	10 U	10 U	10 U	10 U
Hexachlorobenzene	10	10 U	10 U	10 U	10 U	10 U
Pentachlorophenol	50	50 U	50 U	50 U	50 U	50 U
Phenanthrene	10	10 U	10 U	10 U	10 U	10 U
Anthracene	10	10 U	10 U	10 U	10 U	10 U
Di-n-butylphthalate	10	0.3 B	10 U	0.3 B	10 U	0.4 B
Fluoranthene	10	10 U	10 U	10 U	10 U	10 U
Pyrene	10	10 U	10 U	10 U	10 U	10 U
Benzidine	80	80 U	80 U	80 U	80 U	80 U
Butylbenzylphthalate	10	10 U	10 U	10 U	10 U	10 U
3,3'-Dichlorobenzidine	20	20 U	20 U	20 U	20 U	20 U
Benzo(a)anthracene	10	10 U	10 U	10 U	10 U	10 U
Chrysene	10	10 U	10 U	10 U	10 U	10 U
bis(2-Ethylhexyl)phthalate	10	1 B	2 B	3 B	1 B	3 B
Di-n-octylphthalate	10	10 U	10 U	10 U	10 U	10 U
Benzo(b)fluoranthene	10	10 U	10 U	10 U	10 U	10 U
Benzo(k)fluoranthene	10	10 U	10 U	10 U	10 U	10 U
Benzo(a)pyrene	10	10 U	10 U	10 U	10 U	10 U
Indeno(1,2,3-cd)pyrene	10	10 U	10 U	10 U	10 U	10 U
Dibenz(a,h)anthracene	10	10 U	10 U	10 U	10 U	10 U
Benzo(g,h,i)perylene	10	10 U	10 U	10 U	10 U	10 U
Analysis Factor:		1.0	1.0	1.0	1.0	1.0

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

SEMIVOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - S8-75-DG-14
LAB ID:		9271
CHEMICAL	CRQL	
N-Nitrosodimethylamine	10	10 U
bis(2-Chloroethyl) ether	10	10 U
Phenol	10	10 U
2-Chlorophenol	10	10 U
1,3-Dichlorobenzene	10	10 U
1,4-Dichlorobenzene	10	10 U
Benzyl alcohol	10	10 U
1,2-Dichlorobenzene	10	10 U
2-Methylphenol	10	10 U
bis(2-Chloroisopropyl) ether	10	10 U
4-Methylphenol	10	10 U
N-Nitroso-di-n-dipropylamine	10	10 U
Hexachloroethane	10	10 U
Nitrobenzene	10	10 U
Isophorone	10	10 U
2-Nitrophenol	10	10 U
2,4-Dimethylphenol	10	10 U
Benzoic acid	50	50 U
bis(2-Chloroethoxy) methane	10	10 U
2,4-Dichlorophenol	10	10 U
1,2,4-Trichlorobenzene	10	10 U
Naphthalene	10	10 U
4-Chloroaniline	10	10 U
Hexachlorobutadiene	10	10 U
4-Chloro-3-methylphenol	10	10 U
2-Methylnaphthalene	10	10 U
Hexachlorocyclopentadiene	10	10 U
2,4,6-Trichlorophenol	10	10 U
2,4,5-Trichlorophenol	50	50 U
2-Chloronaphthalene	10	10 U
2-Nitroaniline	50	50 U
Dimethylphthalate	10	10 U
Acenaphthylene	10	10 U
2,6-Dinitrotoluene	10	10 U

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

SEMIVOLATILE AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC - S8-75-DG-14
LAB ID:		9271
CHEMICAL	CRQL	
3-Nitroaniline	50	50 U
Acenaphthene	10	10 U
2,4-Dinitrophenol	50	50 U
4-Nitrophenol	50	50 U
Dibenzofuran	10	10 U
2,4-Dinitrotoluene	10	10 U
Diethylphthalate	10	10 U
4-Chlorophenyl-phenyl ether	10	10 U
Fluorene	10	10 U
4-Nitroaniline	50	50 U
4,6-Dinitro-2-methylphenol	50	50 U
N-nitrosodiphenylamine	10	10 U
1,2-diphenyl hydrazine	10	10 U
4-Bromophenyl-phenylether	10	10 U
Hexachlorobenzene	10	10 U
Pentachlorophenol	50	50 U
Phenanthrene	10	10 U
Anthracene	10	10 U
Di-n-butylphthalate	10	10 U
Fluoranthene	10	10 U
Pyrene	10	10 U
Benzidine	80	80 U
Butylbenzylphthalate	10	10 U
3,3'-Dichlorobenzidine	20	20 U
Benzo(a)anthracene	10	10 U
Chrysene	10	10 U
bis(2-Ethylhexyl)phthalate	10	0.6 B
Di-n-octylphthalate	10	0.6 J
Benzo(b)fluoranthene	10	10 U
Benzo(k)fluoranthene	10	10 U
Benzo(a)pyrene	10	10 U
Indeno(1,2,3-cd)pyrene	10	10 U
Dibenz(a,h)anthracene	10	10 U
Benzo(g,h,i)perylene	10	10 U
Analysis Factor:		1.0

8h

APPENDIX K-3

PHASE II - MISCELLANEOUS PARAMETERS

SITE: WARMINSTER NAVAL BASE
CASE NO. 3933
LABORATORY: CEIMIC

Inorganic Analyses

Client ID:	W-MW-30		W-630-RB		WW-MW-46		W-MW-31		W-MW-31-D	
LAB ID:	920336-17		920336-18		920345-07		920343-02		920343-01	
ANALYTE										
% Moisture	NA		NA		NA		NA		NA	
pH	NA		NA		NA		NA		NA	
Chemical Oxygen Demand	5	U	5	U	5	U	5	U	5	U
Alkalinity	206		2	U	50		45		34	
Ammonia	1.75		0.1	U	0.1		0.3		0.3	
Biological Oxygen Demand	2	U	2	U	2	U	2	U	2	U
Chloride	87		2	U	10		45		45	
Hardness	253		2	U	65		202		224	
Nitrate-Nitrite	0.17		0.02		0.87		1.42		1.32	
Sulfate	67		5	U	22		195		188	
Total Dissolved Solids	506		19		139		372		351	
Total Suspended Solids	396		23		33		214		3100	
Dilution Factor:	1.0		1.0		1.0		1.0		1.0	

NA - Not Analyzed

SITE: WARMINSTER NAVAL BASE
CASE NO. 3933
LABORATORY: CEIMIC

Inorganic Analyses

Client ID:	W-MW-06		W-MW-14		W-626-RB		W-MW-21		W-MW-25	
LAB ID:	920333-02		920333-13		920333-16		920336-4		920336-25	
ANALYTE										
% Moisture	NA		NA		NA		NA		NA	
pH	NA		NA		NA		NA		NA	
Chemical Oxygen Demand	5	U	5		5	U	5	U	5	U
Alkalinity	166		34		2	U	77		148	
Ammonia	0.1	U	0.2		0.1	U	0.3		0.2	
Biological Oxygen Demand	2	U	2	U	2	U	2	U	2	U
Chloride	3		2	U	2	U	7		34	
Hardness	199		54		2	U	105		230	
Nitrate-Nitrite	0.02	U	0.38		0.02	U	1.79		5.14	
Sulfate	35		29		5	U	58		52	
Total Dissolved Solids	173		55		5	U	166		364	
Total Suspended Solids	5	U	15		5	U	44	B	628	
Dilution Factor:	1.0		1.0		1.0		1.0		1.0	

NA - Not Analyzed

SITE: WARMINSTER NAVAL BASE
CASE 3933, SDG MISC
LABORATORY: CEIMIC CORPORATION

MISCELLANEOUS PARAMETERS (MG/L)

CLIENT ID:		W-806-FB
LAB ID:		920397-11
PARAMETER	REPORTING LIMIT	
Alkalinity	2	2
Ammonia	0.1	0.1 U
Chloride	2	2 U
COD	5	5 U
Hardness	2	2 U
Nitrate-Nitrite	0.02	0.02 U
Sulfate	5	5 U
TDS	5	11 L(h)
TSS	5	5 UL(h)
TOC	1	1.9

SITE: WARMINSTER NAVAL BASE
CASE NO. 3933
LABORATORY: CEIMIC

Inorganic Analyses

Client ID:	W-MW-32		W-MW-35	
LAB ID:	920343-03		920343-06	
ANALYTE				
% Moisture	NA		NA	
pH	NA		NA	
Chemical Oxygen Demand	5	U	5	U
Alkalinity	60		149	
Ammonia	0.2		0.1	
Biological Oxygen Demand	2	U	2	U
Chloride	45		14	
Hardness	206		151	
Nitrate-Nitrite	4.11		0.45	
Sulfate	101		24	
Total Dissolved Solids	338		193	
Total Suspended Solids	35		6	
Dilution Factor:	1.0		1.0	

NA - Not Analyzed

Data Qualifier Key:

U - The result is nondetected as reported by the laboratory.

L(h) - Positive result is considered to be biased low due to holding time exceedance.

UL(h) - Nondetected result is considered to be biased low due to holding time exceedance.

APPENDIX K-4

PHASE II - TCL LOW-CONCENTRATION VOLATILE ORGANICS

Warminster
CASE NO. 3933, SDG W-OS-01
LABORATORY: CEIMIC CORP

Low Concentration Volatile Aqueous Analyses
ug/L

CLIENT ID:		W-OS-01	W-OS-01-D	W-OS-02	W-OS-03	W-806-TB	W-OS-04
LAB ID:		920397-01	920397-02	920397-03	920397-04	920397-13	920397-14
COMPOUND	CRQL						
Chloromethane	1	50 U	50 U	8 U	1 U	1 U	1 U
Bromomethane	1	50 U	50 U	8 U	1 U	1 U	1 U
Vinyl Chloride	1	50 U	50 U	8 U	1 U	1 U	1 U
Chloroethane	1	50 U	50 U	8 U	1 U	1 U	1 U
Methylene Chloride	1	120 B	50 U	8 U	2 B	3 B	1 U
Acetone	5	R(c)	R(c)	R(c)	R(c)	R(c)	R(c)
Carbon Disulfide	1	50 U	50 U	8 U	1 U	1 U	1 U
1,1-Dichloroethene	1	50 U	50 U	18	1 U	1 U	1 U
1,1-Dichloroethane	1	50 U	50 U	28	1 U	1 U	1 U
1,2-Dichloroethene (total)	1	50 U	50 U	8 U	1 U	1 U	1 U
Chloroform	1	50 U	50 U	8 U	1 U	1 U	1 U
1,2-Dichloroethane	1	50 U	50 U	8 U	1 U	1 U	1 U
2-Butanone	5	R(c)	R(c)	R(c)	R(c)	R(c)	R(c)
1,1,1-Trichloroethane	1	50 U	50 U	100	1 U	1 U	1 U
Carbon Tetrachloride	1	50 U	50 U	8 U	1 U	1 U	1 U
Bromochloromethane	1	50 U	50 U	8 U	1 U	1 U	1 U
Bromodichloromethane	1	50 U	50 U	8 U	1 U	1 U	1 U
1,2-Dichloropropane	1	50 U	50 U	8 U	1 U	1 U	1 U
cis-1,3-Dichloropropene	1	50 U	50 U	8 U	1 U	1 U	1 U
Trans-1,2-Dichloroethene	1	50 U	50 U	8 U	1 U	1 U	1 U
Trichloroethene	1	800	640	110	1 U	1 U	1 U
Dibromochloromethane	1	50 U	50 U	8 U	1 U	1 U	1 U
1,1,2-Trichloroethane	1	50 U	50 U	8 U	1 U	1 U	1 U
Benzene	1	50 U	50 U	8 U	1 U	1 U	1 U
1,2-Dibromoethane	1	50 U	50 U	8 U	1 U	1 U	1 U
trans-1,3-Dichloropropene	1	50 U	50 U	8 U	1 U	1 U	1 U
Bromoform	1	50 U	50 U	8 U	1 U	1 U	1 U
4-Methyl-2-pentanone	5	250 U	250 U	42 U	5 U	5 U	5 U
2-Hexanone	5	250 U	250 U	42 U	5 U	5 U	5 U
Tetrachloroethene	1	50 U	50 U	20	1 U	1 U	2
1,1,2,2-Tetrachloroethane	1	50 U	50 U	8 U	1 U	1 U	1 U
Toluene	1	50 U	50 U	8 U	1 U	1 U	1 U
Chlorobenzene	1	50 U	50 U	8 U	1 U	1 U	1 U
Ethylbenzene	1	50 U	50 U	8 U	1 U	1 U	1 U
Styrene	1	50 U	50 U	8 U	1 U	1 U	1 U
Total Xylenes	1	50 U	50 U	8 U	1 U	1 U	1 U
1,3-Dichlorobenzene	1	50 U	50 U	8 U	1 U	1 U	1 U
1,4-Dichlorobenzene	1	50 U	50 U	8 U	1 U	1 U	1 U
1,2-Dichlorobenzene	1	50 U	50 U	8 U	1 U	1 U	1 U
1,2-Dibromo-3-chloropropane	1	50 U	50 U	8 U	1 U	1 U	1 U

Data Qualifier Key:

U	-	Value is a nondetect as reported by the laboratory.
B	-	Positive result is considered to be an artifact of blank contamination, and should not be considered present.
UL(s)	-	Nondetect is considered to be biased low based on low surrogate recovery.
UJ(c)	-	Nondetect is considered estimated due to calibration noncompliances.
R(c)	-	Nondetect is considered unreliable due to lack of instrumental sensitivity.
J	-	Positive result is reported at a concentration level below its associated CRQL.

SITE: WARMINSTER NAVAL BASE
CASE NO. 3933
LABORATORY: CEIMIC

Aqueous Low-Concentration
Volatile Analyses (ug/L)

Client ID:	W-MW-38		W-MW-39		W-MW-39-D		W-MW-40		W-MW-41		W-MW-42	
LAB ID:	920343-11		920343-12		920343-13		920343-14		920345-01		920345-02	
ANALYTE												
Chloromethane	33	U	25	U	25	U	1	U	1	U	1	U
Bromomethane	33	U	25	U	25	U	1	U	1	U	1	U
Vinyl Chloride	33	U	25	U	25	U	1	U	1	U	1	U
Chloroethane	33	U	25	U	25	U	1	U	1	U	1	U
Methylene Chloride	33	U	25	U	25	U	1	U	1	U	1	U
Acetone	170	U	125	U	125	U	5	U	5	U	5	U
Carbon Disulfide	33	U	25	U	25	U	1	U	1	U	1	U
1,1-Dichloroethene	33	U	25	U	25	U	1	U	1	U	2	
1,1-Dichloroethane	33	U	25	U	25	U	1	U	1	U	5	
cis-1,2-Dichloroethene	510		30		42		1	U	1	U	2	
Chloroform	33	U	25	U	25	U	1	U	1	U	1	U
1,2-Dichloroethane	33	U	25	U	25	U	1	U	1	U	1	U
2-Butanone	170	U	125	U	125	U	5	U	5	U	5	U
1,1,1-Trichloroethane	33	U	25	U	25	U	1	U	1	U	4	
Carbon Tetrachloride	33	U	25	U	42		1	U	1	U	1	U
Bromochloromethane	33	U	25	U	25	U	1	U	1	U	1	U
Bromodichloromethane	33	U	25	U	25	U	1	U	1	U	1	U
1,2-Dichloropropane	33	U	25	U	25	U	1	U	1	U	1	U
cis-1,3-Dichloropropene	33	U	25	U	25	U	1	U	1	U	1	U
Trans-1,2-dichloroethene	33	U	25	U	25	U	1	U	1	U	1	U
Trichloroethene	220		160		220		1	U	1	U	16	
Dibromochloromethane	33	U	25	U	25	U	1	U	1	U	1	U
1,1,2-Trichloroethane	33	U	25	U	25	U	1	U	1	U	1	U
Benzene	33	U	25	U	25	U	1	U	1	U	1	U
1,2-Dibromoethane	33	U	25	U	25	U	1	U	1	U	1	U
trans-1,3-Dichloropropene	33	U	25	U	25	U	1	U	1	U	1	U
Bromoform	33	U	25	U	25	U	1	U	1	U	1	U
4-Methyl-2-Pentanone	170	U	125	U	125	U	5	U	5	U	5	U
2-Hexanone	170	U	125	U	125	U	5	U	5	U	5	U
1,1,2,2-Tetrachloroethane	33	U	25	U	25	U	1	U	1	U	1	U
Tetrachloroethene	350		200		330		1	B	1	B	4	
Toluene	33	U	25	U	25	U	1	U	4		1	U
Chlorobenzene	33	U	25	U	25	U	1	U	1	U	1	U
Ethyl Benzene	33	U	25	U	25	U	1	U	1	U	1	U
Styrene	33	U	25	U	25	U	1	U	1	U	1	U
Xylene (total)	33	U	25	U	25	U	1	U	1	U	1	U
1,3-Dichlorobenzene	33	U	25	U	25	U	1	U	1	U	1	U
1,4-Dichlorobenzene	33	U	25	U	25	U	1	U	1	U	1	U
1,2-Dichlorobenezene	33	U	25	U	25	U	1	U	1	U	1	U
1,2-Dibromo-3-chloropropane	33	U	25	U	25	U	1	U	1	U	1	U

SITE: WARMINSTER NAVAL BASE
CASE NO. 3933
LABORATORY: CEIMIC

Aqueous Low-Concentration
Volatile Analyses (ug/L)

Client ID:	W-MW-43		W-MW-44		W-MW-45		W-MW-45D		W-MW-46	
LAB ID:	920345-03		920345-04		920345-05		920345-06		920345-07	
ANALYTE										
Chloromethane	2	U	5	U	1	U	1	U	1	U
Bromomethane	2	U	5	U	1	U	1	U	1	U
Vinyl Chloride	2	U	5	U	1	U	1	U	1	U
Chloroethane	2	U	5	U	1	U	1	U	1	U
Methylene Chloride	2	U	5	U	1	U	1	U	1	U
Acetone	12	U		R (c)	5	U		R (c)		R (c)
Carbon Disulfide	2	U	5	U	1	U	1	U	1	U
1,1-Dichloroethene	2	U	5	U	1	U	1	U	1	U
1,1-Dichloroethane	2	U	5	U	1	U	1	U	1	U
cis-1,2-Dichloroethene	2	U	5	U	1	U	1	U	1	U
Chloroform	6		5	U	1	U	1	U	1	U
1,2-Dichloroethane	2	U	5	U	1	U	1	U	1	U
2-Butanone	12	U	24	J (c)	5	U	5	U	5	U
1,1,1-Trichloroethane	2	U	5	U	1	U	1	U	1	U
Carbon Tetrachloride	2	U	5	U	1	U	1	U	1	U
Bromochloromethane	2	U	5	U	1	U	1	U	1	U
Bromodichloromethane	2	U	5	U	1	U	1	U	1	U
1,2-Dichloropropane	2	U	5	U	1	U	1	U	1	U
cis-1,3-Dichloropropene	2	U	5	U	1	U	1	U	1	U
Trans-1,2-dichloroethene	2	U	5	U	1	U	1	U	1	U
Trichloroethene	43		5	U	1	U	1	U	1	U
Dibromochloromethane	2	U	5	U	1	U	1	U	1	U
1,1,2-Trichloroethane	2	U	5	U	1	U	1	U	1	U
Benzene	2	U	5	U	1	U	1	U	1	U
1,2-Dibromoethane	2	U	5	U	1	U	1	U	1	U
trans-1,3-Dichloropropene	2	U	5	U	1	U	1	U	1	U
Bromoform	2	U	5	U	1	U	1	U	1	U
4-Methyl-2-Pentanone	12	U	25	U	5	U	5	U	5	U
2-Hexanone	12	U	25	U	5	U	5	U	5	U
1,1,2,2-Tetrachloroethane	2	U	5	U	1	U	1	U	1	U
Tetrachloroethene	2	U	5	U	3		2	B	2	B
Toluene	2	U	5	U	1	U	1	U	1	U
Chlorobenzene	2	U	5	U	1	U	1	U	1	U
Ethyl Benzene	2	U	5	U	1	U	1	U	1	U
Styrene	2	U	5	U	1	U	1	U	1	U
Xylene (total)	2	U	5	U	1	U	1	U	1	U
1,3-Dichlorobenzene	2	U	5	U	1	U	1	U	1	U
1,4-Dichlorobenzene	2	U	5	U	1	U	1	U	1	U
1,2-Dichlorobenezene	2	U	5	U	1	U	1	U	1	U
1,2-Dibromo-3-chloropropane	2	U	5	U	1	U	1	U	1	U

SITE: WARMINSTER NAVAL BASE
CASE NO. 3933
LABORATORY: CEIMIC

Aqueous Low-Concentration
Volatile Analyses (ug/L)

Client ID:	W-MW-27		W-MW-28		W-MW-29		W-MW-30		W-MW-31		W-MW-31-D	
LAB ID:	920336-14		920336-15		920336-16		920336-17		920343-01		920343-02	
ANALYTE												
Chloromethane	1	U	1	U	1	U	1	U	125	U	125	U
Bromomethane	1	U	1	U	1	U	1	U	125	U	125	U
Vinyl Chloride	1	U	1	U	1	U	1	U	125	U	125	U
Chloroethane	1	U	1	U	1	U	1	U	125	U	125	U
Methylene Chloride	1	U	1	B	1	B	1	U	625	U	625	U
Acetone	5	U	5	U	5	U	5	U	125	U	125	U
Carbon Disulfide	1	U	1	U	1	U	1	U	125	U	125	U
1,1-Dichloroethene	3		1		8		1	U	125	U	125	U
1,1-Dichloroethane	3		2		8		1	U	125	U	125	U
cis-1,2-Dichloroethene	1	U	1	U	2		1	U	125	U	125	U
Chloroform	1	U	1	U	2		1	U	125	U	125	U
1,2-Dichloroethane	1	U	1	U	1	U	1	U	125	U	125	U
2-Butanone	5	U	5	U	5	U	5	U	625	U	625	U
1,1,1-Trichloroethane	10		5		13		1	U	125	U	125	U
Carbon Tetrachloride	1	U	1	U	1		1	U	125	U	125	U
Bromochloromethane	1	U	1	U	1	U	1	U	125	U	125	U
Bromodichloromethane	1	U	1	U	1	U	1	U	125	U	125	U
1,2-Dichloropropane	1	U	1	U	1	U	1	U	125	U	125	U
cis-1,3-Dichloropropene	1	U	1	U	1	U	1	U	125	U	125	U
Trans-1,2-dichloroethene	1	U	1	U	2		1	U	125	U	125	U
Trichloroethene	2		1		14		1	U	1800		2300	
Dibromochloromethane	1	U	1	U	1	U	1	U	125	U	125	U
1,1,2-Trichloroethane	1	U	1	U	1	U	1	U	125	U	125	U
Benzene	1	U	1	U	1	U	1	U	125	U	125	U
1,2-Dibromoethane	1	U	1	U	1	U	1	U	125	U	125	U
trans-1,3-Dichloropropene	1	U	1	U	1	U	1	U	125	U	125	U
Bromoform	1	U	1	U	1	U	1	U	125	U	125	UL (m)
4-Methyl-2-Pentanone	5	U	5	U	5	U	5	U	625	U	625	U
2-Hexanone	5	U	5	U	5	U	5	U	625	U	625	U
1,1,2,2-Tetrachloroethane	1	U	1	U	1	U	1	U	125	U	125	U
Tetrachloroethene	7		3		12		1	U	125	U	125	U
Toluene	1	U	1	U	1	U	1	U	125	U	125	U
Chlorobenzene	1	U	1	U	1	U	1	U	125	U	125	U
Ethyl Benzene	1	U	1	U	1	U	1	U	125	U	125	U
Styrene	1	U	1	U	1	U	1	U	125	U	125	U
Xylene (total)	1	U	1	U	1	U	1	U	125	U	125	U
1,3-Dichlorobenzene	1	U	1	U	1	U	1	U	125	U	125	U
1,4-Dichlorobenzene	1	U	1	U	1	U	1	U	125	U	125	U
1,2-Dichlorobenezene	1	U	1	U	1	U	1	U	125	U	125	U
1,2-Dibromo-3-chloropropane	1	U	1	U	1	U	1	U	125	U	125	U

SITE: WARMINSTER NAVAL BASE
CASE NO. 3933
LABORATORY: CEIMIC

Aqueous Low-Concentration
Volatile Analyses (ug/L)

Client ID:	W-MW-32		W-MW-33		W-MW-34		W-MW-35		W-MW-36		W-MW-37	
LAB ID:	920343-03		920343-04		920343-05		920343-06		920343-07		920343-10	
ANALYTE												
Chloromethane	1	UL (s)	25	U	12	U	1	U	1	U	1	U
Bromomethane	1	UL (s)	25	U	12	U	1	U	1	U	1	U
Vinyl Chloride	1	UL (s)	25	U	12	U	1	U	1	U	1	U
Chloroethane	1	UL (s)	25	U	12	U	1	U	1	U	1	U
Methylene Chloride	1	UL (s)	25	U	12	U	1	U	1	U	1	U
Acetone	5	UL (s)	125	U	62	U	5	U	5	U	5	U
Carbon Disulfide	1	UL (s)	25	U	12	U	1	U	1	U	1	U
1,1-Dichloroethene	1	UL (s)	25	U	12	U	1	U	1		1	U
1,1-Dichloroethane	1	UL (s)	25	U	12	U	1	U	2		1	U
cis-1,2-Dichloroethene	1	UL (s)	80		45		1	U	6		1	U
Chloroform	2	B	28	B	12	U	1	U	1	U	1	U
1,2-Dichloroethane	1	UL (s)	25	U	12	U	1	U	1	U	1	U
2-Butanone	5	UL (s)	125	U	62	U	5	U	5	U	5	U
1,1,1-Trichloroethane	1	UL (s)	25	U	12	U	1	U	2		1	U
Carbon Tetrachloride	1	UL (s)	28		12	U	1	U	1	U	1	U
Bromochloromethane	1	UL (s)	25	U	12	U	1	U	1	U	1	U
Bromodichloromethane	1	UL (s)	25	U	12	U	1	U	1	U	1	U
1,2-Dichloropropane	1	UL (s)	25	U	12	U	1	U	1	U	1	U
cis-1,3-Dichloropropene	1	UL (s)	25	U	12	U	1	U	1	U	1	U
Trans-1,2-dichloroethene	1	UL (s)	25	U	12	U	1	U	1	U	1	U
Trichloroethene	1	UL (s)	280		47		3		14		1	U
Dibromochloromethane	1	UL (s)	25	U	12	U	1	U	1	U	1	U
1,1,2-Trichloroethane	1	UL (s)	25	U	12	U	1	U	1	U	1	U
Benzene	1	UL (s)	25	U	12	U	1	U	1	U	1	U
1,2-Dibromoethane	1	UL (s)	25	U	12	U	1	U	1	U	1	U
trans-1,3-Dichloropropene	1	UL (s)	25	U	12	U	1	U	1	U	1	U
Bromoform	1	UL (s)	25	U	12	U	1	U	1	U	1	U
4-Methyl-2-Pentanone	5	UL (s)	125	U	62	U	5	U	5	U	5	U
2-Hexanone	5	UL (s)	125	U	62	U	5	U	5	U	5	U
1,1,2,2-Tetrachloroethane	1	UL (s)	25	U	12	U	1	U	1	U	1	U
Tetrachloroethene	1	UL (s)	300		130		1	U	8		1	U
Toluene	1	UL (s)	25	U	12	U	3		1	U	1	U
Chlorobenzene	1	UL (s)	25	U	12	U	1	U	1	U	1	U
Ethyl Benzene	1	UL (s)	25	U	12	U	1	U	1	U	1	U
Styrene	1	UL (s)	25	U	12	U	1	U	1	U	1	U
Xylene (total)	1	UL (s)	25	U	12	U	1	U	1	U	1	U
1,3-Dichlorobenzene	1	UL (s)	25	U	12	U	1	U	1	U	1	U
1,4-Dichlorobenzene	1	UL (s)	25	U	12	U	1	U	1	U	1	U
1,2-Dichlorobenezene	1	UL (s)	25	U	12	U	1	U	1	U	1	U
1,2-Dibromo-3-chloropropane	1	UL (s)	25	U	12	U	1	U	1	U	1	U

SITE: WARMINSTER NAVAL BASE
CASE NO. 3933
LABORATORY: CEIMIC

Aqueous Low-Concentration
Volatile Analyses (ug/L)

Client ID:	W-MW-16		W-MW-17		W-MW-18		W-MW-19		W-MW-20		W-MW-21	
LAB ID:	920333-15		920336-01		920336-02		920336-03		920336-11		920336-04	
ANALYTE												
Chloromethane	1	U	1	U	1	U	1	U	1	U	1	U
Bromomethane	1	U	1	U	1	U	1	U	1	U	1	U
Vinyl Chloride	1	U	1	U	1	U	1	U	1	U	1	U
Chloroethane	1	U	1	U	1	U	1	U	1	U	1	U
Methylene Chloride	1	U	1	U	1	U	1	U	4	B	1	U
Acetone		R (c)		R (c)		R (c)		R (c)	17	B		R (c)
Carbon Disulfide	1	U	1	U	1	U	1	U	1	U	1	U
1,1-Dichloroethene	1	U	1	U	1	U	1	U	1	U	1	U
1,1-Dichloroethane	1	U	1	U	1	U	1	U	1	U	1	U
cis-1,2-Dichloroethene	1	U	1	U	1	U	2		1	U	1	U
Chloroform	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dichloroethane	1	U	1	U	1	U	1	U	1	U	1	U
2-Butanone	5	U	5	U	5	U	5	U	5	U	5	U
1,1,1-Trichloroethane	1	U	1	U	1	U	1	U	1		1	U
Carbon Tetrachloride	1	U	1	U	1	U	1	U	1	U	1	U
Bromochloromethane	1	U	1	U	1	U	1	U	1	U	1	U
Bromodichloromethane	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dichloropropane	1	U	1	U	1	U	1	U	1	U	1	U
cis-1,3-Dichloropropene	1	U	1	U	1	U	1	U	1	U	1	U
Trans-1,2-dichloroethene	1	U	1	U	1	U	1	U	1	U	1	U
Trichloroethene	1	U	1	U	1	U	6		1	U	1	
Dibromochloromethane	1	U	1	U	1	U	1	U	1	U	1	U
1,1,2-Trichloroethane	1	U	1	U	1	U	1	U	1	U	1	U
Benzene	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dibromoethane	1	U	1	U	1	U	1	U	1	U	1	U
trans-1,3-Dichloropropene	1	U	1	U	1	U	1	U	1	U	1	U
Bromoform	1	U	1	U	1	U	1	U	1	U	1	U
4-Methyl-2-Pentanone	5	U	5	U	5	U	5	U	5	U	5	U
2-Hexanone	5	U	5	U	5	U	5	U	5	U	5	U
1,1,2,2-Tetrachloroethane	1	U	1	U	1	U	1	U	1	U	1	U
Tetrachloroethene	1	U	1	B	1	U	1	U	1	U	1	U
Toluene	1		2		1	U	1	U	1	U	2	
Chlorobenzene	1	U	1	U	1	U	1	U	1	U	1	U
Ethyl Benzene	1	U	1	U	1	U	1	U	1	U	1	U
Styrene	1	U	1	U	1	U	1	U	1	U	1	U
Xylene (total)	1	U	1	U	1	U	1	U	1	U	1	U
1,3-Dichlorobenzene	1	U	1	U	1	U	1	U	1	U	1	U
1,4-Dichlorobenzene	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dichlorobenezene	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dibromo-3-chloropropane	1	U	1	U	1	U	1	U	1	U	1	U

SITE: WARMINSTER NAVAL BASE
CASE NO. 3933
LABORATORY: CEIMIC

Aqueous Low-Concentration
Volatile Analyses (ug/L)

Client ID:	W-MW-22		W-MW-23		W-MW-23-D		W-MW-24		W-MW-25		W-MW-26	
LAB ID:	920336-05		920336-06		920336-07		920336-08		920336-12		920336-13	
ANALYTE												
Chloromethane	1	U	1	U	1	U	1	U	1	U	1	U
Bromomethane	1	U	1	U	1	U	1	U	1	U	1	U
Vinyl Chloride	1	U	1	U	1	U	1	U	1	U	1	U
Chloroethane	1	U	1	U	1	U	1	U	1	U	1	U
Methylene Chloride	1	U	4	B	4	B	2	B	2	B	1	U
Acetone	5	U	5	U	5	U	5	U	5	U	5	U
Carbon Disulfide	1	U	1	U	1	U	1	U	1	U	1	U
1,1-Dichloroethene	1	U	1	U	1	U	1	U	1	U	1	U
1,1-Dichloroethane	1	U	1	U	1	U	1	U	1	U	1	U
cis-1,2-Dichloroethene	1	U	3		2		1	U	1	U	1	U
Chloroform	1	U	1		1	U	1	U	4		2	
1,2-Dichloroethane	1	U	1	U	1	U	1	U	1	U	1	U
2-Butanone	5	U	5	U	5	U	5	U	5	U	5	U
1,1,1-Trichloroethane	1	U	1	U	1	U	1	U	1	U	1	U
Carbon Tetrachloride	1	U	1	U	1	U	1	U	3		1	
Bromochloromethane	1	U	1	U	1	U	1	U	1	U	1	U
Bromodichloromethane	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dichloropropane	1	U	1	U	1	U	1	U	1	U	1	U
cis-1,3-Dichloropropene	1	U	1	U	1	U	1	U	1	U	1	U
Trans-1,2-dichloroethene	1	U	1	U	1	U	1	U	1	U	1	U
Trichloroethene	1	U	8		6		1	U	7		20	
Dibromochloromethane	1	U	1	U	1	U	1	U	1	U	1	U
1,1,2-Trichloroethane	1	U	1	U	1	U	1	U	1	U	1	U
Benzene	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dibromoethane	1	U	1	U	1	U	1	U	1	U	1	U
trans-1,3-Dichloropropene	1	U	1	U	1	U	1	U	1	U	1	U
Bromoform	1	U	1	U	1	U	1	U	1	U	1	U
4-Methyl-2-Pentanone	5	U	5	U	5	U	5	U	5	U	5	U
2-Hexanone	5	U	5	U	5	U	5	U	5	U	5	U
1,1,2,2-Tetrachloroethane	1	U	1	U	1	U	1	U	1	U	1	U
Tetrachloroethene	1	B	3		3		1	U	15		2	B
Toluene	6		1		1		1	U	1	U	1	U
Chlorobenzene	1	U	1	U	1	U	1	U	1	U	1	U
Ethyl Benzene	1	U	1	U	1	U	1	U	1	U	1	U
Styrene	1	U	1	U	1	U	1	U	1	U	1	U
Xylene (total)	1	U	1	U	1	U	1	U	1	U	1	U
1,3-Dichlorobenzene	1	U	1	U	1	U	1	U	1	U	1	U
1,4-Dichlorobenzene	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dichlorobenezene	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dibromo-3-chloropropane	1	U	1	U	1	U	1	U	1	U	1	U

SITE: WARMINSTER NAVAL BASE
CASE NO. 3933
LABORATORY: CEIMIC

Aqueous Low-Concentration
Volatile Analyses (ug/L)

Client ID:	W-MW-05		W-MW-06		W-MW-07		W-MW-08		W-MW-08-D		W-MW-09	
LAB ID:	920333-01		920333-02		920333-03		920333-04		920333-05		920333-06	
ANALYTE												
Chloromethane	1	U	1	U	1	U	1	U	1	U	1	U
Bromomethane	1	U	1	U	1	U	1	U	1	U	1	U
Vinyl Chloride	1	U	1	U	1	U	1	U	1	U	1	U
Chloroethane	1	U	1	U	1	U	1	U	1	U	1	U
Methylene Chloride	1	U	1	U	1	U	1	U	1	U	1	U
Acetone	5	U	5	U	5	U	5	U	5	U		R (c)
Carbon Disulfide	1	U	1	U	1	U	1	U	1	U	1	U
1,1-Dichloroethene	1	U	1	U	1	U	1	U	1	U	1	U
1,1-Dichloroethane	1	U	1	U	1	U	1	U	1	U	1	U
cis-1,2-Dichloroethene	1	U	1	U	1	U	1	U	1	U	1	U
Chloroform	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dichloroethane	1	U	1	U	1	U	1	U	1	U	1	U
2-Butanone	5	U	5	U	5	U	5	U	5	U	27	J (c)
1,1,1-Trichloroethane	1	U	1	U	1	U	1	U	1	U	1	U
Carbon Tetrachloride	1	U	1	U	1	U	1	U	1	U	1	U
Bromochloromethane	1	U	1	U	1	U	1	U	1	U	1	U
Bromodichloromethane	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dichloropropane	1	U	1	U	1	U	1	U	1	U	1	U
cis-1,3-Dichloropropene	1	U	1	U	1	U	1	U	1	U	1	U
Trans-1,2-dichloroethene	1	U	1	U	1	U	1	U	1	U	1	U
Trichloroethene	1	U	1	U	1	U	1	U	1	U	1	U
Dibromochloromethane	1	U	1	U	1	U	1	U	1	U	1	U
1,1,2-Trichloroethane	1	U	1	U	1	U	1	U	1	U	1	U
Benzene	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dibromoethane	1	U	1	U	1	U	1	U	1	U	1	U
trans-1,3-Dichloropropene	1	U	1	U	1	U	1	U	1	U	1	U
Bromoform	1	U	1	U	1	U	1	U	1	U	1	U
4-Methyl-2-Pentanone	5	U	5	U	5	U	5	U	5	U	5	U
2-Hexanone	5	U	5	U	5	U	5	U	5	U	5	U
1,1,2,2-Tetrachloroethane	1	U	1	U	1	U	1	U	1	U	1	U
Tetrachloroethene	1	U	1	U	1	U	1	U	1	U	1	U
Toluene	1	U	4		1	U	1	U	1	U	2	
Chlorobenzene	1	U	1	U	1	U	1	U	1	U	1	U
Ethyl Benzene	1	U	1	U	1	U	1	U	1	U	1	U
Styrene	1	U	1	U	1	U	1	U	1	U	1	U
Xylene (total)	1	U	1	U	1	U	1	U	1	U	1	U
1,3-Dichlorobenzene	1	U	1	U	1	U	1	U	1	U	1	U
1,4-Dichlorobenzene	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dichlorobenezene	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dibromo-3-chloropropane	1	U	1	U	1	U	1	U	1	U	1	U

SITE: WARMINSTER NAVAL BASE
CASE NO. 3933
LABORATORY: CEIMIC

Aqueous Low-Concentration
Volatile Analyses (ug/L)

Client ID:	W-MW-10		W-MW-11		W-MW-12		W-MW-13		W-MW-14		W-MW-15	
LAB ID:	920333-07		920333-10		920333-11		920333-12		920333-13		920333-14	
ANALYTE												
Chloromethane	1	U	1	U	1	U	1	U	1	U	2	
Bromomethane	1	U	1	U	1	U	1	U	1	U	1	U
Vinyl Chloride	1	U	1	U	1	U	1	U	1	U	1	U
Chloroethane	1	U	1	U	1	U	1	U	1	U	1	U
Methylene Chloride	1	U	1	U	1	U	1	U	1	U	1	U
Acetone	5	U	5	U		R (c)	5	U		R (c)		R (c)
Carbon Disulfide	1	U	1	U	1	U	1	U	1	U	1	U
1,1-Dichloroethene	1	U	1	U	1	U	1	U	1	U	1	U
1,1-Dichloroethane	1	U	1	U	1	U	1	U	1	U	1	U
cis-1,2-Dichloroethene	1	U	8	U	1	U	1	U	1	U	1	U
Chloroform	1	U	1	U	1	U	1	U	1	U	2	
1,2-Dichloroethane	1	U	1	U	1	U	1	U	1	U	1	U
2-Butanone	5	U	5	U	5	U	5	U	5	U	5	U
1,1,1-Trichloroethane	1	U	1	U	1	U	1	U	1	U	1	U
Carbon Tetrachloride	1	U	1	U	1	U	1	U	1	U	2	
Bromochloromethane	1	U	1	U	1	U	1	U	1	U	1	U
Bromodichloromethane	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dichloropropane	1	U	1	U	1	U	1	U	1	U	1	U
cis-1,3-Dichloropropene	1	U	1	U	1	U	1	U	1	U	1	U
Trans-1,2-dichloroethene	1	U	1	U	1	U	1	U	1	U	1	U
Trichloroethene	1	U	13		1	U	1	U	1	U	4	
Dibromochloromethane	1	U	1	U	1	U	1	U	1	U	1	U
1,1,2-Trichloroethane	1	U	1	U	1	U	1	U	1	U	1	U
Benzene	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dibromoethane	1	U	1	U	1	U	1	U	1	U	1	U
trans-1,3-Dichloropropene	1	U	1	U	1	U	1	U	1	U	1	U
Bromoform	1	U	1	U	1	U	1	U	1	U	1	U
4-Methyl-2-Pentanone	5	U	5	U	5	U	5	U	5	U	5	U
2-Hexanone	5	U	5	U	5	U	5	U	5	U	5	U
1,1,2,2-Tetrachloroethane	1	U	1	U	1	U	1	U	1	U	1	U
Tetrachloroethene	1	U	1	U	1	U	1	U	1	U	1	U
Toluene	1	U	1	U	1	U	1	U	2		1	U
Chlorobenzene	1	U	1	U	1	U	1	U	1	U	1	U
Ethyl Benzene	1	U	1	U	1	U	1	U	1	U	1	U
Styrene	1	U	1	U	1	U	1	U	1	U	1	U
Xylene (total)	1	U	1	U	1	U	1	U	1	U	1	U
1,3-Dichlorobenzene	1	U	1	U	1	U	1	U	1	U	1	U
1,4-Dichlorobenzene	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dichlorobenezene	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dibromo-3-chloropropane	1	U	1	U	1	U	1	U	1	U	1	U

SITE: WARMINSTER NAVAL BASE
CASE NO. 3933
LABORATORY: CEIMIC

Aqueous Low-Concentration
Volatile Analyses (ug/L)

Client ID:	W-624-RB		W-629-TB		W-630-RB		W-630-TB		W-701-TB		W-702-RB	
LAB ID:	920330-18		920336-10		920336-18		920336-19		920343-09		920343-15	
ANALYTE												
Chloromethane	1	U	1	U	1	U	1	U	1	U	2	U
Bromomethane	1	U	1	U	1	U	1	U	1	U	2	U
Vinyl Chloride	1	U	1	U	1	U	1	U	1	U	2	U
Chloroethane	1	U	1	U	1	U	1	U	1	U	2	U
Methylene Chloride	1	U	3	B	1	U	1	U	1	U	2	U
Acetone	5	U	8		5	U	5	U	5	U	8	
Carbon Disulfide	1	U	1	U	1	U	1	U	1	U	2	U
1,1-Dichloroethene	1	U	1	U	1	U	1	U	1	U	2	U
1,1-Dichloroethane	1	U	1	U	1	U	1	U	1	U	2	U
cis-1,2-Dichloroethene	1	U	1	U	1	U	1	U	1	U	2	U
Chloroform	1	U	1	U	1	U	1	U	1	U	51	
1,2-Dichloroethane	1	U	1	U	1	U	1	U	1	U	2	U
2-Butanone	5	U	5	U	5	U	5	U	5	U	12	U
1,1,1-Trichloroethane	1	U	1	U	1	U	1	U	1	U	2	U
Carbon Tetrachloride	1	U	1	U	1	U	1	U	1	U	2	U
Bromochloromethane	1	U	1	U	1	U	1	U	1	U	2	U
Bromodichloromethane	1	U	1	U	1	U	1	U	1	U	2	U
1,2-Dichloropropane	1	U	1	U	1	U	1	U	1	U	2	U
cis-1,3-Dichloropropene	1	U	1	U	1	U	1	U	1	U	2	U
Trans-1,2-dichloroethene	1	U	1	U	1	U	1	U	1	U	2	U
Trichloroethene	1	U	1	U	1	U	1	U	1	U	2	U
Dibromochloromethane	1	U	1	U	1	U	1	U	1	U	2	U
1,1,2-Trichloroethane	1	U	1	U	1	U	1	U	1	U	2	U
Benzene	1	U	1	U	1	U	1	U	1	U	2	U
1,2-Dibromoethane	1	U	1	U	1	U	1	U	1	U	2	U
trans-1,3-Dichloropropene	1	U	1	U	1	U	1	U	1	U	2	U
Bromoform	1	U	1	U	1	U	1	U	1	U	2	U
4-Methyl-2-Pentanone	5	U	5	U	5	U	5	U	5	U	12	U
2-Hexanone	5	U	5	U	5	U	5	U	5	U	12	U
1,1,2,2-Tetrachloroethane	1	U	1	U	1	U	1	U	1	U	2	U
Tetrachloroethene	1	U	1	U	1	U	1	U	1	U	2	U
Toluene	1	U	1	U	1	U	1	U	1	U	2	U
Chlorobenzene	1	U	1	U	1	U	1	U	1	U	2	U
Ethyl Benzene	1	U	1	U	1	U	1	U	1	U	2	U
Styrene	1	U	1	U	1	U	1	U	1	U	2	U
Xylene (total)	1	U	1	U	1	U	1	U	1	U	2	U
1,3-Dichlorobenzene	1	U	1	U	1	U	1	U	1	U	2	U
1,4-Dichlorobenzene	1	U	1	U	1	U	1	U	1	U	2	U
1,2-Dichlorobenezene	1	U	1	U	1	U	1	U	1	U	2	U
1,2-Dibromo-3-chloropropane	1	U	1	U	1	U	1	U	1	U	2	U

SITE: WARMINSTER NAVAL BASE
CASE NO. 3933
LABORATORY: CEIMIC

Aqueous Low-Concentration
Volatile Analyses (ug/L)

Client ID:	W-702-TB		W-706-TB		W-MW-01		W-MW-02		W-MW-03		W-MW-04	
LAB ID:	920343-16		920345-09		920330-13		920330-14		920330-15		920330-16	
ANALYTE												
Chloromethane	1	U	1	U	1	U	1	U	1	U	1	U
Bromomethane	1	U	1	U	1	U	1	U	1	U	1	U
Vinyl Chloride	1	U	1	U	1	U	1	U	1	U	1	U
Chloroethane	1	U	1	U	1	U	1	U	1	U	1	U
Methylene Chloride	1	U	1	U	1	U	1	U	1	U	1	U
Acetone	5	U	5	U	5	U	5	U	5	U	5	U
Carbon Disulfide	1	U	1	U	1	U	1	U	1	U	1	U
1,1-Dichloroethene	1	U	1	U	1	U	1	U	1	U	1	U
1,1-Dichloroethane	1	U	1	U	1	U	1	U	1	U	1	U
cis-1,2-Dichloroethene	1	U	1	U	1	U	1	U	1	U	1	U
Chloroform	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dichloroethane	1	U	1	U	1	U	1	U	1	U	1	U
2-Butanone	5	U	5	U	5	U	5	U	5	U	5	U
1,1,1-Trichloroethane	1	U	1	U	1	U	1	U	1	U	1	U
Carbon Tetrachloride	1	U	1	U	1	U	1	U	1	U	1	U
Bromochloromethane	1	U	1	U	1	U	1	U	1	U	1	U
Bromodichloromethane	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dichloropropane	1	U	1	U	1	U	1	U	1	U	1	U
cis-1,3-Dichloropropene	1	U	1	U	1	U	1	U	1	U	1	U
Trans-1,2-dichloroethene	1	U	1	U	1	U	1	U	1	U	1	U
Trichloroethene	1	U	1	U	1	U	1	U	1	U	1	U
Dibromochloromethane	1	U	1	U	1	U	1	U	1	U	1	U
1,1,2-Trichloroethane	1	U	1	U	1	U	1	U	1	U	1	U
Benzene	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dibromoethane	1	U	1	U	1	U	1	U	1	U	1	U
trans-1,3-Dichloropropene	1	U	1	U	1	U	1	U	1	U	1	U
Bromoform	1	U	1	U	1	U	1	U	1	U	1	U
4-Methyl-2-Pentanone	5	U	5	U	5	U	5	U	5	U	5	U
2-Hexanone	5	U	5	U	5	U	5	U	5	U	5	U
1,1,2,2-Tetrachloroethane	1	U	1	U	1	U	1	U	1	U	1	U
Tetrachloroethene	1	U	1	U	1	U	1	U	1	U	1	U
Toluene	1	U	1	U	1	U	1	U	1	U	1	U
Chlorobenzene	1	U	1	U	1	U	1	U	1	U	1	U
Ethyl Benzene	1	U	1	U	1	U	1	U	1	U	1	U
Styrene	1	U	1	U	1	U	1	U	1	U	1	U
Xylene (total)	1	U	1	U	1	U	1	U	1	U	1	U
1,3-Dichlorobenzene	1	U	1	U	1	U	1	U	1	U	1	U
1,4-Dichlorobenzene	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dichlorobenezene	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dibromo-3-chloropropane	1	U	1	U	1	U	1	U	1	U	1	U

APPENDIX K-5

PHASE II - TCL ORGANICS

SITE: WARMINSTER NAVAL BASE

Monitoring Well Semivolatile Organics Analysis (ug/L)

Sample No.:	W-MW-09	W-MW-21	W-MW-29	W-MW-39	W-MW-39-D	W-MW-40
Lab Sample ID:	920333-06	920336-04	920336-16	920343-12	920343-13	920343-14
Phenol	10 U	10 U	10 U	10 U	10 U	10 U
bis(2-Chloroethyl)Ether	10 U	10 U	10 U	10 U	10 U	10 U
2-Chlorophenol	10 U	10 U	10 U	10 U	10 U	10 U
1,3-Dichlorobenzene	10 U	10 U	10 U	10 U	10 U	10 U
1,4-Dichlorobenzene	10 U	10 U	10 U	10 U	10 U	10 U
1,2-Dichlorobenzene	3 J	10 U	10 U	10 U	10 U	10 U
2-Methylphenol	10 U	10 U	10 U	10 U	10 U	10 U
2,2'-oxybis(1-Chloropropane)	10 U	10 U	10 U	10 U	10 U	10 U
4-Methylphenol	10 U	10 U	10 U	10 U	10 U	10 U
N-Nitroso-Di-n-Propylamine	10 U	10 U	10 U	10 U	10 U	10 U
Hexachloroethane	10 U	10 U	10 U	10 U	10 U	10 U
Nitrobenzene	10 U	10 U	10 U	10 U	10 U	10 U
Isophorone	10 U	10 U	10 U	10 U	10 U	10 U
2-Nitrophenol	10 U	10 U	10 U	10 U	10 U	10 U
2,4-Dimethylphenol	10 U	10 U	10 U	10 U	10 U	10 U
bis(2-Chloroethoxy)Methane	10 U	10 U	10 U	10 U	10 U	10 U
2,4-Dichlorophenol	10 U	10 U	10 U	10 U	10 U	10 U
1,2,4-Trichlorobenzene	2 J	10 U	10 U	10 U	10 U	10 U
Naphthalene	10 U	10 U	10 U	10 U	10 U	10 U
4-Chloroaniline	10 U	10 U	10 U	10 U	10 U	10 U
Hexachlorobutadiene	10 U	10 UJ	10 U	10 U	10 U	10 U
4-Chloro-3-Methylphenol	10 U	10 U	10 U	10 U	10 U	10 U
2-Methylnaphthalene	10 U	10 U	10 U	10 U	10 U	10 U
Hexachlorocyclopentadiene	10 U	10 U	10 U	10 U	10 U	10 U
2,4,6-Trichlorophenol	10 U	10 U	10 U	10 U	10 U	10 U
2,4,5-Trichlorophenol	25 U	25 U	25 U	25 U	25 U	25 U
2-Chloronaphthalene	10 U	10 U	10 U	10 U	10 U	10 U
2-Nitroaniline	25 U	25 U	25 U	25 U	25 U	25 U
Dimethyl Phthalate	10 U	10 U	10 U	10 U	10 U	10 U
Acenaphthylene	10 U	10 U	10 U	10 U	10 U	10 U
2,6-Dinitrotoluene	10 U	10 U	10 U	10 U	10 U	10 U
3-Nitroaniline	25 U	25 U	25 U	25 U	25 U	25 U
Acenaphthene	10 U	10 U	10 U	10 U	10 U	10 U

SITE: WARMINSTER NAVAL BASE

Monitoring Well Volatile Organics Analysis (ug/L)

Sample No.:	W-MW-09	W-MW-21	W-MW-29	W-MW-39	W-MW-39-D	W-MW-40
Lab Sample ID:	920333-06	920336-04	920336-16	920343-12	920343-13	920343-14
Chloromethane	NA	NA	NA	NA	NA	NA
Bromomethane	NA	NA	NA	NA	NA	NA
Vinyl Chloride	NA	NA	NA	NA	NA	NA
Chloroethane	NA	NA	NA	NA	NA	NA
Methylene Chloride	NA	NA	NA	NA	NA	NA
Acetone	NA	NA	NA	NA	NA	NA
Carbon Disulfide	NA	NA	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	NA	NA	NA	NA
1,1-Dichloroethane	NA	NA	NA	NA	NA	NA
1,2-Dichloroethene (total)	NA	NA	NA	NA	NA	NA
Chloroform	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	NA	NA	NA	NA	NA	NA
2-Butanone	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	NA	NA	NA	NA	NA	NA
Carbon Tetrachloride	NA	NA	NA	NA	NA	NA
Bromodichloromethane	NA	NA	NA	NA	NA	NA
1,2-Dichloropropane	NA	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	NA	NA	NA	NA	NA	NA
Trichloroethene	NA	NA	NA	NA	NA	NA
Dibromochloromethane	NA	NA	NA	NA	NA	NA
1,1,2-Trichloroethane	NA	NA	NA	NA	NA	NA
Benzene	NA	NA	NA	NA	NA	NA
Trans-1,3-Dichloropropene	NA	NA	NA	NA	NA	NA
Bromoform	NA	NA	NA	NA	NA	NA
4-Methyl-2-Pentanone	NA	NA	NA	NA	NA	NA
2-Hexanone	NA	NA	NA	NA	NA	NA
Tetrachloroethene	NA	NA	NA	NA	NA	NA
1,1,2,2-Tetrachloroethane	NA	NA	NA	NA	NA	NA
Toluene	NA	NA	NA	NA	NA	NA
Chlorobenzene	NA	NA	NA	NA	NA	NA
Ethylbenzene	NA	NA	NA	NA	NA	NA
Styrene	NA	NA	NA	NA	NA	NA
Total Xylenes	NA	NA	NA	NA	NA	NA

SITE: WARMINSTER NAVAL BASE

Monitoring Well Pesticide Organics Analysis (ug/L)

Sample No.:	W-MW-09	W-MW-21	W-MW-29	W-MW-39	W-MW-39-D	W-MW-40
Lab Sample ID:	920333-06	920336-04	920336-16	920343-12	920343-13	920343-14
alpha-BHC	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
beta-BHC	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
delta-BHC	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
gamma-BHC (Lindane)	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Heptachlor	0.05 U	0.05 U	0.05 U	R	0.05 U	0.05 U
Aldrin	0.05 U	0.05 U	0.05 U	0.05 UL	0.05 U	0.05 U
Heptachlor epoxide	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Endosulfan I	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Dieldrin	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
4,4'-DDE	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Endrin	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Endosulfan II	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
4,4'-DDD	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Endosulfan sulfate	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
4,4'-DDT	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Methoxychlor	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Endrin ketone	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Endrin aldehyde	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
alpha-Chlordane	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
gamma-Chlordane	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Toxaphene	5 U	5 U	5 U	5 U	5 U	5 U
Aroclor-1016	1 U	1 U	1 U	1 U	1 U	1 U
Aroclor-1221	2 U	2 U	2 U	2 U	2 U	2 U
Aroclor-1232	1 U	1 U	1 U	1 U	1 U	1 U
Aroclor-1242	1 U	1 U	1 U	1 U	1 U	1 U
Aroclor-1248	1 U	1 U	1 U	1 U	1 U	1 U
Aroclor-1254	1 U	1 U	1 U	1 U	1 U	1 U
Aroclor-1260	1 U	1 U	1 U	1 U	1 U	1 U

SITE: WARMINSTER NAVAL BASE

Monitoring Well Semivolatile Organics Analysi s (ug/L) (continued)

Sample No.:	W-MW-09	W-MW-21	W-MW-29	W-MW-39	W-MW-39-D	W-MW-40
Lab Sample ID:	920333-06	920336-04	920336-16	920343-12	920343-13	920343-14
2,4-Dinitrophenol	25 U	25 U	25 UJ	25 UJ	25 UJ	25 U
4-Nitrophenol	25 U	25 U	25 U	25 U	25 U	25 U
Dibenzofuran	10 U	10 U	10 U	10 U	10 U	10 U
2,4-Dinitrotoluene	10 U	10 U	10 U	10 U	10 U	10 U
Diethylphthalate	10 U	10 U	10 U	10 U	10 U	10 U
4-Chlorophenyl-phenylether	10 U	10 U	10 U	10 U	10 U	10 U
Fluorene	10 U	10 U	10 U	10 U	10 U	10 U
4-Nitroaniline	25 U	25 U	25 U	25 U	25 U	25 U
4,6-Dinitro-2-Methylphenol	25 U	25 U	25 U	25 U	25 U	25 U
N-Nitrosodiphenylamine	10 U	10 U	10 U	10 U	10 U	10 U
4-Bromophenyl-penylether	10 U	10 U	10 U	10 U	10 U	10 U
Hexachlorobenzene	10 U	10 U	10 U	10 U	10 U	10 U
Pentachlorophenol	25 U	25 U	25 U	25 U	25 U	25 U
Phenanthrene	10 U	10 U	10 U	10 U	10 U	10 U
Anthracene	10 U	10 U	10 U	10 U	10 U	10 U
Di-n-Butylphthalate	10 U	10 U	10 U	10 U	10 U	10 U
Fluoranthene	10 U	10 U	10 U	10 U	10 U	10 U
Carbazole	10 U	10 U	10 U	10 U	10 U	10 U
Pyrene	10 U	10 U	10 U	10 U	10 U	10 U
Butylbenzylphthalate	10 U	10 U	10 U	10 U	10 U	10 U
3,3'-Dichlorobenzidine	10 U	10 U	10 U	10 U	10 U	10 U
Benzo(a)Anthracene	10 U	10 U	10 U	10 U	10 U	10 U
Chrysene	10 U	10 U	10 U	10 U	10 U	10 U
bis(2-Ethylhexyl)Phthalate	2 B	2 B	3 B	5 B	4 B	2 B
Di-n-Octyl Phthalate	10 U	10 U	R	10 U	4 J	10 U
Benzo(b)Fluoranthene	10 U	10 U	R	10 U	10 U	10 U
Benzo(k)Fluoranthene	10 U	10 U	R	10 U	10 U	10 U
Benzo(a)Pyrene	10 U	10 U	R	10 U	10 U	10 U
Indeno(1,2,3-cd)Pyrene	10 U	10 U	R	10 U	10 U	10 U
Dibenz(a,h)Anthracene	10 U	10 U	R	10 U	10 U	10 U
Benzo(g,h,i)Perylene	10 U	10 U	R	10 U	10 U	10 U

Warminster
CASE NO. 3933, SDG W-OS-01
LABORATORY: CEIMIC CORP

Semivolatile Aqueous Analyses
ug/L

CLIENT ID:		W-OS-01	W-OS-01-D
LAB ID:		920397-01	920397-02
COMPOUND	CRQL		
2,4-Dinitrophenol	25	25 U	25 U
4-Nitrophenol	25	25 U	25 U
Dibenzofuran	10	10 U	10 U
2,4-Dinitrotoluene	10	10 U	10 U
Diethylphthalate	10	10 U	10 U
4-Chlorophenyl-Phenylether	10	10 U	10 U
Fluorene	10	10 U	10 U
4-Nitroaniline	25	25 U	25 UJ(c)
4,6-Dinitro-2-Methylphenol	25	25 U	25 U
N-nitrosodiphenylamine(1)	10	10 U	10 U
4-Bromophenyl-Phenylether	10	10 U	10 U
Hexachlorobenzene	10	10 U	10 U
Pentachlorophenol	25	25 U	25 U
Phenanthrene	10	10 U	10 U
Anthracene	10	10 U	10 U
Di-n-butylphthalate	10	10 U	10 U
Fluoranthene	10	10 U	10 U
Carbazole	10	10 U	10 U
Pyrene	10	10 U	10 U
Butylbenzylphthalate	10	10 U	10 U
3,3'-Dichlorobenzidine	10	10 U	10 U
Benzo(a)anthracene	10	10 U	10 U
Chrysene	10	10 U	10 U
Bis(2-ethylhexyl)phthalate	10	10 U	10 U
Di-n-octylphthalate	10	10 U	10 U
Benzo(b)fluoranthene	10	10 U	10 U
Benzo(k)fluoranthene	10	10 U	10 U
Benzo(a)pyrene	10	10 U	10 U
Indeno(1,2,3-cd)pyrene	10	10 U	10 U
Dibenz(a,h)anthracene	10	10 U	10 U
Benzo(g,h,i)perylene	10	10 U	10 U

Semivolatile Aqueous Analyses
ug/L

Warminster
CASE NO. 3933, SDG W-OS-01
LABORATORY: CEIMIC CORP

CLIENT ID:		W-OS-01	W-OS-01-D
LAB ID:		920397-01	920397-02
COMPOUND	CRQL		
Phenol	10	10 U	10 U
bis(2-Chloroethyl) ether	10	10 U	10 U
2-Chlorophenol	10	10 U	10 U
1,3-Dichlorobenzene	10	10 U	10 U
1,4-Dichlorobenzene	10	10 U	10 U
1,2-Dichlorobenzene	10	10 U	10 U
2-Methylphenol	10	10 U	10 U
2,2'-oxybis(1-Chloropropane)	10	10 U	10 U
4-Methylphenol	10	10 U	10 U
N-Nitroso-di-n-propylamine	10	10 U	10 U
Hexachloroethane	10	10 U	10 U
Nitrobenzene	10	10 U	10 U
Isophorone	10	10 U	10 U
2-Nitrophenol	10	10 U	10 U
2,4-Dimethylphenol	10	10 U	10 U
bis(2-Chloroethoxy)methane	10	10 U	10 U
2,4-Dichlorophenol	10	10 U	10 U
1,2,4-Trichlorobenzene	10	10 U	10 U
Naphthalene	10	10 U	10 U
4-Chloroaniline	10	10 U	10 U
Hexachlorobutadiene	10	10 U	10 U
4-Chloro-3-Methylphenol	10	10 U	10 U
2-Methylnaphthalene	10	10 U	10 U
Hexachlorocyclopentadiene	10	10 U	10 U
2,4,6-Trichlorophenol	10	10 U	10 U
2,4,5-Trichlorophenol	25	25 U	25 U
2-Chloronaphthalene	10	10 U	10 U
2-Nitroaniline	25	25 U	25 U
Dimethylphthalate	10	10 U	10 U
Acenaphthylene	10	10 U	10 U
2,6-Dinitrotoluene	10	10 U	10 U
3-Nitroaniline	25	25 U	25 U
Acenaphthene	10	10 U	10 U

Warminster
CASE NO. 3933, SDG W-OS-01
LABORATORY: CEIMIC CORP

Volatile Soil Analyses
ug/kg

CLIENT ID:	W-SD-07	W-SD-08	W-SD-08-D
LAB ID:	920397-05	920397-06	920397-07
COMPOUND			
Chloromethane	16 U	12 U	13 U
Bromomethane	16 U	12 U	13 U
Vinyl Chloride	16 U	12 U	13 U
Chloroethane	16 U	12 U	13 U
Methylene Chloride	16 U	12 U	13 U
Acetone	19 B	12 U	13 U
Carbon Disulfide	16 U	12 U	13 U
1,1-Dichloroethene	16 U	12 U	13 U
1,1-Dichloroethane	16 U	12 U	13 U
1,2-Dichloroethene(total)	16 U	12 U	13 U
Chloroform	16 U	12 U	13 U
1,2-Dichloroethane	16 U	12 U	13 U
2-Butanone	16 U	12 U	13 U
1,1,1-Trichloroethane	16 U	12 U	13 U
Carbon Tetrachloride	16 U	12 U	13 U
Bromodichloromethane	16 U	12 U	13 U
1,2-Dichloropropane	16 U	12 U	13 U
cis-1,3-Dichloropropene	16 U	12 U	13 U
Trichloroethene	16 U	12 U	13 U
Dibromochloromethane	16 U	12 U	13 U
1,1,2-Trichloroethane	16 U	12 U	13 U
Benzene	16 U	12 U	13 U
trans-1,3-Dichloropropene	16 U	12 U	13 U
Bromoform	16 U	12 U	13 U
4-Methyl-2-pentanone	16 U	12 U	13 U
2-Hexanone	16 U	12 U	13 U
Tetrachloroethene	16 U	12 U	13 U
1,1,2,2-Tetrachloroethane	16 U	12 U	13 U
Toluene	16 U	12 U	13 U
Chlorobenzene	16 U	12 U	13 U
Ethylbenzene	16 U	12 U	13 U
Styrene	16 U	12 U	13 U
Total Xylenes	16 U	12 U	13 U
PERCENT SOLIDS:	62	82	75

Warminster
CASE NO. 3933, SDG W-OS-01
LABORATORY: CEIMIC CORP

Pesticide/PCB Aqueous Analyses
ug/L

CLIENT ID:		W-OS-01	W-OS-01-D
LAB ID:		920397-01	920397-02
COMPOUND	CRQL		
alpha-BHC	0.05	0.050 U	0.050 UL(s)
beta-BHC	0.05	0.050 U	0.050 UL(s)
delta-BHC	0.05	0.050 U	0.050 UL(s)
gamma-BHC(Lindane)	0.05	0.050 U	0.050 UL(s)
Heptachlor	0.05	0.050 U	0.050 UL(s)
Aldrin	0.05	0.050 U	0.050 UL(s)
Heptachlor Epoxide	0.05	0.050 U	0.050 UL(s)
Endosulfan I	0.05	0.050 U	0.050 UL(s)
Dieldrin	0.10	0.10 U	0.10 UL(s)
4,4'-DDE	0.10	0.10 U	0.10 UL(s)
Endrin	0.10	0.10 U	0.10 UL(s)
Endosulfan II	0.10	0.10 U	0.10 UL(s)
4,4'-DDD	0.10	0.10 U	0.10 UL(s)
Endosulfan Sulfate	0.10	0.10 U	0.10 UL(s)
4,4'-DDT	0.10	0.10 U	0.10 UL(s)
Methoxychlor	0.50	0.50 U	0.50 UL(s)
Endrin Ketone	0.10	0.10 U	0.10 UL(s)
Endrin Aldehyde	0.10	0.10 U	0.10 UL(s)
alpha-Chlordane	0.50	0.050 U	0.050 UL(s)
gamma-Chlordane	0.50	0.050 U	0.050 UL(s)
Toxaphene	5.0	5.0 U	5.0 UL(s)
Aroclor-1016	1.0	1.0 U	1.0 UL(s)
Aroclor-1221	2.0	2.0 U	2.0 UL(s)
Aroclor-1232	1.0	1.0 U	1.0 UL(s)
Aroclor-1242	1.0	1.0 U	1.0 UL(s)
Aroclor-1248	1.0	1.0 U	1.0 UL(s)
Aroclor-1254	1.0	1.0 U	1.0 UL(s)
Aroclor-1260	1.0	1.0 U	1.0 UL(s)

Appendix A

Summary of Tentatively Identified Compounds (TICs) Remaining After Data Qualification

Fraction	Named TIC
Volatile	Unknown *
Semivolatile	Unknown(s) **
	C6H12O isomer(s)
	C6H10O isomer
	Unknown acid(s)
	C14H8O2 isomer
	Aliphatic hydrocarbon(s)
	C30H12 isomer
	Unknown aldehyde
	C15H12 isomer(s)
	C17H12 isomer(s)
	C20H12 isomer
	C5H8O isomer(s)
	Unknown ketone
	C6H10O isomer(s)

* An volatile fraction unknown at a retention time of 29.22 was detected in the laboratory method blanks.

** Semivolatile fraction unknowns at retention times of 6.07, 6.33, 8.36, 10.51, 11.84 and 19.65 were detected in the laboratory method blanks. Additionally, the following semivolatile fraction unknowns (which could not be attributed to laboratory method blank contamination) were detected in the associated field quality control blanks at the retention times indicated: 5.13 and 8.83.

Warminster
CASE NO. 3933, SDG W-OS-01
LABORATORY: CEIMIC CORP

Pesticide/PCB Aqueous Analyses
ug/L

CLIENT ID:		W-806-FB	W-806-RB	W-SW-07	W-SW-08	W-SW-08-D
LAB ID:		920397-11	920397-12	920397-08	920397-09	920397-10
COMPOUND	CRQL					
alpha-BHC	0.05	0.050 U	0.050 U	0.050 U	0.050 U	0.050 UL(s)
beta-BHC	0.05	0.050 U	0.050 U	0.050 U	0.050 U	0.050 UL(s)
delta-BHC	0.05	0.050 U	0.050 U	0.050 U	0.050 U	0.050 UL(s)
gamma-BHC(Lindane)	0.05	0.050 U	0.050 U	0.050 U	0.050 U	0.050 UL(s)
Heptachlor	0.05	0.050 U	0.050 U	0.050 U	0.050 U	0.050 UL(s)
Aldrin	0.05	0.050 U	0.050 U	0.050 U	0.050 U	0.050 UL(s)
Heptachlor Epoxide	0.05	0.050 U	0.050 U	0.050 U	0.050 U	0.050 UL(s)
Endosulfan I	0.05	0.050 U	0.050 U	0.050 U	0.050 U	0.050 UL(s)
Dieldrin	0.10	0.10 U	0.10 U	0.10 U	0.10 U	0.10 UL(s)
4,4'-DDE	0.10	0.10 U	0.10 U	0.10 U	0.10 U	0.10 UL(s)
Endrin	0.10	0.10 U	0.10 U	0.10 U	0.10 U	0.10 UL(s)
Endosulfan II	0.10	0.10 U	0.10 U	0.10 U	0.10 U	0.10 UL(s)
4,4'-DDD	0.10	0.10 U	0.10 U	0.10 U	0.10 U	0.10 UL(s)
Endosulfan Sulfate	0.10	0.10 U	0.10 U	0.10 U	0.10 U	0.10 UL(s)
4,4'-DDT	0.10	0.10 U	0.10 U	0.10 U	0.10 U	0.10 UL(s)
Methoxychlor	0.50	0.50 U	0.50 U	0.50 U	0.50 U	0.50 UL(s)
Endrin Ketone	0.10	0.10 U	0.10 U	0.10 U	0.10 U	0.10 UL(s)
Endrin Aldehyde	0.10	0.10 U	0.10 U	0.10 U	0.10 U	0.10 UL(s)
alpha-Chlordane	0.50	0.050 U	0.050 U	0.050 U	0.050 U	0.050 UL(s)
gamma-Chlordane	0.50	0.050 U	0.050 U	0.050 U	0.050 U	0.050 UL(s)
Toxaphene	5.0	5.0 U	5.0 U	5.0 U	5.0 U	5.0 UL(s)
Aroclor-1016	1.0	1.0 U	1.0 U	1.0 U	1.0 U	1.0 UL(s)
Aroclor-1221	2.0	2.0 U	2.0 U	2.0 U	2.0 U	2.0 UL(s)
Aroclor-1232	1.0	1.0 U	1.0 U	1.0 U	1.0 U	1.0 UL(s)
Aroclor-1242	1.0	1.0 U	1.0 U	1.0 U	1.0 U	1.0 UL(s)
Aroclor-1248	1.0	1.0 U	1.0 U	1.0 U	1.0 U	1.0 UL(s)
Aroclor-1254	1.0	1.0 U	1.0 U	1.0 U	1.0 U	1.0 UL(s)
Aroclor-1260	1.0	1.0 U	1.0 U	1.0 U	1.0 U	1.0 UL(s)

Data Qualifier Key:

U	-	Value is a nondetect as reported by the laboratory.
B	-	Positive result is considered to be an artifact of blank contamination, and should not be considered present.
J(s,q)	-	Positive result is considered to be estimated based on low surrogate recovery, and because the %D between first and second column results was greater than 50%.
UL(s)	-	Nondetect is considered to be biased low based on low surrogate recovery.
J(c)	-	Positive result is considered estimated due to calibration noncompliances.
UJ(c)	-	Nondetect is considered estimated due to calibration noncompliances.
UJ(a)	-	Nondetect is considered estimated due to internal standard failure.
UL(m)	-	Nondetect result is considered to be biased low based on low MS/MSD percent recoveries.
J	-	Positive result is reported at a concentration level below its associated CRQL.

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

PESTICIDE/PCB AQUEOUS ANALYSES (ug/L)

CLIENT ID:		FIELD R. BLK	FIELD BLK-TAP	FILED BLK-DI	NADC-R.-65	NADC-27-F.B.	NADC-28-F.B.
LAB ID:		8807	8808	8811	9236	8854	8855
CHEMICAL	CRQL						
alpha-BHC	0.05	0.05 U	0.05 U	0.05 U	0.05 UL	0.05 U	0.05 U
beta-BHC	0.05	0.05 U	0.05 U	0.05 U	0.05 UL	0.05 U	0.05 U
delta-BHC	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Lindane (gamma-BHC)	0.05	0.05 U	0.05 U	0.05 U	0.05 UL	0.05 U	0.05 U
Heptachlor	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Aldrin	0.05	0.05 U	0.05 U	0.05 U	0.05 UL	0.05 U	0.05 U
Heptachlor epoxide	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Endosulfan I	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 U	0.05 U
Dieldrin	1.0	0.1 U	0.1 U	0.1 U	0.1 UL	0.1 U	0.1 U
4,4'-DDE	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
Endrin	1.0	0.1 U	0.1 U	0.1 U	0.1 UL	0.1 U	0.1 U
Endosulfan II	1.0	0.1 U	0.1 U	0.1 U	0.1 UL	0.1 U	0.1 U
4,4'-DDD	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
Endosulfan sulfate	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
4,4'-DDT	1.0	R(x)	R(x)	R(x)	R(x)	R(x)	R(x)
Methoxychlor	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Endrin ketone	1.0	0.1 U	0.1 U	0.1 U	0.1 UL	0.1 U	0.1 U
Chlordane	0.05	0.5 U	0.5 U	0.5 U	0.5 UL	0.5 U	0.5 U
Toxaphene	1.0	1.0 U	1.0 U	1.0 U	1.0 UL	1.0 U	1.0 U
Aroclor-1016	0.05	0.5 U	0.5 U	0.5 U	0.5 UL	0.5 U	0.5 U
Aroclor-1221	0.05	0.5 U	0.5 U	0.5 U	0.5 UL	0.5 U	0.5 U
Aroclor-1232	0.05	0.5 U	0.5 U	0.5 U	0.5 UL	0.5 U	0.5 U
Aroclor-1242	0.05	0.5 U	0.5 U	0.5 U	0.5 UL	0.5 U	0.5 U
Aroclor-1248	0.05	0.5 U	0.5 U	0.5 U	0.5 UL	0.5 U	0.5 U
Aroclor-1254	1.0	1.0 U	1.0 U	1.0 U	1.0 UL	1.0 U	1.0 U
Aroclor-1260	1.0	1.0 U	1.0 U	1.0 U	1.0 UL	1.0 U	1.0 U
Analysis Factor:		1.0	1.0	1.0	1.0	1.0	1.0

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

PESTICIDE/PCB AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC-30-RINS.	NADC-R.B.-53	NADC-RINS.-46	NADC-RINS.-40	NADC-RINS.-59	NADC-RINS.-72
LAB ID:		8901	9104	9020	8977	9156	9270
CHEMICAL	CRQL						
alpha-BHC	0.05	0.05 U	0.05 U	0.05 UL	0.05 U	0.05 UL	0.05 U
beta-BHC	0.05	0.05 U	0.05 U	0.05 UL	0.05 U	0.05 UL	0.05 U
delta-BHC	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Lindane (gamma-BHC)	0.05	0.05 U	0.05 U	0.05 UL	0.05 U	0.05 UL	0.05 U
Heptachlor	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Aldrin	0.05	0.05 U	0.05 U	0.05 UL	0.05 U	0.05 UL	0.05 U
Heptachlor epoxide	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Endosulfan I	0.05	0.05 U	0.05 U	0.05 UL	0.05 U	0.05 UL	0.05 U
Dieldrin	1.0	0.1 U	0.1 U	0.1 UL	0.1 U	0.1 UL	0.1 U
4,4'-DDE	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
Endrin	1.0	0.1 U	0.1 U	0.1 UL	0.1 U	0.1 UL	0.1 U
Endosulfan II	1.0	0.1 U	0.1 U	0.1 UL	0.1 U	0.1 UL	0.1 U
4,4'-DDD	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
Endosulfan sulfate	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
4,4'-DDT	1.0	R(x)	R(x)	R(x)	R(x)	R(x)	R(x)
Methoxychlor	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Endrin ketone	1.0	0.1 U	0.1 U	0.1 UL	0.1 U	0.1 UL	0.1 U
Chlordane	0.05	0.5 U	0.5 U	0.5 UL	0.5 U	0.5 UL	0.5 U
Toxaphene	1.0	1.0 U	1.0 U	1.0 UL	1.0 U	1.0 UL	1.0 U
Aroclor-1016	0.05	0.5 U	0.5 U	0.5 UL	0.5 U	0.5 UL	0.5 U
Aroclor-1221	0.05	0.5 U	0.5 U	0.5 UL	0.5 U	0.5 UL	0.5 U
Aroclor-1232	0.05	0.5 U	0.5 U	0.5 UL	0.5 U	0.5 UL	0.5 U
Aroclor-1242	0.05	0.5 U	0.5 U	0.5 UL	0.5 U	0.5 UL	0.5 U
Aroclor-1248	0.05	0.5 U	0.5 U	0.5 UL	0.5 U	0.5 UL	0.5 U
Aroclor-1254	1.0	1.0 U	1.0 U	1.0 UL	1.0 U	1.0 UL	1.0 U
Aroclor-1260	1.0	1.0 U	1.0 U	1.0 UL	1.0 U	1.0 UL	1.0 U
Analysis Factor:		1.0	1.0	1.0	1.0	1.0	1.0

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

PESTICIDE/PCB AQUEOUS ANALYSES (ug/L)

CLIENT ID:		NADC-S2-20-R.	1-S. WATER	2-S. WATER	2-S. WATER-D	3-S. WATER	5-S. WATER
LAB ID:		8847	8796	8798	8809	8800	8803
CHEMICAL	CRQL						
alpha-BHC	0.05	0.05 U	0.05 U	0.05 U	0.05 U	0.05 UL	0.05 U
beta-BHC	0.05	0.05 U	0.05 U	0.05 U	0.05 U	0.05 UL	0.05 U
delta-BHC	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Lindane (gamma-BHC)	0.05	0.05 U	0.05 U	0.05 U	0.05 U	0.05 UL	0.05 U
Heptachlor	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Aldrin	0.05	0.05 U	0.05 U	0.05 U	0.05 U	0.05 UL	0.05 U
Heptachlor epoxide	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Endosulfan I	0.05	0.05 U	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Dieldrin	1.0	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UL	0.1 U
4,4'-DDE	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
Endrin	1.0	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UL	0.1 U
Endosulfan II	1.0	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UL	0.1 U
4,4'-DDD	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
Endosulfan sulfate	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
4,4'-DDT	1.0	R(x)	R(x)	R(x)	R(x)	R(x)	R(x)
Methoxychlor	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Endrin ketone	1.0	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UL	0.1 U
Chlordane	0.05	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UL	0.5 U
Toxaphene	1.0	1.0 U	1.0 U	1.0 U	1.0 U	1.0 UL	1.0 U
Aroclor-1016	0.05	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UL	0.5 U
Aroclor-1221	0.05	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UL	0.5 U
Aroclor-1232	0.05	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UL	0.5 U
Aroclor-1242	0.05	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UL	0.5 U
Aroclor-1248	0.05	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UL	0.5 U
Aroclor-1254	1.0	1.0 U	1.0 U	1.0 U	1.0 U	1.0 UL	1.0 U
Aroclor-1260	1.0	1.0 U	1.0 U	1.0 U	1.0 U	1.0 UL	1.0 U
Analysis Factor:		1.0	1.0	1.0	1.0	1.0	1.0

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

PESTICIDE/PCB AQUEOUS ANALYSES (ug/L)

CLIENT ID:		6-S. WATER	7-S. WATER	8-S. WATER	S1-64-DG-1	S1-66-WELL-C	S2-23-BG-4
LAB ID:		8805	8795	8793	9161	9237	8850
CHEMICAL	CRQL						
alpha-BHC	0.05	0.05 U	0.05 U	0.05 U	0.05 UL	0.05 U	0.05 U
beta-BHC	0.05	0.05 U	0.05 U	0.05 U	0.05 UL	0.05 U	0.05 U
delta-BHC	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Lindane (gamma-BHC)	0.05	0.05 U	0.05 U	0.05 U	0.05 UL	0.05 U	0.05 U
Heptachlor	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Aldrin	0.05	0.05 U	0.05 U	0.05 U	0.05 UL	0.05 U	0.05 U
Heptachlor epoxide	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Endosulfan I	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UL	0.05 U	0.05 U
Dieldrin	1.0	0.1 U	0.1 U	0.1 U	0.1 UL	0.1 U	0.1 U
4,4'-DDE	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
Endrin	1.0	0.1 U	0.1 U	0.1 U	0.1 UL	0.1 U	0.1 U
Endosulfan II	1.0	0.1 U	0.1 U	0.1 U	0.1 UL	0.1 U	0.1 U
4,4'-DDD	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
Endosulfan sulfate	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
4,4'-DDT	1.0	R(x)	R(x)	R(x)	R(x)	R(x)	R(x)
Methoxychlor	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Endrin ketone	1.0	0.1 U	0.1 U	0.1 U	0.1 UL	0.1 U	0.1 U
Chlordane	0.05	0.5 U	0.5 U	0.5 U	0.5 UL	0.5 U	0.5 U
Toxaphene	1.0	1.0 U	1.0 U	1.0 U	1.0 UL	1.0 U	1.0 U
Aroclor-1016	0.05	0.5 U	0.5 U	0.5 U	0.5 UL	0.5 U	0.5 U
Aroclor-1221	0.05	0.5 U	0.5 U	0.5 U	0.5 UL	0.5 U	0.5 U
Aroclor-1232	0.05	0.5 U	0.5 U	0.5 U	0.5 UL	0.5 U	0.5 U
Aroclor-1242	0.05	0.5 U	0.5 U	0.5 U	0.5 UL	0.5 U	0.5 U
Aroclor-1248	0.05	0.5 U	0.5 U	0.5 U	0.5 UL	0.5 U	0.5 U
Aroclor-1254	1.0	1.0 U	1.0 U	1.0 U	1.0 UL	1.0 U	1.0 U
Aroclor-1260	1.0	1.0 U	1.0 U	1.0 U	1.0 UL	1.0 U	1.0 U
Analysis Factor:		1.0	1.0	1.0	1.0	1.0	1.0

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SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

PESTICIDE/PCB AQUEOUS ANALYSES (ug/L)

CLIENT ID:		S2-22-BG-4-D	S2-24-BG-3	S2-25-D	S2-26-DG-26	S2-32-DG-12	S2-63-WELL-E
LAB ID:		8849	8851	8852	8853	8903	9160
CHEMICAL	CRQL						
alpha-BHC	0.05	0.05 U	0.05 U	0.05 UL	0.05 U	0.05 U	0.05 U
beta-BHC	0.05	0.05 U	0.05 U	0.05 UL	0.05 U	0.05 U	0.05 U
delta-BHC	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Lindane (gamma-BHC)	0.05	0.05 U	0.05 U	0.05 UL	0.05 U	0.05 U	0.05 U
Heptachlor	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Aldrin	0.05	0.05 U	0.05 U	0.05 UL	0.05 U	0.05 U	0.05 U
Heptachlor epoxide	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Endosulfan I	0.05	0.05 U	0.05 U	0.05 UL	0.05 U	0.05 U	0.05 U
Dieldrin	1.0	0.1 U	0.1 U	0.1 UL	0.1 U	0.1 U	0.1 U
4,4'-DDE	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
Endrin	1.0	0.1 U	0.1 U	0.1 UL	0.1 U	0.1 U	0.1 U
Endosulfan II	1.0	0.1 U	0.1 U	0.1 UL	0.1 U	0.1 U	0.1 U
4,4'-DDD	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
Endosulfan sulfate	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
4,4'-DDT	1.0	R(x)	R(x)	R(x)	R(x)	R(x)	R(x)
Methoxychlor	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Endrin ketone	1.0	0.1 U	0.1 U	0.1 UL	0.1 U	0.1 U	0.1 U
Chlordane	0.05	0.5 U	0.5 U	0.5 UL	0.5 U	0.5 U	0.5 U
Toxaphene	1.0	1.0 U	1.0 U	1.0 UL	1.0 U	1.0 U	1.0 U
Aroclor-1016	0.05	0.5 U	0.5 U	0.5 UL	0.5 U	0.5 U	0.5 U
Aroclor-1221	0.05	0.5 U	0.5 U	0.5 UL	0.5 U	0.5 U	0.5 U
Aroclor-1232	0.05	0.5 U	0.5 U	0.5 UL	0.5 U	0.5 U	0.5 U
Aroclor-1242	0.05	0.5 U	0.5 U	0.5 UL	0.5 U	0.5 U	0.5 U
Aroclor-1248	0.05	0.5 U	0.5 U	0.5 UL	0.5 U	0.5 U	0.5 U
Aroclor-1254	1.0	1.0 U	1.0 U	1.0 UL	1.0 U	1.0 U	1.0 U
Aroclor-1260	1.0	1.0 U	1.0 U	1.0 UL	1.0 U	1.0 U	1.0 U
Analysis Factor:		1.0	1.0	1.0	1.0	1.0	1.0

SITE: WARMINSTER
CASE NO. 9710--40004
LABORATORY: RMC

PESTICIDE/PCB AQUEOUS ANALYSES (ug/L)

CLIENT ID:		S2-76-DG-2	S2-77-DG-~~X~~ 23	S3-60-DG-13	S3-61-DG-13-D	S3-62-DG-3	S4-68-~~06~~ BG-6
LAB ID:		9275	9276	9157	9158	9159	9239
CHEMICAL	CRQL						
alpha-BHC	0.05	0.05 UL	0.05 U	0.05 U	0.05 U	0.05 UL(s)	0.05 U
beta-BHC	0.05	0.05 UL	0.05 U	0.05 U	0.05 U	0.05 UL(s)	0.05 U
delta-BHC	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Lindane (gamma-BHC)	0.05	0.05 UL	0.05 U	0.05 U	0.05 U	0.05 UL(s)	0.05 U
Heptachlor	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Aldrin	0.05	0.05 UL	0.05 U	0.05 U	0.05 U	0.05 UL(s)	0.05 U
Heptachlor epoxide	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Endosulfan I	0.05	0.05 UL	0.05 U	0.05 U	0.05 U	0.05 UL(s)	0.05 UJ (c)
Dieldrin	1.0	0.1 UL	0.1 U	0.1 U	0.1 U	0.05 UL(s)	0.1 U
4,4'-DDE	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
Endrin	1.0	0.1 UL	0.1 U	0.1 U	0.1 U	0.05 UL(s)	0.1 U
Endosulfan II	1.0	0.1 UL	0.1 U	0.1 U	0.1 U	0.05 UL(s)	0.1 U
4,4'-DDD	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
Endosulfan sulfate	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
4,4'-DDT	1.0	R(x)	R(x)	R(x)	R(x)	R(x)	R(x)
Methoxychlor	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Endrin ketone	1.0	0.1 UL	0.1 U	0.1 U	0.1 U	0.1 UL(s)	0.1 U
Chlordane	0.05	0.5 UL	0.5 U	0.5 U	0.5 U	0.1 UL(s)	0.5 U
Toxaphene	1.0	1.0 UL	1.0 U	1.0 U	1.0 U	0.1 UL(s)	1.0 U
Aroclor-1016	0.05	0.5 UL	0.5 U	0.5 U	0.5 U	0.1 UL(s)	0.5 U
Aroclor-1221	0.05	0.5 UL	0.5 U	0.5 U	0.5 U	0.1 UL(s)	0.5 U
Aroclor-1232	0.05	0.5 UL	0.5 U	0.5 U	0.5 U	0.1 UL(s)	0.5 U
Aroclor-1242	0.05	0.5 UL	0.5 U	0.5 U	0.5 U	0.1 UL(s)	0.5 U
Aroclor-1248	0.05	0.5 UL	0.5 U	0.5 U	0.5 U	0.1 UL(s)	0.5 U
Aroclor-1254	1.0	1.0 UL	1.0 U	1.0 U	1.0 U	0.1 UL(s)	1.0 U
Aroclor-1260	1.0	1.0 UL	1.0 U	1.0 U	1.0 U	0.1 UL(s)	1.0 U
Analysis Factor:		1.0	1.0	1.0	1.0	1.0	1.0

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SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

PESTICIDE/PCB AQUEOUS ANALYSES (ug/L)

CLIENT ID:		S4-73-DG-22	S4-78-DG-22-D	S4-74-DG-24	S5-50-DG-8	S5-51-DG-20	S5-54-DG-27
LAB ID:		9272	9273	9274	9101	9102	9105
CHEMICAL	CRQL						
alpha-BHC	0.05	0.05 UL	0.05 U	0.05 UL	0.05 UL	0.05 U	0.05 U
beta-BHC	0.05	0.05 UL	0.05 U	0.05 UL	0.05 UL	0.05 U	0.05 U
delta-BHC	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Lindane (gamma-BHC)	0.05	0.05 UL	0.05 U	0.05 UL	0.05 UL	0.05 U	0.05 U
Heptachlor	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Aldrin	0.05	0.05 UL	0.05 U	0.05 UL	0.05 UL	0.05 U	0.05 U
Heptachlor epoxide	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Endosulfan I	0.05	0.05 UL	0.05 U	0.05 U	0.05 UL	0.05 U	0.05 U
Dieldrin	1.0	0.1 UL	0.1 U	0.1 UL	0.1 UL	0.1 U	0.1 U
4,4'-DDE	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
Endrin	1.0	0.1 UL	0.1 U	0.1 UL	0.1 UL	0.1 U	0.1 U
Endosulfan II	1.0	0.1 UL	0.1 U	0.1 UL	0.1 UL	0.1 U	0.1 U
4,4'-DDD	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
Endosulfan sulfate	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
4,4'-DDT	1.0	R(x)	R(x)	R(x)	R(x)	R(x)	R(x)
Methoxychlor	0.05	0.5 UJ (c)	0.5 UJ (c)	0.5 UJ (c)	0.5 UJ (c)	0.5 UJ (c)	0.5 U
Endrin ketone	1.0	0.1 UL	0.1 U	0.1 UL	0.1 UL	0.1 U	0.1 U
Chlordane	0.05	0.5 UL	0.5 U	0.5 UL	0.5 UL	0.5 U	0.5 U
Toxaphene	1.0	1.0 UL	1.0 U	1.0 UL	1.0 UL	1.0 U	1.0 U
Aroclor-1016	0.05	0.5 UL	0.5 U	0.5 UL	0.5 UL	0.5 U	0.5 U
Aroclor-1221	0.05	0.5 UL	0.5 U	0.5 UL	0.5 UL	0.5 U	0.5 U
Aroclor-1232	0.05	0.5 UL	0.5 U	0.5 UL	0.5 UL	0.5 U	0.5 U
Aroclor-1242	0.05	0.5 UL	0.5 U	0.5 UL	0.5 UL	0.5 U	0.5 U
Aroclor-1248	0.05	0.5 UL	0.5 U	0.5 UL	0.5 UL	0.5 U	0.5 U
Aroclor-1254	1.0	1.0 UL	1.0 U	1.0 UL	1.0 UL	1.0 U	1.0 U
Aroclor-1260	1.0	1.0 UL	1.0 U	1.0 UL	1.0 UL	1.0 U	1.0 U
Analysis Factor:		1.0	1.0	1.0	1.0	1.0	1.0

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

PESTICIDE/PCB AQUEOUS ANALYSES (ug/L)

CLIENT ID:		S4-39-DG-18	S4-42-DG-4	S4-43-DG-5	S4-44-DG-7	S4-67-BG-2	S4-68-BG-6
LAB ID:		8976	8979	8980	8981	9238	9239
CHEMICAL	CRQL						
alpha-BHC	0.05	0.05 U	0.05 U	0.05 U	0.05 UL	0.05 UL	0.05 U
beta-BHC	0.05	0.05 U	0.05 U	0.05 U	0.05 UL	0.05 UL	0.05 U
delta-BHC	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Lindane (gamma-BHC)	0.05	0.05 U	0.05 U	0.05 U	0.05 UL	0.05 UL	0.05 U
Heptachlor	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Aldrin	0.05	0.05 U	0.05 U	0.05 U	0.05 UL	0.05 UL	0.05 U
Heptachlor epoxide	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Endosulfan I	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 U
Dieldrin	1.0	0.1 U	0.1 U	0.1 U	0.1 UL	0.1 UL	0.1 U
4,4'-DDE	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
Endrin	1.0	0.1 U	0.1 U	0.1 U	0.1 UL	0.1 UL	0.1 U
Endosulfan II	1.0	0.1 U	0.1 U	0.1 U	0.1 UL	0.1 UL	0.1 U
4,4'-DDD	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
Endosulfan sulfate	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
4,4'-DDT	1.0	R(x)	R(x)	R(x)	R(x)	R(x)	R(x)
Methoxychlor	0.05	0.5 U	0.5 UJ (c)	0.5 UJ (c)	0.5 UJ (c)	0.5 UJ (c)	0.5 UJ (c)
Endrin ketone	1.0	0.1 U	0.1 U	0.1 U	0.1 UL	0.1 UL	0.1 U
Chlordane	0.05	0.5 U	0.5 U	0.5 U	0.5 UL	0.5 UL	0.5 U
Toxaphene	1.0	1.0 U	1.0 U	1.0 U	1.0 UL	1.0 UL	1.0 U
Aroclor-1016	0.05	0.5 U	0.5 U	0.5 U	0.5 UL	0.5 UL	0.5 U
Aroclor-1221	0.05	0.5 U	0.5 U	0.5 U	0.5 UL	0.5 UL	0.5 U
Aroclor-1232	0.05	0.5 U	0.5 U	0.5 U	0.5 UL	0.5 UL	0.5 U
Aroclor-1242	0.05	0.5 U	0.5 U	0.5 U	0.5 UL	0.5 UL	0.5 U
Aroclor-1248	0.05	0.5 U	0.5 U	0.5 U	0.5 UL	0.5 UL	0.5 U
Aroclor-1254	1.0	1.0 U	1.0 U	1.0 U	1.0 UL	1.0 UL	1.0 U
Aroclor-1260	1.0	1.0 U	1.0 U	1.0 U	1.0 UL	1.0 UL	1.0 U
Analysis Factor:		1.0	1.0	1.0	1.0	1.0	1.0

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

PESTICIDE/PCB AQUEOUS ANALYSES (ug/L)

CLIENT ID:		S5-55-DG-21	S6-41-DG-10	S6-47-DG-19	S6-48-DG-17	S6-69-BG-7	S7-56-DG-25
LAB ID:		9106	8978	9021	9022	9240	9153
CHEMICAL	CRQL						
alpha-BHC	0.05	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
beta-BHC	0.05	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
delta-BHC	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Lindane (gamma-BHC)	0.05	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Heptachlor	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Aldrin	0.05	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Heptachlor epoxide	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Endosulfan I	0.05	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Dieldrin	1.0	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
4,4'-DDE	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
Endrin	1.0	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Endosulfan II	1.0	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
4,4'-DDD	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
Endosulfan sulfate	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
4,4'-DDT	1.0	R(x)	R(x)	R(x)	R(x)	R(x)	R(x)
Methoxychlor	0.05	0.5 U	0.5 U	0.5 U	0.5 UJ (c)	0.5 UJ (c)	0.5 UJ (c)
Endrin ketone	1.0	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Chlordane	0.05	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Toxaphene	1.0	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Aroclor-1016	0.05	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Aroclor-1221	0.05	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Aroclor-1232	0.05	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Aroclor-1242	0.05	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Aroclor-1248	0.05	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Aroclor-1254	1.0	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Aroclor-1260	1.0	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Analysis Factor:		1.0	1.0	1.0	1.0	1.0	1.0

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

PESTICIDE/PCB AQUEOUS ANALYSES (ug/L)

CLIENT ID:		S7-58-DG-25-D	S8-49-BG-5	S8-75-DG-14
LAB ID:		9155	9023	9271
CHEMICAL	CRQL			
alpha-BHC	0.05	0.05 U	0.05 U	0.05 U
beta-BHC	0.05	0.05 U	0.05 U	0.05 U
delta-BHC	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Lindane (gamma-BHC)	0.05	0.05 U	0.05 U	0.05 U
Heptachlor	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Aldrin	0.05	0.05 U	0.05 U	0.05 U
Heptachlor epoxide	0.05	0.05 UJ (c)	0.05 UJ (c)	0.05 UJ (c)
Endosulfan I	0.05	0.05 U	0.05 U	0.05 U
Dieldrin	1.0	0.1 U	0.1 U	0.1 U
4,4'-DDE	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
Endrin	1.0	0.1 U	0.1 U	0.1 U
Endosulfan II	1.0	0.1 U	0.1 U	0.1 U
4,4'-DDD	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
Endosulfan sulfate	1.0	0.1 UJ (c)	0.1 UJ (c)	0.1 UJ (c)
4,4'-DDT	1.0	R(x)	R(x)	R(x)
Methoxychlor	0.05	0.5 UJ (c)	0.5 UJ (c)	0.5 UJ (c)
Endrin ketone	1.0	0.1 U	0.1 U	0.1 U
Chlordane	0.05	0.5 U	0.5 U	0.5 U
Toxaphene	1.0	1.0 U	1.0 U	1.0 U
Aroclor-1016	0.05	0.5 U	0.5 U	0.5 U
Aroclor-1221	0.05	0.5 U	0.5 U	0.5 U
Aroclor-1232	0.05	0.5 U	0.5 U	0.5 U
Aroclor-1242	0.05	0.5 U	0.5 U	0.5 U
Aroclor-1248	0.05	0.5 U	0.5 U	0.5 U
Aroclor-1254	1.0	1.0 U	1.0 U	1.0 U
Aroclor-1260	1.0	1.0 U	1.0 U	1.0 U
Analysis Factor:		1.0	1.0	1.0

APPENDIX K-2

PHASE I - INORGANICS

Data Validation Qualifier Key:

K - Positive result for vanadium biased high because of continuing calibration recovery (116 %R) greater than 110% upper quality control limit.

B - Positive result considered to be a false positive attributable to blank contamination.

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

AQUEOUS TAL METALS ANALYSES (mg/L)

CLIENT ID:			NADC - FIELD R. BLANK	FIELD BLK-TAP	FIELD BLK-DI	S2-20-RINSATE	FIELD BLANK-27
LAB ID:			8807	8808	8811	8847	8854
CHEMICAL	CRDL	IDL					
Aluminum	200	1.0	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Antimony	60	0.01	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Arsenic	10	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Barium	200	0.50	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Beryllium	5	0.0005	0.0007	0.0006	0.0005 U	0.0007	0.0005 U
Cadmium	5	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Calcium	5000	0.50	0.50 U	34	0.50 U	0.50 U	70
Chromium	10	0.002	0.003	0.007	0.002 U	0.002 U	0.002 U
Cobalt	50	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Copper	25	0.025	0.025	0.075	0.025 U	0.025 U	0.098
Iron	100	0.10	0.20	0.10 U	0.10 U	0.10 U	0.10 U
Lead	3	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.003
Magnesium	5000	0.50	0.50 U	13.5	0.50 U	0.50 U	26
Manganese	15	0.10	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Mercury	0.2	0.0002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Nickel	40	0.01	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Potassium	5000	0.50	0.50 U	4	0.50 U	0.50 U	2
Selenium	5	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Silver	10	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Sodium	5000	0.50	0.50 U	24	0.50 U	0.50 U	17
Thallium	10	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Vanadium	50	0.01	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Zinc	20	0.02	0.02 U	0.09	0.02 U	0.05	0.07

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

AQUEOUS TAL METALS ANALYSES (mg/L)

CLIENT ID:			NADC - FIELD BLANK-28	RINS. BLANK-30	RINS. BLANK-40	RINS. BLANK-46	RINS. BLANK-53
LAB ID:			8855	8901	8977	9020	9104
CHEMICAL	CRDL	IDL					
Aluminum	200	1.0	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Antimony	60	0.01	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Arsenic	10	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Barium	200	0.50	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Beryllium	5	0.0005	0.0005 U	0.0005 U	0.0005 U	0.002	0.0005 U
Cadmium	5	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Calcium	5000	0.50	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Chromium	10	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Cobalt	50	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Copper	25	0.025	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U
Iron	100	0.10	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Lead	3	0.002	0.002 U	0.002	0.002 U	0.002 U	0.002 U
Magnesium	5000	0.50	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Manganese	15	0.10	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Mercury	0.2	0.0002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Nickel	40	0.01	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Potassium	5000	0.50	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Selenium	5	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Silver	10	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Sodium	5000	0.50	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Thallium	10	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Vanadium	50	0.01	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Zinc	20	0.02	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

AQUEOUS TAL METALS ANALYSES (mg/L)

CLIENT ID:			NADC - 8-S. WATER	S1-64-DG-1	S1-66-WELL-C	S2-22-BG-4-D	S2-23-BG-4
LAB ID:			8793	9161	9237	8849	8850
CHEMICAL	CRDL	IDL					
Aluminum	200	1.0	1.0 U	1.0 U	6.6	1.0 U	1.0 U
Antimony	60	0.01	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Arsenic	10	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Barium	200	0.50	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Beryllium	5	0.0005	0.0005 U	0.0005 U	0.0005 U	0.0031 B	0.0010 B
Cadmium	5	0.002	0.002 U	0.006	0.002 U	0.002 U	0.002 U
Calcium	5000	0.50	22 B	50 B	180 B	48 B	47 B
Chromium	10	0.002	0.002 U	0.045	0.014	0.002 B	0.002 B
Cobalt	50	0.002	0.002 U	0.015	0.004	0.002 U	0.002 U
Copper	25	0.025	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U
Iron	100	0.10	0.10 U	36	35	0.46 B	0.38 B
Lead	3	0.002	0.002 U	0.004 B	0.05	0.002 U	0.002 U
Magnesium	5000	0.50	9.7 B	17 B	20 B	23 B	23 B
Manganese	15	0.10	0.10 U	1.5	0.46	0.10 U	0.10 U
Mercury	0.2	0.0002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Nickel	40	0.01	0.01 U	0.06	0.01 U	0.01 U	0.01 U
Potassium	5000	0.50	1.4 B	3.0 B	2.0 B	1.3 B	1.4 B
Selenium	5	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Silver	10	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Sodium	5000	0.50	12 B	31 B	14 B	26 B	28 B
Thallium	10	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Vanadium	50	0.01	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Zinc	20	0.02	0.02 U	0.18 B	0.15 B	0.06 B	0.02 U

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

AQUEOUS TAL METALS ANALYSES (mg/L)

CLIENT ID:			NADC - S2-24-BG-3	S2-25-D	S2-26-DG-26	S2-32-DG-12	S2-63-WELL-E
LAB ID:			8851	8852	8853	8903	9160
CHEMICAL	CRDL	IDL					
Aluminum	200	1.0	20	1.0 U	7.0	1.0 U	1.0 U
Antimony	60	0.01	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Arsenic	10	0.002	0.004	0.002 U	0.002 U	0.002	0.002 U
Barium	200	0.50	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Beryllium	5	0.0005	0.0031 B	0.0005 U	0.0013 B	0.0005 U	0.0005 U
Cadmium	5	0.002	0.003	0.002 U	0.002 U	0.002 U	0.002 U
Calcium	5000	0.50	99 B	50 B	34 B	35 B	70 B
Chromium	10	0.002	0.034	0.011	0.009	0.002 U	0.006
Cobalt	50	0.002	0.015	0.002 U	0.004	0.002 U	0.002
Copper	25	0.025	0.064 B	0.025 U	0.025 U	0.025 U	0.025 U
Iron	100	0.10	35	17	5.0	0.21 B	13
Lead	3	0.002	0.15	0.002 B	0.006 B	0.002 B	0.003 B
Magnesium	5000	0.50	19.5 B	19 B	21 B	17 B	21 B
Manganese	15	0.10	2.0	0.4	0.7	0.10 U	0.45
Mercury	0.2	0.0002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Nickel	40	0.01	0.03	0.01 U	0.01 U	0.01 U	0.01
Potassium	5000	0.50	5.0 B	1.1 B	3.0 B	1.2 B	6 B
Selenium	5	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Silver	10	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Sodium	5000	0.50	22 B	20 B	28 B	10 B	41 B
Thallium	10	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002
Vanadium	50	0.01	0.04	0.01 U	0.01 U	0.01 U	0.01 U
Zinc	20	0.02	0.22 B	0.03 B	0.03 B	0.02 U	0.89 B

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

AQUEOUS TAL METALS ANALYSES (mg/L)

CLIENT ID:			NADC - S2-76-DG-2	S2-77-DG-23	S3-60-DG-13	S3-61-DG-13-D	S3-62-DG-3
LAB ID:			9275	9276	9157	9158	9159
CHEMICAL	CRDL	IDL					
Aluminum	200	1.0	24.2	4.1	6.4	8.4	6.6
Antimony	60	0.01	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Arsenic	10	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Barium	200	0.50	0.9 B	1.1 B	0.5 B	0.5 B	0.9 B
Beryllium	5	0.0005	0.0021 B	0.0009 B	0.0008 B	0.0006 B	0.0011 B
Cadmium	5	0.002	0.022	0.002 U	0.002 U	0.002 U	0.002 U
Calcium	5000	0.50	76 B	57 B	35 B	35 B	9 B
Chromium	10	0.002	0.22	0.004	0.004	0.002 B	0.007
Cobalt	50	0.002	0.023	0.018	0.002	0.003	0.010
Copper	25	0.025	0.115 B	0.135 B	0.025 U	0.025 U	0.025 U
Iron	100	0.10	62	6	4	5.6	33
Lead	3	0.002	0.082	0.023	0.005 B	0.005 B	0.013 B
Magnesium	5000	0.50	26 B	28 B	24 B	22 B	23 B
Manganese	15	0.10	7	4	0.22	0.25	0.87
Mercury	0.2	0.0002	0.0003	0.0002 U	0.0002U	0.002 U	0.0002 U
Nickel	40	0.01	0.06	0.01 U	0.01 U	0.01 U	0.02
Potassium	5000	0.50	4 B	3 B	2 B	2 B	2 B
Selenium	5	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Silver	10	0.002	0.004	0.002 U	0.002 U	0.002 U	0.002 U
Sodium	5000	0.50	24 B	15 B	14 B	15 B	14 B
Thallium	10	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Vanadium	50	0.01	0.03 K	0.01 U	0.01 U	0.01 U	0.01 U
Zinc	20	0.02	0.53	0.11 B	0.02 U	0.18 B	0.02 U

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

AQUEOUS TAL METALS ANALYSES (mg/L)

CLIENT ID:			NADC - S4-33-DG-28	S4-34-DG-15	S4-35-DG-6	S4-36-DG-16	S4-37-DG-9
LAB ID:			8904	8905	8906	8907	8974
CHEMICAL	CRDL	IDL					
Aluminum	200	1.0	1.0 U	31	5.0	12	5.0
Antimony	60	0.01	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Arsenic	10	0.002	0.002 U	0.002 U	0.002	0.002 U	0.002 U
Barium	200	0.50	0.50 U	0.60 B	0.50 U	0.60 B	0.50 U
Beryllium	5	0.0005	0.001 B	0.002 B	0.002 B	0.002 B	0.0005 U
Cadmium	5	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Calcium	5000	0.50	26 B	61 B	49 B	68 B	29 B
Chromium	10	0.002	0.003 B	0.011	0.003 B	0.004	0.004
Cobalt	50	0.002	0.002 U	0.047	0.003	0.008	0.007
Copper	25	0.025	0.007 B	0.046 B	0.012 B	0.025 U	0.025 U
Iron	100	0.10	1.1	22	8.2	8.0	14
Lead	3	0.002	0.002 U	0.007 B	0.009 B	0.007 B	0.012 B
Magnesium	5000	0.50	9 B	8 B	11 B	28 B	15 B
Manganese	15	0.10	0.31	3.5	0.5	0.6	0.3
Mercury	0.2	0.0002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Nickel	40	0.01	0.01 U	0.02	0.01 U	0.01 U	0.01
Potassium	5000	0.50	1.1	4 B	3 B	8 B	2.1 B
Selenium	5	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Silver	10	0.002	~~16~~ 0.002	0.002 U	0.002 U	0.002 U	0.002 U
Sodium	5000	0.50	~~0.50 U~~ 16 B	11 B	9.4 B	13 B	8.6 B
Thallium	10	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Vanadium	50	0.01	0.01 U	0.02 K	0.01 U	0.01 U	0.01 U
Zinc	20	0.02	0.02 U	0.06 B	0.27 B	0.04 B	1.3

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SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

AQUEOUS TAL METALS ANALYSES (mg/L)

CLIENT ID:			NADC - S4-39-DG-18	S4-42-DG-4	S4-43-DG-5	S4-44-DG-7	S4-67-BG-2
LAB ID:			8976	8979	8980	8981	9238
CHEMICAL	CRDL	IDL					
Aluminum	200	1.0	1.0 U	1.0 U	1.0 U	2.0	11.5
Antimony	60	0.01	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Arsenic	10	0.002	0.002 U	0.004	0.002 U	0.002 U	0.002 U
Barium	200	0.50	0.60 B	0.50 B	0.50 U	0.60 B	0.50 U
Beryllium	5	0.0005	0.0008 B	0.0005 U	0.0005 U	0.002 B	0.0016 B
Cadmium	5	0.002	0.002 U	0.002	0.002 U	0.002 U	0.004
Calcium	5000	0.50	45 B	18 B	30 B	40 B	25 B
Chromium	10	0.002	0.002 U	0.002 U	0.002 U	0.015	0.010
Cobalt	50	0.002	0.010	0.003	0.002 U	0.013	0.009
Copper	25	0.025	0.025 U	0.025 U	0.025 U	0.037 B	0.10 B
Iron	100	0.10	4.3	18	2.4	97	129
Lead	3	0.002	0.002 U	0.004 B	0.002 U	0.008 B	0.023
Magnesium	5000	0.50	20 B	6 B	9 B	18 B	8.2 B
Manganese	15	0.10	1.0	0.3	0.5	2	0.50
Mercury	0.2	0.0002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Nickel	40	0.01	0.01 U	0.01 U	0.01 U	0.03	0.04
Potassium	5000	0.50	1.0 B	1.0 B	0.9 B	3.0 B	5 B
Selenium	5	0.002	0.002 U	0.002 U	0.002	0.002 U	0.002 U
Silver	10	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Sodium	5000	0.50	16 B	10 B	7.2 B	11 B	10 B
Thallium	10	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Vanadium	50	0.01	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Zinc	20	0.02	0.02 U	0.02 U	0.02 U	0.06 B	0.07 B

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

AQUEOUS TAL METALS ANALYSES (mg/L)

CLIENT ID:			NADC - S4-68-BG-6	S4-73-DG-22	S4-78-DG-22-D	S4-74-DG-24	S5-50-DG-8
LAB ID:			9239	9272	9273	9274	9101
CHEMICAL	CRDL	IDL					
Aluminum	200	1.0	14.8	1.0 U	1.0 U	2.9	11.9
Antimony	60	0.01	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Arsenic	10	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Barium	200	0.50	0.8 B	1.1 B	1.1 B	0.50 U	0.50 U
Beryllium	5	0.0005	0.0026 B	0.0005 U	0.0005 U	0.0005 U	0.003 B
Cadmium	5	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002
Calcium	5000	0.50	30 B	31 B	48 B	91 B	18 B
Chromium	10	0.002	0.006	0.002 U	0.002 U	0.002 B	0.018
Cobalt	50	0.002	0.011	0.002 U	0.002 U	0.002	0.017
Copper	25	0.025	0.025 U	0.025 U	0.002 B	0.014 B	0.025 U
Iron	100	0.10	15	0.50 B	0.53 B	2	49
Lead	3	0.002	0.007 B	0.002 U	0.002 U	0.002 U	0.007 B
Magnesium	5000	0.50	5.4 B	12 B	12 B	15 B	6.3 B
Manganese	15	0.10	3	0.15	0.18	0.70	0.43
Mercury	0.2	0.0002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Nickel	40	0.01	0.04	0.01 U	0.01 U	0.01 U	0.06
Potassium	5000	0.50	4 B	1.36 B	3 B	1.1 B	2 B
Selenium	5	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Silver	10	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Sodium	5000	0.50	10 B	10 B	11 B	16 B	17 B
Thallium	10	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Vanadium	50	0.01	0.02 K	0.01 U	0.01 U	0.01 U	0.01 U
Zinc	20	0.02	0.02 U	0.02 U	0.02 U	0.04 B	0.03 B

550
2/1/00

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

AQUEOUS TAL METALS ANALYSES (mg/L)

CLIENT ID:			NADC - S5-51-DG-20	S5-54-DG-27	S5-55-DG-21	S6-47-DG-19	S6-48-DG-17
LAB ID:			9102	9105	9106	9021	9022
CHEMICAL	CRDL	IDL					
Aluminum	200	1.0	3.7	6.6	29	1.0 U	1.5
Antimony	60	0.01	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Arsenic	10	0.002	0.002 U	0.002 U	0.012	0.005	0.003
Barium	200	0.50	0.90 B	0.60 B	1.0 B	0.60 B	0.50 U
Beryllium	5	0.0005	0.0005 U	0.002 B	0.006 B	0.0005 U	0.001 B
Cadmium	5	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Calcium	5000	0.50	71 B	36 B	37 B	52 B	32 B
Chromium	10	0.002	0.003 B	0.008	0.008	0.002 U	0.002 U
Cobalt	50	0.002	0.006	0.009	0.12	0.002 U	0.002 U
Copper	25	0.025	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U
Iron	100	0.10	11	5.8	42	0.9 B	2
Lead	3	0.002	0.004 B	0.002 U	0.005 B	0.002 U	0.002 U
Magnesium	5000	0.50	24 B	14 B	9.3 B	19 B	17 B
Manganese	15	0.10	1.4	0.27	3.0	0.2	0.51
Mercury	0.2	0.0002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Nickel	40	0.01	0.01 U	0.01 U	0.06	0.01 U	0.01
Potassium	5000	0.50	1.3 B	1.4 B	4 B	1.1 B	0.9 B
Selenium	5	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Silver	10	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Sodium	5000	0.50	11 B	19 B	24 B	12 B	9.1 B
Thallium	10	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Vanadium	50	0.01	0.01 U	0.01 U	0.03 K	0.01 U	0.01 U
Zinc	20	0.02	0.03 B	0.02 U	0.05 B	0.02 U	0.02 U

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

AQUEOUS TAL METALS ANALYSES (mg/L)

CLIENT ID:			NADC - S6-41-DG-10	S6-69-BG-7	S7-56-DG-25	S7-58-DG-25-D	S8-75-DG-14
LAB ID:			8978	9240	9153	9155	9271
CHEMICAL	CRDL	IDL					
Aluminum	200	1.0	1.0 U	2.3	1.0 U	1.5	6.8
Antimony	60	0.01	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Arsenic	10	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Barium	200	0.50	0.50 U	0.50 U	0.5 B	0.7 B	1.0 B
Beryllium	5	0.0005	0.003 B	0.0005 B	0.0009 B	0.0009 B	0.0007 B
Cadmium	5	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Calcium	5000	0.50	17 B	13 B	54 B	48 B	29 B
Chromium	10	0.002	0.032	0.002 B	0.002 U	0.002 U	0.004
Cobalt	50	0.002	0.002	0.003	0.002 U	0.002 U	0.003
Copper	25	0.025	0.025 U	0.025 U	0.025 U	0.025 U	0.007 B
Iron	100	0.10	0.6 B	5	0.38 B	0.56 B	6
Lead	3	0.002	0.005 B	0.002 U	0.002 U	0.002 U	0.004 B
Magnesium	5000	0.50	12 B	4 B	30 B	28 B	6 B
Manganese	15	0.10	0.10 U	0.45	0.10 U	0.10 U	0.49
Mercury	0.2	0.0002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Nickel	40	0.01	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Potassium	5000	0.50	2.2 B	2 B	0.9 B	0.9 B	2 B
Selenium	5	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Silver	10	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Sodium	5000	0.50	7.4 B	9 B	12 B	12 B	12 B
Thallium	10	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Vanadium	50	0.01	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Zinc	20	0.02	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U

SITE: WARMINSTER
CASE NO. 9710-40004
LABORATORY: RMC

AQUEOUS TAL METALS ANALYSES (mg/L)

CLIENT ID:			NADC - S8-49-BG-5
LAB ID:			9023
CHEMICAL	CRDL	IDL	
Aluminum	200	1.0	20
Antimony	60	0.01	0.01 U
Arsenic	10	0.002	0.002 U
Barium	200	0.50	1.3 B
Beryllium	5	0.0005	0.004 B
Cadmium	5	0.002	0.002 U
Calcium	5000	0.50	20 B
Chromium	10	0.002	0.005
Cobalt	50	0.002	0.008
Copper	25	0.025	0.19 B
Iron	100	0.10	18
Lead	3	0.002	0.01 B
Magnesium	5000	0.50	4 B
Manganese	15	0.10	4
Mercury	0.2	0.0002	0.0002 U
Nickel	40	0.01	0.04
Potassium	5000	0.50	2 B
Selenium	5	0.002	0.002 U
Silver	10	0.002	0.002 U
Sodium	5000	0.50	7.4 B
Thallium	10	0.002	0.002 U
Vanadium	50	0.01	0.032 K
Zinc	20	0.02	0.05 B

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APPENDIX K-6

PHASE II - TAL INORGANICS AND CYANIDE

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SAMPLE ID NUMBER:	CWSB09	CWSB14	CWSB18	CWSB19	CWSB19-D	DWMW03	DWMW04
SAMPLE TYPE:	TCLP	TCLP	TCLP	TCLP	TCLP	DISSO	DISSO
UNITS:	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
COMPOUND							
ALUMINUM							70.00 B
ANTIMONY							49.00 U
ARSENIC	3.00 UL(c)	3.00 U	3.00 UL(p)	3.00 UL(n)	3.00 UL(n)		2.00 U
BARIUM	288.00	745.00	527.00	742.00 L(m)	742.00 L(m)	63.00	320.00
BERYLLIUM						3.00 B	3.00 B
CADMIUM	3.00 B	3.00 U	3.00	5.00 B	5.00 B	3.00 U	3.00 U
CALCIUM						43000.00	71500.00
CHROMIUM	5.00 U	5.00 U	5.00 U	9.00 B	9.00 B	7.00 B	5.00 U
COBALT						6.00 U	8.00 B
COPPER						4.00 U	4.00 U
CYANIDE							
IRON						10.00 UL(n)	4300.00
LEAD	1.70 B	1.00 UL(p)	1.30 B	1.60 L(p)	1.60 L(p)	1.00 U	1.00 B
MAGNESIUM						9240.00	11000.00
MANGANESE						2.00 L(n)	676.00
MERCURY	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
NICKEL						17.00 U	17.00 U
POTASSIUM						830.00	1110.00
SELENIUM	5.00 UL(p)	5.00 UL(p)	5.00 UL(p)	5.00 U	5.00 U	5.00 U	5.00 U
SILVER	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U
SODIUM						11200.00	11700.00
THALLIUM						2.00 UL(p)	2.00 UL(p)
VANADIUM						5.00 U	5.00 B
ZINC						4.00 B	305.00

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SAMPLE ID NUMBER:	DWMW08-D	DWMW23-D	DWMW31	DWMW31-D	DWMW32	DWMW33	DWMW34
SAMPLE TYPE:	DISSO	DISSO	DISSO	DISSO	DISSO	DISSO	DISSO
UNITS:	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
COMPOUND							
ALUMINUM	83.00 B	78.00 B	59.00 U	92.00 B	81.00 B	94.00 B	194.00 B
ANTIMONY	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U
ARSENIC	2.00 UL(c)	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U
BARIUM	377.00	469.00 L(n)	30.00	28.00	41.00	81.00	71.00
BERYLLIUM	4.00 B	5.00 B	5.00 B	4.00 B	4.00 B	4.00 B	4.00 B
CADMIUM	4.00 B	3.00 U	3.00 U	3.00 U	3.00 B	3.00 B	3.00 B
CALCIUM	78600.00	64200.00	46400.00	52200.00	55800.00	60700.00	80100.00
CHROMIUM	5.00 B	5.00 U	7.00 B	5.00 U	5.00 B	5.00 U	5.00 U
COBALT	6.00 U	6.00 U	6.00 U	6.00 U	10.00 B	6.00 U	6.00 U
COPPER	4.00 B	5.00 B	4.00 U	4.00 U	4.00 U	4.00 U	4.00 U
CYANIDE							
IRON	22.00 B	23.00 B	10.00 U	21.00 B	486.00	1820.00	10.00 U
LEAD	1.00 U	1.70 B	3.60 L(n)	1.00 UL(n)	1.00 UL(n)	1.00 UL(n)	1.00 UL(n)
MAGNESIUM	12400.00	19800.00	21000.00	22900.00	16300.00	17800.00	9780.00
MANGANESE	1760.00 L(c)	661.00 L(m)	26.00	32.00	1750.00	286.00	1.00 B
MERCURY	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
NICKEL	17.00 U	17.00 U	19.00 B	17.00 U	78.00 B	17.00 U	17.00 U
POTASSIUM	1420.00	450.00	1610.00	1910.00	3360.00	1090.00	8460.00
SELENIUM	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U
SILVER	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U
SODIUM	13100.00	10300.00	31800.00	33300.00	31900.00	19100.00	47700.00
THALLIUM	2.00 U	2.00 UL(m,p)	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U
VANADIUM	5.00 U	5.00 U	6.00 B	5.00 U	5.00 U	5.00 U	6.00 B
ZINC	13.00 B	7.00 B	4.00 UJ(d)	4.00 UJ(d)	29.00 J(d)	174.00 J(d)	4.00 B

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SAMPLE ID NUMBER:	DWMW35	DWMW36	DWMW37	DWMW38	DWMW39	DWMW39-D	DWMW40
SAMPLE TYPE:	DISSO	DISSO	DISSO	DISSO	DISSO	DISSO	DISSO
UNITS:	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
COMPOUND							
ALUMINUM	73.00 B	89.00 B	77.00 B	158.00 B	72.00 B	76.00 B	132.00 B
ANTIMONY	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U
ARSENIC	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U
BARIUM	221.00	92.00	67.00	60.00	94.00	93.00	133.00
BERYLLIUM	4.00 B	4.00 B	4.00 B	4.00 B	4.00 B	4.00 B	4.00 B
CADMIUM	3.00 U	3.00 U	3.00 U	3.00 U	3.00 B	3.00 U	3.00 U
CALCIUM	38700.00	40900.00	27900.00	54100.00	55000.00	54800.00	21400.00
CHROMIUM	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U
COBALT	6.00 U	6.00 U	6.00 U	6.00 U	6.00 U	6.00 U	6.00 U
COPPER	4.00 U	5.00 B	4.00 U	6.00 B	4.00 U	4.00 U	4.00 U
CYANIDE							
IRON	10.00 U	10.00 U	57.00 B	40.00 B	3740.00	3980.00	129.00
LEAD	1.00 UL(n)	1.00 UL(n)	1.00 UL(n)	1.00 UL(n)	1.00 UL(n)	1.00 UL(n)	1.00 UL(n)
MAGNESIUM	13100.00	16100.00	10600.00	15700.00	16200.00	16200.00	5820.00
MANGANESE	74.00	243.00	52.00	636.00	393.00	378.00	5.00 B
MERCURY	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U		0.20 U
NICKEL	17.00 B	17.00 U	17.00 U	19.00 B	17.00 U	17.00 U	17.00 U
POTASSIUM	1320.00	2340.00	4410.00	2150.00	928.00	960.00	722.00
SELENIUM	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U
SILVER	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U
SODIUM	11300.00	24400.00	18800.00	40300.00	17900.00	18000.00	9590.00
THALLIUM	2.00 U	2.00 UL(p)	2.00 U	2.00 U	2.00 U		2.00 U
VANADIUM	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U
ZINC	6.00 B	10.00 B	43.00 J(d)	4.00 B	5.00 B	5.00 B	8.00 B

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SAMPLE ID NUMBER:	DWMW41	DWMW42	DWMW43	DWMW44	DWMW45	DWMW45-D	DWMW46
SAMPLE TYPE:	DISSO	DISSO	DISSO	DISSO	DISSO	DISSO	DISSO
UNITS:	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
COMPOUND							
ALUMINUM	88.00 B	101.00 B	101.00 B	106.00 B	113.00 B	82.00 B	80.00 B
ANTIMONY	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U
ARSENIC	2.00 UL(p)	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U
BARIUM	199.00	251.00	38.00	343.00	629.00	666.00	161.00
BERYLLIUM	3.00 B	3.00 B	3.00 B	3.00 B	3.00 B	3.00 B	3.00 B
CADMIUM	3.00 U	4.00 B	3.00 U	3.00 U	3.00 U	3.00 U	3.00 B
CALCIUM	30600.00	45800.00	47100.00	45800.00	45800.00	46800.00	17300.00
CHROMIUM	5.00 U	5.00 U	31.00	5.00 U	5.00 U	5.00 U	5.00 U
COBALT	6.00 U	6.00 B	12.00 B	9.00 B	6.00 B	6.00 B	6.00 U
COPPER	5.00 B	5.00 B	4.00 B	4.00 B	5.00 B	4.00 U	5.00 B
CYANIDE							
IRON	37.00 L(n)	10.00 UL(n)	10.00 UL(n)	4840.00	16.00 L(n)	10.00 UL(n)	10.00 UL(n)
LEAD	1.60 K(m)	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
MAGNESIUM	8750.00	20800.00	19800.00	20900.00	9400.00	9580.00	5340.00
MANGANESE	40.00	43.00	71.00	4190.00	14.00	9.00	4.00
MERCURY	0.20 R(m)	0.20 R(m)	0.20 R(m)	0.20 R(m)	0.20 R(m)	0.20 R(m)	0.20 R(m)
NICKEL	17.00 U	17.00 U	17.00 U	17.00 U	17.00 U	17.00 U	17.00 U
POTASSIUM	1790.00 B	2110.00 B	2880.00	2030.00 B	1140.00 B	1040.00 B	1150.00 B
SELENIUM	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U
SILVER	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U
SODIUM	10400.00	13300.00	29500.00	30700.00	10200.00	10100.00	6970.00
THALLIUM	2.00 U	2.00 U	2.00 U	2.40 B	2.00 U	2.00 U	2.00 U
VANADIUM	5.00 U	6.00	5.00 U	5.00	5.00 U	5.00 U	5.00 U
ZINC	6.00	4.00 U	20.00	7.00	11.00	4.00	17.00

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SAMPLE ID NUMBER:	DSWF06-D	DW617FB	DW618FB	DW622FB	DW624FB	DW624RB	DW626RB
SAMPLE TYPE:	DISSO	DISSO	DISSO	DISSO	DISSO	DISSO	DISSO
UNITS:	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
COMPOUND							
ALUMINUM	103.00 B	59.00 U	99.00 B	93.00 B	110.00 B	81.00 B	69.00 B
ANTIMONY	49.00 U	49.00 U	49.00 UL(n)	49.00 U	49.00 U	49.00 U	49.00 U
ARSENIC	2.00 U	3.00 U	3.00 U	3.00 UL(p,n)	2.00 U	2.00 U	2.00 UL(n)
BARIUM	137.00	161.00	34.00	21.00 U	21.00 U	21.00 U	21.00 U
BERYLLIUM	3.00 B	4.00 B	4.00 B	3.00 B	3.00 B	3.00 B	4.00 B
CADMIUM	3.00	3.00 U	3.00 B	3.00 B	3.00 U	3.00 U	3.00 B
CALCIUM	44100.00	34600.00	22300.00	17.00 U	18.00 B	25.00 B	21.00 B
CHROMIUM	7.00 B	6.00 B	5.00 U	5.00 U	9.00 B	9.00 B	5.00 U
COBALT	6.00 B	6.00 U	6.00 U	6.00 U	6.00 B	7.00 B	6.00 U
COPPER	9.00 B	26.00	4.00 U	4.00 B	4.00 U	4.00 B	4.00 B
CYANIDE							
IRON	10.00 UL(c)	10.00 U	11.00 B	10.00 U	10.00 UL(n)	26.00 B	10.00 U
LEAD	1.20 B	8.80 B	2.40	1.00 UL(p)	1.00 U	1.20 B	1.00 UL(p)
MAGNESIUM	17300.00	13700.00	13700.00	40.00 U	40.00 U	40.00 U	44.00 B
MANGANESE	272.00	2.00 B	292.00	1.00 B	1.00 UL(n)	1.00 UL(n)	1.00 UL(n)
MERCURY	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
NICKEL	19.00	17.00 U	26.00 B	17.00 U	17.00 U	17.00 U	17.00 U
POTASSIUM	1960.00	1210.00 B	1100.00	383.00 U	383.00 U	383.00 U	383.00 U
SELENIUM	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U
SILVER	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U
SODIUM	23200.00	9720.00	9960.00	50.00 U	50.00 U	50.00 U	50.00 U
THALLIUM	2.00 UL(p)	2.00 U	2.00 UL(p)	2.00 U	2.00 U	2.00 U	2.00 U
VANADIUM	5.00 B	5.00 U	5.00 U	6.00 B	5.00 U	6.00	5.00 U
ZINC	76.00	132.00	8.00	6.00	4.00 U	9.00	5.00 B

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SAMPLE ID NUMBER:	DW630RB	DW702RB	DWMW01	DWMW02	DWMW03	DWMW05	DWMW06
SAMPLE TYPE:	DISSO	TOTAL	DISSO	DISSO	DISSO	DISSO	DISSO
UNITS:	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
COMPOUND							
ALUMINUM	59.00 U	90.00 B	92.00 B	111.00 B	102.00 B	66.00 B	81.00 B
ANTIMONY	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U
ARSENIC	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 UL(n)	2.00 UL(n)
BARIUM	21.00 UL(n)	21.00 U	110.00	643.00	63.00	221.00	397.00
BERYLLIUM	5.00 B	4.00 B	3.00 B	3.00 B	3.00 B	4.00 B	4.00 B
CADMIUM	4.00 B	3.00 U	3.00 U	3.00 U	43000.00	3.00 B	3.00 U
CALCIUM	61.00 B	17.00 U	43900.00	28300.00	7.00 B	53600.00	46300.00
CHROMIUM	5.00 U	5.00 U	7.00 B	5.00 U	6.00 U	5.00 U	5.00 B
COBALT	6.00 U	6.00 U	6.00 U	6.00 U	4.00 U	6.00 U	6.00 U
COPPER	6.00 B	4.00 U	4.00 U	4.00 U		4.00 B	4.00 B
CYANIDE					10.00 UL(n)		
IRON	10.00 U	10.00 U	1910.00	7490.00	1.00 U	10.00 U	12.00 B
LEAD	1.00 UL(n)	2.60 L(n)	1.00 U	1.00 U	9240.00	1.20 B	1.20 B
MAGNESIUM	40.00 UL(m)	40.00 U	8990.00	7290.00	2.00 L(n)	7970.00	11800.00
MANGANESE	2.00 B	1.00 B	362.00	682.00	0.20 U	129.00 L(n)	186.00
MERCURY	0.20 U	0.20 U	0.20 U	0.20 U	17.00 U	0.20 U	0.20 U
NICKEL	17.00 U	17.00 U	17.00 U	17.00 U	830.00	17.00 U	17.00 U
POTASSIUM	383.00 U	383.00 U	948.00	927.00	5.00 U	910.00	1460.00
SELENIUM	5.00 U	5.00 U	5.00 U	5.00 U	10.00 U	5.00 U	5.00 U
SILVER	10.00 U	10.00 U	10.00 U	10.00 U	11200.00	10.00 U	10.00 U
SODIUM	184.00 B	50.00 U	9680.00	11100.00	2.00 UL(p)	10300.00	9480.00
THALLIUM	2.00 UL(m)	2.00 U	2.00 UL(p)	2.00 UL(p)	5.00 U	2.00 U	2.00 U
VANADIUM	5.00 U	5.00 U	6.00 B	5.00 U	4.00 B	5.00 B	5.00 U
ZINC	4.00	5.00 J(d)	5.00 B	13.00 B		8.00 B	5.00 B

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SAMPLE ID NUMBER:	DWMW07	DWMW08	DWMW09	DWMW10	DWMW11	DWMW12	DWMW13
SAMPLE TYPE:	DISSO	DISSO	DISSO	DISSO	DISSO	DISSO	DISSO
UNITS:	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
COMPOUND							
ALUMINUM	89.00 B	91.00 B	59.00 U	249.00 B	87.00 B	82.00 B	73.00 B
ANTIMONY	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U
ARSENIC	2.00 UL(n)	2.00 UL(n)	2.00 UL(n)	2.00 UL(n)	2.00 UL(n)	2.00 UL(n)	2.00 UL(n)
BARIUM	166.00	402.00	435.00	61.00	227.00	92.00	60.00
BERYLLIUM	4.00 B	4.00 B	4.00 B	4.00 B	4.00 B	4.00 B	4.00 B
CADMIUM	6.00 B	3.00 B	3.00 B	3.00 U	4.00 B	3.00 U	3.00 U
CALCIUM	25400.00	82000.00	53000.00	12600.00	45400.00	36000.00	18700.00
CHROMIUM	5.00 U	5.00 U	6.00 B	5.00 B	5.00 B	5.00 U	5.00 U
COBALT	6.00 U	6.00 U	6.00 U	6.00 U	6.00 U	6.00 U	6.00 U
COPPER	4.00 B	4.00 B	4.00 B	4.00 B	4.00 B	4.00 U	4.00 B
CYANIDE							
IRON	1430.00	16.00 B	11.00 B	108.00 B	24.00 B	1460.00	2020.00
LEAD	1.20 B	1.70 B	1.00 U	1.30 B	2.00 B	1.00 U	1.00 U
MAGNESIUM	10300.00	12800.00	16800.00	3370.00	14200.00	16000.00	9000.00
MANGANESE	367.00	1760.00	1.00 B	15.00 L(n)	38.00 L(n)	391.00	30.00 L(c)
MERCURY	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
NICKEL	23.00	17.00 U	17.00 U	17.00 U	17.00 U	25.00	17.00 U
POTASSIUM	1710.00	1590.00	1690.00	980.00	994.00	1700.00	1220.00
SELENIUM	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U
SILVER	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U
SODIUM	10400.00	13500.00	10400.00	11400.00	17000.00	9110.00	7070.00
THALLIUM	2.00 U	2.00 U	2.00 U	2.00 U	2.00 UL(p)	2.00 UL(p)	2.00 UL(p)
VANADIUM	5.00 U	5.00 U	5.00 B	5.00 B	5.00 U	5.00 B	5.00 U
ZINC	6.00 B	16.00 B	4.00 B	11.00 B	32.00	73.00	11.00 B

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SAMPLE ID NUMBER:	DWMW14	DWMW15	DWMW16	DWMW17	DWMW18	DWMW19	DWMW20
SAMPLE TYPE:	DISSO	DISSO	DISSO	DISSO	DISSO	DISSO	DISSO
UNITS:	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
COMPOUND							
ALUMINUM	75.00 B	84.00 B	68.00 B	88.00 B	133.00 B	108.00 B	59.00 U
ANTIMONY	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U
ARSENIC	2.00 UL(n)	2.00 UL(n)	2.00 UL(n)	2.00 U	2.00 U	2.00 U	2.00 U
BARIUM	21.00 U	293.00	63.00	83.00 L(n)	61.00 L(n)	199.00 L(n)	54.00 L(n)
BERYLLIUM	4.00 B	4.00 B	4.00 B	4.00 B	4.00 B	4.00 B	5.00 B
CADMIUM	3.00 B	4.00 B	3.00 B	3.00 U	3.00 U	3.00 U	3.00 U
CALCIUM	9430.00	61300.00	27700.00	12800.00	19400.00	33900.00	20400.00
CHROMIUM	5.00 U	6.00	5.00 U	12.00 B	5.00 B	5.00 B	5.00 U
COBALT	6.00 U	6.00 U	6.00 U	6.00 U	6.00 U	6.00 U	6.00
COPPER	4.00 B	4.00 B	4.00 B	8.00 B	5.00 B	4.00 B	6.00 B
CYANIDE							
IRON	31.00 B	32.00 B	13.00 B	15.00 B	43.00 B	47.00 B	5620.00
LEAD	3.40 B	2.40 B	1.60 B	5.20 B	3.60 B	1.20 B	1.80 B
MAGNESIUM	4380.00	17400.00	11000.00	5860.00	7150.00	16000.00	4060.00
MANGANESE	8.00 L(c)	5.00 L(c)	8.00 L(c)	24.00 L(m)	17.00 L(m)	2.00 B	753.00 L(m)
MERCURY	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
NICKEL	17.00 U	17.00 U	17.00 U	17.00 U	17.00 U	17.00 U	17.00 U
POTASSIUM	781.00	1330.00	885.00	18100.00	1160.00	913.00	9010.00
SELENIUM	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U
SILVER	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U
SODIUM	8150.00	12100.00	7590.00	16400.00	10800.00	8960.00	31800.00
THALLIUM	2.00 UL(p)	2.00 U	2.00 U	2.00 UL(m)	2.00 UL(m)	2.00 UL(m)	2.00 UL(m,p)
VANADIUM	6.00 B	5.00 U	5.00 B	7.00 B	5.00 U	5.00 U	8.00 B
ZINC	11.00 B	15.00 B	8.00 B	4.00 B	4.00 B	5.00 B	64.00

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SAMPLE ID NUMBER:	DWMW21	DWMW22	DWMW23	DWMW24	DWMW25	DWMW26	DWMW27
SAMPLE TYPE:	DISSO	DISSO	DISSO	DISSO	DISSO	DISSO	DISSO
UNITS:	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
COMPOUND							
ALUMINUM	74.00 B	74.00 B	86.00 B	59.00 U	59.00 B	59.00 B	66.00 B
ANTIMONY	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U
ARSENIC	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U
BARIUM	37.00 L(n)	56.00 L(n)	500.00 L(n)	22.00 L(n)	169.00 L(n)	74.00 L(n)	193.00 L(n)
BERYLLIUM	5.00 B	5.00 B	5.00 B	5.00 B	5.00 B	5.00 B	5.00 B
CADMIUM	3.00 U	3.00 U	3.00 U	3.00 U	3.00 U	3.00 U	3.00 U
CALCIUM	26900.00	22800.00	65200.00	24300.00	53800.00	53300.00	33000.00
CHROMIUM	5.00 B	5.00 U	5.00 B	5.00 B	5.00 U	60.00	7.00 B
COBALT	6.00 U	6.00 U	6.00 U	6.00 U	6.00 U	6.00 U	6.00 U
COPPER	6.00 B	5.00 B	6.00 B	5.00 B	5.00 B	7.00 B	6.00 B
CYANIDE							
IRON	56.00 B	6630.00	12.00 B	12.00 B	13.00 B	22.00 B	64.00 B
LEAD	1.00 UL(n)	1.00 UL(n)	1.60 B	1.40 B	1.40 B	1.00 UL(n)	2.00 B
MAGNESIUM	9240.00	10900.00	19800.00	11700.00	23300.00	18200.00	14800.00
MANGANESE	8.00 L(m)	164.00 L(m)	810.00 L(m)	3.00 B	36.00 L(m)	32.00 L(m)	31.00 L(m)
MERCURY	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
NICKEL	17.00 U	17.00 U	17.00 U	17.00 U	17.00 U	17.00 U	17.00 U
POTASSIUM	759.00	1310.00	408.00	715.00	1130.00	1430.00	832.00
SELENIUM	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U
SILVER	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U
SODIUM	12700.00	16300.00	10300.00	10600.00	14700.00	22900.00	14100.00
THALLIUM	2.00 UL(m)	2.00 L(m)	2.00 UL(m)	2.00 UL(m,p)	2.00 UL(m,p)	2.00 UL(m,p)	2.00 UL(m)
VANADIUM	6.00 B	6.00 B	5.00 B	5.00 B	5.00 U	5.00 U	6.00 B
ZINC	19.00 B	11.00 B	4.00 B	16.00 B	8.00 B	9.00 B	20.00 B

SAMPLE ID NUMBER:	DWMW28	DWMW29	DWMW30	DWSWF01	DWSWF02	DWSWF03	DWSWF04
SAMPLE TYPE:	DISSO	DISSO	DISSO	DISSO	DISSO	DISSO	DISSO
UNITS:	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
COMPOUND							
ALUMINUM	59.00 U	59.00 U	59.00 U	146.00 B	114.00 B	71.00 B	108.00 B
ANTIMONY	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U
ARSENIC	2.00 U	2.00 U	2.00 U	3.00 UL(n)	3.00 UL(n)	3.00 UL(n)	3.00 UL(n)
BARIUM	271.00 L(n)	286.00 L(n)	89.00 L(n)	50.00	38.00	122.00	53.00
BERYLLIUM	5.00 B	5.00 B	5.00 B	3.00 B	3.00 B	4.00 B	3.00 B
CADMIUM	3.00 U	3.00 U	3.00 U	3.00 B	3.00 B	4.00 B	3.00 U
CALCIUM	34900.00	38600.00	55200.00	9860.00	13200.00	48100.00	15200.00
CHROMIUM	6.00 B	7.00 B	5.00 B	5.00 U	5.00 U	5.00 U	5.00 U
COBALT	6.00 U	6.00 U	12.00	6.00 U	7.00 B	6.00 U	6.00 U
COPPER	4.00 B	6.00 B	5.00 B	4.00 U	4.00 U	4.00 B	4.00 U
CYANIDE							
IRON	300.00	29.00 B	1170.00	93.00 B	177.00	44.00 B	84.00 B
LEAD	1.00 UL(n)	1.00 UL(n)	1.00 UL(n)	1.00 UL(p)	1.00 UL(p)	1.00 U	1.00 UL(p)
MAGNESIUM	18400.00	17100.00	28000.00	4610.00	6170.00	15900.00	6320.00
MANGANESE	26.00 L(m)	8.00 L(m)	4220.00 L(m)	25.00	34.00	162.00	73.00
MERCURY	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
NICKEL	17.00 U	17.00 U	17.00 U	17.00 U	17.00 U	17.00 B	17.00 U
POTASSIUM	723.00	1270.00	3800.00	1690.00	1280.00	2320.00	1290.00
SELENIUM	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U
SILVER	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U
SODIUM	11800.00	11400.00	54200.00	7810.00	7200.00	45600.00	9530.00
THALLIUM	2.00 UL(m)	2.00 UL(m)	2.00 UL(m)	2.00 U	2.00 U	2.00 U	2.00 U
VANADIUM	5.00 U	5.00 U	5.00 B	9.00 B	7.00 B	5.00 U	5.00 B
ZINC	11.00 B	5.00 B	46.00	4.00 B	5.00 B	16.00 B	4.00 U

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SAMPLE ID NUMBER:	DWSWF05	DWSWF06	TW616RB	TW617RB	TW618FB	TW618RB
SAMPLE TYPE:	DISSO	DISSO	TOTAL	TOTAL	TOTAL	TOTAL
UNITS:	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
COMPOUND						
ALUMINUM	77.00 B	96.00 B	59.00 U	62.00 B	157.00 B	126.00 B
ANTIMONY	49.00 U	49.00 U	49.00 U	49.00 U	49.00 UL(n)	49.00 UL(n)
ARSENIC	2.00 U	2.00 U	3.00 UL(n)	5.60 K(p)	2.00 U	3.00 U
BARIUM	76.00	130.00	21.00 U	167.00	36.00	21.00 U
BERYLLIUM	3.00 B	3.00 B	4.00 B	4.00 B	4.00 B	4.00 B
CADMIUM	3.00 U	3.00 U	3.00 U	3.00 B	3.00 U	3.00 B
CALCIUM	20700.00	42000.00	95.00 B	35500.00	22400.00 L(n)	99.00 B
CHROMIUM	6.00 B	8.00 B	5.00 U	6.00 B	5.00 U	6.00 B
COBALT	6.00 U	7.00 B	6.00 U	6.00 B	7.00 B	6.00 B
COPPER	4.00 U	7.00 B	5.00 B	30.00	4.00 U	5.00 B
CYANIDE			10.00 U	10.00 U	10.00 U	10.00 U
IRON	109.00 B	22.00 B	68.00 B	54.00 B	1150.00	15.00 B
LEAD	1.00 U	1.40 B	1.00 UL(n)	1.20 B	2.00	1.00 U
MAGNESIUM	8350.00	16600.00	40.00 U	13900.00	13800.00	40.00 U
MANGANESE	39.00 L(c)	272.00	1.00 B	8.00	309.00	1.00 B
MERCURY	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
NICKEL	17.00 U	17.00 U	17.00 U	17.00 U	27.00 B	19.00 B
POTASSIUM	1390.00	1760.00	444.00 B	1170.00 B	946.00	383.00 U
SELENIUM	5.00 U	5.00 U	5.00 UJ(n)	5.00 U	5.00 UJ(c)	5.00 UJ(c)
SILVER	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U
SODIUM	7990.00	21700.00	50.00 U	9860.00	10200.00	312.00 B
THALLIUM	2.00 UL(p)	2.00 UL(p)	2.00 UL(c)	2.00 UL(c)	2.00 UL(p)	2.00 U
VANADIUM	5.00 U	5.00 B	5.00 U	5.00 U	5.00 U	5.00 U
ZINC	20.00 B	72.00	14.00 B	115.00	6.00	5.00 B

SAMPLE ID NUMBER:	TW622FB	TW622RB	TW624FB	TW624RB	TW626RB	TW630RB	TW702RB
SAMPLE TYPE:	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL
UNITS:	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
COMPOUND							
ALUMINUM	98.00 B	91.00 B	114.00 B	108.00 B	87.00 B	96.00 B	84.00 U
ANTIMONY	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U
ARSENIC	3.00 UL(n)	3.00 UL(n)	2.00 UL(p)	2.00 UL(p)	2.00 U	2.00 U	2.00 U
BARIUM	21.00 U	21.00 U	21.00 U	21.00 U	21.00 U	21.00 U	21.00 U
BERYLLIUM	3.00 B	3.00 B	3.00 B	3.00 B	4.00 B	3.00 B	5.00 B
CADMIUM	3.00 U	4.00 B	3.00 U	3.00 U	4.00 B	3.00 U	3.00 U
CALCIUM	67.00 B	99.00 B	111.00 B	90.00 B	105.00 B	65.00 B	67.00 B
CHROMIUM	5.00 U	5.00 U	7.00 B	5.00 B	7.00 B	5.00 U	8.00 B
COBALT	6.00 U	6.00 B	6.00 B	6.00 U	6.00 U	6.00 U	6.00 B
COPPER	4.00 B	4.00 U	5.00 B	4.00 B	4.00 B	4.00 B	5.00 B
CYANIDE	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 UJ(c)	10.00 U
IRON	37.00 B	125.00	10.00 UL(n)	10.00 UL(n)	26.00 B	21.00 B	42.00 B
LEAD	1.20 B	2.20	1.00 U	1.00 U	1.00 U	1.00 UL(n)	1.30 L(n)
MAGNESIUM	40.00 U	42.00 B	40.00 U	40.00 U	52.00 B	40.00 U	48.00
MANGANESE	1.00 B	1.00 B	1.00 UL(n)	1.00 UL(n)	1.00 B	3.00	1.00 B
MERCURY	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
NICKEL	17.00 U	17.00 U	17.00 U	17.00 U	17.00 U	17.00 U	17.00 U
POTASSIUM	383.00 U	383.00 U	383.00 U	383.00 U	383.00 U	383.00 U	383.00 U
SELENIUM	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 R(m)
SILVER	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U
SODIUM	157.00 B	164.00 B	211.00 B	142.00 B	187.00 B	75.00	102.00 B
THALLIUM	2.00 U	2.00 U	3.60 B	2.00 UL(n,p)	2.00 UL(m)	2.00 UL(p)	2.00 UL(m)
VANADIUM	7.00 B	6.00 B	5.00 U	5.00 U	5.00 B	5.00 U	5.00 U
ZINC	6.00 B	10.00 B	4.00 B	4.00 U	4.00 U	4.00 U	4.00 U

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SAMPLE ID NUMBER:	TWMW01	TWMW02	TWMW03	TWMW04	TWMW05	TWMW06	TWMW07
SAMPLE TYPE:	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL
UNITS:	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
COMPOUND							
ALUMINUM	2360.00	2100.00	956.00	15800.00	352.00 B	4750.00 J(d)	375.00 B
ANTIMONY	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U
ARSENIC	2.00 U	2.00 U	2.00 U	4.00 L(p)	2.00 U	2.80	2.00 U
BARIUM	111.00	628.00	60.00	473.00	250.00	586.00	184.00
BERYLLIUM	3.00 B	2.00 B	2.00 B	3.00 B	4.00 B	4.00 B	4.00 B
CADMIUM	3.00 U	5.00 B	3.00 U	19.00 K(i)	3.00 B	4.00 B	4.00 B
CALCIUM	38900.00	25300.00	35300.00	70100.00	56400.00	54500.00	25100.00
CHROMIUM	23.00 B	17.00 B	12.00 B	60.00	5.00 U	12.00 B	10.00 B
COBALT	6.00 B	10.00 B	6.00 B	18.00 B	6.00 U	10.00 B	7.00
COPPER	22.00 B	11.00 B	7.00 B	86.00	9.00 B	20.00 B	8.00 B
CYANIDE	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U
IRON	9470.00	15400.00	1460.00	77000.00	478.00 L(n)	7370.00 L(m)	5980.00 L(m)
LEAD	10.30	7.00 B	1.80 B	1.00 UL(p)	8.60 B	6.10 B	6.00 B
MAGNESIUM	8510.00	7280.00	7840.00	13600.00	8370.00	15400.00	10200.00
MANGANESE	421.00	614.00	217.00	1020.00 J(n,i)	253.00	1420.00	352.00
MERCURY	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
NICKEL	20.00	19.00	17.00 U	58.00 K(i)	17.00 U	17.00 U	17.00 U
POTASSIUM	1020.00 B	1500.00 B	925.00 B	3260.00 K(i)	832.00	3710.00	1820.00
SELENIUM	5.00 U	5.00 U	5.00 U	5.00 UL(p)	5.00 U	5.00 U	5.00 U
SILVER	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U
SODIUM	9300.00	10300.00	9590.00	12100.00 K(i)	11000.00	10400.00	10300.00
THALLIUM	2.00 UL(n,p)	2.00 UL(n,p)	2.00 UL(n,p)	2.00 UL(n,p)	2.00 UL(m)	2.00 UL(m)	2.00 UL(m)
VANADIUM	7.00 B	8.00 B	5.00 B	43.00 K(i)	5.00 U	9.00 B	5.00 U
ZINC	14.00 B	21.00	23.00	3330.00	7.00 B	27.00	24.00

SAMPLE ID NUMBER:	TWMW08	TWMW08-D	TWMW09	TWMW10	TWMW11	TWMW12	TWMW13
SAMPLE TYPE:	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL
UNITS:	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
COMPOUND							
ALUMINUM	3750.00 J(d)	480.00 B	2910.00 J(d)	3140.00 J(d)	4720.00 J(d)	1530.00 J(d)	659.00 J(d)
ANTIMONY	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U
ARSENIC	2.00 U	2.00 U	2.00 U	3.50	3.10	2.00	3.70 L(p)
BARIUM	473.00	389.00	513.00	136.00	368.00	111.00	87.00
BERYLLIUM	4.00 B	4.00 B	5.00 B	4.00 B	4.00 B	4.00 B	4.00 B
CADMIUM	4.00 B	3.00 U	4.00 B	4.00 B	3.00 U	5.00 B	13.00 B
CALCIUM	78700.00	80200.00	59000.00	12600.00	45400.00	34600.00	18100.00
CHROMIUM	11.00 B	5.00 U	10.00 B	5.00 B	6.00 B	18.00 B	67.00
COBALT	16.00	6.00 U	6.00	6.00 U	6.00 U	6.00 U	6.00 U
COPPER	29.00 B	8.00 B	6.00 B	9.00 B	10.00 B	40.00	69.00
CYANIDE	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	92.00
IRON	3710.00 L(m)	462.00 L(n)	4750.00 L(m)	2470.00 L(m)	4460.00 L(m)	23900.00 L(m)	73500.00 L(m)
LEAD	6.00 B	1.00 U	4.20 B	8.40 B	9.00 B	9.50	9.80
MAGNESIUM	12500.00	12400.00	18300.00	4310.00	15600.00	15900.00	9170.00
MANGANESE	3390.00	1900.00	332.00	213.00	326.00	467.00	123.00
MERCURY	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
NICKEL	17.00 U	17.00 U	17.00 U	17.00 U	18.00	51.00	44.00
POTASSIUM	1720.00	1360.00	3000.00	940.00	1150.00	1790.00	383.00 U
SELENIUM	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U
SILVER	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U
SODIUM	13400.00	13600.00	10900.00	10900.00	17000.00	9930.00	50.00 U
THALLIUM	2.00 UL(m,p)	2.00 UL(m,p)	2.00 UL(m,p)	2.00 UL(m)	2.00 UL(m)	2.00 UL(m)	2.00 UL(m)
VANADIUM	9.00 B	5.00 U	6.00 B	8.00 B	6.00 B	11.00 B	25.00 B
ZINC	35.00	19.00 B	35.00	29.00	42.00	645.00	75.00

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SAMPLE ID NUMBER:	TWMW14	TWMW15	TWMW16	TWMW17	TWMW18	TWMW19	TWMW20
SAMPLE TYPE:	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL
UNITS:	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
COMPOUND							
ALUMINUM	5260.00 J(d)	133.00 B	2720.00 J(d)	976.00	42000.00	7900.00	2040.00
ANTIMONY	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U
ARSENIC	2.00 U	2.00 U	2.00 U	2.00 U	2.40	2.20 L(p)	2.00 U
BARIUM	66.00	338.00	184.00	98.00	969.00	432.00	94.00
BERYLLIUM	4.00 B	4.00 B	4.00 B	3.00 B	6.00 B	5.00 B	5.00 B
CADMIUM	5.00 B	3.00 U	3.00 U	3.00 U	10.00 B	3.00 B	3.00 U
CALCIUM	10800.00	66100.00	27200.00	11200.00	33100.00	35500.00	21100.00
CHROMIUM	13.00 B	5.00 U	7.00 B	15.00 B	65.00	14.00 B	22.00 B
COBALT	16.00	6.00 U	6.00 U	6.00 U	56.00	9.00 B	11.00 B
COPPER	14.00 B	6.00 B	17.00 B	23.00 B	166.00	17.00 B	5.00 B
CYANIDE	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 UJ(c)
IRON	15400.00 L(m)	224.00 L(n)	3550.00 L(m)	1880.00 L(m)	59700.00 L(m)	7610.00 L(m)	8340.00 L(m)
LEAD	10.20	2.00 B	3.20 B	9.40 L(n)	29.20 L(n)	6.20 B	3.20 B
MAGNESIUM	6500.00	18300.00	11400.00	6420.00	23500.00	17700.00	4000.00
MANGANESE	1680.00	72.00	1080.00	68.00	4090.00	642.00	699.00
MERCURY	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
NICKEL	26.00	17.00 U	17.00 U	17.00 U	98.00	28.00	17.00 U
POTASSIUM	2860.00	1580.00	1300.00	23200.00	9690.00	1640.00	10900.00
SELENIUM	5.00 U	5.00 U	5.00 U	5.00 U	5.00 UL(p)	5.00 U	5.00 U
SILVER	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U
SODIUM	9100.00	13000.00	7660.00	18500.00	14700.00	9570.00	28900.00
THALLIUM	2.00 UL(m)	2.00 UL(m)	2.00 UL(m)	2.00 U	2.00 U	2.00 U	2.00 U
VANADIUM	20.00 B	6.00 B	10.00 B	6.00	79.00	13.00	5.00 U
ZINC	51.00	20.00 B	29.00	28.00	127.00	4.00 U	129.00

SAMPLE ID NUMBER:	TWMW21	TWMW22	TWMW23	TWMW23-D	TWMW24	TWMW25	TWMW26
SAMPLE TYPE:	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL
UNITS:	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
COMPOUND							
ALUMINUM	3540.00	59.00 U	404.00 B	689.00 B	3190.00	5500.00	363.00 B
ANTIMONY	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U
ARSENIC	6.50	2.00 UL(p)	2.00 UL(p)	2.00 U	2.00 U	2.00 U	2.00 U
BARIUM	127.00	75.00	582.00	897.00	75.00	362.00	108.00
BERYLLIUM	5.00 B	5.00 B	5.00 B	5.00 B	5.00 B	5.00 B	5.00 B
CADMIUM	3.00 U	4.00 B	3.00 U	3.00 U	3.00 U	3.00 B	3.00 U
CALCIUM	25600.00	20300.00	67500.00	74100.00	27200.00	54000.00	49200.00
CHROMIUM	11.00 B	12.00 B	8.00 B	12.00 B	13.00 B	13.00 B	58.00
COBALT	26.00 B	9.00 B	7.00 B	22.00 B	9.00 B	13.00 B	12.00 B
COPPER	11.00 B	5.00 B	5.00 B	12.00 B	5.00 B	15.00 B	5.00 B
CYANIDE	10.00 U	10.00 U	10.00 UJ(c)	10.00 UJ(c)	10.00 UJ(c)	10.00 UJ(c)	10.00 UJ(c)
IRON	6560.00 L(m)	10200.00 L(m)	774.00 L(n)	1790.00 L(m)	3800.00 L(m)	8900.00 L(m)	422.00 L(n)
LEAD	7.00 B	3.80 B	3.40 B	13.30 L(n)	3.20 B	3.30 B	1.80 B
MAGNESIUM	9700.00	10100.00	20900.00	22800.00	13500.00	24500.00	17300.00
MANGANESE	536.00	160.00	3330.00	15800.00	145.00	974.00	89.00
MERCURY	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
NICKEL	26.00	17.00	17.00 U	17.00 U	17.00 U	19.00	18.00
POTASSIUM	1680.00	1220.00	686.00	949.00	1170.00	2890.00	1450.00
SELENIUM	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U
SILVER	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U
SODIUM	12300.00	14600.00	10500.00	11100.00	12600.00	14200.00	20600.00
THALLIUM	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 UL(p)
VANADIUM	9.00	5.00 U	5.00 U	6.00	6.00	11.00	5.00 U
ZINC	12.00	13.00	8.00	22.00	17.00	28.00	24.00

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SAMPLE ID NUMBER:	TWMW27	TWMW28	TWMW29	TWMW30	TWMW31	TWMW31-D	TWMW32
SAMPLE TYPE:	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL
UNITS:	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
COMPOUND							
ALUMINUM	33300.00	423.00 B	6570.00	8540.00	183.00 B	8080.00	854.00
ANTIMONY	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U
ARSENIC	9.80	2.00 U	2.10	3.10	2.00 U	8.00	2.00 U
BARIUM	583.00	337.00	588.00	183.00	38.00	457.00	56.00
BERYLLIUM	5.00 B	3.00 B	3.00 B	3.00 B	5.00 B	5.00 B	5.00 B
CADMIUM	3.00 B	3.00 B	3.00 B	4.00 B	3.00 B	63.00 K(i)	7.00 B
CALCIUM	46900.00	38100.00	48700.00	54600.00	53800.00	263000.00	54600.00
CHROMIUM	17.00 B	11.00 B	11.00 B	24.00 B	9.00 B	45.00 B	60.00
COBALT	11.00 B	15.00 B	6.00 B	15.00 B	6.00 U	17.00 B	13.00 B
COPPER	90.00	11.00 B	37.00	14.00 B	8.00 B	82.00 K(i)	24.00 B
CYANIDE	10.00 UJ(c)	10.00 UJ(c)	10.00 UJ(c)	10.00 UJ(c)	10.00 U	10.00 U	10.00 U
IRON	18200.00 L(m)	7430.00 L(m)	7200.00 L(m)	19800.00 L(m)	7560.00	345000.00 L(m)	24900.00
LEAD	98.00	15.20 L(n)	8.40 B	8.00 B	16.70 L(n)	426.00 L(m)	25.80 L(n)
MAGNESIUM	28000.00	19500.00	22500.00	31400.00	23600.00	54800.00	16800.00
MANGANESE	615.00	72.00	973.00	4830.00	100.00	2970.00	2000.00
MERCURY	0.41	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
NICKEL	17.00 U	17.00 U	17.00 U	28.00	17.00 U	44.00 B	105.00
POTASSIUM	2260.00	1030.00	2380.00	4520.00	2170.00	2570.00	3360.00
SELENIUM	5.00 UL(p)	5.00 U	5.00 U	5.00 U	5.00 R(m)	5.00 R(m)	5.00 R(m)
SILVER	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U
SODIUM	16200.00	12900.00	12200.00	55900.00	33000.00	36800.00 K(i)	29000.00
THALLIUM	2.00 UL(p)	2.00 UL(p)	2.00 UL(p)	2.00 UL(p)	2.00 UL(m,p)	2.00 UL(m,p)	2.00 UL(m,p)
VANADIUM	14.00	5.00 U	13.00	14.00	5.00 B	90.00 K(i)	7.00 B
ZINC	156.00	22.00	22.00	117.00	53.00	1100.00	68.00

SAMPLE ID NUMBER:	TWMW33	TWMW34	TWMW35	TWMW36	TWMW37	TWMW38	TWMW39
SAMPLE TYPE:	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL
UNITS:	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
COMPOUND							
ALUMINUM	1210.00	1470.00	112.00 B	9990.00	2880.00	158000.00	1410.00
ANTIMONY	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U	49.00 U
ARSENIC	2.00 U	4.10	2.00 U	2.00 U	2.00 U	67.50	3.30
BARIUM	146.00	84.00	224.00	219.00	96.00	1040.00	119.00
BERYLLIUM	5.00 B	5.00 B	5.00 B	5.00 B	5.00 B	15.00 B	5.00 B
CADMIUM	8.00 B	3.00 U	3.00 U	5.00 B	3.00 B	33.00 K(i)	11.00 B
CALCIUM	58500.00	93800.00	37400.00	40400.00	28100.00	141000.00	56000.00
CHROMIUM	25.00 B	12.00 B	7.00 B	37.00 B	31.00 B	76.00	60.00
COBALT	7.00 B	6.00 U	6.00 U	11.00 B	8.00 B	44.00 K(i)	9.00 B
COPPER	19.00 B	5.00 B	4.00 B	36.00	7.00 B	109.00 K(i)	32.00
CYANIDE	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U
IRON	30600.00	3510.00	138.00 B	13800.00	4590.00	113000.00	57100.00
LEAD	11.30 L(n)	5.20 L(n)	1.80 L(n)	7.40 L(n)	5.60 L(n)	325.00 L(m)	13.50 L(n)
MAGNESIUM	17600.00	12300.00	13300.00	17800.00	11500.00	68500.00	17100.00
MANGANESE	633.00	80.00	307.00	1210.00	107.00	3870.00	728.00
MERCURY	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
NICKEL	26.00 B	18.00 B	17.00 U	25.00 B	27.00 B	121.00 K(i)	32.00 B
POTASSIUM	1280.00	8690.00	1770.00	2980.00	5370.00	9110.00	1370.00
SELENIUM	5.00 R(m)	5.00 R(m)	5.00 R(m)	5.00 R(m)	5.00 R(m)	5.00 R(m)	5.00 R(m)
SILVER	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U
SODIUM	18700.00	48200.00	11100.00	24900.00	19600.00	42500.00 K(i)	19700.00
THALLIUM	2.00 UL(m,p)	2.00 UL(m,p)	2.00 UL(m,p)	2.00 UL(m)	2.00 UL(m,p)	2.00 UL(m,p)	2.00 UL(m,p)
VANADIUM	11.00 B	9.00 B	5.00 B	24.00 B	9.00 B	101.00 K(i)	22.00 B
ZINC	1660.00	26.00 B	16.00 B	31.00 B	61.00	516.00	67.00

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SAMPLE ID NUMBER:	TWMW39-D	TWMW40	TWMW41	TWMW42	TWMW43	TWMW44	TWMW45
SAMPLE TYPE:	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL
UNITS:	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
COMPOUND							
ALUMINUM	1820.00	3460.00	59.00 U	16200.00	75.00 B	9860.00	1390.00
ANTIMONY	49.00 U	49.00 U	49.00 U	490.00 U	49.00 U	49.00 U	49.00 U
ARSENIC	4.10	2.00 U	2.00 UL(p)	9.60	2.00 U	4.20	2.00 U
BARIUM	128.00	203.00	224.00	4620.00	47.00	486.00	761.00
BERYLLIUM	4.00 B	5.00 B	4.00 B	5.00 B	4.00 B	3.00 B	3.00 B
CADMIUM	12.00 B	3.00 U	3.00 U	12.00 B	3.00 B	9.00 B	3.00 B
CALCIUM	59900.00	20800.00	30900.00	52700.00	47000.00	49800.00	47300.00
CHROMIUM	62.00	11.00 B	8.00 B	47.00 B	47.00 B	76.00	5.00 B
COBALT	9.00 B	6.00 U	6.00 U	118.00	9.00 B	17.00 B	8.00 B
COPPER	29.00	13.00 B	4.00 U	1660.00	5.00 B	42.00	10.00 B
CYANIDE	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U
IRON	58600.00	3060.00	4330.00 J(d)	26400.00 J(d)	7010.00 J(d)	31700.00 J(d)	2070.00 J(d)
LEAD	16.70 L(n)	3.80 L(n)	5.00	233.00	1.20	36.50	2.40
MAGNESIUM	16800.00	6280.00	9080.00	25200.00	20400.00	24400.00	10100.00
MANGANESE	773.00	351.00	53.00	32100.00	85.00	4910.00	434.00
MERCURY	0.20 U	0.20 U	0.20 R(m)	0.67 L(m)	0.20 R(m)	0.20 R(m)	0.20 R(m)
NICKEL	35.00 B	19.00 B	17.00 U	111.00	26.00	40.00	17.00 U
POTASSIUM	1240.00	1270.00	1970.00 B	3560.00	3030.00	3220.00	1310.00 B
SELENIUM	5.00 R(m)	5.00 R(m)	5.00 UL(p)	5.00 U	5.00 U	5.00 U	5.00 U
SILVER	10.00 U	10.00 U	10.00 U	20.00	10.00 U	10.00 U	10.00 U
SODIUM	19100.00	9530.00	10900.00	13900.00	31400.00	31300.00	10300.00
THALLIUM	2.00 UL(m)	2.00 UL(m,p)	2.00 UL(m)	2.00 UL(m,p)	2.00 UL(m)	2.40 B	2.00 UL(m)
VANADIUM	13.00 B	7.00 B	5.00 U	53.00	5.00 U	22.00	5.00 U
ZINC	73.00	42.00	9.00 B	1010.00	12.00 B	135.00	12.00 B

SAMPLE ID NUMBER:	TWMW45-D	TWMW46	TWSB01	TWSB02	TWSB02-D	TWSB03	TWSB04
SAMPLE TYPE:	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL
UNITS:	ug/L	ug/L	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
COMPOUND							
ALUMINUM	2680.00	3070.00	16600.00	14600.00	15200.00	11700.00	19200.00
ANTIMONY	49.00 U	49.00 U	10.80 UL(m)	10.90 UL(m)	62.50 L(m)	13.00 B	11.30 UL(m)
ARSENIC	2.00 U	2.00 U	4.80 B	8.40 J(c)	12.10 J(c)	2.70 B	5.30 B
BARIUM	711.00	302.00	71.60 B	722.00	824.00	459.00	74.70 B
BERYLLIUM	3.00 B	3.00 B	0.88 B	1.10 B	1.20 B	1.10 B	1.20 B
CADMIUM	3.00 U	3.00 U	2.70 B	22.60 L(m)	22.20 L(m)	18.40 L(m)	3.00 B
CALCIUM	42100.00	17200.00	722.00 B	28700.00 B	28700.00 B	8850.00 B	2090.00 B
CHROMIUM	11.00 B	5.00 U	28.10 K(m)	97.00 K(m)	211.00 K(m)	47.30 K(m)	29.30 K(m)
COBALT	7.00 B	11.00 B	11.00	13.50	15.00	12.20	8.10 B
COPPER	11.00 B	18.00 B	9.70 B	4690.00	2160.00	278.00	13.10 B
CYANIDE	10.00 U	10.00 U	1.50 U	2.10 U	1.60 U	1.80 U	1.70 U
IRON	4500.00 J(d)	3710.00 J(d)	24300.00	62500.00	79400.00	32900.00	29800.00
LEAD	3.20	2.20	11.80	904.00 J(c,p)	15.10	466.00	16.80
MAGNESIUM	9150.00	5810.00	2380.00 B	7570.00 B	9160.00 B	5250.00 B	3300.00 B
MANGANESE	500.00	1290.00	512.00	1180.00	1850.00	662.00	454.00
MERCURY	0.20 R(m)	0.20 R(m)	0.11 U	2.40	2.60	4.70	0.11 U
NICKEL	17.00	19.00	12.80	109.00	179.00	22.50	11.10
POTASSIUM	1440.00 B	1600.00 B	892.00	1200.00	1090.00	1060.00	1070.00
SELENIUM	5.00 U	5.00 U	1.10 UJ(c)	1.20 UJ(c)	1.10 UJ(c)	1.10 UJ(c)	1.10 UJ(c)
SILVER	10.00 U	10.00 U	2.20 U	98.10	67.10	24.00	2.30 U
SODIUM	9940.00	6980.00	910.00 B	2470.00 B	2310.00 B	1320.00 B	1140.00
THALLIUM	2.00 UL(m)	2.80 B	0.45 UL(n)	0.49 UL(n)	0.46 UL(n)	0.42 UL(n)	0.42 UL(n)
VANADIUM	9.00	7.00	34.70	42.80	41.10	38.10	40.30
ZINC	20.00 B	15.00 B	35.80 B	4890.00	2920.00	3040.00	41.70 B

SITE: WARMINSTER NAVAL BASE
CASE 3933, SDG W-OS-01
LABORATORY: CEIMIC CORPORATION

AQUEOUS METAL ANALYSES (UG/L)

CLIENT ID:			W-OS-01		W-OS-01-D		W-OS-02		W-OS-03		W-OS-04		W-SW-07	
LAB ID:			00397-01S		00397-02S		00397-03S		00397-04S		00397-14S		00397-08S	
ANALYTE	CRDL	IDL												
Aluminum	200	59.0	75.0	B	97.0	B	93.0	B	104	B	61.0	B	113	B
Antimony	60	49.0	49.0	U	49.0	U	49.0	U	49.0	U	49.0	U	49.0	U
Arsenic	10	3.0	3.0	U	3.0	U	3.4		4.3		3.2		3.0	U
Barium	200	21.0	238		251		216		374		214		90.0	
Beryllium	5	1.0	4.0	B	5.0	B	5.0	B	4.0	B	4.0	B	3.0	B
Cadmium	5	3.0	5.0	B	3.0	B	4.0	B	3.0	UJ(d)	3.0	UJ(d)	3.0	UJ(d)
Calcium	5000	17.0	47900	J(o)	49500	J(o)	55000	J(o)	35900	J(o)	34600	J(o)	23000	J(o)
Chromium	10	5.0	28.0	B	30.0	B	5.0	U	5.0	U	7.0	B	6.0	B
Cobalt	50	6.0	6.0	U	6.0	U	6.0	U	6.0	U	6.0	U	6.0	U
Copper	25	4.0	6.0	B	6.0	B	8.0	B	30.0	B	6.0	B	4.0	B
Iron	100	10.0	10.0	U	53.0	B	13.0	B	13.0	B	10.0	U	18.0	B
Lead	3	1.0	15.8	J(m,n)	31.2	K(m)	2.6	B	1.0	UL(n)	1.0	UL(n)	1.0	UL(n)
Magnesium	5000	40.0	11100	J(o)	11800	J(o)	15100	J(o)	14000	J(o)	11300	J(o)	8550	J(o)
Manganese	15	1.0	10.0		10.0		33.0		1.0	B	25.0		49.0	
Mercury	0.2	0.20	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
Nickel	40	17.0	17.0	U	17.0	U	17.0	U	17.0	U	17.0	U	17.0	U
Potassium	5000	383	1600	B	1380	B	2190	B	1030	B	1400	B	1320	B
Selenium	5	5.0	5.0	U	5.0	U	5.0	U	5.0	UL(p)	5.0	U	5.0	U
Silver	10	10.0	10.0	U	10.0	U	10.0	U	10.0	U	10.0	U	10.0	U
Sodium	5000	50.0	12700		12000		12200		7810		8970		12100	
Thallium	10	2.0	2.0	UL(p)	2.0	U	2.0	UL(p)	2.0	UL(p)	2.0	U	2.0	UL(p)
Vanadium	50	5.0	5.0	U	5.0	U	5.0	B	5.0	U	5.0	B	5.0	U
Zinc	20	4.0	41.0		50.0		20.0	B	22.0		13.0	B	13.0	B

Data Qualifier Key:

U	-	Value is a nondetect as reported by the laboratory.
B	-	Positive result is considered to be a false positive due to blank contamination.
K(m)	-	Positive sample result is considered to be biased high due to high matrix spike recovery.
J(o)	-	Positive result is considered to be estimated due to ICP serial dilution %D > 10%.
J(m,n)	-	Positive result is considered to be estimated due to negative laboratory blank concentrations and high matrix spike recovery.
UJ(o)	-	Nondetect is considered to be estimated due to ICP serial dilution %D > 10%.
UJ(d)	-	Nondetect is considered to be estimated due to laboratory duplicate imprecision.
UL(n)	-	Nondetect is considered to be biased low due to negative laboratory blank concentrations.
UL(p)	-	Nondetect is considered to be biased low due to low GFAA PDS recovery.

SITE: WARMINSTER NAVAL BASE
CASE 3933, SDG TW-OS-01
LABORATORY: CEIMIC CORPORATION

AQUEOUS METAL ANALYSES (UG/L)

CLIENT ID:			TW-OS-01		TW-OS-01-D		TW-OS-02		TW-OS-03		TW-OS-04		TW-SW-07	
LAB ID:			01397-01S		01397-02S		01397-03S		01397-04S		01397-14S		01397-08S	
ANALYTE	CRDL	IDL												
Aluminum	200	59.0	59.0	U	62.0	B	69.0	U	69.0	U	69.0	U	87.0	B
Antimony	60	49.0	49.0	U	49.0	U	49.0	U	49.0	U	49.0	U	49.0	U
Arsenic	10	3.0	3.0	U	7.4	L(p)	3.7		3.0	U	4.6		3.0	U
Barium	200	21.0	243		243		216		376		209		92.0	
Beryllium	5	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
Cadmium	5	3.0	3.0	U	3.0	U	3.0	U	3.0	B	3.0	U	3.0	U
Calcium	5000	17.0	49800		46600		54200		35800		33200		22600	
Chromium	10	5.0	29.0	B	27.0	B	5.0	B	5.0	U	5.0	U	8.0	B
Cobalt	50	6.0	6.0	U	6.0	U	6.0	U	6.0	U	6.0	U	6.0	U
Copper	25	4.0	30.0	B	131		11.0	B	41.0		8.0	B	9.0	B
Iron	100	10.0	47.0	B	147	B	39.0	B	86.0	B	43.0	B	388	
Lead	3	1.0	203	J(d)	732.7	J(d)	1.4	B	2.6	B	1.0	UJ(d,n)	3.0	B
Magnesium	5000	40.0	12300		11600		15800		14800		12100		9030	
Manganese	15	1.0	13.0		92.0		41.0		1.0	B	26.0		55.0	
Mercury	0.2	0.20	0.20	R(m)	0.20	R(m)	0.20	R(m)	0.20	R(m)	0.20	R(m)	0.20	R(m)
Nickel	40	17.0	17.0	U	17.0	U	17.0	U	17.0	U	17.0	U	20.0	
Potassium	5000	383.0	1380		1340		2080		705		1200		1180	
Selenium	5	5.0	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
Silver	10	10.0	10.0	U	10.0	U	10.0	U	10.0	U	10.0	U	10.0	U
Sodium	5000	50.0	14200		13600		14000		8950		10200		13600	
Thallium	10	2.0	2.0	UL(m,p)	2.0	UL(m,p)	2.0	UL(m,p)	2.0	UL(m)	2.0	UL(m)	2.0	UL(m)
Vanadium	50	5.0	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
Zinc	20	4.0	58.0		82.0		9.0	B	23.0	B	23.0	B	19.0	B
Cyanide	10	10.0	10.0	U	10.0	U	10.0	U	10.0	U	10.0	U	10.0	U

Data Qualifier Key:

U	-	Value is a nondetect as reported by the laboratory.
B	-	Positive result is considered to be a false positive due to blank contamination.
R(m)	-	The nondetect is rejected and considered unreliable due to extremely low matrix spike recovery.
K(m)	-	Positive result is considered biased high due to high matrix spike recovery.
L(p)	-	The positive result is considered biased low due to low GFAA PDS recovery.
J(d)	-	The positive result is estimated due to laboratory duplicate imprecision.
J(d,n)	-	Positive result is estimated due to laboratory duplicate imprecision and negative blank concentrations.
UL(m)	-	Nondetect is considered biased low due to low matrix spike recovery.
UL(p)	-	Nondetect is biased low due to low GFAA PDS recovery.
UL(m,p)	-	The nondetect is considered biased low due to low matrix spike and GFAA PDS recoveries.
UJ(d,n)	-	Nondetect is estimated due to laboratory duplicate imprecision and negative blank concentrations.

APPENDIX L

DATA VALIDATION SUMMARIES

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-2-2-155

TO: NEIL TEAMERSON **DATE:** MARCH 25, 1992

FROM: DWAYNE S. MOCK **COPIES:** D. A. SCHEIB

SUBJECT: ORGANIC DATA VALIDATION - VOA/BNA/PEST/PCB
WARMINSTER NAVAL BASE
CASE NO. 9710-40004

SAMPLES:

Rinsate Blank
Trip Blank
Field Blank-Tap
Field Blank-DI

1-Sediment	2-Sediment	2-Sediment-D	3-Sediment
4-Sediment	5-Sediment	6-Sediment	8-Sediment

1-S. water	2-S. Water	2-S. Water-D	3-S. Water
5-S. Water	6-S. Water	7-S. Water	8-S. Water

<u>NADC-S1</u>-

65-Rinsate Blank

64-DG-1 66-Well-C

<u>NADC-S2</u>-

20-Rinsate Blank
27-Field Blank
30-Rinsate Blank
21-Trip Blank
28-Field Blank
31-Trip Blank

23-BG-4	22-BG4-D	24-BG-3	25-D
26-DG-25	32-DG-12	76-DG-24	77-DG-23
63-Well-E			

<u>NADC-S3</u>-

60-DG-13 61-DG-13-D 62-DG-3

NADC-S4-

38-Trip Blank		40-Rinsate Blank	
45-Trip Blank		46-Rinsate Blank	
52-Trip Blank		53-Rinsate Blank	
33-DG-28	34-DG-15	35-DG-6	36-DG-16
37-DG-9	39-DG-18	68-BG-6	42-DG-4
43-DG-5	44-DG-7	67-BG-2	54-DG-27
73-DG-22-D	74-DG-24	78-DG-22-D	

NADC-S5-

50-DG-8	51-DG-20	54-DG-27	55-DG-21

NADC-S6-

69-BG-7	47-DG-19	48-DG-17	41-DG-10

NADC-S7-

57-Trip Blank		59-Rinsate Blank
56-DG-25	58-DG-25-D	

NADC-S8-

70-Trip Blank		71-Trip Blank
72-Rinsate Blank		
75-DG-14	49-BG-5	

Overview

The sample set for the Warminster site, Case No. 9710-40004, consists of eight (8) sediment samples, fifty one (51) aqueous samples, and twenty-two (22) associated field quality control blanks (i.e. four field blanks, nine trip blanks and nine rinsate blanks). These samples were analyzed for full Target Compound List (TCL) organics (i.e. volatiles, semivolatiles, pesticides, PCBs), with the exception of the nine trip blanks, which were analyzed for volatile organic compounds only. Eight field duplicate pairs were included with this sample set.

The samples were collected by SMC Environmental Services Group from 11/28/91 to 11/29/91 and analyzed by RMC Environmental Chemistry Laboratories under Naval Energy and Environmental Support Activity (NEESA) Level C Quality Assurance/Quality Control (QA/QC) criteria.

All analyses were conducted using Contract Laboratory Program (CLP) Statement of Work (SOW) 2/88 analytical and reporting protocols.

Summary

All compounds were successfully analyzed, with the exception of those results qualified as unreliable, (R). The findings offered in this report are based upon a general review of all available data including data completeness, holding times until extraction/analysis, GC/MS tuning and calibration data, laboratory and field blank results, surrogate recoveries, matrix spike/matrix spike duplicate results, internal standards performance, field duplicate precision, compound identification and compound quantitation.

Areas of concern with respect to data quality are listed below.

Major Problems

- Some initial and continuing calibration Response Factors (RFs) for 2-butanone were less than 0.050. Failure to meet this quality control criterion indicates that the laboratory's instruments could not achieve satisfactory sensitivity for this compound, and therefore, the associated detection limit for this compound is severely compromised. Nondetects for this compound in affected samples are considered to be unreliable and are rejected, qualified (R). These results are biased very low.

- The laboratory had considerable difficulty calibrating for the pesticide compound 4,4'-DDT, on both the first and second analytical columns. In many instances, the laboratory simply cited the presence of interferences and did not calculate a continuing calibration Percent Difference (%D) for thiscompound. Based on the unreliability of the pesticide fraction data for 4,4'-DDT, all sample results for this compound are considered to be unreliable and are rejected,

qualified (R); no positive results were reported. The bias of these sample results cannot be determined.

- Samples NADC-S2-27-FB and NADC-S2-76-DG-24 and subsequent re-extractions/reanalyses of these samples, have semivolatile acid fraction surrogate Percent Recoveries (%Rs) < 10%. Such low acid-fraction surrogate recoveries indicate the presence of matrix interferences which mask/hinder the detection of these compounds. All results for acid-fraction compounds in these samples are considered to be unreliable and are rejected, qualified, (R). These results are biased extremely low.

- Pesticide-fraction Matrix Spike/Matrix Spike Duplicate (MS/MSD) recoveries were extremely low for several compounds of the spiked sample 2-Sediment-D. Nondetects reported for these compounds in the unspiked sample were rejected, qualified (R); no positive results were reported for these compounds.

Minor Problems

- Some initial calibration Relative Standard Deviations (%RSDs) for acetone exceeded 50%. Additionally, some continuing calibration Percent Differences (%Ds) for acetone, methylene chloride, m-xylene, 2-hexanone, vinyl acetate, 4-nitroaniline and benzidine exceeded 50%. Failure to meet these calibration quality control criteria indicates that the laboratory's instrumental responses for these compounds were inconsistent, and consequently, the quantitation of these compounds may not be accurate. Positive sample results (not qualified because of blank contamination), and nondetects for these compounds in affected samples are qualified as estimated,(J) and (UJ), respectively. The bias for these results cannot be determined.

- Some continuing calibration %Ds for 1,2-dichlorobenzene and diethylphthalate exceeded 25%, indicating that the laboratory's instrumental responses for these compounds were inconsistent, and that, therefore, the quantitation of these compounds may not be accurate. Positive results for these compounds are qualified as estimated, (J), in affected samples; the bias of these results cannot be determined. No data qualification is

necessary for associated nondetects for these affected compounds, as the calibration non-compliances were not severe enough to compromise the compounds' detection limits.

- Some continuing calibration %Ds for endosulfan I, 4,4'-DDD, heptachlor epoxide, heptachlor, methoxychlor, 4,4'-DDE, delta BHC and endosulfan sulfate on both the 1st-column and/or 2nd-column exceeded 50%. Hence, the accuracy of the detection limits and exact quantitation of these compounds is uncertain. No positive results were reported for the affected compounds in any sample; affected nondetects are qualified as estimated, (UJ). The bias for these results cannot be determined.

- Maximum concentrations of methylene chloride (8 ug/L), acetone (35 ug/L) and chloroform (2 ug/L) were found in the laboratory method blanks; and a higher concentration (16 ug/L) methylene chloride was found in a field quality control blank. An action level of 80 ug/L methylene chloride was used to evaluate the field quality control blank data, as field quality control blanks are qualified based on laboratory method blank data only. An action level of 160 ug/L methylene chloride was used to evaluate the environmental sample data. Action levels of 350 ug/L acetone and 10 ug/L chloroform were used to evaluate all samples in this data set.

  Additionally, maximum amounts of toluene (13 ug/L), bromodichloromethane (7 ug/L), 1,1,1-trichloroethane (0.6 ug/L), bromoform (1 ug/L), tetrachloroethene (2 ug/L), trichloroethene (0.4 ug/L), trichlorofluoromethane (3 ug/L) and dibromochloromethane (30 ug/L) were detected in the field quality control blanks. Action levels of 5X these maximum contaminant amounts were used to evaluate the environmental sample data.

  Maximum concentrations of di-n-butylphthalate (0.9 ug/L; and 49 ug/Kg) and bis(2-ethylhexyl)phthalate (15 ug/L) were found in the laboratory method blanks.

  An action level of 150 ug/L bis(2-ethylhexyl)phthalate was used to evaluate the field quality control blank data, as this data is qualified only on the basis of laboratory method blank data. A maximum concentration of 92 ug/L was detected for bis(2-ethylhexyl)phthalate

in a field quality control blank. A corresponding action level of 920 ug/L was used to evaluate the aqueous environmental samples.

Also, action levels of 9 ug/L (490 ug/Kg) di-n-butylphthalate were used to evaluate all samples in this data set.

Sample results for these contaminants reported at concentrations less than the respective action level, are qualified, (B). These results are considered to be false positives, and are, therefore, biased high. No actions were taken for bromoform because no positive results were reported for bromoform in any sample.

- Sample 1-Sediment has volatile surrogate Percent Recoveries (%Rs) outside of quality control limits. Because one surrogate recovery (toluene-d8; 122%) was high for this sample, and one surrogate recovery (bromofluorobenzene; 70%) was low, the bias for results reported for this sample cannot be determined. Positive results and nondetects for all compounds in this sample are qualified as estimated, (J) and (UJ), respectively.

- Dibutylchlorendate pesticide surrogate recoveries for the following samples were below the lower advisory limit:

5-Sediment	1-Sediment	3-Surface Water
NADC-S2-25-D	NADC-S4-44-DG-7	NADC-Rinsate-59
NADC-S3-62-DG-3	NADC-S1-64-DG-1	NADC-S5-50-DG-8
NADC-Rinsate-65	NADC-S4-67-BG-2	NADC-S4-73-DG-22
NADC-S4-74-DG-24	NADC-S2-76-DG-2	NADC-Rinsate-46

Poor surrogate recovery indicates the presence of matrix interferences which mask/hinder the detection of target compounds. Positive results and nondetects for all compounds in the affected samples are considered to be biased low, and are qualified, (L) and (UL), accordingly.

- Sample 1-Sediment has volatile internal standard areas outside of quality control limits, and samples 3-Sediment, S2-27-Field Blank and S4-37-DG-9 have semivolatile internal standard areas outside of quality control limits. Poor internal standards performance causes the quantitation of all compounds associated

with the failed internal standards to be inaccurate. Positive results and nondetects for compounds quantitated using the failed internal standards have been qualified as estimated, (J) and (UJ), respectively, in the affected sample. Bias for these results cannot be determined.

- Positive results for some compounds in some samples are qualified as estimated, (J), because they are reported at concentrations below the Contract Required Quantitation Limit (CRQL), and hence, they are not reported with 99% confidence.

Notes

Some initial calibration %RSDs for several compounds exceeded the 30% quality control limit. Only associated positive results are affected since the noncompliances are not severe enough to impact the associated nondetects. No data qualifications were required, however, because the only positive results affected were qualified based on blank contamination.

Continuing calibration %Ds for several volatile and semivolatile compounds exceeded the 25% quality control limit. Only associated positive results are affected since the noncompliances are not severe enough to impact the associated nondetects. No actions were required since the only affected positive results, those of acetone and bis(2-ethylhexyl)phthalate, are qualified based on blank contamination.

Some other pesticide-fraction MS/MSD recoveries exceeded the upper quality control limits for several compounds. No data qualifications were made, however, because no positive results were reported for these compounds in the unspiked sample, and associated nondetects are not compromised.

An MS/MSD Relative Percent Difference (RPD) for aldrin exceeded the quality control limit. No qualifications were made for the associated unspiked sample data, however, because both the MS and MSD recoveries for this compound were within acceptable limits.

Several samples have one base-neutral and/or one acid fraction surrogate recovery outside of quality control limits. In accordance with validation protocol, no action is required.

Tables summarizing the results reported for field duplicate pairs are presented in the attached HNUS Navy CLEAN Data Validation Worksheets (Appendix D.)

The attached Table 1 presents a summary of Tentatively Identified Compounds (TICs) which remain after data validation qualification.

No other items were noted.

Executive Summary

The data are acceptable for use as qualified. Some calibration RFs were less than the minimum quality control criterion causing rejection of some data. The calibration of pesticide compound 4,4'-DDT could not be successfully achieved due to interferences, resulting in rejection of this data. A few semivolatile surrogate recoveries were extremely low resulting in rejection of some data. Several matrix spike recoveries in one sample were extremely low causing some data for the unspiked sample to be rejected.

Several volatile and semivolatile organic compounds were found as contaminants in the laboratory method and field quality control blanks. Some calibration %RSDs of the volatile fraction and %Ds in all fractions exceeded quality control limits, therefore, associated sample results were estimated. Some internal standard areas were below the lower quality control limits, thus, associated sample results were estimated. Some surrogate recoveries were non-compliant resulting in the estimation of various sample results. Positive results for several compounds are estimated since they are reported at concentrations below the CRQL.

The data for these analyses were reviewed with reference to the "National Functional Guidelines for Organic Data Validation" (2/88), as amended for use within USEPA Region III, and the NEESA document entitled "Sampling and Chemical Analysis Quality Assurance requirements for the Navy Installation Restoration Program".

The text of this report has been formulated to address only those problem areas affecting data quality. Documentation of compliance for non-problem areas is presented in the attached Appendix D (HNUS Navy CLEAN Data Validation Worksheets.)

"I attest that the data referenced herein was validated according to the agreed upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

Dwayne S. Mock FOR

Dwayne S. Mock

HALLIBURTON NUS

Data Reviewer

Debra A. Scheib

HALLIBURTON NUS

Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results.
2. Appendix B - Results as Reported by the Laboratory.
3. Appendix C - Results of all Tentatively Identified Compounds (TICs) which have been corrected to exclude analytical artifacts.
4. Appendix D - HNUS Navy CLEAN Data Validation Worksheets.
6. Appendix E - Support Documentation.

cc: D. Scheib

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-2-2-156

TO: NEIL TEAMERSON **DATE:** MARCH 25, 1992

FROM: DWAYNE S. MOCK **COPIES:** D. A. SCHEIB

SUBJECT: INORGANIC DATA VALIDATION - TAL METALS
WARMINSTER NAVAL BASE
CASE NO. 9710-40004

SAMPLES:

Rinsate Blank
Field Blank-DI
Field Blank-Tap

1-Sediment	2-Sediment	2-Sediment-D	3-Sediment
4-Sediment	5-Sediment	6-Sediment	8-Sediment
1-S. water	2-S. Water	2-S. Water-D	3-S. Water
5-S. Water	6-S. Water	7-S. Water	8-S. Water

<u>NADC-S1</u>-

65-Rinsate Blank

64-DG-1 66-Well-C

<u>NADC-S2</u>-

20-Rinsate Blank
28-Field Blank-DI
27-Field Blank-TAP
30-Rinsate Blank

23-BG-4	22-BG4-D	24-BG-3	25-D
26-DG-26	32-DG-12	76-DG-2	77-DG-23
63-Well-E			

<u>NADC-S3</u>-

60-DG-13 61-DG-13-D 62-DG-3

NADC-S4-

40-Rinsate Blank 46-Rinsate Blank
53-Rinsate Blank

33-DG-28	34-DG-15	35-DG-6	36-DG-16
37-DG-9	39-DG-18	68-BG-6	42-DG-4
43-DG-5	44-DG-7	67-BG-2	73-DG-22-D
74-DG-24	78-DG-22		

NADC-S5-

50-DG-8	51-DG-20	54-DG-27	55-DG-21

NADC-S6-

69-BG-7	47-DG-19	48-DG-17	41-DG-10

NADC-S7-

59-Rinsate Blank

56-DG-25 58-DG-25-D

NADC-S8-

72-Rinsate Blank

75-DG-14 49-BG-5

Overview

The sample set for the Warminster site, Case No. 9710-40004, consists of eight (8) sediment samples, nine (9) aqueous samples, and thirteen (13) associated field quality control blanks (i.e. four field blanks and nine rinsate blanks). These samples were analyzed for Target Analyte List (TAL) Metals. Five field duplicate pairs were included with this sample set.

The samples were collected by SMC Environmental Services Group from 11/28/91 to 11/29/91 and analyzed by RMC Environmental Chemistry Laboratories under Naval Energy and Environmental Support Activity (NEESA) Level C Quality Assurance/Quality Control (QA/QC) criteria.

All analyses were conducted using Contract Laboratory Program (CLP) Statement of Work (SOW) 7/88 analytical and reporting protocols.

Summary

All compounds were successfully analyzed. The findings offered in this report are based upon a general review of all available data including data completeness, holding times until extraction/ analysis, calibration data, laboratory and field blank results, matrix spike/post digestion spike recovery results, laboratory control and ICP interference check sample results, serial dilution results, field duplicate precision, compound identification and compound quantitation.

Areas of concern with respect to data quality are listed below.

Minor Problems

- The continuing calibration Percent Recovery (%R) exceeded the upper quality control limit for vanadium, indicating that the laboratory's instrumental responses for this analyte were inconsistent, and that, therefore, the quantitation of this analyte may not be accurate. Positive results for vanadium are likely to be biased high and are therefore qualified, (K).

- Several analytes were found in associated field quality control blanks. The maximum amounts of these analytes found in the blanks, and the corresponding action levels applied to the data, are listed below:

Analyte	Maximum Concentration	Action Level (mg/L)	Action Level (mg/kg)
barium	0.6	3.0	300
beryllium	0.0007	0.0035	0.35
calcium	70	350	35,000
chromium	0.0007	0.0035	0.35
copper	0.098	0.49	49
iron	0.20	1.0	100
lead	0.003	0.015	1.5
magnesium	26	130	13,000
potassium	4	20	2,000
sodium	24	120	12,000
zinc	0.09	0.45	45

Sample results affected by blank contamination and reported at concentrations less than the action level, are considered to be false positives. These results are qualified, (B).

Notes

In accordance with USEPA Region III data validation protocol, no qualifications are made to the data based on the evaluation of field duplicate precision. Tables summarizing the field duplicate results can be found in the attached HNUS Navy CLEAN data validation worksheets.

No other problems were noted.

Executive Summary

The data are acceptable for use as qualified. The continuing calibration recovery for vanadium was high, and associated sample results were qualified accordingly. Several analytes were found in field quality control blanks.

The data for these analyses were reviewed with reference to the "National Functional Guidelines for Inorganic Data Validation" (7/88), as amended for use within USEPA Region III, and the NEESA document entitled "Sampling and Chemical Analysis Quality Assurance requirements for the Navy Installation Restoration Program".

The text of this report has been formulated to address only those problem areas affecting data quality. Documentation of compliance for non-problem areas is presented in the attached Appendix C HNUS Navy CLEAN Data Validation Worksheets.

"I attest that the data referenced herein was validated according to the agreed upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

Rickey C. DeLand FOR
Dwayne S. Mock

HALLIBURTON NUS
Data Reviewer

Debra A. Scheib

HALLIBURTON NUS
Data Validation Quality
Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results.
2. Appendix B - Results as Reported by the Laboratory.
3. Appendix C - HNUS Navy CLEAN Data Validation Worksheets.
4. Appendix D - Support Documentation.

cc: Deb Scheib

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-10-2-003

TO: NEIL TEAMERSON **DATE:** AUGUST 21, 1992

FROM: ROY COHEN

SUBJECT: ORGANIC DATA VALIDATION - LOW CONCENTRATION ORGANICS
CTO #22, WARMINSTER NAWC, WARMINSTER, PA
CASE NO. 3933, SDG W-SD-05

SAMPLES: 5/Aqueous/

W-624-RB

W-MW-01 W-MW-02 W-MW-03 W-MW-04

Overview

The sample set for the Warminster site, Case No. 3933, SDG W-SD-05 consists of four (4) aqueous environmental samples, and one (1) associated rinsate blank (designated -RB). No field duplicate pairs were included with this analytical data set.

The samples were analyzed for low concentration volatile organic compounds utilizing EPA Method 524.2 as stipulated in the EPA Contract Laboratory Program (CLP) Statement of Work (SOW), OLC01.0. All data and reporting deliverables were presented as specified in SOW OLC01.0.

The samples were collected by HALLIBURTON NUS Environmental Corporation on 6/23/92 and 6/24/92 and analyzed by Ceimic Corporation Laboratories under Naval Energy and Environmental Support Activity (NEESA) Level C Quality Assurance/Quality Control (QA/QC) criteria.

Summary

All compounds were successfully analyzed. The findings offered in this report are based upon a general review of all available data including data completeness, holding times until analysis, GC/MS tuning and calibration data, laboratory and field blank results, surrogate spike recoveries, matrix spike/matrix spike duplicate results, internal standards performance, compound identification and quantitation, and Tentatively Identified Compound (TIC) evaluation.

There were no major or minor problems affecting data quality. All data are accepted without qualification.

Executive Summary

Laboratory Performance: No problems were noted.

Other Factors Affecting Data Quality: No problems were noted.

The data for these analyses were reviewed with reference to the "National Functional Guidelines for Organic Data Validation" (2/88), as amended for use within USEPA Region III, and the NEESA document entitled "Sampling and Chemical Analysis Quality Assurance requirements for the Navy Installation Restoration Program" (6/88).

The text of this report has been formulated to address only those problem areas affecting data quality. Documentation of compliance for non-problem areas is presented in the attached Appendix C (HNUS/CLEAN Data Validation Worksheets).

"I attest that the data referenced herein was validated according to the agreed upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

Kelly A. Johnson for

HALLIBURTON NUS Environmental Corporation

Roy Cohen
Data Reviewer

Debra A. Scheib

HALLIBURTON NUS Environmental Corporation

Debra. A. Scheib
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results (including TICs)
2. Appendix B - Results as Reported by the Laboratory (including TICs)
3. Appendix C - HNUS/CLEAN Data Validation Worksheets

cc: D. Scheib

The data for these analyses were reviewed with reference to the "National Functional Guidelines for Inorganic Data Validation" (7/88), as amended for use within USEPA Region III, and the NEESA document entitled "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program".

The text of this report has been formulated to address only those problem areas affecting data quality. Documentation of compliance for non-problem areas is presented in the attached Appendix C (HNUS/CLEAN Data Validation Worksheets.)

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

HALLIBURTON NUS Environmental Corporation

Jennifer Hubbard
Data Reviewer

HALLIBURTON NUS Environmental Corporation

Debra A. Scheib
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory
3. Appendix C - HNUS/CLEAN Data Validation Worksheets
4. Appendix D - Support Documentation

cc: D. A. Scheib

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-08-2-222

TO: NEIL TEAMERSON **DATE:** AUGUST 25, 1992

FROM: JENNIFER HUBBARD **COPIES:** D. A. SCHEIB

SUBJECT: INORGANIC DATA VALIDATION - TAL METALS (DISSOLVED)
NAWC WARMINSTER
CASE NO. 3933, SDG DWMW17

SAMPLES:

DWMW23

W-

630RB-Filtered Rinsate Blank

MW17	MW18	MW19	MW20	MW21	MW22
MW23	MW24	MW25	MW26	MW27	MW28
MW29	MW30				

Overview

The sample set for the Warminster site, Case No. 3933, SDG DWMW17, consists of fifteen (15) filtered water samples (including one field duplicate pair) and one (1) filtered field quality control blank. These samples were analyzed for dissolved Target Analyte List (TAL) Metals.

The samples were collected by HALLIBURTON NUS on June 29 and June 30, 1992 and analyzed by CEIMIC Laboratories under Naval Energy and Environmental Support Activity (NEESA) Level C Quality Assurance/Quality Control (QA/QC) criteria. All analyses were conducted using Contract Laboratory Program Statement of Work (SOW) 7/88 analytical and reporting protocols.

Summary

All compounds were successfully analyzed. The findings offered in this report are based upon a general review of all available data including data completeness, holding times, calibration data, laboratory and field blank results, matrix and post-digestion spike recovery results, laboratory duplicate results, ICP serial dilution results, laboratory control and ICP interference check sample results, compound identification and compound quantitation.

Areas of concern with respect to data quality are listed below.

Minor Problems

- Several analytes were found in associated laboratory quality control blanks. The maximum amounts of these analytes found in the blanks, and the corresponding action levels applied to the data, are listed below:

Analyte	Maximum Concentration (µg/L)	Action Level (µg/L)
aluminum	90.0	450
beryllium	5.0	25.0
cadmium	3.0	15.0
calcium	184	920
chromium	5.0	25.0
copper	6.0	30.0
iron	21.0	105
lead	2.0	10.0
manganese	1.0	5.0
sodium	65.0	325
vanadium	5.0	25.0

Additionally, zinc, which could not be attributed to laboratory blank contamination, was found in the associated filtered rinsate blank. The maximum value detected and the corresponding action level is shown below.

Analyte	Maximum Concentration (µg/L)	Action Level (µg/L)
zinc	4.0	20.0

Sample results affected by blank contamination and reported at concentrations less than the action level are considered to be false positives. These results are qualified, [coded B]. The rinsate blank was not used to qualify itself. No actions were taken for cadmium and sodium because no positive cadmium results were reported and positive sodium results exceeded the action level.

- Negative concentrations, whose absolute values were > IDL, were reported for barium and lead in the laboratory method blanks. These occurrences are due to poor instrument performance (baseline drifting). Positive results and nondetects for these analytes are qualified as biased low, [coded L(n) and UL(n)], respectively.

- Matrix spike recoveries for manganese and thallium were less than 75%, yet > 30%. Positive results and nondetects for these analytes are qualified as biased low, [coded L(m) and UL(m)], respectively.

- GFAA Post Digestion Spike (PDS) recoveries for thallium in samples WMW22, DWMW23, WMW24, WMW20, WMW25, and WMW26 fell below the lower quality control limit of 85%. These results are qualified as biased low, [coded L(p) and UL(p)], respectively, due to due to possible poor instrument performance and/or sample matrix interferences.

Notes

In accordance with USEPA Region III data validation protocol, no qualifications are made to the sample data based on the evaluation of field duplicate precision. Tables summarizing the field duplicate results can be found in the attached HNUS/CLEAN Data Validation Worksheets (APPENDIX C).

CRDL Standard analysis recoveries for several analytes failed to meet the 80-120% quality control criteria. No actions were taken because qualifications are limited to high concentration samples only via USEPA Region III data validation protocol. All samples in this analytical data set are of low concentration.

Several analytes, which were not supposed to be present in the Interference Check Sample (ICS) Solutions, were detected in these solutions at positive and/or negative concentrations > IDL. Samples did not contain concentrations of interfering analytes comparable to the levels detected in the ICS, therefore, no qualifications were required.

Executive Summary

Laboratory Performance: Several analytes were detected as laboratory method blank contaminants. Negative concentrations were reported for two analytes in the laboratory method blanks. CRDL standard recoveries fell outside QC limits for several analytes.

Other Factors Affecting Data Quality: Matrix spike and GFAA PDS recoveries for some analytes fell outside QC limits.

The data for these analyses were reviewed with reference tot he "National Functional Guidelines for Inorganic Data Validation" (7/88), as amended for use within USEPA Region III, and the NEESA document entitled "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program".

The text of this report has been formulated to address only those problem areas affecting data quality. Documentation of compliance for non-problem areas is presented in the attached Appendix C (HNUS/CLEAN Data Validation Worksheets.)

"I attest that the data referenced herein were validated according to the agreed-upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

HALLIBURTON NUS Environmental Corporation

Jennifer Hubbard
Data Reviewer

HALLIBURTON NUS Environmental Corporation

Debra A. Scheib
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory
3. Appendix C - HNUS/CLEAN Data Validation Worksheets
4. Appendix D - Support Documentation

cc: D. A. Scheib

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-51-4-2-131

TO: NEIL TEAMERSON **DATE:** AUGUST 22, 1992

FROM: ROY COHEN

SUBJECT: ORGANIC DATA VALIDATION - FULL TCL ORGANICS
CTO #22, WARMINSTER NAWC, WARMINSTER, PA
CASE NO. 3933, SDG W-MW-05

SAMPLES: 4/Aqueous/

W-625-TB W-626-RB W-626-TB

W-MW-09

Overview

The sample set for the Warminster site, Case No. 3933, SDG W-MW-05 consists of one (1) aqueous sample, two (2) associated trip blanks (designated -TB), and one associated rinsate blank (designated -RB). The field quality control blanks were analyzed for Target Compound List (TCL) volatile organic compounds only, and the aqueous environmental sample was analyzed for TCL semivolatile and pesticide/PCB compounds only. No field duplicate pairs were included with this analytical data set.

The samples were collected by HALLIBURTON NUS Environmental Corporation on 6/25/92 and 6/26/92 and analyzed by Ceimic Corporation Laboratories under Naval Energy and Environmental Support Activity (NEESA) Level C Quality Assurance/Quality Control (QA/QC) criteria. All analyses were conducted using USEPA Contract Laboratory Program (CLP) Statement of Work (SOW) 3/90 analytical and reporting protocols.

Summary

All compounds were successfully analyzed. The findings offered in this report are based upon a general review of all available data including data completeness, holding times until extraction/analysis, GC/MS tuning and calibration data, laboratory and field blank results, surrogate spike recoveries, matrix spike/matrix spike duplicate results, internal standards performance, compound identification and quantitation, and Tentatively Identified Compound (TIC) evaluation.

Areas of concern with respect to data quality are listed below.

Minor Problems

- The following compounds were found in the laboratory method and field quality control blanks in the maximum concentration indicated:

Compounds	Maximum Concentrations (µg/L)	Action Level (µg/L)
methylene chloride	0.65	6.5
toluene*	51	255
bis(2-ethylhexyl)-phthalate	2	20

* - This maximum concentration was detected in a field quality control blank. The associated action level was used to evaluate the environmental sample data, only.

Positive results for these compounds reported at concentrations less than the respective action levels are qualified, (B). These results are considered to be false positives (artifacts of blank contamination).

- High Percent Differences (i.e. %Ds > 50) were noted between the initial calibration average Relative Response Factor (RRF) and continuing calibration RRFs for carbon disulfide. These occurrences indicate inconsistent instrumental responses which may have compromised compound detection limits. Only nondetects have been reported for carbon disulfide in affected samples, and these results have been qualified as estimated, [coded UJ(c)]. The direction of bias for these impacted results cannot be determined.

- Positive results for several compounds are qualified as estimated [J] since they are reported at concentrations below the Contract Required Quantitation Limit (CRQL).

Notes

There were some continuing calibration Percent Differences (%Ds) greater than 25% for acetone and 2-hexanone. No qualifications to the data are required, however, as this non-compliance only

impacts positive sample results, and there were no positive results reported for these compounds in the affected samples.

The recoveries for the pesticide surrogate decachlorobiphenyl (DCB) were below the advisory limits for sample W-MW-09. However, since the recoveries for the other pesticide surrogate (tetrachloro-m-xylene; TCX) were within the advisory limits for both column analyses for this sample, it was deemed that no qualification of the sample data was warranted based on the poor DCB recoveries.

In accordance with USEPA Region III data validation protocol, no qualifications are made to the data based on field duplicate precision. Tables summarizing the results reported for field duplicate pairs are presented in the attached HNUS/CLEAN Validation Worksheets (Appendix C).

No Tentatively Identified Compounds (TICs) were found for the volatile fraction analyses. Some TICs were detected for the semivolatile fraction analyses.

The TICs presented in the attached Appendix A (Qualified Analytical Results), exclude all TICs identified as laboratory or field quality control blank contaminants, siloxane isomers, aldol condensation products, and any TIC specifically identified as a laboratory artifact. These excluded results are considered to be false positives.

No other problems were noted.

Executive Summary

Laboratory Performance: Some continuing calibration relative response factors exhibited %Ds in excess of 50 percent from the initial calibration average RRF. Some other continuing calibration %Ds exceeded 25% for several other compounds. Several compounds were detected as laboratory blank contaminants.

Other Factors Affecting Data Quality: Several compounds were detected as contaminants in the field quality control blanks. The pesticide/PCB fraction analyses yielded poor surrogate recoveries for DCB.

The data for these analyses were reviewed with reference to the "National Functional Guidelines for Organic Data Validation" (2/88), as amended for use within USEPA Region III, and the NEESA document entitled "Sampling and Chemical Analysis Quality Assurance requirements for the Navy Installation Restoration Program" (6/88).

The text of this report has been formulated to address only those problem areas affecting data quality. Documentation of compliance for non-problem areas is presented in the attached Appendix C (HNUS/CLEAN Data Validation Worksheets).

"I attest that the data referenced herein was validated according to the agreed upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

Kelly A Johnson for

HALLIBURTON NUS Environmental Corporation

Roy Cohen
Data Reviewer

Debra A. Scheib

HALLIBURTON NUS Environmental Corporation

Debra. A. Scheib
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results (including TICs)
2. Appendix B - Results as Reported by the Laboratory (including TICs)
3. Appendix C - HNUS/CLEAN Data Validation Worksheets
4. Appendix D - Support Documentation

cc: D. Scheib

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-10-2-002

TO: NEIL TEAMERSON **DATE:** AUGUST 22, 1992

FROM: ROY COHEN

SUBJECT: ORGANIC DATA VALIDATION - LOW CONCENTRATION VOLATILES
CTO #22, WARMINSTER NAWC, WARMINSTER, PA
CASE NO. 3933, SDG W-MW-05

SAMPLES: 13/Aqueous/

W-MW-05	W-MW-06	W-MW-07
W-MW-08	W-MW-08-D	W-MW-09
W-MW-10	W-MW-11	W-MW-12
W-MW-13	W-MW-14	W-MW-15
W-MW-16		

Overview

The sample set for the Warminster site, Case No. 3933, SDG W-MW-05 consists of thirteen (13) monitoring well samples, including one field duplicate pair, the duplicate member of which is designated -D.

The samples were analyzed for low concentration volatile organic compounds utilizing EPA Method 524.2 as stipulated in the EPA Contract Laboratory Program (CLP) Statement of Work (SOW), OLC01.0. All data and reporting deliverables were presented as specified in SOW OLC01.0.

The samples were collected by HALLIBURTON NUS Environmental Corporation on 6/25/92 and 6/26/92 and analyzed by Ceimic Corporation Laboratories under Naval Energy and Environmental Support Activity (NEESA) Level C Quality Assurance/Quality Control (QA/QC) criteria.

Summary

All compounds were successfully analyzed with the exception of those that are rejected, R. The findings offered in this report are based upon a general review of all available data including data completeness, holding times until analysis, GC/MS tuning and calibration data, laboratory blank results, surrogate spike recoveries, matrix spike/matrix spike duplicate results, internal standards performance, field duplicate precision, compound identification and quantitation, and Tentatively Identified Compound (TIC) evaluation.

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-10-2-008

TO: NEIL TEAMERSON **DATE:** AUGUST 25, 1992

FROM: ROY COHEN **COPIES:** D. A. SCHEIB

SUBJECT: ORGANIC DATA VALIDATION - SEMIVOLATILE/PESTICIDE/PCB
WARMINSTER NAWC, WARMINSTER, PA
CASE NO. 3933, SDG W-MW-17

SAMPLES: 3/Aqueous/

W-630-RB W-MW-21 W-MW-29

Overview

The sample set for the Warminster site, Case No. 3933, SDG W-MW-17 consists of two (2) aqueous samples and one (1) associated rinsate blank (designated-RB) which were analyzed for Target Compound List (TCL) semivolatile and pesticide/PCB compounds.

The samples were collected by HALLIBURTON NUS Environmental Corporation on 6/29/92 and 6/30/92 and analyzed by Ceimic Corporation under Naval Energy and Environmental Support Activity (NEESA) Level C Quality Assurance/Quality Control (QA/QC) criteria. All analyses were conducted using Contract Laboratory Program (CLP) Statement of Work (SOW) 3/90 analytical and reporting protocols.

Summary

All compounds were successfully analyzed with the exception of those compound results that are rejected, qualified R. The findings offered in this report are based upon a general review of all available data including data completeness, holding times until extraction/analysis, GC/MS tuning and calibration data, laboratory and field blank results, surrogate spike recoveries, matrix spike/matrix spike duplicate results, internal standards performance, compound identification and quantitation, and Tentatively Identified Compound (TIC) evaluation.

Areas of concern with respect to data quality are listed below.

Major Problems

- The area for semivolatile Internal Standard (IS), perylene-d12, was very low for sample W-MW-29. Upon re-analysis, the IS was not recovered at all, suggesting a severe matrix effect. Therefore, detection limits for all semivolatile compounds that are quantitated from this IS (i.e. those compounds eluting after di-n-octyl phthalate) are considered unreliable, and have been rejected, [coded] R(c) on the data summary.

Minor Problems

- The following compound was found in the laboratory method blank in the maximum concentration indicated:

Compound	Maximum Concentration (µg/L)	Action Level (µg/L)
bis(2-ethylhexyl)-phthalate (BEHP)	2	20

  Results for BEHP that are reported at concentrations within the action level are qualified (B), and are considered to be false positives (artifacts of blank contamination).

- High Percent Differences (%Ds >50%) between the average initial calibration Relative Response Factor (RRF) and the continuing calibration RRFs were obtained for the semivolatile compounds hexachlorocyclopentadiene and 2,4-dinitrophenol. This occurrence indicates inconsistent instrumental responses which may have compromised the detection limits for these compounds. Nondetects for these compounds in all associated samples have been qualified as estimated, [coded] UJ(c); no direction of bias can be inferred.

Notes

Several semivolatile compounds exhibited continuing calibration %Ds that exceeded 25%. However no actions were taken as there were no positive results reported for these compounds in the associated samples, and the associated nondetects were not

compromised.

The recoveries for the pesticide surrogate decachlorobiphenyl (DCB) were below the advisory limits for samples W-MW-21, W-MW-29-D, and W-630-RB but both tetrachloro-m-xylene (TCX) %Rs for these samples were within the advisory limits. Hence, no actions were taken for these samples as there were one set of recoveries within the advisory limits.

The Tentatively Identified Compounds (TICs) are presented in the attached Appendix A (Qualified Analytical Results), excludes all TICs identified as laboratory or field quality control blank contaminants, siloxane isomers, aldol condensation products, and any TIC specifically identified as a laboratory artifact. These excluded results are considered to be false positives.

No other problems were noted.

Executive Summary

Laboratory Performance: Some continuing calibration relative response factors exhibited %Ds in excess of 25 and 50 percent from the initial calibration average RRF. One compound was detected as a laboratory blank contaminant.

Other Factors Affecting Data Quality: One IS was very low for one semivolatile analysis, and the pesticide/PCB fraction DCB surrogate recovery was outside of QC limits in another sample.

The data for these analyses were reviewed with reference to the "National Functional Guidelines for Organic Data Validation" (2/88), as amended for use within USEPA Region III, and the NEESA document entitled "Sampling and Chemical Analysis Quality Assurance requirements for the Navy Installation Restoration Program". **The text of this report has been formulated to address only those problem areas affecting data quality.** Documentation of compliance for non-problem areas is presented in the attached Appendix C (HNUS/CLEAN Data Validation Worksheets).

"I attest that the data referenced herein was validated according to the agreed upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

HALLIBURTON NUS Environmental Corporation

Roy Cohen
Data Reviewer

HALLIBURTON NUS Environmental Corporation

Debra. A. Scheib
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results, including TICs
2. Appendix B - Results as Reported by the Laboratory, including TICs
3. Appendix C - HNUS/CLEAN Data Validation Worksheets
4. Appendix D - Support Documentation

cc: D. Scheib

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-10-2-001

TO: NEIL TEAMERSON **DATE:** AUGUST 25, 1992

FROM: ROY COHEN

SUBJECT: ORGANIC DATA VALIDATION - LOW CONCENTRATION VOLATILES
CTO #22, WARMINSTER NAWC, WARMINSTER, PA
CASE NO. 3933, SDG W-MW-17

SAMPLES: 18/Aqueous/

W-629-TB	W-630-TB	W-630-RB
W-MW-17	W-MW-18	W-MW-19
W-MW-20	W-MW-21	W-MW-22
W-MW-23	W-MW-23-D	W-MW-24
W-MW-25	W-MW-26	W-MW-27
W-MW-28	W-MW-29	W-MW-30

Overview

The sample set for the Warminster site, Case No. 3933, SDG W-MW-17 consists of fifteen (15) aqueous environmental samples (including one field duplicate pair, the duplicate member of which is designated -D), two associated trip blanks (designated -TB), and one associated rinsate blank (designated -RB).

The samples were analyzed for low concentration volatile organic compounds utilizing EPA Method 524.2 as stipulated in the EPA Contract Laboratory Program (CLP) Statement of Work (SOW), OLC01.0. All data and reporting deliverables were presented as specified in SOW OLC01.0.

The samples were collected by HALLIBURTON NUS Environmental Corporation on 6/29/92 and 6/30/92 and analyzed by Ceimic Corporation Laboratories under Naval Energy and Environmental Support Activity (NEESA) Level C Quality Assurance/Quality Control (QA/QC) criteria.

Summary

All compounds were successfully analyzed with the exception of those results that are considered to be unreliable and are rejected, qualified (R). The findings offered in this report are based upon a general review of all available data including data

completeness, holding times until analysis, GC/MS tuning and calibration data, laboratory and field blank results, surrogate spike recoveries, matrix spike/matrix spike duplicate results, internal standards performance, field duplicate precision, compound identification and quantitation, and Tentatively Identified Compound (TIC) evaluation.

Areas of concern with respect to data quality are listed below.

Major Problems

- The continuing calibration Relative Response Factor (RRF) for acetone was below 0.010 for one low concentration daily standard analysis, and the Percent Difference (%D) between this daily RRF and the average initial calibration RRF was greater than 50 percent for the same compound. Only nondetects were reported for acetone in the affected samples. The calibration non-compliances suggest that the detection limit for acetone should be considered unreliable in affected samples. Consequently, these results have been qualified as rejected, [coded R(c)]. These results are potentially biased very low.

Minor Problems

- The following compounds were found in the laboratory method and field quality control blanks in the maximum concentration indicated:

Compounds	Maximum Concentrations (µg/L)	Action Level (µg/L)
methylene chloride	0.8	8
acetone*	8	80
tetrachloroethene*	0.4	2

* - This maximum concentration was detected in a field quality control blank. The associated action level was used to evaluate the environmental sample data, only.

Results for these compounds reported at concentrations within the associated action levels are qualified, (B). These results are considered to be false positives (artifacts of blank contamination).

Notes

Several compounds exhibited continuing calibration %Ds that exceeded 30%. However, no actions were taken as only associated positive results would be affected and there were no positive results reported for these compounds in the associated samples.

In accordance with USEPA Region III data validation protocol, no qualifications are made to the data based on field duplicate precision. Tables summarizing the results reported for field duplicate pairs are presented in the attached HNUS/CLEAN Data Validation Worksheets (Appendix C).

The Tentatively Identified Compounds (TICs) presented in the attached Appendix A (Qualified Analytical Results), exclude all TICs identified as laboratory or field quality control blank contaminants, siloxane isomers, aldol condensation products, known extraction artifacts and any TIC specifically identified as a laboratory artifact. These excluded results are considered to be false positives.

No other problems were noted.

Executive Summary

Laboratory Performance: One initial calibration average RRF was below contractual limits. Some continuing calibration RRFs exhibited %Ds which failed to meet quality control criteria. Several compounds were detected as laboratory blank contaminants.

Other Factors Affecting Data Quality: One compound was detected as a contaminant in the field quality control blanks.

The data for these analyses were reviewed with reference to the "National Functional Guidelines for Organic Data Validation" (2/88), as amended for use within USEPA Region III, and the NEESA document entitled "Sampling and Chemical Analysis Quality Assurance requirements for the Navy Installation Restoration Program" (6/88).

The text of this report has been formulated to address only those problem areas affecting data quality. Documentation of compliance for non-problem areas is presented in the attached Appendix C (HNUS/CLEAN Data Validation Worksheets).

"I attest that the data referenced herein was validated according to the agreed upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

Kelly Johnson for

HALLIBURTON NUS Environmental Corporation

Roy Cohen
Data Reviewer

Debra A. Scheib

HALLIBURTON NUS Environmental Corporation

Debra. A. Scheib
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results (including TICs)
2. Appendix B - Results as Reported by the Laboratory (including TICs)
3. Appendix C - HNUS/CLEAN Data Validation Worksheets
4. Appendix D - Support Documentation

cc: D. Scheib

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-51-4-2-131

TO: NEIL TEAMERSON DATE: AUGUST 31, 1992

FROM: ROY COHEN

SUBJECT: ORGANIC DATA VALIDATION - LOW CONCENTRATION VOLATILES
CTO#22, WARMINSTER NAWC, WARMINSTER, PA
CASE NO. 3933, SDG W-MW-31

SAMPLES: 18/Aqueous/

W-701-TB	W-702-RB	W-702-TB
W-MW-31	W-MW-31-D	W-MW-32
W-MW-33	W-MW-34	W-MW-35
W-MW-36	W-MW-37	W-MW-38
W-MW-39	W-MW-39-D	W-MW-40

Overview

The sample set for the Warminster site, Case No. 3933, SDG W-MW-31 consists of twelve (12) aqueous samples (including two field duplicate pairs, the duplicate members of which are designated -D), two (2) associated trip blanks (designated -TB), and one (1) associated rinsate blank (designated -RB).

The samples were analyzed for low concentration volatile organic compounds utilizing EPA Method 524.2 as stipulated in the EPA Contract Laboratory Program (CLP) Statement of Work (SOW), OLC01.0. All data and reporting deliverables were presented as specified in SOW OLC01.0.

The samples were collected by HALLIBURTON NUS Environmental Corporation on 7/1/92 and 7/2/92 and analyzed by Ceimic Corporation Laboratories under Naval Energy and Environmental Support Activity (NEESA) Level C Quality Assurance/Quality Control (QA/QC) criteria.

Summary

All compounds were successfully analyzed. The findings offered in this report are based upon a general review of all available data including data completeness, holding times until analysis, GC/MS tuning and calibration data, laboratory and field blank results, surrogate spike recoveries, matrix spike/matrix spike duplicate results, internal standards performance, compound identification and quantitation, and Tentatively Identified Compound (TIC) evaluation.

Areas of concern with respect to data quality are listed below.

Minor Problems

- The laboratory made a reporting error for trichloroethene for sample W-MW-31, erroneously reporting the positive result as trans-1,2-dichloroethene. The reviewer has corrected this information and the appropriate results for trichloroethene and trans-1,2-dichloroethene are correctly shown in the summary of qualified analytical results given in the attached Appendix A.

- The following compounds were found in the laboratory method and field quality control blanks in the maximum concentration indicated:

Compounds	Maximum Concentrations (µg/L)	Action Level (µg/L)
methylene chloride	0.65	6.5
tetrachloroethene	0.55	2.75
chloroform*	51	255

* - This maximum concentration was detected in a field quality control blank. The associated action level was used to evaluate the environmental sample data, only.

Results for tetrachloroethene and chloroform reported at concentrations within the respective action levels were qualified, (B). These values are considered to be false positives (artifacts of blank contamination). No qualifications were made for methylene chloride, as the only positive result for this compound was reported at a concentration above the action level.

- Volatile surrogate Percent Recoveries (%Rs) were below quality control limits for sample W-MW-32; the laboratory failed to perform a reanalysis for this sample. Positive and nondetected results for sample W-MW-32 are considered to be biased low, and are qualified as estimated, [coded L(s), UL(s)], respectively.

- Using spiked amount information given in the raw data, the reviewer calculated the Matrix Spike/Matrix Spike Duplicate (MS/MSD) %Rs, then evaluated these recoveries based on professional judgement using a ± 25% quality control criterion. The MS/MSD %Rs for bromoform (both 72%) are thus considered to be low. Consequently, the nondetect reported for bromoform in the unspiked sample (W-MW-31) is considered to be biased low, and was qualified as estimated, [coded UL(m)], accordingly.

Notes

Based on quality control criteria of ± 25%, the MS/MSD %Rs for trichloroethene (144%, 128%) exceeded quality control limits. No qualification to the data for the unspiked sample W-MW-31 was made, however, as these high trichloroethene recoveries are felt to be a factor of chromatographic performance (i.e. detector saturation), due to the significant concentration of trichloroethene already present in the unspiked sample.

The MSD %R for 1,2-dichloropropane (128%) was greater than the 125% upper quality control limit used for evaluation. Because the MS %R and the Relative Percent Difference (RPD) between MS/MSD results were within acceptable limits, no qualifications were made to the unspiked sample (W-MW-31).

In accordance with USEPA Region III data validation protocol, sample results are not qualified based on field duplicate imprecision. A summary of field duplicate results is presented in the attached Appendix C (HNUS/CLEAN Data Validation Worksheets).

The Tentatively Identified Compounds (TICs) are presented in the attached Appendix A (Qualified Analytical Results), exclude all TICs identified as laboratory or field quality control blank contaminants, siloxane isomers, aldol condensation products, and any TIC specifically identified as a laboratory artifact. These excluded results are considered to be false positives.

No other problems were noted.

Executive Summary

Laboratory Performance: Three compounds were detected as laboratory blank contaminants. There was a non-compliant

surrogate %R for sample W-MW-32, and the laboratory failed to reanalyze this sample.

Other Factors Affecting Data Quality: Two compounds were detected as contaminants in the field quality control blanks. There were several high MS/MSD %Rs.

The data for these analyses were reviewed with reference to the "National Functional Guidelines for Organic Data Validation" (2/88), as amended for use within USEPA Region III, and the NEESA document entitled "Sampling and Chemical Analysis QualityAssurance requirements for the Navy Installation Restoration Program" (6/88).

The text of this report has been formulated to address only those problem areas affecting data quality. Documentation of compliance for non-problem areas is presented in the attached Appendix C (HNUS/CLEAN Data Validation Worksheets).

"I attest that the data referenced herein was validated according to the agreed upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

Kelly A. Johnson for

HALLIBURTON NUS Environmental Corporation

Roy Cohen
Data Reviewer

Debra A. Scheib

HALLIBURTON NUS Environmental Corporation

Debra. A. Scheib
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results (including TICs)
2. Appendix B - Results as Reported by the Laboratory (including TICs)
3. Appendix C - HNUS/CLEAN Data Validation Worksheets
4. Appendix D - Support Documentation

cc: D. Scheib

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-10-2-009

TO: NEIL TEAMERSON **DATE:** AUGUST 31, 1992

FROM: ROY COHEN **COPIES:** D. A. SCHEIB

SUBJECT: ORGANIC DATA VALIDATION - SEMIVOLATILE/PESTICIDE/PCB
WARMINSTER NAWC, WARMINSTER, PA
CASE NO. 3933, SDG W-MW-31

SAMPLES: 4/Aqueous/

W-702-RB W-MW-39 W-MW-39-D W-MW-40

Overview

The sample set for the Warminster site, Case No. 3933, SDG W-MW-31 consists of three (3) aqueous samples, (including one field duplicate pair, the duplicate number of which is designated-D), and one (1) associated rinsate blank (designated-RB). All of these samples were analyzed for Target Compound List (TCL) semivolatile and pesticide/PCB compounds.

The samples were collected by HALLIBURTON NUS Environmental Corporation on 7/01/92 and 7/02/92 and analyzed by Ceimic Corporation under Naval Energy and Environmental Support Activity (NEESA) Level C Quality Assurance/Quality Control (QA/QC) criteria. The semivolatile and pesticide/PCB compounds were analyzed and reported as specified in the March, 1990 Contract Laboratory Program (CLP) Statement of Work (SOW).

Summary

All compounds were successfully analyzed with the exception of those data points that are qualified as rejected, R. The findings offered in this report are based upon a general review of all available data including data completeness, holding times until extraction/analysis, GC/MS tuning and calibration data, laboratory and field blank results, surrogate spike recoveries, matrix spike/matrix spike duplicate results, internal standards performance, compound identification and quantitation, and Tentatively Identified Compound (TIC) evaluation.

Areas of concern with respect to data quality are listed below.

Major Problems

- Very low recoveries were obtained for heptachlor for the Matrix Spike/Matrix Spike Duplicate (MS/MSD) analyses of sample W-MW-39. The detection limit for this analyte is considered to be unreliable and is qualified as rejected, [coded R(m)] for sample W-MW-39 on the data summary.

Minor Problems

- The following compound was found in the laboratory method blanks in the maximum concentration indicated:

Compounds	Maximum Concentration (µg/L)	Action Level (µg/L)
Bis(2-ethylhexyl)-phthalate (BEHP)	1.5	10.5

  Positive results for BEHP reported at concentrations within the action level are qualified (B), and are considered to be false positives (artifacts of blank contamination).

- The semivolatile compound 2,4-dinitrophenol exhibited a high Percent Difference (%D greater than 50 percent) between the initial calibration average Relative Response Factor (RRF) and the continuing calibration RRF on one analysis day. A high %D indicates inconsistent analytical instrumentation response for this compound. As a result, the quantitation of this compound may not be accurate. Nondetects for this analyte have been qualified as estimated [UJ(c)] in affected samples; no direction of bias can be inferred.

- The Matrix Spike (MS) %R for aldrin in the pesticide/PCB fraction was below the advisory limits. The result for this compound in the unspiked sample, W-MW-39, is considered to be biased low, and is qualified [UL(m)].

Notes

A continuing calibration %D was greater than 25% for 4-nitrophenol. No actions were warranted in the affected samples as

there were no positive results reported for this compound, and the nondetects were not compromised.

The recoveries for the pesticide surrogate decachlorobiphenyl (DCB) were below the advisory limits for samples W-MW-39, W-MW-39-D, and W-MW-40 but both tetrachloro-m-xylene (TCX) recoveries for these samples were within the advisory limits. Hence, no actions were taken for these samples as there were one set of recoveries within the advisory limits.

Semivolatile fraction Matrix Spike/Matrix Spike Duplicate (MS/MSD) Percent Recoveries (%Rs) for 4-nitrophenol and pentachlorophenol were above the quality control limits. No actions were taken in the unspiked sample as there were no positive results reported for either of these compounds.

Tables summarizing the results reported for field duplicate pairs are presented in the attached HNUS/CLEAN Validation Worksheets (Appendix C).

The Tentatively Identified Compounds (TICs) are presented in the attached Appendix A (Qualified Analytical Results), excluding all TICs identified as laboratory or field quality control blank contaminants, siloxane isomers, aldol condensation products, and any TIC specifically identified as a laboratory artifact. These excluded results are considered to be false positives.

No other problems were noted.

<u>Executive Summary</u>

Laboratory Performance: One continuing calibration relative response factor exhibited a %D in excess of 50 percent from the initial calibration average RRF. One compound was detected as a laboratory blank contaminant.

Other Factors Affecting Data Quality: One compound was detected as a contaminant in the field quality control blank.
Low MS/MSD recoveries occurred for one pesticide compound, and low recoveries for the pesticide surrogate were noted for a few samples.

The data for these analyses were reviewed with reference to the "National Functional Guidelines for Organic Data Validation"

(2/88), as amended for use within USEPA Region III, and the NEESA document entitled "Sampling and Chemical Analysis Quality Assurance requirements for the Navy Installation Restoration Program". **The text of this report has been formulated to address only those problem areas affecting data quality.** Documentation of compliance for non-problem areas is presented in the attached Appendix C (HNUS/CLEAN Data Validation Worksheets).

"I attest that the data referenced herein was validated according to the agreed upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

Kelly Johnson for

HALLIBURTON NUS Environmental Corporation

Roy Cohen
Data Reviewer

Debra A. Scheib

HALLIBURTON NUS Environmental Corporation

Debra. A. Scheib
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results (including TICs)
2. Appendix B - Results as Reported by the Laboratory, (including TICs)
3. Appendix C - HNUS/CLEAN Data Validation Worksheets
4. Appendix D - Support Documentation

cc: D. Scheib

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-9-2-166

TO: NEIL TEAMERSON **DATE:** AUGUST 31, 1992

FROM: ROY COHEN

SUBJECT: ORGANIC DATA VALIDATION - LOW CONCENTRATION VOLATILES
CTO #22, WARMINSTER NAWC, WARMINSTER, PA
CASE NO. 3933, SDG W-MW-41

SAMPLES: 8/Aqueous/

W-706-TB

W-MW-41	W-MW-43	W-MW-45	W-MW-46
W-MW-42	W-MW-44	W-MW-45-D	

Overview

The sample set for the Warminster site, Case No. 3933, SDG W-MW-41 consists of seven (7) aqueous samples (including one field duplicate pair, the duplicate member of which is designated -D), and one (1) associated trip blank (designated -TB).

The samples were analyzed for low concentration volatile organic compounds utilizing EPA Method 524.2 as stipulated in the EPA Contract Laboratory Program (CLP) Statement of Work (SOW), OLC01.0. All data and reporting deliverables were presented as specified in SOW OLC01.0.

The samples were collected by HALLIBURTON NUS Environmental Corporation on 7/6/92 and analyzed by Ceimic Corporation Laboratories under Naval Energy and Environmental Support Activity (NEESA) Level C Quality Assurance/Quality Control (QA/QC) criteria.

Summary

All compounds were successfully analyzed, with the exception of those results qualified as rejected, R. The findings offered in this report are based upon a general review of all available data including data completeness, holding times until analysis, GC/MS tuning and calibration data, laboratory and field blank results, surrogate spike recoveries, matrix spike/matrix spike duplicate results, internal standards performance, field duplicate precision, compound identification and quantitation, and Tentatively Identified Compound (TIC) evaluation.

Areas of concern with respect to data quality are listed below.

Major Problems

- The continuing calibration Relative Response Factor (RRF) for acetone was below 0.010 for one low concentration daily standard analysis, and the Percent Difference (%D) between this daily RRF and the average initial calibration RRF was greater than 50 percent for the same compound. Only nondetects were reported for acetone in the affected samples. The calibration non-compliances suggest that the detection limit for acetone should be considered unreliable in affected samples. Hence, these results have been qualified as rejected, [coded R(c)], and are considered to be potentially biased very low.

Notes

In accordance with USEPA Region III data validation protocol, no qualifications are made to the data based on field duplicate precision. Tables summarizing the results reported for field duplicate pairs are presented in the attached HNUS/CLEAN Data Validation Worksheets (Appendix C).

The Tentatively Identified Compounds (TICs) are presented in the attached Appendix A (Qualified Analytical Results), exclude all TICs identified as laboratory or field quality control blank contaminants, siloxane isomers, aldol condensation products, and any TIC specifically identified as a laboratory artifact. These excluded results are considered to be false positives.

No other problems were noted.

Executive Summary

Laboratory Performance: The laboratory could not demonstrate acceptable sensitivity or consistency of instrumental response for acetone.

Other Factors Affecting Data Quality: No problems were noted.

The data for these analyses were reviewed with reference to the "National Functional Guidelines for Organic Data Validation" (2/88), as amended for use within USEPA Region III, and the NEESA document entitled "Sampling and Chemical Analysis Quality Assurance requirements for the Navy Installation Restoration Program" (6/88).

The text of this report has been formulated to address only those problem areas affecting data quality. Documentation of compliance for non-problem areas is presented in the attached Appendix C (HNUS/CLEAN Data Validation Worksheets).

"I attest that the data referenced herein was validated according to the agreed upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

Karen Sabolosky for
HALLIBURTON NUS Environmental Corporation

Roy Cohen
Data Reviewer

Debra A. Scheib
HALLIBURTON NUS Environmental Corporation

Debra. A. Scheib
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results (including TICs)
2. Appendix B - Results as Reported by the Laboratory (including TICs)
3. Appendix C - HNUS/CLEAN Data Validation Worksheets
4. Appendix D - Support Documentation

cc: D. Scheib

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-8-2-220

TO: NEIL TEAMERSON **DATE:** AUGUST 12, 1992

FROM: JENNIFER HUBBARD

SUBJECT: MISCELLANEOUS PARAMETERS DATA VALIDATION
CTO #22, WARMINSTER NAWC, WARMINSTER, PA
CASE NO. 3933, SDG 920330

SAMPLES: 3/water/W-

624-RB (Rinsate Blank) 624-FB (Field Blank)

MW03

Overview

The sample set for the Warminster site, Case No. 3933, SDG 920330 consists of one (1) water sample and two (2) associated field quality control blanks. Following is a list of the analyses performed, the reference for the analytical method used, and the associated samples upon which the analyses were performed:

Parameter	Method Reference	Associated Samples
Total Organic Carbon (TOC)	EPA Method 415.1	All
Chemical Oxygen Demand (COD)	EPA Method 410.4	All
Hardness	EPA Method 130.2	All
Sulfate	EPA Method 375.4	All
Biological Oxygen Demand (BOD)	EPA Method 405.1	All
Total Suspended Solids (TSS)	EPA Method 160.2	All
Total Dissolved Solids (TDS)	EPA Method 160.1	All

(continued)

Parameter	Method Reference	Associated Samples
Ammonia	EPA Method 350.2	All
Chloride	EPA Method 325.2	All
Nitrate, Nitrite	EPA Method 353.3	All
Alkalinity	EPA Method 310.1	All

The samples were collected by HALLIBURTON NUS Environmental Corporation from 6/23/92 to 6/24/92 and analyzed by Ceimic Corporation Laboratories under Navy Energy and Environmental Support Activity (NEESA) Level E Quality Assurance/Quality Control (QA/QC) criteria.

Summary

All compounds were successfully analyzed. The findings offered in this report are based upon a general review of all available data including holding times until analysis, laboratory and field blank results and laboratory control sample results.

Areas of concern with respect to data quality are listed below.

Minor Problems

- A maximum concentration of 1.2 mg/L TOC was detected in the field quality control blanks. The positive results reported for TOC in samples W-624-FB and W-MW-03 are considered to be false positive results attributable to blank contamination, and are qualified, B, accordingly.

Notes

A maximum concentration of 10 mg/L TDS was detected in the field quality control blanks. No qualification was made to the positive result reported for TDS in sample W-MW-03 because this result is sufficiently above the blank contaminant level not to have been affected by blank contamination.

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-9-2-272

TO: NEIL TEAMERSON **DATE: SEPTEMBER 22, 1992**

FROM: JENNIFER HUBBARD

SUBJECT: MISCELLANEOUS PARAMETERS DATA VALIDATION
CTO #22, WARMINSTER NAWC, WARMINSTER, PA
CASE NO. 3933, SDG 920345

SAMPLES: 1/water/W-

MW46

Overview

The sample set for the Warminster site, Case No. 3933, SDG 920345 consists of one (1) water sample; no field quality control blanks were analyzed with this sample set.

The sample was analyzed for the following list of parameters:

Total Organic Carbon (TOC)	EPA Method 415.1
Chemical Oxygen Demand (COD)	EPA Method 410.4
Hardness	EPA Method 130.2
Sulfate	EPA Method 375.4
Biological Oxygen Demand (BOD)	EPA Method 405.1
Total Suspended Solids (TSS)	EPA Method 160.2
Total Dissolved Solids (TDS)	EPA Method 160.1
Ammonia	EPA Method 350.2
Chloride	EPA Method 325.2
Nitrate, Nitrite	EPA Method 353.3
Alkalinity	EPA Method 310.1

The sample was collected by HALLIBURTON NUS Environmental Corporation on 7/6/92 and analyzed by Ceimic Corporation Laboratories under Navy Energy and Environmental Support Activity (NEESA) Level E Quality Assurance/Quality Control (QA/QC) criteria.

Summary

All compounds were successfully analyzed. The findings offered in this report are based upon a general review of all available data including holding times until analysis, laboratory blank and laboratory control sample results.

There were no areas of concern with respect to data quality; all data are accepted without qualification.

Executive Summary

Laboratory Performance: No problems were noted.

Other Factors Affecting Data Quality: No problems were encountered.

The data for these analyses were reviewed with reference to method-specific quality control criteria, and with respect to the quality control criteria outlined in the NEESA document entitled "Sampling and Chemical Analysis Quality Assurance requirements for the Navy Installation Restoration Program" (6/88).

The text of this report has been formulated to address only those problem areas affecting data quality.

"I attest that the data referenced herein was validated according to the agreed upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

Kelly A. Johnson for

HALLIBURTON NUS Environmental Corporation

Jennifer Hubbard
Data Reviewer

Debra A. Scheib

HALLIBURTON NUS Environmental Corporation

Debra A. Scheib
Data Validation Quality Assurance Officer

HALLIBURTON NUS Environmental Corporation

Debra A. Scheib
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory
3. Appendix C - HNUS/CLEAN Data Validation Worksheets
4. Appendix D - Support Documentation

cc: D. A. Scheib

- Negative blank contamination was noted for lead in the laboratory method blanks. This is indicative of baseling drifting and poor instrument response. Positive sample results for this analyte which are < 10 CRDL are qualified as estimated, [coded L(n)]. Bias is low. Nondetects for lead are biased low, and qualified, [coded UL(n)].

- Matrix spike recovery was below the lower QC limit of 75% for thallium. Results were considered to be biased low and were qualified [coded UL(m)] for non-detects where not previously qualified based on blank contamination. Matrix spike recovery exceeded the upper QC limit of 125% for lead and mercury. Positive results for these analytes were qualified [coded K(m)], biased high, where not previously qualified.

- Graphite Furnace Atomic Absorption (GFAA) Post Digestion Spike (PDS) recoveries fell below the lower QC limit of 85% for selenium in samples WMW31DP and WMW38, and thallium in WMW31, WMW31DP, WMW32, WMW33, WMW34, WMW35, WMW37, WMW38, WMW39, and WMW40. These results were considered to be biased low due to matrix affects and were qualified [coded UL(p)] for non-detects where not previously qualified based on blank contamination. GFAA PDS recoveries for lead exceeded the upper QC limit of 125% for samples WMW32 and WMW34. Positive results for lead in these samples were qualified [coded K(p)], biased high, where not previously qualified.

Notes

GFAA PDS recovery exceeded the upper QC limit of 115% for selenium in samples WMW31, WMW32, WMW36, WMW39, WMW39DP, WMW40, and W702RB. However, no qualifications were necessary since these results were non-detects.

Contract Required Detection Limit (CRDL) Standard analyses are not evaluated as qualifications are limited to high concentration samples only. All samples in this analytical data set are of low concentration.

False positives were observed for antimony, beryllium, cobalt, copper, and nickel in the ICS. However, analyte concentrations were not considered to be comparable to those in the ICS, and no

qualifications were required.

In accordance with USEPA Region III data validation protocol, no qualifications are made to the data based on the evaluation of field duplicates. Tables summarizing the field duplicate results can be found in the attached HNUS/CLEAN Data Vaildation Worksheets (Appendix C).

Executive Summary

Laboratory Performance: Several analytes were detected as laboratory method blank contaminants. CRDL standard recoveries fell outside QC limits for several analytes.

Other Factors Affecting Data Quality: Two analytes were detected as field blank contaminants. Matrix spike recovery was outside QC limits for some analytes. GFAA PDS recoveries fell outside QC limits for several results. False positives were observed in the ICS.

The data for these analyses were reviewed with reference to the "National Functional Guidelines for Inorganic Data Validation" (7/88), as amended for use within USEPA Region III, and the NEESA document entitled "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program".

The text of this report has been formulated to address only those problem areas affecting data quality. Documentation of compliance for non-problem areas is presented in the attached Appendix C (HNUS/CLEAN Data Validation Worksheets.)

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

HALLIBURTON NUS Environmental Corporation

Jennifer Hubbard
Data Reviewer

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-9-2-221

TO: NEIL TEAMERSON

DATE: SEPTEMBER 23, 1992

FROM: JENNIFER HUBBARD

COPIES: D. A. SCHEIB

SUBJECT: INORGANIC DATA VALIDATION - TAL METALS (TOTAL)
NAWC WARMINSTER
CASE NO. 3933, SDG WMW41

SAMPLES: (TW-MW-41)

W-

MW41 MW42 MW43 MW44 MW45 MW46

DW-

MW45

Overview

The sample set for the Warminster site, Case No. 3933, SDG WMW41, consists of seven (7) water samples. These samples were analyzed for Total Target Analyte List (TAL) Metals and cyanide. One field duplicate pair (the duplicate is designated by D preceding the station location name), was included with this sample set.

The samples were collected by HALLIBURTON NUS on July 6, 1992 and analyzed by CEIMIC Laboratories under Naval Energy and Environmental Support Activity (NEESA) Level C Quality Assurance/Quality Control (QA/QC) criteria. All analyses were conducted using Contract Laboratory Program Statement of Work (SOW) 7/88 analytical and reporting protocols.

Summary

All compounds were successfully analyzed. The findings offered in this report are based upon a general review of all available data incuding data completeness, holding times, calibration data, laboratory blank results, matrix spike/post-digestion spike recovery results, laboratory control and ICP interference check sample results, serial dilution results, field duplicate precision, compound identification and compound quantitation.

Areas of concern with respect to data quality are listed below.

Major Problems

- Matrix spike recovery was extremely low (0%) for mercury. Nondetects for mercury were considered to be unreliable and rejected, [coded R(m)].

Minor Problems

- Several analytes were found in associated laboratory quality control blanks. The maximum amounts of these analytes found in the blanks, and the corresponding action levels applied to the data, are listed below:

Analyte	Maximum Conc. (ug/l)	Action Level (ug/l)
Al	107	535
Be	4	20
Cd	4	20
Ca	95	475
Cr	10	50
Co	7	35
Cu	5	25
Fe	33	165
Mg	40	200
Mn	2	10
K	470	2350
Na	110	550
Tl	3.6	18
Zn	6	30

  Sample results affected by blank contamination and reported at concentrations less than the action level are considered to be false positives. These results are qualified (B).

  Negative blank contamination was detected for iron in the laboratory method blank. This is indicative of baseline drifting and poor instrument response. Positive and nondetected sample results for this analyte, are considered biased low and qualified, [coded L(n)] and [coded UL(n)], respectively.

- Laboratory duplicate imprecision was observed for lead and iron. Positive results for these elements not previously qualified due to blank contamination were qualified [coded J(d)]. Bias cannot be determined.

- Matrix spike recovery was below the lower QC limit of 75% for thallium. Positive results were considered to be biased low and were qualified, [coded L(m)], where not previously qualified based on blank contamination. For thallium, nondetects were qualified, [coded UL(m)], biased low, where not previously qualified.

- GFAA PDS recoveries fell below the lower QC limit of 85% for arsenic in sample WMW41, selenium in samples WMW41, and thallium in samples WMW42, WMW44 and WMW46. These results were considered to be biased low and were qualified, [coded UL(p)] for nondetects.

Notes

The continuing calibration percent recovery for cyanide analyses (affecting sample WMW45) exceeded the upper QC limit of 115%. However, since the bias would be high and the result was a non-detect, no qualifications were necessary.

Contract Required Detection Limit (CRDL) Standard analyses are not evaluated as qualifications are limited to high concentration samples only. All samples in this analytical data set are of low concentration.

The ICP Serial dilution Percent Differences (%Ds) for several analytes exceeded the 10% quality control limit. However, initial sample results for these analytes did not exceed 50X IDL and no actions were required.

GFAA PDS recovery exceeded the upper QC limit of 115% for selenium in sample WMW46. However, no qualifications were necessary since these results were non-detects.

False positives were observed for antimony, beryllium, cadmium, cobalt, copper, manganese, nickel, potassium, sodium, and vanadium in the ICS. False negatives were observed for manganese. However, concentrations of interferents in the ICS were not considered to be comparable to concentrations of interferents in the samples, and no qualifications were made.

In accordance with USEPA Region III data validation protocol, no qualifications are made to the data based on the evaluation of field duplicates. Tables summarizing the field duplicate results can be found in the attached HNUS/CLEAN Data Vaildation Worksheets (Appendix C).

Executive Summary

Laboratory Performance: CCV percent recovery for cyanide exceeded the QC limit. Several analytes were detected as laboratory method blank contaminants. CRDL standard recoveries fell outside QC limits for several analytes. Laboratory duplicate imprecision was observed for iron.

Other Factors Affecting Data Quality: Matrix spike recovery was outside QC limits for two analytes. GFAA PDS recoveries fell outside QC limits for several analytes.

The data for these analyses were reviewed with reference to the "National Functional Guidelines for Inorganic Data Validation" (7/88), as amended for use within USEPA Region III, and the NEESA document entitled "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program".

The text of this report has been formulated to address only those problem areas affecting data quality. Documentation of compliance for non-problem areas is presented in the attached Appendix C (HNUS/CLEAN Data Validation Worksheets.)

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

HALLIBURTON NUS Environmental Corporation

Jennifer Hubbard
Data Reviewer

HALLIBURTON NUS Environmental Corporation

Debra A. Scheib
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory
3. Appendix C - HNUS/CLEAN Data Validation Worksheets
4. Appendix D - Support Documentation

cc: D. A. Scheib

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-08-2-225

TO: NEIL TEAMERSON

DATE: AUGUST, 21 1992

FROM: JENNIFER HUBBARD

COPIES: D. A. SCHEIB

SUBJECT: INORGANIC DATA VALIDATION - TAL METALS (DISSOLVED)
WARMINSTER NAVAL BASE
CASE NO. 3933, SDG WSWF05

SAMPLES:

DWSWF6

W-

SWF05	SWF06	MW01	MW02
MW03	MW04		

624FB-Filtered Field Blank 624RB-Rinsate Blank

Overview

The sample set for the Warminster site, Case No. 3933, SDG WSWF05, consists of seven (7) filtered water samples and two (2) aqueous filtered field quality control blanks. These samples were analyzed for dissolved Target Analyte List (TAL) metals. One field duplicate pair (samples WSWF06 and DWSWF06) were included in this data set.

The samples were collected by HALLIBURTON NUS Environmental Corporation on 06/23/92 and 06/24/92 and analyzed by CEIMIC Laboratories under Naval Energy and Environmental Support Activity (NEESA) Level C Quality Assurance/Quality Control (QA/QC) criteria. All analyses were conducted using Contract Laboratory Program Statement of Work (SOW) 7/88 analytical and reporting protocols.

Summary

All compounds were successfully analyzed. The findings offered in this report are based upon a general review of all available data including data completeness, holding times, calibration data, laboratory and field quality control blank results, laboratory and field duplicate results, matrix spike recovery results, post digestion spike recovery and ICP serial dilution results, laboratory control and ICP interference check sample results, compound identification and compound quantitation. Areas of concern with respect to data quality are listed below.

Minor Problems

- Several analytes were detected as contaminants in associated laboratory method and field quality control blanks. The maximum blank contaminant concentrations for these analytes and the corresponding action levels applied to the sample data are listed below:

Analyte	Maximum Concentration (µg/L)	Action Level (µg/L)
aluminum	112	560
beryllium	3.0	15.0
calcium	70.0	350
chromium	8.0	40.0
cobalt	6.0	30.0
copper	5.0	25.0
iron	38.0	190
lead	1.6	8.0
magnesium	48.0	240
thallium	2.4	12.0
vanadium*	6.0	30.0
zinc*	9.0	45.0

*Maximum amount used to set validation action level found in associated field quality control blank.

Sample results affected by blank contamination and reported at concentrations less than the action level are considered to be false positives. These results are qualified, [coded (B)]. No action was taken for vanadium or zinc in sample 62 RB because these values were used to set the validation action levels and as such, are not qualified in accordance with data validation protocol.

- Negative concentrations (≥ IDL) were reported for iron and manganese in the laboratory method blanks. Results such as these are evidence of inconsistent instrument performance (baseline drifting). Positive results for these analytes < 10X CRDL (not qualified due to positive blank contamination) are qualified as biased low, [coded L(n)]. Nondetects for these analytes are qualified, [coded UL(n)], biased low.

- Graphite furnace Post Digestion Spike (PDS) recoveries for thallium in samples WSWF05, WSWF06, DWSWF6, WMW01,

WMW02, WMW03, and WMW04 fell below the 85% lower quality control limit. Failure to meet PDS performance criteria indicates the potential presence of matrix interferences. Affected sample results are nondetects are were qualified as biased low, [coded UL(p)].

Notes

In accordance with USEPA Region III data validation protocol, no qualifications are made to the sample data based on the evaluation of field duplicate precision. Tables summarizing the field duplicate results can be found in the attached HNUS/CLEAN Data Validation Worksheets (APPENDIX C).

CRDL Standard analysis recoveries for several analytes failed to meet the 80-120% quality control criteria. No actions were taken because qualifications are limited to high concentration samples only via USEPA Region III data validation protocol. All samples in this analytical data set are of low concentration.

Several analytes, which were not supposed to be present in the Interference Check Sample (ICS) Solutions, were detected in these solutions at positive and/or negative concentrations > IDL. Samples did not contain concentrations of interfering analytes comparable to the levels detected in the ICS, therefore, no qualifications were required.

The matrix spike recovery for mercury exceeded the 125% upper quality control limit. However, no qualifications were necessary since no positive results were reported for mercury.

The graphite furnace PDS recovery for lead in sample W624RB was below the lower quality control limit of 85%. No further action was necessary since the positive lead result in the affected sample is qualified on the basis of blank contamination.

No other problems were noted.

Executive Summary

Laboratory Performance: Several analytes were detected as laboratory method blank contaminants. CRDL standard analysis recoveries fell outside quality control limits for several analytes. Negative concentrations were reported for iron and manganese in laboratory method blanks.

Other Factors Affecting Data Quality: Vanadium and zinc, which could not be attributed to laboratory blank contamination, were detected as contaminants in the associated rinsate blank. Several graphite furnace PDS recoveries were below quality control limits.

The data for these analyses were reviewed with reference to the "National Functional Guidelines for Inorganic Data Validation" (7/88), as amended for use within USEPA Region III, and the NEESA document entitled "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program".

The text of this report has been formulated to address only those problem areas affecting data quality. Documentation of compliance for non-problem areas is presented in the attached Appendix C (HNUS/CLEAN Data Validation Worksheets.)

"I attest that the data referenced herein were validated according to the agreed-upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

HALLIBURTON NUS Environmental Corporation

Jennifer Hubbard
Data Reviewer

HALLIBURTON NUS Environmental Corporation

Debra A. Scheib
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory
3. Appendix C - HNUS/CLEAN Data Validation Worksheets
4. Appendix D - Support Documentation

cc: D. A. Scheib

Notes

There were some continuing calibration %Ds for methylene chloride, 2-hexanone, and 4-methyl-2-pentanone that exceeded the 30% quality control criterion. No data qualifications were required, since only nondetects were reported for these compounds in affected samples, and these results were not impacted by the non-compliance.

In accordance with USEPA Region III data validation protocol, no qualifications are made to the data based on field duplicate precision. Tables summarizing the results reported for field duplicate pairs are presented in the attached HNUS/CLEAN Data Validation Worksheets (Appendix C).

The Tentatively Identified Compounds (TICs) presented in the attached Appendix A (Qualified Analytical Results), exclude all TICs identified as laboratory or field quality control blank contaminants, siloxane isomers, aldol condensation products, any known artifact of extraction, and any TIC specifically identified as a laboratory artifact. These excluded results are considered to be false positives.

No other problems were noted.

Executive Summary

Laboratory Performance: The laboratory made several errors in the reporting of results. Sufficient instrumental sensitivity could not be demonstrated for acetone. Several calibration %Ds failed to meet quality control criteria. Several compounds were detected as laboratory blank contaminants.

Other Factors Affecting Data Quality: No other problems were noted.

The data for these analyses were reviewed with reference to the "National Functional Guidelines for Organic Data Validation" (2/88), as amended for use within USEPA Region III, and the NEESA document entitled "Sampling and Chemical Analysis Quality Assurance requirements for the Navy Installation Restoration Program" (6/88).

The text of this report has been formulated to address only those problem areas affecting data quality. Documentation of compliance for non-problem areas is presented in the attached Appendix C (HNUS/CLEAN Data Validation Worksheets).

"I attest that the data referenced herein was validated according to the agreed upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

Kelly A. Johnson for

HALLIBURTON NUS Environmental Corporation

Roy Cohen
Data Reviewer

Debra A. Scheib

HALLIBURTON NUS Environmental Corporation

Debra. A. Scheib
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results (including TICs)
2. Appendix B - Results as Reported by the Laboratory, (including TICs)
3. Appendix C - HNUS/CLEAN Data Validation Worksheets
4. Appendix D - Support Documentation

cc: D. Scheib

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-8-2-224

TO: NEIL TEAMERSON **DATE:** AUGUST 24, 1992

FROM: JENNIFER HUBBARD **COPIES:** D.A. SCHEIB

SUBJECT: INORGANIC DATA VALIDATION - TAL METALS (DISSOLVED)
WARMINSTER NAVAL BASE
CASE NO. 3933, SDG DWMW05

SAMPLES:

DWMW05

W-

MW05	MW06	MW07	MW08
MW09	MW10	MW11	MW12
MW13	MW14	MW15	MW16

626RB-Filtered Rinsate Blank

Overview

The sample set for the Warminster site, Case No. 3933, SDG DWMW05, consists of thirteen (13) filtered water samples and one (1) filtered rinsate blank. These samples were analyzed for dissolved Target Analyte List (TAL) metals.

The samples were collected by HALLIBURTON NUS Environmental Corporation on 06/25/92 and 06/26/92 and analyzed by CEIMIC Laboratories under Naval Energy and Environmental Energy and Environmental Support Activity (NEESA) Level C Quality Assurance/Quality Control (QA/QC) Criteria. All analyses were conducted using Contract Laboratory Program Statement of Work (SOW) 7/88 analytical and reporting protocols.

Summary

All compounds were successfully analyzed. The findings offered in this report are based upon a general review of all available data including data completeness, holding times, calibration data, laboratory and field blank results, matrix spike and post digestion spike recovery results, laboratory duplicate results, ICP serial dilution results, laboratory control and ICP interference check sample results, compound identification and compound quantitation.

Areas of concern with respect to data quality are listed below.

Minor Problems

- Several analytes were detected as contaminants in the associated laboratory method blanks. The maximum blank contaminant concentrations for these analytes and the corresponding action levels applied to the data are listed below:

Analyte	Maximum Concentration (ug/L)	Action Level (ug/L)
aluminum	120	600
beryllium	4.0	20.0
cadmium	5.0	25.0
calcium	104	520
chromium	6.0	30.0
copper	6.0	30.0
iron	25.0	125
lead	1.2	6.0
magnesium	62.0	310
manganese	1.0	5.0
sodium	260	1300
vanadium	5.0	25.0
zinc	4.0	20.0

Sample results affected by blank contamination and reported at concentrations less than the action level are considered to be false positives. These results are qualified, [B].

- Negative concentrations ≥ IDL were reported for arsenic and manganese int he continuing calibration blanks. This is a matter of inconsistent instrument performance and is indicative of baseline drifting. Positive results for manganese < 10 x CRDL (not qualified due to blank contamination) were qualified as biased low, [coded L (n)]. No positive results were reported for arsenic. Nondetects for both analytes were qualified as biased low, [coded UL(n)].

- Graphite furnace Post Digestion Spike (PDS) recoveries for lead in sample WQ626RB and thallium in samples WMW11, WMW12, WMW13 and WMW14 fell below the 85% lower quality control limit, indicating possible poor instrument performance or the

potential presence of matrix interferences. Affected sample results are nondetects; these results are considered to be biased low and were qualified, [coded UL(p)].

Notes

In accordance with USEPA region III data validation protocol, no qualifications are made to the sample data based on the evaluation of field duplicate precision. Tables summarizing the field duplicate results can be found in the attached HNUS/CLEAN Data Validation Worksheets (APPENDIX C).

CRDL Standard analysis recoveries for several analytes did not meet the 80-120% quality control criteria. No actions were taken because qualifications are limited to high concentration samples only; all samples in this analytical data set are of low concentration.

Several analytes, which were not supposed to be present in the Interference Check Standard (ICS) solutions, were detected in these solutions at positive and/or negative concentrations > IDL. Samples did not contain concentrations of interfering analytes comparable to the levels detected in the ICS, therefore, no qualifications were required.

Graphite furnace PDS recoveries for arsenic, lead and selenium in several samples failed to meet the 85-115% quality control criteria. No actions were necessary because either the affected positive sample results are qualified due to blank contamination, or nondetects in affected samples were not compromised by high PDS recoveries.

No other problems were encountered.

Executive Summary

Laboratory Performance: Several analytes were detected as laboratory method blank contaminants. Arsenic and manganese were detected at negative concentrations in the laboratory method blanks. CRDL standard recoveries fell outside quality control limits for several analytes.

Other Factors Affecting Data Quality: Graphite furnace PDS recoveries for several analytes in some samples did not meet the quality control limits.

The data for these analyses were reviewed with referenced to the "National Functional Guidelines for Inorganic Data Validation" (7/88), as amended for use within USEPA Region III, and the NEESA document entitled "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program".

The text of this report has been formulated to address only those problem areas affecting data quality. Documentation of compliance for non-problem areas is presented in the attached Appendix C (HNUS/CLEAN Data Validation Worksheets.)

"I attest that the data referenced herein were validated according to the agreed-upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

HALLIBURTON NUS Environmental Corporation

Jennifer Hubbard
Data Reviewer

HALLIBURTON NUS Environmental Corporation

Debra A. Scheib
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory
3. Appendix C - HNUS/CLEAN Data Validation Worksheets
4. Appendix D - Support Documentation

cc: D. Scheib

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-08-2-226

TO: NEIL TEAMERSON

DATE: AUGUST 24, 1992

FROM: JENNIFER HUBBARD

COPIES: D. A. SCHEIB

SUBJECT: INORGANIC DATA VALIDATION - TAL METALS
NAWC WARMINSTER
CASE NO. 3933, SDG TWMW05

SAMPLES:

W-

626RB-Rinsate Blank

MW05	MW06	MW07	MW08	MW09	MW10
MW11	MW12	MW13	MW14	MW15	MW16

DW-MW08

Overview

The sample set for the Warminster site, Case No. 3933, SDG TWMW05, consists of thirteen (13) water samples and one (1) associated field quality control blank. These samples were analyzed for Total Target Analyte List (TAL) Metals and cyanide. One field duplicate pair (the duplicate is designated by D preceding the station location name), was included with this sample set.

The samples were collected by HALLIBURTON NUS Environmental Corporation from 6/25/92 to 6/26/92 and analyzed by CEIMIC Laboratories under Naval Energy and Environmental Support Activity (NEESA) Level C Quality Assurance/Quality Control (QA/QC) criteria. All analyses were conducted using Contract Laboratory Program Statement of Work (SOW) 7/88 analytical and reporting protocols.

Summary

All compounds were successfully analyzed. The findings offered in this report are based upon a general review of all available data incuding data completeness, holding times, calibration data, laboratory and field blank results, matrix spike/post-digestion

spike recovery results, laboratory control and ICP interference check sample results, serial dilution results, field duplicate precision, compound identification and compound quantitation.

Areas of concern with respect to data quality are listed below.

Minor Problems

- Several analytes were found in associated laboratory quality control blanks. The maximum amounts of these analytes found in the blanks, and the corresponding action levels applied to the data, are listed below:

Analyte	Maximum Conc. (ug/l)	Action Level (ug/l)
Al	120	600
Be	5.0	25.0
Cd	5.0	25.0
Ca	85.0	425
Cr	6.0	30.0
Cu	6.0	30.0
Fe	24.0	120
Pb	1.8	9.0
Mg	47.0	235
Mn	1.0	5.0
Na	198	990
V	5.0	25.0
Zn	4.0	20.0

  No analytes were found in the associated field quality control blank that were not attributable to laboratory blank contamination.

  Sample results affected by blank contamination and reported at concentrations less than the action level are considered to be false positives. These results are qualified, [coded (B)].

- Nondetects and any remaining positive results < 10X CRDL are considered biased low and qualified, [coded L(n)] and [coded UL(n)], respectively, in instances where negative values were reported for the laboratory method blanks for an analyte. Such is the case for iron. Only positive sample results were reported for this analyte and these results are qualified as mentioned above. Negative blank contamination is indicative

of baseline drifting and poor instrument performance.

- Laboratory duplicate imprecision was observed for aluminum. Positive results for this analyte not previously qualified due to blank contamination were estimated and qualified, [coded J(d)]. Bias cannot be determined.

- Matrix spike recoveries were below the 75% lower quality control for aluminum, iron, and thallium. Positive and nondetected sample results for these analytes are considered to be potentially biased low due to matrix interferences and are qualified, [coded L(m)] and [coded UL(m)], respectively, where not previously qualified based on blank contamination.

- Graphite Furnace Atomic Absorption (GFAA) post digestion analytical spike recoveries fell below the lower quality control limit of 85% for arsenic in sample WMW13 and thallium in samples WMW08, DWMW08, and WMW09. These results were considered to be potentially biased low due to sample matrix affects and were qualified [coded L(p)] for positive results and [coded UL(p)] for nondetects, where not previously qualified due to blank contamination.

Notes

CRDL Standard analysis recoveries for several analytes did not meet the 80-120% quality control criteria. No actions were taken because qualifications are limited to high concentration samples only. All samples in this analytical data set are of low concentration.

The percent recovery for the Initial Calibration Verification (ICV) for lead (88.6%) analyzed on 7/21 fell below the 90% lower quality control limit. The samples affected would be WMW05, WMW06, and WMW07. However, lead in all these samples was qualified, [coded (B)], due to blank contamination, hence no further qualifications were made.

GFAA Post Digestion analytical spike recoveries exceeded the upper quality control limit of 115% for selenium in samples WMW05, WMW06, and WMW07. However, only nondetected sample

results were reported for this analyte and these results are not compromised. Hence no actions were required.

False positives were observed for antimony, beryllium, cadmium, cobalt, copper, manganese, nickel, sodium, and vanadium in the (Interference Check Sample) ICS. However, concentrations of the interferent analytes (aluminum, calcium, iron and magnesium) present in the samples were not comparable to the levels present in the ICS solution; hence no actions were necessary.

The Percent Differences (%Ds) for several analytes exceeded the 10% quality control limit for the serial dilution analyses. However, initial sample results for these analytes did not exceed 50X the IDL and no actions were required.

Because it is unusual to observe cyanide in a monitoring well at a concentration of 92 ug/l, especially when it was not detected in other samples, the reviewer examined this result closely. It appears that the absorbance measured for cyanide in this sample was extremely close to results obtained for CCVs, and it is suspected that a mix-up may have occurred. However, the sample result in the raw data was labeled as belonging to sample WMW13 and cannot be discounted with available information. Therefore, if this well is a critical sampling point, confirmatory re-sampling of this well might be desirable, at the project manager's discretion.

In accordance with USEPA Region III data validation protocol, no qualifications are made to the data based on the evaluation of field duplicates. Tables summarizing the field duplicate results can be found in the attached HNUS/CLEAN Data Vaildation Worksheets (Appendix C).

Executive Summary

Laboratory Performance: Initial calibration verification recovery for lead was slightly below the lower qualitly control limit. One cyanide result is questionable but cannot be qualified with available information. Several analytes were detected as laboratory method blank contaminants. CRDL standard analysis recoveries fell outside QC limits for several analytes. Laboratory duplicate imprecision was observed for aluminum.

Other Factors Affecting Data Quality: Matrix spike recoveries were outside QC limits for several analytes. GFAA PDS recoveries fell outside QC limits for several analytes.

The data for these analyses were reviewed with reference to the "National Functional Guidelines for Inorganic Data Validation" (7/88), as amended for use within USEPA Region III, and the NEESA document entitled "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program".

The text of this report has been formulated to address only those problem areas affecting data quality. Documentation of compliance for non-problem areas is presented in the attached Appendix C (HNUS/CLEAN Data Validation Worksheets.)

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

HALLIBURTON NUS Environmental Corporation

Jennifer Hubbard
Data Reviewer

HALLIBURTON NUS Environmental Corporation

Debra A. Scheib
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory
3. Appendix C - HNUS/CLEAN Data Validation Worksheets
4. Appendix D - Support Documentation

cc: D. A. Scheib

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-08-2-227

TO: NEIL TEAMERSON **DATE:** AUGUST 25, 1992

FROM: JENNIFER HUBBARD **COPIES:** D. A. SCHEIB

SUBJECT: INORGANIC DATA VALIDATION - TAL METALS
WARMINSTER NAVAL BASE
CASE NO. 3933, SDG WSD05

SAMPLES:

D-

WSD6 WSW6

W-

MW01	MW02	SB2D	MW03	MW04	SW05
SW06	SD05	SD06	SDW01		

624FB-Field Blank 624RB-Rinsate Blank

Overview

The sample set for the Warminster site, Case No. 3933, SDG WSD05, consists of four (4) soil samples (including one field duplicate pair), seven (7) water samples (including one field duplicate pair), and two (2) associated field quality control blanks. Additionally, results for the field duplicate (WSB2D) of another sample not analyzed in this analytical data set were included. These samples were analyzed for Target Analyte List (TAL) metals. Based on the contract required frequency, laboratory duplicate, matrix spike, or ICP serial dilution analyses were included as part of this SDG.

The samples were collected by HALLIBURTON NUS Environmental Corporation on 06/23/92 and 06/24/92 and analyzed by CEIMIC Laboratories under Naval Energy and Environmental Support Activity (NEESA) Level C Quality Assurance/Quality Control (QA/QC) criteria. All analyses were conducted using Contract Laboratory Program Statement of Work (SOW) 7/88 analytical and reporting protocols.

Summary

All compounds were successfully analyzed. The findings offered in this report are based upon a general review of all available

data including data completeness, holding times, calibration data, laboratory and field blank results, matrix spike and post digestion spike recoveries, laboratory control and ICP interference check sample results, ICP serial dilution results, and compound quantitation.

Areas of concern with respect to data quality are listed below.

Minor Problems

- Several analytes were found as contaminants in the associated laboratory blanks. The maximum blank concentrations for these analytes and the corresponding action levels applied to the data are listed below:

Analyte	Maximum Concentration (µg/L)	Action Levels (µg/L)	Action Levels (mg/kg)
aluminum	112	565	112
beryllium	4.0	20.0	4.0
cadmium	3.0	15.0	3.0
chromium	8.0	40.0	8.0
cobalt	6.0	30.0	6.0
copper	5.0	25.0	5.0
magnesium	48.0	240	48.0
potassium	447	2345	447
thallium	2.4	12.0	2.4
vanadium	5.0	25.0	5.0

Samples Affected: All

Additionally, calcium, sodium, and zinc were detected in both matrix preparation blanks. Maximum concentrations found and the corresponding action levels are shown below:

Analyte	Maximum Concentration	Action Level
calcium	86 µg/L, 29.8 mg/kg	430 µg/L, 149 mg/kg
sodium	287 µg/L, 20.8 mg/kg	1435 µg/L, 104 mg/kg
zinc	4 µg/L, 0.8 mg/kg	20.0 µg/L, 4.0 mg/kg

A concentration of 2.0 µg/L lead was detected in the aqueous preparation blank. Aqueous sample data were evaluated using a 10.0 µg/L action level for lead.

No analytes were found in associated field quality control blanks which could not be attributed to laboratory blank contamination.

Dilution factors, aliquot used for analysis and sample percent solids were considered when applying the action levels. Sample results affected by blank contamination and reported at concentrations less than the action level are considered to be false positives. These results are qualified, [coded B].

- Negative concentrations, whose absolute values were > IDL, were reported for iron, manganese, thallium, and lead in the laboratory method blanks. These occurrences are indications of poor instrument performance (base-line fluctuations). Positive results and nondetects for these analytes are qualified as biased low, [coded L(n) and UL(n)], respectively.

- The Method of Standard Additions (MSA) correlation coefficient for lead in sample DWSD6 was less than 0.995. This result was qualified as estimated, [coded J(c)], due to a statistical lack of linearity for the analytical curve generated by this method.

- Laboratory duplicate imprecision was observed for chromium and lead for the sediments. Positive results for these elements not previously qualified due to blank contamination were qualified, [coded J(d)], as estimated. Sample bias could not be determined.

- Matrix spike recoveries were below the lower quality control limit of 75% for arsenic, chromium, and copper for the sediment matrix. Positive results (not qualified due to blank contamination) and nondetects for these analytes in sediments were considered to be biased low and qualified, [coded L(m) and UL(m)], respectively.

- The matrix spike recovery exceeded the upper quality control limit of 125% for mercury in the sediment matrix. Positive mercury results (not qualified due to blank contamination) are qualified, [coded K(m)], as biased high.

- Graphite furnace Post Digestion Spike (PDS) recoveries for arsenic in samples WMW04, W624FB, and W624RB, lead in sample WMW04, selenium in sample WMW04, and thallium

in all samples except sample DWSW6 fell below the lower quality control limit of 85%. Positive results (not qualified due to blank contamination) and nondetects for these analytes in affected samples were considered to be biased low and qualified, [coded L(p) and UL(p)], respectively.

- Graphite furnace PDS recoveries exceeded the upper QC limit of 115% for selenium in samples WSD06, DWSD6, WSDW01, WSW05, WSW06, WMW03, and W624RB. Positive results (not qualified due to blank contamination) were qualified, [coded K(p)], biased high.

- False positives were observed for cadmium, cobalt, manganese, nickel, potassium, sodium, and vanadium in the Interference Check Sample (ICS) solutions. Positive results (not qualified due to blank contamination) for these elements in samples with concentrations of interferents comparable to concentrations of ICS interferents (samples WMW04, WSD05, WSD06, and WSDW01) were qualified, [coded K(i)], biased high.

Notes

In accordance with USEPA Region III data validation protocol, no qualifications are made to the data based on the evaluation of field duplicates. Tables summarizing the field duplicate results can be found in the attached HNUS Navy CLEAN Data Validation Worksheets (Appendix C).

Contract Required Detection Limit (CRDL) Standard analysis recoveries for several analytes were poor. No actions were needed as qualifications are limited to high concentration sample; all samples in this analytical data set are of low concentration.

Matrix spike recoveries for mercury and selenium in the aqueous matrix exceeded the upper quality control limit of 125%. However, no positive results for these analytes were reported in the water samples, thus, no qualification was not necessary.

False positives for antimony, beryllium, and copper were reported in the ICS. However, results for these analytes were either nondetects or not considered comparable to ICS concentrations, and no qualifications were made.

ICP serial dilution Percent Differences (%Ds) for several analytes did not meet the quality control criterion. No qualifications were necessary as initial sample results for these analytes were < 50X IDL.

Executive Summary

Laboratory Performance: Several analytes were detected as laboratory method blank contaminants. Negative concentrations were reported for iron, manganese, thallium, and lead in the laboratory method blanks. CRDL Standard analysis recoveries fell outside QC limits for several analytes. Laboratory duplicate imprecision was observed for several analytes for the sediment matrix. The MSA correlation coefficient for lead in one sample was less than 0.995. ICP interferences from high interfering analyte sample concentrations were noted for several analytes in a few samples.

Other Factors Affecting Data Quality: Matrix spike recoveries were outside QC limits for some analytes in the sediment matrix. GFAA PDS recoveries fell outside QC limits for several analytes in various samples.

The data for these analyses were reviewed with reference tot he "National Functional Guidelines for Inorganic Data Validation" (7/88), as amended for use within USEPA Region III, and the NEESA document entitled "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program".

The text of this report has been formulated to address only those problem areas affecting data quality. Documentation of compliance for non-problem areas is presented in the attached Appendix C (HNUS/CLEAN Data Validation Worksheets.)

"I attest that the data referenced herein were validated according to the agreed-upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

Duane L. Mock for

HALLIBURTON NUS Environmental Corporation

Jennifer Hubbard
Data Reviewer

Debra A. Scheib

HALLIBURTON NUS Environmental Corporation

Debra A. Scheib
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory
3. Appendix C - HNUS/CLEAN Data Validation Worksheets
4. Appendix D - Support Documentation

cc: D. A. Scheib

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-08-2-223

TO: NEIL TEAMERSON

DATE: AUGUST 25, 1992

FROM: JENNIFER HUBBARD

COPIES: D. A. SCHEIB

SUBJECT: INORGANIC DATA VALIDATION - TAL METALS
NAWC WARMINSTER
CASE NO. 3933, SDG TWMW17

SAMPLES:

DWMW23

W-

630RB-Rinsate Blank

MW17	MW18	MW19	MW20	MW21	MW22
MW23	MW24	MW25	MW26	MW27	MW28
MW29	MW30				

Overview

The sample set for the Warminster site, Case No. 3933, SDG TWMW17, consists of fifteen (15) water samples and one (1) associated field quality control rinsate blank. These samples were analyzed for Total Target Analyte List (TAL) Metals and cyanide. One field duplicate pair (the duplicate is designated by D preceding the station location name), was included with this sample set.

The samples were collected by HALLIBURTON NUS Environmental Corporation from June 29 to June 30, 1992 and analyzed by CEIMIC Laboratories under Naval Energy and Environmental Support Activity (NEESA) Level C Quality Assurance/Quality Control (QA/QC) criteria. All analyses were conducted using Contract Laboratory Program Statement of Work (SOW) 7/88 analytical and reporting protocols.

Summary

All compounds were successfully analyzed. The findings offered in this report are based upon a general review of all available data incuding data completeness, holding times, calibration data, laboratory and field blank results, matrix spike/post-digestion spike recovery results, laboratory control and ICP interference check sample results, serial dilution results, field duplicate precision, compound identification and compound quantitation.

Areas of concern with respect to data quality are listed below.

Minor Problems

- Several analytes were found in associated laboratory quality control blanks. The maximum amounts of these analytes found in the blanks, and the corresponding action levels applied to the data, are listed below:

Analyte	Maximum Conc. (ug/l)	Action Level (ug/l)
Al	162	810
Be	5	25
Cd	4	20
Ca	76	380
Cr	8	40
Co	10	50
Cu	5	25
Fe	12	60
Pb	1.8	9

  Analytes that were found in the associated field quality control blank that cannot be attributed to laboratory blank contamination are listed below.

Analyte	Maximum Conc.	Action Level
Mn	3	15
Na	75	375

  Sample results affected by blank contamination and reported at concentrations less than the action level are considered to be false positives. These results are qualified (B). This rinsate blank was not used to qualify itself.

- Negative blank contamination was detected for lead and iron in the laboratory method blanks. This is indicative of baseline drifting and poor instrument response. Positive sample results for these analytes, < 10 CRDL and nondetects are biased low, qualified [coded L(n)] and [coded UL(n)], respectively.

- The calibration coefficient for one run of cyanide analyses was less than 0.995. Cyanide non-detects in the affected samples (W630RB, WMW20, WMW23, DWMW23, WMW24, WMW25, WMW26, WMW27, WMW28, WMW29, and WMW30) were qualified as estimated, [coded UJ(c)].

- The matrix spike recovery was below the lower QC limit of 75% for iron. Results were considered to be biased low and were qualified, [coded L(m)] for positive results and [coded UL(m)] for non-detects where not previously qualified due to blank contamintion.

- Graphite Furnace Atomic Absorption (GFAA) Post Digestion Spike (PDS) recoveries fell below the lower QC limit of 85% for arsenic in samples WMW19, WMW22, and WMW23, selenium in WMW18 and WMW27, and thallium in WMW26, WMW27, WMW28, WMW29, WMW30, and W630RB. These results were considered to be biased low because they are potentially influenced by poor instrument performance and sample matrix affects, and were qualified, [coded L(p)] for positive results and [coded UL(p)] for non-detects, where not previously qualified.

Notes

GFAA PDS recoveries exceeded the upper QC limit of 115% for selenium in samples WMW25, WMW28, W630RB, and WMW30. However, no qualifications were necessary since these results were non-detects.

Contract Required Detection Limit (CRDL) Standard analyses are not evaluated as qualifications are limited to high concentration samples only. All samples in this analytical data set are of low concentration.

False positives were observed for antimony, beryllium, cadmium, cobalt, copper, manganese, nickel, sodium, and vanadium in the Interference Check Sample (ICS). False negatives were observed for cadmium and manganese. However, concentrations of interferents in the ICS were not considered to be comparable to concentrations of interferents in the samples, except for WMW18. In that sample, analyte concentrations were not considered to be comparable to those in the ICS, and no qualifications were made.

In accordance with USEPA Region III data validation protocol, no qualifications are made to the data based on the evaluation of field duplicates. Tables summarizing the field duplicate results can be found in the attached HNUS/CLEAN Data Vaildation Worksheets (Appendix C).

Executive Summary

Laboratory Performance: The correlation coefficient for cyanide was less than 0.995. Several analytes were detected as laboratory method blank contaminants. CRDL standard recoveries fell outside QC limits for several analytes.

Other Factors Affecting Data Quality: Matrix spike recovery was outside QC limits for one analyte. GFAA PDS recoveries fell outside QC limits for several results.

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-10-2-273

TO: NEAL TEAMERSON **DATE:** OCTOBER 26, 1992

FROM: RICKY C. DEPAUL RCD

SUBJECT: MISCELLANEOUS DATA VALIDATION
CTO #22, WARMINSTER NAVAL BASE
CASE NO. 3933, SDG MISC

SAMPLES: 1/Aqueous/W-806-FB

Overview

The sample set for the CTO #22 Warminster site, Case No. 3933, SDG MISC, consists of one (1) water sample, a field blank designated with the suffix -FB. No field duplicates were included with this analytical data set. This sample was analyzed for the following miscellaneous parameters: alkalinity (as $CaCO_3$), ammonia (as N), chloride, Chemical Oxygen Demand (COD), Hardness (as $CaCO_3$), nitrate-nitrite (as N), sulfate, Total Dissolved Solids (TDS), Total Suspended Solids (TSS) and Total Organic Carbon (TOC).

The sample was collected by HALLIBURTON NUS Environmental Corporation on 8/6/92 and analyzed by Ceimic Corporation, under Naval Energy and Environmental Support Activity (NEESA) Level C Quality Assurance/Quality Control (QA/QC) criteria. All analyses were conducted using method-specific quality control criteria.

Summary

All miscellaneous parameters were successfully analyzed. The findings offered in this report are based upon a general review of all available data including holding times, laboratory method blank results, laboratory control sample results, and blank spike duplicate results.

No major problems were noted with the miscellaneous data. Minor problems are discussed below.

Minor Problems

The 7-day holding time for the analyses of TDS and TSS was exceeded by eleven days. The integrity of sample constituents may become compromised with prolonged holding time. The positive result for the analysis of TDS is considered to be biased low and is qualified, [coded L(h)]. The nondetected sample result for

TSS is likewise considered to be biased low and is qualified, [coded UL(h)].

No other problems were noted.

Executive Summary

Laboratory Performance: The analyses of TDS and TSS were performed out of established holding times.

Other Factors Affecting Data Quality: None.

Data for these analyses were reviewed with reference to method-specific quality control criteria and the quality control criteria outlined in the NEESA document entitled "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program", (6/88).

The text of this report has been formulated to address only those problem areas affecting data quality.

"I attest that the data referenced herein were validated according to the agreed-upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

Ricky C. DePaul

HALLIBURTON NUS Environmental Corporation

Ricky C. DePaul
Data Reviewer

Debra A. Scheib

HALLIBURTON NUS Environmental Corporation

Debra A. Scheib
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory
3. Appendix C - Support Documentation

cc: D. A. Scheib (HNUS, Pittsburgh)

A positive result for nitrate, nitrite was detected in the rinsate blank. No qualifications were made to the associated sample data because no positive results were reported for nitrate, nitrite in either other sample.

In accordance with USEPA Region III data validation protocol, no qualifications have been made to field quality control blank results which have been used to set blank contaminant action levels.

Executive Summary

Laboratory Performance: No problems were noted.

Other Factors Affecting Data Quality: The field quality control blank analyses yielded positive results for several parameters.

The data for these analyses were reviewed with reference to method-specific quality control criteria, and with respect to the quality control criteria outlined in the NEESA document entitled "Sampling and Chemical Analysis Quality Assurance requirements for the Navy Installation Restoration Program" (6/88).

The text of this report has been formulated to address only those problem areas affecting data quality.

"I attest that the data referenced herein was validated according to the agreed upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

Kelly A Johnson for

HALLIBURTON NUS Environmental Corporation

Jennifer Hubbard
Data Reviewer

HALLIBURTON NUS Environmental Corporation

Debra A. Scheib
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory

cc: D. Scheib (HNUS/Pittsburgh)

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-8-2-219

TO: NEIL TEAMERSON **DATE:** AUGUST 13, 1992

FROM: JENNIFER HUBBARD

SUBJECT: MISCELLANEOUS PARAMETERS DATA VALIDATION
CTO #22, WARMINSTER NAWC, WARMINSTER, PA
CASE NO. 3933, SDG 920333

SAMPLES: 3/water/W-

626-RB (Rinsate Blank)

MW06 MW14

Overview

The sample set for the Warminster site, Case No. 3933, SDG 920333 consists of two (2) water samples and one (1) associated rinsate blank. Following is a list of the analyses performed, the reference for the analytical method used, and the associated samples upon which the analyses were performed:

Parameter	Method Reference	Associated Samples
Total Organic Carbon (TOC)	EPA Method 415.1	All
Chemical Oxygen Demand (COD)	EPA Method 410.4	All
Hardness	EPA Method 130.2	All
Sulfate	EPA Method 375.4	All
Biological Oxygen Demand (BOD)	EPA Method 405.1	All
Total Suspended Solids (TSS)	EPA Method 160.2	All
Total Dissolved Solids (TDS)	EPA Method 160.1	All

(continued)

Parameter	Method Reference	Associated Samples
Ammonia	EPA Method 350.2	All
Chloride	EPA Method 325.2	All
Nitrate, Nitrite	EPA Method 353.3	All
Alkalinity	EPA Method 310.1	All

The samples were collected by HALLIBURTON NUS Environmental Corporation from 6/25/92 to 6/26/92 and analyzed by Ceimic Corporation Laboratories under Navy Energy and Environmental Support Activity (NEESA) Level E Quality Assurance/Quality Control (QA/QC) criteria.

Summary

All compounds were successfully analyzed. The findings offered in this report are based upon a general review of all available data including holding times until analysis, laboratory and field blank results and laboratory control sample results.

There were no areas of concern with respect to data quality; all data are accepted without qualification.

Executive Summary

Laboratory Performance: No problems were noted.

Other Factors Affecting Data Quality: No problems were encountered.

The data for these analyses were reviewed with reference to method-specific quality control criteria, and with respect to the quality control criteria outlined in the NEESA document entitled "Sampling and Chemical Analysis Quality Assurance requirements for the Navy Installation Restoration Program" (6/88).

The text of this report has been formulated to address only those problem areas affecting data quality.

"I attest that the data referenced herein was validated according to the agreed upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

Kelly A Johnson for

HALLIBURTON NUS Environmental Corporation

Jennifer Hubbard
Data Reviewer

Debra A. Scheib

HALLIBURTON NUS Environmental Corporation

Debra A. Scheib
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory

cc: D. Scheib (HNUS/Pittsburgh)

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-8-2-221

TO: NEIL TEAMERSON **DATE: AUGUST 25, 1992**

FROM: JENNIFER HUBBARD

SUBJECT: MISCELLANEOUS PARAMETERS DATA VALIDATION
CTO #22, WARMINSTER NAWC, WARMINSTER, PA
CASE NO. 3933, SDG 920336

SAMPLES: 4/water/W-

630RB (RINSATE BLANK)

MW21 MW25 MW30

Overview

The sample set for the Warminster site, Case No. 3933, SDG 920336 consists of three (3) water samples, and one (1) associated rinsate blank. No field duplicate pairs were included with this sample set.

The samples were analyzed for the following list of parameters:

Total Organic Carbon (TOC)	EPA Method 415.1
Chemical Oxygen Demand (COD)	EPA Method 410.4
Hardness	EPA Method 130.2
Sulfate	EPA Method 375.4
Biological Oxygen Demand (BOD)	EPA Method 405.1
Total Suspended Solids (TSS)	EPA Method 160.2
Total Dissolved Solids (TDS)	EPA Method 160.1
Ammonia	EPA Method 350.2
Chloride	EPA Method 325.2
Nitrate, Nitrite	EPA Method 353.3
Alkalinity	EPA Method 310.1

The samples were collected by HALLIBURTON NUS Environmental Corporation from 6/29/92 to 6/30/92 and analyzed by Ceimic Corporation Laboratories under Navy Energy and Environmental Support Activity (NEESA) Level E Quality Assurance/Quality Control (QA/QC) criteria.

Summary

All compounds were successfully analyzed. The findings offered in this report are based upon a general review of all available data including holding times until analysis, laboratory blank and laboratory control sample results.

Areas of concern with respect to data quality are discussed below.

Minor Problems

- A concentration of 23 mg/L TSS was detected in the associated rinsate blank. The result reported for TSS in sample W-MW-21 (44 mg/L) is considered to be a false positive result attributable to blank contamination. This value has been qualified, B, accordingly. No other environmental sample values were deemed to be affected.

Note

Concentrations of nitrate, nitrite and TDS were also detected in the associated rinsate blank. No qualifications were made to the environmental sample data as the levels of these parameters found in the samples are sufficiently above the level felt to be attributable to blank contamination.

In accordance with USEPA Region III data validation protocol, no qualifications have been made to field quality control blank results which have been used to set blank contaminant action levels.

Executive Summary

Laboratory Performance: No problems were noted.

Other Factors Affecting Data Quality: Several parameters were present in the field quality control blank.

The data for these analyses were reviewed with reference to method-specific quality control criteria, and with respect to the quality control criteria outlined in the NEESA document entitled "Sampling

and Chemical Analysis Quality Assurance requirements for the Navy Installation Restoration Program" (6/88).

The text of this report has been formulated to address only those problem areas affecting data quality.

"I attest that the data referenced herein was validated according to the agreed upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

Kelly A Johnson for

HALLIBURTON NUS Environmental Corporation

Jennifer Hubbard
Data Reviewer

Debra A. Scheib

HALLIBURTON NUS Environmental Corporation

Debra A. Scheib
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory

cc: D. Scheib (HNUS/Pittsburgh)

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-9-2-273

TO: NEIL TEAMERSON **DATE:** SEPTEMBER 22, 1992

FROM: JENNIFER HUBBARD

SUBJECT: MISCELLANEOUS PARAMETERS DATA VALIDATION
CTO #22, WARMINSTER NAWC, WARMINSTER, PA
CASE NO. 3933, SDG 920343

SAMPLES: 4/water/W-

MW31 MW31-D MW32 MW35

Overview

The sample set for the Warminster site, Case No. 3933, SDG 920343 consists of four (4) water samples, (including one field duplicate pair, the duplicate member of which is designated -D following the station location name). No field quality control blanks were analyzed with this sample set.

The samples were analyzed for the following list of parameters:

Total Organic Carbon (TOC)*	EPA Method 415.1
Chemical Oxygen Demand (COD)	EPA Method 410.4
Hardness	EPA Method 130.2
Sulfate	EPA Method 375.4
Biological Oxygen Demand (BOD)	EPA Method 405.1
Total Suspended Solids (TSS)	EPA Method 160.2
Total Dissolved Solids (TDS)	EPA Method 160.1
Ammonia	EPA Method 350.2
Chloride	EPA Method 325.2
Nitrate, Nitrite	EPA Method 353.3
Alkalinity	EPA Method 310.1

* Sample W-MW35 was not analyzed for TOC.

The samples were collected by HALLIBURTON NUS Environmental Corporation from 7/1/92 to 7/2/92 and analyzed by Ceimic Corporation Laboratories under Navy Energy and Environmental Support Activity (NEESA) Level E Quality Assurance/Quality Control (QA/QC) criteria.

Summary

All compounds were successfully analyzed. The findings offered in this report are based upon a general review of all available data including holding times until analysis, laboratory blank and laboratory control sample results, and field duplicate precision.

There were no areas of concern with respect to data quality; all data are accepted without qualification. Items of note are discussed below.

Note

In accordance with USEPA Region III data validation protocol, no qualifications are made to the data based on field duplicate precision. The attached Table-1 summarizes the results reported for field duplicate pairs.

Executive Summary

Laboratory Performance: No problems were noted.

Other Factors Affecting Data Quality: No problems were encountered.

The data for these analyses were reviewed with reference to method-specific quality control criteria, and with respect to the quality control criteria outlined in the NEESA document entitled "Sampling and Chemical Analysis Quality Assurance requirements for the Navy Installation Restoration Program" (6/88).

The text of this report has been formulated to address only those problem areas affecting data quality.

"I attest that the data referenced herein was validated according to the agreed upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

Kelly A. Johnson for

HALLIBURTON NUS Environmental Corporation

Jennifer Hubbard
Data Reviewer

Debra A. Scheib

HALLIBURTON NUS Environmental Corporation

Debra A. Scheib
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory

cc: D. Scheib (HNUS/Pittsburgh)

Table-1A

COMPARISON OF FIELD DUPLICATE RESULTS

Parameter	Sample ID W-MW31	Duplicate ID W-MW31-D	RPD
TOC	2.6	2.7	-3.77
Alkalinity	34	45	-27.8
Ammonia	0.3	0.3	0
Chloride	45	45	0
Hardness	224	202	10.3
Nitrate, nitrite	1.32	1.42	-7.30
Sulfate	188	195	-3.66
TDS	351	372	-5.81
TSS	3,100	214	174

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory

cc: D. Scheib (HNUS/Pittsburgh)

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-2-9-222

TO: NEIL TEAMERSON

DATE: SEPTEMBER 23, 1992

FROM: JENNIFER HUBBARD

COPIES: D. A. SCHEIB

SUBJECT: INORGANIC DATA VALIDATION - TAL METALS (DISSOLVED)
WARMINSTER NAVAL BASE
CASE NO. 3933, SDG MW41

(DW-MW-41)

SAMPLES:

DWMW45

W-

MW41 MW42 MW43 MW44 MW45 MW46

Overview

The sample set for the Warminster site, Case No. 3933, SDG MW41, consists of seven (7) filtered water samples. These samples were analyzed for dissolved Target Analyte List (TAL) metals. No field quality control blanks were included with this analytical data set.

The samples were collected by HALLIBURTON NUS on 07/06/92 and analyzed by CEIMIC Laboratories under Naval Energy and Environmental Support Activity (NEESA) Level C Quality Assurance/Quality Control (QA/QC) criteria. All analyses were conducted using Contract Laboratory Program Statement of Work (SOW) 7/88 analytical and reporting protocols.

Summary

All compounds were successfully analyzed with the exception of those which were rejected, qualified [coded R]. The findings offered in this report are based upon a general review of all available data including data completeness, holding times, calibration data, laboratory blank results, matrix and post-digestion spike recovery results, laboratory duplicate results, ICP serial dilution results, laboratory control and ICP interference check sample results, compound identification and compound quantitation.

Areas of concern with respect to data quality are listed below.

Major Problems

- The matrix spike recovery for mercury (0%) was extremely low (< 30%). Only nondetects were reported for this analyte, and these results are qualified as rejected, [coded R], and considered to be unreliable.

Minor Problems

- Several analytes were found as contaminants in the associated laboratory blanks. The maximum blank concentrations and the corresponding action levels, which are applied to the data, are listed below:

Analyte	Maximum Concentration (ug/L)	Action Level (ug/L)
aluminum	107	535
beryllium	4.0	20.0
cadmium	4.0	20.0
calcium	63.0	315
cobalt	7.0	35.0
copper	5.0	25.0
potassium	448	2240
sodium	103	515
thallium	3.0	15.0

  Sample results affected by blank contamination and reported at concentrations less than the action level are considered to be false positives. These results are qualified, [coded B].

- Negative concentrations, whose absolute values were > IDL, were reported for lead in the laboratory method blanks. Positive results and nondetects for this analyte are qualified as biased low, [coded L(n) and UL(n)], respectively.

- Matrix spike recoveries for lead and selenium were greater than 125% upper quality control limit. Positive results for lead were qualified as biased high, [coded K(m)]. No actions were taken for selenium since no positive results were reported for this analyte.

- The graphite furnace Post Digestion Spike (PDS) recovery for arsenic in sample WMW41 fell below the 85% lower quality control limit. The nondetect in this

sample was qualified, [coded UL(p)], biased low based on the potential influence of sample matrix interference.

Notes

Contract Required Detection Limit (CRDL) Standard analysis recoveries for several analytes were poor. No actions were needed since qualifications are limited to high concentration samples; all of the samples in this analytical data set are of low concentration.

Several elements, including antimony, beryllium, cadmium, cobalt, copper, nickel, potassium, sodium, and vanadium, were detected as false positives in the Interference Check Samples (ICS). Manganese was detected as a false negative. However, results were not qualified since the field samples did not contain concentrations of interferents or analytes comparable to concentrations detected in the ICS.

The graphite furnace PDS recovery fell below the lower QC limit of 85% for thallium in sample WMW44. However, this result had already been attributed to blank contamination, and further qualification was unnecessary. Graphite furnace PDS recoveries exceeded the upper QC limit of 115% for selenium in samples WMW42, WMW43, WMW44, DWMW45, and WMW46. However, no positive selenium results were reported for these samples, thus, no qualifiers were necessary.

Executive Summary

Laboratory Performance: Several analytes were detected as laboratory method blank contaminants. Lead was reported at negative concentrations in the laboratory method blanks. CRDL standard recoveries fell outside QC limits for several analytes.

Other Factors Affecting Data Quality: Matrix spike and GFAA PDS recoveries fell outside QC limits for several analytes.

The data for these analyses were reviewed with reference tot he "National Functional Guidelines for Inorganic Data Validation" (7/88), as amended for use within USEPA Region III, and the NEESA document entitled "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program".

The text of this report has been formulated to address only those problem areas affecting data quality. Documentation of compliance for non-problem areas is presented in the attached Appendix C (HNUS/CLEAN Data Validation Worksheets.)

"I attest that the data referenced herein were validated according to the agreed-upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

HALLIBURTON NUS Environmental Corporation

Jennifer Hubbard
Data Reviewer

HALLIBURTON NUS Environmental Corporation

Debra A. Scheib
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory
3. Appendix C - HNUS/CLEAN Data Validation Worksheets
4. Appendix D - Support Documentation

cc: D. A. Scheib

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-9-2-220

TO: NEIL TEAMERSON

DATE: SEPTEMBER 23, 1992

FROM: JENNIFER HUBBARD

COPIES: D. A. SCHEIB

SUBJECT: INORGANIC DATA VALIDATION - TAL METALS (~~TOTAL~~) DISSOLVED
NAWC WARMINSTER
CASE NO. 3933, SDG WMW31
(DW-MW-31)

SAMPLES:

W-

MW31	MW31-DP	MW32	MW33	MW34	MW35
MW36	MW37	MW38	MW39	MW39-DP	MW40

702RB-Rinsate Blank

Overview

The sample set for the Warminster site, Case No. 3933, SDG WMW31, consists of twelve (12) filtered water samples (including two field duplicate pairs, the duplicate members of which are designated -DP), and one (1) associated field quality control blank. These samples were analyzed for Target Analyte List (TAL) Metals.

The samples were collected by HALLIBURTON NUS Environmental Corporation from 7/1/92 to 7/2/92 and analyzed by CEIMIC Corporation Laboratories under Naval Energy and Environmental Support Activity (NEESA) Level C Quality Assurance/Quality Control (QA/QC) criteria. All analyses were conducted using Contract Laboratory Program (CLP) Statement of Work (SOW) 7/88 analytical and reporting protocols.

Summary

All compounds were successfully analyzed. The findings offered in this report are based upon a general review of all available data inlcuding data completeness, holding times, calibration data, laboratory and field blank results, matrix spike recovery results, laboratory control and ICP interference check sample results, field duplicate precision, compound identification and compound quantitation.

Areas of concern with respect to data quality are listed below.

Minor Problems

- Several analytes were detected as contaminants in the associated laboratory method blanks. The maximum

amounts of these analytes found in the blanks, and the corresponding action levels applied to the data, are listed below:

Analyte	Maximum Conc. (ug/l)	Action Level
Aluminum	107	535
Beryllium	5.0	25.0
Cadmium	4.0	20.0
Calcium	77.0	385
Chromium	9.0	45.0
Cobalt	6.0	30.0
Copper	5.0	25.0
Iron	25.0	125
Manganese	1.0	5.0
Nickel	18.0	90.0
Sodium	132	660
Vanadium	5.0	25.0

One analyte was found in the associated filtered rinsate blank that cannot be attributed to laboratory blank contamination. It's concentration and the corresponding action level is shown below.

Analyte	Maximum Conc. (ug/l)	Action Level
Zinc	5.0	25.0

Sample results affected by blank contamination and reported at concentrations less than the action level are considered to be false positives. These results are qualified, [coded (B)]. The rinsate blank was not used to qualify itself.

- Negative concentrations ≥ IDL were reported for lead in the laboratory method blanks. Negative blank contamination is indicative of baseline drifting and poor instrument response. Nondetects for this analyte were qualified as biased low, [coded UL(n)]. Positive results reported for lead which were < 10X CRDL are qualified, [coded L(n)].

- Laboratory duplicate imprecision was observed for zinc. Positive results and nondetects for this analyte are qualified as estimated, [coded J(d)],

(where not qualified for blank contamination) and [coded UJ(d)], respectively, because the exact quantitation of this analyte may not be accurate.

- Graphite Furnace Atomic Absorption (GFAA) Post Digestion Spike (PDS) recoveries fell below the lower quality control limit of 85% for lead in samples WMW35, MW39DP and WMW40, and thallium in sample WMW36. These results are considered to be biased low because of potential sample matrix affect, and were qualified, [coded L(p)] for positive results, and [coded UL(p)] for nondetects where not qualified for blank contamination.

Notes

The matrix spike recovery for mercury exceeded the 125% upper quality control limit. However, no qualifications were necessary as only nondetected sample results were reported for this analyte in the environmental samples.

GFAA PDS recoveries for selenium exceeded the 115% upper control limit in all samples. However, only nondetected sample results were reported for this analyte which are not compromised; hence not actions were required.

Contract Required Detection Limit (CRDL) Standard analysis recoveries for several analytes failed to meet the 80-120% quality control criteria. No actions were taken because qualificatios are limited to high concentration samples only; all samples in this analytical data set are of low concentraiton.

Several analytes which were not supposed to be present in the ICS (Interference Check Sample) solution were present at concentrations which exceeded the IDL. However, the interferring analytes (aluminum, calcium, iron and magnesium) were not present in the environmental samples at comparable levels of that detected in the ICS solution and no actions were necessary.

Executive Summary

Laboratory Performance: Several analytes were detected as laboratory method blank contaminants. Lead was detected as negative blank contamination in the laboratory method blanks. CRDL standard recoveries fell outside quality control limits for several analytes. Laboratory duplicate imprecision was noted for

zinc.

Other Factors Affecting Data Quality: Zinc was detected in the field quality control blank and could not be attributed to laboratory blank contamination. Matrix spike and GFAA PDS recoveries fell outside QC limits for several analytes.

The data for these analyses were reviewed with reference tot he "National Functional Guidelines for Inorganic Data Validation" (7/88), as amended for use within USEPA Region III, and the NEESA document entitled "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program".

The text of this report has been formulated to address only those problem areas affecting data quality. Documentation of compliance for non-problem areas is presented in the attached Appendix C (HNUS/CLEAN Data Validation Worksheets.)

"I attest that the data referenced herein were validated according to the agreed-upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

HALLIBURTON NUS Environmental Corporation

Jennifer Hubbard
Data Reviewer

HALLIBURTON NUS Environmental Corporation

Debra A. Scheib
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory
3. Appendix C - HNUS/CLEAN Data Validation Worksheets
4. Appendix D - Support Documentation

cc: D. A. Scheib

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-9-2-220

TO: NEIL TEAMERSON

DATE: SEPTEMBER 23, 1992

FROM: JENNIFER HUBBARD

COPIES: D. A. SCHEIB

SUBJECT: INORGANIC DATA VALIDATION - TAL METALS (TOTAL)
NAWC WARMINSTER
CASE NO. 3933, SDG WMW31

SAMPLES: (TW-MW-31)

W-

702RB-Rinsate Blank

MW31	MW31DP	MW32	MW33	MW34	MW35
MW36	MW37	MW38	MW39	MW39DP	MW40

Overview

The sample set for the Warminster site, Case No. 3933, SDG WMW31, consists of twelve (12) water samples and one (1) associated field quality control blank. These samples were analyzed for Total Target Analyte List (TAL) Metals and cyanide. Two field duplicate pairs (the duplicates are designated by DP following the station location name), were included with this sample set.

The samples were collected by HALLIBURTON NUS from July 1 to 2, 1992 and analyzed by CEIMIC Laboratories under Naval Energy and Environmental Support Activity (NEESA) Level C Quality Assurance/Quality Control (QA/QC) criteria. All analyses were conducted using Contract Laboratory Program Statement of Work (SOW) 7/88 analytical and reporting protocols.

Summary

All compounds were successfully analyzed with the exception of those results which were rejected, qualified [coded (R)]. The findings offered in this report are based upon a general review of all available data incuding data completeness, holding times, calibration data, laboratory and field blank results, matrix spike/post-digestion spike recovery results, laboratory control and ICP interference check sample results, serial dilution results, field duplicate precision, compound identification and compound quantitation.

Areas of concern with respect to data quality are listed below.

Major Problems

- Matrix spike recovery was extremely low (0%) for selenium; nondetects are considered to be unreliable and were rejected [coded (R)].

Minor Problems

- Several analytes were found in associated laboratory blanks. The maximum amounts of these analytes found in the blanks, and the corresponding action levels applied to the data, are listed below:

Analyte	Maximum Conc. (ug/l)	Action Level (ug/l)
Al	107	535
Be	5	25
Cd	4	20
Ca	76	380
Cr	9	45
Co	6	30
Cu	5	25
Fe	46	230
Mn	1	5
Ni	18	90
Na	149	745
V	5	25
Zn	8	40

Analytes that were found in the associated field quality control blank which could not be attributed to laboratory blank contamination are listed below. This rinsate blank was not used to qualify itself.

Analyte	Maximum Conc. (ug/l)	Action Level (ug/l)
Pb	1.3	6.5
Mg	48	240

Sample results affected by blank contamination and reported at concentrations less than the action level are considered to be false positives. These results are qualified, [coded (B)].

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-10-2-298

TO: NEIL TEAMERSON **DATE:** OCTOBER 29, 1992

FROM: RICKY C. DEPAUL

SUBJECT: INORGANIC DATA VALIDATION - TAL METALS & CYANIDE
CTO #22, WARMINSTER NAVAL BASE
CASE NO. 3933, SDG TW-OS-01

SAMPLES: 10/Aqueous/

TW-OS-

01 01-D 02 03 04

TW-SW-

07 08 08-D

TW-

806-FB 806-FB

3/Soil/

TW-SD-

07 08 08-D

Overview

The sample set for the CTO #22, Warminster Naval Base site, Case No. 3933, SDG TW-OS-01, consists of eight (8) water samples (including two field duplicate pairs, the duplicate members of which were designated -D), three (3) soil samples (including a field duplicate designated as -D), and two associated field quality control blanks (i.e. one field blank designated -FB, and one rinsate blank designated -RB). These samples were analyzed for Target Analyte List (TAL) metals and cyanide.

The samples were collected by HALLIBURTON NUS Environmental Corporation on 8/6/92 and 8/12/92 and analyzed by CEIMIC Corporation, under Naval Energy and Environmental Support

Activity (NEESA) Level D Quality Assurance/Quality Control (QA/QC) criteria. All analyses were conducted using Contract Laboratory Program (CLP) Statement of Work (SOW) 3/90 analytical and reporting protocols.

Summary

All metals were successfully analyzed in all samples with the exception of those results rejected, [coded (R)]. The findings offered in this report are based upon a general review of all available data including data completeness, holding times, calibration data, laboratory method and field quality control blank results, matrix spike and post digestion spike recoveries, laboratory control sample results, ICP interference check sample results, laboratory duplicate results, graphite furnace results, ICP serial dilution results, and analyte quantitation.

Areas of concern with respect to data quality are listed below.

Major Problems

- The Matrix Spike (MS) Percent Recovery (%R) for mercury (0.0%) was extremely low (< 30.0%) for the aqueous matrix, suggesting the presence of severe sample matrix interferences which lead to uncertainties with respect to the affected analyte's detection and quantitation. Only nondetects were reported for this analyte in the water samples; these results are considered unreliable and qualified as rejected, [coded R(m)].

Minor Problems

- The following analytes were detected as contaminants in the laboratory method blanks at the maximum concentrations indicated:

Analyte	Maximum Concentration	Aqueous Action Level	Soil Action Level
aluminum	12.0 mg/kg	N/A	60.0 mg/kg
	66.0 ug/L	330 ug/L	N/A
cadmium	3.0 ug/L	15.0 ug/L	3.0 mg/kg
calcium	11.0 mg/kg	N/A	55.0 mg/kg
	107 ug/L	535 ug/L	N/A
chromium	7.0 ug/L	35.0 ug/L	7.0 mg/kg
copper	6.0 ug/L	30.0 ug/L	6.0 mg/kg
iron	5.4 mg/kg	N/A	27.0 mg/kg
	37.0 ug/L	185 ug/L	N/A
lead	0.47 mg/kg	N/A	2.35 mg/kg
magnesium	42.0 ug/L	210 ug/L	42.0 mg/kg
manganese	0.20 mg/kg	N/A	1.0 mg/kg
	1.0 ug/L	5.0 ug/L	N/A
sodium	31.0 mg/kg	N/A	155 mg/kg
	273 ug/L	1360 ug/L	N/A
vanadium	5.0 ug/L	25.0 ug/L	5.0 mg/kg
zinc	1.0 mg/kg	N/A	5.0 mg/kg
	7.0 ug/L	35.0 ug/L	N/A

Positive sample results for these analytes less than or equal to the established action level are qualified, [B]. Dilution factors, sample size, and percent solids were considered when applying these action levels. These results are considered to be false positives attributable to blank contamination.

- Lead (which could not be attributed to laboratory blank contamination) was detected in the field blank at a concentration of 2.2 ug/L. Action levels of 11.0 ug/L and 2.2 mg/kg were applied to the aqueous samples, soil samples, respectively. Dilution factors, sample size, and percent solids were considered when applying these action levels. Positive sample results for lead less than or equal to the action level are qualified, [B]; these results are false positive results attributable to blank contamination.

- The Matrix Spike (MS) Percent Recovery (%R) for lead (497.4%) for the soil matrix greatly exceeded the 125% upper quality control limit. A review of the associated raw data yielded no evidence of laboratory error, hence, the presence of significant matrix effects is suspected. Only positive sample results for

lead are potentially affected by this non-compliance, and these results are qualified as biased high, [coded K(m)].

- Several problems were noted for the analysis of lead for the aqueous matrix. Poor instrument performance was noted for this analyte as a result of negative concentrations reported in the laboratory method blanks (positive results < 10X CRDL and nondetects are affected.) Also, the laboratory duplicate Relative Percent Difference (%RPD) for lead (27.0%) was high (> 20%) for the aqueous matrix. Finally, the Graphite Furnace Atomic Absorption (GFAA) Post Digestion Spike (PDS) %Rs for lead in samples TW-OS-02 (127.0%), TW-OS-03 (128.2%) and TW-SW-07 (123.2%) exceeded the 115% upper quality control limit.

  Positive lead results in aqueous samples TW-OS-01 and TW-OS-01-D are qualified as estimated, [coded J(d)], based on laboratory duplicate imprecision; bias unknown. The positive result for lead in sample TW-806-FB is qualified as estimated, [coded J(d,n)], based on laboratory duplicate imprecision and negative concentrations reported in the laboratory method blanks; bias unknown. Likewise, nondetects for this analyte in samples TW-OS-04 and TW-806-RB are qualified as estimated, [coded UJ(d,n)]. No actions were taken for the remaining aqueous sample results for lead because these results are qualified based on false positives attributable to blank contamination.

- The MS %R for manganese (593.2 %) failed to meet the 125% upper quality control limit for the soil matrix. A review of the associated raw data yielded no evidence of laboratory error, hence, the presence of significant matrix effects is suspected. Only positive sample results were reported for this analyte in soils. These results are qualified as biased high, [coded K(m)].

- The GFAA PDS %R for arsenic in sample TW-OS-01-D (81.2%) was below the 85% lower quality control limit. The positive sample result for this analyte in this sample is qualified as potentially biased low, [coded L(p)].

- GFAA PDS %Rs for selenium in samples TW-806-FB (83.0%) and TW-806-RB (76.0%) were less than the 85% lower

control limit. Only nondetects were reported for this analyte in these samples, and these results are considered to be biased low and are qualified, [coded UL(p)], accordingly.

- The MS %R for thallium for the aqueous matrix was below the 75% lower control limit. In addition, thallium GFAA PDS spike recoveries for samples TW-OS-01 (72.8%), TW-OS-01-D (67.5%) and TW-OS-02 (84.5%) failed to meet the 85% lower control limit. The nondetects for thallium in these samples are qualified as biased low, [coded UL(m,p)]. Nondetects in the remaining samples are qualified as biased low, [coded UL(m)]. Results for these samples are felt to have been influenced by the presence of sample matrix interferences.

Notes

Negative concentrations, whose absolute values were > IDL, were reported for lead in the laboratory method blanks. These occurrences suggest poor instrument performance (base-line drifting). None of the sample data were impacted, however, because all results reported for lead (which were not qualified based on field blank contamination), were reported at concentrations > 10X CRDL. The impact of any potential low bias upon results reported at this level of concentration are deemed insignificant.

Recoveries for numerous analytes failed to meet the 80-120% quality control criteria for the Contract Required Detection Limit (CRDL) Standard analyses. However, in accordance with USEPA Region III data validation protocol, no corrective actions are necessary for low concentration samples.

Several analytes, other than lead, were detected in the field quality control blanks. Results for these analytes, however, were attributed to laboratory method blank contamination.

GFAA PDS recoveries for arsenic and selenium in some samples were high (> 115%). However, only nondetects were reported for these analytes in the affected samples, and these results are not compromised by high PDS recoveries. Hence, no actions were required.

In accordance with USEPA Region III data validation protocol, no qualifications are made to the sample data based on field duplicate results. Tables summarizing the field duplicate results can be found in the attached HNUS/CLEAN Data Validation Worksheets (APPENDIX C).

No other problems were noted.

Executive Summary

Laboratory Performance: Several analytes were detected as contaminants in the laboratory method blanks. Negative concentrations were reported for lead in the laboratory method blanks. Poor laboratory duplicate precision was observed for lead in the water matrix.

Other Factors Affecting Data Quality: Lead was detected as a contaminant in the associated field blank. The soil matrix spike recoveries for lead and manganese were high. The aqueous matrix spike recovery for mercury was extremely low, while the matrix spike recovery for thallium was relatively low. Several GFAA PDS recoveries for arsenic, selenium and thallium were outside quality control limits.

Data for these analyses were reviewed with reference to the "National Functional Guidelines for Inorganic Data Validation" (7/88), as amended for use within USEPA Region III, and the NEESA document entitled "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program", (6/88).

The text of this report has been formulated to address only those problem areas affecting data quality. Documentation of compliance for non-problem areas is presented in the attached Appendix C (HNUS/CLEAN Data Validation Worksheets.)

"I attest that the data referenced herein were validated according to the agreed-upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

Ricky C. DePaul

HALLIBURTON NUS Environmental Corporation

Ricky C. DePaul
Data Reviewer

HALLIBURTON NUS Environmental Corporation

Debra A. Scheib
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results.
2. Appendix B - Results as Reported by the Laboratory.
3. Appendix C - HNUS\CLEAN Data Validation Worksheets.
4. Appendix D - Support Documentation.

cc: D. A. Scheib (HNUS, Pittsburgh)

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-10-2-311

TO: NEIL TEAMERSON **DATE:** OCTOBER 30, 1992

FROM: KENT WEAVER

SUBJECT: ORGANIC DATA VALIDATION - LOW CONCENTRATION VOLATILE ORGANICS/TCL SEMIVOLATILE AND PESTICIDE/PCB ORGANIC COMPOUNDS

CTO #22, WARMINSTER NAVAL BASE
CASE NO. 3933, SDG W-OS-01 (LC)

SAMPLES: 6/Aqueous/W-

OS-01	OS-01-D	OS-02
OS-03	OS-04	

806-TB

Overview

The sample set for the CTO #22, Warminster Naval base site, Case No. 3933, SDG W-OS-01 (LC), consists of a total of five aqueous samples (including one field duplicate pair, the duplicate member of which is designated -D), and one associated trip blank (designated -TB.)

All samples were analyzed for low-concentration volatile organic compounds using USEPA Method 524.2. In addition, samples OS-01 and OS-01-D were analyzed for TCL (Target Compound List) semivolatile and pesticide/PCB organic compounds using Contract Laboratory Program (CLP) Statement of Work (SOW) 3/90 analytical methods.

The samples were collected by HALLIBURTON NUS Environmental Corporation on 8/17/92 and analyzed by CEIMIC Corporation Laboratories under Naval Energy and Environmental Support Activity (NEESA) Level C Quality Assurance/Quality Control (QA/QC) criteria. The data for these analyses were reported in accordance with CLP SOW 3/90 reporting protocols.

Summary

All compounds were successfully analyzed with the exception of those results qualified as unreliable, [R]. The findings offered in this report are based upon a general review of all available data including data completeness, holding times until extraction/

analysis, initial and continuing calibration data, laboratory and field blank results, internal standards performance, surrogate spike and matrix spike/matrix spike duplicate recoveries, field duplicate precision, compound identification and quantitation, and Tentatively Identified Compound (TIC) evaluation.

Areas of concern with respect to data quality are listed below.

Minor Problems

- Some initial and continuing calibration Relative Response Factors (RRFs) for acetone and 2-butanone failed to meet the 0.50 minimum quality control criterion, indicating significant instrumental reproducibility problems and lack of sensitivity. Only nondetects were reported for these compounds in affected samples, and these results are considered to be unreliable and are qualified as rejected, [coded R(c)]. The bias for these results is considered to be very low.

- The following compound was found in the laboratory method blanks in the maximum concentration indicated:

Compound	Maximum Concentration	Action Level
methylene chloride	2 ug/L	20 ug/L

  Dilution factors were considered during application of this action level. Results reported for this compound at concentrations within the action level have been qualified, [B], and are considered to be false positives (artifacts of blank contamination.)

- Low recoveries for the pesticide surrogate spike compound decachlorobiphenyl (DCB) were noted for the laboratory method blank analysis and for sample W-OS-01-D (as well as for the MS analysis which was performed using this sample.) These occurrences indicate poor laboratory performance and the potential presence of sample matrix interferences. Nondetects for all compounds in the affected sample have been qualified as biased low, [coded UL(s)]; no positive results were reported.

- Positive results for several compounds are qualified as estimated, [J], because they are reported at

concentrations below the Contract Required Quantitation Limit (CRQL).

Notes

Continuing calibration %Ds for methylene chloride exceeded 25%. No qualifications to the data were necessary, however, as all positive results reported for methylene chloride were qualified based on blank contamination.

In accordance with USEPA Region III data validation protocol, no qualifications are made to the data based on field duplicate precision.

No Tentatively Identified Compounds (TICs) were found in any sample.

No other problems were noted.

Executive Summary

Laboratory Performance: Initial and continuing calibration RRFs for two compounds were below 0.50. Methylene chloride was detected in the laboratory method blank analyses.

Other Factors Affecting Data Quality: Some recoveries for the pesticide/PCB surrogate DCB did not meet advisory limits.

The data for these analyses were reviewed with reference to the "National Functional Guidelines for Organic Data Validation" (2/88), as amended for use within USEPA Region III, and the NEESA document entitled "Sampling and Chemical Analysis Quality Assurance requirements for the Navy Installation Restoration Program" (6/88).

The text of this report has been formulated to address only those problem areas affecting data quality.

"I attest that the data referenced herein was validated according to the agreed upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

HALLIBURTON NUS Environmental Corporation

Kent Weaver
Data Reviewer

HALLIBURTON NUS Environmental Corporation

Debra A. Scheib
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results (including TICs)
2. Appendix B - Results as Reported by the Laboratory (including TICs)
3. Appendix C - Support Documentation

cc: D. Scheib (HNUS, Pittsburgh)

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-10-2-285

TO: NEIL TEAMERSON **DATE:** OCTOBER 28, 1992

FROM: RICKY C. DEPAUL

SUBJECT: INORGANIC DATA VALIDATION - TAL METALS (DISSOLVED)
CTO #22, WARMINSTER NAVAL BASE
CASE NO. 3933, SDG W-OS-01

SAMPLES: 9/Aqueous/

W-OS-

01	01-D	02	03	04

W-SW-

07	08	08-D

W806FB

Overview

The sample set for the CTO #22 Warminster Naval Base site, Case No. 3933, SDG W-OS-01, consists of nine (9) filtered water samples and one (1) associated filtered field blank (designated with the suffix -FB). Two field duplicates (designated -D) were included with this analytical data set. These samples were analyzed for dissolved Target Analyte List (TAL) metals (excluding cyanide.)

The samples were collected by HALLIBURTON NUS Environmental Corporation on 8/6/92 and 8/12/92 and analyzed by CEIMIC Corporation under Naval Energy and Environmental Support Activity (NEESA) Level D Quality Assurance/Quality Control (QA/QC) criteria. All analyses were conducted using Contract Laboratory Program (CLP) Statement of Work (SOW) 3/90 analytical and reporting protocols.

Summary

All metals were successfully analyzed in all samples. The findings offered in this report are based upon a general review of all available data including data completeness, holding times, calibration data, laboratory method and field blank results, matrix spike and post digestion spike recoveries, laboratory

control sample results, ICP interference check sample results, laboratory duplicate results, graphite furnace atomic absorption results, ICP serial dilution results, and analyte quantitation.

No major problems were noted. Minor problems and items of note are listed below.

Minor Problems

- The following analytes were detected as contaminants in the laboratory method blanks at the maximum concentrations indicated:

Analyte	Maximum Concentration (ug/L)	Aqueous Action Level (ug/L)
aluminum	134	670
beryllium	5.0	25.0
cadmium	4.0	20.0
calcium	439	2200
chromium	6.0	30.0
copper	15.0	75.0
iron	82.0	410
lead	2.2	11.0
magnesium	215	1080
manganese	1.0	5.0
nickel	22.0	110
potassium	451	2260
sodium	282	1410
vanadium	5.0	25.0
zinc	4.0	20.0

  Positive sample results for these analytes less than or equal to the established action level are qualified, [B]. These results are considered to be false positives attributable to blank contamination. No actions were necessary for calcium and nickel since no positive results were reported for nickel and all positive calcium results exceeded the action level.

- Negative concentrations, whose absolute values were > IDL, were reported for lead in the laboratory method blanks. These occurrences suggest poor instrument performance (base-line drifting) and possible

compromise of analyte detection and quantitation. Nondetects for this analyte are qualified as biased low, [coded UL(n)].

The positive result for lead in sample W-OS-01-D is not affected by the negative concentrations reported in the associated laboratory blank analyses because it is reported at a concentration >10X CRDL (thus any potential low bias is not deemed significant.) However, this result is affected by a high Matrix Spike Percent Recovery (i.e. MS %R > 125%) and is, therefore, qualified as biased high, [coded K(m)]. Only positive results (not discounted as false positives attributable to blank contamination) are affected by this high matrix spike recovery.

The positive lead result for sample W-OS-01 is affected both by the negative concentrations occurring in the laboratory blanks and the high matrix spike recovery. Because the bias for this result cannot be determined, this result is qualified as estimated, [coded J(m,n)].

- The laboratory duplicate Relative Percent Difference (%RPD) for cadmium (200%) failed to meet the 20% quality control limit for waters, indicating a lack of precision for the laboratory analyses. All positive sample results for cadmium are qualified due to blank contamination, thus, no further actions are required. Nondetects for this analyte are considered to be estimated and are qualified, [coded UJ(d)], as the bias for these results could not be determined.

- ICP serial dilution Percent Differences (%Ds) for calcium and magnesium exceeded the 10% quality control limit (undiluted sample results were > 50X the respective IDL), thus indicating potential suppression of the responses for these analytes. Positive results not qualified due to blank contamination and nondetects for these analytes are considered estimated and are qualified, [coded J(o), UJ(o)], respectively. The direction of bias is not certain.

- Graphite Furnace Atomic Absorption (GFAA) Post Digestion Spike (PDS) %Rs for selenium in sample W-OS-03 (84.0%) and thallium in samples W-OS-01 (81.8%), W-OS-02 (80.2%), W-OS-03 (83.2%), W-SW-07 (82.0%) and W-SW-08-D (84.5%) failed to meet the 85% lower quality

control limit. Only nondetects were reported for these analytes in the affected samples, and these results are qualified as biased low, [coded UL(p)], based on the possible influences of sample matrix effects.

Notes

Recoveries for numerous analytes failed to meet the 80-120% quality control criteria for the Contract Required Detection Limit (CRDL) Standard analyses. However, in accordance with USEPA Region III data validation protocol, no corrective actions are necessary for low concentration samples.

All positive results reported in the field blank, sample W-806-FB, were attributed to laboratory method blank contamination.

GFAA PDS recoveries for arsenic in four samples failed to meet the 115% upper quality control limit. However, only nondetects were reported for this analyte in the affected samples, and these results were not felt to have been compromised. Hence, no actions were required.

The laboratory did not analyze a Laboratory Control Sample (LCS) for mercury. Therefore, the mercury sample data could not be evaluated for this parameter.

In accordance with USEPA Region III data validation protocol, no qualifications are made to the data based on field duplicate results. A comparison of these results are presented in Appendix C (HNUS/CLEAN Data Validation Worksheets).

No other problems were noted.

Executive Summary

Laboratory Performance: Several analytes were detected as contaminants in the laboratory method blanks. Negative concentrations were reported for lead in the laboratory method blanks. Poor laboratory duplicate precision was observed for cadmium. The ICP serial dilution %Ds for calcium and magnesium exceeded control limits. A laboratory control sample recovery was not reported for mercury.

Other Factors Affecting Data Quality: The matrix spike recovery for lead was high. Several GFAA PDS recoveries for selenium and thallium were below the lower quality control limit.

Data for these analyses were reviewed with reference to the "National Functional Guidelines for Inorganic Data Validation" (7/88), as amended for use within USEPA Region III, and the NEESA document entitled "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program", (6/88).

The text of this report has been formulated to address only those problem areas affecting data quality.

"I attest that the data referenced herein were validated according to the agreed-upon validation criteria as specified in the NEESA Guidelines and the Quality Assurance Project Plan (QAPP)."

Ricky C. DePaul

HALLIBURTON NUS Environmental Corporation

Ricky C. DePaul
Data Reviewer

Debra A. Scheib

HALLIBURTON NUS Environmental Corporation

Debra A. Scheib
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory
3. Appendix C - HNUS/CLEAN Data Validation Worksheets
4. Appendix D - Support Documentation

cc: D. A. Scheib (HNUS, Pittsburgh)

APPENDIX M

SAMPLE CALCULATIONS

HALLIBURTON NUS Environmental Corporation and Subsidiaries			STANDARD CALCULATION SHEET
CLIENT: NavyCLEAN	FILE NO.: 3933	BY: J. Hubbard	PAGE 1 OF 3
SUBJECT: Representative Conc. - Warminster Manganese - Unfiltered Monitoring Wells, Sites 1, 2, 3		CHECKED BY: M Stewart	DATE: 10/7/92

Objective: Determine representative concentrations of contaminants.

Approach: Use upper 95% confidence limit (UCL) on arithmetic mean, or maximum if UCL exceeds maximum positive detection. Average duplicates and use 1/2 detection limit for non-detects.

Relevant Equations:

$$S = \sqrt{\frac{\Sigma x_i^2 - \frac{(\Sigma x_i)^2}{n}}{n-1}}$$

where: S = Standard deviation
x_i = individual sample value
n = number of samples

$$\bar{x} = \Sigma x_i / n$$

where: $\bar{x}$ = arithmetic mean
x_i = individual sample value
n = number of samples

$$UCL = \bar{x} + t_{(\alpha, n-1)} \frac{s}{\sqrt{n}}$$

where: UCL = Representative concentration (upper confidence limit)
s = Standard deviation
$\bar{x}$ = arithmetic mean
n = number of samples
t = distribution factor
α = Level of significance

$$CL = 1 - \alpha$$

where: CL = Confidence ~~Limit~~ Level
α = Level of significance

(Source: Zar, 1974)

HALLIBURTON NUS Environmental Corporation and Subsidiaries	STANDARD CALCULATION SHEET

CLIENT: Navy CLEAN	FILE NO.: 3933	BY: J. Hubbard	PAGE 2 OF 3
SUBJECT: Representative Conc. - Warminster		CHECKED BY: [illegible]	DATE: 10/7/92

Assumptions: For 95% UCL, CL = 0.95 (2-sided) when considering only upper value ($\bar{x} + t\frac{s}{\sqrt{n}}$), CL = 0.975.

Sample Calculation: For manganese in unfiltered MWs, following results reported:

(ug/L)

	x_i	x_i^2
	50 (½ DL)	2500
	307	94249
	4000	16000000
	32100	1.0304 E9
$\bar{x}$ of field dup.s →	50 (½ DL)	2500
	3870	14976900
	400	160000
$\bar{x}$ of field dup.s →	750.5	563250.25
	460	211600
$\bar{x}$ of field dup.s →	1535	2356225
	450	202500
	633	400689
$\bar{x}$ of field dup.s →	235	55225
	615	378225
	85	7225
	1500	2250000
	2000	4000000
	7000	49000000
	4910	24108100
	700	490000
	1210	1464100
	870	756900
	72	5184
	53	2809
	$\Sigma x_i = 63855.5$	$\Sigma x_i^2 = 1.1474 E9$

n = 24

HALLIBURTON NUS Environmental Corporation and Subsidiaries	STANDARD CALCULATION SHEET

CLIENT: Navy CLEAN	FILE NO.: 3933	BY: J. Hubbard	PAGE 3 OF 3
SUBJECT: Representative Conc. - Warminster		CHECKED BY: N Strauch	DATE: 10/7/92

$$s = \sqrt{\frac{\sum x_i^2 - \frac{(\sum x_i)^2}{n}}{n-1}} = \sqrt{\frac{1.147\text{E}9 - \frac{(63855.5)^2}{24}}{24-1}} = 6519.18 \checkmark$$

$\alpha = 1 - CL = 1 - 0.95 = 0.05$ (2-sided)

$\alpha = 1 - CL = 1 - 0.975 = 0.025$ (1-sided)

$$\bar{x} = \frac{\sum x_i}{n} = \frac{63855.5}{24} = 2660.6458$$

$$UCL = \bar{x} + t_{(\alpha, n-1)} \frac{s}{\sqrt{n}} = 2660.6458 + (2.069)\frac{6519.18}{\sqrt{24}}$$

$$= 5413.9 \text{ ug/L} \approx 5410 \text{ ug/L} \checkmark$$

TABLE D.10 Critical Values of the t Distribution (Zar, 1974)

n-1	α(2): 0.50	0.20	0.10	0.05	0.02	0.01	0.005	0.002	0.001
	α(1): 0.25	0.10	0.05	0.025	0.01	0.005	0.0025	0.001	0.0005
1	1.000	3.078	6.314	12.706	31.821	63.657	127.321	318.309	636.619
2	0.816	1.886	2.920	4.303	6.965	9.925	14.089	22.327	31.599
3	0.765	1.638	2.353	3.182	4.541	5.841	7.453	10.215	12.924
4	0.741	1.533	2.132	2.776	3.747	4.604	5.598	7.173	8.610
5	0.727	1.476	2.015	2.571	3.365	4.032	4.773	5.893	6.869
6	0.718	1.440	1.943	2.447	3.143	3.707	4.317	5.208	5.959
7	0.711	1.415	1.895	2.365	2.998	3.499	4.029	4.785	5.408
8	0.706	1.397	1.860	2.306	2.896	3.355	3.833	4.501	5.041
9	0.703	1.383	1.833	2.262	2.821	3.250	3.690	4.297	4.781
10	0.700	1.372	1.812	2.228	2.764	3.169	3.581	4.144	4.587
11	0.697	1.363	1.796	2.201	2.718	3.106	3.497	4.025	4.437
12	0.695	1.356	1.782	2.179	2.681	3.055	3.428	3.930	4.318
13	0.694	1.350	1.771	2.160	2.650	3.012	3.372	3.852	4.221
14	0.692	1.345	1.761	2.145	2.624	2.977	3.326	3.787	4.140
15	0.691	1.341	1.753	2.131	2.602	2.947	3.286	3.733	4.073
16	0.690	1.337	1.746	2.120	2.583	2.921	3.252	3.686	4.015
17	0.689	1.333	1.740	2.110	2.567	2.898	3.222	3.646	3.965
18	0.688	1.330	1.734	2.101	2.552	2.878	3.197	3.610	3.922
19	0.688	1.328	1.729	2.093	2.539	2.861	3.174	3.579	3.883
20	0.687	1.325	1.725	2.086	2.528	2.845	3.153	3.552	3.850
21	0.686	1.323	1.721	2.080	2.518	2.831	3.135	3.527	3.819
22	0.686	1.321	1.717	2.074	2.508	2.819	3.119	3.505	3.792
23	0.685	1.319	1.714	2.069	2.500	2.807	3.104	3.485	3.768
24	0.685	1.318	1.711	2.064	2.492	2.797	3.091	3.467	3.745
25	0.684	1.316	1.708	2.060	2.485	2.787	3.078	3.450	3.725

Compare to Max. pos. conc: 32100 ug/L

UCL is less, ∴ use UCL

$\boxed{\text{Rep conc.} = 5410 \text{ ug/L}}$ ✓

References: Zar, Jerrold H., 1974. Biostatistical Analysis. Prentice-Hall, Inc., Englewood Cliffs, NJ.

HALLIBURTON NUS Environmental Corporation and Subsidiaries	STANDARD CALCULATION SHEET

CLIENT: Navy CLEAN	FILE NO.: 3933	BY: J. Hubbard	PAGE 1 OF 2
SUBJECT: Groundwater Ingestion - Warminster		CHECKED BY: Stuart	DATE: 10/7/92

Arsenic in Unfiltered Groundwater - Site 4 - Adult Resident

Objective: Determine oral exposure to groundwater chemicals.

Approach: Estimate exposure based on estimated intake; determine risks using RfD and cancer slope factors.

Relevant Equations:

$$IEX = \frac{C \cdot IR \cdot EF \cdot ED}{BW \cdot AT}$$

where: IEX = Ingestion exposure (mg/kg/day)
IR = Ingestion rate (L/day)
C = Groundwater representative concentration (mg/L)
EF = Exposure frequency (days/yr)
ED = Exposure duration (yr)
BW = Body weight (kg)
AT = Averaging time
= 365 days/yr · Lifetime (carc.)
= 365 days/yr · ED (non-carc.)

(Source: USEPA, Dec. 1989)

Assumptions:

C = 0.0021 mg/L for arsenic
IR = 2 L/day
EF = 350 days/yr
ED = 30 yr
BW = 70 kg
AT = 365 days/yr · 30 yr (noncarc)
= 365 days/yr · 70 yr (carc)

RfD oral = 3×10^{-4} mg/kg/day
CSF oral = 1.75 per (mg/kg/day) (USEPA, Aug. 1992)

HALLIBURTON NUS Environmental Corporation and Subsidiaries	STANDARD CALCULATION SHEET

CLIENT: Navy CLEAN	FILE NO.: 3933	BY: J. Hubbard	PAGE 2 OF 2
SUBJECT: Groundwater Ingestion - Warminster		CHECKED BY: M Stuart	DATE: 10/7/92

Sample Calculations:

Noncarcinogenic

$$IEX_1 = \frac{C \cdot IR \cdot EF \cdot ED}{BW \cdot AT} = \frac{(0.0021\ mg/L)(2\ L/day)(350\ days/yr)(30\ yr)}{(70\ kg)(365\ \frac{day}{yr} \cdot 30\ yr)}$$

$$= 5.75 \times 10^{-5}\ mg/kg/day$$ ✓

$$HQ = \frac{IEX_1}{RfD} = \frac{5.75 \times 10^{-5}\ mg/kg/day}{3 \times 10^{-4}\ mg/kg/day} = \boxed{1.9 \times 10^{-1}}$$ ✓

Carcinogenic

$$IEX_2 = \frac{C \cdot IR \cdot EF \cdot ED}{BW \cdot AT} = \frac{(0.0021\ \frac{mg}{L})(2\ \frac{L}{day})(350\ \frac{days}{yr})(30\ yr)}{(70\ kg)(365\ \frac{day}{yr} \cdot 70\ yr)}$$

$$= 2.47 \times 10^{-5}\ mg/kg/day$$ ✓

$$CR = (IEX_2)(CSF) = (2.47 \times 10^{-5}\ mg/kg/day)\left(\frac{1.75}{mg/kg/day}\right)$$

$$= \boxed{4.3 \times 10^{-5}}$$ ✓

References:

USEPA, Dec. 1989. Risk Assessment Guidance for Superfund Sites. Vol I. Interim Final. OERR, EPA 540/1-89/002.

USEPA, Aug. 1992. Integrated Risk Information System (IRIS). Record for arsenic, Aug. 2, 1992.

HALLIBURTON NUS Environmental Corporation and Subsidiaries	STANDARD CALCULATION SHEET

CLIENT: Navy CLEAN	FILE NO.: 3933	BY: J. Hubbard	PAGE 1 OF 6
SUBJECT: Inhalation of Groundwater - Warminster Tetrachloroethene, Adult Resident, Current Groundwater Sites 1, 2, 3		CHECKED BY: Norman Shaw	DATE: 10/7/92

Objective: Determine intakes of groundwater chemicals that would potentially be emitted during showering (via inhalation exposure).

Approach: Use Foster and Chrostowski model; calculate risks from estimated exposure.

Relevant Equations:

$$IEX = S \cdot IR \cdot EF \cdot ED \left[D_S + \frac{e^{-R_a D_T}}{R_a} - \frac{e^{R_a (D_S - D_T)}}{R_a} \right]$$

where:
- IEX = Inhalation exposure dose (mg/kg/day)
- S = Volatile chemical generation rate (ug/m³/min)
- EF = Exposure frequency (days/yr)
- ED = Exposure duration (yr)
- BW = Body weight (kg)
- AT = Averaging time (days)
  - = 365 days/yr × lifetime (carc.)
  - = 365 days/yr × ED (non-carc.)
- CF = Conversion factor (1×10^6 L/m³/mg/kg)
- R_a = Air exchange rate (min⁻¹)
- D_S = Shower duration (min)
- D_T = Total time in shower room (min)
- IR = Inhalation rate (L/min)

$$S = (C_{wd} \cdot FR) / SV$$

where:
- S = Volatile chem. generation rate (ug/m³/min)
- C_{wd} = Concentration leaving shower droplet (ug/L)
- FR = Shower flow rate (L/min)
- SV = Shower room air volume (m³)

$$C_{wd} = C_{wo}\left[1 - \exp\left(-K_{aL} \cdot t_s\right) / 60d\right)\right]$$

where: C_{wo} = Conc. of chemical in shower water (ug/L)
K_{aL} = Adjusted overall mass transfer co-efficient (cm/hr)
t_s = Shower droplet time (sec)*
d = Shower droplet diameter (mm)*

*Units cancel as follows:

The term $\frac{6}{d}$ is introduced to account for the surface area to volume ratio: $A = 4\pi r^2$, $V = 4/3\pi r^3$, $d = 2r$

$$\frac{A}{V} = \frac{4\pi r^2}{4/3\pi r^3} = \frac{3}{r} = \frac{3}{d/2} = \frac{6}{d}$$

$$\left(\frac{6}{d\,mm}\right)\left(K_{aL}\,\frac{cm}{hr}\right)\left(10\,\frac{mm}{cm}\right)\left(t_s\,sec\right)\left(\frac{hr}{3600\,sec}\right) = \frac{K_{aL}\,t_s}{60d}$$

$$K_{aL} = K_L\left(T_1 m_2 / T_s m_1\right)^{-1/2}$$

where: K_L = overall mass transfer coefficient
T_1 = Calibration water temp of K_L (K)
T_s = shower water temp. (K)
m_1 = Viscosity of water at T_1 (cp)
m_2 = Viscosity of water at T_2 (cp) ← centipoise

$$K_L = \frac{1}{\frac{1}{K_l} + \frac{RT}{HK_g}}$$

where: K_l = Liquid phase mass transfer coeff. (cm/hr)
K_g = Gas phase mass transfer coeff. (cm/hr)
T = Temp. corresponding to Henry's Law constant (K)

HALLIBURTON NUS Environmental Corporation and Subsidiaries	STANDARD CALCULATION SHEET

CLIENT: Navy CLEAN	FILE NO.: 3933	BY: J. Hubbard	PAGE 3 OF 6
SUBJECT: Inhalation of Groundwater - Warminster		CHECKED BY: Norman Stanton	DATE: 10/7/92

R = Ideal gas law constant $\left(\frac{atm\ m^3}{mol\ K}\right)$

H = Henry's Law Constant (atm m^3/mol)

$HQ = \frac{IEX_1}{RFD}$ where: HQ = Hazard Quotient
IEX_1 = Inhalation exposure dose (noncarc.) (mg/kg/day)
RfD = Inhalation risk reference dose (mg/kg/day)

$CR = IEX_2 \cdot CSF$ where: CR = Estimated cancer risk
IEX_2 = Inhalation exposure dose (time-weighted: carc.) (mg/kg/day)
CSF = Inhalation cancer slope factor $(mg/kg/day)^{-1}$

$K_l = (20\ cm/hr)\left[\frac{44}{MW}\right]^{1/2}$

where: K_l = Liquid phase mass transfer coeff. (cm/hr)
MW = Molecular weight of chemical (g)

$K_g = (3000\ cm/hr)\left[\frac{18}{MW}\right]^{1/2}$

where: K_g = Gas phase mass transfer coefficient (cm/hr)
MW = Molecular weight of chemical (g)

Assumptions:

K_l is based on K_l for CO_2
K_g is based on K_g for H_2O
IR = 10.4 L/min
BW = 70 kg
D_s = 12 min
AT = 365 day/yr · 30 yr (non-carc)
365 day/yr · 70 yr (carc)
D_T = 20 min
$R_a = 8.3 \times 10^{-3}\ min^{-1}$ (Assume 1/2 volume/hr)

HALLIBURTON NUS Environmental Corporation and Subsidiaries	STANDARD CALCULATION SHEET

CLIENT: Navy CLEAN	FILE NO.: 3433	BY: J. Hubbard	PAGE 4 OF 6
SUBJECT: Inhalation of Groundwater-Leominster		CHECKED BY: M Strout	DATE: 10/7/92

FR = 10 L/min
SV = 12 m^3
d = 1 mm
t_s = 2 sec
T_1 = 293 K (20C)
T_s = 318 K (45C)
m_1 = 0.982 cp
m_2 = 0.616 cp
T = 293 K
R = 8.2×10^{-5} atm m^3/mol K
C_{wo} = Rep. conc. of PCE = ~~29.8~~ 128 ug/L (PRH)
MW = 165.83 g
RfDinhal = N/A
CSFinhal = 2×10^{-3} per mg/kg/day
H = 1.53×10^{-2} atm m^3/mol

Sample Calculations:

$$K_l = 20\frac{cm}{hr}\sqrt{\frac{44}{MW}} = \left(20\frac{cm}{hr}\right)\sqrt{\frac{44g}{165.83g}} = 10.30\ cm/hr$$

$$K_g = 3000\frac{cm}{hr}\sqrt{\frac{18}{MW}} = 3000\frac{cm}{hr}\sqrt{\frac{18g}{165.83g}} = 988.38\ cm/hr$$

$$K_L = \frac{1}{\frac{1}{K_l} + \frac{RT}{HK_g}} = \frac{1}{\frac{1}{10.30\frac{cm}{hr}} + \frac{\left(8.2\times10^{-5}\frac{atm\,m^3}{mol\,K}\right)(293K)}{\left(1.53\times10^{-2}\frac{atm\,m^3}{mol}\right)\left(\cancel{12}\ 988.38\frac{cm}{hr}\right)}}$$

$$= \frac{1}{0.097\frac{hr}{cm} + 1.59\times10^{-3}\frac{hr}{cm}} = 1.01\times10^{1}\ cm/hr$$

$$K_{aL} = K_L\sqrt{\frac{1}{\frac{T_1 m_2}{T_s m_1}}} = (10.1\ cm/hr)\frac{1}{\sqrt{\frac{(293K)(0.616cp)}{(318K)(0.982cp)}}} = 13.28\ cm/hr$$

$$C_{wd} = C_{wo}\left[1 - e^{-\frac{K_{aL}t_s}{60d}}\right]$$

$$= \left(\cancel{29.8}\ 128\ \frac{ug}{L}\right)\left[1 - e^{\frac{-(13.28)(2)}{(60)(1)}}\right] = \cancel{10.66}\ 45.78\ ug/L$$

(PRH)

$$S = \frac{C_{wd} \cdot FR}{SV} = \frac{(45.78\ \frac{ug}{L})(10\ \frac{L}{min})}{12\ m^3} = 38.15\ \frac{ug}{m^3 min}$$ ✓

For $$IEX = \frac{S \cdot IR \cdot EF \cdot ED}{BW \cdot AT \cdot Ra \cdot CF}\left[\underbrace{D_s + \frac{e^{-RaD_T}}{Ra} - \frac{e^{Ra(D_s - D_T)}}{Ra}}\right],$$

let $K =$

$$K = 12\ min + \frac{e^{-(8.3\times10^{-3} min^{-1})(20 min)} - e^{(8.3\times10^{-3} min^{-1})(12 min - 20 min)}}{8.3\times10^{-3} min^{-1}}$$

$$= 12\ min + \frac{0.847 - 0.936}{8.3\times10^{-3} min^{-1}} = 1.277\ min$$ ✓

Noncarcinogenic:

$$IEX_1 = \frac{S \cdot IR \cdot EF \cdot ED \cdot K}{BW \cdot AT \cdot Ra \cdot CF}$$

$$= \frac{(38.15\ \frac{ug}{m^3 min})(10.4\ \frac{L}{min})(350\ \frac{days}{yr})(30\ yr)(1.277\ min)}{(70\ kg)(365\ \frac{days}{yr} \cdot 30\ yr)(8.3\times10^{-3} min^{-1})(10^6\ \frac{L\ ug}{m^3\ mg})}$$

$$= 8.36\times10^{-4}\ mg/kg\ (per\ day)$$ ✓

No inhalation RfD ∴ HQ = N/A

Carcinogenic:

$$IEX_2 = \frac{S \cdot IR \cdot EF \cdot ED \cdot K}{BW \cdot AT \cdot RA \cdot CF}$$

$$= \frac{(38.15\ \frac{ug}{m^3 min})(10.4\ \frac{L}{min})(350\ \frac{days}{yr})(30\ yr)(1.277\ min)}{(70\ kg)(365\ \frac{days}{yr} \cdot 70\ yr)(8.3\times10^{-3} min^{-1})(10^6\ \frac{L\ ug}{m^3\ mg})}$$

$$= 3.58\times10^{-4}\ mg/kg\ (per\ day)$$ ✓

HALLIBURTON NUS Environmental Corporation and Subsidiaries			STANDARD CALCULATION SHEET
CLIENT: Navy CLEAN	FILE NO.: 3933	BY: J. Hubbard	PAGE 6 OF 6
SUBJECT: Inhalation of Groundwater-Warminster		CHECKED BY: J. Shaw	DATE: 10/7/92

$$CR = (IEX_2)(CSF) = (3.58 \times 10^{-4}\ mg/kg/day)\left(\frac{2 \times 10^{-3}}{mg/kg/day}\right)$$

$$= \boxed{7.2 \times 10^{-7}}$$

✓

References:

Foster, SA and PC Chrostowski, 1987. Inhalation Exposures to Volatile Organic Contaminants in the Shower. Presented at the 80th Annual Meeting of the Air Pollution Control Association, New York, June.

USEPA, December 1989. Risk Assessment Guidance for Superfund Sites Vol I. Interim Final. OERR, EPA 540/1-89/002.

~~USEPA, August~~ JRH

HALLIBURTON NUS Environmental Corporation and Subsidiaries	STANDARD CALCULATION SHEET

CLIENT: Navy CLEAN	FILE NO.: 3933	BY: J. Hubbard	PAGE 1 OF 4
SUBJECT: Dermal Groundwater Exposure - Warminster 1,1-Dichloroethane, Adult Employees, Sites 1,2,3		CHECKED BY: [illegible]	DATE: 10/8/92

Objective: Estimate dermal absorption of chemicals in groundwater.

Approach: Use chemical-specific absorption factors to estimate dose; calculate risks from estimated doses.

Relevant Equations: For Inorganics:

$$DA = K \cdot C_v \cdot t \cdot CF$$

where: DA = Dose absorbed per event (mg/cm²)
K = Permeability coefficient from water (cm/hr)
C_v = Concentration of chemical in water (mg/~~cm³~~ L)
CF = Conversion factor (L/cm³: 1E-3)

For organics:

If $t < t^*$, $$DA = 2 \cdot CF \cdot K_p \cdot C_v \sqrt{\frac{6\tau t}{\pi}}$$

If $t > t^*$, $$DA = K_p \cdot CF \cdot C_v \left[\frac{t}{1+B} + 2\tau\left(\frac{1+3B}{1+B}\right) \right]$$

where: DA = Dose absorbed per event (mg/cm²)
K_p = Permeability coefficient (cm/hr)
C_v = Vehicle concentration (mg/cm³)
τ = Lag time (hr)
B = Dimensionless partition coefficient
t = Duration of event (hr)
CF = Conversion factor (L/cm³: 1e-3)

HALLIBURTON NUS Environmental Corporation and Subsidiaries			STANDARD CALCULATION SHEET
CLIENT: Navy CLEAN	FILE NO.: 3933	BY: J. Hubbard	PAGE 2 OF 4
SUBJECT: Dermal Groundwater Exposure - Warminster		CHECKED BY: Shaw	DATE: 10/8/92

$$DAD = \frac{DA \cdot EV \cdot ED \cdot EF \cdot A}{BW \cdot AT}$$

where: DAD = Dermally absorbed dose (mg/kg/day)
DA = Dose absorbed per event (mg/cm²/event)
A = Skin surface area available for contact (cm²)
EV = Event frequency (event/day)
EF = Exposure frequency (days/yr)
ED = Exposure duration (yr)
BW = Body weight (kg)
AT = Averaging time (days):
= 365 days/yr × Lifetime (carc.)
= 365 days/yr × ED (non-carc.)

$$HQ = DAD_1 / RFD$$

where: HQ = Hazard Quotient
DAD_1 = (Noncarcinogenic) Dermally absorbed dose (mg/kg/day)
RFD = Reference dose (mg/kg/day)

$$CR = DAD_2 \cdot CSF$$

where: CR = Cancer risk
DAD_2 = (Carcinogenic, time-weighted) Dermally absorbed dose (mg/kg/day)
CSF = Cancer slope factor (mg/kg/day)⁻¹

(Source: USEPA, Jan. 1992)

Assumptions:

For 1,1-DCE:

$CF = 1 \times 10^{-3}$ L/cm³
$K_p = 1.6 \times 10^{-2}$ cm/hr (estimated; USEPA, Jan. 1992)
$\tau = 3.4 \times 10^{-1}$ hr
$t^* = 8.2 \times 10^{-1}$ hr
$B = 1.3 \times 10^{-2}$

$C_v = 0.003$ mg/L
$t = 0.03$ hr/event (2 minutes/day, handwashing)
$A = 2270\ cm^2$ (hands + forearms)
$EV = 1$/day
$EF = 250$ day/yr
$ED = 25$ yr
$BW = 70$ kg
$AT = 365$ day/yr · 25 yr (non cancer.)
365 day/yr · 70 yr (cancer.)
RfD = 9E-3 mg/kg/day
CSF = 6E-1 per mg/kg/day (USEPA, Aug. 2, 1992)

Sample Calculation:

1,1,-DCE is organic
$t = 0.03$ hr
$t^* = 0.8$ hr $\therefore t < t^*$
$\therefore$ use

$$DA = 2 \cdot CF \cdot K_p \cdot C_v \sqrt{\frac{6\tau t}{\pi}}$$

$$= 2 \cdot 1\times10^{-3}\frac{L}{cm^3} \cdot 1.6\times10^{-7}\frac{cm}{hr} \cdot 0.003\frac{mg}{L}\sqrt{\frac{6 \cdot 0.3396\ hr}{\pi}}$$

$$= \left(1.008\times10^{-7}\frac{mg}{cm^2\ hr}\right)(0.1396\ hr)$$

$$= 1.4\times10^{-8}\ mg/cm^2 \text{ (per event)}$$

$$DAD_1 = \frac{DA \cdot EV \cdot ED \cdot EF \cdot A}{BW \cdot AT}$$

$$= \frac{\left(1.4\times10^{-8}\frac{mg}{ev.\ cm^2}\right)\left(1\frac{ev.}{day}\right)(25\ yr)\left(250\frac{days}{yr}\right)(2270\ cm^2)}{70\ kg \cdot \left(365\frac{days}{yr} \cdot 25\ yr\right)}$$

$$= 3.1\times10^{-7}\ mg/kg/day \quad ✓$$

$$DAD_2 = \frac{\left(1.4\times10^{-8}\frac{mg}{cm^2}\right)\left(1\frac{ev}{day}\right)(25\ yr)\left(250\frac{days}{yr}\right)(2270\ cm^2)}{70\ kg\ (365\ days/yr \cdot 70\ yr)}$$

$$= 1.1\times10^{-7}\ mg/kg/day \quad ✓$$

HALLIBURTON NUS Environmental Corporation and Subsidiaries	STANDARD CALCULATION SHEET

CLIENT: Navy CLEAN	FILE NO.: 3933	BY: J. Hubbard	PAGE 4 OF 4
SUBJECT: Dermal Groundwater Exposure - Warminster		CHECKED BY: N Strauf	DATE: 10/8/92

$$HQ = \frac{DAD_1}{RfD} = \frac{3.1 \times 10^{-7}\ mg/kg/day}{9 \times 10^{-3}\ mg/kg/day} = \boxed{3.4 \times 10^{-5}}$$ ✓

$$CR = DAD_2 \cdot CSF = (1.1 \times 10^{-7}\ mg/kg/day)\left(\frac{6 \times 10^{-1}}{mg/kg/day}\right) = \boxed{6.6 \times 10^{-8}}$$

References:

USEPA, Jan. 1992. Dermal Exposure Assessment: Principles and Applications. Interim Report. OHEA, Washington, DC. EPA/600/8-91/011B.

USEPA, Aug. 2, 1992. Integrated Risk Information System (IRIS). Record for 1,1-dichloroethene.

APPENDIX N

RISK ASSESSMENT SPREADSHEETS

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE ONE)
SITE NAME: WARMINSTER, SITES 1, 2, 3
MEDIUM: GROUNDWATER (CURRENT)
RECEPTOR(S): ADULT RESIDENT

RELEVANT EQUATIONS:

INORGANICS

DA = (K)(Cv)(t)

DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
K = PERMEABILITY COEFFICIENT FROM WATER (cm/hr)
Cv = CONCENTRATION OF CHEMICAL IN WATER (mg/cm^3)
t = DURATION OF EVENT (hr/event)

ORGANICS

DA = 2 CF Kp Cv [((6TAUt)/PI)^0.5] IF t < t*

DA = Kp CF Cv [(t/(1 + B)) + [2TAU ((1+3B)/(1 + B))]] IF t > t*

DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
Kp = PERMEABILITY COEFFICIENT (cm/hr)
Cv = VEHICLE CONCENTRATION (mg/cm^3)
TAU = LAG TIME (hr)
B = DIMENSIONLESS PARTITION COEFFICIENT
t = DURATION OF EVENT (hr/event)
CF = CONVERSION FACTOR (L/cm^3: 1e-3)

REFERENCES: USEPA, DECEMBER 1989; USEPA, JANUARY 1992

DAD = (DA EV ED EF A)/(BW AT)

DAD = DERMALLY ABSORBED DOSE (mg/kg/day)
DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (cm^2)
EV = EVENT FREQUENCY (event/day)
EF = EXPOSURE FREQUENCY (day/yr)
ED = EXPOSURE DURATION (yr)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days)

HQ = DAD1/RFD

HQ = HAZARD QUOTIENT
DAD1 = DAD FOR NONCARCINOGENIC RISKS (mg/kg/day)
RFD = REFERENCE DOSE (mg/kg/day)

CR = DAD2 CSF

CR = CANCER RISK
DAD2 = DAD FOR CARCINOGENIC RISK
CSF = CANCER SLOPE FACTOR ((mg/kg/day)^-1))

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)

SITE NAME: WARMINSTER, SITES 1, 2, 3

MEDIUM: GROUNDWATER (CURRENT)

RECEPTOR(S): ADULT RESIDENT

ENTER INPUTS

A =	19400(cm^2)	
EV =	1(event/day)	
EF =	350(day/yr)	
ED1 =	30(yr)	NON-CARCINOGENIC
ED2 =	30(yr)	CARCINOGENIC
BW =	70(kg)	
AT1 =	10950(days)	NON-CARCINOGENIC
AT2 =	25550(days)	CARCINOGENIC
t =	.2(hr/event)	

ENTER 0 UNDER DA-i FOR ALL ORGANICS; ENTER 0 UNDER DA-o FOR ALL INORGANICS

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE THREE)
SITE NAME: WARMINSTER, SITES 1, 2, 3
MEDIUM: GROUNDWATER (CURRENT)
RECEPTOR(S): ADULT RESIDENT

CHEMICAL	Cv (mg/L)	Kp or K	DA	DA-i	DA-o	TAU	t*	B	X1	X2	DAD1	DAD2	RFD-ORAL	CSF-ORAL
Vinyl chloride	.0015	7.3e-3	6.204e-9		0	6.204e-9	.21	.51	.0023	6.204e-9	6.805e-9	1.649e-6	7.066e-7		1.9
1,1-Dichloroethene	.003	1.6e-2	3.460e-8		0	3.460e-8	.34	.82	.013	3.460e-8	4.295e-8	9.196e-6	3.941e-6	.009	.6
1,2-Dichloroethane	.0035	5.3e-3	1.357e-8		0	1.357e-8	.35	.84	.003	1.357e-8	1.676e-8	3.606e-6	1.545e-6		.091
Trichloroethene	.469	2.3e-1	9.891e-5		0	9.891e-5	.55	1.3	.026	9.891e-5	1.457e-4	2.629e-2	1.127e-2	.006	.011
Tetrachloroethene	.128	3.7e-1	5.555e-5		0	5.555e-5	.9	4.3	.25	5.555e-5	1.269e-4	1.476e-2	6.327e-3	.01	.052
Chloroform	.0138	1.3e-1	1.521e-6		0	1.521e-6	.47	1.1	.0093	1.521e-6	2.073e-6	4.041e-4	1.732e-4	.01	.0061
Carbon tetrachloride	.0168	2.2e-2	3.984e-7		0	3.984e-7	.76	1.8	.068	3.984e-7	7.025e-7	1.059e-4	4.537e-5	.0007	.13
Benzene	.002	1.1e-1	1.387e-7		0	1.387e-7	.26	.63	.013	1.387e-7	1.608e-7	3.686e-5	1.580e-5		.029
1,2-Dichloropropane	.001	1e-2	8.108e-9		0	8.108e-9	.43	1	.01	8.108e-9	1.075e-8	2.155e-6	9.234e-7		.068
Pyrene	.0006	5.29e-1	4.806e-7		0	4.806e-7	1.5	7.2	15.1	4.806e-7	2.742e-6	1.277e-4	5.474e-5	.03	.59
1,1-Dichloroethane	.008	8.9e-3	5.208e-8		0	5.208e-8	.35	.84	.0062	5.208e-8	6.461e-8	1.384e-5	5.932e-6	.1	
1,2-Dichloroethene	.027	5.5e-3	1.071e-7		0	1.071e-7	.34	.82	.003	1.071e-7	1.312e-7	2.845e-5	1.219e-5	.01	
cis-1,2-Dichloroethene	.138	5.5e-3	5.472e-7		0	5.472e-7	.34	.82	.003	5.472e-7	6.706e-7	1.454e-4	6.232e-5	.01	
1,1,1-Trichloroethane	.01	1.7e-2	1.587e-7		0	1.587e-7	.57	1.4	.031	1.587e-7	2.384e-7	4.217e-5	1.807e-5	.09	
Trichlorofluoromethane	.0298	1.7e-2	4.852e-7		0	4.852e-7	.6	1.4	.034	4.852e-7	7.459e-7	1.289e-4	5.526e-5	.3	
Toluene	.004	1e0	2.798e-6		0	2.798e-6	.32	.77	.054	2.798e-6	3.581e-6	7.435e-4	3.186e-4	.2	
Ethylbenzene	.0002	1e0	1.544e-7		0	1.544e-7	.39	1.3	.14	1.544e-7	2.294e-7	4.104e-5	1.759e-5	.1	
Xylenes	.002	8e-2	1.235e-7		0	1.235e-7	.39	1.4	.16	1.235e-7	1.868e-7	3.283e-5	1.407e-5	2	
1,2-Dichlorobenzene	.0007	6.1e-2	4.385e-8		0	4.385e-8	.69	3.2	.24	4.385e-8	8.862e-8	1.165e-5	4.995e-6	.09	
2-Butanone	.024	5e-3	7.268e-8		0	7.268e-8	.24	.58	.00019	7.268e-8	8.162e-8	1.932e-5	8.278e-6	.05	
Di-n-octyl phthalate	.003	3.3e-2	5.609e-7		0	5.609e-7	21	100	13	5.609e-7	1.188e-5	1.491e-4	6.389e-5	.02	
Diethyl phthalate	.000375	4.8e-3	3.147e-9		0	3.147e-9	2	4.7	.03	3.147e-9	7.969e-9	8.364e-7	3.585e-7	.8	
Phenanthrene	.0003	2.3e-1	8.947e-8		0	8.947e-8	1.1	5.6	2.9	8.947e-8	3.811e-7	2.378e-5	1.019e-5	.029	
Fluoranthene	.0006	3.6e-1	3.271e-7		0	3.271e-7	1.5	7.3	8.9	3.271e-7	1.817e-6	8.692e-5	3.725e-5	.04	
Arsenic	.0106	1e-3	2.12e-9	2.12e-9	0					0	2.12e-9	5.634e-7	2.415e-7	.0003	1.75
Lead	.0855	4e-6	6.84e-11	6.84e-11	0					0	6.84e-11	1.818e-8	7.790e-9		
Chromium	.0494	2e-3	1.976e-8	1.976e-8	0					0	1.976e-8	5.251e-6	2.251e-6	.005	
Manganese	5.41	1e-3	1.082e-6	1.082e-6	0					0	1.082e-6	2.875e-4	1.232e-4	.005	
Thallium	.00114	1e-3	2.28e-10	2.28e-10	0					0	2.28e-10	6.059e-8	2.597e-8	.00007	
Aluminum	25.82	1e-3	5.164e-6	5.164e-6	0					0	5.164e-6	1.372e-3	5.882e-4	2.9	
Barium	.873	1e-3	1.746e-7	1.746e-7	0					0	1.746e-7	4.640e-5	1.989e-5	.07	
Cobalt	.0228	4e-4	1.824e-9	1.824e-9	0					0	1.824e-9	4.847e-7	2.077e-7		
Copper	.236	1e-3	4.72e-8	4.72e-8	0					0	4.72e-8	1.254e-5	5.376e-6	.037	
Mercury	.00022	1e-3	4.4e-11	4.4e-11	0					0	4.4e-11	1.169e-8	5.011e-9	.0003	
Nickel	.0436	1e-4	8.72e-10	8.72e-10	0					0	8.72e-10	2.317e-7	9.932e-8	.02	
Silver	.00558	6e-4	6.70e-10	6.70e-10	0					0	6.70e-10	1.779e-7	7.626e-8	.005	
Vanadium	.0245	1e-3	4.9e-9	4.9e-9	0					0	4.9e-9	1.302e-6	5.581e-7	.007	
Zinc	.4	6e-4	4.8e-8	4.8e-8	0					0	4.8e-8	1.276e-5	5.467e-6	.2	

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE FOUR)
SITE NAME: WARMINSTER, SITES 1, 2, 3
MEDIUM: GROUNDWATER (CURRENT)
RECEPTOR(S): ADULT RESIDENT

CHEMICAL	HQ	CR
Vinyl chloride	N/A	1.343e-6
1,1-Dichloroethene	1.022e-3	2.365e-6
1,2-Dichloroethane	N/A	1.406e-7
Trichloroethene	4.3809e0	1.239e-4
Tetrachloroethene	1.4763e0	3.290e-4
Chloroform	4.041e-2	1.056e-6
Carbon tetrachloride	1.512e-1	5.898e-6
Benzene	N/A	4.581e-7
1,2-Dichloropropane	N/A	6.279e-8
Pyrene	4.258e-3	3.230e-5
1,1-Dichloroethane	1.384e-4	0
1,2-Dichloroethene	2.845e-3	0
cis-1,2-Dichloroethene	1.454e-2	0
1,1,1-Trichloroethane	4.686e-4	0
Trichlorofluoromethane	4.298e-4	0
Toluene	3.717e-3	0
Ethylbenzene	4.104e-4	0
Xylenes	1.642e-5	0
1,2-Dichlorobenzene	1.295e-4	0
2-Butanone	3.863e-4	0
Di-n-octyl phthalate	7.453e-3	0
Diethyl phthalate	1.046e-6	0
Phenanthrene	8.199e-4	0
Fluoranthene	2.173e-3	0
Arsenic	1.878e-3	4.225e-7
Lead	N/A	0
Chromium	1.050e-3	0
Manganese	5.751e-2	0
Thallium	8.656e-4	0
Aluminum	4.732e-4	0
Barium	6.629e-4	0
Cobalt	N/A	0
Copper	3.390e-4	0
Mercury	3.898e-5	0
Nickel	1.159e-5	0
Silver	3.559e-5	0
Vanadium	1.860e-4	0
Zinc	6.378e-5	0
TOTAL	6.1508e0	4.970e-4

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE ONE)
SITE NAME: WARMINSTER, SITES 1, 2, 3
MEDIUM: GROUNDWATER (CURRENT)
RECEPTOR(S): CHILD RESIDENT

RELEVANT EQUATIONS:

INORGANICS

DA = (K)(Cv)(t)

DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
K = PERMEABILITY COEFFICIENT FROM WATER (cm/hr)
Cv = CONCENTRATION OF CHEMICAL IN WATER (mg/cm^3)
t = DURATION OF EVENT (hr/event)

ORGANICS

DA = 2 CF Kp Cv [((6TAUt)/PI)^0.5] IF t < t*

DA = Kp CF Cv [(t/(1 + B)) + [2TAU ((1+3B)/(1 + B))]] IF t > t*

DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
Kp = PERMEABILITY COEFFICIENT (cm/hr)
Cv = VEHICLE CONCENTRATION (mg/cm^3)
TAU = LAG TIME (hr)
B = DIMENSIONLESS PARTITION COEFFICIENT
t = DURATION OF EVENT (hr/event)
CF = CONVERSION FACTOR (L/cm^3: 1e-3)

REFERENCES: USEPA, DECEMBER 1989; USEPA, JANUARY 1992

DAD = (DA EV ED EF A)/(BW AT)

DAD = DERMALLY ABSORBED DOSE (mg/kg/day)
DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (cm^2)
EV = EVENT FREQUENCY (event/day)
EF = EXPOSURE FREQUENCY (day/yr)
ED = EXPOSURE DURATION (yr)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days)

HQ = DAD1/RFD

HQ = HAZARD QUOTIENT
DAD1 = DAD FOR NONCARCINOGENIC RISKS (mg/kg/day)
RFD = REFERENCE DOSE (mg/kg/day)

CR = DAD2 CSF

CR = CANCER RISK
DAD2 = DAD FOR CARCINOGENIC RISK
CSF = CANCER SLOPE FACTOR ((mg/kg/day)^-1))

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)

SITE NAME: WARMINSTER, SITES 1, 2, 3

MEDIUM: GROUNDWATER (CURRENT)

RECEPTOR(S): CHILD RESIDENT

ENTER INPUTS

A =	5910(cm^2)	
EV =	1(event/day)	
EF =	350(day/yr)	
ED1 =	6(yr)	NON-CARCINOGENIC
ED2 =	6(yr)	CARCINOGENIC
BW =	15(kg)	
AT1 =	2190(days)	NON-CARCINOGENIC
AT2 =	25550(days)	CARCINOGENIC
t =	.2(hr/event)	

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE THREE)
SITE NAME: WARMINSTER, SITES 1, 2, 3
MEDIUM: GROUNDWATER (CURRENT)
RECEPTOR(S): CHILD RESIDENT

CHEMICAL	Cv (mg/L)	Kp or K	DA	DA-i	DA-o	TAU	t*	B	X1	X2	DAD1	DAD2	RFD-ORAL	CSF-ORAL
Vinyl chloride	.0015	7.3e-3	6.204e-9		0	6.204e-9	.21	.51	.0023	6.204e-9	6.805e-9	2.344e-6	2.009e-7		1.9
1,1-Dichloroethene	.003	1.6e-2	3.460e-8		0	3.460e-8	.34	.82	.013	3.460e-8	4.295e-8	1.307e-5	1.121e-6	.009	.6
1,2-Dichloroethane	.0035	5.3e-3	1.357e-8		0	1.357e-8	.35	.84	.003	1.357e-8	1.676e-8	5.126e-6	4.394e-7		.091
Trichloroethene	.469	2.3e-1	9.891e-5		0	9.891e-5	.55	1.3	.026	9.891e-5	1.457e-4	3.737e-2	3.203e-3	.006	.011
Tetrachloroethene	.128	3.7e-1	5.555e-5		0	5.555e-5	.9	4.3	.25	5.555e-5	1.269e-4	2.099e-2	1.799e-3	.01	.052
Chloroform	.0138	1.3e-1	1.521e-6		0	1.521e-6	.47	1.1	.0093	1.521e-6	2.073e-6	5.745e-4	4.924e-5	.01	.0061
Carbon tetrachloride	.0168	2.2e-2	3.984e-7		0	3.984e-7	.76	1.8	.068	3.984e-7	7.025e-7	1.505e-4	1.290e-5	.0007	.13
Benzene	.002	1.1e-1	1.387e-7		0	1.387e-7	.26	.63	.013	1.387e-7	1.608e-7	5.240e-5	4.491e-6		.029
1,2-Dichloropropane	.001	1e-2	8.108e-9		0	8.108e-9	.43	1	.01	8.108e-9	1.075e-8	3.063e-6	2.626e-7		.068
Pyrene	.0006	5.29e-1	4.806e-7		0	4.806e-7	1.5	7.2	15.1	4.806e-7	2.742e-6	1.816e-4	1.556e-5	.03	
1,1-Dichloroethane	.008	8.9e-3	5.208e-8		0	5.208e-8	.35	.84	.0062	5.208e-8	6.461e-8	1.968e-5	1.687e-6	.1	
1,2-Dichloroethene	.027	5.5e-3	1.071e-7		0	1.071e-7	.34	.82	.003	1.071e-7	1.312e-7	4.045e-5	3.467e-6	.01	
cis-1,2-Dichloroethene	.138	5.5e-3	5.472e-7		0	5.472e-7	.34	.82	.003	5.472e-7	6.706e-7	2.067e-4	1.772e-5	.01	
1,1,1-Trichloroethane	.01	1.7e-2	1.587e-7		0	1.587e-7	.57	1.4	.031	1.587e-7	2.384e-7	5.995e-5	5.139e-6	.09	
Trichlorofluoromethane	.0298	1.7e-2	4.852e-7		0	4.852e-7	.6	1.4	.034	4.852e-7	7.459e-7	1.833e-4	1.571e-5	.3	
Toluene	.004	1e0	2.798e-6		0	2.798e-6	.32	.77	.054	2.798e-6	3.581e-6	1.057e-3	9.060e-5	.2	
Ethylbenzene	.0002	1e0	1.544e-7		0	1.544e-7	.39	1.3	.14	1.544e-7	2.294e-7	5.834e-5	5.001e-6	.1	
Xylenes	.002	8e-2	1.235e-7		0	1.235e-7	.39	1.4	.16	1.235e-7	1.868e-7	4.667e-5	4.001e-6	2	
1,2-Dichlorobenzene	.0007	6.1e-2	4.385e-8		0	4.385e-8	.69	3.2	.24	4.385e-8	8.862e-8	1.657e-5	1.420e-6	.09	
2-Butanone	.024	5e-3	7.268e-8		0	7.268e-8	.24	.58	.00019	7.268e-8	8.162e-8	2.746e-5	2.354e-6	.05	
Di-n-octyl phthalate	.003	3.3e-2	5.609e-7		0	5.609e-7	21	100	13	5.609e-7	1.188e-5	2.119e-4	1.816e-5	.02	
Diethyl phthalate	.000375	4.8e-3	3.147e-9		0	3.147e-9	2	4.7	.03	3.147e-9	7.969e-9	1.189e-6	1.019e-7	.8	
Phenanthrene	.0003	2.3e-1	8.947e-8		0	8.947e-8	1.1	5.6	2.9	8.947e-8	3.811e-7	3.380e-5	2.898e-6	.029	
Fluoranthene	.0006	3.6e-1	3.271e-7		0	3.271e-7	1.5	7.3	8.9	3.271e-7	1.817e-6	1.236e-4	1.059e-5	.04	
Arsenic	.0106	1e-3	2.12e-9	2.12e-9	0					0	2.12e-9	8.010e-7	6.865e-8	.0003	1.75
Lead	.0855	4e-6	6.84e-11	6.84e-11	0					0	6.84e-11	2.584e-8	2.215e-9		
Chromium	.0494	2e-3	1.976e-8	1.976e-8	0					0	1.976e-8	7.465e-6	6.399e-7	.005	
Manganese	5.41	1e-3	1.082e-6	1.082e-6	0					0	1.082e-6	4.088e-4	3.504e-5	.005	
Thallium	.00114	1e-3	2.28e-10	2.28e-10	0					0	2.28e-10	8.614e-8	7.383e-9	.00007	
Aluminum	25.82	1e-3	5.164e-6	5.164e-6	0					0	5.164e-6	1.951e-3	1.672e-4	2.9	
Barium	.873	1e-3	1.746e-7	1.746e-7	0					0	1.746e-7	6.597e-5	5.654e-6	.07	
Cobalt	.0228	4e-4	1.824e-9	1.824e-9	0					0	1.824e-9	6.891e-7	5.907e-8		
Copper	.236	1e-3	4.72e-8	4.72e-8	0					0	4.72e-8	1.783e-5	1.529e-6	.037	
Mercury	.00022	1e-3	4.4e-11	4.4e-11	0					0	4.4e-11	1.662e-8	1.425e-9	.0003	
Nickel	.0436	1e-4	8.72e-10	8.72e-10	0					0	8.72e-10	3.294e-7	2.824e-8	.02	
Silver	.00558	6e-4	6.70e-10	6.70e-10	0					0	6.70e-10	2.530e-7	2.168e-8	.005	
Vanadium	.0245	1e-3	4.9e-9	4.9e-9	0					0	4.9e-9	1.851e-6	1.587e-7	.007	
Zinc	.4	6e-4	4.8e-8	4.8e-8	0					0	4.8e-8	1.813e-5	1.554e-6	.2	

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE FOUR)
SITE NAME: WARMINSTER, SITES 1, 2, 3
MEDIUM: GROUNDWATER (CURRENT)
RECEPTOR(S): CHILD RESIDENT

CHEMICAL	HQ	CR
Vinyl chloride	N/A	3.817e-7
1,1-Dichloroethene	1.453e-3	6.724e-7
1,2-Dichloroethane	N/A	3.999e-8
Trichloroethene	6.2281e0	3.523e-5
Tetrachloroethene	2.0987e0	9.354e-5
Chloroform	5.745e-2	3.004e-7
Carbon tetrachloride	2.150e-1	1.677e-6
Benzene	N/A	1.303e-7
1,2-Dichloropropane	N/A	1.785e-8
Pyrene	6.053e-3	0
1,1-Dichloroethane	1.968e-4	0
1,2-Dichloroethene	4.045e-3	0
cis-1,2-Dichloroethene	2.067e-2	0
1,1,1-Trichloroethane	6.661e-4	0
Trichlorofluoromethane	6.110e-4	0
Toluene	5.285e-3	0
Ethylbenzene	5.834e-4	0
Xylenes	2.334e-5	0
1,2-Dichlorobenzene	1.841e-4	0
2-Butanone	5.492e-4	0
Di-n-octyl phthalate	1.060e-2	0
Diethyl phthalate	1.486e-6	0
Phenanthrene	1.166e-3	0
Fluoranthene	3.089e-3	0
Arsenic	2.670e-3	1.201e-7
Lead	N/A	0
Chromium	1.493e-3	0
Manganese	8.176e-2	0
Thallium	1.231e-3	0
Aluminum	6.728e-4	0
Barium	9.424e-4	0
Cobalt	N/A	0
Copper	4.820e-4	0
Mercury	5.541e-5	0
Nickel	1.647e-5	0
Silver	5.060e-5	0
Vanadium	2.645e-4	0
Zinc	9.067e-5	0
TOTAL	8.7442e0	1.321e-4

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE ONE)
SITE NAME: WARMINSTER, SITES 1, 2, 3
MEDIUM: GROUNDWATER (CURRENT)
RECEPTOR(S): ADULT EMPLOYEE

RELEVANT EQUATIONS:

REFERENCES: USEPA, DECEMBER 1989; USEPA, JANUARY 1992

INORGANICS

DA = (K)(Cv)(t)

DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
K = PERMEABILITY COEFFICIENT FROM WATER (cm/hr)
Cv = CONCENTRATION OF CHEMICAL IN WATER (mg/cm^3)
t = DURATION OF EVENT (hr/event)

ORGANICS

DA = 2 CF Kp Cv [((6TAUt)/PI)^0.5] IF t < t*

DA = Kp CF Cv [(t/(1 + B)) + [2TAU ((1+3B)/(1 + B))]] IF t > t*

DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
Kp = PERMEABILITY COEFFICIENT (cm/hr)
Cv = VEHICLE CONCENTRATION (mg/cm^3)
TAU = LAG TIME (hr)
B = DIMENSIONLESS PARTITION COEFFICIENT
t = DURATION OF EVENT (hr/event)
CF = CONVERSION FACTOR (L/cm^3: 1e-3)

DAD = (DA EV ED EF A)/(BW AT)

DAD = DERMALLY ABSORBED DOSE (mg/kg/day)
DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (cm^2)
EV = EVENT FREQUENCY (event/day)
EF = EXPOSURE FREQUENCY (day/yr)
ED = EXPOSURE DURATION (yr)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days)

HQ = DAD1/RFD

HQ = HAZARD QUOTIENT
DAD1 = DAD FOR NONCARCINOGENIC RISKS (mg/kg/day)
RFD = REFERENCE DOSE (mg/kg/day)

CR = DAD2 CSF

CR = CANCER RISK
DAD2 = DAD FOR CARCINOGENIC RISK
CSF = CANCER SLOPE FACTOR ((mg/kg/day)^-1))

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)

SITE NAME: WARMINSTER, SITES 1, 2, 3

MEDIUM: GROUNDWATER (CURRENT)

RECEPTOR(S): ADULT EMPLOYEE

ENTER INPUTS

A =	2270(cm^2)	
EV =	1(event/day)	
EF =	250(day/yr)	
ED1 =	25(yr)	NON-CARCINOGENIC
ED2 =	25(yr)	CARCINOGENIC
BW =	70(kg)	
AT1 =	9125(days)	NON-CARCINOGENIC
AT2 =	25550(days)	CARCINOGENIC
t =	.03(hr/event)	

ENTER 0 UNDER DA-i FOR ALL ORGANICS; ENTER 0 UNDER DA-o FOR ALL INORGANICS

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE THREE)
SITE NAME: WARMINSTER, SITES 1, 2, 3
MEDIUM: GROUNDWATER (CURRENT)
RECEPTOR(S): ADULT RESIDENT

CHEMICAL	Cv (mg/L)	Kp or K	DA	DA-i	DA-o	TAU	t*	B	X1	X2	DAD1	DAD2	RFD-ORAL	CSF-ORAL
Vinyl chloride	.0015	7.3e-3	2.403e-9	0	2.403e-9	.21	.51	.0023	2.403e-9	4.948e-9	5.337e-8	1.906e-8		1.9
1,1-Dichloroethene	.003	1.6e-2	1.340e-8	0	1.340e-8	.34	.82	.013	1.340e-8	3.490e-8	2.977e-7	1.063e-7	.009	.6
1,2-Dichloroethane	.0035	5.3e-3	5.255e-9	0	5.255e-9	.35	.84	.003	5.255e-9	1.362e-8	1.167e-7	4.169e-8		.091
Trichloroethene	.469	2.3e-1	3.831e-5	0	3.831e-5	.55	1.3	.026	3.831e-5	1.278e-4	8.509e-4	3.039e-4	.006	.011
Tetrachloroethene	.128	3.7e-1	2.151e-5	0	2.151e-5	.9	4.3	.25	2.151e-5	1.205e-4	4.779e-4	1.707e-4	.01	.052
Chloroform	.0138	1.3e-1	5.889e-7	0	5.889e-7	.47	1.1	.0093	5.889e-7	1.771e-6	1.308e-5	4.672e-6	.01	.0061
Carbon tetrachloride	.0168	2.2e-2	1.543e-7	0	1.543e-7	.76	1.8	.068	1.543e-7	6.437e-7	3.427e-6	1.224e-6	.0007	.13
Benzene	.002	1.1e-1	5.372e-8	0	5.372e-8	.26	.63	.013	5.372e-8	1.239e-7	1.193e-6	4.261e-7		.029
1,2-Dichloropropane	.001	1e-2	3.140e-9	0	3.140e-9	.43	1	.01	3.140e-9	9.067e-9	6.974e-8	2.491e-8		.068
Pyrene	.0006	5.29e-1	1.861e-7	0	1.861e-7	1.5	7.2	15.1	1.861e-7	2.739e-6	4.135e-6	1.477e-6	.03	
1,1-Dichloroethane	.008	8.9e-3	2.017e-8	0	2.017e-8	.35	.84	.0062	2.017e-8	5.258e-8	4.480e-7	1.600e-7	.1	
1,2-Dichloroethene	.027	5.5e-3	4.146e-8	0	4.146e-8	.34	.82	.003	4.146e-8	1.060e-7	9.210e-7	3.289e-7	.01	
cis-1,2-Dichloroethene	.138	5.5e-3	2.119e-7	0	2.119e-7	.34	.82	.003	2.119e-7	5.419e-7	4.707e-6	1.681e-6	.01	
1,1,1-Trichloroethane	.01	1.7e-2	6.146e-8	0	6.146e-8	.57	1.4	.031	6.146e-8	2.104e-7	1.365e-6	4.875e-7	.09	
Trichlorofluoromethane	.0298	1.7e-2	1.879e-7	0	1.879e-7	.6	1.4	.034	1.879e-7	6.626e-7	4.174e-6	1.491e-6	.3	
Toluene	.004	1e0	1.084e-6	0	1.084e-6	.32	.77	.054	1.084e-6	2.936e-6	2.407e-5	8.595e-6	.2	
Ethylbenzene	.0002	1e0	5.981e-8	0	5.981e-8	.39	1.3	.14	5.981e-8	1.996e-7	1.328e-6	4.744e-7	.1	
Xylenes	.002	8e-2	4.785e-8	0	4.785e-8	.39	1.4	.16	4.785e-8	1.634e-7	1.063e-6	3.796e-7	2	
1,2-Dichlorobenzene	.0007	6.1e-2	1.698e-8	0	1.698e-8	.69	3.2	.24	1.698e-8	8.277e-8	3.772e-7	1.347e-7	.09	
2-Butanone	.024	5e-3	2.815e-8	0	2.815e-8	.24	.58	.00019	2.815e-8	6.122e-8	6.253e-7	2.233e-7	.05	
Di-n-octyl phthalate	.003	3.3e-2	2.172e-7	0	2.172e-7	21	100	13	2.172e-7	1.188e-5	4.825e-6	1.723e-6	.02	
Diethyl phthalate	.000375	4.8e-3	1.219e-9	0	1.219e-9	2	4.7	.03	1.219e-9	7.672e-9	2.707e-8	9.670e-9	.8	
Phenanthrene	.0003	2.3e-1	3.465e-8	0	3.465e-8	1.1	5.6	2.9	3.465e-8	3.781e-7	7.697e-7	2.749e-7	.029	
Fluoranthene	.0006	3.6e-1	1.267e-7	0	1.267e-7	1.5	7.3	8.9	1.267e-7	1.814e-6	2.814e-6	1.005e-6	.04	
Arsenic	.0106	1e-3	3.18e-10	3.18e-10	0				0	3.18e-10	7.063e-9	2.523e-9	.0003	1.75
Lead	.0855	4e-6	1.03e-11	1.03e-11	0				0	1.03e-11	2.28e-10	8.14e-11		
Chromium	.0494	2e-3	2.964e-9	2.964e-9	0				0	2.964e-9	6.583e-8	2.351e-8	.005	
Manganese	5.41	1e-3	1.623e-7	1.623e-7	0				0	1.623e-7	3.605e-6	1.287e-6	.005	
Thallium	.00114	1e-3	3.42e-11	3.42e-11	0				0	3.42e-11	7.60e-10	2.71e-10	.00007	
Aluminum	25.82	1e-3	7.746e-7	7.746e-7	0				0	7.746e-7	1.720e-5	6.145e-6	2.9	
Barium	.873	1e-3	2.619e-8	2.619e-8	0				0	2.619e-8	5.817e-7	2.078e-7	.07	
Cobalt	.0228	4e-4	2.74e-10	2.74e-10	0				0	2.74e-10	6.077e-9	2.170e-9		
Copper	.236	1e-3	7.08e-9	7.08e-9	0				0	7.08e-9	1.573e-7	5.616e-8	.037	
Mercury	.00022	1e-3	6.6e-12	6.6e-12	0				0	6.6e-12	1.47e-10	5.24e-11	.0003	
Nickel	.0436	1e-4	1.31e-10	1.31e-10	0				0	1.31e-10	2.905e-9	1.038e-9	.02	
Silver	.00558	6e-4	1.00e-10	1.00e-10	0				0	1.00e-10	2.231e-9	7.97e-10	.005	
Vanadium	.0245	1e-3	7.35e-10	7.35e-10	0				0	7.35e-10	1.633e-8	5.830e-9	.007	
Zinc	.4	6e-4	7.2e-9	7.2e-9	0				0	7.2e-9	1.599e-7	5.711e-8	.2	

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE FOUR)
SITE NAME: WARMINSTER, SITES 1, 2, 3
MEDIUM: GROUNDWATER (CURRENT)
RECEPTOR(S): ADULT RESIDENT

CHEMICAL	HQ	CR
Vinyl chloride	N/A	3.622e-8
1,1-Dichloroethene	3.308e-5	6.379e-8
1,2-Dichloroethane	N/A	3.793e-9
Trichloroethene	1.418e-1	3.343e-6
Tetrachloroethene	4.779e-2	8.875e-6
Chloroform	1.308e-3	2.850e-8
Carbon tetrachloride	4.896e-3	1.591e-7
Benzene	N/A	1.236e-8
1,2-Dichloropropane	N/A	1.694e-9
Pyrene	1.378e-4	0
1,1-Dichloroethane	4.480e-6	0
1,2-Dichloroethene	9.210e-5	0
cis-1,2-Dichloroethene	4.707e-4	0
1,1,1-Trichloroethane	1.517e-5	0
Trichlorofluoromethane	1.391e-5	0
Toluene	1.203e-4	0
Ethylbenzene	1.328e-5	0
Xylenes	5.314e-7	0
1,2-Dichlorobenzene	4.192e-6	0
2-Butanone	1.251e-5	0
Di-n-octyl phthalate	2.413e-4	0
Diethyl phthalate	3.384e-8	0
Phenanthrene	2.654e-5	0
Fluoranthene	7.034e-5	0
Arsenic	2.354e-5	4.415e-9
Lead	N/A	0
Chromium	1.317e-5	0
Manganese	7.210e-4	0
Thallium	1.085e-5	0
Aluminum	5.933e-6	0
Barium	8.310e-6	0
Cobalt	N/A	0
Copper	4.250e-6	0
Mercury	4.886e-7	0
Nickel	1.453e-7	0
Silver	4.462e-7	0
Vanadium	2.332e-6	0
Zinc	7.996e-7	0
TOTAL	1.978e-1	1.253e-5

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE ONE)
SITE NAME: WARMINSTER, SITES 5, 6, 7
MEDIUM: GROUNDWATER (CURRENT)
RECEPTOR(S): ADULT RESIDENT

RELEVANT EQUATIONS:

REFERENCES: USEPA, DECEMBER 1989; USEPA, JANUARY 1992

INORGANICS

DA = (K)(Cv)(t)

DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
K = PERMEABILITY COEFFICIENT FROM WATER (cm/hr)
Cv = CONCENTRATION OF CHEMICAL IN WATER (mg/cm^3)
t = DURATION OF EVENT (hr/event)

ORGANICS

DA = 2 CF Kp Cv [((6TAUt)/PI)^0.5] IF t < t*

DA = Kp CF Cv [(t/(1 + B)) + [2TAU ((1+3B)/(1 + B))]] IF t > t*

DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
Kp = PERMEABILITY COEFFICIENT (cm/hr)
Cv = VEHICLE CONCENTRATION (mg/cm^3)
TAU = LAG TIME (hr)
B = DIMENSIONLESS PARTITION COEFFICIENT
t = DURATION OF EVENT (hr/event)
CF = CONVERSION FACTOR (L/cm^3: 1e-3)

DAD = (DA EV ED EF A)/(BW AT)

DAD = DERMALLY ABSORBED DOSE (mg/kg/day)
DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (cm^2)
EV = EVENT FREQUENCY (event/day)
EF = EXPOSURE FREQUENCY (day/yr)
ED = EXPOSURE DURATION (yr)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days)

HQ = DAD1/RFD

HQ = HAZARD QUOTIENT
DAD1 = DAD FOR NONCARCINOGENIC RISKS (mg/kg/day)
RFD = REFERENCE DOSE (mg/kg/day)

CR = DAD2 CSF

CR = CANCER RISK
DAD2 = DAD FOR CARCINOGENIC RISK
CSF = CANCER SLOPE FACTOR ((mg/kg/day)^-1))

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)
SITE NAME: WARMINSTER, SITES 5, 6, 7
MEDIUM: GROUNDWATER (CURRENT)
RECEPTOR(S): ADULT RESIDENT

ENTER INPUTS

A =	19400(cm^2)	
EV =	1(event/day)	
EF =	350(day/yr)	
ED1 =	30(yr)	NON-CARCINOGENIC
ED2 =	30(yr)	CARCINOGENIC
BW =	70(kg)	
AT1 =	10950(days)	NON-CARCINOGENIC
AT2 =	25550(days)	CARCINOGENIC
t =	.2(hr/event)	

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE THREE)
SITE NAME: WARMINSTER, SITES 5, 6, 7
MEDIUM: GROUNDWATER (CURRENT)
RECEPTOR(S): ADULT RESIDENT

CHEMICAL	Cv (mg/L)	Kp or K	DA	DA-i	DA-o	TAU	t*	B	X1	X2	DAD1	DAD2	RFD-ORAL	CSF-ORAL
Trichloroethene	.0044	2.3e-1	9.279e-7		0	9.279e-7	.55	1.3	2.6e-2	9.279e-7	1.367e-6	2.466e-4	1.057e-4	6e-3	1.1e-2
Tetrachloroethene	.0018	3.7e-1	7.812e-7		0	7.812e-7	.9	4.3	2.5e-1	7.812e-7	1.785e-6	2.076e-4	8.897e-5	1e-2	5.2e-2
Carbon tetrachloride	.0016	2.2e-2	3.794e-8		0	3.794e-8	.76	1.8	6.8e-2	3.794e-8	6.691e-8	1.008e-5	4.321e-6	7e-4	1.3e-1
Chloromethane	.002	4.2e-3	4.406e-9		0	4.406e-9	.18	.43	8.1e-4	4.406e-9	4.708e-9	1.171e-6	5.018e-7		1.3e-2
Chloroform	.0014	1.3e-1	1.543e-7		0	1.543e-7	.47	1.1	9.3e-3	1.543e-7	2.103e-7	4.100e-5	1.757e-5	1e-2	6.1e-3
1,2-Dichloroethene	.0038	5.5e-3	1.507e-8		0	1.507e-8	.34	.82	3e-3	1.507e-8	1.846e-8	4.004e-6	1.716e-6	1e-2	
cis-1,2-Dichloroethene	.0026	5.5e-3	1.031e-8		0	1.031e-8	.34	.82	3e-3	1.031e-8	1.263e-8	2.740e-6	1.174e-6	1e-2	
Toluene	.0024	1e0	1.679e-6		0	1.679e-6	.32	.77	5.4e-2	1.679e-6	2.149e-6	4.461e-4	1.912e-4	2e-1	
1,1,1-Trichloroethane	.001	1.7e-2	1.587e-8		0	1.587e-8	.57	1.4	3.1e-2	1.587e-8	2.384e-8	4.217e-6	1.807e-6	9e-2	
Di-n-octyl phthalate	.0009	3.3e-2	1.683e-7		0	1.683e-7	21	100	1.3e1	1.683e-7	3.564e-6	4.472e-5	1.917e-5	2e-2	
Diethyl phthalate	.002	4.8e-3	1.679e-8		0	1.679e-8	2	4.7	3e-2	1.679e-8	4.250e-8	4.461e-6	1.912e-6	8e-1	
Arsenic	.0034	1e-3	6.8e-10	6.8e-10		0				0	6.8e-10	1.807e-7	7.745e-8	3e-4	1.75e0
Cadmium	.002	1e-3	4e-10	4e-10		0				0	4e-10	1.063e-7	4.556e-8	5e-4	
Lead	.0071	4e-6	5.68e-12	5.68e-12		0				0	5.68e-12	1.509e-9	6.47e-10		
Barium	.388	1e-3	7.76e-8	7.76e-8		0				0	7.76e-8	2.062e-5	8.838e-6	7e-2	
Cobalt	.0232	4e-4	1.856e-9	1.856e-9		0				0	1.856e-9	4.932e-7	2.114e-7		
Copper	.0341	1e-3	6.82e-9	6.82e-9		0				0	6.82e-9	1.812e-6	7.768e-7	3.7e-2	
Manganese	2	1e-3	4e-7	4e-7		0				0	4e-7	1.063e-4	4.556e-5	5e-3	
Nickel	.0323	1e-4	6.46e-10	6.46e-10		0				0	6.46e-10	1.717e-7	7.358e-8	2e-2	
Cyanide	.0263	1e-3	5.26e-9	5.26e-9		0				0	5.26e-9	1.398e-6	5.991e-7	2e-2	
Vanadium	.0163	1e-3	3.26e-9	3.26e-9		0				0	3.26e-9	8.664e-7	3.713e-7	7e-3	
Zinc	.228	6e-4	2.736e-8	2.736e-8		0				0	2.736e-8	7.271e-6	3.116e-6	2e-1	
____			0	0		0				0	0	0	0		
____			0	0		0				0	0	0	0		
____			0	0		0				0	0	0	0		
____			0	0		0				0	0	0	0		
____			0	0		0				0	0	0	0		
____			0	0		0				0	0	0	0		
____			0	0		0				0	0	0	0		
____			0	0		0				0	0	0	0		
____			0	0		0				0	0	0	0		
____			0	0		0				0	0	0	0		
____			0	0		0				0	0	0	0		
____			0	0		0				0	0	0	0		
____			0	0		0				0	0	0	0		
____			0	0		0				0	0	0	0		
____			0	0		0				0	0	0	0		
____			0	0		0				0	0	0	0		

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE FOUR)
SITE NAME: WARMINSTER, SITES 5, 6, 7
MEDIUM: GROUNDWATER (CURRENT)
RECEPTOR(S): ADULT RESIDENT

CHEMICAL	HQ	CR
Trichloroethene	4.110e-2	1.163e-6
Tetrachloroethene	2.076e-2	4.627e-6
Carbon tetrachloride	1.440e-2	5.618e-7
Chloromethane	N/A	6.524e-9
Chloroform	4.100e-3	1.072e-7
1,2-Dichloroethene	4.004e-4	0
cis-1,2-Dichloroethene	2.740e-4	0
Toluene	2.230e-3	0
1,1,1-Trichloroethane	4.686e-5	0
Di-n-octyl phthalate	2.236e-3	0
Diethyl phthalate	5.576e-6	0
Arsenic	6.024e-4	1.355e-7
Cadmium	2.126e-4	0
Lead	N/A	0
Barium	2.946e-4	0
Cobalt	N/A	0
Copper	4.898e-5	0
Manganese	2.126e-2	0
Nickel	8.584e-6	0
Cyanide	6.989e-5	0
Vanadium	1.238e-4	0
Zinc	3.636e-5	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
TOTAL	1.082e-1	6.600e-6

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE ONE)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, WTMA #26 (OS-02)
RECEPTOR(S): CHILD RESIDENT

RELEVANT EQUATIONS:

REFERENCES: USEPA, DECEMBER 1989; USEPA, JANUARY 1992

INORGANICS

DA = (K)(Cv)(t)

DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
K = PERMEABILITY COEFFICIENT FROM WATER (cm/hr)
Cv = CONCENTRATION OF CHEMICAL IN WATER (mg/cm^3)
t = DURATION OF EVENT (hr/event)

ORGANICS

DA = 2 Kp Cv CF [((6TAUt)/PI)^0.5] IF t < t*

DA = Kp Cv CF [(t/(1 + B)) + [2TAU ((1+3B)/(1 + B))]] IF t > t*

DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
Kp = PERMEABILITY COEFFICIENT (cm/hr)
Cv = VEHICLE CONCENTRATION (mg/cm^3)
TAU = LAG TIME (hr)
B = DIMENSIONLESS PARTITION COEFFICIENT
t = DURATION OF EVENT (hr/event)
CF = CONVERSION FACTOR (L/cm^3: 1e-3)

DAD = (DA EV ED EF A)/(BW AT)

DAD = DERMALLY ABSORBED DOSE (mg/kg/day)
DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (cm^2)
EV = EVENT FREQUENCY (event/day)
EF = EXPOSURE FREQUENCY (day/yr)
ED = EXPOSURE DURATION (yr)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days)

HQ = DAD1/RFD

HQ = HAZARD QUOTIENT
DAD1 = DAD FOR NONCARCINOGENIC RISKS (mg/kg/day)
RFD = REFERENCE DOSE (mg/kg/day)

CR = DAD2 CSF

CR = CANCER RISK
DAD2 = DAD FOR CARCINOGENIC RISK
CSF = CANCER SLOPE FACTOR ((mg/kg/day)^-1))

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, WTMA #26 (OS-02)
RECEPTOR(S): CHILD RESIDENT

ENTER INPUTS

A =	5910(cm^2)	
EV =	1(event/day)	
EF =	350(day/yr)	
ED1 =	6(yr)	NON-CARCINOGENIC
ED2 =	6(yr)	CARCINOGENIC
BW =	15(kg)	
AT1 =	2190(days)	NON-CARCINOGENIC
AT2 =	25550(days)	CARCINOGENIC
t =	.2(hr/event)	

ENTER 0 UNDER DA-i FOR ALL ORGANICS; ENTER 0 UNDER DA-o FOR ALL INORGANICS

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE THREE)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, WTMA #26 (OS-02)
RECEPTOR(S): CHILD RESIDENT

CHEMICAL	Cv (mg/L)	Kp or K	DA	DA-i	DA-o	TAU	t*	B	X1	X2	DAD1	DAD2	RFD-ORAL	CSF-ORAL
Tetrachloroethene	.02	3.7e-1	8.680e-6	0	8.680e-6	.9	4.3	.25	8.680e-6	1.983e-5	3.279e-3	2.811e-4	1e-2	5.2e-2
Trichloroethene	.11	2.3e-1	2.320e-5	0	2.320e-5	.55	1.3	.026	2.320e-5	3.417e-5	8.765e-3	7.512e-4	6e-3	1.1e-2
1,1-Dichloroethene	.018	1.6e-2	2.076e-7	0	2.076e-7	.34	.82	.013	2.076e-7	2.577e-7	7.844e-5	6.724e-6	9e-3	6e-1
1,1,1-Trichloroethane	.1	1.7e-2	1.587e-6	0	1.587e-6	.57	1.4	.031	1.587e-6	2.384e-6	5.995e-4	5.139e-5	9e-2	
1,1-Dichloroethane	.028	8.9e-3	1.823e-7	0	1.823e-7	.35	.84	.0062	1.823e-7	2.261e-7	6.887e-5	5.903e-6	1e-1	
Arsenic	.0037	1e-3	7.4e-10	7.4e-10	0				0	7.4e-10	2.796e-7	2.396e-8	3e-4	1.75e0
Barium	.216	1e-3	4.32e-8	4.32e-8	0				0	4.32e-8	1.632e-5	1.399e-6	7e-2	
Manganese	.041	1e-3	8.2e-9	8.2e-9	0				0	8.2e-9	3.098e-6	2.655e-7	5e-3	
			0	0	0				0	0	0	0		
			0	0	0				0	0	0	0		
			0	0	0				0	0	0	0		
			0	0	0				0	0	0	0		
			0	0	0				0	0	0	0		
			0	0	0				0	0	0	0		
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			0	0	0				0	0	0	0		
			0	0	0				0	0	0	0		
			0	0	0				0	0	0	0		
			0	0	0				0	0	0	0		
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			0	0	0				0	0	0	0		
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			0	0	0				0	0	0	0		
			0	0	0				0	0	0	0		
			0	0	0				0	0	0	0		

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE FOUR)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, WTMA #26 (OS-02)
RECEPTOR(S): CHILD RESIDENT

CHEMICAL	HQ	CR
Tetrachloroethene	3.279e-1	1.462e-5
Trichloroethene	1.4608e0	8.264e-6
1,1-Dichloroethene	8.716e-3	4.034e-6
1,1,1-Trichloroethane	6.661e-3	0
1,1-Dichloroethane	6.887e-4	0
Arsenic	9.319e-4	4.194e-8
Barium	2.332e-4	0
Manganese	6.196e-4	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
TOTAL	1.8065e0	2.696e-5

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE ONE)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, WTMA #26 (OS-02)
RECEPTOR(S): ADULT EMPLOYEE

RELEVANT EQUATIONS:

REFERENCES: USEPA, DECEMBER 1989; USEPA, JANUARY 1992

INORGANICS

DA = (K)(Cv)(t)

DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
K = PERMEABILITY COEFFICIENT FROM WATER (cm/hr)
Cv = CONCENTRATION OF CHEMICAL IN WATER (mg/cm^3)
t = DURATION OF EVENT (hr/event)

ORGANICS

DA = 2 Kp Cv CF [((6TAUt)/PI)^0.5] IF t < t*

DA = Kp Cv CF [(t/(1 + B)) + [2TAU ((1+3B)/(1 + B))]] IF t > t*

DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
Kp = PERMEABILITY COEFFICIENT (cm/hr)
Cv = VEHICLE CONCENTRATION (mg/cm^3)
TAU = LAG TIME (hr)
B = DIMENSIONLESS PARTITION COEFFICIENT
t = DURATION OF EVENT (hr/event)
CF = CONVERSION FACTOR (L/cm^3: 1e-3)

DAD = (DA EV ED EF A)/(BW AT)

DAD = DERMALLY ABSORBED DOSE (mg/kg/day)
DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (cm^2)
EV = EVENT FREQUENCY (event/day)
EF = EXPOSURE FREQUENCY (day/yr)
ED = EXPOSURE DURATION (yr)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days)

HQ = DAD1/RFD

HQ = HAZARD QUOTIENT
DAD1 = DAD FOR NONCARCINOGENIC RISKS (mg/kg/day)
RFD = REFERENCE DOSE (mg/kg/day)

CR = DAD2 CSF

CR = CANCER RISK
DAD2 = DAD FOR CARCINOGENIC RISK
CSF = CANCER SLOPE FACTOR ((mg/kg/day)^-1))

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, WTMA #26 (OS-02)
RECEPTOR(S): ADULT EMPLOYEE

ENTER INPUTS

A =	2270(cm^2)	
EV =	1(event/day)	
EF =	250(day/yr)	
ED1 =	25(yr)	NON-CARCINOGENIC
ED2 =	25(yr)	CARCINOGENIC
BW =	70(kg)	
AT1 =	9125(days)	NON-CARCINOGENIC
AT2 =	25550(days)	CARCINOGENIC
t =	.03(hr/event)	

ENTER 0 UNDER DA-i FOR ALL ORGANICS; ENTER 0 UNDER DA-o FOR ALL INORGANICS

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE THREE)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, WTMA #26 (OS-02)
RECEPTOR(S): ADULT EMPLOYEE

CHEMICAL	Cv (mg/L)	Kp or K	DA	DA-i	DA-o	TAU	t*	B	X1	X2	DAD1	DAD2	RFD-ORAL	CSF-ORAL
Tetrachloroethene	.02	3.7e-1	3.362e-6	0	3.362e-6	.9	4.3	.25	3.362e-6	1.883e-5	7.467e-5	2.667e-5	1e-2	5.2e-2
Trichloroethene	.11	2.3e-1	8.985e-6	0	8.985e-6	.55	1.3	.026	8.985e-6	2.998e-5	1.996e-4	7.127e-5	6e-3	1.1e-2
1,1-Dichloroethene	.018	1.6e-2	8.041e-8	0	8.041e-8	.34	.82	.013	8.041e-8	2.094e-7	1.786e-6	6.379e-7	9e-3	6e-1
1,1,1-Trichloroethane	.1	1.7e-2	6.146e-7	0	6.146e-7	.57	1.4	.031	6.146e-7	2.104e-6	1.365e-5	4.875e-6	9e-2	
1,1-Dichloroethane	.028	8.9e-3	7.060e-8	0	7.060e-8	.35	.84	.0062	7.060e-8	1.840e-7	1.568e-6	5.600e-7	1e-1	
Arsenic	.0037	1e-3	1.11e-10	1.11e-10	0				0	1.11e-10	2.465e-9	8.81e-10	3e-4	1.75e0
Barium	.216	1e-3	6.48e-9	6.48e-9	0				0	6.48e-9	1.439e-7	5.140e-8	7e-2	
Manganese	.041	1e-3	1.23e-9	1.23e-9	0				0	1.23e-9	2.732e-8	9.757e-9	5e-3	
____				0	0	0				0	0	0	0	
____				0	0	0				0	0	0	0	
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____				0	0	0				0	0	0	0	
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____				0	0	0				0	0	0	0	

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE FOUR)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, WTMA #26 (OS-02)
RECEPTOR(S): ADULT EMPLOYEE

CHEMICAL	HQ	CR
Tetrachloroethene	7.467e-3	1.387e-6
Trichloroethene	3.326e-2	7.840e-7
1,1-Dichloroethene	1.985e-4	3.827e-7
1,1,1-Trichloroethane	1.517e-4	0
1,1-Dichloroethane	1.568e-5	0
Arsenic	8.218e-6	1.541e-9
Barium	2.056e-6	0
Manganese	5.464e-6	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
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____	N/A	0
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____	N/A	0
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____	N/A	0
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____	N/A	0
____	N/A	0
____	N/A	0
TOTAL	4.111e-2	2.555e-6

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE ONE)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, LEWIS (OS-03)
RECEPTOR(S): ADULT RESIDENT

RELEVANT EQUATIONS:

REFERENCES: USEPA, DECEMBER 1989; USEPA, JANUARY 1992

INORGANICS

DA = (K)(Cv)(t)

DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
K = PERMEABILITY COEFFICIENT FROM WATER (cm/hr)
Cv = CONCENTRATION OF CHEMICAL IN WATER (mg/cm^3)
t = DURATION OF EVENT (hr/event)

ORGANICS

DA = 2 Kp Cv CF [((6TAUt)/PI)^0.5] IF t < t*

DA = Kp Cv CF [(t/(1 + B)) + (2TAU ((1+3B)/(1 + B)))] IF t > t*

DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
Kp = PERMEABILITY COEFFICIENT (cm/hr)
Cv = VEHICLE CONCENTRATION (mg/cm^3)
TAU = LAG TIME (hr)
B = DIMENSIONLESS PARTITION COEFFICIENT
t = DURATION OF EVENT (hr/event)
CF = CONVERSION FACTOR (L/cm^3: 1e-3)

DAD = (DA EV ED EF A)/(BW AT)

DAD = DERMALLY ABSORBED DOSE (mg/kg/day)
DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (cm^2)
EV = EVENT FREQUENCY (event/day)
EF = EXPOSURE FREQUENCY (day/yr)
ED = EXPOSURE DURATION (yr)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days)

HQ = DAD1/RFD

HQ = HAZARD QUOTIENT
DAD1 = DAD FOR NONCARCINOGENIC RISKS (mg/kg/day)
RFD = REFERENCE DOSE (mg/kg/day)

CR = DAD2 CSF

CR = CANCER RISK
DAD2 = DAD FOR CARCINOGENIC RISK
CSF = CANCER SLOPE FACTOR ((mg/kg/day)^-1))

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, LEWIS (OS-03)
RECEPTOR(S): ADULT RESIDENT

ENTER INPUTS

A =	19400(cm^2)	
EV =	1(event/day)	
EF =	350(day/yr)	
ED1 =	30(yr)	NON-CARCINOGENIC
ED2 =	30(yr)	CARCINOGENIC
BW =	70(kg)	
AT1 =	10950(days)	NON-CARCINOGENIC
AT2 =	25550(days)	CARCINOGENIC
t =	.2(hr/event)	

ENTER 0 UNDER DA-i FOR ALL ORGANICS; ENTER 0 UNDER DA-o FOR ALL INORGANICS

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE THREE)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, LEWIS (OS-03)
RECEPTOR(S): ADULT RESIDENT

CHEMICAL	Cv (mg/L)	Kp or K	DA	DA-i	DA-o	TAU	t*	B	X1	X2	DAD1	DAD2	RFD-ORAL	CSF-ORAL
Barium	.376	1e-3	7.52e-8	7.52e-8		0				0	7.52e-8	1.998e-5	8.565e-6	7e-2
Copper	.041	1e-3	8.2e-9	8.2e-9		0				0	8.2e-9	2.179e-6	9.339e-7	3.7e-2
----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
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----				0	0	0				0	0	0	0	
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----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
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----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
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----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE FOUR)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, LEWIS (OS-03)
RECEPTOR(S): ADULT RESIDENT

CHEMICAL	HQ	CR
Barium	2.855e-4	0
Copper	5.890e-5	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
TOTAL	3.444e-4	0

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE ONE)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, LEWIS (OS-03)
RECEPTOR(S): CHILD RESIDENT

RELEVANT EQUATIONS:

REFERENCES: USEPA, DECEMBER 1989; USEPA, JANUARY 1992

INORGANICS

DA = (K)(Cv)(t)

DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
K = PERMEABILITY COEFFICIENT FROM WATER (cm/hr)
Cv = CONCENTRATION OF CHEMICAL IN WATER (mg/cm^3)
t = DURATION OF EVENT (hr/event)

ORGANICS

DA = 2 Kp Cv CF [((6TAUt)/PI)^0.5] IF t < t*

DA = Kp Cv CF [(t/(1 + B)) + [2TAU ((1+3B)/(1 + B))]] IF t > t*

DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
Kp = PERMEABILITY COEFFICIENT (cm/hr)
Cv = VEHICLE CONCENTRATION (mg/cm^3)
TAU = LAG TIME (hr)
B = DIMENSIONLESS PARTITION COEFFICIENT
t = DURATION OF EVENT (hr/event)
CF = CONVERSION FACTOR (L/cm^3: 1e-3)

DAD = (DA EV ED EF A)/(BW AT)

DAD = DERMALLY ABSORBED DOSE (mg/kg/day)
DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (cm^2)
EV = EVENT FREQUENCY (event/day)
EF = EXPOSURE FREQUENCY (day/yr)
ED = EXPOSURE DURATION (yr)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days)

HQ = DAD1/RFD

HQ = HAZARD QUOTIENT
DAD1 = DAD FOR NONCARCINOGENIC RISKS (mg/kg/day)
RFD = REFERENCE DOSE (mg/kg/day)

CR = DAD2 CSF

CR = CANCER RISK
DAD2 = DAD FOR CARCINOGENIC RISK
CSF = CANCER SLOPE FACTOR ((mg/kg/day)^-1))

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, LEWIS (OS-03)
RECEPTOR(S): CHILD RESIDENT

ENTER INPUTS

A =	5910(cm^2)	
EV =	1(event/day)	
EF =	350(day/yr)	
ED1 =	6(yr)	NON-CARCINOGENIC
ED2 =	6(yr)	CARCINOGENIC
BW =	15(kg)	
AT1 =	2190(days)	NON-CARCINOGENIC
AT2 =	25550(days)	CARCINOGENIC
t =	.2(hr/event)	

ENTER 0 UNDER DA-i FOR ALL ORGANICS; ENTER 0 UNDER DA-o FOR ALL INORGANICS

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE THREE)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, LEWIS (OS-03)
RECEPTOR(S): CHILD RESIDENT

CHEMICAL	Cv (mg/L)	Kp or K	DA	DA-i	DA-o	TAU	t*	B	X1	X2	DAD1	DAD2	RFD-ORAL	CSF-ORAL
Barium	.376	1e-3	7.52e-8	7.52e-8		0				0	7.52e-8	2.841e-5	2.435e-6	7e-2
Copper	.041	1e-3	8.2e-9	8.2e-9		0				0	8.2e-9	3.098e-6	2.655e-7	3.7e-2
----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
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----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
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----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
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----				0	0	0				0	0	0	0	
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----				0	0	0				0	0	0	0	
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----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	
----				0	0	0				0	0	0	0	

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE FOUR)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, LEWIS (OS-03)
RECEPTOR(S): CHILD RESIDENT

CHEMICAL	HQ	CR
Barium	4.059e-4	0
Copper	8.373e-5	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
----	N/A	0
TOTAL	4.896e-4	0

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE ONE)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, AZTEC (OS-04)
RECEPTOR(S): ADULT EMPLOYEE

RELEVANT EQUATIONS:

REFERENCES: USEPA, DECEMBER 1989; USEPA, JANUARY 1992

INORGANICS

DA = (K)(Cv)(t)

DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
K = PERMEABILITY COEFFICIENT FROM WATER (cm/hr)
Cv = CONCENTRATION OF CHEMICAL IN WATER (mg/cm^3)
t = DURATION OF EVENT (hr/event)

ORGANICS

DA = 2 Kp Cv CF [((6TAUt)/PI)^0.5] IF t < t*

DA = Kp Cv CF [(t/(1 + B)) + [2TAU ((1+3B)/(1 + B))]] IF t > t*

DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
Kp = PERMEABILITY COEFFICIENT (cm/hr)
Cv = VEHICLE CONCENTRATION (mg/cm^3)
TAU = LAG TIME (hr)
B = DIMENSIONLESS PARTITION COEFFICIENT
t = DURATION OF EVENT (hr/event)
CF = CONVERSION FACTOR (L/cm^3: 1e-3)

DAD = (DA EV ED EF A)/(BW AT)

DAD = DERMALLY ABSORBED DOSE (mg/kg/day)
DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (cm^2)
EV = EVENT FREQUENCY (event/day)
EF = EXPOSURE FREQUENCY (day/yr)
ED = EXPOSURE DURATION (yr)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days)

HQ = DAD1/RFD

HQ = HAZARD QUOTIENT
DAD1 = DAD FOR NONCARCINOGENIC RISKS (mg/kg/day)
RFD = REFERENCE DOSE (mg/kg/day)

CR = DAD2 CSF

CR = CANCER RISK
DAD2 = DAD FOR CARCINOGENIC RISK
CSF = CANCER SLOPE FACTOR ((mg/kg/day)^-1))

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, AZTEC (OS-04)
RECEPTOR(S): ADULT EMPLOYEE

ENTER INPUTS

A =	2270(cm^2)	
EV =	1(event/day)	
EF =	250(day/yr)	
ED1 =	25(yr)	NON-CARCINOGENIC
ED2 =	25(yr)	CARCINOGENIC
BW =	70(kg)	
AT1 =	9125(days)	NON-CARCINOGENIC
AT2 =	25550(days)	CARCINOGENIC
t =	.03(hr/event)	

ENTER 0 UNDER DA-i FOR ALL ORGANICS; ENTER 0 UNDER DA-o FOR ALL INORGANICS

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE THREE)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, AZTEC (OS-04)
RECEPTOR(S): ADULT EMPLOYEE

CHEMICAL	Cv (mg/L)	Kp or K	DA	DA-i	DA-o	TAU	t*	B	X1	X2	DAD1	DAD2	RFD-ORAL	CSF-ORAL
Tetrachloroethene	.002	3.7e-1	3.362e-7		0	3.362e-7	.9	4.3	.25	3.362e-7	1.883e-6	7.467e-6	2.667e-6	1e-2	5.2e-2
Arsenic	.0046	1e-3	1.38e-10	1.38e-10		0				0	1.38e-10	3.065e-9	1.095e-9	3e-4	1.75e0
Barium	.209	1e-3	6.27e-9	6.27e-9		0				0	6.27e-9	1.393e-7	4.974e-8	7e-2	
Manganese	.026	1e-3	7.8e-10	7.8e-10		0				0	7.8e-10	1.732e-8	6.187e-9	5e-3	
				0	0	0				0	0	0	0		
				0	0	0				0	0	0	0		
				0	0	0				0	0	0	0		
				0	0	0				0	0	0	0		
				0	0	0				0	0	0	0		
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				0	0	0				0	0	0	0		
				0	0	0				0	0	0	0		
				0	0	0				0	0	0	0		
				0	0	0				0	0	0	0		

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE FOUR)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, AZTEC (OS-04)
RECEPTOR(S): ADULT EMPLOYEE

CHEMICAL	HQ	CR
Tetrachloroethene	7.467e-4	1.387e-7
Arsenic	1.022e-5	1.916e-9
Barium	1.990e-6	0
Manganese	3.465e-6	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
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____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
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____	N/A	0
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____	N/A	0
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____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
TOTAL	7.623e-4	1.406e-7

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE ONE)
SITE NAME: WARMINSTER, SITES 1, 2, 3 (CURRENT)
MEDIUM: GROUNDWATER
RECEPTOR(S): ADULT AND CHILD RESIDENTS

RELEVANT EQUATIONS: REFERENCES: USEPA, DECEMBER 1989

OEX = (CGW EF ED ABS IR)/(BW AT)

OEX = ORAL EXPOSURE DOSE (mg/kg/day)
CGW = CONCENTRATION OF CHEMICAL IN GROUNDWATER (mg/l)
EF = EXPOSURE FREQUENCY (day/yr)
ED = EXPOSURE DURATION (yr)
ABS = FRACTION ABSORBED
IR = INGESTION RATE (l/day)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days)

HQ = OEX1/RFD

HQ = HAZARD QUOTIENT
OEX1 = NONCARCINOGENIC ORAL EXPOSURE DOSE (mg/kg/day)
RFD = REFERENCE DOSE (CHRONIC, ORAL) (mg/kg/day)

CR = (OEX2) (CSF)

CR = CANCER RISK
OEX2 = CARCINOGENIC ORAL EXPOSURE DOSE (mg/kg/day)
CSF = CANCER SLOPE FACTOR (ORAL) (mg/kg/day)^-1

ENTER INPUTS:

EF (adult) =	350(day/yr)	
EF (child) =	350(day/yr)	
ED (adult) =	30(yr)	
ED (child) =	6(yr)	
ABS (adult) =	1	
ABS (child) =	1	
IR (adult) =	2(l/day)	
IR (child) =	1(l/day)	
BW (adult) =	70(kg)	
BW (child) =	15(kg)	
AT1 (adult) =	10950(days)	(NONCARCINOGENIC)
AT2 (adult) =	25550(days)	(CARCINOGENIC)
AT1 (child) =	2190(days)	(NONCARCINOGENIC)
AT2 (child) =	25550(days)	(CARCINOGENIC)

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE TWO)
SITE NAME: WARMINSTER, SITES 1, 2, 3 (CURRENT)
MEDIUM: GROUNDWATER
RECEPTOR(S): ADULT AND CHILD RESIDENTS

CHEMICAL	CGW (mg/l)	RFD	CSF	OEX1 ADULT	OEX2 ADULT	OEX1 CHILD	OEX2 CHILD
Vinyl chloride	.0015		1.9e0	4.110e-5	1.761e-5	9.589e-5	8.219e-6
1,1-Dichloroethene	.003	9e-3	6e-1	8.219e-5	3.523e-5	1.918e-4	1.644e-5
1,2-Dichloroethane	.0035		9.1e-2	9.589e-5	4.110e-5	2.237e-4	1.918e-5
Trichloroethene	.469	6e-3	1.1e-2	1.285e-2	5.507e-3	2.998e-2	2.570e-3
Tetrachloroethene	.128	1e-2	5.2e-2	3.507e-3	1.503e-3	8.183e-3	7.014e-4
Chloroform	.0138	1e-2	6.1e-3	3.781e-4	1.620e-4	8.822e-4	7.562e-5
Carbon tetrachloride	.0168	7e-4	1.3e-1	4.603e-4	1.973e-4	1.074e-3	9.205e-5
Benzene	.002		2.9e-2	5.479e-5	2.348e-5	1.279e-4	1.096e-5
1,2-Dichloropropane	.001		6.8e-2	2.740e-5	1.174e-5	6.393e-5	5.479e-6
Pyrene	.0006	3e-2		1.644e-5	7.045e-6	3.836e-5	3.288e-6
1,1-Dichloroethane	.008	1e-1		2.192e-4	9.393e-5	5.114e-4	4.384e-5
1,2-Dichloroethene	.027	1e-2		7.397e-4	3.170e-4	1.726e-3	1.479e-4
cis-1,2-Dichloroethene	.138	1e-2		3.781e-3	1.620e-3	8.822e-3	7.562e-4
1,1,1-Trichloroethane	.01	9e-2		2.740e-4	1.174e-4	6.393e-4	5.479e-5
Trichlorofluoromethane	.0298	3e-1		8.164e-4	3.499e-4	1.905e-3	1.633e-4
Toluene	.004	2e-1		1.096e-4	4.697e-5	2.557e-4	2.192e-5
Ethylbenzene	.0002	1e-1		5.479e-6	2.348e-6	1.279e-5	1.096e-6
Xylenes	.002	2e0		5.479e-5	2.348e-5	1.279e-4	1.096e-5
1,2-Dichlorobenzene	.0007	9e-2		1.918e-5	8.219e-6	4.475e-5	3.836e-6
2-Butanone	.024	5e-2		6.575e-4	2.818e-4	1.534e-3	1.315e-4
Di-n-octyl phthalate	.003	2e-2		8.219e-5	3.523e-5	1.918e-4	1.644e-5
Diethyl phthalate	.000375	8e-1		1.027e-5	4.403e-6	2.397e-5	2.055e-6
Phenanthrene	.0003	2.9e-2		8.219e-6	3.523e-6	1.918e-5	1.644e-6
Fluoranthene	.0006	4e-2		1.644e-5	7.045e-6	3.836e-5	3.288e-6
Arsenic	.0106	3e-4	1.75e0	2.904e-4	1.245e-4	6.776e-4	5.808e-5
Lead	.0855			2.342e-3	1.004e-3	5.466e-3	4.685e-4
Chromium	.0494	5e-3		1.353e-3	5.800e-4	3.158e-3	2.707e-4
Manganese	5.41	5e-3		1.482e-1	6.352e-2	3.458e-1	2.964e-2
Thallium	.00114	7e-5		3.123e-5	1.339e-5	7.288e-5	6.247e-6
Aluminum	25.82	2.9e0		7.074e-1	3.032e-1	1.6506e0	1.415e-1
Barium	.873	7e-2		2.392e-2	1.025e-2	5.581e-2	4.784e-3
Cobalt	.0228			6.247e-4	2.677e-4	1.458e-3	1.249e-4
Copper	.236	3.7e-2		6.466e-3	2.771e-3	1.509e-2	1.293e-3
Mercuy	.00022	3e-4		6.027e-6	2.583e-6	1.406e-5	1.205e-6
Nickel	.0436	2e-2		1.195e-3	5.119e-4	2.787e-3	2.389e-4
Silver	.00558	5e-3		1.529e-4	6.552e-5	3.567e-4	3.058e-5
Vanadium	.0245	7e-3		6.712e-4	2.877e-4	1.566e-3	1.342e-4
Zinc	.4	2e-1		1.096e-2	4.697e-3	2.557e-2	2.192e-3
_____				0	0	0	0
_____				0	0	0	0
_____				0	0	0	0
_____				0	0	0	0
_____				0	0	0	0
_____				0	0	0	0
_____				0	0	0	0
_____				0	0	0	0
_____				0	0	0	0
_____				0	0	0	0
_____				0	0	0	0
_____				0	0	0	0
_____				0	0	0	0

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE THREE)
SITE NAME: WARMINSTER, SITES 1, 2, 3 (CURRENT)
MEDIUM: GROUNDWATER
RECEPTOR(S): ADULT AND CHILD RESIDENTS

CHEMICAL	HQ ADULT	HQ CHILD	CR ADULT	CR CHILD
Vinyl chloride	N/A	N/A	3.346e-5	1.562e-5
1,1-Dichloroethene	9.132e-3	2.131e-2	2.114e-5	9.863e-6
1,2-Dichloroethane	N/A	N/A	3.740e-6	1.745e-6
Trichloroethene	2.1416e0	4.9970e0	6.058e-5	2.827e-5
Tetrachloroethene	3.507e-1	8.183e-1	7.815e-5	3.647e-5
Chloroform	3.781e-2	8.822e-2	9.884e-7	4.613e-7
Carbon tetrachloride	6.575e-1	1.5342e0	2.564e-5	1.197e-5
Benzene	N/A	N/A	6.810e-7	3.178e-7
1,2-Dichloropropane	N/A	N/A	7.984e-7	3.726e-7
Pyrene	5.479e-4	1.279e-3	0	0
1,1-Dichloroethane	2.192e-3	5.114e-3	0	0
1,2-Dichloroethene	7.397e-2	1.726e-1	0	0
cis-1,2-Dichloroethene	3.781e-1	8.822e-1	0	0
1,1,1-Trichloroethane	3.044e-3	7.103e-3	0	0
Trichlorofluoromethane	2.721e-3	6.350e-3	0	0
Toluene	5.479e-4	1.279e-3	0	0
Ethylbenzene	5.479e-5	1.279e-4	0	0
Xylenes	2.740e-5	6.393e-5	0	0
1,2-Dichlorobenzene	2.131e-4	4.972e-4	0	0
2-Butanone	1.315e-2	3.068e-2	0	0
Di-n-octyl phthalate	4.110e-3	9.589e-3	0	0
Diethyl phthalate	1.284e-5	2.997e-5	0	0
Phenanthrene	2.834e-4	6.613e-4	0	0
Fluoranthene	4.110e-4	9.589e-4	0	0
Arsenic	9.680e-1	2.2588e0	2.178e-4	1.016e-4
Lead	N/A	N/A	0	0
Chromium	2.707e-1	6.316e-1	0	0
Manganese	2.9644e1	6.9169e1	0	0
Thallium	4.462e-1	1.0411e0	0	0
Aluminum	2.439e-1	5.692e-1	0	0
Barium	3.417e-1	7.973e-1	0	0
Cobalt	N/A	N/A	0	0
Copper	1.748e-1	4.078e-1	0	0
Mercury	2.009e-2	4.688e-2	0	0
Nickel	5.973e-2	1.394e-1	0	0
Silver	3.058e-2	7.134e-2	0	0
Vanadium	9.589e-2	2.237e-1	0	0
Zinc	5.479e-2	1.279e-1	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
TOTAL	3.6026e1	8.4061e1	4.430e-4	2.067e-4

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE ONE

SITE NAME: WARMINSTER, SITES 1, 2, 3 (CURRENT)
MEDIUM: GROUNDWATER--using filtered metals
RECEPTOR(S): ADULT AND CHILD RESIDENTS

RELEVANT EQUATIONS: REFERENCES: USEPA, DECEMBER 1989

OEX = (CGW EF ED ABS IR)/(BW AT)

OEX = ORAL EXPOSURE DOSE (mg/kg/day)
CGW = CONCENTRATION OF CHEMICAL IN GROUNDWATER (mg/l)
EF = EXPOSURE FREQUENCY (day/yr)
ED = EXPOSURE DURATION (yr)
ABS = FRACTION ABSORBED
IR = INGESTION RATE (l/day)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days)

HQ = OEX1/RFD

HQ = HAZARD QUOTIENT
OEX1 = NONCARCINOGENIC ORAL EXPOSURE DOSE (mg/kg/day)
RFD = REFERENCE DOSE (CHRONIC, ORAL) (mg/kg/day)

CR = (OEX2) (CSF)

CR = CANCER RISK
OEX2 = CARCINOGENIC ORAL EXPOSURE DOSE (mg/kg/day)
CSF = CANCER SLOPE FACTOR (ORAL) (mg/kg/day)^-1

ENTER INPUTS:

EF (adult) =	350(day/yr)	
EF (child) =	350(day/yr)	
ED (adult) =	30(yr)	
ED (child) =	6(yr)	
ABS (adult) =	1	
ABS (child) =	1	
IR (adult) =	2(l/day)	
IR (child) =	1(l/day)	
BW (adult) =	70(kg)	
BW (child) =	15(kg)	
AT1 (adult) =	10950(days)	(NONCARCINOGENIC)
AT2 (adult) =	25550(days)	(CARCINOGENIC)
AT1 (child) =	2190(days)	(NONCARCINOGENIC)
AT2 (child) =	25550(days)	(CARCINOGENIC)

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE TWO)
SITE NAME: WARMINSTER, SITES 1, 2, 3 (CURRENT)
MEDIUM: GROUNDWATER--using filtered metals
RECEPTOR(S): ADULT AND CHILD RESIDENTS

CHEMICAL	CGW (mg/l)	RFD	CSF	DEX1 ADULT	DEX2 ADULT	DEX1 CHILD	DEX2 CHILD
Vinyl chloride	.0015		1.9e0	4.110e-5	1.761e-5	9.589e-5	8.219e-6
1,1-Dichloroethene	.003	9e-3	6e-1	8.219e-5	3.523e-5	1.918e-4	1.644e-5
1,2-Dichloroethane	.0035		9.1e-2	9.589e-5	4.110e-5	2.237e-4	1.918e-5
Trichloroethene	.469		1.1e-2	1.285e-2	5.507e-3	2.998e-2	2.570e-3
Tetrachloroethene	.128	1e-2	5.2e-2	3.507e-3	1.503e-3	8.183e-3	7.014e-4
Chloroform	.0138	1e-2	6.1e-3	3.781e-4	1.620e-4	8.822e-4	7.562e-5
Carbon tetrachloride	.0168	7e-4	1.3e-1	4.603e-4	1.973e-4	1.074e-3	9.205e-5
Benzene	.002		2.9e-2	5.479e-5	2.348e-5	1.279e-4	1.096e-5
1,2-Dichloropropane	.001		6.8e-2	2.740e-5	1.174e-5	6.393e-5	5.479e-6
Styrene	.0006	3e-2	5.9e-1	1.644e-5	7.045e-6	3.836e-5	3.288e-6
1,1-Dichloroethane	.008	1e-1		2.192e-4	9.393e-5	5.114e-4	4.384e-5
1,2-Dichloroethene	.027	1e-2		7.397e-4	3.170e-4	1.726e-3	1.479e-4
cis-1,2-Dichloroethene	.138	1e-2		3.781e-3	1.620e-3	8.822e-3	7.562e-4
1,1,1-Trichloroethane	.01	9e-2		2.740e-4	1.174e-4	6.393e-4	5.479e-5
Trichlorofluoromethane	.0298	3e-1		8.164e-4	3.499e-4	1.905e-3	1.633e-4
Toluene	.004	2e-1		1.096e-4	4.697e-5	2.557e-4	2.192e-5
Ethylbenzene	.0002	1e-1		5.479e-6	2.348e-6	1.279e-5	1.096e-6
Xylenes	.002	2e0		5.479e-5	2.348e-5	1.279e-4	1.096e-5
1,2-Dichlorobenzene	.0007	9e-2		1.918e-5	8.219e-6	4.475e-5	3.836e-6
2-Butanone	.024	5e-2		6.575e-4	2.818e-4	1.534e-3	1.315e-4
Di-n-octyl phthalate	.003	2e-2		8.219e-5	3.523e-5	1.918e-4	1.644e-5
Diethyl phthalate	.000375	8e-1		1.027e-5	4.403e-6	2.397e-5	2.055e-6
Phenanthrene	.0003	2.9e-2		8.219e-6	3.523e-6	1.918e-5	1.644e-6
Fluoranthene	.0006	4e-2		1.644e-5	7.045e-6	3.836e-5	3.288e-6
Arsenic	0	3e-4	1.75e0	0	0	0	0
Lead	.00186			5.096e-5	2.184e-5	1.189e-4	1.019e-5
Chromium	0	5e-3		0	0	0	0
Manganese	1.31	1e-1		3.589e-2	1.538e-2	8.374e-2	7.178e-3
Thallium	0	7e-5		0	0	0	0
Aluminum	0	2.9e0		0	0	0	0
Barium	.21	7e-2		5.753e-3	2.466e-3	1.342e-2	1.151e-3
Cobalt	0			0	0	0	0
Copper	0	3.7e-2		0	0	0	0
Mercury	0	3e-4		0	0	0	0
Nickel	0	2e-2		0	0	0	0
Silver	0	5e-3		0	0	0	0
Vanadium	.00339	7e-3		9.288e-5	3.980e-5	2.167e-4	1.858e-5
Zinc	0	2e-1		0	0	0	0
-----				0	0	0	0
-----				0	0	0	0
-----				0	0	0	0
-----				0	0	0	0
-----				0	0	0	0
-----				0	0	0	0
-----				0	0	0	0
-----				0	0	0	0
-----				0	0	0	0
-----				0	0	0	0
-----				0	0	0	0
-----				0	0	0	0
-----				0	0	0	0

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE THREE)
SITE NAME: WARMINSTER. SITES 1, 2, 3 (CURRENT)
MEDIUM: GROUNDWATER--using filtered metals
RECEPTOR(S): ADULT AND CHILD RESIDENTS

CHEMICAL	HQ ADULT	HQ CHILD	CR ADULT	CR CHILD
Vinyl chloride	N/A	N/A	3.346e-5	1.562e-5
1,1-Dichloroethene	9.132e-3	2.131e-2	2.114e-5	9.863e-6
1,2-Dichloroethane	N/A	N/A	3.740e-6	1.745e-6
Trichloroethene	N/A	N/A	6.058e-5	2.827e-5
Tetrachloroethene	3.507e-1	8.183e-1	7.815e-5	3.647e-5
Chloroform	3.781e-2	8.822e-2	9.884e-7	4.613e-7
Carbon tetrachloride	6.575e-1	1.5342e0	2.564e-5	1.197e-5
Benzene	N/A	N/A	6.810e-7	3.178e-7
1,2-Dichloropropane	N/A	N/A	7.984e-7	3.726e-7
Pyrene	5.479e-4	1.279e-3	4.157e-6	1.940e-6
1,1-Dichloroethane	2.192e-3	5.114e-3	0	0
1,2-Dichloroethene	7.397e-2	1.726e-1	0	0
cis-1,2-Dichloroethene	3.781e-1	8.822e-1	0	0
1,1,1-Trichloroethane	3.044e-3	7.103e-3	0	0
Trichlorofluoromethane	2.721e-3	6.350e-3	0	0
Toluene	5.479e-4	1.279e-3	0	0
Ethylbenzene	5.479e-5	1.279e-4	0	0
Xylenes	2.740e-5	6.393e-5	0	0
1,2-Dichlorobenzene	2.131e-4	4.972e-4	0	0
2-Butanone	1.315e-2	3.068e-2	0	0
Di-n-octyl phthalate	4.110e-3	9.589e-3	0	0
Diethyl phthalate	1.284e-5	2.997e-5	0	0
Phenanthrene	2.834e-4	6.613e-4	0	0
Fluoranthene	4.110e-4	9.589e-4	0	0
Arsenic	0	0	0	0
Lead	N/A	N/A	0	0
Chromium	0	0	0	0
Manganese	3.589e-1	8.374e-1	0	0
Thallium	0	0	0	0
Aluminum	0	0	0	0
Barium	8.219e-2	1.918e-1	0	0
Cobalt	N/A	N/A	0	0
Copper	0	0	0	0
Mercury	0	0	0	0
Nickel	0	0	0	0
Silver	0	0	0	0
Vanadium	1.327e-2	3.096e-2	0	0
Zinc	0	0	0	0
-----	N/A	N/A	0	0
-----	N/A	N/A	0	0
-----	N/A	N/A	0	0
TOTAL	1.9889e0	4.6408e0	2.293e-4	1.070e-4

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE ONE)
SITE NAME: WARMINSTER, SITES 1, 2, 3 (CURRENT)
MEDIUM: GROUNDWATER
RECEPTOR(S): ADULT EMPLOYEES

RELEVANT EQUATIONS: REFERENCES: USEPA, DECEMBER 1989

OEX = (CGW EF ED ABS IR)/(BW AT)

OEX = ORAL EXPOSURE DOSE (mg/kg/day)
CGW = CONCENTRATION OF CHEMICAL IN GROUNDWATER (mg/l)
EF = EXPOSURE FREQUENCY (day/yr)
ED = EXPOSURE DURATION (yr)
ABS = FRACTION ABSORBED
IR = INGESTION RATE (l/day)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days)

HQ = OEX1/RFD

HQ = HAZARD QUOTIENT
OEX1 = NONCARCINOGENIC ORAL EXPOSURE DOSE (mg/kg/day)
RFD = REFERENCE DOSE (CHRONIC, ORAL) (mg/kg/day)

CR = (OEX2) (CSF)

CR = CANCER RISK
OEX2 = CARCINOGENIC ORAL EXPOSURE DOSE (mg/kg/day)
CSF = CANCER SLOPE FACTOR (ORAL) (mg/kg/day)^-1

ENTER INPUTS:

EF (adult) =	250(day/yr)	
EF (child) =	0(day/yr)	
ED (adult) =	25(yr)	
ED (child) =	0(yr)	
ABS (adult) =	1	
ABS (child) =	1	
IR (adult) =	1(l/day)	
IR (child) =	0(l/day)	
BW (adult) =	70(kg)	
BW (child) =	15(kg)	
AT1 (adult) =	9125(days)	(NONCARCINOGENIC)
AT2 (adult) =	25550(days)	(CARCINOGENIC)
AT1 (child) =	2190(days)	(NONCARCINOGENIC)
AT2 (child) =	25550(days)	(CARCINOGENIC)

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE TWO)
SITE NAME: WARMINSTER, SITES 1, 2, 3 (CURRENT)
MEDIUM: GROUNDWATER
RECEPTOR(S): ADULT EMPLOYEES

CHEMICAL	CGW (mg/l)	RFD	CSF	OEX1 ADULT	OEX2 ADULT	OEX1 CHILD	OEX2 CHILD
Vinyl chloride	.0015		1.9e0	1.468e-5	5.242e-6	0	0
1,1-Dichloroethene	.003	9e-3	6e-1	2.935e-5	1.048e-5	0	0
1,2-Dichloroethane	.0035		9.1e-2	3.425e-5	1.223e-5	0	0
Trichloroethene	.469	6e-3	1.1e-2	4.589e-3	1.639e-3	0	0
Tetrachloroethene	.128	1e-2	5.2e-2	1.252e-3	4.473e-4	0	0
Chloroform	.0138	1e-2	6.1e-3	1.350e-4	4.822e-5	0	0
Carbon tetrachloride	.0168	7e-4	1.3e-1	1.644e-4	5.871e-5	0	0
Benzene	.002		2.9e-2	1.957e-5	6.989e-6	0	0
1,2-Dichloropropane	.001		6.8e-2	9.785e-6	3.495e-6	0	0
Pyrene	.0006	3e-2		5.871e-6	2.097e-6	0	0
1,1-Dichloroethane	.008	1e-1		7.828e-5	2.796e-5	0	0
1,2-Dichloroethene	.027	1e-2		2.642e-4	9.435e-5	0	0
cis-1,2-Dichloroethene	.138	1e-2		1.350e-3	4.822e-4	0	0
1,1,1-Trichloroethane	.01	9e-2		9.785e-5	3.495e-5	0	0
Trichlorofluoromethane	.0298	3e-1		2.916e-4	1.041e-4	0	0
Toluene	.004	2e-1		3.914e-5	1.398e-5	0	0
Ethylbenzene	.0002	1e-1		1.957e-6	6.989e-7	0	0
Xylenes	.002	2e0		1.957e-5	6.989e-6	0	0
1,2-Dichlorobenzene	.0007	9e-2		6.849e-6	2.446e-6	0	0
2-Butanone	.024	5e-2		2.348e-4	8.387e-5	0	0
Di-n-octyl phthalate	.003	2e-2		2.935e-5	1.048e-5	0	0
Diethyl phthalate	.000375	8e-1		3.669e-6	1.310e-6	0	0
Phenanthrene	.0003	2.9e-2		2.935e-6	1.048e-6	0	0
Fluoranthene	.0006	4e-2		5.871e-6	2.097e-6	0	0
Arsenic	.0106	3e-4	1.75e0	1.037e-4	3.704e-5	0	0
Lead	.0855			8.366e-4	2.988e-4	0	0
Chromium	.0494	5e-3		4.834e-4	1.726e-4	0	0
Manganese	5.41	5e-3		5.294e-2	1.891e-2	0	0
Thallium	.00114	7e-5		1.115e-5	3.984e-6	0	0
Aluminum	25.82	2.9e0		2.526e-1	9.023e-2	0	0
Barium	.873	7e-2		8.542e-3	3.051e-3	0	0
Cobalt	.0228			2.231e-4	7.968e-5	0	0
Copper	.236	3.7e-2		2.309e-3	8.247e-4	0	0
Mercuy	.00022	3e-4		2.153e-6	7.688e-7	0	0
Nickel	.0436	2e-2		4.266e-4	1.524e-4	0	0
Silver	.00558	5e-3		5.460e-5	1.950e-5	0	0
Vanadium	.0245	7e-3		2.397e-4	8.562e-5	0	0
Zinc	.4	2e-1		3.914e-3	1.398e-3	0	0
_____				0	0	0	0
_____				0	0	0	0
_____				0	0	0	0
_____				0	0	0	0
_____				0	0	0	0
_____				0	0	0	0
_____				0	0	0	0
_____				0	0	0	0
_____				0	0	0	0
_____				0	0	0	0
_____				0	0	0	0
_____				0	0	0	0
_____				0	0	0	0

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE THREE)
SITE NAME: WARMINSTER, SITES 1, 2, 3 (CURRENT)
MEDIUM: GROUNDWATER
RECEPTOR(S): ADULT EMPLOYEES

CHEMICAL	HQ ADULT	HQ CHILD	CR ADULT	CR CHILD
Vinyl chloride	N/A	N/A	9.959e-6	0
1,1-Dichloroethene	3.262e-3	0	6.290e-6	0
1,2-Dichloroethane	N/A	N/A	1.113e-6	0
Trichloroethene	7.648e-1	0	1.803e-5	0
Tetrachloroethene	1.252e-1	0	2.326e-5	0
Chloroform	1.350e-2	0	2.942e-7	0
Carbon tetrachloride	2.348e-1	0	7.632e-6	0
Benzene	N/A	N/A	2.027e-7	0
1,2-Dichloropropane	N/A	N/A	2.376e-7	0
Pyrene	1.957e-4	0	0	0
1,1-Dichloroethane	7.828e-4	0	0	0
1,2-Dichloroethene	2.642e-2	0	0	0
cis-1,2-Dichloroethene	1.350e-1	0	0	0
1,1,1-Trichloroethane	1.087e-3	0	0	0
Trichlorofluoromethane	9.720e-4	0	0	0
Toluene	1.957e-4	0	0	0
Ethylbenzene	1.957e-5	0	0	0
Xylenes	9.785e-6	0	0	0
1,2-Dichlorobenzene	7.610e-5	0	0	0
2-Butanone	4.697e-3	0	0	0
Di-n-octyl phthalate	1.468e-3	0	0	0
Diethyl phthalate	4.587e-6	0	0	0
Phenanthrene	1.012e-4	0	0	0
Fluoranthene	1.468e-4	0	0	0
Arsenic	3.457e-1	0	6.482e-5	0
Lead	N/A	N/A	0	0
Chromium	9.667e-2	0	0	0
Manganese	1.0587e1	0	0	0
Thallium	1.594e-1	0	0	0
Aluminum	8.712e-2	0	0	0
Barium	1.220e-1	0	0	0
Cobalt	N/A	N/A	0	0
Copper	6.241e-2	0	0	0
Mercuy	7.175e-3	0	0	0
Nickel	2.133e-2	0	0	0
Silver	1.092e-2	0	0	0
Vanadium	3.425e-2	0	0	0
Zinc	1.957e-2	0	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
TOTAL	1.2867e1	0	1.318e-4	0

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE ONE)
SITE NAME: WARMINSTER, SITES 1, 2, 3 (CURRENT)
MEDIUM: GROUNDWATER--using filtered metals
RECEPTOR(S): ADULT EMPLOYEES

RELEVANT EQUATIONS:

REFERENCES: USEPA, DECEMBER 1989

DEX = (CGW EF ED ABS IR)/(BW AT)

DEX = ORAL EXPOSURE DOSE (mg/kg/day)
CGW = CONCENTRATION OF CHEMICAL IN GROUNDWATER (mg/l)
EF = EXPOSURE FREQUENCY (day/yr)
ED = EXPOSURE DURATION (yr)
ABS = FRACTION ABSORBED
IR = INGESTION RATE (l/day)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days)

HQ = DEX1/RFD

HQ = HAZARD QUOTIENT
DEX1 = NONCARCINOGENIC ORAL EXPOSURE DOSE (mg/kg/day)
RFD = REFERENCE DOSE (CHRONIC, ORAL) (mg/kg/day)

CR = (DEX2) (CSF)

CR = CANCER RISK
DEX2 = CARCINOGENIC ORAL EXPOSURE DOSE (mg/kg/day)
CSF = CANCER SLOPE FACTOR (ORAL) (mg/kg/day)^-1

ENTER INPUTS:

EF (adult) =	250(day/yr)	
EF (child) =	0(day/yr)	
ED (adult) =	25(yr)	
ED (child) =	0(yr)	
ABS (adult) =	1	
ABS (child) =	1	
IR (adult) =	1(l/day)	
IR (child) =	0(l/day)	
BW (adult) =	70(kg)	
BW (child) =	15(kg)	
AT1 (adult) =	9125(days)	(NONCARCINOGENIC)
AT2 (adult) =	25550(days)	(CARCINOGENIC)
AT1 (child) =	2190(days)	(NONCARCINOGENIC)
AT2 (child) =	25550(days)	(CARCINOGENIC)

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE ONE)

SITE NAME: WARMINSTER, SITES 5, 6, 7

MEDIUM: GROUNDWATER (CURRENT)

RECEPTOR(S): CHILD RESIDENT

RELEVANT EQUATIONS:

REFERENCES: USEPA, DECEMBER 1989; USEPA, JANUARY 1992

INORGANICS

DA = (K)(Cv)(t)

DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
K = PERMEABILITY COEFFICIENT FROM WATER (cm/hr)
Cv = CONCENTRATION OF CHEMICAL IN WATER (mg/cm^3)
t = DURATION OF EVENT (hr/event)

ORGANICS

DA = 2 CF Kp Cv [((6TAUt)/PI)^0.5] IF t < t*

DA = Kp CF Cv [(t/(1 + B)) + [2TAU ((1+3B)/(1 + B))]] IF t > t*

DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
Kp = PERMEABILITY COEFFICIENT (cm/hr)
Cv = VEHICLE CONCENTRATION (mg/cm^3)
TAU = LAG TIME (hr)
B = DIMENSIONLESS PARTITION COEFFICIENT
t = DURATION OF EVENT (hr/event)
CF = CONVERSION FACTOR (L/cm^3: 1e-3)

DAD = (DA EV ED EF A)/(BW AT)

DAD = DERMALLY ABSORBED DOSE (mg/kg/day)
DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (cm^2)
EV = EVENT FREQUENCY (event/day)
EF = EXPOSURE FREQUENCY (day/yr)
ED = EXPOSURE DURATION (yr)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days)

HQ = DAD1/RFD

HQ = HAZARD QUOTIENT
DAD1 = DAD FOR NONCARCINOGENIC RISKS (mg/kg/day)
RFD = REFERENCE DOSE (mg/kg/day)

CR = DAD2 CSF

CR = CANCER RISK
DAD2 = DAD FOR CARCINOGENIC RISK
CSF = CANCER SLOPE FACTOR ((mg/kg/day)^-1))

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)

SITE NAME: WARMINSTER, SITES 5, 6, 7

MEDIUM: GROUNDWATER (CURRENT)

RECEPTOR(S): CHILD RESIDENT

ENTER INPUTS

A =	5910(cm^2)	
EV =	1(event/day)	
EF =	350(day/yr)	
ED1 =	6(yr)	NON-CARCINOGENIC
ED2 =	6(yr)	CARCINOGENIC
BW =	70(kg)	
AT1 =	2190(days)	NON-CARCINOGENIC
AT2 =	25550(days)	CARCINOGENIC
t =	.2(hr/event)	

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE THREE)
SITE NAME: WARMINSTER, SITES 5, 6, 7
MEDIUM: GROUNDWATER (CURRENT)
RECEPTOR(S): CHILD RESIDENT

CHEMICAL	Cv (mg/L)	Kp or K	DA	DA-i	DA-o	TAU	t*	B	X1	X2	DAD1	DAD2	RFD-ORAL	CSF-ORAL
Trichloroethene	.0044	2.3e-1	9.279e-7	0	9.279e-7	.55	1.3	2.6e-2	9.279e-7	1.367e-6	7.512e-5	6.439e-6	6e-3	1.1e-2
Tetrachloroethene	.0018	3.7e-1	7.812e-7	0	7.812e-7	.9	4.3	2.5e-1	7.812e-7	1.785e-6	6.324e-5	5.421e-6	1e-2	5.2e-2
Carbon tetrachloride	.0016	2.2e-2	3.794e-8	0	3.794e-8	.76	1.8	6.8e-2	3.794e-8	6.691e-8	3.072e-6	2.633e-7	7e-4	1.3e-1
Chloromethane	.002	4.2e-3	4.406e-9	0	4.406e-9	.18	.43	8.1e-4	4.406e-9	4.708e-9	3.567e-7	3.058e-8		1.3e-2
Chloroform	.0014	1.3e-1	1.543e-7	0	1.543e-7	.47	1.1	9.3e-3	1.543e-7	2.103e-7	1.249e-5	1.071e-6	1e-2	6.1e-3
1,2-Dichloroethene	.0038	5.5e-3	1.507e-8	0	1.507e-8	.34	.82	3e-3	1.507e-8	1.846e-8	1.220e-6	1.046e-7	1e-2	
cis-1,2-Dichloroethene	.0026	5.5e-3	1.031e-8	0	1.031e-8	.34	.82	3e-3	1.031e-8	1.263e-8	8.346e-7	7.154e-8	1e-2	
Toluene	.0024	1e0	1.679e-6	0	1.679e-6	.32	.77	5.4e-2	1.679e-6	2.149e-6	1.359e-4	1.165e-5	2e-1	
1,1,1-Trichloroethane	.001	1.7e-2	1.587e-8	0	1.587e-8	.57	1.4	3.1e-2	1.587e-8	2.384e-8	1.285e-6	1.101e-7	9e-2	
Di-n-octyl phthalate	.0009	3.3e-2	1.683e-7	0	1.683e-7	21	100	1.3e1	1.683e-7	3.564e-6	1.362e-5	1.168e-6	2e-2	
Diethyl phthalate	.002	4.8e-3	1.679e-8	0	1.679e-8	2	4.7	3e-2	1.679e-8	4.250e-8	1.359e-6	1.165e-7	8e-1	
Arsenic	.0034	1e-3	6.8e-10	6.8e-10	0				0	6.8e-10	5.505e-8	4.719e-9	3e-4	1.75e0
Cadmium	.002	1e-3	4e-10	4e-10	0				0	4e-10	3.238e-8	2.776e-9	5e-4	
Lead	.0071	4e-6	5.68e-12	5.68e-12	0				0	5.68e-12	4.60e-10	3.94e-11		
Barium	.388	1e-3	7.76e-8	7.76e-8	0				0	7.76e-8	6.282e-6	5.385e-7	7e-2	
Cobalt	.0232	4e-4	1.856e-9	1.856e-9	0				0	1.856e-9	1.503e-7	1.288e-8		
Copper	.0341	1e-3	6.82e-9	6.82e-9	0				0	6.82e-9	5.521e-7	4.733e-8	3.7e-2	
Manganese	2	1e-3	4e-7	4e-7	0				0	4e-7	3.238e-5	2.776e-6	5e-3	
Nickel	.0323	1e-4	6.46e-10	6.46e-10	0				0	6.46e-10	5.230e-8	4.483e-9	2e-2	
Cyanide	.0263	1e-3	5.26e-9	5.26e-9	0				0	5.26e-9	4.258e-7	3.650e-8	2e-2	
Vanadium	.0163	1e-3	3.26e-9	3.26e-9	0				0	3.26e-9	2.639e-7	2.262e-8	7e-3	
Zinc	.228	6e-4	2.736e-8	2.736e-8	0				0	2.736e-8	2.215e-6	1.899e-7	2e-1	
___			0	0	0				0	0	0	0		
___			0	0	0				0	0	0	0		
___			0	0	0				0	0	0	0		
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___			0	0	0				0	0	0	0		
___			0	0	0				0	0	0	0		
___			0	0	0				0	0	0	0		

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE FOUR)
SITE NAME: WARMINSTER, SITES 5, 6, 7
MEDIUM: GROUNDWATER (CURRENT)
RECEPTOR(S): CHILD RESIDENT

CHEMICAL	HQ	CR
Trichloroethene	1.252e-2	7.083e-8
Tetrachloroethene	6.324e-3	2.819e-7
Carbon tetrachloride	4.388e-3	3.423e-8
Chloromethane	N/A	3.97e-10
Chloroform	1.249e-3	6.530e-9
1,2-Dichloroethene	1.220e-4	0
cis-1,2-Dichloroethene	8.346e-5	0
Toluene	6.795e-4	0
1,1,1-Trichloroethane	1.427e-5	0
Di-n-octyl phthalate	6.812e-4	0
Diethyl phthalate	1.699e-6	0
Arsenic	1.835e-4	8.258e-9
Cadmium	6.477e-5	0
Lead	N/A	0
Barium	8.975e-5	0
Cobalt	N/A	0
Copper	1.492e-5	0
Manganese	6.477e-3	0
Nickel	2.615e-6	0
Cyanide	2.129e-5	0
Vanadium	3.770e-5	0
Zinc	1.108e-5	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
TOTAL	3.297e-2	4.021e-7

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE ONE)
SITE NAME: WARMINSTER, SITES 5, 6, 7
MEDIUM: GROUNDWATER (CURRENT)
RECEPTOR(S): ADULT EMPLOYEE

RELEVANT EQUATIONS:

REFERENCES: USEPA, DECEMBER 1989; USEPA, JANUARY 1992

INORGANICS

DA = (K)(Cv)(t)

DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
K = PERMEABILITY COEFFICIENT FROM WATER (cm/hr)
Cv = CONCENTRATION OF CHEMICAL IN WATER (mg/cm^3)
t = DURATION OF EVENT (hr/event)

ORGANICS

DA = 2 CF Kp Cv [((6TAUt)/PI)^0.5] IF t < t*

DA = Kp CF Cv [(t/(1 + B)) + [2TAU ((1+3B)/(1 + B))]] IF t > t*

DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
Kp = PERMEABILITY COEFFICIENT (cm/hr)
Cv = VEHICLE CONCENTRATION (mg/cm^3)
TAU = LAG TIME (hr)
B = DIMENSIONLESS PARTITION COEFFICIENT
t = DURATION OF EVENT (hr/event)
CF = CONVERSION FACTOR (L/cm^3: 1e-3)

DAD = (DA EV ED EF A)/(BW AT)

DAD = DERMALLY ABSORBED DOSE (mg/kg/day)
DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (cm^2)
EV = EVENT FREQUENCY (event/day)
EF = EXPOSURE FREQUENCY (day/yr)
ED = EXPOSURE DURATION (yr)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days)

HQ = DAD1/RFD

HQ = HAZARD QUOTIENT
DAD1 = DAD FOR NONCARCINOGENIC RISKS (mg/kg/day)
RFD = REFERENCE DOSE (mg/kg/day)

CR = DAD2 CSF

CR = CANCER RISK
DAD2 = DAD FOR CARCINOGENIC RISK
CSF = CANCER SLOPE FACTOR ((mg/kg/day)^-1))

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)
SITE NAME: WARMINSTER, SITES 5, 6, 7
MEDIUM: GROUNDWATER (CURRENT)
RECEPTOR(S): ADULT EMPLOYEE

ENTER INPUTS

A =	2270(cm^2)	
EV =	1(event/day)	
EF =	250(day/yr)	
ED1 =	25(yr)	NON-CARCINOGENIC
ED2 =	25(yr)	CARCINOGENIC
BW =	70(kg)	
AT1 =	9125(days)	NON-CARCINOGENIC
AT2 =	25550(days)	CARCINOGENIC
t =	.03(hr/event)	

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE THREE)
SITE NAME: WARMINSTER, SITES 5, 6, 7
MEDIUM: GROUNDWATER (CURRENT)
RECEPTOR(S): ADULT EMPLOYEE

CHEMICAL	Cv (mg/L)	Kp or K	DA	DA-i	DA-o	TAU	t*	B	X1	X2	DAD1	DAD2	RFD-ORAL	CSF-ORAL
Trichloroethene	.0044	2.3e-1	3.594e-7		0	3.594e-7	.55	1.3	2.6e-2	3.594e-7	1.199e-6	7.982e-6	2.851e-6	6e-3	1.1e-2
Tetrachloroethene	.0018	3.7e-1	3.025e-7		0	3.025e-7	.9	4.3	2.5e-1	3.025e-7	1.694e-6	6.720e-6	2.400e-6	1e-2	5.2e-2
Carbon tetrachloride	.0016	2.2e-2	1.469e-8		0	1.469e-8	.76	1.8	6.8e-2	1.469e-8	6.131e-8	3.264e-7	1.166e-7	7e-4	1.3e-1
Chloromethane	.002	4.2e-3	1.707e-9		0	1.707e-9	.18	.43	8.1e-4	1.707e-9	3.281e-9	3.790e-8	1.354e-8		1.3e-2
Chloroform	.0014	1.3e-1	5.975e-8		0	5.975e-8	.47	1.1	9.3e-3	5.975e-8	1.796e-7	1.327e-6	4.740e-7	1e-2	6.1e-3
1,2-Dichloroethene	.0038	5.5e-3	5.836e-9		0	5.836e-9	.34	.82	3e-3	5.836e-9	1.492e-8	1.296e-7	4.629e-8	1e-2	
cis-1,2-Dichloroethene	.0026	5.5e-3	3.993e-9		0	3.993e-9	.34	.82	3e-3	3.993e-9	1.021e-8	8.869e-8	3.167e-8	1e-2	
Toluene	.0024	1e0	6.501e-7		0	6.501e-7	.32	.77	5.4e-2	6.501e-7	1.762e-6	1.444e-5	5.157e-6	2e-1	
1,1,1-Trichloroethane	.001	1.7e-2	6.146e-9		0	6.146e-9	.57	1.4	3.1e-2	6.146e-9	2.104e-8	1.365e-7	4.875e-8	9e-2	
Di-n-octyl phthalate	.0009	3.3e-2	6.517e-8		0	6.517e-8	21	100	1.3e1	6.517e-8	3.564e-6	1.448e-6	5.170e-7	2e-2	
Diethyl phthalate	.002	4.8e-3	6.501e-9		0	6.501e-9	2	4.7	3e-2	6.501e-9	4.092e-8	1.444e-7	5.157e-8	8e-1	
Arsenic	.0034	1e-3	1.02e-10	1.02e-10	0					0	1.02e-10	2.266e-9	8.09e-10	3e-4	1.75e0
Cadmium	.002	1e-3	6e-11	6e-11	0					0	6e-11	1.333e-9	4.76e-10	5e-4	
Lead	.0071	4e-6	8.52e-13	8.52e-13	0					0	8.52e-13	1.89e-11	6.76e-12		
Barium	.388	1e-3	1.164e-8	1.164e-8	0					0	1.164e-8	2.585e-7	9.234e-8	7e-2	
Cobalt	.0232	4e-4	2.78e-10	2.78e-10	0					0	2.78e-10	6.184e-9	2.208e-9		
Copper	.0341	1e-3	1.023e-9	1.023e-9	0					0	1.023e-9	2.272e-8	8.115e-9	3.7e-2	
Manganese	2	1e-3	6e-8	6e-8	0					0	6e-8	1.333e-6	4.760e-7	5e-3	
Nickel	.0323	1e-4	9.69e-11	9.69e-11	0					0	9.69e-11	2.152e-9	7.69e-10	2e-2	
Cyanide	.0263	1e-3	7.89e-10	7.89e-10	0					0	7.89e-10	1.752e-8	6.259e-9	2e-2	
Vanadium	.0163	1e-3	4.89e-10	4.89e-10	0					0	4.89e-10	1.086e-8	3.879e-9	7e-3	
Zinc	.228	6e-4	4.104e-9	4.104e-9	0					0	4.104e-9	9.116e-8	3.256e-8	2e-1	
___			0	0	0					0	0	0	0		
___			0	0	0					0	0	0	0		
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___			0	0	0					0	0	0	0		
___			0	0	0					0	0	0	0		
___			0	0	0					0	0	0	0		

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE FOUR)
SITE NAME: WARMINSTER, SITES 5, 6, 7
MEDIUM: GROUNDWATER (CURRENT)
RECEPTOR(S): ADULT EMPLOYEE

CHEMICAL	HQ	CR
Trichloroethene	1.330e-3	3.136e-8
Tetrachloroethene	6.720e-4	1.248e-7
Carbon tetrachloride	4.663e-4	1.515e-8
Chloromethane	N/A	1.76e-10
Chloroform	1.327e-4	2.891e-9
1,2-Dichloroethene	1.296e-5	0
cis-1,2-Dichloroethene	8.869e-6	0
Toluene	7.220e-5	0
1,1,1-Trichloroethane	1.517e-6	0
Di-n-octyl phthalate	7.238e-5	0
Diethyl phthalate	1.805e-7	0
Arsenic	7.552e-6	1.416e-9
Cadmium	2.665e-6	0
Lead	N/A	0
Barium	3.693e-6	0
Cobalt	N/A	0
Copper	6.141e-7	0
Manganese	2.665e-4	0
Nickel	1.076e-7	0
Cyanide	8.762e-7	0
Vanadium	1.552e-6	0
Zinc	4.558e-7	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
___	N/A	0
TOTAL	3.054e-3	1.758e-7

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE ONE)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, WAGNER & SONS (OS-01/01D)
RECEPTOR(S): ADULT EMPLOYEE

RELEVANT EQUATIONS:

INORGANICS

DA = (K)(Cv)(t)

DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
K = PERMEABILITY COEFFICIENT FROM WATER (cm/hr)
Cv = CONCENTRATION OF CHEMICAL IN WATER (mg/cm^3)
t = DURATION OF EVENT (hr/event)

ORGANICS

DA = 2 Kp Cv CF [((6TAUt)/PI)^0.5] IF t < t*

DA = Kp Cv CF [(t/(1 + B)) + [2TAU ((1+3B)/(1 + B))]] IF t > t*

DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
Kp = PERMEABILITY COEFFICIENT (cm/hr)
Cv = VEHICLE CONCENTRATION (mg/cm^3)
TAU = LAG TIME (hr)
B = DIMENSIONLESS PARTITION COEFFICIENT
t = DURATION OF EVENT (hr/event)
CF = CONVERSION FACTOR (L/cm^3: 1e-3)

REFERENCES: USEPA, DECEMBER 1989; USEPA, JANUARY 1992

DAD = (DA EV ED EF A)/(BW AT)

DAD = DERMALLY ABSORBED DOSE (mg/kg/day)
DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (cm^2)
EV = EVENT FREQUENCY (event/day)
EF = EXPOSURE FREQUENCY (day/yr)
ED = EXPOSURE DURATION (yr)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days)

HQ = DAD1/RFD

HQ = HAZARD QUOTIENT
DAD1 = DAD FOR NONCARCINOGENIC RISKS (mg/kg/day)
RFD = REFERENCE DOSE (mg/kg/day)

CR = DAD2 CSF

CR = CANCER RISK
DAD2 = DAD FOR CARCINOGENIC RISK
CSF = CANCER SLOPE FACTOR ((mg/kg/day)^-1))

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, WAGNER & SONS (OS-01/01D)
RECEPTOR(S): ADULT EMPLOYEE

ENTER INPUTS

A =	2270(cm^2)	
EV =	1(event/day)	
EF =	250(day/yr)	
ED1 =	25(yr)	NON-CARCINOGENIC
ED2 =	25(yr)	CARCINOGENIC
BW =	70(kg)	
AT1 =	9125(days)	NON-CARCINOGENIC
AT2 =	25550(days)	CARCINOGENIC
t =	.03(hr/event)	

ENTER 0 UNDER DA-i FOR ALL ORGANICS; ENTER 0 UNDER DA-o FOR ALL INORGANICS

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE THREE)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, WAGNER & SONS (OS-01/01D)
RECEPTOR(S): ADULT EMPLOYEE

CHEMICAL	Cv (mg/L)	Kp or K	DA	DA-i	DA-o	TAU	t*	B	X1	X2	DAD1	DAD2	RFD-ORAL	CSF-ORAL
Trichloroethene	.72	2.3e-1	5.881e-5	0	5.881e-5	.55	1.3	.026	5.881e-5	1.962e-4	1.306e-3	4.665e-4	6e-3	1.1e-2
Arsenic	.00445	1e-3	1.34e-10	1.34e-10	0				0	1.34e-10	2.965e-9	1.059e-9	3e-4	1.75e0
Lead	.46785	4e-6	5.61e-11	5.61e-11	0				0	5.61e-11	1.247e-9	4.45e-10		
Barium	.243	1e-3	7.29e-9	7.29e-9	0				0	7.29e-9	1.619e-7	5.783e-8	7e-2	
Copper	.073	1e-3	2.19e-9	2.19e-9	0				0	2.19e-9	4.864e-8	1.737e-8	3.7e-2	
Manganese	.0525	1e-3	1.575e-9	1.575e-9	0				0	1.575e-9	3.498e-8	1.249e-8	5e-3	
Zinc	.07	6e-4	1.26e-9	1.26e-9	0				0	1.26e-9	2.799e-8	9.995e-9	3e-1	
___			0	0	0				0	0	0	0		
___			0	0	0				0	0	0	0		
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___			0	0	0				0	0	0	0		
___			0	0	0				0	0	0	0		
___			0	0	0				0	0	0	0		
___			0	0	0				0	0	0	0		
___			0	0	0				0	0	0	0		
___			0	0	0				0	0	0	0		

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE FOUR)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, WAGNER & SONS (OS-01/01D)
RECEPTOR(S): ADULT EMPLOYEE

CHEMICAL	HQ	CR
Trichloroethene	2.177e-1	5.132e-6
Arsenic	9.884e-6	1.853e-9
Lead	N/A	0
Barium	2.313e-6	0
Copper	1.315e-6	0
Manganese	6.997e-6	0
Zinc	9.329e-8	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
TOTAL	2.177e-1	5.133e-6

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE ONE)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, WTMA #26 (OS-02)
RECEPTOR(S): ADULT RESIDENT

RELEVANT EQUATIONS:

REFERENCES: USEPA, DECEMBER 1989; USEPA, JANUARY 1992

INORGANICS

DA = (K)(Cv)(t)

DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
K = PERMEABILITY COEFFICIENT FROM WATER (cm/hr)
Cv = CONCENTRATION OF CHEMICAL IN WATER (mg/cm^3)
t = DURATION OF EVENT (hr/event)

ORGANICS

DA = 2 Kp Cv CF [((6TAUt)/PI)^0.5] IF t < t*

DA = Kp Cv CF [(t/(1 + B)) + [2TAU ((1+3B)/(1 + B))]] IF t > t*

DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
Kp = PERMEABILITY COEFFICIENT (cm/hr)
Cv = VEHICLE CONCENTRATION (mg/cm^3)
TAU = LAG TIME (hr)
B = DIMENSIONLESS PARTITION COEFFICIENT
t = DURATION OF EVENT (hr/event)
CF = CONVERSION FACTOR (L/cm^3: 1e-3)

DAD = (DA EV ED EF A)/(BW AT)

DAD = DERMALLY ABSORBED DOSE (mg/kg/day)
DA = DOSE ABSORBED PER EVENT (mg/cm^2/event)
A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (cm^2)
EV = EVENT FREQUENCY (event/day)
EF = EXPOSURE FREQUENCY (day/yr)
ED = EXPOSURE DURATION (yr)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days)

HQ = DAD1/RFD

HQ = HAZARD QUOTIENT
DAD1 = DAD FOR NONCARCINOGENIC RISKS (mg/kg/day)
RFD = REFERENCE DOSE (mg/kg/day)

CR = DAD2 CSF

CR = CANCER RISK
DAD2 = DAD FOR CARCINOGENIC RISK
CSF = CANCER SLOPE FACTOR ((mg/kg/day)^-1))

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, WTMA #26 (OS-02)
RECEPTOR(S): ADULT RESIDENT

ENTER INPUTS

A =	19400(cm^2)	
EV =	1(event/day)	
EF =	350(day/yr)	
ED1 =	30(yr)	NON-CARCINOGENIC
ED2 =	30(yr)	CARCINOGENIC
BW =	70(kg)	
AT1 =	10950(days)	NON-CARCINOGENIC
AT2 =	25550(days)	CARCINOGENIC
t =	.2(hr/event)	

ENTER 0 UNDER DA-i FOR ALL ORGANICS; ENTER 0 UNDER DA-o FOR ALL INORGANICS

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE THREE)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, WTMA #26 (OS-02)
RECEPTOR(S): ADULT RESIDENT

CHEMICAL	Cv (mg/L)	Kp or K	DA	DA-i	DA-o	TAU	t*	B	X1	X2	DAD1	DAD2	RFD-ORAL	CSF-ORAL
Tetrachloroethene	.02	3.7e-1	8.680e-6	0	8.680e-6	.9	4.3	.25	8.680e-6	1.983e-5	2.307e-3	9.886e-4	1e-2	5.2e-2
Trichloroethene	.11	2.3e-1	2.320e-5	0	2.320e-5	.55	1.3	.026	2.320e-5	3.417e-5	6.165e-3	2.642e-3	6e-3	1.1e-2
1,1-Dichloroethene	.018	1.6e-2	2.076e-7	0	2.076e-7	.34	.82	.013	2.076e-7	2.577e-7	5.518e-5	2.365e-5	9e-3	6e-1
1,1,1-Trichloroethane	.1	1.7e-2	1.587e-6	0	1.587e-6	.57	1.4	.031	1.587e-6	2.384e-6	4.217e-4	1.807e-4	9e-2	
1,1-Dichloroethane	.028	8.9e-3	1.823e-7	0	1.823e-7	.35	.84	.0062	1.823e-7	2.261e-7	4.844e-5	2.076e-5	1e-1	
Arsenic	.0037	1e-3	7.4e-10	7.4e-10	0				0	7.4e-10	1.967e-7	8.428e-8	3e-4	1.75e0
Barium	.216	1e-3	4.32e-8	4.32e-8	0				0	4.32e-8	1.148e-5	4.920e-6	7e-2	
Manganese	.041	1e-3	8.2e-9	8.2e-9	0				0	8.2e-9	2.179e-6	9.339e-7	5e-3	
___				0	0	0			0	0	0	0		
___				0	0	0			0	0	0	0		
___				0	0	0			0	0	0	0		
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___				0	0	0			0	0	0	0		

RISK ASSESSMENT SPREADSHEET: DERMAL CONTACT WITH GROUNDWATER (PAGE FOUR)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFF-SITE GROUNDWATER, WTMA #26 (OS-02)
RECEPTOR(S): ADULT RESIDENT

CHEMICAL	HQ	CR
Tetrachloroethene	2.307e-1	5.141e-5
Trichloroethene	1.0275e0	2.906e-5
1,1-Dichloroethene	6.131e-3	1.419e-5
1,1,1-Trichloroethane	4.686e-3	0
1,1-Dichloroethane	4.844e-4	0
Arsenic	6.555e-4	1.475e-7
Barium	1.640e-4	0
Manganese	4.358e-4	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
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____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
____	N/A	0
TOTAL	1.2707e0	9.481e-5

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE TWO)
SITE NAME: WARMINSTER, SITES 1, 2, 3 (CURRENT)
MEDIUM: GROUNDWATER--using filtered metals
RECEPTOR(S): ADULT EMPLOYEES

CHEMICAL	CGW (mg/l)	RFD	CSF	DEX1 ADULT	DEX2 ADULT	DEX1 CHILD	DEX2 CHILD
Vinyl chloride	.0015		1.9e0	1.468e-5	5.242e-6	0	0
1,1-Dichloroethene	.003	9e-3	6e-1	2.935e-5	1.048e-5	0	0
1,2-Dichloroethane	.0035		9.1e-2	3.425e-5	1.223e-5	0	0
Trichloroethene	.469		1.1e-2	4.589e-3	1.639e-3	0	0
Tetrachloroethene	.128	1e-2	5.2e-2	1.252e-3	4.473e-4	0	0
Chloroform	.0138	1e-2	6.1e-3	1.350e-4	4.822e-5	0	0
Carbon tetrachloride	.0168	7e-4	1.3e-1	1.644e-4	5.871e-5	0	0
Benzene	.002		2.9e-2	1.957e-5	6.989e-6	0	0
1,2-Dichloropropane	.001		6.8e-2	9.785e-6	3.495e-6	0	0
Styrene	.0006	3e-2	5.9e-1	5.871e-6	2.097e-6	0	0
1,1-Dichloroethane	.008	1e-1		7.828e-5	2.796e-5	0	0
1,2-Dichloroethene	.027	1e-2		2.642e-4	9.435e-5	0	0
cis-1,2-Dichloroethene	.138	1e-2		1.350e-3	4.822e-4	0	0
1,1,1-Trichloroethane	.01	9e-2		9.785e-5	3.495e-5	0	0
Trichlorofluoromethane	.0298	3e-1		2.916e-4	1.041e-4	0	0
Toluene	.004	2e-1		3.914e-5	1.398e-5	0	0
Ethylbenzene	.0002	1e-1		1.957e-6	6.989e-7	0	0
Xylenes	.002	2e0		1.957e-5	6.989e-6	0	0
1,2-Dichlorobenzene	.0007	9e-2		6.849e-6	2.446e-6	0	0
2-Butanone	.024	5e-2		2.348e-4	8.387e-5	0	0
Di-n-octyl phthalate	.003	2e-2		2.935e-5	1.048e-5	0	0
Diethyl phthalate	.000375	8e-1		3.669e-6	1.310e-6	0	0
Phenanthrene	.0003	2.9e-2		2.935e-6	1.048e-6	0	0
Fluoranthene	.0006	4e-2		5.871e-6	2.097e-6	0	0
Arsenic	0	3e-4	1.75e0	0	0	0	0
Lead	.00186			1.820e-5	6.500e-6	0	0
Chromium	0	5e-3		0	0	0	0
Manganese	1.31	1e-1		1.282e-2	4.578e-3	0	0
Thallium	0	7e-5		0	0	0	0
Aluminum	0	2.9e0		0	0	0	0
Barium	.21	7e-2		2.055e-3	7.339e-4	0	0
Cobalt	0			0	0	0	0
Copper	0	3.7e-2		0	0	0	0
Mercury	0	3e-4		0	0	0	0
Nickel	0	2e-2		0	0	0	0
Silver	0	5e-3		0	0	0	0
Vanadium	.00339	7e-3		3.317e-5	1.185e-5	0	0
Zinc	0	2e-1		0	0	0	0
---				0	0	0	0
---				0	0	0	0
---				0	0	0	0
---				0	0	0	0
---				0	0	0	0
---				0	0	0	0
---				0	0	0	0
---				0	0	0	0
---				0	0	0	0
---				0	0	0	0
---				0	0	0	0
---				0	0	0	0
---				0	0	0	0

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE THREE)
SITE NAME: WARMINSTER, SITES 1, 2, 3 (CURRENT)
MEDIUM: GROUNDWATER--using filtered metals
RECEPTOR(S): ADULT EMPLOYEES

CHEMICAL	HQ ADULT	HQ CHILD	CR ADULT	CR CHILD
Vinyl chloride	N/A	N/A	9.959e-6	0
1,1-Dichloroethene	3.262e-3	0	6.290e-6	0
1,2-Dichloroethane	N/A	N/A	1.113e-6	0
Trichloroethene	N/A	N/A	1.803e-5	0
Tetrachloroethene	1.252e-1	0	2.326e-5	0
Chloroform	1.350e-2	0	2.942e-7	0
Carbon tetrachloride	2.348e-1	0	7.632e-6	0
Benzene	N/A	N/A	2.027e-7	0
1,2-Dichloropropane	N/A	N/A	2.376e-7	0
Pyrene	1.957e-4	0	1.237e-6	0
1,1-Dichloroethane	7.828e-4	0	0	0
1,2-Dichloroethene	2.642e-2	0	0	0
cis-1,2-Dichloroethene	1.350e-1	0	0	0
1,1,1-Trichloroethane	1.087e-3	0	0	0
Trichlorofluoromethane	9.720e-4	0	0	0
Toluene	1.957e-4	0	0	0
Ethylbenzene	1.957e-5	0	0	0
Xylenes	9.785e-6	0	0	0
1,2-Dichlorobenzene	7.610e-5	0	0	0
2-Butanone	4.697e-3	0	0	0
Di-n-octyl phthalate	1.468e-3	0	0	0
Diethyl phthalate	4.587e-6	0	0	0
Phenanthrene	1.012e-4	0	0	0
Fluoranthene	1.468e-4	0	0	0
Arsenic	0	0	0	0
Lead	N/A	N/A	0	0
Chromium	0	0	0	0
Manganese	1.282e-1	0	0	0
Thallium	0	0	0	0
Aluminum	0	0	0	0
Barium	2.935e-2	0	0	0
Cobalt	N/A	N/A	0	0
Copper	0	0	0	0
Mercuy	0	0	0	0
Nickel	0	0	0	0
Silver	0	0	0	0
Vanadium	4.739e-3	0	0	0
Zinc	0	0	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
TOTAL	7.103e-1	0	6.825e-5	0

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE ONE)
SITE NAME: WARMINSTER, SITES 5, 6, 7 (CURRENT)
MEDIUM: GROUNDWATER
RECEPTOR(S): ADULT AND CHILD RESIDENTS

RELEVANT EQUATIONS: REFERENCES: USEPA, DECEMBER 1989

OEX = (CGW EF ED ABS IR)/(BW AT)

OEX = ORAL EXPOSURE DOSE (mg/kg/day)
CGW = CONCENTRATION OF CHEMICAL IN GROUNDWATER (mg/l)
EF = EXPOSURE FREQUENCY (day/yr)
ED = EXPOSURE DURATION (yr)
ABS = FRACTION ABSORBED
IR = INGESTION RATE (l/day)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days)

HQ = OEX1/RFD

HQ = HAZARD QUOTIENT
OEX1 = NONCARCINOGENIC ORAL EXPOSURE DOSE (mg/kg/day)
RFD = REFERENCE DOSE (CHRONIC, ORAL) (mg/kg/day)

CR = (OEX2) (CSF)

CR = CANCER RISK
OEX2 = CARCINOGENIC ORAL EXPOSURE DOSE (mg/kg/day)
CSF = CANCER SLOPE FACTOR (ORAL) (mg/kg/day)^-1

ENTER INPUTS:

EF (adult) =	350(day/yr)	
EF (child) =	350(day/yr)	
ED (adult) =	30(yr)	
ED (child) =	6(yr)	
ABS (adult) =	1	
ABS (child) =	1	
IR (adult) =	2(l/day)	
IR (child) =	1(l/day)	
BW (adult) =	70(kg)	
BW (child) =	15(kg)	
AT1 (adult) =	10950(days)	(NONCARCINOGENIC)
AT2 (adult) =	25550(days)	(CARCINOGENIC)
AT1 (child) =	2190(days)	(NONCARCINOGENIC)
AT2 (child) =	25550(days)	(CARCINOGENIC)

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE TWO)
SITE NAME: WARMINSTER, SITES 5, 6, 7 (CURRENT)
MEDIUM: GROUNDWATER
RECEPTOR(S): ADULT AND CHILD RESIDENTS

CHEMICAL	CGW (mg/l)	RFD	CSF	OEX1 ADULT	OEX2 ADULT	OEX1 CHILD	OEX2 CHILD
Trichloroethene	.0044	6e-3	1.1e-2	1.205e-4	5.166e-5	2.813e-4	2.411e-5
Tetrachoroethene	.0018	1e-2	5.2e-2	4.932e-5	2.114e-5	1.151e-4	9.863e-6
Carbon tetrachloride	.0016	7e-4	1.3e-1	4.384e-5	1.879e-5	1.023e-4	8.767e-6
Chloromethane	.002		1.3e-2	5.479e-5	2.348e-5	1.279e-4	1.096e-5
Chloroform	.0014	1e-2	6.1e-3	3.836e-5	1.644e-5	8.950e-5	7.671e-6
1,2-Dichloroethene	.0038	1e-2		1.041e-4	4.462e-5	2.429e-4	2.082e-5
cis-1,2-Dichloroethene	.0026	1e-2		7.123e-5	3.053e-5	1.662e-4	1.425e-5
Toluene	.0024	2e-1		6.575e-5	2.818e-5	1.534e-4	1.315e-5
1,1,1-Trichloroethane	.001	9e-2		2.740e-5	1.174e-5	6.393e-5	5.479e-6
Di-n-octyl phthalate	.0009	2e-2		2.466e-5	1.057e-5	5.753e-5	4.932e-6
Diethyl phthalate	.002	8e-1		5.479e-5	2.348e-5	1.279e-4	1.096e-5
Arsenic	.0034	3e-4	1.75e0	9.315e-5	3.992e-5	2.174e-4	1.863e-5
Cadmium	.002	5e-4		5.479e-5	2.348e-5	1.279e-4	1.096e-5
Lead	.0071			1.945e-4	8.337e-5	4.539e-4	3.890e-5
Barium	.388	7e-2		1.063e-2	4.556e-3	2.480e-2	2.126e-3
Cobalt	.0232			6.356e-4	2.724e-4	1.483e-3	1.271e-4
Copper	.0341	3.7e-2		9.342e-4	4.004e-4	2.180e-3	1.868e-4
Manganese	2	5e-3		5.479e-2	2.348e-2	1.279e-1	1.096e-2
Nickel	.0323	2e-2		8.849e-4	3.793e-4	2.065e-3	1.770e-4
Cyanide	.0263	2e-2		7.205e-4	3.088e-4	1.681e-3	1.441e-4
Vanadium	.0163	7e-3		4.466e-4	1.914e-4	1.042e-3	8.932e-5
Zinc	.228	2e-1		6.247e-3	2.677e-3	1.458e-2	1.249e-3
				0	0	0	0
				0	0	0	0
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				0	0	0	0

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE THREE)
SITE NAME: WARMINSTER, SITES 5, 6, 7 (CURRENT)
MEDIUM: GROUNDWATER
RECEPTOR(S): ADULT AND CHILD RESIDENTS

CHEMICAL	HQ ADULT	HQ CHILD	CR ADULT	CR CHILD
Trichloroethene	2.009e-2	4.688e-2	5.683e-7	2.652e-7
Tetrachoroethene	4.932e-3	1.151e-2	1.099e-6	5.129e-7
Carbon tetrachloride	6.262e-2	1.461e-1	2.442e-6	1.140e-6
Chloromethane	N/A	N/A	3.053e-7	1.425e-7
Chloroform	3.836e-3	8.950e-3	1.003e-7	4.679e-8
1,2-Dichloroethene	1.041e-2	2.429e-2	0	0
cis-1,2-Dichloroethene	7.123e-3	1.662e-2	0	0
Toluene	3.288e-4	7.671e-4	0	0
1,1,1-Trichloroethane	3.044e-4	7.103e-4	0	0
Di-n-octyl phthalate	1.233e-3	2.877e-3	0	0
Diethyl phthalate	6.849e-5	1.598e-4	0	0
Arsenic	3.105e-1	7.245e-1	6.986e-5	3.260e-5
Cadmium	1.096e-1	2.557e-1	0	0
Lead	N/A	N/A	0	0
Barium	1.519e-1	3.543e-1	0	0
Cobalt	N/A	N/A	0	0
Copper	2.525e-2	5.892e-2	0	0
Manganese	1.0959e1	2.5571e1	0	0
Nickel	4.425e-2	1.032e-1	0	0
Cyanide	3.603e-2	8.406e-2	0	0
Vanadium	6.380e-2	1.489e-1	0	0
Zinc	3.123e-2	7.288e-2	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
TOTAL	1.1842e1	2.7632e1	7.438e-5	3.471e-5

ISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE ONE)

ITE NAME: WARMINSTER, SITES 5, 6, 7 (CURRENT)
EDIUM: GROUNDWATER--using filtered metals
ECEPTOR(S): ADULT AND CHILD RESIDENTS

ELEVANT EQUATIONS:

REFERENCES: USEPA, DECEMBER 1989

EX = (CGW EF ED ABS IR)/(BW AT)

EX = ORAL EXPOSURE DOSE (mg/kg/day)
GW = CONCENTRATION OF CHEMICAL IN GROUNDWATER (mg/l)
F = EXPOSURE FREQUENCY (day/yr)
D = EXPOSURE DURATION (yr)
BS = FRACTION ABSORBED
R = INGESTION RATE (l/day)
W = BODY WEIGHT (kg)
T = AVERAGING TIME (days)

Q = DEX1/RFD

Q = HAZARD QUOTIENT
EX1 = NONCARCINOGENIC ORAL EXPOSURE DOSE (mg/kg/day)
FD = REFERENCE DOSE (CHRONIC, ORAL) (mg/kg/day)

R = (DEX2) (CSF)

R = CANCER RISK
EX2 = CARCINOGENIC ORAL EXPOSURE DOSE (mg/kg/day)
SF = CANCER SLOPE FACTOR (ORAL) (mg/kg/day)^-1

NTER INPUTS:

F (adult) =	350(day/yr)	
F (child) =	350(day/yr)	
D (adult) =	30(yr)	
D (child) =	6(yr)	
BS (adult) =	1	
BS (child) =	1	
R (adult) =	2(l/day)	
R (child) =	1(l/day)	
W (adult) =	70(kg)	
W (child) =	15(kg)	
T1 (adult) =	10950(days)	(NONCARCINOGENIC)
T2 (adult) =	25550(days)	(CARCINOGENIC)
T1 (child) =	2190(days)	(NONCARCINOGENIC)
T2 (child) =	25550(days)	(CARCINOGENIC)

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE TWO)
SITE NAME: WARMINSTER, SITES 5, 6, 7 (CURRENT)
MEDIUM: GROUNDWATER--using filtered metals
RECEPTOR(S): ADULT AND CHILD RESIDENTS

HEMICAL	CGW (mg/l)	RFD	CSF	DEX1 ADULT	DEX2 ADULT	DEX1 CHILD	DEX2 CHILD
richloroethene	.0044		1.1e-2	1.205e-4	5.166e-5	2.813e-4	2.411e-5
etrachloroethene	.0018	1e-2	5.2e-2	4.932e-5	2.114e-5	1.151e-4	9.863e-6
arbon tetrachloride	.0016	7e-4	1.3e-1	4.384e-5	1.879e-5	1.023e-4	8.767e-6
hloroethane	.002		1.3e-2	5.479e-5	2.348e-5	1.279e-4	1.096e-5
hloroform	.0014	1e-2	6.1e-3	3.836e-5	1.644e-5	8.950e-5	7.671e-6
.2-Dichloroethene	.0038	1e-2		1.041e-4	4.462e-5	2.429e-4	2.082e-5
is-1.2-Dichloroethene	.0026	1e-2		7.123e-5	3.053e-5	1.662e-4	1.425e-5
oluene	.0024	2e-1		6.575e-5	2.818e-5	1.534e-4	1.315e-5
.1,1-Trichloroethane	.001	9e-2		2.740e-5	1.174e-5	6.393e-5	5.479e-6
i-n-octyl phthalate	.0009	2e-2		2.466e-5	1.057e-5	5.753e-5	4.932e-6
iethyl phthalate	.002	8e-1		5.479e-5	2.348e-5	1.279e-4	1.096e-5
rsenic	0	3e-4	1.75e0	0	0	0	0
admium	0	5e-4		0	0	0	0
ead	0			0	0	0	0
arium	.214	7e-2		5.863e-3	2.513e-3	1.368e-2	1.173e-3
obalt	0			0	0	0	0
opper	0	3.7e-2		0	0	0	0
anganese	0	1e-1		0	0	0	0
ickel	0	2e-2		0	0	0	0
yanide	0	2e-2		0	0	0	0
anadium	0	7e-3		0	0	0	0
inc	.031	2e-1		8.493e-4	3.640e-4	1.982e-3	1.699e-4
hallium	.0012	7e-5		3.288e-5	1.409e-5	7.671e-5	6.575e-6
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----				0	0	0	0
----				0	0	0	0

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE THREE)
SITE NAME: WARMINSTER, SITES 5, 6, 7 (CURRENT)
MEDIUM: GROUNDWATER--using filtered metals
RECEPTOR(S): ADULT AND CHILD RESIDENTS

CHEMICAL	HQ ADULT	HQ CHILD	CR ADULT	CR CHILD
Trichloroethene	N/A	N/A	5.683e-7	2.652e-7
Tetrachloroethene	4.932e-3	1.151e-2	1.099e-6	5.129e-7
Carbon tetrachloride	6.262e-2	1.461e-1	2.442e-6	1.140e-6
Chloromethane	N/A	N/A	3.053e-7	1.425e-7
Chloroform	3.836e-3	8.950e-3	1.003e-7	4.679e-8
1,2-Dichloroethene	1.041e-2	2.429e-2	0	0
cis-1,2-Dichloroethene	7.123e-3	1.662e-2	0	0
Toluene	3.288e-4	7.671e-4	0	0
1,1,1-Trichloroethane	3.044e-4	7.103e-4	0	0
Di-n-octyl phthalate	1.233e-3	2.877e-3	0	0
Diethyl phthalate	6.849e-5	1.598e-4	0	0
Arsenic	0	0	0	0
Cadmium	0	0	0	0
Lead	N/A	N/A	0	0
Barium	8.376e-2	1.954e-1	0	0
Cobalt	N/A	N/A	0	0
Copper	0	0	0	0
Manganese	0	0	0	0
Nickel	0	0	0	0
Cyanide	0	0	0	0
Vanadium	0	0	0	0
Zinc	4.247e-3	9.909e-3	0	0
Thallium	4.697e-1	1.0959e0	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
TOTAL	6.485e-1	1.5132e0	4.515e-6	2.107e-6

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE ONE)
SITE NAME: WARMINSTER, SITES 5, 6, 7 (CURRENT)
MEDIUM: GROUNDWATER
RECEPTOR(S): ADULT EMPLOYEES

RELEVANT EQUATIONS: REFERENCES: USEPA, DECEMBER 1989

OEX = (CGW EF ED ABS IR)/(BW AT)

OEX = ORAL EXPOSURE DOSE (mg/kg/day)
CGW = CONCENTRATION OF CHEMICAL IN GROUNDWATER (mg/l)
EF = EXPOSURE FREQUENCY (day/yr)
ED = EXPOSURE DURATION (yr)
ABS = FRACTION ABSORBED
IR = INGESTION RATE (l/day)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days)

HQ = OEX1/RFD

HQ = HAZARD QUOTIENT
OEX1 = NONCARCINOGENIC ORAL EXPOSURE DOSE (mg/kg/day)
RFD = REFERENCE DOSE (CHRONIC, ORAL) (mg/kg/day)

CR = (OEX2) (CSF)

CR = CANCER RISK
OEX2 = CARCINOGENIC ORAL EXPOSURE DOSE (mg/kg/day)
CSF = CANCER SLOPE FACTOR (ORAL) (mg/kg/day)^-1

ENTER INPUTS:

EF (adult) =	250(day/yr)	
EF (child) =	0(day/yr)	
ED (adult) =	25(yr)	
ED (child) =	0(yr)	
ABS (adult) =	1	
ABS (child) =	1	
IR (adult) =	1(l/day)	
IR (child) =	0(l/day)	
BW (adult) =	70(kg)	
BW (child) =	15(kg)	
AT1 (adult) =	9125(days)	(NONCARCINOGENIC)
AT2 (adult) =	25550(days)	(CARCINOGENIC)
AT1 (child) =	2190(days)	(NONCARCINOGENIC)
AT2 (child) =	25550(days)	(CARCINOGENIC)

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE TWO)
SITE NAME: WARMINSTER, SITES 5, 6, 7 (CURRENT)
MEDIUM: GROUNDWATER
RECEPTOR(S): ADULT EMPLOYEES

CHEMICAL	CGW (mg/l)	RFD	CSF	OEX1 ADULT	OEX2 ADULT	OEX1 CHILD	OEX2 CHILD
Trichloroethene	.0044	6e-3	1.1e-2	4.305e-5	1.538e-5	0	0
Tetrachoroethene	.0018	1e-2	5.2e-2	1.761e-5	6.290e-6	0	0
Carbon tetrachloride	.0016	7e-4	1.3e-1	1.566e-5	5.591e-6	0	0
Chloromethane	.002		1.3e-2	1.957e-5	6.989e-6	0	0
Chloroform	.0014	1e-2	6.1e-3	1.370e-5	4.892e-6	0	0
1,2-Dichloroethene	.0038	1e-2		3.718e-5	1.328e-5	0	0
cis-1,2-Dichloroethene	.0026	1e-2		2.544e-5	9.086e-6	0	0
Toluene	.0024	2e-1		2.348e-5	8.387e-6	0	0
1,1,1-Trichloroethane	.001	9e-2		9.785e-6	3.495e-6	0	0
Di-n-octyl phthalate	.0009	2e-2		8.806e-6	3.145e-6	0	0
Diethyl phthalate	.002	8e-1		1.957e-5	6.989e-6	0	0
Arsenic	.0034	3e-4	1.75e0	3.327e-5	1.188e-5	0	0
Cadmium	.002	5e-4		1.957e-5	6.989e-6	0	0
Lead	.0071			6.947e-5	2.481e-5	0	0
Barium	.388	7e-2		3.796e-3	1.356e-3	0	0
Cobalt	.0232			2.270e-4	8.107e-5	0	0
Copper	.0341	3.7e-2		3.337e-4	1.192e-4	0	0
Manganese	2	5e-3		1.957e-2	6.989e-3	0	0
Nickel	.0323	2e-2		3.160e-4	1.129e-4	0	0
Cyanide	.0263	2e-2		2.573e-4	9.191e-5	0	0
Vanadium	.0163	7e-3		1.595e-4	5.696e-5	0	0
Zinc	.228	2e-1		2.231e-3	7.968e-4	0	0
				0	0	0	0
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RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE THREE)
SITE NAME: WARMINSTER, SITES 5, 6, 7 (CURRENT)
MEDIUM: GROUNDWATER
RECEPTOR(S): ADULT EMPLOYEES

CHEMICAL	HQ ADULT	HQ CHILD	CR ADULT	CR CHILD
Trichloroethene	7.175e-3	0	1.691e-7	0
Tetrachoroethene	1.761e-3	0	3.271e-7	0
Carbon tetrachloride	2.237e-2	0	7.269e-7	0
Chloromethane	N/A	N/A	9.086e-8	0
Chloroform	1.370e-3	0	2.984e-8	0
1,2-Dichloroethene	3.718e-3	0	0	0
cis-1,2-Dichloroethene	2.544e-3	0	0	0
Toluene	1.174e-4	0	0	0
1,1,1-Trichloroethane	1.087e-4	0	0	0
Di-n-octyl phthalate	4.403e-4	0	0	0
Diethyl phthalate	2.446e-5	0	0	0
Arsenic	1.109e-1	0	2.079e-5	0
Cadmium	3.914e-2	0	0	0
Lead	N/A	N/A	0	0
Barium	5.424e-2	0	0	0
Cobalt	N/A	N/A	0	0
Copper	9.018e-3	0	0	0
Manganese	3.9139e0	0	0	0
Nickel	1.580e-2	0	0	0
Cyanide	1.287e-2	0	0	0
Vanadium	2.278e-2	0	0	0
Zinc	1.115e-2	0	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
TOTAL	4.2294e0	0	2.214e-5	0

ISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE ONE)
ITE NAME: WARMINSTER. SITES 5, 6, 7 (CURRENT)
EDIUM: GROUNDWATER--using filtered metals
ECEPTOR(S): ADULT EMPLOYEES

ELEVANT EQUATIONS: REFERENCES: USEPA, DECEMBER 1989

EX = (CGW EF ED ABS IR)/(BW AT)

EX = ORAL EXPOSURE DOSE (mg/kg/day)
GW = CONCENTRATION OF CHEMICAL IN GROUNDWATER (mg/l)
F = EXPOSURE FREQUENCY (day/yr)
D = EXPOSURE DURATION (yr)
BS = FRACTION ABSORBED
R = INGESTION RATE (l/day)
W = BODY WEIGHT (kg)
T = AVERAGING TIME (days)

Q = OEX1/RFD

Q = HAZARD QUOTIENT
EX1 = NONCARCINOGENIC ORAL EXPOSURE DOSE (mg/kg/day)
FD = REFERENCE DOSE (CHRONIC, ORAL) (mg/kg/day)

R = (OEX2) (CSF)

R = CANCER RISK
EX2 = CARCINOGENIC ORAL EXPOSURE DOSE (mg/kg/day)
SF = CANCER SLOPE FACTOR (ORAL) (mg/kg/day)^-1

NTER INPUTS:

F (adult) =	250(day/yr)	
F (child) =	0(day/yr)	
D (adult) =	25(yr)	
D (child) =	0(yr)	
BS (adult) =	1	
BS (child) =	1	
R (adult) =	1(l/day)	
R (child) =	0(l/day)	
W (adult) =	70(kg)	
W (child) =	15(kg)	
T1 (adult) =	9125(days)	(NONCARCINOGENIC)
T2 (adult) =	25550(days)	(CARCINOGENIC)
T1 (child) =	2190(days)	(NONCARCINOGENIC)
T2 (child) =	25550(days)	(CARCINOGENIC)

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE TWO)

SITE NAME: WARMINSTER, SITES 5, 6, 7 (CURRENT)

MEDIUM: GROUNDWATER--using filtered metals

RECEPTOR(S): ADULT EMPLOYEES

CHEMICAL	CGW (mg/l)	RFD	CSF	DEX1 ADULT	DEX2 ADULT	DEX1 CHILD	DEX2 CHILD
Trichloroethene	.0044		1.1e-2	4.305e-5	1.538e-5	0	0
Tetrachoroethene	.0018	1e-2	5.2e-2	1.761e-5	6.290e-6	0	0
Carbon tetrachloride	.0016	7e-4	1.3e-1	1.566e-5	5.591e-6	0	0
Chloromethane	.002		1.3e-2	1.957e-5	6.989e-6	0	0
Chloroform	.0014	1e-2	6.1e-3	1.370e-5	4.892e-6	0	0
1,2-Dichloroethene	.0038	1e-2		3.718e-5	1.328e-5	0	0
cis-1,2-Dichloroethene	.0026	1e-2		2.544e-5	9.086e-6	0	0
Toluene	.0024	2e-1		2.348e-5	8.387e-6	0	0
1,1,1-Trichloroethane	.001	9e-2		9.785e-6	3.495e-6	0	0
Di-n-octyl phthalate	.0009	2e-2		8.806e-6	3.145e-6	0	0
Diethyl phthalate	.002	8e-1		1.957e-5	6.989e-6	0	0
Arsenic	0	3e-4	1.75e0	0	0	0	0
Cadmium	0	5e-4		0	0	0	0
Lead	0			0	0	0	0
Barium	.214	7e-2		2.094e-3	7.478e-4	0	0
Cobalt	0			0	0	0	0
Copper	0	3.7e-2		0	0	0	0
Manganese	0	1e-1		0	0	0	0
Nickel	0	2e-2		0	0	0	0
Cyanide	0	2e-2		0	0	0	0
Vanadium	0	7e-3		0	0	0	0
Zinc	.031	2e-1		3.033e-4	1.083e-4	0	0
Thallium	.0012	7e-5		1.174e-5	4.193e-6	0	0
------				0	0	0	0
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------				0	0	0	0

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE THREE)
SITE NAME: WARMINSTER, SITES 5, 6, 7 (CURRENT)
MEDIUM: GROUNDWATER--using filtered metals
RECEPTOR(S): ADULT EMPLOYEES

CHEMICAL	HQ ADULT	HQ CHILD	CR ADULT	CR CHILD
Trichloroethene	N/A	N/A	1.691e-7	0
Tetrachloroethene	1.761e-3	0	3.271e-7	0
Carbon tetrachloride	2.237e-2	0	7.269e-7	0
Chloromethane	N/A	N/A	9.086e-8	0
Chloroform	1.370e-3	0	2.984e-8	0
1,2-Dichloroethene	3.718e-3	0	0	0
cis-1,2-Dichloroethene	2.544e-3	0	0	0
Toluene	1.174e-4	0	0	0
1,1,1-Trichloroethane	1.087e-4	0	0	0
Di-n-octyl phthalate	4.403e-4	0	0	0
Diethyl phthalate	2.446e-5	0	0	0
Arsenic	0	0	0	0
Cadmium	0	0	0	0
Lead	N/A	N/A	0	0
Barium	2.991e-2	0	0	0
Cobalt	N/A	N/A	0	0
Copper	0	0	0	0
Manganese	0	0	0	0
Nickel	0	0	0	0
Cyanide	0	0	0	0
Vanadium	0	0	0	0
Zinc	1.517e-3	0	0	0
Thallium	1.677e-1	0	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
TOTAL	2.316e-1	0	1.344e-6	0

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE ONE)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFFSITE GROUNDWATER, WAGNER & SONS (OS-01/01D)
RECEPTOR(S): ADULT EMPLOYEES

RELEVANT EQUATIONS: REFERENCES: USEPA, DECEMBER 1989

OEX = (CGW EF ED ABS IR)/(BW AT)

OEX = ORAL EXPOSURE DOSE (mg/kg/day)
CGW = CONCENTRATION OF CHEMICAL IN GROUNDWATER (mg/l)
EF = EXPOSURE FREQUENCY (day/yr)
ED = EXPOSURE DURATION (yr)
ABS = FRACTION ABSORBED
IR = INGESTION RATE (l/day)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days)

HQ = OEX1/RFD

HQ = HAZARD QUOTIENT
OEX1 = NONCARCINOGENIC ORAL EXPOSURE DOSE (mg/kg/day)
RFD = REFERENCE DOSE (CHRONIC, ORAL) (mg/kg/day)

CR = (OEX2) (CSF)

CR = CANCER RISK
OEX2 = CARCINOGENIC ORAL EXPOSURE DOSE (mg/kg/day)
CSF = CANCER SLOPE FACTOR (ORAL) (mg/kg/day)^-1

ENTER INPUTS:

EF (adult) =	250(day/yr)	
EF (child) =	0(day/yr)	
ED (adult) =	25(yr)	
ED (child) =	0(yr)	
ABS (adult) =	1	
ABS (child) =	1	
IR (adult) =	1(l/day)	
IR (child) =	0(l/day)	
BW (adult) =	70(kg)	
BW (child) =	15(kg)	
AT1 (adult) =	9125(days)	(NONCARCINOGENIC)
AT2 (adult) =	25550(days)	(CARCINOGENIC)
AT1 (child) =	2190(days)	(NONCARCINOGENIC)
AT2 (child) =	25550(days)	(CARCINOGENIC)

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE TWO)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFFSITE GROUNDWATER, WAGNER & SONS (OS-01/01D)
RECEPTOR(S): ADULT EMPLOYEES

CHEMICAL	CGW (mg/l)	RFD	CSF	OEX1 ADULT	OEX2 ADULT	OEX1 CHILD	OEX2 CHILD
Trichloroethene	.72	6e-3	1.1e-2	7.045e-3	2.516e-3	0	0
Arsenic	.00445	3e-4	1.75e0	4.354e-5	1.555e-5	0	0
Lead	.46785			4.578e-3	1.635e-3	0	0
Barium	.243	7e-2		2.378e-3	8.492e-4	0	0
Copper	.073	3.7e-2		7.143e-4	2.551e-4	0	0
Manganese	.0525	5e-3		5.137e-4	1.835e-4	0	0
Zinc	.07	3e-1		6.849e-4	2.446e-4	0	0
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RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE THREE)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFFSITE GROUNDWATER, WAGNER & SONS (OS-01/01D)
RECEPTOR(S): ADULT EMPLOYEES

CHEMICAL	HQ ADULT	HQ CHILD	CR ADULT	CR CHILD
Trichloroethene	1.1742e0	0	2.768e-5	0
Arsenic	1.451e-1	0	2.721e-5	0
Lead	N/A	N/A	0	0
Barium	3.397e-2	0	0	0
Copper	1.931e-2	0	0	0
Manganese	1.027e-1	0	0	0
Zinc	2.283e-3	0	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
TOTAL	1.4776e0	0	5.489e-5	0

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE ONE)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFFSITE GROUNDWATER, WTMA #26 (OS-02)
RECEPTOR(S): ADULT AND CHILD RESIDENTS

RELEVANT EQUATIONS: REFERENCES: USEPA, DECEMBER 1989

OEX = (CGW EF ED ABS IR)/(BW AT)

OEX = ORAL EXPOSURE DOSE (mg/kg/day)
CGW = CONCENTRATION OF CHEMICAL IN GROUNDWATER (mg/l)
EF = EXPOSURE FREQUENCY (day/yr)
ED = EXPOSURE DURATION (yr)
ABS = FRACTION ABSORBED
IR = INGESTION RATE (l/day)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days)

HQ = OEX1/RFD

HQ = HAZARD QUOTIENT
OEX1 = NONCARCINOGENIC ORAL EXPOSURE DOSE (mg/kg/day)
RFD = REFERENCE DOSE (CHRONIC, ORAL) (mg/kg/day)

CR = (OEX2) (CSF)

CR = CANCER RISK
OEX2 = CARCINOGENIC ORAL EXPOSURE DOSE (mg/kg/day)
CSF = CANCER SLOPE FACTOR (ORAL) (mg/kg/day)^-1

ENTER INPUTS:

EF (adult) =	350(day/yr)	
EF (child) =	350(day/yr)	
ED (adult) =	30(yr)	
ED (child) =	6(yr)	
ABS (adult) =	1	
ABS (child) =	1	
IR (adult) =	2(l/day)	
IR (child) =	1(l/day)	
BW (adult) =	70(kg)	
BW (child) =	15(kg)	
AT1 (adult) =	10950(days)	(NONCARCINOGENIC)
AT2 (adult) =	25550(days)	(CARCINOGENIC)
AT1 (child) =	2190(days)	(NONCARCINOGENIC)
AT2 (child) =	25550(days)	(CARCINOGENIC)

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE TWO)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFFSITE GROUNDWATER, WTMA #26 (OS-02)
RECEPTOR(S): ADULT AND CHILD RESIDENTS

CHEMICAL	CGW (mg/l)	RFD	CSF	OEX1 ADULT	OEX2 ADULT	OEX1 CHILD	OEX2 CHILD
Tetrachloroethene	.02	1e-2	5.2e-2	5.479e-4	2.348e-4	1.279e-3	1.096e-4
Trichloroethene	.11	6e-3	1.1e-2	3.014e-3	1.292e-3	7.032e-3	6.027e-4
1,1-Dichloroethene	.018	9e-3	6e-1	4.932e-4	2.114e-4	1.151e-3	9.863e-5
1,1,1-Trichloroethane	.1	9e-2		2.740e-3	1.174e-3	6.393e-3	5.479e-4
1,1-Dichloroethane	.028	1e-1		7.671e-4	3.288e-4	1.790e-3	1.534e-4
Arsenic	.0037	3e-4	1.75e0	1.014e-4	4.344e-5	2.365e-4	2.027e-5
Barium	.216	7e-2		5.918e-3	2.536e-3	1.381e-2	1.184e-3
Manganese	.041	5e-3		1.123e-3	4.814e-4	2.621e-3	2.247e-4
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RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE THREE)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFFSITE GROUNDWATER, WTMA #26 (OS-02)
RECEPTOR(S): ADULT AND CHILD RESIDENTS

CHEMICAL	HQ ADULT	HQ CHILD	CR ADULT	CR CHILD
Tetrachloroethene	5.479e-2	1.279e-1	1.221e-5	5.699e-6
Trichloroethene	5.023e-1	1.1720e0	1.421e-5	6.630e-6
1,1-Dichloroethene	5.479e-2	1.279e-1	1.268e-4	5.918e-5
1,1,1-Trichloroethane	3.044e-2	7.103e-2	0	0
1,1-Dichloroethane	7.671e-3	1.790e-2	0	0
Arsenic	3.379e-1	7.884e-1	7.603e-5	3.548e-5
Barium	8.454e-2	1.973e-1	0	0
Manganese	2.247e-1	5.242e-1	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
	N/A	N/A	0	0
TOTAL	1.2971e0	3.0265e0	2.293e-4	1.070e-4

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE ONE)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFFSITE GROUNDWATER, WTMA #26 (OS-02)
RECEPTOR(S): ADULT EMPLOYEES

RELEVANT EQUATIONS: REFERENCES: USEPA, DECEMBER 1989

OEX = (CGW EF ED ABS IR)/(BW AT)

OEX = ORAL EXPOSURE DOSE (mg/kg/day)
CGW = CONCENTRATION OF CHEMICAL IN GROUNDWATER (mg/l)
EF = EXPOSURE FREQUENCY (day/yr)
ED = EXPOSURE DURATION (yr)
ABS = FRACTION ABSORBED
IR = INGESTION RATE (l/day)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days)

HQ = OEX1/RFD

HQ = HAZARD QUOTIENT
OEX1 = NONCARCINOGENIC ORAL EXPOSURE DOSE (mg/kg/day)
RFD = REFERENCE DOSE (CHRONIC, ORAL) (mg/kg/day)

CR = (OEX2) (CSF)

CR = CANCER RISK
OEX2 = CARCINOGENIC ORAL EXPOSURE DOSE (mg/kg/day)
CSF = CANCER SLOPE FACTOR (ORAL) (mg/kg/day)^-1

ENTER INPUTS:

EF (adult) =	250(day/yr)	
EF (child) =	0(day/yr)	
ED (adult) =	25(yr)	
ED (child) =	0(yr)	
ABS (adult) =	1	
ABS (child) =	1	
IR (adult) =	1(l/day)	
IR (child) =	0(l/day)	
BW (adult) =	70(kg)	
BW (child) =	15(kg)	
AT1 (adult) =	9125(days)	(NONCARCINOGENIC)
AT2 (adult) =	25550(days)	(CARCINOGENIC)
AT1 (child) =	2190(days)	(NONCARCINOGENIC)
AT2 (child) =	25550(days)	(CARCINOGENIC)

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE TWO)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFFSITE GROUNDWATER, WTMA #26 (OS-02)
RECEPTOR(S): ADULT EMPLOYEES

CHEMICAL	CGW (mg/l)	RFD	CSF	OEX1 ADULT	OEX2 ADULT	OEX1 CHILD	OEX2 CHILD
Tetrachloroethene	.02	1e-2	5.2e-2	1.957e-4	6.989e-5	0	0
Trichloroethene	.11	6e-3	1.1e-2	1.076e-3	3.844e-4	0	0
1,1-Dichloroethene	.018	9e-3	6e-1	1.761e-4	6.290e-5	0	0
1,1,1-Trichloroethane	.1	9e-2		9.785e-4	3.495e-4	0	0
1,1-Dichloroethane	.028	1e-1		2.740e-4	9.785e-5	0	0
Arsenic	.0037	3e-4	1.75e0	3.620e-5	1.293e-5	0	0
Barium	.216	7e-2		2.114e-3	7.548e-4	0	0
Manganese	.041	5e-3		4.012e-4	1.433e-4	0	0
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RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE THREE)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFFSITE GROUNDWATER, WTMA #26 (OS-02)
RECEPTOR(S): ADULT EMPLOYEES

CHEMICAL	HQ ADULT	HQ CHILD	CR ADULT	CR CHILD
Tetrachloroethene	1.957e-2	0	3.634e-6	0
Trichloroethene	1.794e-1	0	4.228e-6	0
1,1-Dichloroethene	1.957e-2	0	3.774e-5	0
1,1,1-Trichloroethane	1.087e-2	0	0	0
1,1-Dichloroethane	2.740e-3	0	0	0
Arsenic	1.207e-1	0	2.263e-5	0
Barium	3.019e-2	0	0	0
Manganese	8.023e-2	0	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
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______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
______	N/A	N/A	0	0
TOTAL	4.632e-1	0	6.823e-5	0

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE ONE)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFFSITE GROUNDWATER, LEWIS (OS-03)
RECEPTOR(S): ADULT AND CHILD RESIDENTS

RELEVANT EQUATIONS: REFERENCES: USEPA, DECEMBER 1989

OEX = (CGW EF ED ABS IR)/(BW AT)

OEX = ORAL EXPOSURE DOSE (mg/kg/day)
CGW = CONCENTRATION OF CHEMICAL IN GROUNDWATER (mg/l)
EF = EXPOSURE FREQUENCY (day/yr)
ED = EXPOSURE DURATION (yr)
ABS = FRACTION ABSORBED
IR = INGESTION RATE (l/day)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days)

HQ = OEX1/RFD

HQ = HAZARD QUOTIENT
OEX1 = NONCARCINOGENIC ORAL EXPOSURE DOSE (mg/kg/day)
RFD = REFERENCE DOSE (CHRONIC, ORAL) (mg/kg/day)

CR = (OEX2) (CSF)

CR = CANCER RISK
OEX2 = CARCINOGENIC ORAL EXPOSURE DOSE (mg/kg/day)
CSF = CANCER SLOPE FACTOR (ORAL) (mg/kg/day)^-1

ENTER INPUTS:

EF (adult) =	350(day/yr)	
EF (child) =	350(day/yr)	
ED (adult) =	30(yr)	
ED (child) =	6(yr)	
ABS (adult) =	1	
ABS (child) =	1	
IR (adult) =	2(l/day)	
IR (child) =	1(l/day)	
BW (adult) =	70(kg)	
BW (child) =	15(kg)	
AT1 (adult) =	10950(days)	(NONCARCINOGENIC)
AT2 (adult) =	25550(days)	(CARCINOGENIC)
AT1 (child) =	2190(days)	(NONCARCINOGENIC)
AT2 (child) =	25550(days)	(CARCINOGENIC)

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE TWO)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFFSITE GROUNDWATER, LEWIS (OS-03)
RECEPTOR(S): ADULT AND CHILD RESIDENTS

CHEMICAL	CGW (mg/l)	RFD	CSF	DEX1 ADULT	DEX2 ADULT	DEX1 CHILD	DEX2 CHILD
Barium	.376	7e-2		1.030e-2	4.415e-3	2.404e-2	2.060e-3
Copper	.041	3.7e-2		1.123e-3	4.814e-4	2.621e-3	2.247e-4
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0
------				0	0	0	0

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE THREE)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFFSITE GROUNDWATER, LEWIS (OS-03)
RECEPTOR(S): ADULT AND CHILD RESIDENTS

CHEMICAL	HQ ADULT	HQ CHILD	CR ADULT	CR CHILD
Barium	1.472e-1	3.434e-1	0	0
Copper	3.036e-2	7.084e-2	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
------	N/A	N/A	0	0
TOTAL	1.775e-1	4.142e-1	0	0

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE ONE)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFFSITE GROUNDWATER, AZTEC (OS-04)
RECEPTOR(S): ADULT EMPLOYEES

RELEVANT EQUATIONS: REFERENCES: USEPA, DECEMBER 1989

OEX = (CGW EF ED ABS IR)/(BW AT)

OEX = ORAL EXPOSURE DOSE (mg/kg/day)
CGW = CONCENTRATION OF CHEMICAL IN GROUNDWATER (mg/l)
EF = EXPOSURE FREQUENCY (day/yr)
ED = EXPOSURE DURATION (yr)
ABS = FRACTION ABSORBED
IR = INGESTION RATE (l/day)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days)

HQ = OEX1/RFD

HQ = HAZARD QUOTIENT
OEX1 = NONCARCINOGENIC ORAL EXPOSURE DOSE (mg/kg/day)
RFD = REFERENCE DOSE (CHRONIC, ORAL) (mg/kg/day)

CR = (OEX2) (CSF)

CR = CANCER RISK
OEX2 = CARCINOGENIC ORAL EXPOSURE DOSE (mg/kg/day)
CSF = CANCER SLOPE FACTOR (ORAL) (mg/kg/day)^-1

ENTER INPUTS:

EF (adult) =	250(day/yr)	
EF (child) =	0(day/yr)	
ED (adult) =	25(yr)	
ED (child) =	0(yr)	
ABS (adult) =	1	
ABS (child) =	1	
IR (adult) =	1(l/day)	
IR (child) =	0(l/day)	
BW (adult) =	70(kg)	
BW (child) =	15(kg)	
AT1 (adult) =	9125(days)	(NONCARCINOGENIC)
AT2 (adult) =	25550(days)	(CARCINOGENIC)
AT1 (child) =	2190(days)	(NONCARCINOGENIC)
AT2 (child) =	25550(days)	(CARCINOGENIC)

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE TWO)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFFSITE GROUNDWATER, AZTEC (OS-04)
RECEPTOR(S): ADULT EMPLOYEES

CHEMICAL	CGW (mg/l)	RFD	CSF	OEX1 ADULT	OEX2 ADULT	OEX1 CHILD	OEX2 CHILD
Tetrachloroethene	.002	1e-2	5.2e-2	1.957e-5	6.989e-6	0	0
Arsenic	.0046	3e-4	1.75e0	4.501e-5	1.607e-5	0	0
Barium	.209	7e-2		2.045e-3	7.304e-4	0	0
Manganese	.026	5e-1		2.544e-4	9.086e-5	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
______				0	0	0	0
				0	0	0	0

RISK ASSESSMENT SPREADSHEET: INGESTION OF GROUNDWATER (PAGE THREE)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFFSITE GROUNDWATER, AZTEC (OS-04)
RECEPTOR(S): ADULT EMPLOYEES

CHEMICAL	HQ ADULT	HQ CHILD	CR ADULT	CR CHILD
Tetrachloroethene	1.957e-3	0	3.634e-7	0
Arsenic	1.500e-1	0	2.813e-5	0
Barium	2.921e-2	0	0	0
Manganese	5.088e-4	0	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
_____	N/A	N/A	0	0
TOTAL	1.817e-1	0	2.849e-5	0

RISK ASSESSMENT SPREADSHEET: INHALATION OF GROUNDWATER (PAGE ONE)
SITE NAME: WARMINSTER SITES 1, 2, 3
MEDIUM: GROUNDWATER (CURRENT)
RECEPTOR(S): ADULT RESIDENT

RELEVANT EQUATIONS:

IEX = Q (S IR EF ED)/(BW AT Ra CF)

Q = Ds + ((e^(-Ra DT))/Ra) - (e^(Ra (Ds - DT))/Ra)

IEX = INHALATION EXPOSURE DOSE (mg/kg/day)
S = VOLATILE CHEMICAL GENERATION RATE (ug/m^3/min)
EF = EXPOSURE FREQUENCY (days/yr)
ED = EXPOSURE DURATION (yr)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days)
CF = CONVERSION FACTOR (1e6 l ug/m^3 mg)
Ra = AIR EXCHANGE RATE (1/min)
Ds = DURATION OF SHOWER (min)
DT = TOTAL TIME IN SHOWER ROOM (min)
IR = INHALATION RATE (l/min)

S = (Cwd FR)/SV

S = VOLATILE CHEMICAL GENERATION RATE (ug/m^3/min)
Cwd = CONCENTRATION LEAVING SHOWER DROPLET (ug/l)
FR = SHOWER FLOW RATE (l/min)
SV = SHOWER ROOM AIR VOLUME (m^3)

Cwd = Cwo [1 - e^((-Kal ts)/60d)]

Cwd = CONCENTRATION LEAVING SHOWER DROPLET (ug/l)
Cwo = CONCENTRATION OF CHEMICAL IN SHOWER WATER (ug/l)
Kal = ADJUSTED OVERALL MASS TRANSFER COEFFICIENT (cm/hr)
ts = SHOWER DROPLET TIME (sec)
d = SHOWER DROPLET DIAMETER (mm)
60 = CONVERSION FACTOR (cm sec/hr mm)

Kal = KL((T1 m2/ Ts m1)^-0.5)

Kal = ADJUSTED OVERALL MASS TRANSFER COEFFICIENT (cm/hr)
KL = OVERALL MASS TRANSFER COEFFICIENT
T1 = CALIBRATION WATER TEMP OF KL (K)
Ts = SHOWER WATER TEMPERATURE (K)
m1 = VISCOSITY OF WATER AT T1 (centipoise)
m2 = VISOCOSITY OF WATER AT Ts (cp)

REFERENCES: FOSTER AND CHROSTOWSKI, 1987; USEPA, DECEMBER 1989

KL = 1/[(1/Kl) + (R T /H Kg)]

KL = OVERALL MASS TRANSFER COEFFICIENT
Kl = LIQUID PHASE MASS TRANSFER COEFFICIENT (cm/hr)
Kg = GAS PHASE MASS TRANSFER COEFFICIENT (cm/hr)
T = TEMP. CORRESPONDING TO HENRY'S LAW CONSTANT (K)
R = IDEAL GAS LAW CONSTANT (atm m^3/mol K)
H = HENRY'S LAW CONSTANT (atm m^3/mol)

Kl = 20 cm/hr ((44/MW)^0.5)

Kl = LIQUID PHASE MASS TRANSFER COEFFICIENT (cm/hr)
MW = MOLECULAR WEIGHT OF CHEMICAL (g)
(based on Kl for carbon dioxide)

Kg = 3000 cm/hr ((18/MW)^0.5)

Kg = GAS PHASE MASS TRANSFER COEFFICIENT (cm/hr)
MW = MOLECULAR WEIGHT OF CHEMICAL (g)
(based on Kg for water)

HQ = IEX1/RFD

HQ = HAZARD QUOTIENT
IEX1 = NONCARCINOGENIC INHALATION EXPOSURE DOSE (mg/kg/day)
RFD = REFERENCE DOSE (CHRONIC, INHALATION) (mg/kg/day)

CR = IEX2 CSF

CR = CANCER RISK
IEX2 = CARCINOGENIC INHALATION EXPOSURE DOSE (mg/kg/day)
CSF = CANCER SLOPE FACTOR (INHALATION) (mg/kg/day)^-1

RISK ASSESSMENT SPREADSHEET: INHALATION OF GROUNDWATER (PAGE TWO)
SITE NAME: WARMINSTER SITES 1, 2, 3
MEDIUM: GROUNDWATER (CURRENT)
RECEPTOR(S): ADULT RESIDENT

INSERT INPUTS:

IR =	10.4(l/min)	EF =	3.5e2(day/yr)
BW =	70(kg)	ED =	3e1(yr)
Ds =	12(min)		
DT =	20(min)		
Ra =	.0083(min)^-1		
FR =	10(l/min)		
SV =	2.94(m^3)		
d =	1(mm)		
ts =	2(sec)		
T1 =	293(K)		
Ts =	318(K)		
m1 =	.982(cp)		
m2 =	.616(cp)		
T =	293(K)		
R =	.000082(atm m^3/mol K)		
AT1 =	10950(days) (NONCARCINOGENIC)		
AT2 =	25550(days) (CARCINOGENIC)		
CF =	1000000(l ug/m^3 mg)		

PRELIMINARY CALCULATION:

Q = 1.340879(min)

RISK ASSESSMENT SPREADSHEET: INHALATION OF GROUNDWATER (PAGE THREE)
SITE NAME: WARMINSTER SITES 1, 2, 3
MEDIUM: GROUNDWATER (CURRENT)
RECEPTOR(S): ADULT RESIDENT

CHEMICAL	Cwo (ug/l)	MW	H	RFD	CSF	IEX1	IEX2	HQ	CR
Vinyl chloride	1.5	62.5	8.14e-2		2.95e-1	6.106e-5	2.617e-5	N/A	7.720e-6
1,1-Dichloroethene	3	96.94	1.9e-1		1.75e-1	1.047e-4	4.488e-5	N/A	7.854e-6
1,2-Dichloroethane	3.5	98.96	9.14e-4		9.1e-2	1.009e-4	4.324e-5	N/A	3.935e-6
Trichloroethene	469	131.39	9.1e-3		6e-3	1.432e-2	6.136e-3	N/A	3.681e-5
Tetrachloroethene	128	165.83	1.53e-2		2e-3	3.597e-3	1.542e-3	N/A	3.083e-6
Chloroform	13.8	119.38	2.88e-3		8.1e-2	4.185e-4	1.794e-4	N/A	1.453e-5
Carbon tetrachloride	16.8	153.82	2.3e-2		5.25e-2	4.884e-4	2.093e-4	N/A	1.099e-5
Benzene	2	78.12	5.5e-3		2.9e-2	7.317e-5	3.136e-5	N/A	9.094e-7
1,2-Dichloropropane	1	112.99	2.31e-3	1.1e-3		3.052e-5	1.308e-5	2.774e-2	0
Pyrene	.6	202.3	5.1e-6			3.821e-7	1.637e-7	N/A	0
1,1-Dichloroethane	8	98.96	4.26e-3	1.43e-1		2.659e-4	1.140e-4	1.859e-3	0
1,2-Dichloroethene	27	96.94	4.08e-3			9.027e-4	3.869e-4	N/A	0
cis-1,2-Dichloroethene	138	96.94	4.08e-3			4.614e-3	1.977e-3	N/A	0
1,1,1-Trichloroethane	10	133.41	3e-2	3e-1		3.079e-4	1.320e-4	1.026e-3	0
Trichlorofluoromethane	29.8	137.4	1.1e-1	2e-1		9.114e-4	3.906e-4	4.557e-3	0
Toluene	4	92.13	6.66e-3	1e-1		1.386e-4	5.939e-5	1.386e-3	0
Ethylbenzene	.2	106.16	6.6e-3	3e-1		6.572e-6	2.816e-6	2.191e-5	0
Xylenes	2	106.16	4.33e-3			6.478e-5	2.776e-5	N/A	0
1,2-Dichlorobenzene	.7	147.01	1.93e-3	5.71e-2		1.897e-5	8.130e-6	3.322e-4	0
2-Butanone	24	72.1	2.08e-5	2.9e-1		9.621e-5	4.123e-5	3.318e-4	0
Di-n-octyl phthalate	3	391	1.7e-5			4.354e-6	1.866e-6	N/A	0
Diethyl phthalate	.375	222.2	1.2e-6			5.461e-8	2.341e-8	N/A	0
Phenanthrene	.3	178.2	2.26e-4			4.388e-6	1.881e-6	N/A	0
Fluoranthene	.6	202.3	6.5e-6			4.838e-7	2.073e-7	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
TOTAL								3.726e-2	8.583e-5

RISK ASSESSMENT SPREADSHEET: INHALATION OF GROUNDWATER (PAGE ONE)
SITE NAME: WARMINSTER SITES 5, 6, 7
MEDIUM: GROUNDWATER (CURRENT)
RECEPTOR(S): ADULT RESIDENT

RELEVANT EQUATIONS:

IEX = Q (S IR EF ED)/(BW AT Ra CF)

Q = Ds + ((e^(-Ra DT))/Ra) - (e^(Ra (Ds - DT))/Ra)

IEX = INHALATION EXPOSURE DOSE (mg/kg/day)
S = VOLATILE CHEMICAL GENERATION RATE (ug/m^3/min)
EF = EXPOSURE FREQUENCY (days/yr)
ED = EXPOSURE DURATION (yr)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days)
CF = CONVERSION FACTOR (1e6 l ug/m^3 mg)
Ra = AIR EXCHANGE RATE (1/min)
Ds = DURATION OF SHOWER (min)
DT = TOTAL TIME IN SHOWER ROOM (min)
IR = INHALATION RATE (l/min)

S = (Cwd FR)/SV

S = VOLATILE CHEMICAL GENERATION RATE (ug/m^3/min)
Cwd = CONCENTRATION LEAVING SHOWER DROPLET (ug/l)
FR = SHOWER FLOW RATE (l/min)
SV = SHOWER ROOM AIR VOLUME (m^3)

Cwd = Cwo [1 - e^((-Kal ts)/60d)]

Cwd = CONCENTRATION LEAVING SHOWER DROPLET (ug/l)
Cwo = CONCENTRATION OF CHEMICAL IN SHOWER WATER (ug/l)
Kal = ADJUSTED OVERALL MASS TRANSFER COEFFICIENT (cm/hr)
ts = SHOWER DROPLET TIME (sec)
d = SHOWER DROPLET DIAMETER (mm)
60 = CONVERSION FACTOR (cm sec/hr mm)

Kal = KL((T1 m2/ Ts m1)^-0.5)

Kal = ADJUSTED OVERALL MASS TRANSFER COEFFICIENT (cm/hr)
KL = OVERALL MASS TRANSFER COEFFICIENT
T1 = CALIBRATION WATER TEMP OF KL (K)
Ts = SHOWER WATER TEMPERATURE (K)
m1 = VISCOSITY OF WATER AT T1 (centipoise)
m2 = VISOCOSITY OF WATER AT Ts (cp)

REFERENCES: FOSTER AND CHROSTOWSKI, 1987; USEPA, DECEMBER 1989

KL = 1/[(1/Kl) + (R T /H Kg)]

KL = OVERALL MASS TRANSFER COEFFICIENT
Kl = LIQUID PHASE MASS TRANSFER COEFFICIENT (cm/hr)
Kg = GAS PHASE MASS TRANSFER COEFFICIENT (cm/hr)
T = TEMP. CORRESPONDING TO HENRY'S LAW CONSTANT (K)
R = IDEAL GAS LAW CONSTANT (atm m^3/mol K)
H = HENRY'S LAW CONSTANT (atm m^3/mol)

Kl = 20 cm/hr ((44/MW)^0.5)

Kl = LIQUID PHASE MASS TRANSFER COEFFICIENT (cm/hr)
MW = MOLECULAR WEIGHT OF CHEMICAL (g)
(based on Kl for carbon dioxide)

Kg = 3000 cm/hr ((18/MW)^0.5)

Kg = GAS PHASE MASS TRANSFER COEFFICIENT (cm/hr)
MW = MOLECULAR WEIGHT OF CHEMICAL (g)
(based on Kg for water)

HQ = IEX1/RFD

HQ = HAZARD QUOTIENT
IEX1 = NONCARCINOGENIC INHALATION EXPOSURE DOSE (mg/kg/day)
RFD = REFERENCE DOSE (CHRONIC, INHALATION) (mg/kg/day)

CR = IEX2 CSF

CR = CANCER RISK
IEX2 = CARCINOGENIC INHALATION EXPOSURE DOSE (mg/kg/day)
CSF = CANCER SLOPE FACTOR (INHALATION) (mg/kg/day)^-1

RISK ASSESSMENT SPREADSHEET: INHALATION OF GROUNDWATER (PAGE TWO)
SITE NAME: WARMINSTER SITES 5, 6, 7
MEDIUM: GROUNDWATER (CURRENT)
RECEPTOR(S): ADULT RESIDENT

INSERT INPUTS:

IR =	10.4(l/min)	EF =	3.5e2(day/yr)
BW =	70(kg)	ED =	3e1(yr)
Ds =	12(min)		
DT =	20(min)		
Ra =	.0083(min)^-1		
FR =	10(l/min)		
SV =	2.94(m^3)		
d =	1(mm)		
ts =	2(sec)		
T1 =	293(K)		
Ts =	318(K)		
m1 =	.982(cp)		
m2 =	.616(cp)		
T =	293(K)		
R =	.000082(atm m^3/mol K)		
AT1 =	10950(days) (NONCARCINOGENIC)		
AT2 =	25550(days) (CARCINOGENIC)		
CF =	1000000(l ug/m^3 mg)		

PRELIMINARY CALCULATION:

Q = 1.340879(min)

RISK ASSESSMENT SPREADSHEET: INHALATION OF GROUNDWATER (PAGE THREE)
SITE NAME: WARMINSTER SITES 5, 6, 7
MEDIUM: GROUNDWATER (CURRENT)
RECEPTOR(S): ADULT RESIDENT

CHEMICAL	Cwo (ug/l)	MW	H	RFD	CSF	IEX1	IEX2	HQ	CR
Trichloroethene	4.4	131.39	9.1e-3		6e-3	1.343e-4	5.756e-5	N/A	3.454e-7
Tetrachloroethene	1.8	165.83	1.53e-2		2e-3	5.059e-5	2.168e-5	N/A	4.336e-8
Carbon tetrachloride	1.6	153.82	2.3e-2		5.25e-2	4.652e-5	1.994e-5	N/A	1.047e-6
Chloromethane	2	50.94	4e-2		6.3e-3	8.695e-5	3.726e-5	N/A	2.348e-7
Chloroform	1.4	119.38	2.88e-3		8.1e-2	4.246e-5	1.820e-5	N/A	1.474e-6
1,2-Dichloroethene	3.8	96.94	4.08e-3			1.270e-4	5.445e-5	N/A	0
cis-1,2-Dichloroethene	2.6	96.94	4.08e-3			8.692e-5	3.725e-5	N/A	0
Toluene	2.4	92.13	6.66e-3	1e-1		8.315e-5	3.564e-5	8.315e-4	0
1,1,1-Trichloroethane	1	133.41	3e-2	3e-1		3.079e-5	1.320e-5	1.026e-4	0
Di-n-octyl phthalate	.9	391	1.7e-5			1.306e-6	5.598e-7	N/A	0
Diethyl phthalate	2	222.2	1.2e-6			2.913e-7	1.248e-7	N/A	0
______						0	0	N/A	0
______						0	0	N/A	0
______						0	0	N/A	0
______						0	0	N/A	0
______						0	0	N/A	0
______						0	0	N/A	0
______						0	0	N/A	0
______						0	0	N/A	0
______						0	0	N/A	0
______						0	0	N/A	0
______						0	0	N/A	0
______						0	0	N/A	0
______						0	0	N/A	0
______						0	0	N/A	0
______						0	0	N/A	0
______						0	0	N/A	0
______						0	0	N/A	0
______						0	0	N/A	0
______						0	0	N/A	0
______						0	0	N/A	0
______						0	0	N/A	0
______						0	0	N/A	0
______						0	0	N/A	0
TOTAL								9.341e-4	3.144e-6

RISK ASSESSMENT SPREADSHEET: INHALATION OF GROUNDWATER (PAGE ONE)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFFSITE GROUNDWATER - WTMA 26 (OS-02)
RECEPTOR(S): ADULT RESIDENT

RELEVANT EQUATIONS:

IEX = Q (S IR EF ED)/(BW AT Ra CF)

Q = Ds + ((e^(-Ra DT))/Ra) - (e^(Ra (Ds - DT))/Ra)

IEX = INHALATION EXPOSURE DOSE (mg/kg/day)
S = VOLATILE CHEMICAL GENERATION RATE (ug/m^3/min)
EF = EXPOSURE FREQUENCY (days/yr)
ED = EXPOSURE DURATION (yr)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days)
CF = CONVERSION FACTOR (1e6 l ug/m^3 mg)
Ra = AIR EXCHANGE RATE (1/min)
Ds = DURATION OF SHOWER (min)
DT = TOTAL TIME IN SHOWER ROOM (min)
IR = INHALATION RATE (l/min)

S = (Cwd FR)/SV

S = VOLATILE CHEMICAL GENERATION RATE (ug/m^3/min)
Cwd = CONCENTRATION LEAVING SHOWER DROPLET (ug/l)
FR = SHOWER FLOW RATE (l/min)
SV = SHOWER ROOM AIR VOLUME (m^3)

Cwd = Cwo [1 - e^((-Kal ts)/60d)]

Cwd = CONCENTRATION LEAVING SHOWER DROPLET (ug/l)
Cwo = CONCENTRATION OF CHEMICAL IN SHOWER WATER (ug/l)
Kal = ADJUSTED OVERALL MASS TRANSFER COEFFICIENT (cm/hr)
ts = SHOWER DROPLET TIME (sec)
d = SHOWER DROPLET DIAMETER (mm)
60 = CONVERSION FACTOR (cm sec/hr mm)

Kal = KL((T1 m2/ Ts m1)^-0.5)

Kal = ADJUSTED OVERALL MASS TRANSFER COEFFICIENT (cm/hr)
KL = OVERALL MASS TRANSFER COEFFICIENT
T1 = CALIBRATION WATER TEMP OF KL (K)
Ts = SHOWER WATER TEMPERATURE (K)
m1 = VISCOSITY OF WATER AT T1 (centipoise)
m2 = VISOCOSITY OF WATER AT Ts (cp)

REFERENCES: FOSTER AND CHROSTOWSKI, 1987; USEPA, DECEMBER 1989

KL = 1/[(1/Kl) + (R T /H Kg)]

KL = OVERALL MASS TRANSFER COEFFICIENT
Kl = LIQUID PHASE MASS TRANSFER COEFFICIENT (cm/hr)
Kg = GAS PHASE MASS TRANSFER COEFFICIENT (cm/hr)
T = TEMP. CORRESPONDING TO HENRY'S LAW CONSTANT (K)
R = IDEAL GAS LAW CONSTANT (atm m^3/mol K)
H = HENRY'S LAW CONSTANT (atm m^3/mol)

Kl = 20 cm/hr ((44/MW)^0.5)

Kl = LIQUID PHASE MASS TRANSFER COEFFICIENT (cm/hr)
MW = MOLECULAR WEIGHT OF CHEMICAL (g)
(based on Kl for carbon dioxide)

Kg = 3000 cm/hr ((18/MW)^0.5)

Kg = GAS PHASE MASS TRANSFER COEFFICIENT (cm/hr)
MW = MOLECULAR WEIGHT OF CHEMICAL (g)
(based on Kg for water)

HQ = IEX1/RFD

HQ = HAZARD QUOTIENT
IEX1 = NONCARCINOGENIC INHALATION EXPOSURE DOSE (mg/kg/day)
RFD = REFERENCE DOSE (CHRONIC, INHALATION) (mg/kg/day)

CR = IEX2 CSF

CR = CANCER RISK
IEX2 = CARCINOGENIC INHALATION EXPOSURE DOSE (mg/kg/day)
CSF = CANCER SLOPE FACTOR (INHALATION) (mg/kg/day)^-1

RISK ASSESSMENT SPREADSHEET: INHALATION OF GROUNDWATER (PAGE TWO)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFFSITE GROUNDWATER - WTMA 26 (OS-02)
RECEPTOR(S): ADULT RESIDENT

INSERT INPUTS:

IR =	10.4(l/min)	EF =	3.5e2(day/yr)
BW =	70(kg)	ED =	3e1(yr)
Ds =	12(min)		
DT =	20(min)		
Ra =	.0083(min)^-1		
FR =	10(l/min)		
SV =	2.94(m^3)		
d =	1(mm)		
ts =	2(sec)		
T1 =	293(K)		
Ts =	318(K)		
m1 =	.982(cp)		
m2 =	.616(cp)		
T =	293(K)		
R =	.000082(atm m^3/mol K)		
AT1 =	10950(days) (NONCARCINOGENIC)		
AT2 =	25550(days) (CARCINOGENIC)		
CF =	1000000(l ug/m^3 mg)		

PRELIMINARY CALCULATION:

Q = 1.340879(min)

RISK ASSESSMENT SPREADSHEET: INHALATION OF GROUNDWATER (PAGE THREE)
SITE NAME: NAWC WARMINSTER
MEDIUM: OFFSITE GROUNDWATER - WTMA 26 (OS-02)
RECEPTOR(S): ADULT RESIDENT

CHEMICAL	Cwo (ug/l)	MW	H	RFD	CSF	IEX1	IEX2	HQ	CR
Tetrachloroethene	20	165.83	1.53e-2		2e-3	5.621e-4	2.409e-4	N/A	4.818e-7
Trichloroethene	110	131.39	9.1e-3		1.7e-2	3.358e-3	1.439e-3	N/A	2.446e-5
1,1-Dichloroethene	18	96.94	1.9e-1		1.75e-1	6.283e-4	2.693e-4	N/A	4.712e-5
1,1,1-Trichloroethene	100	133.41	3e-2	3e-1		3.079e-3	1.320e-3	1.026e-2	0
1,1-Dichloroethane	28	98.96	4.26e-3	1.43e-1		9.306e-4	3.988e-4	6.508e-3	0
Arsenic	3.7	74.92			1.5e1	0	0	N/A	0
Barium	216	137.34		1e-4		0	0	0	0
Manganese	41	55		1e-4		0	0	0	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
						0	0	N/A	0
TOTAL								1.677e-2	7.207e-5

APPENDIX N-1

CURRENT GROUNDWATER

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Benz(a)anthracene
Enter Matrix: Current Monitoring Wells Upgradient

Enter number of samples: 6
Degrees of Freedom: 5

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	4
2	5	4
3	5	4
4	17	100
5	5	4
6	5	4
7		0
8		0
9		0
10		0
11		0
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 7 Std. Dev.: 4.898979

Upper 95% confidence limit on mean: 12.142

Representative Concentration: 12.142

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Benzo[b]fluoranthene
Enter Matrix: Current Monitoring Wells Upgradient

Enter number of samples: 5
Degrees of Freedom: 4

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	88.36
2	5	88.36
3	52	1413.76
4	5	88.36
5	5	88.36
6		0
7		0
8		0
9		0
10		0
11		0
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 14.4 Std. Dev.: 21.01904

Upper 95% confidence limit on mean: 40.4944 Representative Concentration: 40.4944

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Benzo[g,h,i]perylene
Enter Matrix: Current Monitoring Wells Upgradient

Enter number of samples: 5
Degrees of Freedom: 4

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	9
2	5	9
3	20	144
4	5	9
5	5	9
6		0
7		0
8		0
9		0
10		0
11		0
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 8 Std. Dev.: 6.708204

Upper 95% confidence limit on mean: 16.328

Representative Concentration: 16.328

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Benzo[a]pyrene
Enter Matrix: Current Monitoring Wells Upgradient

Enter number of samples: 5
Degrees of Freedom: 4

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	14.44
2	5	14.44
3	24	231.04
4	5	14.44
5	5	14.44
6		0
7		0
8		0
9		0
10		0
11		0
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 8.8 Std. Dev.: 8.497058

Upper 95% confidence limit on mean: 19.3488 Representative Concentration: 19.3488

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Butylbenzyl phthalate
Enter Matrix: Current Monitoring Wells Upgradient

Enter number of samples: 6
Degrees of Freedom: 5

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	.5877778
2	5	.5877778
3	5	.5877778
4	5	.5877778
5	.4	14.69444
6	5	.5877778
7		0
8		0
9		0
10		0
11		0
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 4.233333 Std. Dev.: 1.877942

Upper 95% confidence limit on mean: 6.204433 Representative Concentration: 5

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Carbon tetrachloride
Enter Matrix: Current Monitoring Wells Upgradient

Enter number of samples: 15
Degrees of Freedom: 14

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	3	1.521111
2	1	.5877778
3	1	.5877778
4	6	17.92111
5	2.5	.5377778
6	.5	1.604444
7	2.5	.5377778
8	.5	1.604444
9	2.5	.5377778
10	.5	1.604444
11	.5	1.604444
12	2.5	.5377778
13	.5	1.604444
14	2.5	.5377778
15	.5	1.604444
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 1.766667 Std. Dev.: 1.533747

Upper 95% confidence limit on mean: 2.616112

Representative Concentration: 2.616112

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Chloroform
Enter Matrix: Current Monitoring Wells Upgradient

Enter number of samples: 15
Degrees of Freedom: 14

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	4	5.366944
2	2	.1002778
3	2	.1002778
4	6	18.63361
5	2.5	.6669444
6	.5	1.400278
7	.5	1.400278
8	.5	1.400278
9	.25	2.054444
10	.5	1.400278
11	.5	1.400278
12	2.5	.6669444
13	.5	1.400278
14	2.5	.6669444
15	.5	1.400278
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 1.683333 Std. Dev.: 1.648773

Upper 95% confidence limit on mean: 2.596484

Representative Concentration: 2.596484

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Chrysene
Enter Matrix: Current Monitoring Wells Upgradient

Enter number of samples: 6
Degrees of Freedom: 5

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	17.36111
2	5	17.36111
3	5	17.36111
4	30	434.0278
5	5	17.36111
6	5	17.36111
7		0
8		0
9		0
10		0
11		0
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 9.166667 Std. Dev.: 10.20621

Upper 95% confidence limit on mean: 19.87917 Representative Concentration: 19.87917

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Dibenz[a,h]anthracene
Enter Matrix: Current Monitoring Wells Upgradient

Enter number of samples: 5
Degrees of Freedom: 4

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	0
2	5	0
3	5	0
4	5	0
5	5	0
6		0
7		0
8		0
9		0
10		0
11		0
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 5 Std. Dev.: 0

Upper 95% confidence limit on mean: 5

Representative Concentration: 5

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: 1,1-Dichloroethane
Enter Matrix: Current Monitoring Wells Upgradient

Enter number of samples: 15
Degrees of Freedom: 14

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	.5	2.25
2	.5	2.25
3	8	36
4	6	16
5	2.5	.25
6	.5	2.25
7	2.5	.25
8	.5	2.25
9	2	0
10	.5	2.25
11	.5	2.25
12	2.5	.25
13	.5	2.25
14	2.5	.25
15	.5	2.25
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 2 Std. Dev.: 2.251983

Upper 95% confidence limit on mean: 3.247231

Representative Concentration: 3.247231

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: 1,1-Dichloroethene
Enter Matrix: Current Monitoring Wells Upgradient

Enter number of samples: 15
Degrees of Freedom: 14

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	.5	2.25
2	.5	2.25
3	8	36
4	6	16
5	2.5	.25
6	.5	2.25
7	2.5	.25
8	.5	2.25
9	2	0
10	.5	2.25
11	.5	2.25
12	2.5	.25
13	.5	2.25
14	2.5	.25
15	.5	2.25
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 2 Std. Dev.: 2.251983

Upper 95% confidence limit on mean: 3.247231

Representative Concentration: 3.247231

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: cis-1,2-Dichloroethene
Enter Matrix: Current Monitoring Wells Upgradient

Enter number of samples: 10
Degrees of Freedom: 9

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	.5	21.16
2	.5	21.16
3	2	9.61
4	45	1592.01
5	.5	21.16
6	.5	21.16
7	.5	21.16
8	.5	21.16
9	.5	21.16
10	.5	21.16
11		0
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 5.1 Std. Dev.: 14.02735

Upper 95% confidence limit on mean: 15.13387

Representative Concentration: 15.13387

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: trans-1,2-Dichloroethene
Enter Matrix: Current Monitoring Wells Upgradient

Enter number of samples: 10
Degrees of Freedom: 9

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	.5	.49
2	.5	.49
3	2	.64
4	6	23.04
5	.5	.49
6	.5	.49
7	.5	.49
8	.5	.49
9	.5	.49
10	.5	.49
11		0
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 1.2 Std. Dev.: 1.751190

Upper 95% confidence limit on mean: 2.452639

Representative Concentration: 2.452639

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Diethyl phthalate
Enter Matrix: Current Monitoring Wells Upgradient

Enter number of samples: 6
Degrees of Freedom: 5

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	.64
2	5	.64
3	5	.64
4	5	.64
5	5	.64
6	.2	16
7		0
8		0
9		0
10		0
11		0
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 4.2 Std. Dev.: 1.959592

Upper 95% confidence limit on mean: 6.2568

Representative Concentration: 5

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Di-n-octyl phthalate
Enter Matrix: Current Monitoring Wells Upgradient

Enter number of samples: 5
Degrees of Freedom: 4

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	2.6896
2	5	2.6896
3	1	5.5696
4	.8	6.5536
5	5	2.6896
6		0
7		0
8		0
9		0
10		0
11		0
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 3.36 Std. Dev.: 2.246775

Upper 95% confidence limit on mean: 6.149293

Representative Concentration: 5

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Fluoranthene
Enter Matrix: Current Monitoring Wells Upgradient

Enter number of samples: 6
Degrees of Freedom: 5

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	46.69444
2	5	46.69444
3	5	46.69444
4	46	1167.361
5	5	46.69444
6	5	46.69444
7		0
8		0
9		0
10		0
11		0
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 11.83333 Std. Dev.: 16.73818

Upper 95% confidence limit on mean: 29.40183 Representative Concentration: 29.40183

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Indeno[1,2,3-c,d]pyrene
Enter Matrix: Current Monitoring Wells Upgradient

Enter number of samples: 5
Degrees of Freedom: 4

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	9
2	5	9
3	20	144
4	5	9
5	5	9
6		0
7		0
8		0
9		0
10		0
11		0
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 8 Std. Dev.: 6.708204

Upper 95% confidence limit on mean: 16.328

Representative Concentration: 16.328

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Phenanthrene
Enter Matrix: Current Monitoring Wells Upgradient

Enter number of samples: 6
Degrees of Freedom: 5

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	4
2	5	4
3	5	4
4	17	100
5	5	4
6	5	4
7		0
8		0
9		0
10		0
11		0
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 7 Std. Dev.: 4.898979

Upper 95% confidence limit on mean: 12.142 Representative Concentration: 12.142

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Pyrene
Enter Matrix: Current Monitoring Wells Upgradient

Enter number of samples: 6
Degrees of Freedom: 5

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	25
2	5	25
3	5	25
4	35	625
5	5	25
6	5	25
7		0
8		0
9		0
10		0
11		0
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 10 Std. Dev.: 12.24745

Upper 95% confidence limit on mean: 22.855

Representative Concentration: 22.855

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Tetrachloroethene
Enter Matrix: Current Monitoring Wells Upgradient

Enter number of samples: 15
Degrees of Freedom: 14

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	15	12.25
2	1	110.25
3	12	.25
4	130	14042.25
5	2.5	81
6	.5	121
7	2.5	81
8	.5	121
9	2	90.25
10	.5	121
11	.5	121
12	2.5	81
13	.5	121
14	1.5	100
15	1	110.25
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 11.5 Std. Dev.: 33.07297

Upper 95% confidence limit on mean: 29.81702

Representative Concentration: 29.81702

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: 1,1,1,-Trichloroethane
Enter Matrix: Current Monitoring Wells Upgradient

Enter number of samples: 15
Degrees of Freedom: 14

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	.5	5.137778
2	.5	5.137778
3	13	104.7211
4	6	10.45444
5	2.5	.0711111
6	.5	5.137778
7	2.5	.0711111
8	.5	5.137778
9	6	10.45444
10	.5	5.137778
11	.5	5.137778
12	5	4.987778
13	.5	5.137778
14	2.5	.0711111
15	.5	5.137778
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 2.766667 Std. Dev.: 3.504419

Upper 95% confidence limit on mean: 4.707542

Representative Concentration: 4.707542

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Trichloroethene
Enter Matrix: Current Monitoring Wells Upgradient

Enter number of samples: 15
Degrees of Freedom: 14

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	7	.0544444
2	20	175.1211
3	14	52.32111
4	47	1618.721
5	2.5	18.20444
6	.5	39.27111
7	2.5	18.20444
8	.5	39.27111
9	.5	39.27111
10	.5	39.27111
11	.5	39.27111
12	2.5	18.20444
13	.5	39.27111
14	2.5	18.20444
15	.5	39.27111
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 6.766667 Std. Dev.: 12.51837

Upper 95% confidence limit on mean: 13.69980

Representative Concentration: 13.69980

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Aluminum
Enter Matrix: Unfiltered Groundwater, Upgradient

Enter number of samples: 15
Degrees of Freedom: 14

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5500	2330508.
2	181.5	46855394
3	6570	208483.6
4	1470	30875804
5	20000	1.6831e8
6	8540	2290380.
7	2880	17194292
8	11500	20011308
9	187.5	46773289
10	20000	1.6831e8
11	3070	15654684
12	2300	22340748
13	5260	3120876.
14	14800	60425748
15	3140	15105660
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 7026.6 Std. Dev.: 6653.707

Upper 95% confidence limit on mean: 10711.67

Representative Concentration: 10711.67

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Arsenic
Enter Matrix: Unfiltered Groundwater, Upgradient

Enter number of samples: 15
Degrees of Freedom: 14

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	1	.6188444
2	1	.6188444
3	2.1	.0981778
4	4.1	5.351511
5	4	4.898844
6	3.1	1.724844
7	1	.6188444
8	1	.6188444
9	1	.6188444
10	1	.6188444
11	1	.6188444
12	1	.6188444
13	1	.6188444
14	1	.6188444
15	3.5	2.935511
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 1.786667 Std. Dev.: 1.230486

Upper 95% confidence limit on mean: 2.468155 Representative Concentration: 2.468155

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Barium
Enter Matrix: Unfiltered Groundwater, Upgradient

Enter number of samples: 15
Degrees of Freedom: 14

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	362	10281.96
2	108	23286.76
3	588	107190.8
4	84	31187.56
5	250	112.36
6	183	6021.76
7	96	27093.16
8	250	112.36
9	184	5867.56
10	650	151632.4
11	302	1713.96
12	250	112.36
13	66	37869.16
14	400	19432.36
15	136	15525.16
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 260.6 Std. Dev.: 176.7645

Upper 95% confidence limit on mean: 358.4986

Representative Concentration: 358.4986

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Calcium
Enter Matrix: Unfiltered Groundwater, Upgradient

Enter number of samples: 15
Degrees of Freedom: 14

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	54000	4.6196e8
2	49200	2.7867e8
3	48700	2.6222e8
4	93800	3.7569e9
5	49500	2.8877e8
6	54600	4.8812e8
7	28100	19418711
8	12500	4.0027e8
9	25100	54858711
10	10000	5.0655e8
11	17200	2.3429e8
12	6500	6.7635e8
13	10800	4.7118e8
14	15000	3.0648e8
15	12600	3.9628e8
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 32506.67 Std. Dev.: 24788.09

Upper 95% confidence limit on mean: 46235.22

Representative Concentration: 46235.22

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Cadmium
Enter Matrix: Unfiltered Groundwater, Upgradient

Enter number of samples: 15
Degrees of Freedom: 14

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	1.5	.1111111
2	1.5	.1111111
3	1.5	.1111111
4	1.5	.1111111
5	3	1.361111
6	2	.0277778
7	1.5	.1111111
8	4	4.694444
9	2	.0277778
10	1	.6944444
11	1.5	.1111111
12	1	.6944444
13	2.5	.4444444
14	1	.6944444
15	2	.0277778
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 1.833333 Std. Dev.: .8164966

Upper 95% confidence limit on mean: 2.285539

Representative Concentration: 2.285539

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Chromium
Enter Matrix: Unfiltered Groundwater, Upgradient

Enter number of samples: 15
Degrees of Freedom: 14

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	6.5	27.38778
2	58	2140.604
3	5.5	38.85444
4	6	32.87111
5	34	495.8044
6	12	.0711111
7	15.5	14.18778
8	10	3.004444
9	5	45.33778
10	5	45.33778
11	2.5	85.25444
12	1	115.2044
13	6.5	27.38778
14	6	32.87111
15	2.5	85.25444
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 11.73333 Std. Dev.: 15.09360

Upper 95% confidence limit on mean: 20.09272 Representative Concentration: 20.09272

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Cobalt
Enter Matrix: Unfiltered Groundwater, Upgradient

Enter number of samples: 15
Degrees of Freedom: 14

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	6.5	.4444444
2	6	1.361111
3	3	17.36111
4	3	17.36111
5	15	61.36111
6	7.5	.1111111
7	4	10.02778
8	9	3.361111
9	7	.0277778
10	8	.6944444
11	5.5	2.777778
12	3	17.36111
13	16	78.02778
14	11	14.69444
15	3	17.36111
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 7.166667 Std. Dev.: 4.160472

Upper 95% confidence limit on mean: 9.470888

Representative Concentration: 9.470888

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Copper
Enter Matrix: Unfiltered Groundwater, Upgradient

Enter number of samples: 15
Degrees of Freedom: 14

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	7.5	134.56
2	2.5	275.56
3	37	320.41
4	2.5	275.56
5	32	166.41
6	7	146.41
7	3.5	243.36
8	50	954.81
9	4	228.01
10	95	5760.81
11	9	102.01
12	12.5	43.56
13	7	146.41
14	12.5	43.56
15	4.5	213.16
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 19.1 Std. Dev.: 25.43142

Upper 95% confidence limit on mean: 33.18485

Representative Concentration: 33.18485

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Iron
Enter Matrix: Unfiltered Groundwater, Upgradient

Enter number of samples: 15
Degrees of Freedom: 14

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	8900	2642142.
2	422	1.0208e8
3	7200	11058729
4	3510	49216773
5	35000	5.9900e8
6	19800	86016969
7	4590	35229765
8	12900	5638409.
9	5980	20661267
10	18000	55868649
11	3710	46450586
12	5000	30530782
13	15400	23761075
14	15000	20021449
15	2470	64890543
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 10525.47 Std. Dev.: 9075.359

Upper 95% confidence limit on mean: 15551.73

Representative Concentration: 15551.73

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Lead
Enter Matrix: Unfiltered Groundwater, Upgradient

Enter number of samples: 15
Degrees of Freedom: 14

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	1.15	188.4214
2	.9	195.3472
3	4.2	113.9912
4	5.2	93.63788
5	150	18258.32
6	4	118.3019
7	5.6	86.05654
8	23	65.98854
9	3	141.0552
10	5	97.54854
11	2.2	160.6979
12	1	192.5619
13	10.2	21.87121
14	3.5	129.4285
15	4.2	113.9912
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 14.87667 Std. Dev.: 37.77491

Upper 95% confidence limit on mean: 35.79780

Representative Concentration: 35.79780

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Magnesium
Enter Matrix: Unfiltered Groundwater, Upgradient

Enter number of samples: 15
Degrees of Freedom: 14

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	24500	1.7890e8
2	17300	38134742
3	22500	1.2940e8
4	12300	1381408.
5	9750	188970B.
6	31400	4.1109e8
7	11500	140875.1
8	4100	49345942
9	10200	855008.4
10	2000	83259542
11	5810	28245682
12	2000	83259542
13	6500	21387542
14	2700	70975008
15	4310	46439682
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 11124.67 Std. Dev.: 9042.367

Upper 95% confidence limit on mean: 16132.66

Representative Concentration: 16132.66

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Manganese
Enter Matrix: Unfiltered Groundwater, Upgradient

Enter number of samples: 15
Degrees of Freedom: 14

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	974	156183.0
2	89	1638912.
3	973	156974.4
4	80	1662037.
5	2000	397908.6
6	4830	11977137
7	107	1593149.
8	500	755508.6
9	352	1034696.
10	4000	6921109.
11	1290	6272.64
12	450	844928.6
13	1680	96596.64
14	3000	2659509.
15	213	1336798.
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 1369.2 Std. Dev.: 1493.742

Upper 95% confidence limit on mean: 2196.489

Representative Concentration: 2196.489

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Nickel
Enter Matrix: Unfiltered Groundwater, Upgradient

Enter number of samples: 15
Degrees of Freedom: 14

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	19	3.484444
2	18	8.217778
3	8.5	152.9344
4	9	140.8178
5	30	83.41778
6	28	50.88444
7	13.5	54.26778
8	40	366.0844
9	8.5	152.9344
10	40	366.0844
11	19	3.484444
12	5	251.7511
13	26	26.35111
14	40	366.0844
15	8.5	152.9344
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 20.86667 Std. Dev.: 12.47779

Upper 95% confidence limit on mean: 27.77732 Representative Concentration: 27.77732

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Potassium
Enter Matrix: Unfiltered Groundwater, Upgradient

Enter number of samples: 15
Degrees of Freedom: 14

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	2890	30741.78
2	1450	1599382.
3	2380	112001.8
4	8690	35704608
5	2500	46081.78
6	4520	3259228.
7	5370	7050795.
8	2500	46081.78
9	1820	800428.4
10	1000	2940082.
11	800	3665948.
12	1000	2940082.
13	2860	21121.78
14	2000	510748.4
15	940	3149442.
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 2714.667 Std. Dev.: 2102.325

Upper 95% confidence limit on mean: 3879.011 Representative Concentration: 3879.011

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Sodium
Enter Matrix: Unfiltered Groundwater, Upgradient

Enter number of samples: 15
Degrees of Freedom: 14

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	14200	2598544
2	20600	22924944
3	12200	13046544
4	48200	1.0490e9
5	11000	23155344
6	55900	1.6070e9
7	19600	14348944
8	5000	1.1690e8
9	10300	30382144
10	3700	1.4670e8
11	6980	78004224
12	4500	1.2796e8
13	9100	45050944
14	5000	1.1690e8
15	10900	24127744
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 15812 Std. Dev.: 15625.37

Upper 95% confidence limit on mean: 24465.90

Representative Concentration: 24465.90

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Vanadium
Enter Matrix: Unfiltered Groundwater, Upgradient

Enter number of samples: 15
Degrees of Freedom: 14

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	11	.64
2	2.5	59.29
3	13	7.84
4	4.5	32.49
5	40	888.04
6	14	14.44
7	4.5	32.49
8	5	27.04
9	2.5	59.29
10	10	.04
11	7	10.24
12	5	27.04
13	10	.04
14	20	96.04
15	4	38.44
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 10.2 Std. Dev.: 9.611749

Upper 95% confidence limit on mean: 15.52334

Representative Concentration: 15.52334

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Zinc
Enter Matrix: Unfiltered Groundwater, Upgradient

Enter number of samples: 15
Degrees of Freedom: 14

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	28	95.38778
2	24	189.5211
3	22	248.5878
4	13	613.3878
5	110	5217.654
6	117	6277.921
7	61	539.7878
8	35	7.654444
9	24	189.5211
10	25	162.9878
11	7.5	916.0711
12	10	770.9878
13	51	175.1211
14	10	770.9878
15	29	76.85444
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 37.76667 Std. Dev.: 34.07181

Upper 95% confidence limit on mean: 56.63688 Representative Concentration: 56.63688

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Barium

Enter Matrix: Filtered Groundwater, ~~Sites 1, 2, 3~~ Upgradient

JRH 9/9

Enter number of samples: 10

Degrees of Freedom: 9

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	169	2867.603
2	74	1718.103
3	286	29087.30
4	71	1975.803
5	89	699.6025
6	67	2347.403
7	166	2555.303
8	61	2964.803
9	10.5	11014.50
10	161	2074.803
11		0
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 115.45 Std. Dev.: 79.79503

Upper 95% confidence limit on mean: 172.5280

Representative Concentration: 172.5280

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Calcium
Enter Matrix: Filtered Groundwater, ~~Sites 1, 2, 3~~ Upgradient

JRH 9/9

Enter number of samples: 10
Degrees of Freedom: 9

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	53800	2.7017e8
2	53300	2.5399e8
3	38600	1530169
4	80100	1.8265e9
5	55200	3.1816e8
6	27900	89548369
7	25400	1.4311e8
8	12600	6.1321e8
9	9430	7.8025e8
10	17300	4.0252e8
11		0
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 37363 Std. Dev.: 22849.62

Upper 95% confidence limit on mean: 53707.50

Representative Concentration: 53707.50

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Chromium

Enter Matrix: Filtered Groundwater, ~~Sites 1, 2, 3~~ Upgradient

JRB 9/9

Enter number of samples: 10

Degrees of Freedom: 9

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	2.5	33.0625
2	60	2678.063
3	3.5	22.5625
4	2.5	33.0625
5	2.5	33.0625
6	2.5	33.0625
7	2.5	33.0625
8	2.5	33.0625
9	2.5	33.0625
10	1.5	45.5625
11		0
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 8.25 Std. Dev.: 18.18921

Upper 95% confidence limit on mean: 21.26087

Representative Concentration: 21.26087

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Cobalt
Enter Matrix: Filtered Groundwater, ~~Sites 1, 2, 3~~ Upgradient
JRH 9/9

Enter number of samples: 10
Degrees of Freedom: 9

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	3	.81
2	3	.81
3	3	.81
4	3	.81
5	12	65.61
6	3	.81
7	3	.81
8	3	.81
9	3	.81
10	3	.81
11		0
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 3.9 Std. Dev.: 2.846050

Upper 95% confidence limit on mean: 5.9358

Representative Concentration: 5.9358

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Iron 93 ~~b~~ a/4

Enter Matrix: Filtered Groundwater, ~~Sites 1, 2, 3~~ upgradient

Enter number of samples: 10

Degrees of Freedom: 9

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	6.5	71556.25
2	11	69169
3	14.5	67340.25
4	5	72361
5	1170	802816
6	28.5	60270.25
7	1430	1336336
8	54	48400
9	15.5	66822.25
10	5	72361
11		0
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 274 Std. Dev.: 544.4092

Upper 95% confidence limit on mean: 663.4198

Representative Concentration: 663.4198

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Magnesium
Enter Matrix: Filtered Groundwater, ~~Sites 1, 2, 3~~ JR 11/9
Upgradient

Enter number of samples: 10
Degrees of Freedom: 9

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	23300	1.0533e8
2	18200	26656569
3	17100	16507969
4	9780	10608049
5	28000	2.2389e8
6	10600	5938969
7	10300	7491169
8	3370	93450889
9	4380	74943649
10	5340	59243809
11		0
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 13037 Std. Dev.: 8327.075

Upper 95% confidence limit on mean: 18993.42

Representative Concentration: 18993.42

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Manganese
Enter Matrix: Filtered Groundwater, Sites ~~1, 2, 3~~ Upgradient
JRH 9/9

Enter number of samples: 10
Degrees of Freedom: 9

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	36	192063.1
2	32	195585.1
3	8	217389.1
4	.5	224439.1
5	4220	14030643
6	52	178295.1
7	367	11502.56
8	15	210910.6
9	8	217389.1
10	4	221135.1
11		0
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 474.25 Std. Dev.: 1320.747

Upper 95% confidence limit on mean: 1418.990

Representative Concentration: 1418.990

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Nickel

Enter Matrix: Filtered Groundwater, ~~Srtes 1, 2, 3~~ Upgradient

JRH 9/9

Enter number of samples: 10

Degrees of Freedom: 9

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	8.5	2.1025
2	8.5	2.1025
3	8.5	2.1025
4	8.5	2.1025
5	8.5	2.1025
6	8.5	2.1025
7	23	170.3025
8	8.5	2.1025
9	8.5	2.1025
10	8.5	2.1025
11		0
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 9.95 Std. Dev.: 4.585303

Upper 95% confidence limit on mean: 13.2299

Representative Concentration: 13.2299

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Potassium

Enter Matrix: Filtered Groundwater, ~~Sites 1, 2, 3~~ Upgradient

JRH 9/9

Enter number of samples: 10

Degrees of Freedom: 9

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	1130	1754565.
2	1430	1049805.
3	1270	1403277.
4	8460	36064829
5	3800	1810101.
6	4410	3823589.
7	1710	554429.2
8	980	2174445.
9	781	2800937.
10	575	3532896.
11		0
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 2454.6 Std. Dev.: 2471.367

Upper 95% confidence limit on mean: 4222.386

Representative Concentration: 4222.386

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Sodium

Enter Matrix: Filtered Groundwater, ~~Sites 1, 2,~~ 3

9M ff 9/9

Upgradient

Enter number of samples: 10

Degrees of Freedom: 9

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	14700	35545444
2	22900	5008644
3	11400	85784644
4	47700	7.3105e8
5	54200	1.1248e9
6	18800	3467044
7	10400	1.0531e8
8	11400	85784644
9	8150	1.5655e8
10	6970	1.8747e8
11		0
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 20662 Std. Dev.: 16735.76

Upper 95% confidence limit on mean: 32633.21

Representative Concentration: 32633.21

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Zinc

Enter Matrix: Filtered Groundwater, ~~Sites 1, 2,~~ 3

JR # 9/9

Upgradient

Enter number of samples: 10

Degrees of Freedom: 9

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	4	96.04
2	4.5	86.49
3	2.5	127.69
4	2	139.24
5	46	1036.84
6	43	852.64
7	3	116.64
8	5.5	68.89
9	10.5	10.89
10	17	10.24
11		0
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 13.8 Std. Dev.: 16.81798

Upper 95% confidence limit on mean: 25.83002

Representative Concentration: 25.83002

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Benzene
Enter Matrix: Current Monitoring Wells Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	2.5	9.752609
2	.5	26.24428
3	2.5	9.752609
4	.5	26.24428
5	.95	21.83615
6	16.5	118.3109
7	2.5	9.752609
8	12.5	47.29428
9	2.5	9.752609
10	62.5	3235.003
11	1	21.37136
12	12.5	47.29428
13	2.5	9.752609
14	.5	26.24428
15	1	21.37136
16	2.5	9.752609
17	.5	26.24428
18	2.5	9.752609
19	2.5	9.752609
20	2	13.12553
21	.5	26.24428
22	2.5	9.752609
23	.5	26.24428
24	.5	26.24428
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 5.622917 Std. Dev.: 12.84877

Upper 95% confidence limit on mean: 11.04937

Representative Concentration: 11.04937

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: 2-Butanone
Enter Matrix: Current Monitoring Wells Sites 1, 2, 3

Enter number of samples: 13
Degrees of Freedom: 12

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	2.5	1709.504
2	2.5	1709.504
3	85	1693.639
4	62.5	347.9660
5	312.5	72174.89
6	62.5	347.9660
7	2.5	1709.504
8	6	1432.331
9	2.5	1709.504
10	24	393.8698
11	2.5	1709.504
12	2.5	1709.504
13	2.5	1709.504
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 43.84615 Std. Dev.: 85.80850

Upper 95% confidence limit on mean: 95.70417 Representative Concentration: 95.70417

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Carbon tetrachloride
Enter Matrix: Current Monitoring Wells Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	2.5	57.34907
2	.5	91.64073
3	2.5	57.34907
4	.5	91.64073
5	10	.0053168
6	16.5	41.30740
7	44	1151.047
8	27.25	295.0522
9	16	35.13032
10	62.5	2748.599
11	13	8.567817
12	28	321.3803
13	2.5	57.34907
14	.5	91.64073
15	1	82.31782
16	2.5	57.34907
17	.5	91.64073
18	2.5	57.34907
19	2.5	57.34907
20	2.5	57.34907
21	.5	91.64073
22	2.5	57.34907
23	.5	91.64073
24	.5	91.64073
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 10.07292 Std. Dev.: 15.85763

Upper 95% confidence limit on mean: 16.77012

Representative Concentration: 16.77012

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Chloroform
Enter Matrix: Current Monitoring Wells Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	1	49.02334
2	.5	56.27500
3	.49	56.42514
4	.5	56.27500
5	25	288.9433
6	16.5	72.22167
7	17	80.97000
8	12.5	20.23500
9	15	48.97667
10	62.5	2970.068
11	13	24.98334
12	14	35.98000
13	.2	60.86600
14	.5	56.27500
15	6	4.006669
16	1.5	42.27167
17	1	49.02334
18	.4	57.78534
19	2.5	30.26834
20	.3	59.31567
21	.5	56.27500
22	.15	61.64867
23	.5	56.27500
24	.5	56.27500
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 8.001667 Std. Dev.: 13.75352

Upper 95% confidence limit on mean: 13.81023 Representative Concentration: 13.81023

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: 1,2-Dichlorobenzene
Enter Matrix: Current Monitoring Wells Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	2.163351
2	.5	35.65085
3	5	2.163351
4	.5	35.65085
5	5	2.163351
6	16.5	100.5842
7	.4	36.85502
8	12.5	36.35085
9	.7	33.30252
10	62.5	3139.268
11	.7	33.30252
12	12.5	36.35085
13	5	2.163351
14	.5	35.65085
15	1	29.93002
16	5	2.163351
17	.5	35.65085
18	5	2.163351
19	5	2.163351
20	5	2.163351
21	.5	35.65085
22	5	2.163351
23	.5	35.65085
24	.5	35.65085
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 6.470833 Std. Dev.: 12.70907

Upper 95% confidence limit on mean: 11.83829 Representative Concentration: 11.83829

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: 1,1-Dichloroethane
Enter Matrix: Current Monitoring Wells Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	1	31.87543
2	.5	37.77127
3	5	2.708767
4	5	2.708767
5	8	1.833767
6	16.5	97.10460
7	5	2.708767
8	12.5	34.27127
9	2	21.58377
10	62.5	3119.688
11	5	2.708767
12	12.5	34.27127
13	3	13.29210
14	3	13.29210
15	1	31.87543
16	2.5	17.18793
17	.5	37.77127
18	2	21.58377
19	2.5	17.18793
20	2	21.58377
21	2	21.58377
22	3	13.29210
23	2	21.58377
24	.5	37.77127
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 6.645833 Std. Dev.: 12.60993

Upper 95% confidence limit on mean: 11.97142 Representative Concentration: 11.97142

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: 1,2-Dichloroethane
Enter Matrix: Current Monitoring Wells Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	2.5	11.39063
2	.5	28.89063
3	2.5	11.39063
4	.5	28.89063
5	3.5	5.640625
6	16.5	112.8906
7	3	8.265625
8	12.5	43.89063
9	3	8.265625
10	62.5	3206.391
11	3	8.265625
12	12.5	43.89063
13	2.5	11.39063
14	.5	28.89063
15	1	23.76563
16	2.5	11.39063
17	.5	28.89063
18	2.5	11.39063
19	2.5	11.39063
20	2.5	11.39063
21	.5	28.89063
22	2.5	11.39063
23	.5	28.89063
24	.5	28.89063
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 5.875 Std. Dev.: 12.77672

Upper 95% confidence limit on mean: 11.27103

Representative Concentration: 11.27103

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: 1,1-Dichloroethene
Enter Matrix: Current Monitoring Wells Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	2.5	9.968491
2	.5	26.59766
3	2	13.37578
4	2	13.37578
5	.175	30.05552
6	16.5	117.5643
7	2	13.37578
8	12.5	46.82266
9	2	13.37578
10	62.5	3231.093
11	2	13.37578
12	12.5	46.82266
13	3	7.061199
14	3	7.061199
15	1	21.69037
16	2.5	9.968491
17	.5	26.59766
18	.6	25.57620
19	2.5	9.968491
20	1	21.69037
21	1	21.69037
22	2	13.37578
23	1	21.69037
24	.5	26.59766
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 5.657292 Std. Dev.: 12.83469

Upper 95% confidence limit on mean: 11.07780 Representative Concentration: 11.07780

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: cis-1,2-Dichloroethene
Enter Matrix: Current Monitoring Wells Sites 1, 2, 3

Enter number of samples: 13
Degrees of Freedom: 12

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	.5	2866.367
2	2	2708.001
3	510	207900.9
4	36	325.3861
5	62.5	71.59763
6	80	674.0015
7	.5	2866.367
8	1	2813.078
9	.5	2866.367
10	2.5	2656.213
11	6	2307.694
12	.5	2866.367
13	.5	2866.367
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 54.03846 Std. Dev.: 139.5793

Upper 95% confidence limit on mean: 138.3927

Representative Concentration: 138.3927

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: 1,2-Dichloroethene
Enter Matrix: Current Monitoring Wells Sites 1, 2, 3

Enter number of samples: 11
Degrees of Freedom: 10

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	1	153.9855
2	2.5	119.0083
3	62	2361.076
4	23	91.98554
5	3	108.3492
6	40	707.0764
7	2.5	119.0083
8	2.5	119.0083
9	2.5	119.0083
10	6	54.89463
11	2.5	119.0083
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 13.40909 Std. Dev.: 20.18021

Upper 95% confidence limit on mean: 26.96550 Representative Concentration: 26.96550

APPENDIX N-2

UPPER CONFIDENCE LIMITS

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: 1,2-Dichloropropane
Enter Matrix: Current Monitoring Wells Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	2.5	10.29340
2	.5	27.12674
3	2.5	10.29340
4	.5	27.12674
5	2.5	10.29340
6	16.5	116.4601
7	2.5	10.29340
8	12.5	46.12674
9	1	22.16840
10	62.5	3225.293
11	2.5	10.29340
12	12.5	46.12674
13	2.5	10.29340
14	.5	27.12674
15	1	22.16840
16	2.5	10.29340
17	.5	27.12674
18	2.5	10.29340
19	2.5	10.29340
20	2.5	10.29340
21	.5	27.12674
22	2.5	10.29340
23	.5	27.12674
24	.5	27.12674
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 5.708333 Std. Dev.: 12.82229

Upper 95% confidence limit on mean: 11.12361

Representative Concentration: 11.12361

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Diethyl phthalate
Enter Matrix: Current Monitoring Wells Sites 1, 2, 3

Enter number of samples: 12
Degrees of Freedom: 11

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	1.405213
2	5	1.405213
3	5	1.405213
4	5	1.405213
5	5	1.405213
6	5	1.405213
7	5	1.405213
8	.375	11.83073
9	5	1.405213
10	.2	13.06521
11	5	1.405213
12	.2	13.06521
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 3.814583 Std. Dev.: 2.144932

Upper 95% confidence limit on mean: 5.177417 Representative Concentration: 5

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Di-n-octylphthalate
Enter Matrix: Current Monitoring Wells Sites 1, 2, 3

Enter number of samples: 12
Degrees of Freedom: 11

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	.3	11.08333
2	5	1.879184
3	2.25	1.902101
4	5	1.879184
5	3	.3958507
6	5	1.879184
7	2	2.654184
8	5	1.879184
9	1	6.912517
10	5	1.879184
11	5	1.879184
12	5	1.879184
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 3.629167 Std. Dev.: 1.811636

Upper 95% confidence limit on mean: 4.780233

Representative Concentration: 4.780233

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Ethylbenzene
Enter Matrix: Current Monitoring Wells Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	2.5	10.08063
2	.5	26.78063
3	2.5	10.08063
4	.5	26.78063
5	2.5	10.08063
6	16.5	117.1806
7	.2	29.97563
8	12.5	46.58063
9	2.5	10.08063
10	62.5	3229.081
11	2.5	10.08063
12	12.5	46.58063
13	2.5	10.08063
14	.5	26.78063
15	1	21.85563
16	2.5	10.08063
17	.5	26.78063
18	2.5	10.08063
19	2.5	10.08063
20	2.5	10.08063
21	.5	26.78063
22	2.5	10.08063
23	.5	26.78063
24	.5	26.78063
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 5.675 Std. Dev.: 12.83610

Upper 95% confidence limit on mean: 11.09611 Representative Concentration: 11.09611

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Fluoranthene
Enter Matrix: Current Monitoring Wells Sites 1, 2, 3

Enter number of samples: 12
Degrees of Freedom: 11

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	.1344444
2	5	.1344444
3	5	.1344444
4	5	.1344444
5	5	.1344444
6	5	.1344444
7	5	.1344444
8	5	.1344444
9	5	.1344444
10	.6	16.26778
11	5	.1344444
12	5	.1344444
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 4.633333 Std. Dev.: 1.270171

Upper 95% confidence limit on mean: 5.440367

Representative Concentration: 5

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Phenanthrene
Enter Matrix: Current Monitoring Wells Sites 1, 2, 3

Enter number of samples: 12
Degrees of Freedom: 11

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	.1534028
2	5	.1534028
3	5	.1534028
4	5	.1534028
5	5	.1534028
6	5	.1534028
7	5	.1534028
8	5	.1534028
9	5	.1534028
10	.3	18.56174
11	5	.1534028
12	5	.1534028
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 4.608333 Std. Dev.: 1.356773

Upper 95% confidence limit on mean: 5.470392 Representative Concentration: 5

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Pyrene
Enter Matrix: Current Monitoring Wells Sites 1, 2, 3

Enter number of samples: 12
Degrees of Freedom: 11

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	.1344444
2	5	.1344444
3	5	.1344444
4	5	.1344444
5	5	.1344444
6	5	.1344444
7	5	.1344444
8	5	.1344444
9	5	.1344444
10	.6	16.26778
11	5	.1344444
12	5	.1344444
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 4.633333 Std. Dev.: 1.270171

Upper 95% confidence limit on mean: 5.440367

Representative Concentration: 5

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Tetrachloroethene
Enter Matrix: Current Monitoring Wells Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	2	4992.306
2	.5	5206.524
3	3	4851.993
4	4	4713.681
5	130	3288.306
6	350	76919.56
7	440	134941.4
8	265	36996.12
9	27	2084.493
10	62.5	103.1494
11	130	3288.306
12	300	51685.18
13	2	4992.306
14	7	4310.743
15	1	5134.618
16	.25	5242.665
17	.5	5206.524
18	.5	5206.524
19	2.5	4921.899
20	2.5	4921.899
21	8	4180.431
22	2	4992.306
23	3	4851.993
24	.5	5206.524
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 72.65625 Std. Dev.: 129.9230

Upper 95% confidence limit on mean: 127.5270 Representative Concentration: 127.5270

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Toluene
Enter Matrix: Current Monitoring Wells Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	4.5	2.573351
2	3	9.635851
3	2.5	12.99002
4	.5	31.40668
5	2.5	12.99002
6	16.5	108.0734
7	2.5	12.99002
8	12.5	40.90668
9	2.5	12.99002
10	62.5	3180.490
11	2.5	12.99002
12	12.5	40.90668
13	2.5	12.99002
14	.5	31.40668
15	1	26.05252
16	2.5	12.99002
17	.5	31.40668
18	2.5	12.99002
19	2.5	12.99002
20	2.5	12.99002
21	.5	31.40668
22	2.5	12.99002
23	.5	31.40668
24	4	4.427517
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 6.104167 Std. Dev.: 12.70568

Upper 95% confidence limit on mean: 11.47019 Representative Concentration: 11.47019

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: 1,1,1-Trichloroethane
Enter Matrix: Current Monitoring Wells Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	1	36.37598
2	.5	42.65723
3	5	4.125977
4	4	9.188477
5	1.5	30.59473
6	16.5	89.65723
7	5	4.125977
8	12.5	29.90723
9	.25	45.98535
10	62.5	3076.782
11	4	9.188477
12	12.5	29.90723
13	9.5	6.094727
14	10	8.813477
15	1	36.37598
16	2.5	20.53223
17	.5	42.65723
18	.5	42.65723
19	2.5	20.53223
20	1.5	30.59473
21	2	25.31348
22	8	.9384766
23	5	4.125977
24	.5	42.65723
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 7.03125 Std. Dev.: 12.66592

Upper 95% confidence limit on mean: 12.38049 Representative Concentration: 12.38049

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Trichloroethene
Enter Matrix: Current Monitoring Wells Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	6	48200.37
2	3	49526.65
3	14	44751.64
4	16	43909.46
5	155	4976.715
6	220	30.75627
7	150	5707.173
8	190	1263.506
9	2100	3513578.
10	2050	3328633.
11	150	5707.173
12	280	2965.256
13	.75	50533.17
14	2	49972.74
15	43	33322.98
16	.5	50645.63
17	.5	50645.63
18	.35	50713.16
19	2.5	49749.44
20	13	45175.73
21	14	44751.64
22	1	50420.83
23	1	50420.83
24	.5	50645.63
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 225.5458 Std. Dev.: 575.8263

Upper 95% confidence limit on mean: 468.7362 Representative Concentration: 468.7362

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Trichlorofluoromethane
Enter Matrix: Current Monitoring Wells Sites 1, 2, 3

Enter number of samples: 11
Degrees of Freedom: 10

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	2.5	90.25
2	2.5	90.25
3	1.5	110.25
4	10	4
5	91	6241
6	12	0
7	2.5	90.25
8	2.5	90.25
9	2.5	90.25
10	2.5	90.25
11	2.5	90.25
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 12 Std. Dev.: 26.43293

Upper 95% confidence limit on mean: 29.75678 Representative Concentration: 29.75678

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Vinyl chloride
Enter Matrix: Current Monitoring Wells Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	3.835069
2	.5	41.71007
3	5	3.835069
4	.5	41.71007
5	1.5	29.79340
6	16.5	91.04340
7	5	3.835069
8	12.5	30.71007
9	5	3.835069
10	62.5	3084.877
11	5	3.835069
12	12.5	30.71007
13	5	3.835069
14	.5	41.71007
15	1	35.50174
16	5	3.835069
17	.5	41.71007
18	5	3.835069
19	2.5	19.87674
20	5	3.835069
21	5	3.835069
22	5	3.835069
23	.5	41.71007
24	.5	41.71007
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 6.958333 Std. Dev.: 12.53683

Upper 95% confidence limit on mean: 12.25305 Representative Concentration: 12.25305

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Xylenes
Enter Matrix: Current Monitoring Wells Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	2.5	10.5625
2	.5	27.5625
3	2.5	10.5625
4	.5	27.5625
5	2.5	10.5625
6	16.5	115.5625
7	2	14.0625
8	12.5	45.5625
9	2.5	10.5625
10	62.5	3220.563
11	2.5	10.5625
12	12.5	45.5625
13	2.5	10.5625
14	.5	27.5625
15	1	22.5625
16	2.5	10.5625
17	.5	27.5625
18	2.5	10.5625
19	2.5	10.5625
20	2.5	10.5625
21	.5	27.5625
22	2.5	10.5625
23	.5	27.5625
24	.5	27.5625
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 5.75 Std. Dev.: 12.80795

Upper 95% confidence limit on mean: 11.15922 Representative Concentration: 11.15922

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Aluminum
Enter Matrix: Unfiltered Groundwater, Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	500	1.3791e8
2	56	1.4854e8
3	4100	66320155
4	16200	15652161
5	500	1.3791e8
6	158000	2.124e10
7	500	1.3791e8
8	1615	1.1297e8
9	6600	31851561
10	4085.75	66552434
11	500	1.3791e8
12	1210	1.2174e8
13	7400	23461611
14	33300	4.4337e8
15	37.5	1.4899e8
16	500	1.3791e8
17	854	1.2973e8
18	24200	1.4295e8
19	9860	5682115.
20	7000	27496586
21	9990	5079248.
22	6600	31851561
23	211.5	1.4477e8
24	29.5	1.4919e8
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 12243.72 Std. Dev.: 32134.68

Upper 95% confidence limit on mean: 25815.25 Representative Concentration: 25815.25

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Arsenic
Enter Matrix: Unfiltered Groundwater, Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	2	8.580017
2	1	15.43835
3	1	15.43835
4	9.6	21.81668
5	1	15.43835
6	67.5	3915.109
7	1	15.43835
8	3.7	1.510851
9	1	15.43835
10	4.5	.1841840
11	1	15.43835
12	1	15.43835
13	1	15.43835
14	9.8	23.72502
15	1	15.43835
16	1	15.43835
17	1	15.43835
18	1	15.43835
19	4.2	.5316840
20	1	15.43835
21	1	15.43835
22	1	15.43835
23	1	15.43835
24	1	15.43835
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 4.929167 Std. Dev.: 13.56772

Upper 95% confidence limit on mean: 10.65926

Representative Concentration: 10.65926

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Barium
Enter Matrix: Unfiltered Groundwater, Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	250	58463.21
2	224	71712.38
3	550	3388.210
4	4620	17042104
5	250	58463.21
6	1040	300532.4
7	250	58463.21
8	123.5	135638.8
9	250	58463.21
10	247.5	59678.42
11	250	58463.21
12	146	119571.9
13	250	58463.21
14	583	8318.960
15	47	197839.6
16	250	58463.21
17	56	189914.4
18	450	1746.543
19	486	33.54340
20	250	58463.21
21	219	74415.29
22	450	1746.543
23	337	23960.46
24	224	71712.38
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 491.7917 Std. Dev.: 903.3758

Upper 95% confidence limit on mean: 873.3169 Representative Concentration: 873.3169

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Cadmium
Enter Matrix: Unfiltered Groundwater, Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	1	21.77778
2	1.5	17.36111
3	1	21.77778
4	6	.1111111
5	1	21.77778
6	33	747.1111
7	1	21.77778
8	5.75	.0069444
9	1	21.77778
10	32.25	706.6736
11	1	21.77778
12	4	2.777778
13	1	21.77778
14	1.5	17.36111
15	1.5	17.36111
16	6	.1111111
17	3.5	4.694444
18	22	266.7778
19	4.5	1.361111
20	1	21.77778
21	2.5	10.02778
22	1	21.77778
23	1.5	17.36111
24	1.5	17.36111
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 5.666667 Std. Dev.: 9.377258

Upper 95% confidence limit on mean: 9.626991 Representative Concentration: 9.626991

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Calcium
Enter Matrix: Unfiltered Groundwater, Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	17500	9.4851e8
2	37400	1.1876e8
3	28500	3.9196e8
4	52700	19378338
5	47500	636671.0
6	141000	8.5937e9
7	25000	5.4279e8
8	57950	93162713
9	90000	1.7391e9
10	158400	1.212e10
11	35000	1.7683e8
12	58500	1.0408e8
13	17500	9.4851e8
14	46900	1954171.
15	47000	1684588.
16	25000	5.4279e8
17	54600	39716254
18	38000	1.0605e8
19	49800	2256254.
20	17000	9.7956e8
21	40400	62377088
22	4500	1.9183e9
23	38100	1.0400e8
24	30900	3.0269e8
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 48297.92 Std. Dev.: 36032.09

Upper 95% confidence limit on mean: 63515.45 Representative Concentration: 63515.45

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Chromium
Enter Matrix: Unfiltered Groundwater, Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	1	811.0629
2	3.5	674.9171
3	4	649.1879
4	23.5	35.75043
5	1	811.0629
6	76	2164.188
7	11	341.4796
8	61	993.5629
9	14	239.6046
10	13.5	255.3338
11	6	551.2713
12	12.5	288.2921
13	2.5	727.8754
14	8.5	440.1254
15	23.5	35.75043
16	46	272.9379
17	60	931.5213
18	220	36298.19
19	76	2164.188
20	9	419.3963
21	18.5	120.5421
22	7	505.3129
23	5.5	575.0004
24	4	649.1879
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 29.47917 Std. Dev.: 47.06875

Upper 95% confidence limit on mean: 49.35785

Representative Concentration: 49.35785

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Cobalt
Enter Matrix: Unfiltered Groundwater, Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	1	133.4506
2	3	91.24230
3	18	29.67980
4	118	11119.26
5	1	133.4506
6	44	988.9715
7	1	133.4506
8	4.5	64.83605
9	4	73.13813
10	5.75	46.26834
11	2	111.3465
12	3.5	81.94021
13	2.5	101.0444
14	5.5	49.73188
15	4.5	64.83605
16	15	5.992296
17	6.5	36.62771
18	23	109.1590
19	8.5	16.41938
20	4	73.13813
21	5.5	49.73188
22	10	6.513129
23	7.5	25.52355
24	3	91.24230
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 12.55208 Std. Dev.: 24.34980

Upper 95% confidence limit on mean: 22.83581

Representative Concentration: 22.83581

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Copper
Enter Matrix: Unfiltered Groundwater, Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	12.5	6816.566
2	2	8660.629
3	67.5	759.6914
4	1660	2449029.
5	12.5	6816.566
6	109	194.2539
7	12.5	6816.566
8	30.5	4168.316
9	12.5	6816.566
10	43	2710.504
11	12.5	6816.566
12	9.5	7320.941
13	12.5	6816.566
14	90	25.62891
15	2.5	8567.816
16	12.5	6816.566
17	12	6899.379
18	57.5	1410.941
19	42	2815.629
20	12.5	6816.566
21	36	3488.379
22	12.5	6816.566
23	5.5	8021.441
24	2	8660.629
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 95.0625 Std. Dev.: 334.5394

Upper 95% confidence limit on mean: 236.3495 Representative Concentration: 236.3495

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Iron
Enter Matrix: Unfiltered Groundwater, Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	105	7.8205e8
2	69	7.8407e8
3	6000	4.8709e8
4	26400	2789457.
5	210	7.7619e8
6	113000	7.2131e9
7	17000	1.2255e8
8	57850	8.8684e8
9	35000	48022590
10	126280	9.6452e9
11	13000	2.2711e8
12	30600	6400057.
13	4800	5.4150e8
14	18200	97420190
15	7010	4.4353e8
16	36000	62882257
17	24900	10049957
18	62000	1.1512e9
19	31700	13175690
20	5000	5.3223e8
21	13800	2.0364e8
22	33000	24303257
23	7430	4.2602e8
24	4330	5.6360e8
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 28070.17 Std. Dev.: 33002.59

Upper 95% confidence limit on mean: 42008.24

Representative Concentration: 42008.24

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Lead
Enter Matrix: Unfiltered Groundwater, Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	1	2284.641
2	1.8	2208.804
3	23	665.5325
4	233	33930.41
5	1	2284.641
6	325	76287.59
7	1	2284.641
8	15.1	1135.550
9	50	1.445004
10	221.35	29774.22
11	1.5	2237.093
12	11.3	1406.094
13	2.5	2143.497
14	98	2420.845
15	1.2	2265.562
16	3	2097.449
17	25.8	528.9042
18	82	1102.378
19	36.5	151.2388
20	3	2097.449
21	7.4	1713.788
22	6.5	1789.114
23	15.2	1128.820
24	5	1918.258
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 48.79792 Std. Dev.: 86.94275

Upper 95% confidence limit on mean: 85.51670

Representative Concentration: 85.51670

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Magnesium
Enter Matrix: Unfiltered Groundwater, Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	8500	1.0271e8
2	13300	28457779
3	14000	21479363
4	25200	43104696
5	11500	50902279
6	68500	2.4866e9
7	9500	83440613
8	16950	2037821.
9	10000	74556029
10	39200	4.2294e8
11	10500	66171446
12	17600	1070363.
13	23000	19056863
14	28000	87711029
15	20400	3116696.
16	8500	1.0271e8
17	16800	3365696.
18	13000	31748529
19	24400	33240029
20	10500	66171446
21	17800	696529.3
22	11500	50902279
23	19500	748946.0
24	9080	91290063
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 18634.58 Std. Dev.: 12979.89

Upper 95% confidence limit on mean: 24116.42 Representative Concentration: 24116.42

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Manganese
Enter Matrix: Unfiltered Groundwater, Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	50	6815472.
2	307	5539649.
3	4000	1793870.
4	32100	8.6668e8
5	50	6815472.
6	3870	1462538.
7	400	5110520.
8	750.5	3648657.
9	460	4842842.
10	1535	1267079.
11	450	4886955.
12	633	4111348.
13	235	5883758.
14	615	4184667.
15	85	6633951.
16	1500	1347099.
17	2000	436452.9
18	7000	18829995
19	4910	5059594.
20	700	3844132.
21	1210	2104373.
22	870	3206413.
23	72	6701087.
24	53	6799817.
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 2660.646 Std. Dev.: 6520.874

Upper 95% confidence limit on mean: 5414.625 Representative Concentration: 5414.625

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Mercury
Enter Matrix: Unfiltered Groundwater, Sites 1, 2, 3

Enter number of samples: 21
Degrees of Freedom: 20

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	.1	.0025961
2	.1	.0025961
3	.1	.0025961
4	.67	.2694104
5	.1	.0025961
6	.1	.0025961
7	.1	.0025961
8	.1	.0025961
9	.1	.0025961
10	.1	.0025961
11	.1	.0025961
12	.1	.0025961
13	.1	.0025961
14	.4	.0620247
15	.1	.0025961
16	.1	.0025961
17	.3	.0222152
18	.1	.0025961
19	.1	.0025961
20	.1	.0025961
21	.1	.0025961
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: .1509524 Std. Dev.: .1414887

Upper 95% confidence limit on mean: .2153584 Representative Concentration: .2153584

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Nickel
Enter Matrix: Unfiltered Groundwater, Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	543.4727
2	8.5	392.5352
3	5	543.4727
4	111	6837.223
5	5	543.4727
6	121	8590.973
7	5	543.4727
8	16.75	133.6914
9	5	543.4727
10	15.25	170.6289
11	10	335.3477
12	13	234.4727
13	5	543.4727
14	8.5	392.5352
15	26	5.347656
16	60	1004.098
17	105	5880.973
18	60	1004.098
19	40	136.5977
20	5	543.4727
21	12.5	250.0352
22	20	69.09766
23	8.5	392.5352
24	8.5	392.5352
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 28.3125 Std. Dev.: 36.13202

Upper 95% confidence limit on mean: 43.57224

Representative Concentration: 43.57224

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Potassium
Enter Matrix: Unfiltered Groundwater, Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	600	2273184.
2	1770	114046.9
3	1500	369309.4
4	3560	2109151.
5	675	2052653.
6	9110	49032089
7	550	2426455.
8	1305	644340.7
9	1000	1227018.
10	2370	68796.92
11	3000	796184.4
12	1280	685101.1
13	1000	1227018.
14	2260	23192.75
15	3030	850621.9
16	1500	369309.4
17	3360	1568234.
18	2000	11601.09
19	3220	1237193.
20	1500	369309.4
21	2980	760892.8
22	1000	1227018.
23	1030	1161455.
24	985	1260474.
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 2107.708 Std. Dev.: 1767.640

Upper 95% confidence limit on mean: 2854.241 Representative Concentration: 2854.241

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Silver
Enter Matrix: Unfiltered Groundwater, Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	1	8.506944
2	5	1.173611
3	1	8.506944
4	20	258.6736
5	1	8.506944
6	5	1.173611
7	1	8.506944
8	5	1.173611
9	1	8.506944
10	5	1.173611
11	1	8.506944
12	5	1.173611
13	1	8.506944
14	5	1.173611
15	5	1.173611
16	1	8.506944
17	5	1.173611
18	4	.0069444
19	5	1.173611
20	1	8.506944
21	5	1.173611
22	1	8.506944
23	5	1.173611
24	5	1.173611
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 3.916667 Std. Dev.: 3.944359

Upper 95% confidence limit on mean: 5.582499 Representative Concentration: 5.582499

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Sodium
Enter Matrix: Unfiltered Groundwater, Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5000	1.3841e8
2	11100	32087504
3	7500	85832504
4	13900	8205838.
5	13500	10657504
6	42500	6.6231e8
7	10000	45759588
8	19400	6945421.
9	7000	95347088
10	34900	3.2889e8
11	20500	13953338
12	18700	3745838.
13	7250	90527296
14	16200	318754.3
15	31400	2.1420e8
16	1500	2.3301e8
17	29000	1.4971e8
18	12000	22701254
19	31300	2.1128e8
20	14000	7642921.
21	24900	66185004
22	7000	95347088
23	12900	14935004
24	10900	34393338
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 16764.58 Std. Dev.: 10575.57

Upper 95% confidence limit on mean: 21230.99

Representative Concentration: 21230.99

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Thallium
Enter Matrix: Unfiltered Groundwater, Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	1	.0025
2	1	.0025
3	1	.0025
4	1	.0025
5	1	.0025
6	1	.0025
7	1	.0025
8	1	.0025
9	1	.0025
10	1	.0025
11	2	.9025
12	1	.0025
13	1	.0025
14	1	.0025
15	1	.0025
16	1	.0025
17	1	.0025
18	1	.0025
19	1.2	.0225
20	1	.0025
21	1	.0025
22	1	.0025
23	1	.0025
24	1	.0025
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 1.05 Std. Dev.: .2064187

Upper 95% confidence limit on mean: 1.137177 Representative Concentration: 1.137177

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Vanadium
Enter Matrix: Unfiltered Groundwater, Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	96.69444
2	2.5	152.1111
3	5	96.69444
4	53	1456.694
5	5	96.69444
6	101	7424.694
7	5	96.69444
8	8.75	37.00694
9	5	96.69444
10	46.25	987.0069
11	5	96.69444
12	5.5	87.11111
13	5	96.69444
14	14	.6944444
15	2.5	152.1111
16	5	96.69444
17	3.5	128.4444
18	30	230.0278
19	22	51.36111
20	5	96.69444
21	12	8.027778
22	5	96.69444
23	2.5	152.1111
24	2.5	152.1111
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 14.83333 Std. Dev.: 22.82872

Upper 95% confidence limit on mean: 24.47465

Representative Concentration: 24.47465

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Zinc
Enter Matrix: Unfiltered Groundwater, Sites 1, 2, 3

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	10	49274.75
2	8	50166.67
3	55	31321.63
4	1010	605316.4
5	20	44935.17
6	516	80667.83
7	15	47079.96
8	70	26237.25
9	75	24642.46
10	581.5	122164.8
11	445	45377.88
12	1660	2039244.
13	50	33116.42
14	156	5772.834
15	6	51066.58
16	90	20158.08
17	68	26889.17
18	530	88816.42
19	135	9404.959
20	15	47079.96
21	15.5	46863.23
22	10	49274.75
23	22	44091.25
24	4.5	51746.77
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 231.9792 Std. Dev.: 397.8589

Upper 95% confidence limit on mean: 400.0080

Representative Concentration: 400.0080

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Barium
Enter Matrix: Filtered Groundwater, Sites 1, 2, 3

Enter number of samples: 13
Degrees of Freedom: 12

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	221	5458.936
2	251	10792.01
3	60	7589.090
4	93.5	2874.609
5	29	13951.24
6	81	4371.244
7	193	2105.398
8	38	11906.17
9	41	11260.47
10	343	38370.78
11	92	3037.706
12	271	15347.40
13	199	2692.013
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Aritb. Mean: 147.1154 Std. Dev.: 103.9860

Upper 95% confidence limit on mean: 209.9589

Representative Concentration: 209.9589

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Calcium
Enter Matrix: Filtered Groundwater, Sites 1, 2, 3

Enter number of samples: 13
Degrees of Freedom: 12

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	38700	46344675
2	45800	85443.79
3	54100	73827751
4	54900	88215444
5	49300	14381598
6	60700	2.3081e8
7	33000	1.5644e8
8	47100	2535444.
9	55800	1.0593e8
10	45800	85443.79
11	40900	21230828
12	34900	1.1252e8
13	30600	2.2224e8
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 45507.69 Std. Dev.: 9463.303

Upper 95% confidence limit on mean: 51226.80 Representative Concentration: 51226.80

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Chromium
Enter Matrix: Filtered Groundwater, Sites 1, 2, 3

Enter number of samples: 13
Degrees of Freedom: 12

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	2.5	5.504438
2	2.5	5.504438
3	2.5	5.504438
4	2.5	5.504438
5	3	3.408284
6	2.5	5.504438
7	3.5	1.812130
8	31	684.0237
9	2.5	5.504438
10	2.5	5.504438
11	2.5	5.504438
12	3	3.408284
13	2.5	5.504438
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 4.846154 Std. Dev.: 7.864436

Upper 95% confidence limit on mean: 9.598993 Representative Concentration: 9.598993

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Iron
Enter Matrix: Filtered Groundwater, Sites 1, 2, 3

Enter number of samples: 13
Degrees of Freedom: 12

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	763237.4
2	5	763237.4
3	20	737253.4
4	3860	8888540.
5	7.25	759311.1
6	1820	886168.8
7	32	716790.2
8	5	763237.4
9	486	154161.9
10	4840	15692416
11	5	763237.4
12	300	334818.0
13	37	708348.8
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 878.6346 Std. Dev.: 1631.225

Upper 95% confidence limit on mean: 1864.459

Representative Concentration: 1864.459

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Lead
Enter Matrix: Filtered Groundwater, Sites 1, 2, 3

Enter number of samples: 13
Degrees of Freedom: 12

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	.5	.3462870
2	.5	.3462870
3	.5	.3462870
4	.5	.3462870
5	2.05	.9245562
6	.5	.3462870
7	1	.0078254
8	.5	.3462870
9	.5	.3462870
10	5	15.30013
11	.5	.3462870
12	.5	.3462870
13	1.6	.2616716
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 1.088462 Std. Dev.: 1.278370

Upper 95% confidence limit on mean: 1.861039

Representative Concentration: 1.861039

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Magnesium
Enter Matrix: Filtered Groundwater, Sites 1, 2, 3

Enter number of samples: 13
Degrees of Freedom: 12

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	13100	14970947
2	20800	14674793
3	15700	1610947.
4	16200	591716.0
5	21950	24808062
6	17800	690177.5
7	14800	4705562.
8	19800	8013254.
9	16300	447869.8
10	20900	15450947
11	16100	755562.1
12	18400	2047101.
13	8750	67555754
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 16969.23 Std. Dev.: 3609.278

Upper 95% confidence limit on mean: 19150.48

Representative Concentration: 19150.48

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Manganese
Enter Matrix: Filtered Groundwater, Sites 1, 2, 3

Enter number of samples: 13
Degrees of Freedom: 12

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	74	277040.3
2	43	310634.7
3	636	1271.197
4	385.5	46158.87
5	29	326436.4
6	286	98813.50
7	31	324155.0
8	71	280207.4
9	1750	1321704.
10	4190	12885615
11	243	127696.3
12	26	329873.5
13	40	313987.8
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 600.3462 Std. Dev.: 1177.695

Upper 95% confidence limit on mean: 1312.081

Representative Concentration: 1312.081

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Potassium
Enter Matrix: Filtered Groundwater, Sites 1, 2, 3

Enter number of samples: 13
Degrees of Freedom: 12

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	1320	60743.29
2	1055	261592.9
3	2150	340517.1
4	944	387458.4
5	1760	37457.14
6	1090	227015.6
7	832	539433.8
8	2880	1725383.
9	3360	3216780.
10	1015	304109.8
11	2340	598361.8
12	723	711427.4
13	895	450860.6
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 1566.462 Std. Dev.: 859.3186

Upper 95% confidence limit on mean: 2085.787 Representative Concentration: 2085.787

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Sodium
Enter Matrix: Filtered Groundwater, Sites 1, 2, 3

Enter number of samples: 13
Degrees of Freedom: 12

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	11300	1.1664e8
2	13300	77440000
3	40300	3.3124e8
4	17950	17222500
5	32550	1.0920e8
6	19100	9000000
7	14100	64000000
8	29500	54760000
9	31900	96040000
10	30700	73960000
11	24400	5290000
12	11800	1.0609e8
13	10400	1.3689e8
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 22100 Std. Dev.: 9990.725

Upper 95% confidence limit on mean: 28137.85 Representative Concentration: 28137.85

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Vanadium
Enter Matrix: Filtered Groundwater, Sites 1, 2, 3

Enter number of samples: 13
Degrees of Freedom: 12

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	2.5	.0946746
2	6	10.19083
3	2.5	.0946746
4	2.5	.0946746
5	2.5	.0946746
6	2.5	.0946746
7	3	.0369822
8	2.5	.0946746
9	2.5	.0946746
10	2.5	.0946746
11	2.5	.0946746
12	2.5	.0946746
13	2.5	.0946746
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 2.807692 Std. Dev.: .9690730

Upper 95% confidence limit on mean: 3.393348

Representative Concentration: 3.393348

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Zinc
Enter Matrix: Filtered Groundwater, Sites 1, 2, 3

Enter number of samples: 13
Degrees of Freedom: 12

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	3	310.3018
2	2	346.5325
3	2	346.5325
4	2.5	328.1672
5	2	346.5325
6	174	23526.84
7	10	112.6864
8	20	.3786982
9	29	70.30178
10	7	185.3787
11	5	243.8402
12	5.5	228.4749
13	6	213.6095
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 20.61538 Std. Dev.: 46.77925

Upper 95% confidence limit on mean: 48.88623

Representative Concentration: 48.88623

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Carbon tetrachloride
Enter Matrix: Current Monitoring Wells Sites 5, 6, 7

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	2.5	1.557296
2	.5	.5656293
3	2.5	1.557296
4	.5	.5656293
5	2.5	1.557296
6	.5	.5656293
7	.3	.9064627
8	.5	.5656293
9	1	.0635460
10	2	.5593793
11	.75	.2520877
12	.5	.5656293
13	.5	.5656293
14	.5	.5656293
15	2.5	1.557296
16	.5	.5656293
17	2.5	1.557296
18	.5	.5656293
19	2.5	1.557296
20	.5	.5656293
21	2.5	1.557296
22	.5	.5656293
23	2.5	1.557296
24	.5	.5656293
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 1.252083 Std. Dev.: .9561562

Upper 95% confidence limit on mean: 1.655899

Representative Concentration: 1.655899

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Chloroform
Enter Matrix: Current Monitoring Wells Sites 5, 6, 7

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	.5	.3282335
2	.75	.1042752
3	.2	.7619835
4	.5	.3282335
5	2.5	2.036567
6	.5	.3282335
7	.5	.3282335
8	.5	.3282335
9	1	.0053168
10	2	.8594835
11	.3	.5974002
12	.5	.3282335
13	.5	.3282335
14	.5	.3282335
15	2.5	2.036567
16	.5	.3282335
17	2.5	2.036567
18	.5	.3282335
19	2.5	2.036567
20	.5	.3282335
21	2.5	2.036567
22	.5	.3282335
23	2.5	2.036567
24	.5	.3282335
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 1.072917 Std. Dev.: .9044551

Upper 95% confidence limit on mean: 1.454898 Representative Concentration: 1.454898

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Chloromethane
Enter Matrix: Current Monitoring Wells Sites 5, 6, 7

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	5.640625
2	.5	4.515625
3	5	5.640625
4	.5	4.515625
5	5	5.640625
6	.5	4.515625
7	5	5.640625
8	.5	4.515625
9	5	5.640625
10	2	.390625
11	5	5.640625
12	.5	4.515625
13	.5	4.515625
14	.5	4.515625
15	5	5.640625
16	.5	4.515625
17	5	5.640625
18	.5	4.515625
19	5	5.640625
20	.5	4.515625
21	5	5.640625
22	.5	4.515625
23	5	5.640625
24	.5	4.515625
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 2.625 Std. Dev.: 2.251811

Upper 95% confidence limit on mean: 3.576014

Representative Concentration: 3.576014

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: cis-1,2-Dichloroethene
Enter Matrix: Current Monitoring Wells Sites 5, 6, 7

Enter number of samples: 13
Degrees of Freedom: 12

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	2.5	1.331361
2	.5	.7159763
3	.5	.7159763
4	8	44.27367
5	.5	.7159763
6	2	.4275148
7	.5	.7159763
8	.5	.7159763
9	.5	.7159763
10	.5	.7159763
11	.5	.7159763
12	.5	.7159763
13	.5	.7159763
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 1.346154 Std. Dev.: 2.105396

Upper 95% confidence limit on mean: 2.618541

Representative Concentration: 2.618541

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: 1,2-Dichloroethene
Enter Matrix: Current Monitoring Wells Sites 5, 6, 7

Enter number of samples: 11
Degrees of Freedom: 10

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	2	.8264463
2	3	.0082645
3	2.5	.1673554
4	7	16.73554
5	2.5	.1673554
6	2	.8264463
7	2.5	.1673554
8	3	.0082645
9	2.5	.1673554
10	2.5	.1673554
11	2.5	.1673554
12		0
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 2.909091 Std. Dev.: 1.393165

Upper 95% confidence limit on mean: 3.844974 Representative Concentration: 3.844974

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Di-ethyl phthalate
Enter Matrix: Current Monitoring Wells Sites 5, 6, 7

Enter number of samples: 12
Degrees of Freedom: 11

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	2.054444
2	.2	11.33444
3	5	2.054444
4	5	2.054444
5	5	2.054444
6	5	2.054444
7	5	2.054444
8	.2	11.33444
9	5	2.054444
10	2	2.454444
11	.4	10.02778
12	5	2.054444
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 3.566667 Std. Dev.: 2.165571

Upper 95% confidence limit on mean: 4.942614 Representative Concentration: 4.942614

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Di-n-octyl phthalate
Enter Matrix: Current Monitoring Wells Sites 5, 6, 7

Enter number of samples: 12
Degrees of Freedom: 11

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	2.25
2	.9	6.76
3	5	2.25
4	5	2.25
5	.2	10.89
6	5	2.25
7	5	2.25
8	.6	8.41
9	5	2.25
10	5	2.25
11	.3	10.24
12	5	2.25
13		0
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 3.5 Std. Dev.: 2.221793

Upper 95% confidence limit on mean: 4.911669

Representative Concentration: 4.911669

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Tetrachloroethene
Enter Matrix: Current Monitoring Wells Sites 5, 6, 7

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	1	.0937891
2	3	2.868789
3	1.5	.0375391
4	.5	.6500391
5	2.5	1.425039
6	.5	.6500391
7	2.5	1.425039
8	.5	.6500391
9	2.5	1.425039
10	.5	.6500391
11	4	7.256289
12	.5	.6500391
13	.5	.6500391
14	.5	.6500391
15	.35	.9144141
16	.5	.6500391
17	.5	.6500391
18	.5	.6500391
19	2.5	1.425039
20	.5	.6500391
21	2.5	1.425039
22	.5	.6500391
23	2.5	1.425039
24	.5	.6500391
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 1.30625 Std. Dev.: 1.106730

Upper 95% confidence limit on mean: 1.773658

Representative Concentration: 1.773658

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Toluene
Enter Matrix: Current Monitoring Wells Sites 5, 6, 7

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	2.5	.4726563
2	1	.6601563
3	2.5	.4726563
4	2	.0351563
5	2.5	.4726563
6	1	.6601563
7	2.5	.4726563
8	.5	1.722656
9	2.5	.4726563
10	.5	1.722656
11	2.5	.4726563
12	.5	1.722656
13	2	.0351563
14	.5	1.722656
15	2.5	.4726563
16	6	17.53516
17	2.5	.4726563
18	.5	1.722656
19	2.5	.4726563
20	.5	1.722656
21	2.5	.4726563
22	.5	1.722656
23	2.5	.4726563
24	.5	1.722656
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 1.8125 Std. Dev.: 1.283783

Upper 95% confidence limit on mean: 2.354684

Representative Concentration: 2.354684

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: 1,1,1-Trichloroethane
Enter Matrix: Current Monitoring Wells Sites 5, 6, 7

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	2.5	1.128906
2	.5	.8789063
3	2.5	1.128906
4	.5	.8789063
5	2.5	1.128906
6	.5	.8789063
7	2.5	1.128906
8	.5	.8789063
9	2.5	1.128906
10	.5	.8789063
11	2.5	1.128906
12	.5	.8789063
13	.5	.8789063
14	.5	.8789063
15	2.5	1.128906
16	.5	.8789063
17	2.5	1.128906
18	.5	.8789063
19	2.5	1.128906
20	.5	.8789063
21	2.5	1.128906
22	.5	.8789063
23	2.5	1.128906
24	1	.1914063
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 1.4375 Std. Dev.: 1.003391

Upper 95% confidence limit on mean: 1.861265 Representative Concentration: 1.861265

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Trichloroethene
Enter Matrix: Current Monitoring Wells Sites 5, 6, 7

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	6	8.875434
2	7	15.83377
3	.5	6.354601
4	1	4.083767
5	2.5	.2712674
6	.5	6.354601
7	8	24.79210
8	13	99.58377
9	1	4.083767
10	4	.9587674
11	7	15.83377
12	6	8.875434
13	.5	6.354601
14	.5	6.354601
15	2.5	.2712674
16	.5	6.354601
17	2.5	.2712674
18	.5	6.354601
19	2.5	.2712674
20	.5	6.354601
21	2.5	.2712674
22	.5	6.354601
23	2.5	.2712674
24	.5	6.354601
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 3.020833 Std. Dev.: 3.241977

Upper 95% confidence limit on mean: 4.390027

Representative Concentration: 4.390027

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Aluminum
Enter Matrix: Unfiltered Groundwater. Sites 5, 6, 7

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	3700	3216680.
2	273.25	27251119
3	29000	5.5256e8
4	3540	3816203.
5	1500	15948125
6	2720	7692360.
7	500	24935146
8	4720	598318.4
9	500	24935146
10	66.5	29452442
11	1000	20191636
12	7900	5791192.
13	976	20407900
14	42000	1.3327e9
15	2000	12204615
16	2040	11926734
17	11900	41043109
18	29.5	29855410
19	6600	1224319.
20	3190	5306160.
21	5000	243552.5
22	1530	15709415
23	500	24935146
24	659	23372491
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 5493.510 Std. Dev.: 9858.424

Upper 95% confidence limit on mean: 9657.047 Representative Concentration: 9657.047

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Arsenic
Enter Matrix: Unfiltered Groundwater. Sites 5, 6, 7

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	1	1.657656
2	1	1.657656
3	12	94.33266
4	6.5	17.74516
5	3	.5076563
6	1	1.657656
7	1	1.657656
8	3.1	.6601563
9	5	7.357656
10	1	1.657656
11	1	1.657656
12	2.2	.0076563
13	1	1.657656
14	2.4	.0126563
15	1	1.657656
16	1	1.657656
17	1	1.657656
18	1	1.657656
19	1	1.657656
20	1	1.657656
21	1	1.657656
22	2	.0826563
23	1	1.657656
24	3.7	1.995156
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 2.2875 Std. Dev.: 2.532967

Upper 95% confidence limit on mean: 3.357255

Representative Concentration: 3.357255

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Barium
Enter Matrix: Unfiltered Groundwater, Sites 5, 6, 7

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	450	23161.04
2	739.5	195087.8
3	500	40879.79
4	127	29176.91
5	250	2286.035
6	184	12953.29
7	300	4.785156
8	368	4926.285
9	300	4.785156
10	338	1615.035
11	300	4.785156
12	432	18006.29
13	98	39925.04
14	969	450492.7
15	300	4.785156
16	94	41539.54
17	250	2286.035
18	75	49645.41
19	300	4.785156
20	75	49645.41
21	250	2286.035
22	111	34898.91
23	250	2286.035
24	87	44441.91
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 297.8125 Std. Dev.: 213.2118

Upper 95% confidence limit on mean: 387.8589 Representative Concentration: 387.8589

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Cadmium
Enter Matrix: Unfiltered Groundwater, Sites 5, 6, 7

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	1	.5316840
2	1.5	.0525174
3	1	.5316840
4	1.5	.0525174
5	1	.5316840
6	1.5	.0525174
7	1	.5316840
8	1.5	.0525174
9	1	.5316840
10	1.5	.0525174
11	1	.5316840
12	1.5	.0525174
13	1.5	.0525174
14	5	10.69835
15	1	.5316840
16	1.5	.0525174
17	2	.0733507
18	2	.0733507
19	1	.5316840
20	1.5	.0525174
21	1	.5316840
22	2.5	.5941840
23	1	.5316840
24	6.5	22.76085
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 1.729167 Std. Dev.: 1.318589

Upper 95% confidence limit on mean: 2.286050

Representative Concentration: 2.286050

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Calcium
Enter Matrix: Unfiltered Groundwater, Sites 5, 6, 7

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	35500	70700069
2	70800	1.9104e9
3	18500	73816736
4	25600	2225069.
5	16000	1.2303e8
6	27200	11736.11
7	22500	21083403
8	45400	3.3520e8
9	26000	1191736.
10	66100	1.5217e9
11	25500	2533403.
12	35500	70700069
13	11200	2.5255e8
14	33100	36100069
15	20000	50291736
16	21100	35900069
17	9000	3.2731e8
18	20300	46126736
19	18000	82658403
20	27200	11736.11
21	14500	1.5855e8
22	34600	56375069
23	8500	3.4565e8
24	18100	80850069
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 27091.67 Std. Dev.: 15610.64

Upper 95% confidence limit on mean: 33684.55

Representative Concentration: 33684.55

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Chromium
Enter Matrix: Unfiltered Groundwater, Sites 5, 6, 7

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	1.5	111.1267
2	5	49.58507
3	8	16.33507
4	5.5	42.79340
5	1	121.9184
6	3.5	72.96007
7	1	121.9184
8	3	81.75174
9	1	121.9184
10	2.5	91.04340
11	1	121.9184
12	7	25.41840
13	7.5	20.62674
14	65	2804.585
15	15	8.751736
16	11	1.085069
17	18	35.50174
18	6	36.50174
19	8	16.33507
20	6.5	30.71007
21	4	64.66840
22	9	9.251736
23	32	398.3351
24	67	3020.418
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 12.04167 Std. Dev.: 17.96792

Upper 95% confidence limit on mean: 19.63011 Representative Concentration: 19.63011

JPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Cobalt
Enter Matrix: Unfiltered Groundwater. Sites 5, 6, 7

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	6	42.38553
2	7.25	27.67198
3	120	11554.01
4	13	.2396918
5	1	132.4897
6	3	90.44803
7	10	6.302192
8	3	90.44803
9	1	132.4897
10	3	90.44803
11	1	132.4897
12	4.5	64.16678
13	3	90.44803
14	56	1891.344
15	13	.2396918
16	5.5	49.14594
17	17	20.15636
18	4.5	64.16678
19	9	12.32303
20	4.5	64.16678
21	7	30.36469
22	3	90.44803
23	2	110.4689
24	3	90.44803
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 12.51042 Std. Dev.: 25.43304

Upper 95% confidence limit on mean: 23.25163 Representative Concentration: 23.25163

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Copper
Enter Matrix: Unfiltered Groundwater, Sites 5, 6, 7

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	12.5	51.51053
2	4.25	237.9949
3	12.5	51.51053
4	5.5	200.9897
5	12.5	51.51053
6	8.5	124.9272
7	12.5	51.51053
8	5	215.4168
9	12.5	51.51053
10	3	278.1251
11	12.5	51.51053
12	8.5	124.9272
13	11.5	66.86469
14	166	21410.40
15	18.5	1.385525
16	2.5	295.0522
17	12.5	51.51053
18	2.5	295.0522
19	12.5	51.51053
20	2.5	295.0522
21	12.5	51.51053
22	40	413.0209
23	12.5	51.51053
24	69	2432.750
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 19.67708 Std. Dev.: 34.20339

Upper 95% confidence limit on mean: 34.12230

Representative Concentration: 34.12230

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Iron
Enter Matrix: Unfiltered Groundwater, Sites 5, 6, 7

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	11000	48471185
2	1282	2.7823e8
3	42000	5.7782e8
4	6560	1.3001e8
5	2000	2.5479e8
6	3550	2.0771e8
7	4300	1.8665e8
8	4460	1.8231e8
9	450	3.0667e8
10	224	3.1464e8
11	235	3.1425e8
12	7610	1.0717e8
13	1880	2.5863e8
14	59700	1.7421e9
15	97000	6.2470e9
16	8340	92585290
17	49000	9.6335e8
18	10200	60250585
19	5800	1.4792e8
20	3800	2.0057e8
21	14000	15698435
22	23900	35258360
23	300	3.1195e8
24	73500	3.0845e9
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 17962.13 Std. Dev.: 26431.55

Upper 95% confidence limit on mean: 29125.04

Representative Concentration: 29125.04

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Lead
Enter Matrix: Unfiltered Groundwater, Sites 5, 6, 7

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	2	6.609184
2	7.5	8.580017
3	2.5	4.288351
4	3.5	1.146684
5	1	12.75085
6	1.6	8.825851
7	1	12.75085
8	4.5	.0050174
9	1	12.75085
10	1	12.75085
11	1	12.75085
12	3.1	2.163351
13	9.4	23.32085
14	29.2	606.5959
15	4	.3258507
16	1.6	8.825851
17	3.5	1.146684
18	1.9	7.133351
19	1	12.75085
20	1.6	8.825851
21	6	2.042517
22	9.5	24.29668
23	2.5	4.288351
24	9.8	27.34418
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 4.570833 Std. Dev.: 5.979202

Upper 95% confidence limit on mean: 7.096047

Representative Concentration: 7.096047

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Magnesium
Enter Matrix: Unfiltered Groundwater, Sites 5, 6, 7

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	12000	630700.7
2	21850	1.1330e8
3	4650	42976951
4	9700	2267534.
5	8500	7321534.
6	11400	37700.69
7	10000	1454034.
8	15600	19308701
9	9500	2909867.
10	18300	50327201
11	14500	10851534
12	17700	42174201
13	6420	22904201
14	23500	1.5115e8
15	9000	4865701.
16	4000	51924034
17	3150	64896451
18	10100	1222867.
19	7000	17689034
20	13500	5263201.
21	7500	13733201
22	15900	22035201
23	6000	27100701
24	9170	4144617.
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 11205.83 Std. Dev.: 5439.333

Upper 95% confidence limit on mean: 13503.04

Representative Concentration: 13503.04

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Manganese
Enter Matrix: Unfiltered Groundwater, Sites 5, 6, 7

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	1400	71489.39
2	9565	71104948
3	3000	3487089.
4	536	355961.4
5	510	387661.9
6	1080	2769.391
7	1000	17589.39
8	326	650643.9
9	200	869789.4
10	72	1124925.
11	50	1172077.
12	642	240712.9
13	68	1133426.
14	4090	8746067.
15	2000	752339.4
16	699	188030.6
17	430	493681.9
18	160	945999.4
19	270	744121.9
20	145	975403.1
21	300	693264.4
22	467	443056.6
23	50	1172077.
24	123	1019343.
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 1132.625 Std. Dev.: 2051.431

Upper 95% confidence limit on mean: 1999.012 Representative Concentration: 1999.012

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Nickel
Enter Matrix: Unfiltered Groundwater, Sites 5, 6, 7

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	296.1267
2	8.5	187.9184
3	60	1428.210
4	26	14.37674
5	10	149.0434
6	8.5	187.9184
7	5	296.1267
8	18	17.71007
9	5	296.1267
10	8.5	187.9184
11	5	296.1267
12	28	33.54340
13	8.5	187.9184
14	98	5744.377
15	30	60.71007
16	8.5	187.9184
17	60	1428.210
18	17	27.12674
19	5	296.1267
20	8.5	187.9184
21	10	149.0434
22	51	828.9601
23	5	296.1267
24	44	474.8767
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 22.20833 Std. Dev.: 24.01128

Upper 95% confidence limit on mean: 32.34909 Representative Concentration: 32.34909

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Potassium
Enter Matrix: Unfiltered Groundwater, Sites 5, 6, 7

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	650	7114889.
2	817.5	6249375.
3	2000	1735477.
4	1680	2680997.
5	450	8221839.
6	1300	4069802.
7	500	7937602.
8	1150	4697514.
9	550	7658364.
10	158	9981650.
11	450	8221839.
12	16400	1.7116e8
13	23200	3.9532e8
14	9690	40610349
15	1500	3302852.
16	10900	57496202
17	1000	5370227.
18	1220	4398982.
19	700	6850652.
20	1170	4611219.
21	1050	5140989.
22	1790	2332874.
23	1100	4916752.
24	191.5	9771095.
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 3317.375 Std. Dev.: 5822.913

Upper 95% confidence limit on mean: 5776.583

Representative Concentration: 5776.583

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Sodium
Enter Matrix: Unfiltered Groundwater, Sites 5, 6, 7

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5500	21442688
2	10800	448062.9
3	12000	3494563.
4	12300	4706188.
5	4550	31143375
6	7660	6103988.
7	8000	4539563.
8	17000	47188313
9	6000	17062063
10	13000	8233313.
11	6000	17062063
12	9570	314300.4
13	18500	70046438
14	14700	20879188
15	5500	21442688
16	28900	3.5229e8
17	8500	2658938.
18	14600	19975313
19	9500	397687.9
20	12600	6097813.
21	4300	33996188
22	9930	40250.39
23	3700	41352938
24	25	1.0212e8
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 10130.63 Std. Dev.: 6018.230

Upper 95% confidence limit on mean: 12672.32 Representative Concentration: 12672.32

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Vanadium
Enter Matrix: Unfiltered Groundwater, Sites 5, 6, 7

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	21.48709
2	4.25	29.00271
3	30	414.7163
4	9	.4037543
5	5	21.48709
6	5	21.48709
7	5	21.48709
8	3	44.02875
9	5	21.48709
10	3	44.02875
11	5	21.48709
12	13	11.32042
13	6	13.21625
14	79	4811.445
15	5	21.48709
16	2.5	50.91417
17	5	21.48709
18	2.5	50.91417
19	5	21.48709
20	6	13.21625
21	5	21.48709
22	5.5	17.10167
23	5	21.48709
24	12.5	8.205838
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 9.635417 Std. Dev.: 15.80434

Upper 95% confidence limit on mean: 16.31011 Representative Concentration: 16.31011

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Zinc
Enter Matrix: Unfiltered Groundwater, Sites 5, 6, 7

Enter number of samples: 24
Degrees of Freedom: 23

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	15	8625.766
2	15	8625.766
3	25	6868.266
4	12	9192.016
5	10	9579.516
6	29	6221.266
7	10	9579.516
8	42	4339.516
9	10	9579.516
10	10	9579.516
11	10	9579.516
12	2	11209.52
13	28	6380.016
14	127	365.7656
15	30	6064.516
16	129	446.2656
17	15	8625.766
18	13	9001.266
19	10	9579.516
20	17	8258.266
21	1300	1421162.
22	645	288503.3
23	10	9579.516
24	75	1080.766
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 107.875 Std. Dev.: 285.2936

Upper 95% confidence limit on mean: 228.3639 Representative Concentration: 228.3639

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Cyanide
Enter Matrix: Unfiltered Groundwater, Sites 5, 6, 7

Enter number of samples: 13
Degrees of Freedom: 12

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	5	44.78698
2	5	44.78698
3	5	44.78698
4	5	44.78698
5	5	44.78698
6	5	44.78698
7	5	44.78698
8	5	44.78698
9	5	44.78698
10	5	44.78698
11	5	44.78698
12	5	44.78698
13	92	6449.325
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 11.69231 Std. Dev.: 24.12946

Upper 95% confidence limit on mean: 26.27485 Representative Concentration: 26.27485

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Barium
Enter Matrix: Filtered Groundwater, Sites 5, 6, 7

Enter number of samples: 13
Degrees of Freedom: 12

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	484.5	123417.1
2	37	9252.960
3	63	4926.960
4	227	8799.883
5	293	25538.50
6	199	4330.652
7	83	2519.268
8	61	5211.729
9	56	5958.652
10	22	12363.73
11	92	1696.806
12	66	5357.114
13	54	6271.422
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 133.1923 Std. Dev.: 134.0537

Upper 95% confidence limit on mean: 214.2071

Representative Concentration: 214.2071

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Calcium
Enter Matrix: Filtered Groundwater, Sites 5, 6, 7

Enter number of samples: 13
Degrees of Freedom: 12

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	64700	1.0779e9
2	26900	24693254
3	27700	17382485
4	45400	1.8308e8
5	61300	8.6617e8
6	33900	4124024.
7	12800	3.6364e8
8	19400	1.5548e8
9	22800	82250947
10	24300	57293254
11	36000	17063254
12	18700	1.7343e8
13	20400	1.3154e8
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 31869.23 Std. Dev.: 16212.16

Upper 95% confidence limit on mean: 41666.98

Representative Concentration: 41666.98

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Cobalt
Enter Matrix: Filtered Groundwater, Sites 5, 6, 7

Enter number of samples: 13
Degrees of Freedom: 12

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	3	.0532544
2	3	.0532544
3	3	.0532544
4	3	.0532544
5	3	.0532544
6	3	.0532544
7	3	.0532544
8	3	.0532544
9	3	.0532544
10	3	.0532544
11	3	.0532544
12	3	.0532544
13	6	7.668639
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 3.230769 Std. Dev.: .8320503

Upper 95% confidence limit on mean: 3.733615

Representative Concentration: 3.733615

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Iron
Enter Matrix: Filtered Groundwater, Sites 5, 6, 7

Enter number of samples: 13
Degrees of Freedom: 12

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	8.75	1467080.
2	28	1420818.
3	6.5	1472536.
4	12	1459218.
5	16	1449570.
6	23.5	1431566.
7	7.5	1470110.
8	21.5	1436356.
9	6630	29268308
10	6	1473749.
11	1460	57609.23
12	2020	640030.8
13	5620	19360169
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 1219.981 Std. Dev.: 2280.481

Upper 95% confidence limit on mean: 2598.180

Representative Concentration: 2598.180

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Magnesium
Enter Matrix: Filtered Groundwater, Sites 5, 6, 7

Enter number of samples: 13
Degrees of Freedom: 12

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	19800	65348569
2	9240	6131338.
3	11000	512876.3
4	14200	6169492.
5	17400	32306107
6	16000	18351338
7	5860	34294538
8	7150	20849761
9	10900	666107.1
10	11700	260.9467
11	16000	18351338
12	9000	7377492.
13	4060	58616692
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 11716.15 Std. Dev.: 4734.412

Upper 95% confidence limit on mean: 14577.38

Representative Concentration: 14577.38

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Manganese
Enter Matrix: Filtered Groundwater, Sites 5, 6, 7

Enter number of samples: 13
Degrees of Freedom: 12

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	735.5	322755.1
2	8	25403.46
3	8	25403.46
4	38	16740.38
5	5	26368.76
6	1	27683.84
7	24	20559.15
8	17	22615.53
9	164	11.45562
10	1.5	27517.71
11	391	50003.84
12	30	18874.53
13	753	342945.4
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 167.3846 Std. Dev.: 277.9212

Upper 95% confidence limit on mean: 335.3452

Representative Concentration: 335.3452

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Nickel
Enter Matrix: Filtered Groundwater. Sites 5, 6, 7

Enter number of samples: 13
Degrees of Freedom: 12

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	8.5	1.610947
2	8.5	1.610947
3	8.5	1.610947
4	8.5	1.610947
5	8.5	1.610947
6	8.5	1.610947
7	8.5	1.610947
8	8.5	1.610947
9	8.5	1.610947
10	8.5	1.610947
11	25	231.9763
12	8.5	1.610947
13	8.5	1.610947
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 9.769231 Std. Dev.: 4.576277

Upper 95% confidence limit on mean: 12.53488

Representative Concentration: 12.53488

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Potassium
Enter Matrix: Filtered Groundwater, Sites 5, 6, 7

Enter number of samples: 13
Degrees of Freedom: 12

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	429	6423495.
2	759	4859651.
3	885	4320002.
4	994	3878779.
5	1330	2668197.
6	913	4204393.
7	18100	2.2911e8
8	1160	3252474.
9	1310	2733935.
10	715	5055579.
11	1700	1596335.
12	1220	3039658.
13	9010	36560627
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 2963.462 Std. Dev.: 5063.825

Upper 95% confidence limit on mean: 6023.763

Representative Concentration: 6023.763

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Sodium
Enter Matrix: Filtered Groundwater, Sites 5, 6, 7

Enter number of samples: 13
Degrees of Freedom: 12

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	10300	8026325.
2	12700	187555.6
3	7590	30725702
4	17000	14953094
5	12100	1067248.
6	8960	17414571
7	16400	10672786
8	10800	5443248.
9	16300	10029402
10	10600	6416479.
11	9110	16185148
12	7070	36760902
13	31800	3.4845e8
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 13133.08 Std. Dev.: 6495.745

Upper 95% confidence limit on mean: 17058.75 Representative Concentration: 17058.75

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Thallium
Enter Matrix: Filtered Groundwater, Sites 5, 6, 7

Enter number of samples: 13
Degrees of Freedom: 12

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	1	.0059172
2	1	.0059172
3	1	.0059172
4	1	.0059172
5	1	.0059172
6	1	.0059172
7	1	.0059172
8	1	.0059172
9	2	.8520710
10	1	.0059172
11	1	.0059172
12	1	.0059172
13	1	.0059172
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 1.076923 Std. Dev.: .2773501

Upper 95% confidence limit on mean: 1.244538 Representative Concentration: 1.244538

UPPER 95% CONFIDENCE LIMIT ON THE ARITHMETIC MEAN

Enter Chemical: Zinc
Enter Matrix: Filtered Groundwater, Sites 5, 6, 7

Enter number of samples: 13
Degrees of Freedom: 12

Enter sample results (use 1/2 DL for non-detects)

Sample No.	Sample Results	(Xi-Xbar)**2
1	2.75	197.0784
2	9.5	53.12167
3	4	163.5447
4	32	231.3909
5	7.5	86.27552
6	2.5	204.1601
7	2	218.6986
8	2	218.6986
9	5.5	127.4294
10	8	77.23706
11	73	3159.737
12	5.5	127.4294
13	64	2228.929
14		0
15		0
16		0
17		0
18		0
19		0
20		0
21		0
22		0
23		0
24		0
25		0
26		0
27		0
28		0
29		0
30		0

Arith. Mean: 16.78846 Std. Dev.: 24.31346

Upper 95% confidence limit on mean: 31.48220 Representative Concentration: 31.48220

APPENDIX O

TOXICITY PROFILES

ACETONE

Acetone is a ketone, volatile solvent, and common laboratory contaminant. Acetone is used in the production of lubricating oils and as an intermediate in the manufacture of chloroform and various pharmaceuticals and pesticides (Sittig, 1985).

Acetone can cause irritation of the eyes and upper respiratory tract and can be absorbed through the skin. Headaches, dizziness, and dermatitis are other signs of acetone toxicity (Sittig, 1985). Acetone has not been classified as a carcinogen by EPA.

ALUMINUM

Most hazardous exposures to aluminum occur during smelting and refining processes. Aluminum and its alloys are used in the shipbuilding, electrical, building, aircraft, automobile, light engineering, and jewelry industries. Aluminum foil is widely used in packaging. Aluminum chloride is used in petroleum processing and in the rubber industry (Sittig, 1985). Aluminum is also a common, virtually ubiquitous element.

Aluminum is not generally regarded as an industrial poison. Salts of aluminum can cause dermatoses, eczema, conjuctivitis, and irritation of the mucous membranes of the upper respiratory system. Inhalation of finely divided powder has been reported as a cause of pulmonary fibrosis. Aluminum in aerosols has been implicated in Alzheimers disease (Sax, 1989; Sittig, 1985).

Aluminum has not been classified as a carcinogen by EPA.

ANTIMONY

Antimony is used in mining, smelting, refining, alloy and abrasive manufacture, and typesetting in printing. Antimony has also been used in ammunition, battery plates, pigments, plasticizers, glass, enamels, pottery, pharmaceuticals, and explosives (Sittig, 1985).

Antimony and its compounds are generally regarded as primary skin irritants. Symptoms of acute oral poisoning include violent irritation of the nose, mouth, stomach, and intestines, vomiting, bloody stools, slow shallow respiration, pulmonary congestion, coma, and sometimes death due to circulatory or respiratory failure. Chronic oral poisoning presents symptoms of dry throat, nausea, headache, sleeplessness, loss of appetite, and dizziness. Liver and kidney degenerative changes are late manifestations. Antimony has not been classified as a carcinogen.

ARSENIC

Exposure to arsenic occurs mainly through occupational uses in the agricultural, pigment, glass, and metal smelting industries. Arsenic is a ubiquitous metalloid element whose compounds are considered to be human oral and inhalation carcinogens (Sax, 1989). Arsenic, as an element, is not considered acutely toxic to humans. Most animal toxicity studies have been conducted using arsenic trioxide (Clayton and Clayton, 1982). In human, 80% of the absorbed dose is distributed to the liver, viscera, bone, skin, hair, and nails. Once ingested, arsenic compounds cause systemic skin and GI effects in humans (Sax, 1989). Chronic exposure affects the skin, mucous membranes, GI tract, nervous systems, and occasionally the circulatory system (Clayton and Clayton, 1982).

Trivalent arsenic may complex with glutathione peroxidase, causing enzyme inactivity. This enzyme is essential for the maintenance of red blood cell integrity (Clayton and Clayton, 1982).

EPA classifies arsenic in drinking water as a Group A known oral human carcinogen.

BENZO[A]PYRENE

Benzo[a]pyrene is a polycyclic aromatic hydrocarbon (PAH) that occurs naturally in crude and shale oils, coal tars, and asphalt. It is also a byproduct of combustion and is considered a potent carcinogen (Sittig, 1985). Most benzo[a]pyrene enters the environment as particulate and vapor following combustion (Sittig, 1985).

Although benzo[a]pyrene and other PAHs have low oral and dermal acute toxicities in laboratory animals (Clayton and Clayton, 1982), benzo[a]pyrene has produced tumors in all species tested by both the oral and dermal route of application (Sittig, 1985). EPA classifies benzo[a]pyrene as a Group B2 probable human carcinogen, whereas IARC classifies benzo[a]pyrene as having sufficient animal evidence and inadequate human data (RTECS, 1991). In primates, benzo[a]pyrene is readily excreted following metabolic oxidation, or may be excreted unchanged (Clayton and Clayton, 1982).

BARIUM

Metallic barium is commonly used to form alloys with nickel, lead, magnesium, and other metals. Compounds of barium are used in the manufacture of rubber, paints, glass, paper, and linoleum. Barium compounds can also be found in valves, X-ray diagnostics, and rodenticides (Sittig, 1985).

In occupational exposures, barium poisoning is rare. However, the ingestion of soluble barium compounds has a strong effect on muscle tissues, particularly the smooth muscles, by increasing their contractility (Sittig, 1985). If extreme, this can result in cardiac arrest. Other effects include increases peristalsis, vascular constriction, bladder contraction, and swelling of the brain. Vasoconstriction results in hypertension, the most common effect observed in barium-exposed subjects. Target organs include the heart, lungs, CNS, respiratory system, skin, and eyes.

Inhalation of barium sulfate dusts, the major source of barium metal, has produced a benign form of pneumoconiosis. Chest X-rays in these cases reveal circumscribed nodules (Clayton and Clayton, 1982). Barium is not classified as a carcinogen.

BENZENE

Benzene is an aromatic hydrocarbon with a distinct odor. It is used as a motor fuel additive, as well as a solvent in fats, inks, oils, paints, plastics, and rubber. It is also used as an intermediate chemical in the manufacture of styrene, phenols, cumene, nylon, and maleic anhydride.

Acute inhalation of large amounts of benzene has led to CNS depression with symptoms including headache, giddiness, vertigo, delirium, and respiratory irritation (Clayton and Clayton, 1982). Extremely high doses have been known to cause death from ventricular fibrillation. Chronic inhalation of lower levels has resulted in similar sumptoms as well as aplastic anemia, hyperbilirubinemia, and immunotoxic effects (monocytosis and absolute lymphocytosis) (Clayton and Clayton, 1982). Ingestion of benzene has caused staggering gait, vomiting, rapid pulse, loss of consciousness, and CNS depression. Higher concentrations have resulted in coma and death. Benzene is poorly absorbed by the skin; however, it is an irritant which can produce defatting dermatitis. It has also been known to cause sensitization. Target organs include the blood, CNS, skin, bone marrow, eyes, and respiratory system (Sittig, 1985). Benzene is not readily soluble in body fluids, but it is readily deposited in fatty tissues or absorbed into memebranes due to its high lipid solubility.

EPA has classified benzene as a Group A known human carcinogen. This is based on an increased incidence of leukemia in exposed workers and neoplasia in rats.

BERYLLIUM

Beryllium is used in the manufacturing of electrical components, chemicals, ceramics, and X-ray tubes, as well as in a variety of alloys. The major source of beryllium exposure of the general population is through the burning of coal (Sittig, 1985).

Adverse effects can include contact dermatitis, eye irritation, and effects on the respiratory system (via inhalation of fume or dust), liver, spleen, and heart (Sittig, 1985). Beryllium is also classified by EPA as a Group B2 probable human carcinogen via the oral and inhalation routes.

BROMOMETHANE

Bromomethane is primarily used as a fumigant for soils, grain, warehouses, and ships. Other uses include specialized fire extinguishing agent, solvent for aniline dyes, extraction of oils from wool, nuts, seed, and flowers, and methylation during organic synthesis (Sittig, 1985).

Repeated or prolonged dermal contact with liquid bromomethane may result in severe skin burns. Vapor contact may lead to itching dermatitis. Liquid bromomethane has also been shown to cause corneal burns. Inhalation of large quantities has led to respiratory failure. Lower concentrations will cause lung irritation accompanied by congestion and pulmonary edema. Chronic exposures may lead to excitation and convulsions which give way to paralysis of the extremities. It is believed that the toxic effect of bromomethane is due to its ability to methylate certain compounds (Clayton and Clayton, 1982). Symptoms include headaches, nausea, vertigo, and tremors. Target organs include the CNS, respiratory system, skin, and eyes (Sittig, 1985).

EPA has listed bromomethane as Group D (not classifiable as to carcinogenicity). IARC has listed bromomethane as having limited animal evidence and inadequate human evidence (RTECS, 1991). The limited evidence available does indicate a potential for forestomach carcinomas in rodents.

2-BUTANONE

2-Butanone, also known as methyl ethyl ketone, is used as a solvent in nitrocellulose coating and vinyl film and smokeless powder mangufacture, and in cements and adhesives (Sittig, 1985). 2-Butanone can affect the CNS and can be an eye or skin irritant. Generally, the ketones are not known for severe toxicity (Sax, 1989; Sittig, 1985). 2-Butanone has not been classified as a carcinogen by EPA.

CADMIUM

Cadmium, usually obtained from copper, lead and zinc ore, is used as an anticorrosive coating for metals, and as a component of alloys. As an environmental contaminant, it is virtually ubiquitous.

Cadmium primarily affects the respiratory and GI tract (Clayton and Clayton, 1982). Cadmium compounds produce renal, pulmonary, cardiovascular, and skeletal effects based on chronic exposure. Cadmium compounds are poorly absorbed by the GI tract, readily absorbed via inhalation and only negligibly absorbed through intact skin (Sittig, 1985). Due to differences in absorption rates, different refernce doses have been developed for cadmium in food and in water.

EPA classifies cadmium compounds as Group B1 probable human carcinogens via inhalation.

CARBON TETRACHLORIDE

Carbon tetrachloride is a common solvent that has found uses in oils, fats, lacquers, rubber, waxes, and resins. Carbon tetrachloride is also used to synthesize fluorocarbons. Other applications include dry cleaning agents, fire extinguishers, fumigants, and antihelmintics (Sittg, 1985).

Prolonged skin contact with carbon tetrachloride may lead to defatting dermatitis, while eye contact may be only slightly irritating. Skin absorption is reported to be negligible (Clayton and Clayton, 1982). Both inhalation and ingestion of carbon tetrachloride can lead to CNS depression with symptoms including dizziness, vertigo, headache, and incoordination. Other symptoms may include nausea and vomiting (Sittig, 1985). Chronic exposures have been shown to cause liver and kidney damage. Alcohol is known to have a synergistic effect in conjunction with carbon tetrachloride. One study shows the absorption rate of inhaled carbon tetrachloride to be 30%.

EPA has classified carbon tetrachloride as a Group B2 probable human carcinogen.

CHLORDANE

Chlordane is an insecticide that has been extensively used for termite control, but it has been banned in the United States. Systemic effects in humans include tremors, convulsions, ataxia, and gastritis. The fatal dose to humans is estimated to be between 6 and 60 g. Chlordane can be absorbed through the skin. Liver damage has been reported from chronic exposure. Chlordane is a lipophilic, persistent compound that, like DDT, can bioconcentrate significantly. Chlordane is often detected in conjunction with heptachlor; heptachlor can be a component of technical grade chlordane. Chlordane is classified by EPA as a Group B2 probable human carcinogen (Sittig, 1985; Sax, 1989).

CHLOROBENZENE

Chlorobenzene is used in the maufacture of aniline, phenol, and chloronitrobenzene and as an intermediate in the manufacture of dyestuffs and many pesticides. Chlorobenzene can cause skin and eye irritation and effects on the CNS and liver (Sittig, 1985). Chlorobenzene has not been classified by EPA as a carcinogen.

CHLOROFORM

Chloroform was one of the earliest anesthetics, but this use has been abandoned due to toxic effects. It is currently used as a solvent in the lacquer industry, and in purification of certain pharmaceuticals. It is also used in the manufacture of synthetic silk, plastics, floor polishes, and fluorocarbons. Chloroform is a common contaminant of city water supplies where it is formed by the interaction of chlorine and naturally occurring organic compounds (Sittig, 1985).

Prolonged dermal contact with chloroform may result in burns. Skin absorption occurs to a small extent. The anesthetic qualities of chloroform at high concentrations have caused death due to liver dysfunction, and cardiac arrest due to cardiac muscle sensitization (Clayton and Clayton, 1982). Symptoms of exposure include digestive disturbances, dizziness, and coma. Target organs include the liver, kidneys, heart, eyes, and skin.

Chloroform has been shown to be highly embryotoxic, and to a lesser exent teratogenic. It is classified a Group B2 probable human carcinogen by EPA because of its possible association with rectal, bladder, and colon cancers. Cancer of the liver, kidney, and thyroid have also been detected in test animal populations.

CHLOROMETHANE

Chloromethane, also known as methyl chloride, is a gas that is used mainly as an organic synthesis intermediate. It is used as a propellant for plastic foams, a rubber solvent, and an extractant for greases and oils. It has been used as a refrigerant in the past (Sittig, 1985).

Dermal and eye contact with chloromethane are rare and do not appear to affect exposed individuals. Inhalation primarily affects the nervous system, causing tremors, staggering gait, loss of memory, drowsiness, and blurred vision. Extremely high doses have resulted in nausea, vomiting, and abdominal pain (Clayton and Clayton, 1982). There is limited evidence of hepatic and renal toxicity. Target organs include the liver, kidneys, and CNS. The metabolism of chloromethane is nearly complete, with approximately 5% being excreted unchanged in exhaled air. The remainder is metabolized to unknown nonvolatile compounds in the body (Clayton and Clayton, 1982).

IARC has reviewed the carcinogenicity of chloromethane and determined that there is inadequate evidence in both animals and humans (RTECS, 1991). EPA has classified chloromethane as a Group C possible human carcinogen, although this is not yet considered to be fully reviewed, Agency-wide consensus (USEPA, Jan. 1, 1992).

CHROMIUM

Chromium is refined by roasting chromite ores. Chromium is used in the plating, anodizing, and photography industries. It may also be used as a catalyst (Sittig, 1985). Trivalent chromium is an essential nutrient, and there is evidence that hexavalent chromium is reduced to trivalent chromium in organisms.

Hexavalent chromium is more toxic and mobile than trivalent chromium. Effects of chromium exposure include skin ulcers, various forms of dermatitis, perforated nasal septa, respiratory system inflammation, and liver enlargement. The skin, upper respiratory tract, lungs, liver, kidneys, and GI tract are target organs and systems for chromium effects (Clayton and Clayton, 1982).

Hexavalent chromium is considered to be a Group A known human carcinogen by inhalation, according to EPA. Bronchigenic carcinoma has been observed in occupational exposures (Clayton and Clayton, 1982).

COBALT

Cobalt is used in the manufacture of a number of alloys, including those used for permanent magnets. Alloys are used in the electrical, automobile, and aircraft industries. Cobalt is also used as a binder in the manufacture of tungsten carbide tools. Cobalt can be found in pigments, glass, pottery, and photographic materials (Sittig, 1985).

Cobalt targets the respiratory system and skin upon exposure. It is a mild eye and skin irritant that may cause sensitization. Cross-sensitization may occur with nickel and chromium. Inhalation of cobalt dusts causes asthma-like symptoms which may eventually develop into chemical pneumoconiosis. Chronic ingestion of cobalt (as in beer at over 1000 ug/l) can cause vomiting, diarrhea, and cardiotoxicity (Clayton and Clayton, 1982; USEPA, 1977).

COPPER

Copper is an excellent conductor and is used throughout the electrical industry. It is also used in piping, roofing materials, cooking utensils, chemical equipment, and coinage. Copper is used to form alloys such as bronze, brass, and gun metal. Copper is also used in pesticides, catalysts, paints, and electroplating (Sittig, 1985).

Dermal contact with copper salts has caused irritation, itching, and dermatitis. Eye contact has resulted in conjuctivitis and ulcerization of the cornea. Inhalation of copper dusts and fumes may cause upper respiratory irritation, a metallic taste in the mouth, nausea, metal fume fever, and discoloration of the skin and hair. Copper salts may cause nasopharyngeal congestion, and occasionally perforated nasal septa upon inhalation. Ingestion of copper salts may produce increased salivation, nausea, vomiting, gastric pain, hemorrhagic gastritis, and diarrhea (Sittig, 1985). Chronic effects may be seen only in individuals with Wilson's diease (hepatolenticular degeneration) in which the body has an increased ability to absorb, store, and retain copper. Target organs include respiratory system, skin, liver, kidneys, and eyes. Copper is not classified as a carcinogen.

CYANIDE

Sodium and potassium cyanides are used primarily in the extraction of ores, electroplating, and metal treatment (Sittig, 1985). Cyanide is generally not considered to be a persistent environmental contaminant because it is quickly degraded in the environment.

Exposure to cyanide can result in nausea, confusion, vertigo, convulsions, paralysis, and cardiac arrhythmia. Chronic exposure to cyanide solutions can produce a "cyanide rash". Chronic cyanide poisoning is reported to cause anorexia, headache, nausea, and irritation of the upper respiratory tract and eyes (Sax, 1989). Cyanide is believed to act by preventing the release of oxygen to tissues by red blood cells (Casarett and Doull, 1986).

DDT, DDD AND DDE

4,4'-DDT is an insecticide that has been banned in the United States since 1972. 4,4'-DDT and its metabolites, 4,4'-DDD and 4,4'-DDE, are toxicants with long-term persistence in soil and water. Their high lipophilicity and low water solubility result in concentrated accumulation in the fat of wildlife and humans (Sittig, 1985). Thinning of eagle and osprey eggshells led to population declines for those birds (Casarett and Doull, 1986).

Because of the persistence and dispersion of DDT compounds, they are therefore widespread environmental contaminants. Toxic effects to humans include paresthesia, convulsions, vomiting, and skin irritation. The target organs are the CNS, liver, kidneys, skin, and peripheral nervous system (Sittig, 1985). Experimental ingestion of 1.5 g of 4,4'-DDT resulted in discomfort, moderate neurological changes, and vomiting (Sax, 1989).

4,4'-DDT, 4,4'-DDD, and 4,4'-DDE are classified as oral Group B2 probable human carcinogens. 4,4'-DDT is also classified as an inhalation Group B2 carcinogen.

1,2-DICHLOROBENZENE

1,2-Dichlorobenzene (1,2-DCB) is a process solvent in the manufacture of toluene diisocyanate, and an intermediate in dyes, herbicides, and degreasers (Sittig, 1985).

Dermal exposure to 1,2-DCB may cause chemical burns with blistering. The eyes and upper respiratory system may also be irritated by 1,2-DCB. In addition, both oral and inhalation exposure routes may lead to liver and kidney damage (Sittig, 1985).

1,2-DCB is metabolized to various dichlorophenols in the body. Many of the dichlorophenols are as toxic as 1,2-DCB (CLayton and Clayton, 1982). EPA considers 1,2-DCB to be Group D, unclassifiable as to carcinogenicity.

1,4-DICHLOROBENZENE

1,4-Dichlorobenzene is used primarily as a deodorant and insecticide and is a byproduct of chlorobenzene production (Sittig, 1985).

1,4-Dichlorobenzene has been associated with hemolytic anemia and liver necrosis. The dichlorobenzenes reportedly impart an offensive taste and odor to water (Sittig, 1985). Human systemic effects by ingestion include respiratory and eye effects, liver injury, and eye irritation (Sax, 1989).

1,4-Dichlorobenzene is classified as a Group B2 probable human carcinogen by EPA.

1,1-DICHLOROETHANE

1,1-Dichloroethane (1,1-DCA), also known as ethylidene dichloride, is an organic solvent which is used as a cleaning and degreasing agent. it is also used as an intermediate in the synthesis of some organic chemicals.

Dermal exposure to 1,1-DCA has been shown to cause defatting dermatitis, but this compound is reported to not be readily absorbed through the skin. Inhalation of high concentrations may cause upper respiratory irritation, gastrointestinal upset, and CNS depression. Symptoms include dizziness, nausea, vomiting, and mental confusion. Chronic exposures have been shown to cause liver, kidney, and adrenal injury (Clayton and Clayton, 1985). 1,1-DCA has not been classified by EPA as to carcinogenicity.

1,2-DICHLOROETHANE

1,2-Dichloroethane (1,2-DCA), also known as ethylene dichloride, is used in the manufacture of ethylene glycol, polyvinyl chloride, nylon, rayon, rubber, and plastics. It is used as a solvent in resins, asphalt, rubber, cellulose acetate, cellulose ester, and paints. It is also used as a degreaser, an extracting agent for soybean oil and caffeine, an antiknock gasoline additive, a fumigant, and a dry cleaning solvent. It may also be used in the photographic, adhesive, water softening, cosmetic, and pharmaceutical industries (Sittig, 1985).

Prolonged dermal contact with 1,2-DCA may cause severe irritation and defatting dermatitis. Skin absorption does occur, but to a limited degree. Acute exposure to high concentrations results in CNS depression and respiratory failure with symptoms including dizziness, nausea, vomiting, and respiratory irritation (Clayton and Clayton, 1982). Chronic exposures may result in neurologic changes, as well as hepatic and renal damage. Some studies have also noted adrenal effects (Clayton and Clayton, 1982).

EPA has classified 1,2-DCA as a Group B2 probable human carcinogen, based on studies in which a variety of tumor types have been identified. 1,2-DCA has also been shown to alkylate DNA.

1,1-DICHLOROETHENE

1,1-Dichloroethene (1,1-DCE), also known as vinylidene chloride, is used in the manufacture of 1,1,1-trichloroethane. However, its most common use is in polyvinylidene copolymers used in packing, including Saran. Otehr polymer applications include mortars, concretes, and fabrics (Sittig, 1985).

1,1-DCE is an eye and skin irritant. This irritation may be due to the inhibitor hydroquinone monomethyl ether which is added to prevent peroxide formation. Skin absorption is not significant due to the high volatility of 1,1-DCE. Ingestion of 1,1-DCE results in liver damage, as well as changes in ciliated cells of the bronchioles. Inhalation of high concentrations of 1,1-DCE has resulted in CNS depression, as well as liver and kidney damage. Chronic exposures have also resulted in hepatic, renal, adrenal, and respiratory damage (Clayton and Clayton, 1982). 1,1-DCE is rapidly absorbed by the respiratory and digestive tracts, but has limited solubility and is not stored in body tissues.

Chronic exposure has also resulted in the production of cancerous cells in exposed individuals. EPA has classified 1,1-DCE as a Group C possible human carcinogen. 1,1-DCE has been shown to alkylate DNA.

1,2-DICHLOROETHENE

1,2-Dichloroethene (1,2-DCE) is used as a solvent for waxes, resins, and acetylcellulose. It is also used in rubber extraction, refrigeration, pharmaceuticals, and in the extraction of oils from meat and fish (Sittig, 1985).

Research indicates that the cis and trans isomers of 1,2-DCE have similar, if not equal, toxicological properties. 1,2-DCE is both an eye and dermal primary irritant. Irritation of the upper respiratory tract may accompany acute inhalation exposures. Acute inhalation exposures may also result in CNS depression with symptoms including dizziness, nausea, and vomiting (Sittig, 1985). Chronic inhalation studies have demonstrated 1,2-DCE to have toxic effects on the lungs, liver, and kidneys. A decreased leukocyte count has also been noted (Clayton and Clayton, 1982).

1,2-DCE is not classified as a carcinogen by EPA.

1,2-DICHLOROPROPANE

1,2-Dichloropropane is used as a chemical intermediate in PCE and carbon tetrachloride synthesis and as a solvent. 1,2-Dichloropropane can be used as a fumigant, scouring compound, and degreaser (Sittig, 1985).

1,2-Dichloropropane can have irritating effects to the skin (defatting dermatitis) and eyes. 1,2-Dichloropropane can also cause liver, kidney, and heart damage. Fatty degeneration of the liver and kidney have been reported in animals (Sax, 1989).

1,2-Dichloropropane is classified as a Group B2 probable human carcinogen by EPA via the oral route, based on the occurrence of liver tumors in mice.

DIELDRIN

Dieldrin is a chlorinated hydrocarbon insecticide that is currently banned in the United States. It was used to control corn and citrus pests (Sittig, 1985).

Dieldrin has low volatility and low water solubility, which contribute to its persistence, and has a high affinity for fat, which results in a tendency to bioaccumulate. Dieldrin can affect the central nervous system, liver, kidneys, and skin. Symptoms include headache, dizziness, nausea, clonic or tonic convulsions, and coma (Sittig, 1985).

Dieldrin is classified by EPA as a Group B2 probable human carcinogen via the oral and inhalation routes.

ETHYLBENZENE

Ethylbenzene is used in the manufacture of cellulose acetate, styrene, and synthetic rubber. It may also be used as a solvent and as a component of aviation and automotive gasolines. Ethylbenzene is also a common contaminant of mixed xylenes (Sittig, 1985).

Ehtylbenzene is an eye and skin irritant that may cause defatting dermatitis. It may also cause CNS depression and upper respiratory irritation following inhalation. There is some concern regarding hepatic and renal toxicity; however, this is due primarily to the metabolic pathways that are located in these organs. Target organs include eyes, upper respiratory system, skin, and CNS. A number of metabolites can be formed, including hippuric acid and mandelic acid. An increase in microsomal enzyme synthesis has also been noted following ethylbenzene exposures (Clayton and Clayton, 1982). EPA considers ethylbenzene to be Group D, not classifiable as to carcinogenicity.

LEAD

Lead rarely occurs in the elmental state and must be refined from lead-containing ores. Lead is used in the chemical industry to line tanks that may be subject to corrosion. Lead is also found in solder, automobile fillers, X-ray shielding, manufacturing of tetraethyl lead (gasoline additive), paint pigments, and storage batteries (Sittig, 1985).

Lead, a generally ubiquitous element, is considered a cumulative poison in humans as inorganic compounds (Clayton and Clayton, 1982). Inhalation and ingestion of lead compounds by humans causes systemic effects in target organs including CNS, blood, and kidneys (Sax, 1989). Lead is readily absorbed when inhaled; however, when ingested, most of the lead is eliminated in the feces and not absorbed.

Chronic inorganic lead exposure causes effects on the hematopoletic system, producing anemia. Other effects, such as neurological, renal, and reproductive effects are also associated with chronic exposure to inorganic lead comounds (Clayton and Clayton, 1982). Inorganic lead compunds interfere with heme synthesis by reacting with the thiol groups on enzymes and amino acids.

Alkyl lead compounds are associated with acute rather than chronic responses in humans. These effects are primarily CNS oriented (Clayton and Clayton, 1982).

EPA considers lead to be a Group B2 probable human carcinogen, but no Agency-wide consensus has been reached concerning a cancer slope factor.

MANGANESE

Manganese is used in the manufacture of dry cell batteries, paints, dyes, and in the chemical and glass and ceramics industries. Manganese is normally ingested as a trace nutrient in food; the average human intake is reported to be approximately 10 mg/day (Sittig, 1985).

Manganese dust and fumes can be somewhat irritating to mucous membranes. Chronic manganese poisoning can cause apathy, anorexia, and asthenia. Headache, spasms, and arthralgias can follow, with manganese psychosis (confusion, compulsions, hallucinations) finally resulting. Neurological damage can also include tremors and effects upon speech. Severe poisoning resembles classic Parkinson's disease (Sittig, 1985).

Manganese is not classified as a carcinogen by EPA.

MERCURY

Mercury is found in all types of rocks; however, the ore most often used to refine mercury is cinnabar. Mercury is most commonly used in the electrical and chemical industries. It is also present in dental amalgams. Both pharmaceuticals and pesticides containing mercury are no longer in use (Clayton and Clayton, 1982). Inorganic mercury is used in metal plating, tanning, feltmaking, taxidermy, and photography.

Mercury is a primary irritant of skin and mucous membrances with exposure routes via inhalation (metallic), ingestion, eyes, skin, and mucous membranes. Target organs incude skin, respiratory system, CNS, and kidneys (Sittig, 1985). Mercury has a high affinity for sulfhydryl groups on proteins (Clayton and Clayton, 1982) and is considered a general protoplasmic poison (Sax, 1989). Mercury is readily absorbed by the respiratory system and intact skin (Sax, 1989). Inorganic mercury salts accumulate in the kidneys. Exposure to mercury may produce the following symptoms: coughing, chest pains, tremors, insomnia, headaches, salivation, GI disturbances, weight loss, and proteinuria.

EPA classifies mercury and its compounds as Group D, not classifiable as to carcinogenicity. Positive mutagenicity data exist for the inorganic salts, and some data have shown tumorigencity and teratogeneicity in experimental test organisms (Sax, 1989).

METHOXYCHLOR

Methoxychlor is a chlorinated insecticide that has been used to control flies, elm bark beetles, and blackflies. It has been used on agricultural crops such as alfalfa, fruits and vegetables, and grains, and on livestock including cattle, swine, goats, and sheep (Sittig, 1985).

Methoxychlor is considered to have low mammalian toxicity. Effects in humans have not been reported. In animals, adverse effects can include trembling, convulsions, and kidney and liver damage (Sittig, 1985; Sax, 1989).

4-METHYLPHENOL

4-Methylphenol, also known as p-cresol, can be used as a disinfectant, as an ore flotation agent, and as an intermediate in the manufacture of chemicals, dyes, and plastics (Sittig, 1985).

4-Methylphenol is corrosive and can cause burns. Skin rashes can result from repeated or prolonged exposure. 4-Methylphenol can be absorbed through the skin. Toxic effects include muscle weakness, dizziness, tinnitus, and confusion. Symptoms of chronic poisoning include vomiting, headache, dizziness, and skin rash. The CNS, liver, kidneys, and skin are target organs (Sittig, 1985).

4-Methylphenol is not classified as a carcinogen by EPA.

NICKEL

Nickel is refined from ores containing sulfur, antimony, and arsenic. Nickel is commonly used in the production of alloys, including stainless steel, and in electroplating. Nickel is also found in magnetic tapes, surgical instruments, batteries, crank case oils, and enamels. It may also be used to catalyze reactions in fats and oils, coal oils, and plastics.

Nickel is considered a skin sensitizer, causing dermatitis in occupational settings, and a reproductive toxicant. Routes of exposure to humans include inhalation (dusts) and ingestion. The most significant exposure route is via food; however, only approximately 10% of the nickel ingested in food and water is absorbed by the GI tract (Sittig, 1985). Chronic nickel salt exposure has been associated with kidney and CVS changes (Clayton and Clayton, 1982). Insoluble nickel dusts have been shown to be carcinogenic via inhalation, especially nickel carbonyl (Sax, 1989).

Nickel has not been classified as a carcinogen by EPA. IARC has classified nickel carbonyl as a Class 1 carcinogen (sufficient animal and human evidence) (RTECS, 1991).

PHTHALATES

The phthalate esters include butylbenzyl phthalate, di-n-butyl phthalate, diethyl phthalate, dimethyl phthalate, di-n-octyl phthalate, bis(2-ethylhexyl) phthalate (also known as di-2-ethylhexyl phthalate), and di-n-octyl phthalate. As plasticizers, the phthalate esters are used in virtually every major product category, and are now ubiquitous environmental contaminants. They are noted for their low acute and low chronic toxicity (Casarett and Doull, 1986).

Irritation and GI distress have been reported for exposure to high concentrations of di-n-butyl phthalate. However, the greatest concern when dealing with phthalates is the carcinogenicity of bis(2-ethylhexyl) phthalate (Sittig, 1985). Bis(2-ethylhexyl) phthalate is classified by EPA as a Group B2 carcinogen.

POLYCHLORINATED BIPHENYLS (AROCLORS)

Polychlorinated biphenyls (PCBs) are extremely stable, nonflammable compounds that have been used chiefly in the electrical industry as an insulator in capacitors and transformers. They are also used in the manufacture of plasticizers, hydraulic fluids, inks, sealants, adhesives, pesticide extenders, and microencapsulation of dyes in carbonless duplicating paper (Clayton and Clayton, 1982). The United Sates Congress eliminated the production and sale of PCBs in 1976. PCBs are still being used, but are slowly being phased out of most operations. PCBs may be contaminants of waste oils.

Dermal contact with PCBs can result in chloracne with the formation of sebaceous cysts and pustules. In addition, eye and upper respiratory system irritation may occur. PCBs are readily absorbed by the intact skin. The major effect of PCBs is hepatotoxicity. Symptoms incude jaundice, edema, vomiting, anorexia, nausea, and fatigue. Oral intake of PCBs may result in embryotoxicity. Target organs include the skin, eyes, and liver (Sittig, 1985).

Certain PCBs have demonstrated an ability to cause cancer in the GI tract and other organs. EPA classifies PCBs as Group B2 probable human carcinogens, based on hepatocellular carcinomas in rats and mice (Aroclor 1260) and limited evidence of liver cancer in humans.

POLYCYLIC AROMATIC HYDROCARBONS

Polycyclic aromatic hydrocarbons (PAHs), also called polynuclear aromatic hydrocarbons, are compounds consisting of annelated aromatic rings. They occur in a variety of products such as coal, tar, tobacco smoke, and petroleum. They occur in the products of the combustion of organic material (Casarett and Doull, 1986). PAHs can be formed in any hydrocarbon combustion process and may be released from oil spills (Sittig, 1985). This group of compounds includes phenanthrene, fluoranthene, pyrene, benz[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[a]pyrene (q.v.), indeno[1,2,3-c,d]pyrene, dibenz[a,h]anthracene, benzo[g,h,i]perylene, naphthalene, acenaphthylene, acenaphthene, dibenzofuran, fluorene, anthracene, benzo[k]fluoranthene, and carbazole.

Naphthalene is an irritant that can cause dermatitis, toxic effects on the red blood cells, liver, kidneys, and CNS. However, the greatest concern when dealing with PAHs is their carcinogenic potential. Carcinogenic effects have been reported for benzo[a]pyrene, pyrene, benz[a]anthracene, chrysene, benzo[b]fluoranthene, indeno[1,2,3-c,d]pyrene, dibenz[a,h]anthracene, benzo[g,h,i]perylene, benzo[k]fluoranthene, and carbazole, resulting in EPA's classification as Group B2 probable human carcinogens.

SELENIUM

Selenium is refined from sulfide ores of copper, gold, nickel, and silver. Most selenium is used in the manufacture of selenium rectifiers. It is also used as a pigment in paints, dyes, and glass. Other uses include rubber vulcanization, electrode manufacture, insecticides, photographic toning, and as an additive to anti-dandruff shampoos. Selenium is also used for photostatic and X-ray xerography.

Elemental selenium is relatively nontoxic. However, a number of selenium compounds, including selenium dioxide and selenium oxychloride, can be severely irritating and destructive to tissues. Exposure to these compounds is also severely irritating to the eyes, upper respiratory tract, and gastric mucosa. Selenium dioxide may also penetrate the free nails, resulting in painful nail beds and paronychia (Clayton and Clayton, 1982). There is limited evidence that inhalation of selenium may cause liver and kidney damage. Smypmtoms of selenium exposure include garlic odor of the breath, pallor, indigestion, giddiness, and irritability. Target organs include the upper respiratory system, eyes, skin, liver, kidneys, and blood (Sittig, 1985).

Selenium is considered to belong to Group D, not classifiable as to carcinogenicity.

SILVER

Silver is used in the manufacture of silverware, jewelry, scientific instruments, photographic films, plates, and paper, and mirrors. The main effect of silver exposure derives from the deposition of small particles in the skin, resulting in a permanent discoloration called argyria. Silver nitrate can be irritating to the skin, eyes, and intestinal tract. All forms of silver are extremely cumulative once they enter body tissues, and very little is excreted (Sittig, 1985).

TETRACHLOROETHENE

Tetrachloroethene (PCE), also known as perchloroethylene, is a commonly used solvent in the dry cleaning, degreasing, and textile industries. It is also used as an intermediate in the manufacture of organic chemicals (Sittig, 1985).

Prolonged dermal exposure may produce defatting dermatitis. Inhalation of large concentrations will irritate the upper respiratory tract and cause eye irritation. Other effects include CNS depression and liver damage. Chronic exposures to lower concentrations have also shown liver damage, as well as nephropathy (Clayton and Clayton, 1982).

EPA ECAO classifies PCE as a Group B2 probable human carcinogen, although this is not considered Agency-wide consensus at this time.

THALLIUM

Thallium and its compounds have been used as pesticides. Thallium salts may be skin irritants and sensitizers, but these effects occur rarely in industry. Thallium is extremely toxic and cumulative. Symptoms of poisoning include fatigue, metallic taste, loss of hair, and peripheral neuritis. The GI system can also be affected (Sittig, 1985). Thallium has not been classified as a carcinogen by EPA.

TOLUENE

Toluene is a feed stock for a number of chemical products, including toluene diisocyanate, phenol, benzoic acid, saccharins, and other compounds. Toluene is also used as a solvent for paints and coatings, and as a component of automobile and aviation fuels (Sittig, 1985).

The most rapid route of entry for toluene is through the respiratory system, where 93% is retained by the body. Similar rates of absorption occur in the intestinal tract, and the skin is able to absorb small amounts of toluene. Low concentrations of inhaled toluene may result in respiratory tract irritation, eye irritation, nausea, and hilarity. Higher concentrations (>800 ppm) are characterized by nasal mucous secretion, metallic taste, and drowsiness, which may eventually lead to paresthesia, narcosis, and collapse. Chronic inhalation of toluene has resulted in liver, kidney, and neural changes. Dermal exposure may lead to defatting dermatitis. Ingestion of toluene may also lead to damage of the liver, kidney, and cerebellum (Clayton and Clayton, 1982). Upon entering the body, toluene is metabolized to benzoic acid, which can form byproducts that are excreted in the urine.

EPA considers toluene unclassifiable as to carcinogenicity, and IARC has found both human and animal evidence insufficient to determine carcinogenicity (RTECS, 1991).

1,2,4-TRICHLOROBENZENE

1,2,4-Trichlorobenzene is used as a dye carrier, herbicide intermediate, heat transfer medium, dielectric fluid in transformers, degreaser, lubricant, and insecticide. 1,2,4-Trichlorobenzene can be irritating to the skin. Acute exposure causes drowsiness, incoordination, and unconsciousness. In animals, liver damage has been reported. Chronic 1,2,4-Trichlorobenzene exposure has been reported to cause liver, kidney, and lung damage (Sittig, 1985). 1,2,4-Trichlorobenzene is not classified as a carcinogen by EPA.

1,1,1-TRICHLOROETHANE

1,1,1-Trichloroethane (1,1,1-TCA), also known as methyl chloroform, has partially replaced the uses of carbon tetrachloride and TCE as solvents. 1,1,1-TCA is used in the degreasing and cleaning of metal parts. It is also used as a dry-cleaning agent, vapor degreaser, and propellant (Sittig, 1985).

Dermal exposure to 1,1,1-TCA has shown it to be a mild skin irritant that is poorly absorbed by the intact skin. High concentrations of airborne 1,1,1-TCA have been known to cause CNS depression and cardiac sensitization to epinephrine. Symptoms of exposure include dizziness and drowsiness. Some studies have shown hepatic and hematopoietic effects that are reversible following exposure. A majority of all absorbed 1,1,1-TCA is excreted unchanged in exhaled breath (Clayton and Clayton, 1982).

EPA considers 1,1,1-TCA to be Group D, not classifiable as to carcinogenicity. IARC has found insufficient evidence for both human and animal carcinogenicity (RTECS, 1991).

TRICHLOROETHENE

Trichloroethene (TCE) is used extensively as a solvent in vapor degreasers. Other uses include extraction of caffeine and dry cleaning. TCE is also used as an intermediate in the production of pesticides, waxes, gums, resins, paints, varnishes, and trichloroacetic acid (Sittig, 1985).

Dermal and eye exposure to TCE may result in moderate irritation. Inhalation and ingestion of TCE have similar effects on the body. The primary effect due to exposure is CNS depression. High concentrations may result in complete anesthesia and cardiac sensitization to adrenalin. Hepatic and renal toxicity have also been found to occur. Lower exposures result in a lesser degree of CNS depression with symptoms incuding dizzines, vertigo, tremors, nausea, and blurred vision. Target organs include respiratory system, heart, liver, kidneys, and CNS depression. TCE is metabolized to trichloroacetic acid and trichloroethanol, which are excreted in the urine (Clayton and Clayton, 1982).

EPA has withdrawn its original statement classifying TCE as a Group B2 probable human carcinogen and is currently reviewing the carcinogenicity of TCE. IARC has classified TCE as having limited animal and inadequate human evidence (RTECS, 1991).

TRICHLOROFLUOROMETHANE

Trichlorofluoromethane is most commonly used as a refrigerant. It has also been used as an aerosol propellant and a manufacturing intermediate. The use of fluorocarbons as aerosol propellants was banned by the EPA in 1978 (Clayton and Clayton, 1982).

Dermal contact with trichlorofluoromethane is reportedly of little concern. Inhalation of trichlorofluoromethane has led to respiratory and cardiac toxicity. Effects include bronchoconstriction and bronchospams. Cardiac toxicity is in the form of bradycardia and inverted T-waves. Uptake of trichlorofluoromethane by the lungs is a slow and incomplete process due to its lipid insolubility (Clayton and Clayton, 1982). Oral toxicity studies have shown increased incidence of pleuritis and pericarditis, as well as accelerated mortality by the Tarone test. EPA and IARC have not reviewed the carcinogenicity of trichlorofluoromethane.

VANADIUM

Vanadium is extracted from ores by roasting for use in high speed and other alloy steels. Vanadium compounds, including vanadium pentoxide, are used as catalysts in glass manufacturing, and as electrode coating in welding. Vanadium compounds also find uses in dyeing, insecticides, photography, and metallurgy.

Elemental vanadium is poorly absorbed by the body. However, vanadium compunds can result in irritation of the eyes and skin, skin lesions, and a green discoloration of the skin. Vanadium compounds are also irritants of the upper respiratory system, resulting in hemorrhagic rhinitis, tracheitis, chest pain, and, in severe inhalation cases, pulmonary edema. No chronic lung lesions have been associated with vanadium inhalation. Large doses of Vanadium have also been associated with localized vasoconstriction (Clayton and Clayton, 1982). Biochemical studies have shown vanadium to inhibit cholesterol synthesis and cholinesterase activity (Sittig, 1985). Target organs for vanadium pentoxide include respiratory system, skin, and eyes. Vanadium is not classified as a carcinogen.

VINYL CHLORIDE

Vinyl chloride is a volatile organic compound used in the manufacture of polyvinyl chloride and other resins. It is also used as a chemical intermediate and a solvent (Sittig, 1985).

Vinyl chloride is a skin irritant. Reportedly, vinyl chloride can be absorbed dermally, orally, and via inhalation. Vinyl chloride is a CNS depressant; chronic exposure may also cause hepatic damage. Vinyl chloride is classified by EPA as a Group A human carcinogen and has been specifically associated with angiosarcoma of the liver. Experimental evidence also suggests associations with tumors of the liver, lungs, brain, and kidneys (Sittig, 1985).

XYLENES

Xylenes are most commonly used as solvents in paints, lacquers, inks, dyes, adhesives, cements, cleaning fluids, and aviation fuels. They are also used as a chemical feed stock in the manufacture of xylidines, benzoic acid, phthalic anhydride, terephthalic acids, and esters. Other uses include quartz crystal oscillators, hydrogen peroxide, perfumes, insect repellents, resins, and leather preparations. Xylenes may be found as contaminants in almost all petrochemicals (Sittg, 1985).

Xylenes are both eye and skin irritants. They are also readily absorbed through the intact skin. Inhalation of high concentrations can cause vasodilation, CNS depression, and cardiac sensitization to epinephrine. Symptoms include flushing and reddening of the face, dizziness, tremors, confusion, salivation, and cardiac stress. Chronic effects are similar to those of acute exposures, but may also include paresthesia, anorexia, and flatulence. Clinical effects include anemia, mucosal hemorrhage, and bone marrow hyperplasia. Xylenes do pass through the placenta, and there is limited evidence of teratogenic effects (Clayton and Clayton, 1982).

Xylenes are not classified as carcinogens by EPA. IARC has found evidence for carcinogenesis inadequate for both humans and animals.

ZINC

Zinc is a common element and an essential metal not usually noted for toxicity. The average American intake is reported to be approximately 12 to 15 g, mostly from food. About 20 to 30 percent of ingested zinc is absorbed (Casarett and Doull, 1986).
Some zinc salts can be irritants. GI distress has occasionally been reported after ingestion of high zinc concentrations. Metal fume fever can result from inhalation of zinc fumes (Casarett and Doull, 1986). Zinc is not classified as a carcinogen by EPA.