Y/SUB/96-KDS15V/4

Y-12

OAK RIDGE
Y-12
PLANT

LOCKHEED MARTIN

CALENDAR YEAR 1995
GROUNDWATER QUALITY REPORT FOR THE UPPER EAST FORK POPLAR CREEK HYDROGEOLOGIC REGIME
Y-12 PLANT, OAK RIDGE, TENNESSEE

1995 Groundwater Quality Data Interpretations and Proposed Program Modifications

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August 1996

Prepared by

AJA TECHNICAL SERVICES, INC.
Under Purchase Order 70Y-KDS15V

for the

Y-12 Plant Surveillance and Maintenance Program,
Environmental Restoration Division
and the
Y-12 Plant Environmental Management Department
Health, Safety, Environment, and Accountability Organization
Oak Ridge Y-12 Plant
Oak Ridge, Tennessee 37831

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List of Acronyms and Abbreviations

ASO	Analytical Services Organization
BCV	Bear Creek Valley
Bear Creek Regime	Bear Creek Hydrogeologic Regime
bgs	below ground surface
BT	buried tributary
BTEX	benzene, toluene, ethylbenzene, and xylenes
CMP	Comprehensive Monitoring Plan
CY	calendar year
DNAPL	dense, non-aqueous phase liquids
DOE	U.S. Department of Energy
East Fork Regime	Upper East Fork Poplar Creek Hydrogeologic Regime
Energy Systems	Lockheed Martin Energy Systems, Inc. (formerly Martin Marietta Energy Systems, Inc.)
ft	feet
GWPP	Groundwater Protection Program
GWQR	Groundwater Quality Report
HSEA	Health, Safety, Environment, and Accountability (Organization)
ICP	Inductively Coupled Plasma (spectroscopy)
K-25	Oak Ridge K-25 Site
MCL	maximum contaminant level
MDA	minimum detectable activity
msl	mean sea level
µg/L	micrograms per liter
mg/L	milligrams per liter
ORR	Oak Ridge Reservation
PCE	tetrachloroethene
pCi/L	picoCuries per liter
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
SDWA	Safe Drinking Water Act
SESD	Sampling and Environmental Support Department
TCE	trichloroethene
TDEC	Tennessee Department of Environment and Conservation
TDS	total dissolved solids
TSS	total suspended solids
UST	underground storage tank
UEFPC	Upper East Fork Poplar Creek
UTL	upper tolerance limit
VOC	volatile organic compound
WCMBF	Waste Machine Coolant Biodegradation Facility

List of Acronyms and Abbreviations (contd.)

1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethene
1,2-DCA	1,2-dichloroethane
1,2-DCE	1,2-dichloroethene
1,1,1-TCA	1,1,1-trichloroethane
^{99}Tc	technetium-99
^{234}U	uranium-234
^{235}U	uranium-235
^{238}U	uranium-238

1.0 INTRODUCTION

This groundwater quality report (GWQR) contains an evaluation of the groundwater quality data obtained during the 1995 calendar year (CY) at several waste management facilities associated with the U.S. Department of Energy (DOE) Y-12 Plant located on the DOE Oak Ridge Reservation (ORR) southeast of Oak Ridge, Tennessee (Figure 1). These sites lie within the boundaries of the Upper East Fork Poplar Creek Hydrogeologic Regime (East Fork Regime), which is one of three hydrogeologic regimes defined for the purposes of groundwater quality monitoring at the Y-12 Plant (Figure 2). The Environmental Management Department of the Y-12 Plant Health, Safety, Environment, and Accountability (HSEA) Organization manages the groundwater monitoring activities in each regime under the auspices of the Y-12 Plant Groundwater Protection Program (GWPP). The purpose of the GWPP is to characterize the hydrogeology and to monitor groundwater quality at the Y-12 Plant and surrounding area to ensure protection of local groundwater resources in accordance with federal, state, and local regulations, DOE Orders, and Lockheed Martin Energy Systems, Inc. (Energy Systems) corporate policy.

The annual GWQR for the East Fork Regime is completed in two parts. Part 1 consists primarily of data appendices and serves as a reference for the groundwater quality data obtained each CY under the lead of the Y-12 Plant GWPP. Because it contains information needed to comply with reporting requirements of Resource Conservation and Recovery Act (RCRA) interim status assessment monitoring, the Part 1 GWQR is submitted to the Tennessee Department of Environment and Conservation (TDEC) by the RCRA reporting deadline (March 1 of the following CY); Energy Systems submitted the 1995 Part 1 GWQR for the East Fork Regime to the TDEC in February 1996 (Lockheed Martin Energy Systems, Inc. 1996). Part 2 (this report) contains an evaluation of the data with respect to regime-wide groundwater quality.

2.0 BACKGROUND INFORMATION

The East Fork Regime encompasses a portion of Bear Creek Valley (BCV) between a surface water and shallow groundwater divide at the west end of the Y-12 Plant and the ORR boundary along Scarboro Road east of the plant (unless otherwise noted, directions are in reference to the Y-12 Plant grid system) (Figure 2). Bear Creek Valley is flanked to the north by Pine Ridge and to the south by Chestnut Ridge. Ground elevations range from about 1,300 feet (ft) above mean sea level (msl) on the ridge crests to 900 ft msl along Upper East Fork Poplar Creek (UEFPC). The most prominent topographic feature is the gap in Pine Ridge cut by UEFPC northeast of the Y-12 Plant (Figure 3). Industrial facilities and support structures occupy most of the regime, which, for the purposes of this report, is divided into: (1) the Western Plant Area, defined as the portion of the regime west of the Y-12 Plant grid coordinate easting 55,000, (2) the Central Plant Area, defined as the part of the regime between grid coordinate eastings 55,000 and 62,000, and (3) the Eastern Plant Area, defined as the portion of the regime east of grid coordinate easting 62,000 (Figure 3).

2.1 Hydrologic Framework

The following overview of the hydrogeologic system in the East Fork Regime is based on: (1) the conceptual groundwater flow models described in Science Applications International Corporation (1996), (2) the general hydrogeologic framework and associated nomenclature described in Solomon et al. (1992), (3) hydraulic properties and flow characteristics presented in Moore (1988 and 1992), and Moore and Toran (1992); and (4) results of hydrologic studies and investigations in BCV, including Drier et al. (1987), Shevenell (1994), Shevenell et al. (1993), and Goldstrand (1995). Key aspects of the geology in the East Fork Regime, the principal hydrogeologic units and respective groundwater flow characteristics, and the general hydrology of UEFPC are summarized in the following discussion.

2.1.1 Geology

The geology of the East Fork Regime is characterized by alternating sequences of clastic and carbonate strata that form the distinctive topography of the Valley and Ridge Physiographic

Province. Near the Y-12 Plant, shale and siltstone beds of the Rome Formation form Pine Ridge to the north, limestone and shale formations of the Conasauga Group form BCV, and the primarily dolostone formations of the Knox Group form Chestnut Ridge to the south (Figure 3). Strike and dip of bedding are generally N 55°E and 45°SE, respectively (as referenced to true north). Bedrock is overlain by up to 40 ft of several materials, including man-made fill, alluvium, colluvium, fine-grained residuum from the weathering of the bedrock, and saprolite (weathered bedrock). Where undisturbed, the saprolite often retains primary textural features of the unweathered bedrock, including fractures (Solomon et al. 1992).

Extensive cut-and-fill areas within the Y-12 Plant have substantially altered the shallow subsurface throughout much of the East Fork Regime (Figure 4). Most of the fill, which generally consists of a heterogeneous mixture of building debris and recompacted soil/residuum that contains many voids, was placed within the tributaries and main channel of UEFPC (Sutton and Field 1995). In areas where the fill is below the unsaturated zone, the heterogeneous composition and varying thickness (5 to 25 ft) may significantly influence shallow groundwater flow directions and contaminant migration patterns.

2.1.2 Groundwater System

In the Y-12 Plant vicinity, the Rome Formation, the Conasauga Group, and the Knox Group comprise two basic hydrogeologic units: (1) the Aquifer, consisting of the Maynardville Limestone (upper Conasauga Group) and Copper Ridge Dolomite (lower Knox Group), and (2) the Aquitard, consisting of the remaining Conasauga Group formations (Nolichucky Shale, Maryville Limestone, Rogersville Shale, Rutledge Limestone, and Pumpkin Valley Shale) and Rome Formation (Figure 3). The Aquifer floors the axis of BCV (Maynardville Limestone) and forms Chestnut Ridge (Knox Group), and the Aquitard formations form the northern slope of BCV toward Pine Ridge (Figure 3). The Aquitard, which underlies most of the contaminant source areas in the East Fork Regime, is hydraulically upgradient of the Maynardville Limestone, which functions as a hydrologic drain in BCV and provides the principal avenues for contaminant transport.

Fractures provide the primary groundwater flowpaths in both units, but dissolution of carbonates in the Aquifer has enlarged fractures and produced solution cavities and conduits that greatly enhance its hydraulic conductivity relative to the Aquitard. Although negligible in both units, flow through the porous rock matrix plays an important role in contaminant migration because of matrix diffusion processes. Most of the flow in both units is primarily parallel to bedding (along strike and dip), which in the Aquitard may or may not coincide with the direction of maximum hydraulic gradient inferred from water level isopleths. Flow tangent to bedding occurs primarily along permeable zones formed by cross-cutting fractures or fracture zones (and possibly small faults). Some of these cross-cutting structures may act as barriers to lateral flow, causing groundwater from deeper intervals to upwell and discharge to the shallower flow system in each hydrogeologic unit.

Nearly all groundwater flow in the Aquitard occurs within a highly permeable interval near the bedrock/residuum interface (the water table interval). Below the water table interval, flow is most active at depths less than 100-ft below ground surface (bgs); however, contaminants in groundwater more than 100-ft bgs clearly indicate permeable flowpaths at depth. Flow occurs in response to precipitation when flowpaths in the residual soils become saturated and rapidly transmit water laterally (stormflow) down slope toward springs and seeps in drainage features, and vertically (recharge) to the water table interval. Inflow into the water table interval promotes strike-parallel groundwater flow toward discharge areas in nearby cross-cutting streams. Only a small percentage of total flow ultimately recharges to the deeper bedrock, where upward hydraulic gradients predominate.

Decreasing groundwater flux with depth in the Aquitard also is reflected by distinct changes in groundwater geochemistry. Most water table interval and shallow (i.e., <100-ft bgs) bedrock wells monitor calcium-magnesium-bicarbonate groundwater. Based primarily on data obtained in the Bear Creek Hydrogeologic Regime (Bear Creek Regime), a fairly abrupt change to sodium-bicarbonate groundwater occurs at a depth of about 100-ft bgs, and is interpreted to be a function of longer groundwater residence time related to reduced fracture aperture or increased fracture spacing (Solomon et. al. 1992). Another geochemical boundary indicative of reduced groundwater flux is denoted by a transitional change from sodium-bicarbonate groundwater to sodium-chloride groundwater. This transition typically occurs at a depth of about 400-ft bgs, and is usually accompanied by increased total dissolved solids (TDS).

Most groundwater flow in the Aquifer occurs at shallow depths (i.e., <100 ft bgs) in an extensively interconnected maze of solution conduits and cavities (karst network). Flow in the shallow karst network is relatively rapid, and during rainfall, may occur as "quickflow" recharge/discharge toward springs or nearby surface drainage features (Shevenell 1994). Below the shallow karst network, fractures provide the primary flowpaths, and there are important lithologic controls on groundwater flow (Goldstrand 1995). Lithologic and hydrologic characteristics (e.g., porosity) differentiate seven distinct stratigraphic zones (numbered from bottom to top) in the Maynardville Limestone, with the more permeable zones at the bottom (Zone 2) and top (Zone 6) of the formation (Shevenell et al. 1993). Because of vuggy porosity related to dissolution of gypsum nodules, Zone 6 is the most permeable interval and probably transmits the bulk of the groundwater in this formation (Goldstrand 1995)

Active groundwater circulation occurs at greater depth than in the Aquitard, and is reflected by the fairly homogeneous geochemistry of the groundwater; virtually every monitoring well in the Maynardville Limestone, regardless of depth, monitors calcium-magnesium-bicarbonate groundwater. Some shallow wells monitor sulfate-enriched groundwater, which probably reflects dissolution of gypsum and/or locally disseminated sulfides, and several deep wells monitor calcium-magnesium-sulfate groundwater with TDS above 1,000 milligrams per liter (mg/L). Overall, however, the higher hydraulic conductivity and greater groundwater circulation in the Aquifer impart more geochemical homogeneity in comparison to groundwater in the Aquitard.

The water table in the East Fork Regime, under both seasonally high and low flow conditions, is a subdued replica of the ground surface, with steep gradients along the flanks of Pine Ridge and Chestnut Ridge and a gentle slope down the axis of BCV (Figure 5). The overall pattern of groundwater flow is southeast from the Aquitard and Chestnut Ridge toward the Maynardville Limestone, and along strike toward the east end of the Y-12 Plant. At the east end of the regime, flow directions apparently diverge; flow in the water table interval follows UEFPC north through the water gap in Pine Ridge, and flow in the bedrock interval of the Maynardville Limestone continues east along strike toward Union Valley.

Horizontal hydraulic gradients average about 0.038 across BCV (strike-normal) in the Aquitard, and about 0.011 along the axis of BCV (strike-parallel) in the Aquifer (Maynardville

Limestone). Static water level data for several two- and three-well clusters indicate that vertical hydraulic gradients are predominately upward in the Aquitard and downward in the Aquifer, and often reverse in response to seasonal (or episodic) groundwater flow conditions. Upward gradients in the Aquitard average about 0.05, and are highest (0.1 to 0.22) at Maryville Limestone and Rogersville Shale monitoring-well clusters in the northern Central Plant Area. Downward gradients are more common in the Aquifer, with the highest gradients (0.58) indicated by data for wells in the Eastern Plant Area. Vertical gradients are also strongly downward from the water table interval to the shallow bedrock in Aquitard monitoring wells along Scarboro Road at the eastern end of the regime. However, vertical gradients are strongly upward from the deeper (>100 ft) to the shallow bedrock. Vertical gradients (and inferred groundwater flow patterns) in this area probably reflect the hydrologic influence of the bedrock structure associated with the gap in Pine Ridge.

Groundwater flow near Lake Reality is influenced by the cone of depression created during operation of a 6-ft diameter, 20-ft deep sump that was installed in CY 1990 to reduce hydraulic pressure that periodically raises the synthetic liner in Lake Reality. Automatic operation of the sump pump was suspended between September 1991 and October 1993, then returned to automatic control until December 1994 when it was again deactivated because of concerns regarding the quality of the water discharged from the sump. Calculations using water level monitoring data obtained when the sump was temporarily reactivated in July 1995 indicated pumping and recovery rates of about 91 and 38 gallons per minute, respectively (Jago 1995). Water level data from nearby water table and shallow bedrock monitoring wells delineated an elongated water table depression in the Nolichucky Shale oriented parallel with strike, and showed decreased water levels in the Maynardville Limestone along the main channel of UEFPC (Figure 6). The shape of the water table depression reflects the greater permeability of strike-parallel flowpaths (e.g., bedding-plane fractures) in Nolichucky Shale, and decreased water levels in the Maynardville Limestone may indicate enhanced permeability along a fracture zone associated with UEFPC.

2.1.3 Surface Water System

Surface water in the East Fork Regime is drained by UEFPC, which was extensively altered and modified during construction of the Y-12 Plant (Figure 4). The headwaters and several thousand feet of the main channel in the upper reach of the creek, including all the northern tributaries of the creek in the Western Plant Area and Central Plant Area, were filled and replaced with an extensive network of underground storm drains. For reference purposes, each buried tributary (BT) of UEFPC is designated with a value representing the tributary number counted downstream from the headwaters (e.g., BT-1).

The underground network of storm drains in the Western Plant Area and Central Plant Area direct surface runoff into the exposed portion of the main channel of UEFPC about 3,000-ft west of New Hope Pond. This section of the creek was straightened during construction of the Y-12 Plant and modified in the early 1960s to direct surface runoff and storm-drain discharge into New Hope Pond, which was designed to regulate the flow and quality of water exiting the Y-12 Plant. These functions are currently performed by Lake Reality, a lined surface impoundment constructed to replace New Hope Pond after its approved RCRA closure in 1988. Water enters Lake Reality from an extension of the New Hope Pond inlet diversion ditch, and exits through a weir in the west berm. The total surface area of Lake Reality is about 2.5-acres, and with an average water depth of 7-ft, contains approximately 6-million gallons of water during normal operations. From the outfall at Lake Reality, UEFPC passes north through a gap in Pine Ridge and exits the ORR.

The bulk (70%) of dry-weather flow in UEFPC is attributable to once-through non-contact cooling water, condensate, and cooling tower blowdown. The remaining 30% is from groundwater discharge (CDM Federal Programs Corporation 1994).

2.2 Contaminant Source Areas

There are multiple potential sources of groundwater contamination within the East Fork Regime, including hazardous and non-hazardous waste treatment, storage, or disposal sites; bulk product transfer, storage, and use areas; and the many process pipelines, effluent drains, and utilities associated with the industrial operations at the Y-12 Plant. Groundwater contaminants include inorganic compounds (e.g, nitrate), trace metals (e.g., barium), volatile organic compounds (VOCs), and radioactivity. Known and suspected sources of each major type of groundwater contaminant are summarized below.

Potential Source Areas	Types of Groundwater Contaminants			
	Inorganics	Trace Metals	VOCs	Radioactivity
Western Plant Area				
S-3 Site Eastern Plume	★	★	★	★
Abandoned Nitric Acid Pipeline	?	.	.	?
Rust Garage Area	.	.	★	.
Y-12 Plant Salvage Yard	.	★	★	.
Mercury Process Spill Areas	.	?	.	.
Interim Drum Yard	.	.	★	.
Fire Training Facility	.	.	★	.
S-2 Site	★	★	★	.
Waste Coolant Processing Facility	.	.	★	.
Central Plant Area				
Tank 0134-U	.	.	✓	.
Tank 2331-U	.	.	★	.
Bldg. 9212 Complex (CMP Grid D2)	?	?	★	.
Unspecified (CMP Grid E2)	?	?	?	.
Unspecified (CMP Grid E3)	?	?	?	.
Unspecified (CMP Grid F3)	?	?	?	.
Unspecified (CMP Grid G3)	?	?	?	.
Unspecified (CMP Grid H3)	?	?	?	.
Eastern Plant Area				
Building 9754-2 Fuel Facility	.	.	★	.
Unspecified (CMP Grid J3)	.	.	?	.
Unspecified (EXP-I)	.	.	?	.
Unspecified (EXP-J)	.	.	?	.
Oil Skimmer Basin (New Hope Pond)	.	★	★	★

★=Confirmed source; ?=Suspected source; ✓=Migration from unspecified, upgradient source; CMP=Comprehensive Monitoring Plan

The sites in the Western Plant Area are all confirmed or suspected sources of the specified groundwater contaminants. Sources of the groundwater contamination in the Central Plant Area include former petroleum fuel underground storage tanks (USTs), the Building 9212 complex and other unspecified sources indicated by data obtained from the Comprehensive Monitoring Plan (CMP) grid-well network (see Section 2.3). Groundwater contamination at New Hope Pond primarily reflects downgradient transport in the Aquifer from upgradient source areas. Locations of the known and suspected source areas are shown on Figure 7, and brief site descriptions are provided below. More thorough descriptions of many of the sites, including the regulatory status and operational history, and references for technical reports containing additional site-specific details are provided in Section 2 of the Part 1 GWQR.

S-3 Site Eastern Plume

The S-3 Site Eastern Plume (hereafter called the S-3 Site Plume) is a reservoir of contamination in the Aquitard that was emplaced during operation of four contiguous surface impoundments (the S-3 Ponds) located in the Bear Creek Regime near the west end of the Y-12 Plant (Figure 7). Each of the 400 x 400 x 17-ft ponds were used primarily for percolation/evaporation of nitric acid effluent (with depleted uranium in solution) transferred to ponds primarily via the Abandoned Nitric Acid Pipeline.

Operation of the former S-3 Ponds between 1951 and 1983 created a mound in the water table, substantially reduced the groundwater pH (which dissolved carbonate within bedrock), and emplaced a large reservoir of contamination in the Nolichucky Shale. Contaminants were driven downward by the hydraulic head in the ponds and the greater density of the acidic effluent, and transported laterally (east and west) by predominantly strike-parallel groundwater flowpaths and the hydraulic gradients induced by the mound in the water table. Neutralization and denitrification of the acidic effluent during closure of the S-3 Site produced several feet of sludge, which was stabilized with coarse aggregate and left in place when the ponds were filled, graded, and capped per the approved RCRA closure plan. The sludge is below the saturated zone and may remain an active source of groundwater contamination (Science Applications International Corporation 1996), but the shallow groundwater divide at the west end of the Y-12 Plant now probably precludes additional migration of contaminants into the East Fork Regime from the source area.

The principal components of the S-3 Site Plume are nitrate, technetium-99 (^{99}Tc), uranium isotopes (primarily ^{234}U and ^{238}U), trace metals (e.g., barium), and several VOCs including tetrachloroethene (PCE), acetone, chloroform, and methylene chloride. In the Bear Creek Regime, nitrate and ^{99}Tc are the "signature" S-3 Site contaminants because it is the only known (or significant) source area in the regime. In the East Fork Regime, however, only ^{99}Tc may be confidently considered a "signature" contaminant from the S-3 Site Plume because: (1) there are other confirmed (e.g., S-2 Site) and potential (e.g., Abandoned Nitric Acid Pipeline and associated buildings) nitrate sources in the regime, and (2) ^{99}Tc-bearing wastes were not generated by Y-12 Plant operations (they were shipped in tanker trucks from the Oak Ridge K-25 Site and off-loaded into the former S-3 Ponds).

Abandoned Nitric Acid Pipeline

The Abandoned Nitric Acid Pipeline was used between 1951 and 1983 to transport nitric acid effluent to the S-3 Site (Figure 7). The pipeline originally transported effluent from operations in Buildings 9212 and 9206, and later was connected to the uranium recovery process lines at the H-1 Foundry (Building 9998). Most of the pipeline consists of 1.5- to 3-inch diameter, Type 347 stainless-steel pipe (some sections were 6-inch diameter) buried up to 14-ft bgs. Sections of the pipeline that passed over water or sewer lines were encased in concrete. Based on its operational history, nitrate and uranium isotopes are the most likely groundwater contaminants.

Rust Garage Area

The Rust Garage Area is located between the S-3 Site and the Y-12 Plant Salvage Yard (Figure 7). Building 9754-1 at the Rust Garage formerly housed a fueling station that included four USTs with associated subsurface piping: a 12,000-gallon gasoline tank (Tank 1222-U), an 8,000-gallon gasoline tank (Tank 2028-U), a 12,000-gallon diesel fuel tank (Tank 1219-U), and a 1,000-gallon used oil tank (Tank 2068-U). Releases of gasoline and diesel fuel during operation of the refueling station produced a plume of dissolved benzene, toluene, ethylbenzene, and xylenes (BTEX) in the shallow groundwater that has intermingled with the S-3 Plume.

Y-12 Plant Salvage Yard

The Y-12 Plant Salvage Yard includes several known and suspected sources of groundwater contamination, including: the Scrap Metal Storage Area, the Oil/Solvent Drum Storage Area, the Oil Storage Tanks, the Drum Deheader, and three concrete sumps designated Tanks 2063-U, 2328-U, and 2329-U (Figure 7). Much of the groundwater contamination beneath the site is attributable to the S-3 Site Plume; however, several areas within the Y-12 Plant Salvage Yard, particularly the

Drum Deheader and the concrete sumps, are confirmed sources of PCE, trichloroethene (TCE), and 1,2-dichloroethene (1,2-DCE) in the groundwater.

Interim Drum Yard

The Interim Drum Yard is a graveled, covered, and diked outdoor staging area used to store drums containing various hazardous, mixed, and non-hazardous wastes including chromium and mercury-contaminated sludge, chlorinated and non-chlorinated organics, and plating solutions (Figure 7). The site presently contains approximately 700 drums of waste, all in overpacks. Groundwater monitoring data obtained during the late-1980s showed VOCs (primarily carbon tetrachloride and chloroform) in the groundwater immediately south and west of the site.

Waste Coolant Processing Area

The Waste Coolant Processing Area is used to treat waste coolants collected from various shops within the Y-12 Plant (Figure 7). It originally consisted of the Waste Machine Coolant Biodegradation Facility (WMCBF), an unloading/storage area, and a treatment basin/effluent drain field, but the WMCBF and the treatment basin/effluent drain field were closed in 1985. Operation of the facility has emplaced a plume of dissolved VOCs in the shallow groundwater. Components of the plume include PCE, TCE, 1,2-DCE, 1,1-dichloroethene (1,1-DCE), 1,1,1-trichloroethane (1,1,1-TCA), 1,1-dichloroethane (1,1-DCA), and vinyl chloride. The site is the only confirmed source of chloroethanes in the groundwater throughout the East Fork Regime.

Fire Training Facility

At the Fire Training Facility, located on the southern flank of Chestnut Ridge west (upgradient) of the S-2 Site (Figure 7), chlorinated solvents and other flammable materials were placed in shallow pans and burned for training purposes. Monitoring wells were installed near the site and subsequent sampling confirmed the site as a probable source of PCE, 1,2-DCE, and TCE in the Aquifer at the east end of the Bear Creek Regime and the west end of the East Fork Regime.

S-2 Site

The S-2 Site is an unlined reservoir used from 1945 to 1951 for percolation, evaporation, or neutralization of an unknown quantity of liquid wastes (Figure 7). Waste materials reportedly included nitrates of aluminum, copper, nickel, and chromium; sulfates; diethyl ether and pentaethers; nitric, hydrochloric, and sulfuric acids; dibutyl carbinol and tributyl phosphates; hydrogen fluoride; cadmium; natural and enriched uranium; and cyanide compounds. After closure in 1951, the remaining liquids were neutralized, and the reservoir was filled with soil and seeded with grass. Groundwater data obtained since the mid-1980s confirm the S-2 Site as a source of nitrate, cadmium, cobalt, copper, and VOCs (PCE and TCE) in the Aquifer.

Tank 0134-U

Tank 0134-U was a 117-gallon gasoline UST that serviced emergency electrical power generation equipment at Building 9204-2 (Figure 7). Holes were observed in the tank when it was removed in 1989, and a dissolved BTEX plume was subsequently identified in the groundwater. As a result of tank removal and other remedial actions performed in compliance with TDEC regulations, dissolved BTEX concentrations in the shallow groundwater at the site were below respective analytical reporting limits by December 1991. Additionally, TCE in the shallow groundwater at the site probably reflects migrations from an upgradient source (possibly Building 9204-2), and substantial differences between TCE concentrations (which were unaffected by removal of the tank) in wells only 70-ft apart suggest preferential migration along a nearby utility line or storm drain (HSW Environmental Consultants, Inc. 1993). Based on its operational history, elevated gross alpha activity in the groundwater at Tank 0134-U also probably reflects migration of radionuclides (probably uranium isotopes) from an upgradient source area.

Tank 2331-U

Tank 2331-U was a 560-gallon gasoline UST installed in 1973 to service gasoline-powered equipment in Building 9201-1 (Figure 7), and was emptied, excavated, and removed in December 1988. Free product was not observed when the tank was excavated, but leak tests performed in

September 1988 indicated that the tank had released product into the subsurface, and a dissolved BTEX plume was subsequently delineated in the shallow groundwater at the site.

Z-Oil System

The Z-Oil System consists of several pumping houses, cooling towers, above-ground storage tanks, and above-ground piping that have been used since 1943 as the coolant system for Calutron magnetic separators (Martin Marietta Energy Systems, Inc. 1990). The bulk of the Z-Oil System is located along the southern boundary of the Y-12 Plant. Most components of the system were dismantled, but some are still in use. Numerous releases from the Z-Oil System have been documented, and historical photographs show oil-stained soils and surficial pools of oil at an above ground Z-Oil storage tank formerly located about 50 ft northwest of Tank 2331-U (Building 9201-1 was extended over the former tank location). Samples of Z-Oil that seeped into a pit excavated when Tank 2331-U was removed contained numerous VOCs, including 1,1-DCA, acetone, and 1,1,2,2-tetrachloroethane (Brumback 1994).

Building 9754-2 Fuel Facility

The Building 9754-2 Fuel Facility (Figure 7) was used from 1978 to 1989 to dispense gasoline and diesel fuel from two USTs: a 20,000-gallon tank containing unleaded gasoline (Tank 0439-U), and a 10,000-gallon diesel fuel tank (Tank 0440-U). Both tanks were in an unlined, gravel-filled pit about 12-ft deep. The top of the tank pit was open to precipitation and surface runoff, which drained from the pit into a nearby collection basin. Free product was observed in the collection basin in June 1989, and for several weeks free product and contaminated groundwater were regularly pumped from a sump installed next to the tank pit; both tanks were removed from the pit in September 1989. Data for monitoring wells installed at the site indicated a fairly limited dissolved BTEX plume, and elevated cadmium and cobalt concentrations in the shallow groundwater (HSW Environmental Consultants, Inc. 1993).

Garage Underground Tanks

The Garage Underground Tanks were located about 100-ft north of the old Building 9754 Fuel Facility (which predated the Building 9752-2 Fuel facility). The site originally included a 10,000-gallon diesel fuel tank and a 10,000-gallon leaded gasoline tank; a 20,000-gallon unleaded gasoline tank was installed at the site in 1975. The fuel tanks gravity-fed three 1,000-gallon tanks at dispenser island in front of the former Building 9754-2 Fuel Facility. In 1978, the dispenser tanks were emptied and the three fuel tanks were converted to waste oil storage. All three USTs were excavated and removed in October 1989.

Oil Skimmer Basin

As noted in the previous section, New Hope Pond was constructed in 1963 to regulate the flow and quality of water in UEFPC. To provide a contingency for control of accidental releases of oils or other substances within the Y-12 Plant, an oil skimmer at the inlet to the pond was equipped with a boom that diverted oils and floating debris into a 25 x 40-ft retention basin. A weir at the outlet of the Oil Skimmer Basin retained the oil and debris for subsequent removal and disposal. Direct hydraulic connection between the basin and shallow groundwater observed during installation of nearby monitoring wells strongly suggest that the Oil Skimmer Basin is a source of PCE, TCE, and 1,2-DCE (and possibly uranium) in the shallow groundwater immediately upgradient of New Hope Pond.

Unspecified Source Areas

Available data indicate several unspecified sources of groundwater contamination in the Central Plant Area and the Eastern Plant Area (Figure 7). Most are probably associated with industrial processes and operations housed in nearby buildings, such as Building 9212 (PCE in the groundwater at CMP Grid D3), Building 9204-2 (TCE in the Aquitard monitoring wells at Tank 0134-U), and Building 9206 (chloroethenes and chloromethanes in the water table and shallow bedrock at CMP Grid E3). Buildings 9202, 9203, and 9205 housed operations which required large amounts of carbon tetrachloride (ChemRisk 1993), and are the probable source(s) of chloromethanes in the groundwater at CMP Grid G3. Additionally, chlorinated solvents and other industrial chemicals were shipped to the Y-12 Plant in railroad tankers, and bulk transfer/handling areas along railroad spurs within the plant may also be sources of VOCs in the shallow groundwater.

2.3 Groundwater Contamination

Conceptual models for groundwater flow and contaminant transport in the Aquitard and the Aquifer, as described in the *Remedial Investigation Report for Bear Creek Valley* (Science Applications International Corporation 1996), and groundwater quality data obtained through implementation of the *Comprehensive Groundwater Monitoring Plan for the U.S. Department of Energy Y-12 Plant* (Comprehensive Monitoring Plan) (Geraghty & Miller, Inc. 1990) provide the basis for the following overview of groundwater contamination in the East Fork Regime. Groundwater quality data are primarily for: (1) water table interval and shallow bedrock (i.e., <100-ft bgs) monitoring wells , (2) Aquitard monitoring wells installed for site-specific (i.e., regulatory) purposes or as part of the grid-well network recommended in the CMP, and (3) Aquifer monitoring wells installed for site-specific purposes in the Western Plant Area and Eastern Plant Area (the Aquifer portion of the CMP grid-well network has not been completed in the Central Plant Area). As described in the following sections, the extent of nitrate essentially illustrates groundwater transport patterns in the Aquitard, dissolved VOC plumes generally reflect multiple source areas and illustrate groundwater transport patterns in the Aquifer, and transport of trace metals and radionuclides is generally less extensive compared to that of nitrate and VOCs.

2.3.1 Nitrate

Based on the distribution of nitrate, the S-3 Plume extends more than 100-ft bgs and at least 2,500-ft east of the S-3 Site (Figure 8). Nitrate (as N) concentrations (hereafter synonymous with "nitrate" concentrations) within the plume exceed 10,000 mg/L. Highly mobile and chemically stable in groundwater, nitrate essentially traces the primary transport pathways for all groundwater contaminants from the S-3 Site plume, particularly in the bedrock. Based on the conceptual model for groundwater flow and contaminant transport at the S-3 Site (Science Applications International Corporation 1996), nitrate concentrations in the Aquitard generally reflect the following groundwater transport pattern:

- Strike-parallel transport in the water table interval, shallow bedrock (i.e., <100-ft bgs), and deeper bedrock toward the buried headwaters of UEFPC located about 500-ft east of the S-3 Site;

- Discharge from the water table interval into the buried headwaters, which channels contaminated groundwater toward the southeast, and upward migration from the deep bedrock into the shallow bedrock, and from the shallow bedrock to the water table interval;

- Eastward, strike-parallel transport in the water table interval and shallow bedrock toward a buried tributary of UEFPC (BT-1) located between the Y-12 Plant Salvage Yard and the Waste Coolant Processing Area about 1,800-ft east of the S-3 Site;

- Discharge from the water table interval into BT-1 (which channels the bulk of the contaminated shallow groundwater toward the southeast), and strike-parallel transport in the shallow bedrock beneath the buried tributary; and

- Eastward, strike-parallel transport in the shallow bedrock toward a buried tributary of UEFPC (BT-2) located between Building 9204-4 and Building 9204-5 about 2,700-ft east of the S-3 Site.

Buried tributaries of UEFPC elsewhere in the East Fork Regime may similarly influence groundwater flow and contaminant migration patterns.

In the Bear Creek Regime, nitrate concentrations exceed 10 mg/L in Aquifer monitoring wells more than 9,000-ft southwest of the S-3 Site. In the East Fork Regime, however, nitrate concentrations are below 5 mg/L in Aquifer monitoring wells only 500-ft southeast of the S-3 Plume (Figure 8). Considering the similarly high nitrate concentrations (>10,000 mg/L) in the Aquitard both east and west of the S-3 Site, the general lack of nitrate in the Aquifer east of the site suggests less directly connected migration pathways, and/or greater flux to the west during operation of the S-3 Site. Low nitrate concentrations in the Aquifer east of the S-3 Site also may reflect dilution by recharge of nitrate-free surface runoff and daily process water discharge from the Y-12 Plant (which provides the bulk of dry-weather flow in UEFPC).

2.3.2 Volatile Organic Compounds

Because of their relative mobility in groundwater and influx from multiple sources, several VOCs are the most pervasive contaminants in the East Fork Regime. Chloroethenes (primarily PCE, TCE, and 1,2-DCE) are the principal components of dissolved VOC plumes in the Western Plant Area and the Central Plant Area. Chloromethanes (primarily carbon tetrachloride and chloroform) are primary plume components in the Eastern Plant Area. Some of the VOCs (e.g., chloroform) are probably degradation products of parent compounds (e.g., carbon tetrachloride) within the plumes. Concentrations of plume constituents exceed 1% of respective maximum solubilities and indicate dense, non-aqueous phase liquids (DNAPL) in the Aquitard at the Waste Coolant Processing Area (1,1,1-TCA), and unspecified source areas upgradient of CMP Grid D3 (PCE) and Tank 0134-U (TCE), and in the Aquifer near the unspecified source(s) of carbon tetrachloride upgradient of New Hope Pond.

The distribution of dissolved VOCs in the Aquitard generally reflect the migration patterns indicated by the nitrate plume, with strike-parallel transport in the water table interval and shallow bedrock toward the headwaters and buried tributaries of UEFPC, which direct the plumes into the Aquifer (Figure 8). Limited cross-strike migration in areas between these buried drainage features, which is suggested by the apparently separate, strike-oriented plume of dissolved chloroethenes in the shallow groundwater at the Salvage Yard Drum Deheader, further indicate their strong influence on contaminant transport patterns. Also, the vertical hydraulic gradients characteristic of the Aquitard in many areas indicate upward migration from sources in the deeper bedrock, which further supports evidence of widespread DNAPL occurrence in the subsurface.

Although VOC data for the Central Plant Area are limited, results for the current network of Aquifer monitoring wells indicate a heterogeneous dissolved VOC plume in the water table interval/shallow bedrock extending eastward from the Fire Training Facility in the Western Plant Area to New Hope Pond in the Eastern Plant Area, and in the shallow and deep bedrock up to 2,000-ft east of the ORR boundary (Figure 8). Based on applicable aspects of conceptual groundwater flow and contaminant transport models for the Maynardville Limestone in the Bear Creek Regime (Science Applications International Corporation 1996), the extent of dissolved VOCs suggest the following general migration pattern:

- Direct influx of chloromethanes from the Interim Drum Yard (or nearby source) into the lower Maynardville Limestone, and direct influx of chloroethenes from the Fire Training Facility and S-2 Site into the upper Maynardville Limestone;

- Additional influx of chloroethenes into the water table interval/shallow bedrock (lower Maynardville Limestone) via groundwater inflow from the Nolichucky Shale, including inflow from the buried UEFPC headwaters east of the S-3 Site, the buried tributary west of the Waste Coolant Processing Area (BT-1), and the buried tributary between Building 9204-4 and Building 9204-5 (BT-2);

- Groundwater transport along strike in the water table interval/shallow bedrock of the Aquitard (downward hydraulic gradients also indicate down-dip migration vectors);

- Influx of chloroethenes and chloromethanes into the water table interval/shallow bedrock via groundwater inflow from suspected VOC source areas near the Nolichucky Shale/Maynardville Limestone contact, including groundwater discharge into the Maynardville Limestone from nearby buried tributaries of UEFPC (BT-6, BT-7, and BT-8);

- Influx of BTEX from Tank 2331-U via direct recharge into the water table interval/shallow bedrock (mid- Maynardville Limestone), but apparently limited transport (or extensive dilution) in the groundwater;

- Influx of chloromethanes (i.e., carbon tetrachloride) via direct recharge into the upper Maynardville Limestone (possibly including down-dip migration of DNAPL) from unspecified source(s) in the Central or Eastern Plant Area upgradient of New Hope Pond;

- Strike-parallel transport in the water table interval, shallow bedrock, and deep bedrock of the Maynardville Limestone toward New Hope Pond;

- Direct influx of chloroethenes from the former Oil Skimmer Basin into the water table interval/shallow bedrock at New Hope Pond, and inflow of chloroethenes from the unspecified source area(s) in the Aquitard near CMP Grid J3; and

- Divergent transport patterns in groundwater at New Hope Pond, with chloroethenes in the water table interval/shallow bedrock transported northeast toward Lake Reality, particularly along the UEFPC diversion channel, but continued eastward transport of chloromethanes (carbon tetrachloride and chloroform) along intermediate and deep groundwater flowpaths in the upper Maynardville Limestone.

Hydrologic interaction with buried utility lines and subsurface drains also probably influence migration of VOCs in the shallow groundwater.

2.3.3 Trace Metals

Trace metals are the least extensive groundwater contaminants in the East Fork Regime, and occur primarily in the low pH S-3 Site plume. Components of the plume include not only metal ions and/or ion-complexes that are usually not mobile (or more readily attenuated) in less acidic groundwater (beryllium, cadmium, cobalt, manganese, mercury, and nickel), but also metals that are mobile under a wider range of groundwater pH conditions (barium, boron, strontium, and uranium). Some of these metals were entrained in the acidic wastes disposed at the site (e.g., uranium), and others were dissolved from the underlying saprolite and bedrock (e.g., barium). Maximum concentrations within the plume exceed applicable water quality standards by an order-of-magnitude or more. Additionally, erratic concentration changes characteristic of some metals possibly reflect an association with colloidal particles, as opposed to changes in the hydrochemical transport of dissolved solutes (McCarthy 1992).

Analytical results from monitoring wells in the Y-12 Plant Salvage Yard reflect strike-parallel transport of mobile trace metals (e.g., barium) in the water table interval, shallow bedrock, and deep bedrock to the east of the S-3 Site, and migration patterns similar to that of nitrate. Low trace metal concentrations in the groundwater at the Waste Coolant Processing Area suggest that the bulk of the S-3 Plume in the water table interval discharges into BT-1.

As shown in the following summary, elevated concentrations of boron, cadmium, cobalt, copper, lead, mercury, strontium, and uranium occur in the groundwater elsewhere in the East Fork Regime, but only the S-2 Site is a confirmed source area.

Known/Suspected Source Area	**Trace Metal**								
	Bo	**Cd**	**Co**	**Cu**	**Pb**	**Mn**	**Hg**	**Sr**	**U**
S-2 Site	.	★	★	★	★	.	★	.	★
Tank 0134-U	.	.	✓	.	.	✓	.	.	✓
Tank 2331-U	.	.	.	.	.	.	.	.	✓
Unspecified (CMP Grid E3 and F3)	?	.	.	.	.	.	.	.	.
Building 9754-2 Fuel Facility	.	?	?	.	.	?	.	.	.
Oil Skimmer Basin	✓	.	.	.	✓.	.	✓	✓	✓

★=Confirmed source; ?=Suspected source; ✓=Migration from unspecified, upgradient source

Available data do not indicate extensive transport in the groundwater from any of the above confirmed or suspected source areas. This suggests that the unspecified trace metal source areas are probably not far upgradient of Tank 0134-U and Tank 2331-U. Trace metals in the groundwater near New Hope Pond probably reflect both groundwater and surface water transport from one or more upgradient source areas in the Y-12 Plant.

2.3.4 Radioactivity

Results for gross alpha and gross beta activity indicate groundwater contamination in: (1) the Aquitard (S-3 Plume) in the Western Plant Area, (2) the Aquifer at the S-2 Site and near the Tank 2331-U site in the Central Plant Area, and (3) the Aquifer near New Hope Pond in the Eastern Plant Area (Figure 8). As noted in Section 2.2, the S-3 Plume is a confirmed source of uranium isotopes (primarily U^{234} and U^{238}) and ^{99}Tc. Gross alpha activity and gross beta activity within the S-3 Plume generally reflect the relative migration of uranium isotopes and ^{99}Tc, respectively, and show strike-parallel transport in the water table interval, shallow bedrock, and deep bedrock toward the headwaters of UEFPC and the buried tributary (BT-1) west of the Waste Coolant Processing Area. Like nitrate, available data generally show relatively low gross alpha and gross beta activity (although ^{99}Tc is nearly as mobile as nitrate in groundwater) in the Aquifer downgradient of the S-3 Plume. Gross alpha activity also decreases rapidly in the groundwater downgradient of the other confirmed source area (the S-2 Site), which suggests that the alpha activity in the groundwater at Tank 2331-U and New Hope Pond reflect similarly limited migration of uranium isotopes from the upgradient, unspecified source areas.

3.0 CY 1995 GROUNDWATER AND SURFACE WATER SAMPLING

Groundwater and surface water sampling in the East Fork Regime during CY 1995 was performed in general accordance with the *Sampling and Analysis Plan for Groundwater and Surface Water Monitoring at the Y-12 Plant during Calendar Year 1995* (Sampling and Analysis Plan) (HSW Environmental Consultants, Inc. 1994). Deviations from the Sampling and Analysis Plan were documented in addenda issued by the Y-12 Plant GWPP Manager throughout the year. The following sections provide an overview of these monitoring activities, including information regarding the sampling locations, frequency, and procedures, analytical parameters, and a discussion of the results of quality assurance/quality control (QA/QC) sampling.

3.1 Sampling Locations

Groundwater and surface water samples were collected from a total 97 monitoring wells, one spring, and one surface water station (Table 1). Four additional monitoring wells were sampled solely for fecal coliform analyses and are not included in the scope of this report. As described in Section 3.1 of the Part 1 GWQR, sampling was performed for the purposes of the monitoring programs listed below (Energy Systems 1996), and some of the wells were sampled to meet requirements of more than one regulatory driver.

Monitoring Programs	Monitoring wells	Springs	Surface Water Stations
RCRA Interim Status Assessment Monitoring	9	.	.
DOE 5400.1 Exit Pathway and Perimeter Monitoring	19	1	1
DOE Order 5400.1 Surveillance Monitoring	59	.	.
Best-Management Practice Monitoring	10	.	.

Sampling locations are shown on Figure 9. Selected construction information for the monitoring wells is summarized on Table 2; detailed well construction data are provided in Appendix C of the Part 1 GWQR.

3.2 Sampling Frequency

Groundwater and surface water samples were collected during each quarter of CY 1995; first through fourth quarter sampling events were performed January 19 to March 22, May 8 to June 29, July 13 to September 28, and October 30 to December 14, respectively. The number of sampling locations included in each quarterly sampling event varied depending on the requirements of the governing monitoring programs (Table 1). Overall, groundwater samples were collected quarterly from 93 wells, semiannually from the surface water station, and once from 4 wells and one spring. Fourteen wells that were sampled quarterly were dropped from monitoring program after the second quarter sampling event.

3.3 Sample Collection

Personnel from the Oak Ridge K-25 Site (K-25) Sampling and Environmental Support Department (SESD) collected groundwater samples from the monitoring wells; personnel from the Y-12 Plant Compliance Monitoring Services Section of the HSEA Organization assisted with collection of samples from the spring and surface water station. Sampling was performed in accordance with the most recent version of the technical procedure for groundwater sampling (SESD-TP-8204) and surface water sampling approved by the Y-12 Plant GWPP Manager.

Filtered and unfiltered samples were collected from each location; filtering was performed in the field with an in-line 0.45 micron filter. To reduce the potential for cross-contamination, samples were generally collected in sequence from the least contaminated wells to the most contaminated wells in each sampling group (a series of monitoring wells grouped for sampling and data-tracking purposes).

Quality assurance/quality control samples included 113 laboratory blanks, 165 trip blanks, four field blanks, 37 equipment rinsate samples, and 36 duplicate groundwater samples. Laboratory blanks were samples of deionized water analyzed along with a specific number of associated groundwater and surface water samples. Trip blanks were samples of deionized water transported in each cooler containing groundwater and surface water samples scheduled for VOC analysis. Field blanks were samples of deionized water collected at the well head before samples were collected from selected wells. Equipment rinsates were samples of the deionized water used to decontaminate the groundwater sampling equipment, and were collected after a sampling team had completed sampling at a site or finished a sampling group. If more than one pump was used to collect the groundwater samples within a sampling group, an equipment rinsate sample was collected from each pump.

3.4 Laboratory Analysis

The bulk of the groundwater and surface water samples collected during CY 1995 were analyzed for a standard suite of analytes that included:

- principal cations (calcium, magnesium, potassium, and sodium) and anions (carbonate and bicarbonate alkalinity, chloride, fluoride, nitrate, and sulfate);
- trace metals (the term used to differentiate metals that are typically minor groundwater constituents, such as cobalt and nickel, from metals that occur as principal ionic constituents, such as magnesium and sodium);
- VOCs;
- gross alpha activity and gross beta activity;
- total suspended solids (TSS), TDS, and turbidity;
- field and laboratory determinations of pH and specific conductance, and;
- field determinations of temperature, dissolved oxygen, and oxidation-reduction potential.

Unfiltered groundwater and surface water samples were analyzed for the entire standard suite of constituents and parameters; filtered samples were analyzed only for the principal cations and trace metals. Samples collected for special purposes (e.g., in Union Valley) were analyzed for targeted parameters. Analytical results for all groundwater and surface water samples are presented in Appendix E of the Part 1 GWQR.

Laboratory blanks, trip blanks, field blanks, and equipment rinsate samples were analyzed for VOCs; selected equipment rinsates were also analyzed for nitrate, trace metals, gross alpha and gross beta activity, and selected radionuclides. Analytical results are summarized in Appendix L of the Part 1 GWQR. Duplicate groundwater samples were analyzed for the constituents and parameters specified for the well from which the duplicate sample was collected. Analytical results for the duplicate samples are presented in Appendix F of the Part 1 GWQR.

Most of the laboratory analyses were performed by the K-25 Analytical Services Organization (ASO). Selected radiochemical analyses were performed by the Oak Ridge National Laboratory ASO.

3.5 Quality Assurance/Quality Control Sampling

Review of the CY 1995 data reported for the laboratory blanks, trip blanks, field blanks, and equipment rinsate samples shows continued improvement by the K-25 ASO with regard to laboratory contamination of QA/QC samples, but also indicates systemic problems with VOC-contamination of the source of deionized water used to prepare trip blanks and decontaminate sampling equipment.

One or more of eleven VOCs were detected in 20 (18%) of the laboratory blanks, 142 (86%) of the trip blanks, three of four field blanks, and 27 (73%) of the equipment rinsate samples (Table 3). These compounds included: (1) four common laboratory reagents (acetone, 2-butanone, methylene chloride, and toluene), (2) five compounds (1,1,1,-TCA, 1,2-dichloroethane[1,2-DCA], 1,2-DCE, PCE, and TCE) which are the primary VOCs present in the groundwater in the East Fork Regime (VOC plume constituents), and (3) two compounds (2-hexanone and xylenes) that are neither common laboratory reagents nor primary VOC plume constituents.

Common laboratory reagents were detected in 19 (17%) of the laboratory blanks, 38 (23%) of the trip blanks, and ten (26%) of the equipment rinsate samples. As in previous years, acetone, 2-butanone, and methylene chloride were detected most frequently (Table 3). However, as summarized below, the very low percentages of QA/QC samples with methylene chloride collected in 1994 and 1995 contrast with historical results.

Calendar Year	Percent of Samples with Methylene Chloride		
	Laboratory Blanks	Trip Blanks	Equipment Rinsates
1992	37	52	33
1993	37	26	30
1994	14	11	8
1995	4	12	5

The overall reduction in the number of QA/QC samples containing methylene chloride (and other laboratory reagents) illustrates improved performance of the K-25 ASO with regard to laboratory contamination of QA/QC samples.

Five VOC plume constituents were detected in the QA/QC samples: 1,1,1-TCA in 135 (82%) of the trip blanks, two (50%) of the field blanks, and 22 (59%) of the equipment rinsate samples; PCE in one laboratory blank and one trip blank; 1,2-DCE in two trip blanks; TCE in one trip blank; and 1,2-DCA in one laboratory blank (Table 3). As summarized below, 1,1,1-TCA was detected in at least half of the trip blanks, field blanks, and equipment rinsate samples analyzed each quarter of CY 1995, including all but seven of the trip blanks, one field blank, and five of the equipment rinsate samples that contained any VOCs.

Type of QA/QC Sample	Number of Samples				
	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual Total
Laboratory Blanks					
Total:	32	29	29	23	113
with VOCs:	5	2	5	8	20
with 1,1,1-TCA:	0	0	0	0	0
Trip Blanks					
Total:	47	45	35	38	165
with VOCs:	45	40	23	34	142
with 1,1,1-TCA:	43	40	22	30	135

Type of QA/QC Sample	Number of Samples				
	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual Total
Equipment Rinsates					
Total:	9	9	7	11	36
with VOCs:	8	5	5	9	27
with 1,1,1-TCA:	8	5	2	7	22
Field Blanks					
Total:	1	1	1	1	4
with VOCs:	1	0	1	1	3
with 1,1,1-TCA:	1	0	0	1	2

The lack of 1,1,1-TCA in the laboratory blanks discounts the analytical environment as a source of the contamination in the trip blanks and equipment rinsate samples. Cross contamination during sample handling and transportation, and procedural deficiencies with equipment decontamination, are not indicated because 1,1,1-TCA was detected in trip blanks and equipment rinsate samples associated with wells that monitor uncontaminated groundwater. Contamination of the deionized water used by the K-25 ASO was identified as the cause of the 1,1,1-TCA in these QA/QC samples. Similar "source water" contamination with chloroform and 1,2-dichloropropane occurred during CYs 1991 and 1992 (HSW Environmental Consultants, Inc. 1993), and was determined by the K-25 ASO to have resulted from: (1) an insufficient replacement frequency for the ionization columns, (2) improper flushing of the deionized water system, and (3) problems with system handling and maintenance (Buckley 1992). Routine QA/QC sampling is now performed by the K-25 ASO to monitor the quality of the deionized water source.

Review of the data for toluene, PCE, xylenes, and 1,2-DCA detected in the QA/QC samples clearly indicates laboratory contamination. Toluene, PCE, and xylenes detected in the trip blanks were detected in the associated laboratory blank sample that was analyzed on March 15. Although 1,2-DCA was detected in a laboratory blank analyzed on August 9, this compound was not detected in associated QA/QC samples. These results are probably analytical artifacts.

A first quarter trip blank associated with the groundwater sample from well GW-337 contained 1,2-DCE (12 micrograms per liter [μg/L]) and TCE (2 μg/L). The results for this trip blank reflect contamination in the cooler from the high concentrations of 1,2-DCE (7,900 μg/L) and TCE (1,100 μg/L) in the March 3 sample from well GW-337.

Results of Inductively Coupled Plasma (ICP) analyses reported for one equipment rinsate sample collected during the fourth quarter of CY 1995 also indicate that the deionized water equipment was not always kept in proper working order. As summarized below, the calcium, iron, magnesium, and strontium concentrations reported for this sample are not characteristic of deionized water.

Sample Number	**Associated Well**	**Date Sampled**	**Concentration (mg/L)**			
			Calcium	**Iron**	**Magnesium**	**Strontium**
ER-EF-9	GW-232	12/14/95	1.2	1.1	0.31	0.13

Review of the data for the rinsate samples did not indicate problems with sampling equipment decontamination; furthermore, all results for nitrate and radioanalytes were below the detection limit or the specified minimum detectable activity (MDA), respectively.

4.0 GROUNDWATER QUALITY DATA

This section presents a review of the CY 1995 groundwater monitoring data with respect to the overall extent of groundwater contamination in the East Fork Regime. It is based on the underlying assumptions and outcome of the respective data screening and evaluation procedures described in Appendix C for principal ions, trace metals, VOCs, and radiological parameters.

4.1 Principal Ions

Principal ion results for most of the Aquitard (Figure 10) and Aquifer (Figure 11) monitoring wells sampled during CY 1995 generally reflect the respective geochemical characteristics described in Section 2.1. Most of the monitoring wells yield samples of calcium-magnesium-bicarbonate groundwater characterized by: carbonate alkalinity, fluoride, and nitrate below respective analytical reporting limits; low proportions (<10%) of chloride, potassium, sodium, and sulfate; pH between 6.5 and 8.0; and TDS of 150 to 700 mg/L. Significant deviation from these geochemical characteristics were primarily related to relative proportions of magnesium, unusually low TDS, and atypically high concentrations/proportions of chloride, nitrate, and sodium. Some of these atypical results reflect natural geochemical variability, but many probably reflect groundwater contamination.

Relative proportions of magnesium define two general populations of Aquifer monitoring wells (Figure 11). Magnesium proportions of 35 to 45% are typical of the groundwater samples from wells completed in the upper part of the Maynardville Limestone (e.g., GW-240, GW-380, and GW-604), and probably reflect groundwater inflow from the Copper Ridge Dolomite. Lower magnesium proportions are typical of the groundwater samples from Aquifer wells completed in the water table interval and lower part of the Maynardville Limestone, and probably indicate groundwater inflow from the Nolichucky Shale.

Groundwater samples from five Aquitard monitoring wells (GW-746, GW-761, GW-767, GW-785, and GW-787) and four Aquifer monitoring wells (GW-252, GW-785, GW-617, and GW-619) had distinctively low TDS (i.e., 50 to 130 mg/L) relative to other wells of similar depth. Most of these wells are completed within the water table interval less than 25-ft bgs, and the very low TDS indicates short groundwater residence time and "quickflow" recharge/discharge (Shevenell

1994). However, the many buildings and paved areas severely limit recharge via surface infiltration near well GW-761, and the low TDS of the groundwater at the well may indicate recharge from leaking potable water supply lines or other sources of similarly less mineralized water.

Chloride and sodium concentrations are typically below 10 mg/L in the calcium-magnesium-bicarbonate at shallow depths in the Aquitard and the Aquifer. Contamination from road salt may explain the unusually high chloride and sodium concentrations in the groundwater at two Aquifer monitoring wells (GW-148 and GW-380), and five Aquitard monitoring wells (GW-772, GW-776, GW-780, GW-783, and GW-784). Filtered and unfiltered groundwater samples from water table interval wells GW-380 (15.5-ft bgs) and GW-780 (18-ft bgs), for example, had chloride concentrations of 34 to 89 mg/L, and sodium concentrations of 17 to 63 mg/L. Results for these wells may reflect recharge of surface runoff in unpaved areas, and influx from leaking storm sewers in areas where buildings and paved surfaces preclude surface infiltration.

Groundwater samples from Aquitard monitoring wells GW-752 and GW-760, and Aquifer monitoring well GW-775 had very high chloride (30 to 170 mg/L), but relatively low sodium (4 to 12 mg/L). Chloride concentrations in the groundwater at each of these water table interval wells probably reflect contamination from separate sources within the Y-12 Plant, possibly industrial waste water or leaking sanitary sewers. Chloride is stable and highly mobile in groundwater, and the extreme concentrations (i.e., >100 mg/L) in the groundwater at well GW-760 suggest a nearby source area.

Groundwater samples from eleven shallow (i.e., <80-ft bgs) Aquitard monitoring wells had unusually high sodium concentrations (12 to 130 mg/L), but relatively normal (i.e., <10 mg/L) chloride levels (GW-149, GW-208, GW-383, GW-744, GW-747, GW-764, GW-766, GW-768, GW-778, GW-779, GW-781, and GW-788). Sodium dominates the ion chemistry of the samples from several of these wells, particularly GW-768, GW-779, GW-781, and GW-788 (Figure 10). Elevated sodium concentration in the shallow groundwater at these wells may reflect upward migration of sodium-bicarbonate groundwater from the deeper bedrock, as would be expected in light of the upward hydraulic gradients characteristic of the Aquitard, or a shallower geochemical transition to this type groundwater than is evident in the Bear Creek Regime. Alternatively, the elevated sodium levels in the groundwater at these wells, coupled with boron concentrations that exceed applicable water-quality standards (see Section 4.2), may indicate contamination from industrial chemicals or process wastes.

Nitrate concentrations in the groundwater samples collected from all the Aquitard monitoring wells except GW-108, GW-109, GW-274, and GW-275 were below the 10 mg/L maximum contaminant level (MCL) for drinking water (Figure 12). The CY 1995 data for these wells, and historical data for monitoring-well cluster GW-105/106, show that nitrate concentrations remain very high within the mass of the S-3 Plume, but have substantially decreased since closure of the former S-3 Ponds.

Monitoring Well		**Nitrate (mg/L)**					
Number	**Depth (ft bgs)**	**May 1986**	**June 1987**	**June 1988**	**June 1989**	**January 1990**	**June 1995**
GW-105	17.0	2,000	1,921	2,310	1,289	921	.
GW-106	75.0	783	1,050	561		706	.
GW-108	58.6	12,463	15,800	11,100	12,450	13,100	10,000
GW-109	128.5	10,296	9,212	10,400	11,365	9,960	8,850
GW-274	35.0	15,800	13,700	11,800	9,842	10,900	4,270
GW-275	65.5	9,400	8,083	8,130	9,808	8,770	7,580

Declining nitrate concentrations in the groundwater at these wells are a direct result of closing and capping the former surface impoundments. More rapidly decreasing nitrate concentrations in the water table interval, as illustrated by data for wells GW-105 and GW-274, reflect more active groundwater circulation and greater contaminant flushing by seasonal recharge/discharge cycles (Shevenell and Goldstrand 1994).

Historical data showing nitrate levels above 1,000 mg/L in the groundwater at well GW-105 indicate transport in the water table interval toward the buried headwaters of UEFPC about 200-ft east of the well. Very low nitrate concentrations (i.e., <2 mg/L) in the water table interval immediately east of the former UEFPC headwaters indicate that it provides a highly permeable migration pathway, which diverts the bulk of the nitrate-contaminated groundwater to the southeast (HSW Environmental Consultants, Inc. 1991). This may partially explain the extremely high nitrate concentrations in the groundwater at well GW-108, whereas wells GW-337, GW-338, GW-617, and GW-618 have very low nitrate concentrations.

Nitrate concentrations in the groundwater at well GW-274 are several orders-of-magnitude higher than in any other water table interval well at the Y-12 Plant Salvage Yard, including wells located much closer to the S-3 Site (e.g., GW-105). The very high nitrate concentrations suggest: preferred migration from the S-3 Plume along an east-west oriented subsurface drain located immediately south of the well (HSW Environmental Consultants, Inc. 1991), higher relative hydraulic conductivity/contaminant flux in the groundwater flowpaths intercepted by the well, influx of nitrate from an additional source, or a combination of these factors. Additionally, lower nitrate concentrations in the groundwater at the shallow bedrock well paired with well GW-274 probably reflect the relative range of hydraulic conductivity and contaminant flux within different stratigraphic horizons in the Nolichucky Shale.

Strike-parallel transport in the bedrock is reflected by the nitrate concentrations in the groundwater at Aquitard monitoring wells GW-106, GW-108, GW-109, and GW-275. Well GW-106 intercepts groundwater flowpaths in the Nolichucky Shale that, projected along strike (assuming a dip of 45°), subcrop beneath the northernmost of the four impoundments that formerly comprised the S-3 Ponds. Based on similar along-strike projections, the monitored intervals for wells GW-108, GW-109, and GW-275 probably intercept flowpaths that subcrop beneath the southernmost ponds. Substantially lower nitrate concentrations in the groundwater at well GW-106, compared to wells GW-108 and GW-109, suggest greater flux from the southernmost ponds, possibly as a result of enhanced permeability related to dissolution of carbonate strata in the middle and upper Nolichucky Shale. Data obtained in the Bear Creek Regime during CY 1995 also indicate greater contaminant flux along strike-parallel flowpaths that subcrop beneath the southernmost ponds at the site (AJA Technical Services, Inc. 1996a).

Static water level data for monitoring well pairs GW-108/109 and GW-274/275 show upward hydraulic gradients (0.036 to 0.039) from the deeper bedrock (GW-109) to the shallow bedrock (GW-108), and from the shallow bedrock (GW-275) to the water table interval (GW-274). These data strongly indicate nitrate concentrations in the water table interval are at least partially attributable to upward migration from the deeper flow system in the Aquitard.

Nitrate concentrations were below 5 mg/L in the groundwater samples from all of the Aquitard monitoring wells east of the Y-12 Plant Salvage Yard (Figure 12). The very low nitrate levels (i.e., <1 mg/L) in the groundwater at the Waste Coolant Processing Area as indicated by the CY 1995 results for wells GW-337 (<0.02 mg/L reporting limit) and GW-338 (<1.0 mg/L), suggest that the bulk of the nitrate-contaminated groundwater in the water table interval and shallow bedrock east of well GW-274 discharges into a buried tributary (BT-1) of UEFPC (Figure 4). Eastward migration beneath this buried tributary along strike-parallel flowpaths in the deeper bedrock cannot be ruled out because all of the monitoring wells at the Waste Coolant Processing Area are completed at depths less than 40-ft bgs. However, if the S-3 Site plume extends beneath the site, the low nitrate concentrations in the shallow groundwater suggest limited upward migration from the deeper bedrock, extensive dilution by the nitrate-free groundwater in the water table interval, or a combination of both.

Groundwater samples collected during CY 1994 from a basement sump near the east end of Building 9204-4 had nitrate concentrations above 1,000 mg/L (HSW Environmental Consultants, Inc. 1995). Available information indicates less than 5-ft of fill beneath Building 9204-4 (Sutton and Field 1995), which suggests that the basement sump produces groundwater from the water table interval beneath the fill. In light of the very low nitrate concentrations in the groundwater at the Waste Coolant Processing Area only 300-ft south of Building 9204-4, migration in the water table interval from the S-3 Site Plume seems an unlikely source of the nitrate in the basement sump. High concentrations in the basement sump may reflect transport from a separate source of nitrate. Also, operation of the sump apparently restricts migration in the water table interval toward the Waste Coolant Processing Area.

Nitrate concentrations exceeded 100 mg/L in the groundwater samples collected during CY 1994 from basement sumps near the west end of Building 9201-5, which is about 250-ft east of Building 9204-4 (Figure 12) (HSW Environmental Consultants, Inc. 1995). Both sumps probably produce groundwater from the 10 to 25-ft of fill material within the buried tributary of UEFPC (BT-2) that underlies the west end of Building 9201-5 (Figure 4). Nitrate levels above 100 mg/L in the northernmost basement sump suggest that the buried tributary (BT-2) directs nitrate southward from an upgradient source area, possibly a plume emplaced during operation of the (Abandoned)

Nitric Acid Pipeline, which traverses a fork of the buried tributary about 400-ft north of Building 9201-5.

Annual average nitrate concentrations were below 1 mg/L for all of the Aquifer monitoring wells in the western and central plant areas except GW-251 (61 mg/L) at the S-2 Site, and downgradient wells GW-617 (2 mg/L), and GW-618 (2 mg/L) (Figure 12). The overall lack of nitrate in the Aquifer downgradient of the S-2 Site (and the S-3 Plume) is conspicuous when compared to the Bear Creek Regime, where nitrate concentrations exceed 10 mg/L in the Aquifer for several thousand feet downgradient of the S-3 Site. As noted in Section 2.1.3, the bulk of the dry-weather flow in UEFPC is from process water discharged to the subsurface drainage network, and the low nitrate concentrations in the Aquifer may reflect dilution by recharge from stormwater runoff or process water flow.

Nitrate and water-level elevation data for shallow bedrock well GW-251 and water table interval well GW-617 illustrate dilution- and flow-related temporal concentration trends common to other contaminants in the groundwater elsewhere in the East Fork Regime (Figure 13). Dilution-related trends are illustrated by the inverse relationship between nitrate concentrations and groundwater elevations at well GW-251. Results for this well possibly reflect relatively steady nitrate influx via matrix diffusion/advective transport from a contaminant reservoir in the bedrock underlying the S-2 Site, and dilution from recharge of uncontaminated groundwater. A flow-related trend is suggested by the direct relationship between nitrate concentrations and groundwater elevations at well GW-617. This concentration trend indicates greater flux from the source area or greater advective transport (or both) in response to precipitation. As noted in Section 4.1, the low TDS characteristic of the groundwater samples from well GW-617 indicate quickflow recharge/discharge flowpaths.

The following factors support the S-3 Site plume as the more probable source of nitrate in the groundwater at well GW-617: (1) it is only 500-ft downgradient (along strike) from the confluence of the buried main channel of UEFPC and BT-1, both of which probably direct nitrate-contaminated groundwater from the S-3 Plume into the lower (Zone 2) Maynardville Limestone, (2) gross beta activity in the groundwater at the well (see Section 4.4) may be from ^{99}Tc (the "signature" S-3 Plume contaminant), and (3) migration patterns from the S-2 Site would be across strike. Based on these factors, the S-3 Plume also is the more likely source of alpha radioactivity in the groundwater at the well (see Section 4.4.1).

Low nitrate levels (i.e., 2 to 4 mg/L) in the Aquifer at New Hope Pond reflect transport from the S-2 Site, the S-3 Plume, and other potential source areas (e.g., Building 9212) in the Central Plant Area. Data for a three-well cluster immediately upgradient of New Hope Pond show concentrations below the reporting limit in the shallow bedrock (GW-381), but seasonal, dilution-related nitrate concentration trends in the water table interval (GW-380), and an increasing trend with no clear relationship to groundwater flow in the deeper bedrock (GW-382) (Figure 14). Influx of nitrate from the S-3 Plume and other potential sources in the Aquitard into the water table interval along the contact between the Nolichucky Shale/Maynardville Limestone (particularly via the buried headwaters and tributaries of UEFPC), and seasonal inflow/recharge (also via buried UEFPC tributaries) of nitrate-free groundwater/surface water during downgradient transport in the lower Maynardville Limestone (e.g., Zone 2), may explain the dilution-related concentration trend in the groundwater at water table well GW-380 and the lack of nitrate in shallow bedrock well GW-381. Nitrate in the groundwater at well GW-382 possibly reflects transport from contaminant sources through the upper Maynardville Limestone (e.g., Zone 6). The apparently increasing concentration trend indicated by the data for the well may reflect the leading edge of a nitrate plume or "pulse" of nitrate-contamination in the deeper groundwater flowpaths.

4.2 Trace Metals

Interpretation of the CY 1995 groundwater data for trace metals focused on representative total concentrations that exceeded MCLs for drinking water, or upper tolerance limits (UTLs) assumed to reflect concentrations in uncontaminated groundwater at the Y-12 Plant (see discussion in Appendix C). A total of 177 unfiltered samples collected from 19 monitoring wells in the Western Plant Area, 22 monitoring wells in the Central Plant Area, and 22 monitoring wells, one spring, and one surface water sampling station in the Eastern Plant Area had elevated concentrations of one or more trace metals. As in previous years, however, most of these results were sampling and/or analytical artifacts caused by preservation of highly turbid groundwater samples, or other similarly extraneous factors (e.g., corrosion of stainless steel well casing and screen). The following sections describe the results that most likely represent groundwater contamination by trace metals in the Western, Central, and Eastern plant areas.

4.2.1 Western Plant Area

The S-3 Plume contains a heterogeneous distribution of several trace metals (Figure 15), and the CY 1995 results for wells GW-108, GW-109, GW-274, and GW-275 show elevated concentrations of one or more of the following: aluminum, barium, beryllium, boron, cadmium, cobalt, manganese, mercury, nickel, strontium, uranium, and zinc (Table 4). The highest concentration of each metal except barium and strontium occurs in the groundwater at well GW-109, which suggests that the bulk of the trace-metal contaminants within the S-3 Plume is at least 100-ft bgs in the Aquitard. Higher barium and strontium concentrations in the groundwater at wells GW-108 and GW-275 reflect their greater mobility relative to other trace metals in the plume.

As summarized below, total barium concentrations within the S-3 Plume generally increased through late-1988, and subsequently decreased through mid-1995.

Monitoring Well Number	Total Barium (mg/L)					
	May 1986	Nov. 1987	Sep. 1988	June 1989	Jan. 1990	June 1995
GW-105	17	19	25	12	.	.
GW-106	4.3	2.9	1.7	1.3	.	.
GW-108	130	170	182	150	150	120
GW-109	54	52	71	53	54	53
GW-274	110	120	137	110	83	37
GW-275	80	130	101	110	120	96

These results may reflect a slowly migrating “slug” of barium-contaminated groundwater. Barium results for well GW-274 also indicate the same rapid concentration decrease evident for nitrate in the well, and likewise reflect greater groundwater circulation and contaminant flushing in the water table interval. Additionally, inflow of contaminated groundwater diverted by the headwaters of UEFPC may explain the very high and relatively stable total barium concentrations in the shallow bedrock at well GW-108. The somewhat asymptotic barium concentrations in the deeper groundwater, as indicated by results for well GW-109, suggest steady influx of trace metals via matrix diffusion/advective transport from the contaminant reservoir in the Aquitard, as well as low rates of groundwater flow.

As noted in Section 2.3, the S-2 Site is a confirmed source of groundwater contamination in the Aquifer, and the principal trace metal contaminants from the site are cadmium, cobalt, and copper. The CY 1995 data show elevated concentrations of each metal in the groundwater at well GW-251 (Table 4). Temporal concentration trends indicate seasonally fluctuating, but generally decreasing concentrations in the groundwater at the well (Figure 16). Data for well GW-251 also show generally direct relationships between water-level elevations and total cadmium, cobalt, and copper concentrations, which suggests flow- or flux- related groundwater transport. Stable forms of these metals include oxides (copper) and carbonate compounds (cadmium and cobalt) that are potentially mobile in groundwater (Fetter 1993).

Total and dissolved cadmium concentrations in the groundwater at Aquifer monitoring well GW-618 exceed the 0.005 mg/L MCL for drinking water, and ranged from 0.018 to 0.022 mg/L in the groundwater samples collected from the well during CY 1995. Nitrate in the groundwater at well GW-618 indicates the S-3 Site Plume as the probable source of the cadmium in the well. Elevated cadmium concentrations in the groundwater at well GW-618 possibly reflect discharge from the S-3 Site Plume into the buried headwaters of UEFPC, and transport along the buried creek channel into the Aquifer upgradient of the well. Historical data for the well show a generally decreasing concentration trend from May 1990 through January 1993 and a generally increasing trend following a concentration "spike" in September 1993, but no consistent relationship between cadmium concentrations and water level elevations (Figure 16).

4.2.2 Central Plant Area

As noted in Section 4.1, samples from Aquitard monitoring wells GW-764, GW-777, GW-778, GW-781, GW-788 contained atypically high sodium concentrations. These samples also exhibited had elevated boron concentrations (Table 4). Total (and dissolved) boron concentrations were highest (an order-of-magnitude higher than the applicable UTL) in the samples from wells GW-781(0.42 to 0.52 mg/L) and GW-788 (1.1 to 1.5 mg/L), both of which produce groundwater from the lower Nolichucky Shale at depths of about 60 to 70 ft bgs (Table 2). Boron is probably present as the borate [$B(OH)_3$] ion, which is stable and relatively mobile in groundwater (Fetter 1993), and the apparent association with sodium may indicate groundwater contamination from a boron-bearing industrial chemical (or associated waste) such as borax (i.e., hydrated sodium borate). Alternatively, elevated boron concentrations in the groundwater at wells GW-781 and GW-788 may reflect upward migration of sodium-bicarbonate groundwater with naturally higher boron concentrations (HSW Environmental Consultants, Inc. 1993). This interpretation is supported by temporal concentration trends and water level fluctuations that generally reflect dilution from inflow of shallow groundwater water with lower boron (and sodium) levels (Figure 17).

4.2.3 Eastern Plant Area

Based on review and interpretation of the CY 1995 trace metal data for monitoring wells in the Eastern Plant Area (Table 4), the results that most likely reflect groundwater contamination are for Aquitard monitoring wells GW-768 (boron) and GW-149 (boron), and Aquifer monitoring wells GW-154 (boron and uranium), GW-222 (uranium), and GW-605 (uranium) (Figure 15). Boron and uranium contamination also is indicated by elevated concentrations in the surface water samples collected from UEFPC downstream of Lake Reality (Table 4).

Elevated total boron concentrations in the groundwater near New Hope Pond probably reflect surface water and shallow groundwater transport from upgradient source areas in the Y-12 Plant (Figure 15). The apparent association with surface water in UEFPC is indicated by the elevated concentrations in the groundwater at water table interval well GW-154 (0.135 mg/L), which is only 11-ft deep and is adjacent to the buried original UEFPC channel (about 500 ft north of the current channel), and the elevated concentrations (0.062 mg/L) in the surface water samples collected at station LRSPW downstream of Lake Reality. As noted in Section 2.3, evidence of a direct hydraulic connection with the Oil Skimmer Basin was observed during installation of well GW-222, but the background boron concentrations in the groundwater at this well suggest the Oil Skimmer Basin is not a source of boron in the groundwater at well GW-154. This also supports evidence for surface water transport in UEFPC as a source of boron in the groundwater near New Hope Pond.

Median uranium concentrations determined from CY 1995 data for water table interval well GW-154 (0.52 mg/L), shallow bedrock well GW-222 (0.15 mg/L), deep bedrock well GW-605 (0.18 mg/L); and surface water sampling station LRPSW (0.017 mg/L) exceeded applicable UTLs, and along with elevated gross alpha activity (see Section 4.4), indicate contamination in the groundwater near New Hope Pond. Stable forms of uranium in groundwater include oxides (+6 valence), such as uranyl cations (UO_2^{2+}), that tend to form complexes with a variety of anions, including carbonate (Fetter 1993). The source(s) of the uranium is probably within the Central Plant Area, although the high concentrations (and gross alpha activities) in the shallow groundwater at wells GW-154 and GW-222 suggest that the Oil Skimmer Basin may also be a common source of uranium in these wells.

Historical data show total uranium concentrations in the shallow groundwater at well GW-154 have decreased from more than 2 mg/L in January 1990 to less than 0.5 mg/L in November 1995 (Figure 18), probably as a direct response to closure of the Oil Skimmer Basin in 1988 and completion of the impermeable cap in 1989. More variable uranium concentrations in the groundwater at well GW-222, and the direct relationship with groundwater elevations in the well (particularly since November 1994), suggest flow-related concentration fluctuations (Figure 18), and a less direct response to closure of the Oil Skimmer Basin. Seasonally fluctuating but generally increased concentrations in the groundwater at well GW-605 indicate increased flux in the deeper groundwater flow system (Figure 18).

4.3 Volatile Organic Compounds

Volatile organic compounds are the most prevalent groundwater contaminants in the East Fork Regime and, in general, dissolved plumes of VOCs have migrated downgradient from sources in the Aquitard and intermingled with plumes from sources in the Aquifer (Maynardville Limestone), creating a continuous plume that extends from the Western Plant Area into Union Valley about 2,000-ft beyond the ORR boundary east (downgradient) of New Hope Pond (Figure 19). Three general groups of dissolved chlorinated solvents occur in the groundwater: (1) chloroethenes in the Western, Central, and Eastern plant areas, (2) chloroethanes in the Central Plant Area and Union Valley, and (3) chloromethanes in the Central and Eastern plant areas.

4.3.1 Western Plant Area

As noted in Section 2.2, confirmed sources of VOCs in the Western Plant Area are the S-3 Site Plume, the Oil/Solvent Drum Storage Area and/or Salvage Yard Drum Deheader, the Waste Coolant Processing Area, the Fire Training Facility, and the S-2 Site. Chloroethenes (primarily PCE, TCE, and 1,2-DCE) are the principal components of dissolved VOC plumes in the groundwater at these sites (Figure 21). Varying proportions of PCE and 1,2-DCE generally characterize these plumes (TCE is a minor component of each): (1) PCE is the primary component of the S-3 Site Plume in the Aquitard and the VOC plume in the Aquifer at the S-2 Site; (2) 1,2-DCE dominates the dissolved VOC plumes in the Aquitard at the Waste Coolant Processing Area and the Oil/Solvent Drum Storage Area and/or Salvage Yard Drum Deheader, and (3) nearly equal proportions of PCE and 1,2-DCE dominate the dissolved plume in the Aquifer at the Fire Training Facility (Figure 21).

The CY 1995 results for wells GW-108, GW-109, GW-274, and GW-275 show relatively low VOC concentrations within the S-3 Plume (Table 5). Summed VOC concentrations were highest in the groundwater samples from water table well GW-274 (104 μg/L) and bedrock well GW-109 (521 μg/L), and lowest in the groundwater samples from shallow bedrock wells GW-108 (98 μg/L) and GW-275 (4 μg/L). Varying concentrations of PCE, TCE, 1,2-DCE, chloroform, and methylene chloride in the groundwater samples from these wells reflect the heterogeneous nature of the S-3 Site Plume (Table 5). The relatively low VOC concentrations compared to nitrate levels in the groundwater at each of these wells reflect their lower relative mobility, but similar migration patterns toward the buried UEFPC headwaters.

Based primarily on data for Aquitard monitoring wells that were not sampled during CY 1995, the Oil/Solvent Drum Storage Area and/or the Salvage Yard Drum Deheader (Drum Deheader) is a confirmed source of an apparently separate plume of dissolved chlorinated solvents (primarily chloroethenes) in the shallow groundwater north of the S-3 Plume (Figure 20). Historical data indicate 1,2-DCE is the primary component of the plume (Figure 21) and summed chloroethene concentrations exceed 1,000 μg/L.

Strike parallel transport eastward from the Drum Deheader is the suspected source of the 1,2-DCE (16 μg/L), TCE (3 μg/L), and PCE (2 μg/L) in the groundwater at water table interval well

GW-192 (Table 5). Completed at a depth of 17-ft bgs in the Maryville Limestone on the east side of the Beta-4 Security Pits, GW-192 forms a two-well cluster with shallow bedrock (60-ft bgs) well GW-191. Along with the CY 1995 data, historical results for these wells show temporal 1,2-DCE concentration fluctuations between 5 and 35 μg/L (5 to 23 μg/L in CY 1995) in the groundwater at well GW-192, but no 1,2-DCE (or any other VOC) in the groundwater at well GW-191. Additionally, groundwater elevations in the well generally correlate with 1,2-DCE concentrations, and along with water level data for well GW-191, indicate upward hydraulic gradients (about 0.07) from the shallow bedrock to the water table interval during seasonally high and low groundwater flow conditions. These data indicate strike parallel, flow-related groundwater transport from the Drum Deheader toward discharge areas in the water table interval along the upper reach of BT-1, which probably passes beneath (or through) the Beta-4 Security Pits and channels the VOC-contaminated groundwater to the south.

The dissolved VOC plume in the shallow groundwater at the Waste Coolant Processing Area contains the most diverse population of VOCs with the highest individual and summed concentrations in the East Fork Regime. As shown by the CY 1995 data for water table well GW-337, components of the plume include a variety of chloroethenes (mainly PCE, TCE, 1,2-DCE, 1,1-DCE, and vinyl chloride), chloroethanes (1,1,1-TCA and 1,2-DCA), and chloromethanes (e.g., carbon tetrachloride and methylene chloride) (Table 5). Historical data for several monitoring wells at the site that were not sampled during CY 1995 show PCE concentrations exceed 1% of maximum solubility, and indicate DNAPL in the subsurface at the site. Results for well GW-337 show 1,2-DCE concentrations above 6,000 μg/L, PCE and TCE above 500 μg/L, and 1,1-DCE, 1,1,1-TCA, 1,1-DCA, and vinyl chloride above 100 μg/L (Table 5). Along with historical data for the well, the CY 1995 results indicate generally stable (e.g., PCE) or decreasing (e.g., 1,2-DCE) concentration trends, but no clear relationships with groundwater elevations in the well (Figure 22). Assuming similar groundwater flow/contaminant transport patterns in the Aquitard indicated by nitrate from the S-3 Plume, VOCs in the groundwater at the Waste Coolant Processing Area probably migrate along strike in the Aquitard toward discharge areas in the water table interval along the buried tributary of UEFPC (BT-2) east of the site, and south toward the Aquifer (Figure 20).

The Fire Training Facility in the Western Plant Area is the farthest upgradient source of VOCs in the Aquifer in the East Fork Regime (Figure 20), and a source of chloroethenes (primarily PCE and 1,2-DCE) in the Western Plant Area (Figure 21). The CY 1995 results for Aquifer monitoring wells GW-619 (41-ft bgs) and GW-620 (75-ft bgs) show summed chloroethene concentrations of 271 µg/L, and 833 µg/L, respectively (Table 5). Along with data obtained since January 1991, results for these wells indicate overall decreasing temporal trends with seasonally fluctuating concentrations of the principal VOCs (Figure 23). This suggests downward migration of VOCs into the upper Maynardville Limestone (Zone 6), and potentially decreasing flux from the Fire Training Facility (as indicated by the decreasing concentration trend in well GW-620). Generally inverse relationships with groundwater elevations in each well also suggest dilution from recharge of less contaminated groundwater. Low TDS and magnesium proportions above 35% of total cations characterize the unfiltered samples from well GW-619 and indicate quickflow groundwater recharge/discharge from the Copper Ridge Dolomite.

Historical data for Aquifer monitoring wells indicate that the S-2 Site is a relatively minor source of VOCs in the Western Plant Area (Figure 20). Data obtained during CY 1995 show several chloroethenes (primarily PCE and TCE) and chloromethanes (carbon tetrachloride and chloroform) in the groundwater at GW-251 (Table 5), but individual concentrations were less than 100 µg/L. Summed average concentrations of these VOCs (131 µg/L) reflect a decrease of about 70% from the summed average concentrations (660 µg/L) determined from the CY 1991 data for well GW-251. Chloroethenes (and other VOCs) from the S-2 Site probably recharge into the upper Maynardville Limestone, and migrate along strike to the east. Low chloromethane concentrations in the groundwater at the site indicate that it is probably not the source of these compounds in the Eastern Plant Area.

The source of the chloroethenes in the groundwater at Aquifer monitoring wells GW-617 and GW-618 is probably the Waste Coolant Processing Area directly north of these wells (Figure 21). Summed average PCE, TCE, and 1,2-DCE concentrations were generally below 5 µg/L, and 30 µg/L, in the groundwater samples from wells GW-617 and GW-618, respectively (Table 5). Chloroethene concentrations in the groundwater at well GW-617 exhibit generally concurrent but widely fluctuating concentration trends (more so after September 1993), and consistently inverse relationships with groundwater elevations (Figure 24). Results for well GW-618 exhibit more divergent concentrations of individual compounds, and do not exhibit a consistent relationship with groundwater elevations, particularly a series of concentration highs and lows between December 1993 and May 1994 (Figure 24).

4.3.2 Central Plant Area

As noted in Section 2.2, there are multiple unspecified sources of VOCs probably associated with buildings in the Central Plant Area that are indicated by high concentrations of chloroethenes in Aquitard monitoring wells at CMP Grid D2 (GW-791 and GW-792) (Table 5). Other potential source of VOCs are indicated by historical data for monitoring wells near Tank 0134-U and Tank 2331-U. Lower VOC concentrations in the groundwater at other Aquitard monitoring wells in the Central Plant Area, including well-clusters installed at CMP Grid E3 (GW-781, GW-782, and GW-783), CMP Grid F3 (GW-789), CMP Grid G3 (GW-769 and GW-770); and CMP Grid H3 (GW-775 and GW-776), probably reflect transport from upgradient sources (Table 5).

Results for samples collected during CY 1995 from shallow bedrock well GW-791 (71-ft bgs) and water table well GW-792 (29-ft bgs) support data obtained since installation of the wells in early 1994 showing PCE in the Aquitard (Maryville Limestone) south of Building 9212 (Figure 21; Building 9212 is shown on Figure 7). Tetrachloroethene concentrations in the bedrock (2,400 µg/L) are more than an order-of-magnitude higher than in the water table interval (14 µg/L), and groundwater elevations demonstrate consistently upward hydraulic gradients (Figure 25). The high PCE concentrations (>1% maximum solubility) indicate DNAPL in the subsurface, and lower concentrations in the water table interval reflect upward migration of dissolved PCE. Results for these wells suggest upward migration from the bedrock, and strike-parallel transport toward discharge areas in the water table along a western fork of BT-7 located about 750-ft to the east (Figure 4).

Temporal PCE concentration trends in the groundwater at wells GW-791 and GW-792 potentially indicate delayed responses to groundwater recharge in the Aquitard (Figure 25). Groundwater samples were collected in March 1995 following 1.8-inches of rainfall during the previous 24 hours (as gauged by the National Oceanic and Atmospheric Administration in Oak

Ridge, Tennessee). In response to the rainfall, groundwater elevations in both wells increased about 1.5-ft, and PCE concentrations decreased in the groundwater at well GW-791 but remained unchanged in the groundwater at well GW-792. Data obtained through the rest of the year show increased PCE concentrations in June 1995, despite lower groundwater elevations, but flow-related water level/PCE concentration relationships in August and November 1995. Note also that the low PCE (420 µg/L) in the first sample collected from well GW-791 in March 1994 possibly reflects inflow of less contaminated groundwater from the water table interval during installation and development of the well.

Data for samples collected in CY 1995 are consistent with historical results showing chloroethenes, chloroethanes, and chloromethanes in the groundwater at Aquitard monitoring wells GW-781 (63-ft bgs), GW-782 (30-ft bgs), and GW-783 (10-ft bgs) (Figure 19). Chloroethenes (primarily PCE, TCE, and 1,2-DCE) and chloroethanes (1,1,1-TCA and 1,1-DCA) are the principal components of the VOC plume (chloromethanes were not detected in samples from well GW-781) (Figure 19). Summed concentrations of the VOCs in the groundwater at each well are highest at GW-782 (426 µg/L) and lowest at GW-781 (15 µg/L) (Table 5). Higher summed concentrations in the groundwater at well GW-782 suggest primarily strike-parallel VOC transport in the shallow bedrock, and low summed concentrations in the groundwater at well GW-781 suggest that the screened interval for the well is below the primary transport pathways intercepted by well GW-782 (assuming a dip of 45°), particularly in light of the dominantly upward hydraulic gradients indicated by water level elevations in the wells (Figure 26).

Results obtained since June 1994 for wells GW-781, GW-782, and GW-783 indicate concurrent temporal concentration fluctuations that generally reflect dilution during high-flow conditions. As illustrated by data for PCE and 1,1-DCA (Figure 26), chlorothene and chloroethane concentrations in the groundwater at each well decreased in response to 1.8-inches of rainfall the day before the well was sampled in March 1995 (note also the reversed vertical hydraulic gradient between GW-782 and GW-783). A similar pattern is indicated by the data for the samples collected in November 1995. These relationships suggest that VOC concentrations in the shallow groundwater in this area reflect influx via upward migration from the deeper bedrock. Very low (i.e.,<1 μg/L) VOC concentrations in the groundwater at CMP Grid F3 monitoring wells (GW-788 and GW-789) suggest limited strike parallel transport to the east.

Low concentrations of chloroethenes in the groundwater at wells GW-775, GW-776, and GW-789 and chloromethanes in the groundwater at wells GW-769 and GW-770 (Table 5) probably reflect transport in the groundwater from unspecified source areas in the Central Plant Area (Figure 20). As illustrated by the data for wells GW-769 and GW-770, consistently upward vertical gradients in the Aquitard at these wells, and typically higher VOC concentrations in the groundwater at each well cluster, suggest upward migration of dissolved contaminants from a DNAPL source in the subsurface, and strike parallel transport in the water table interval (Figure 27).

4.3.3 Eastern Plant Area

Chloromethanes and chloroethenes are the most pervasive groundwater contaminants in the Eastern Plant Area (Figure 20). In general, chloroethenes occur in the Aquitard and Aquifer, but chloromethanes occur primarily in the Aquifer. Carbon tetrachloride and chloroform are the most common chloromethanes in the groundwater, and PCE, TCE, and 1,2-DCE are the most prevalent chloroethenes (Table 5).

As illustrated by the following data for carbon tetrachloride, chloromethane concentrations have generally increased in the groundwater downgradient of New Hope Pond, probably in response to the installation of the impermeable cap (which decreases surface recharge), but have generally decreased or remained fairly stable in the groundwater upgradient of the site.

Monitoring Well Number	Annual Average Carbon tetrachloride (μg/L)					
	CY 1990	CY 1991	CY 1992	CY 1993	CY 1994	CY 1995
Upgradient						
GW-222	5	ND	NS	NS	ND	69
GW-223	49	28	NS	NS	1.0	17
GW-381	6,850	6,475	5,675	5,825	4,800	4,950
GW-382	5,322	5,425	5,105	5,125	6,225	5,700
GW-383	15.3	8	4	2	2	2
GW-605	NS	24	110	140	128	238
GW-606	NS	2,700	1,078	738	680	555

ND = Not detected; NS = Not sampled

Monitoring Well Number	Annual Average Carbon tetrachloride (μg/L)					
	CY 1990	CY 1991	CY 1992	CY 1993	CY 1994	CY 1995
Downgradient						
GW-151	358	273	313	420	420	505
GW-153	168	81	NS	NS	100	153
GW-220	150	215	340	373	370	475
GW-240	14.3	10	10	11	11	13
GW-733	NS	NS	22	70	40	44

ND = Not detected; NS = Not sampled

Carbon tetrachloride results for the above listed monitoring wells, and CY 1994 data from 10 sampling ports in well GW-722 that monitor discrete vertical intervals within the Maynardville Limestone, show concentrations that vary with depth, and indicate that the lower boundary of the chloromethane plume generally occurs at 560-ft bgs (about 400 ft msl) (Figure 28).

Potential upgradient sources of the chloromethanes include Buildings 9202, 9203, and 9205 in the Central Plant Area where large amounts of carbon tetrachloride were used to convert uranium trioxide to uranium tetrachloride (ChemRisk 1993), and potential spills and leaks from railroad tankers along the rail spur that roughly parallels UEFPC toward the west end of the Y-12 Plant. As illustrated by carbon tetrachloride, concentrations of chloromethanes in the groundwater at Aquifer monitoring well clusters GW-605/606 (Figure 29) and GW-380/381/382 (Figure 30) upgradient of New Hope Pond have remained relatively stable since CY 1991.

Carbon tetrachloride concentrations in the groundwater monitored by wells GW-151 and GW-220 have generally increased since CY 1991 (Figure 31). This concentration increase coincides with the operational history of the Lake Reality Sump. As noted in Section 2.1.2, groundwater has been pumped intermittently from the sump to reduce hydrostatic pressure below the synthetic liner in Lake Reality, and pumping has induced groundwater flow toward the sump and consequently increased VOC concentrations in the groundwater monitored by wells GW-151 and GW-220.

Data for monitoring wells GW-151 and GW-222 (as well as other well clusters at the Y-12 Plant) show a change from generally flow-related (direct) VOC concentration/water level correlations to dilution-related (inverse) VOC concentration/water level correlations beginning in CY 1994 (Figure 31). This pattern generally coincides with a change in the sampling protocol initiated in CY 1994 wherein groundwater samples were collected from the deeper well (GW-222) before the samples were collected from the shallower well (GW-151); samples were previously collected first from GW-151 then from well GW-222. It is possible that the apparent change in VOC concentration/water level relationships evident for these monitoring wells is an artifact of the revised sampling protocol and not a change in the groundwater flow/contaminant transport conditions.

As illustrated by the PCE data summarized below, higher concentrations and increasing trends in the upgradient Aquifer and Aquitard monitoring wells clearly indicate one or more upgradient sources of the chloroethenes in the groundwater in the vicinity of New Hope Pond.

Monitoring Well	**Annual Average PCE Concentrations (μg/L)**					
	CY 1990	**CY 1991**	**CY 1992**	**CY 1993**	**CY 1994**	**CY 1995**
Upgradient						
GW-222	30	13	NS	NS	6	156
GW-223	220	175	NS	NS	15	248
GW-382	125	208	205	217.5	280	255
GW-383	214	315	365	253	292.5	403
GW-762	NS	NS	840	955	755	1,200
GW-763	NS	NS	11	20.3	7.8	13
Downgradient						
GW-151	16	15	15	20	21	24
GW-153	5	3	NS	NS	4	5
GW-220	9	12	22	28	33.5	40

NS = Not sampled

One potential upgradient source area is indicated by the high PCE concentrations in the groundwater at Aquitard monitoring wells GW-762 and GW-763 west of Lake Reality (Figure 21). Concentrations in the groundwater at shallow bedrock well GW-762 (59-ft bgs) averaged 1,200 µg/L (Table 5), which is almost two orders-of-magnitude higher than average PCE levels (13 µg/L) in the groundwater at water table well GW-763 (16-ft bgs). In contrast with the Aquitard in the Western and Central plant areas, groundwater elevations in these wells show downward hydraulic gradients (about 0.06) during seasonally high and low groundwater flow conditions. These wells are located adjacent to the railroad spur that parallels Second Street in the Y-12 Plant, and PCE in the groundwater at the wells may reflect spills or leaks from railroad tankers. Alternatively, results for these wells may indicate strike-parallel migration from a source area within the Y-12 Plant. In either case, PCE and other chloroethenes in the groundwater at these wells probably migrate along strike in the shallow bedrock toward UEFPC. This may explain the relatively high PCE (403 μg/L) concentrations in the groundwater at shallow bedrock well GW-383 (Figure 20).

Available data show vertical segregation of the VOC plume in the groundwater at the east end of the Y-12 Plant near New Hope Pond. In general, chloroethenes are more prevalent in the water table and shallow bedrock intervals, whereas chloromethanes (primarily carbon tetrachloride) generally dominate the dissolved VOC plume in the deeper bedrock. The different types of VOCs in the shallow and deep groundwater suggest separate sources of chloroethenes and chloromethanes, and possibly indicate that the transport of chloroethenes is more closely associated with UEFPC (and the altered stream channel).

As noted previously, dissolved VOCs have migrated in the Aquifer beyond the ORR boundary into Union Valley east of the Y-12 Plant. Based on the current monitoring well network, the most extensive transport appears to occur in the uppermost stratigraphic zones in the Maynardville Limestone (Figure 20). Data for Aquifer monitoring well GW-733, which is completed at a depth of 256 ft bgs in the Maynardville Limestone near the ORR boundary along Scarboro Road, show variable chloromethane concentrations (particlularly carbon tetrachloride), but relatively stable chloroethene concentrations (Figure 32). Data for Aquifer monitoring well GW-170 in Union Valley, which is completed at a depth of 157 ft bgs in the Maynardville Limestone, show chloroethene and chloromethanes in the groundwater about 1,000 ft east of the ORR boundary. In general, the chloroethenes concentrations (particularly PCE) show fairly direct correlations with water levels in the well, whereas the chloromethanes (particularly carbon tetrachloride) show dilution-related concentration/water level relationships (Figure 32).

4.4 Semi-Volatile Organic Compounds

Samples collected during the first, second, and third quarters of CY 1995 from six exit pathway wells in Union Valley and a surface water station near Lake Reality were analyzed for semi-volatile (base, neutral, and acid extractable) organic compounds; analytical results are provided in Appendix E of the Part 1 GWQR. As shown in the following data summary, di-n-butylphthalate and bis(2-ethylhexyl)phthalate were detected in the samples from four wells and one surface water sampling station:

Monitoring well	**Date Sampled**	**Concentration (µg/L)**	
		Bis(2-ethylhexyl)phthalate	**Di-n-butylphthalate**
GW-169	03/15/95	Not Detected	2
GW-169	06/12/95	5	Not Detected
GW-169	09/28/95	Not Detected	1
GW-171	03/13/95	Not Detected	2
GW-172	03/13/95	Not Detected	1
GW-230	03/15/95	Not Detected	2
GW-230	06/15/95	3	1
GW-232	06/16/95	6	1

Additionally, all of the samples with diethylphthalate and seven of the 14 samples with di-n-butylphthalate were also associated with laboratory blank samples that contained the respective compound; therefore, these results were considered analytical artifacts. Although bis(2-ethylhexyl)phthalate was not detected in the associated laboratory blanks, results for samples collected from three wells during the second quarter likewise probably reflect sampling and/or laboratory artifacts.

4.5 Radioactivity

Review and interpretation of the CY 1995 data for radioanalytes (i.e., gross alpha, gross beta, and speciated radioisotopes) is based on the data screening and evaluation criteria described in Appendix C regarding the MDA (see Section C.2.1) and counting error (see Section C.2.8) associated with each result, and is focused on representative gross alpha activities that exceed the 15 picocurie per liter (pCi/L) MCL for drinking water, and representative gross beta activities that exceed the Safe Drinking Water Act (SDWA) screening level of 50 pCi/L (see Section C.3.2). Based on the assumptions associated with these criteria, the CY 1995 data for gross alpha and gross beta activity are generally characterized as shown in the following summary.

Location/ Number of Wells	Number of Monitoring Wells					
	Gross Alpha Activity Data			Gross Beta Activity Data		
	>MDA	>15 pCi/L	Max. (pCi/L)	>MDA	>50 pCi/L	Max. (pCi/L)
Western Plant Area	8	1	122 ± 62	12	4	9,500 ± 600
Central Plant Area	7	1	23 ± 3	5	0	36 ± 29
Eastern Plant Area	15*	3	463 ± 24	17**	3	205 ± 9
* = includes surface station LRSPW; ** = Includes surface station LRSPW and spring SCR7.1SP						

This summary illustrates four key aspects of the available data regarding the extent of radioactive contamination in groundwater in the East Fork Regime: (1) limited migration of alpha-emitting radioisotopes (i.e., ^{234}U and ^{238}U) from the S-3 Site Plume in the Western Plant Area; (2) substantial attenuation in the Aquitard, or dilution during groundwater transport in the Aquifer (or both) of beta-emitting radioisotopes (i.e., ^{99}Tc) from the S-3 Site Plume; (3) no major sources of alpha- or beta-emitting radioisotopes in the Aquitard within the Central Plant Area, and only minor alpha radioactivity in the groundwater (although this may be an artifact of the monitoring well network); and (4) potential sources of alpha-emitting radionuclides in the Eastern Plant Area, and more extensive areas of alpha and beta radioactivity in the groundwater.

4.5.1 Alpha Radioactivity

Annual average gross alpha activity determined from representative CY 1995 data for five monitoring wells exceeded 15 pCi/L: GW-109 in the Western Plant Area, GW-782 at CMP Grid E3 in the Central Plant Area, and wells GW-154, GW-222, and GW-605 in the Eastern Plant Area. As in previous years, alpha radioactivity was generally highest in the groundwater in the Western and Eastern Plant areas (Table 6).

Historical groundwater monitoring data and operational information for the S-3 Ponds indicate a diverse population of radioisotopes within the S-3 Site Plume, but alpha-radioactivity is primarily from ^{234}U and ^{238}U. Of the groundwater samples collected during CY 1995 from monitoring wells within the S-3 Site Plume, gross alpha activity exceeded the specified MDA only in the sample from well GW-109 (122 ± 62 pCi/L). Although considered qualitative because of potential QA/QC deficiencies, comparison with historical (CY 1990) data for well GW-109 (>1,000 pCi/L) suggest an order-of-magnitude decrease in alpha radioactivity. Data for UST monitoring wells at the Rust Spoil Area show (qualitatively) similarly decreasing alpha radioactivity in the water table interval (HSW Environmental Consultants, Inc. 1993). The generally low (i.e., <15 pCi/L) or decreasing alpha radioactivity, in light of the much higher beta radioactivity within in the S-3 Site Plume (Table 7), reflect more limited groundwater transport of ^{234}U and ^{238}U relative to ^{99}Tc.

Data for samples collected during CY 1995 show generally low levels of alpha radioactivity in the groundwater at CMP Grid E3 in the Central Plant Area (Figure 33). As indicated by the annual average, the highest activity (23 ± 3 pCi/L) occurs in the shallow bedrock at well GW-782 (Table 6). As with the VOCs in the groundwater at these wells, higher annual average gross alpha activity for well GW-782 reflects upward migration from the deeper bedrock, and dilution-related activity fluctuations (Figure 34) (note the sharply decreased activity in response to the 1.8-inch rainfall before sampling in March 1995). The source of elevated alpha radioactivity in the groundwater at these wells has not been identified, but may coincide with the unspecified source of alpha radioactivity in the groundwater at Tank 0134-U, which is about 700-ft to the west (hydraulically upgradient) (HSW Environmental Consultants, Inc. 1995). In either case, however, results for these and the other Aquitard monitoring wells that comprise the CMP Grid Network in the Central Plant Area do not indicate major sources of alpha-emitting radioisotopes.

Results for Aquifer monitoring wells in the Western Plant Area show slightly elevated alpha-radioactivity in the groundwater at the S-2 Site (10 to 15 pCi/L) , and essentially background levels in the groundwater at well GW-617 (6.5 ± 3.9 pCi/L). Although monitoring well coverage is limited in this area, these results do not indicate extensive transport of alpha-emitting radionuclides from the S-3 Plume or the S-2 Site. Low alpha radioactivity in the groundwater at these Aquifer monitoring wells, and in the groundwater at monitoring wells comprising the current CMP Grid Network in the Aquitard, suggest that any major source of alpha-emitting radionuclides in the Central Plant Area probably overlies the Aquifer, or that dilution from stormwater runoff and process water flow effectively reduce alpha activity in the Aquitard in the Central Plant Area.

Gross alpha activity in the groundwater samples from monitoring wells in the Eastern Plant Area were typically below 10 pCi/L, and consistently exceeded 15 pCi/L only in the groundwater samples from wells GW-154, GW-222, and GW-605 (results for samples from wells GW-169 and

GW-199 were considered inaccurate because of very high TSS). Additionally, the CY 1995 data for surface water station LRSPW indicate alpha activity slightly below the 15 pCi/L MCL downstream of Lake Reality (Table 6). These results are consistent with historical data showing alpha radioactivity in the groundwater upgradient and downgradient of New Hope Pond.

Gross alpha activity results for wells GW-154, GW-222, and GW-605 mirror the uranium concentration trends and relationships with water level elevations described in Section 4.2.3. Alpha radioactivity in the shallow groundwater at well GW-154 has slightly decreased from about 800 pCi/L to less than 600 pCi/L between January 1990 and November 1995 (Figure 35), probably as a direct response to closure of the Oil Skimmer Basin. More widely variable alpha radioactivity in the groundwater at well GW-222, and direct relationships with groundwater elevations, suggest flow-related activity fluctuations (Figure 35). Seasonally fluctuating but generally increasing alpha radioactivity in the groundwater at well GW-605 potentially reflects an increased flux of uranium isotopes in the deeper groundwater flow system (Figure 35). Upgradient sources of uranium isotopes include process buildings within the Central Plant Area (e.g., Buildings 9201-1 and 9201-2).

As noted in Section 3.3, groundwater samples from monitoring wells and one spring located in Union Valley east of the ORR boundary were analyzed for a suite of radioisotopes to determine if any off-site migration has occurred. Aside from strontium results for samples collected from Aquifer monitoring wells GW-169 (90.1 ± 36 pCi/L) and GW-171 (40 ± 27 pCi/L), the results from each of the radionuclides were either below the applicable MDA, or were typically slightly above the MDA but had proportionally high (i.e. >50%) counting errors (Table 8). Additionally, results for well GW-169 were probably inaccurate because of very high TSS (4,720 mg/L).

4.5.2 Beta Radioactivity

Annual average gross beta activity determined from the CY 1995 data for seven monitoring wells exceeded 50 pCi/L: GW-108, GW-109, GW-274, and GW-275 in the Western Plant Area (Figure 36); GW-199 at CMP Grid I1, and wells GW-154 and GW-605 in the Eastern Plant. Results for wells in the Western Plant Area reflect transport of beta-emitting radionuclides (primarily ^{99}Tc) within the S-3 Site Plume. Elevated gross beta activity results at well GW-199 may be inaccurate because of the high TSS of the unfiltered samples from the well. Beta-radioactivity in the groundwater in the Eastern Plant Area may indicate transport of ^{99}Tc from the S-3 Site Plume, but also possibly indicates other radioisotopes in the groundwater (e.g., ^{89}Sr and ^{90}Sr).

Historical monitoring data and operational information for the S-3 Site indicate that beta radioactivity in the S-3 Site Plume is primarily from ^{99}Tc, but also may include activity from tritium (^{3}H), radium-228, and isotopes of thorium (^{234}Th and ^{231}Th) and strontium (^{89}Sr and ^{90}Sr) (Geraghty & Miller, Inc. 1989). Along with the historical gross beta activity results summarized below, the CY 1995 data for wells GW-108, GW-109, GW-274, and GW-275 show opposing temporal trends: increasing beta activity in the shallow bedrock at well GW-108 and water table interval at well GW-274, but decreasing trends in the deeper bedrock at well GW-109 and shallow bedrock at well GW-275.

Monitoring Well		**Gross Beta Activity ± Counting Error (pCi/L)**		
Number	**Depth (ft bgs)**	**CY 1989***	**CY 1990***	**CY 1995**
GW-108	58.6	2,515 ± 169	3,150 ± 600	9,500 ± 600
GW-109	128.5	18,443 ± 350	10,100 ± 460	7,300 ± 770
GW-274	35.0	1,675 ± 161	1,650 ± 230	4,230 ± 460
GW-275	65.5	534 ± 146	256 ± 160	125 ± 60
NS = Not Sampled; * = Annual average activity				

These trends suggest that beta activity in the groundwater at wells GW-108 and GW-274 may primarily reflect upward migration of ^{99}Tc from the contaminant reservoir in the deeper bedrock. The distribution of beta radioactivity within the S-3 Site Plume also suggests a similar degree of mobility of ^{99}Tc in groundwater relative to nitrate, and similar strike-parallel migration toward the buried headwaters of UEFPC (Figure 36). As with nitrate, background beta-radioactivity in the groundwater at the Waste Coolant Processing Area suggests limited ^{99}Tc transport to the east of BT-1. Considering that ^{99}Tc in the groundwater most likely reflects transport from the S-3 Site Plume, the presence of ^{99}Tc in samples from the basement sumps in Buildings would effectively confirm the source nitrate in the groundwater produced from each sump.

Gross beta activity results for wells GW-154, GW-222, and GW-605 at New Hope Pond generally mirror the alpha-activity trends and relationships with water level elevations described in the previous section. Beta radioactivity in the shallow groundwater at well GW-154 decreased from about 700 pCi/L to about 100 pCi/L between January 1990 and November 1995 (Figure 37), probably as a direct response to closure of the Oil Skimmer Basin. More widely variable beta radioactivity in the groundwater at well GW-222 and direct relationships with groundwater elevations suggest flow-related activity fluctuations (Figure 37). Gross beta results for well GW-605 show similar seasonal fluctuations, but generally do not indicate a trend (Figure 37).

A clearly distinct source (i.e. beta-emitting radioisotopes) of the beta activity in the groundwater at New Hope Pond is not identified by available monitoring data, but the similar temporal trends in alpha and beta radioactivity may indicate a common, upgradient source of radioisotopes. Some of the activity may be from uranium isotopes: alpha activity is associated with decay of ^{234}U, ^{235}U, and ^{238}U, whereas beta activity is derived from decay of daughter isotopes of ^{238}U (e.g., ^{234}Th), which are assumed to be in secular equilibrium with the parent isotopes (Science Applications International Corporation 1996).

5.0 CONCLUSIONS AND RECOMMENDATIONS

Groundwater monitoring data for CY 1995 are consistent with previous monitoring results showing VOCs, nitrate, trace metals, and radioactivity as the primary groundwater contaminants in the East Fork Regime.

The overall pattern of groundwater flow is generally from the Aquitard to the Aquifer, and along strike in the Aquifer toward the Eastern Plant Area. Vertical hydraulic gradients in the Aquitard and the Aquifer are consistently upward and consistently downward, respectively, during both seasonally high and low groundwater flow conditions. However, the buried former headwaters and northern tributaries of UEFPC, as well as underground storm drains, substantially influence groundwater flow and contaminant migration patterns in the shallow subsurface.

Calcium-magnesium-bicarbonate groundwater usually occurs only at shallow depths in the Aquitard, but generally occurs throughout the Aquifer regardless of depth. In the Aquitard, the transition from calcium-magnesium-bicarbonate groundwater to sodium bicarbonate groundwater may occur at a shallower depth (i.e., <80 ft bgs) in the East Fork Regime than in the Bear Creek Regime (typically 100-ft bgs). Variations from the typical geochemical characteristics of the shallow calcium-magnesium-bicarbonate groundwater in the Aquitard and the Aquifer are primarily related to chloride, sodium, and nitrate contamination.

Elevated chloride and sodium concentrations in the shallow groundwater at several Aquitard monitoring wells in the Central and Eastern plant areas probably reflect contamination from road salt. In areas where buildings and paved surfaces preclude infiltration from the ground surface, elevated chloride and sodium concentrations may indicate leaking subsurface storm drains.

The S-3 Site Plume is a primary source of nitrate, trace metals, and radioactivity in the East Fork Regime. Nitrate is the principal and most mobile component of the S-3 Site Plume. Based on the current conceptual models for groundwater flow and contaminant transport, the distribution of nitrate indicates the following migration pattern in the Aquitard: (1) eastward strike-parallel transport in the water table interval, shallow bedrock, and deep bedrock toward the buried former headwaters of UEFPC; (2) upward migration from the deep bedrock to the shallow bedrock to the water table interval, and discharge from the water table interval into the buried headwaters, which channels the contaminated groundwater into the Aquifer to the southeast; and (3) eastward, strike-parallel transport in the water table and shallow bedrock intervals toward discharge areas in the water table interval along a buried tributary of UEFPC (BT-1), which also channels contaminated groundwater into the Aquifer.

Nitrate in water samples collected during CY 1994 from basement sumps in Building 9204-4 and Building 9204-5, both located east of the Waste Coolant Processing Area, potentially indicate additional sources of nitrate, but available data do not conclusively discount migration and upwelling from the S-3 Site Plume.

Elevated trace metal concentrations occur primarily in the acidic groundwater within the S-3 Site Plume, but also in groundwater with more neutral pH in the Eastern Plant area, where contamination appears to reflect combined surface water/shallow groundwater transport. Elevated sodium and boron concentrations in the groundwater at several Aquitard monitoring wells within the Central Plant Area may reflect contamination from industrial chemicals or wastes (e.g., borax mop water).

Alpha and beta radioactivity are highest in the groundwater within the S-3 Site Plume. Alpha activity is primarily from uranium isotopes, and beta activity is primarily from ^{99}Tc. The distribution of elevated gross alpha activity in the S-3 Site Plume suggest limited migration of uranium isotopes relative to ^{99}Tc. Relative to nitrate in the S-3 Site Plume, the extent of gross beta activity suggests similar extent and migration patterns for ^{99}Tc.

The overall lack of nitrate and beta activity in the Aquifer downgradient of the S-3 Site Plume contrasts with the Bear Creek Regime where nitrate and beta activity in the Aquifer extend for more than 9,000-ft downgradient of the S-3 Site. This may indicate greater dilution in the Aquifer from surface runoff and process water discharge in the Y-12 Plant.

Volatile organic compounds are the most extensive groundwater contaminants in the East Fork Regime. Principal components of dissolved VOC plumes are chloroethenes (PCE, TCE, and 1,2-DCE), chloroethanes (1,1,1-TCA and 1,1-DCA), and chloromethanes (carbon tetrachloride and chloroform). There are multiple sources within the East Fork Regime, and CY 1995 data suggest DNAPL in the Aquitard at the Waste Coolant Processing Area in the Western Plant Area, Building 9212 in the Central Plant Area (historical data also indicate DNAPL in the Aquitard near Building

9206), and an unspecified source in the Aquifer in the Eastern Plant area upgradient of New Hope Pond.

The extent of VOCs in the Aquitard suggest similar migration patterns indicated by the distribution of nitrate in the S-3 Site Plume: upward migration from the bedrock to the water table interval, and strike parallel transport toward discharge areas in the buried tributaries of UEFPC. The strike-oriented plume of dissolved chloroethenes (primarily 1,2-DCE) from the Oil/Solvent Drum Storage Area and/or the Salvage Yard Drum Deheader also reflect this migration pattern in the Aquifer.

Volatile organic compounds are more pervasive in the Aquifer, which reflects inputs from multiple source areas (including influx of contaminated groundwater from the buried tributaries of UEFPC), downward migration into the bedrock, and strike-parallel transport toward the Eastern Plant Area and beyond the ORR boundary into Union Valley.

Groundwater and surface water sampling and analysis activities planned for the East Fork Regime during CY 1997 are specified in the *Sampling and Analysis Plan for Groundwater and Surface Water Monitoring at the Y-12 Plant During Calendar Year 1997* (AJA Technical Services, Inc. 1996b). Besides these planned monitoring activities, the following actions are recommended:

- Additional investigation of the buried drainage features in the East Fork Regime should be performed. This investigation should include a detailed review of lithologic logs for all available shallow monitoring wells to identify those that may be completed within the filled tributaries.

- Samples of the water discharging from Outfall 51, which captures a buried spring, should be collected and analyzed for a suite of indicator parameters (e.g., VOCs, nitrate, gross alpha, and gross beta).

- Pressure transducers should be used in selected Aquitard and Aquifer monitoring wells clusters to obtain continuous water-level hydrographs needed to evaluate vertical hydraulic gradients and relationships between water-level fluctuations and contaminant concentrations.

- Aquifer monitoring wells in the Maynardville Limestone, preferably a series of wells along a strike-normal traverse (i.e., an Exit Pathway Picket), should be installed in the Central Plant Area.

- A sampling survey of sumps in buildings throughout the Y-12 Plant should be completed. Samples from the sumps that are suspected to intercept groundwater should be analyzed for several contamination indicator parameters, including VOCs, nitrate, gross alpha, and gross beta. Samples with elevated gross beta activity should be analyzed for ^{99}Tc to determine if the S-3 Site Plume is the source of the beta radioactivity.

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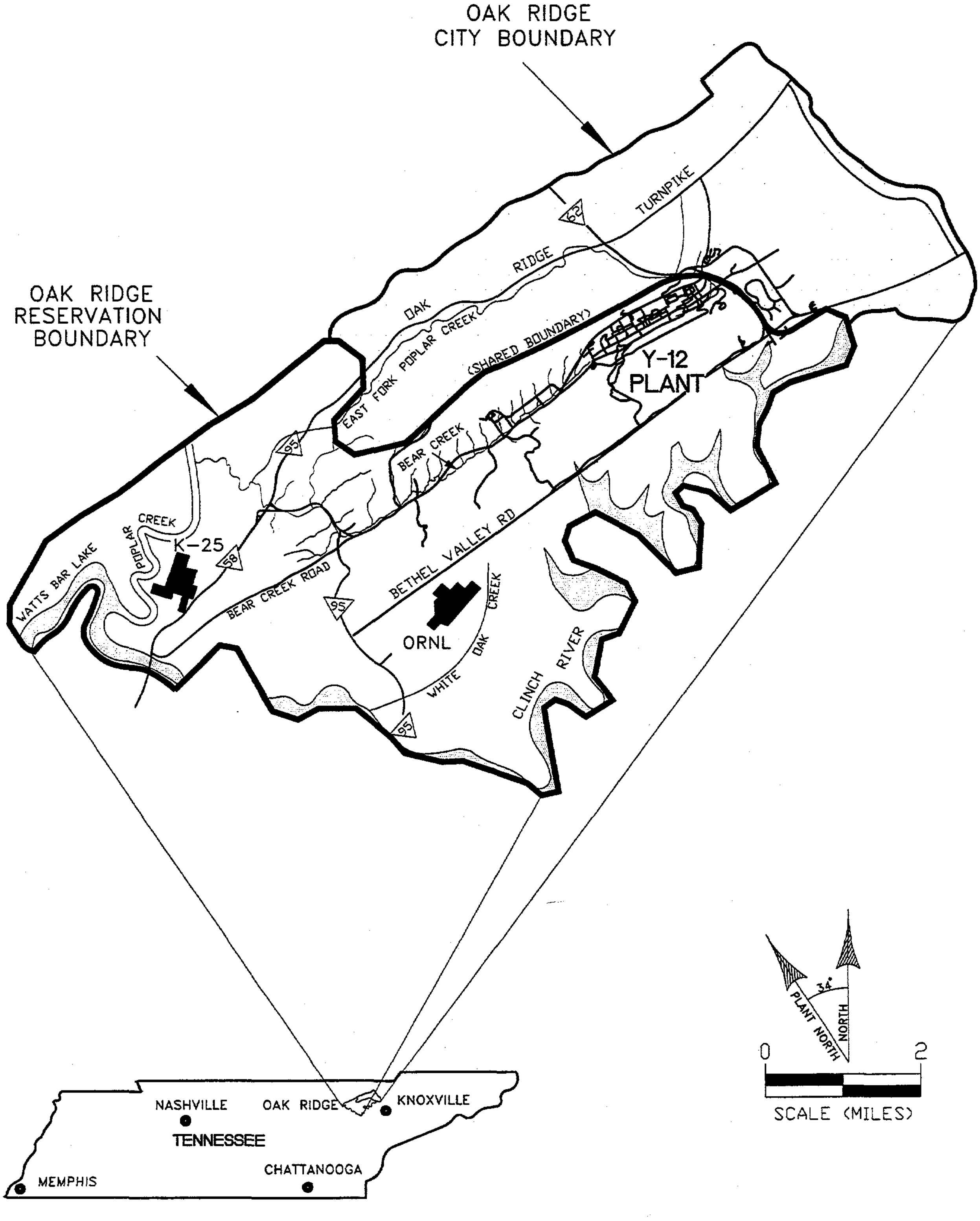


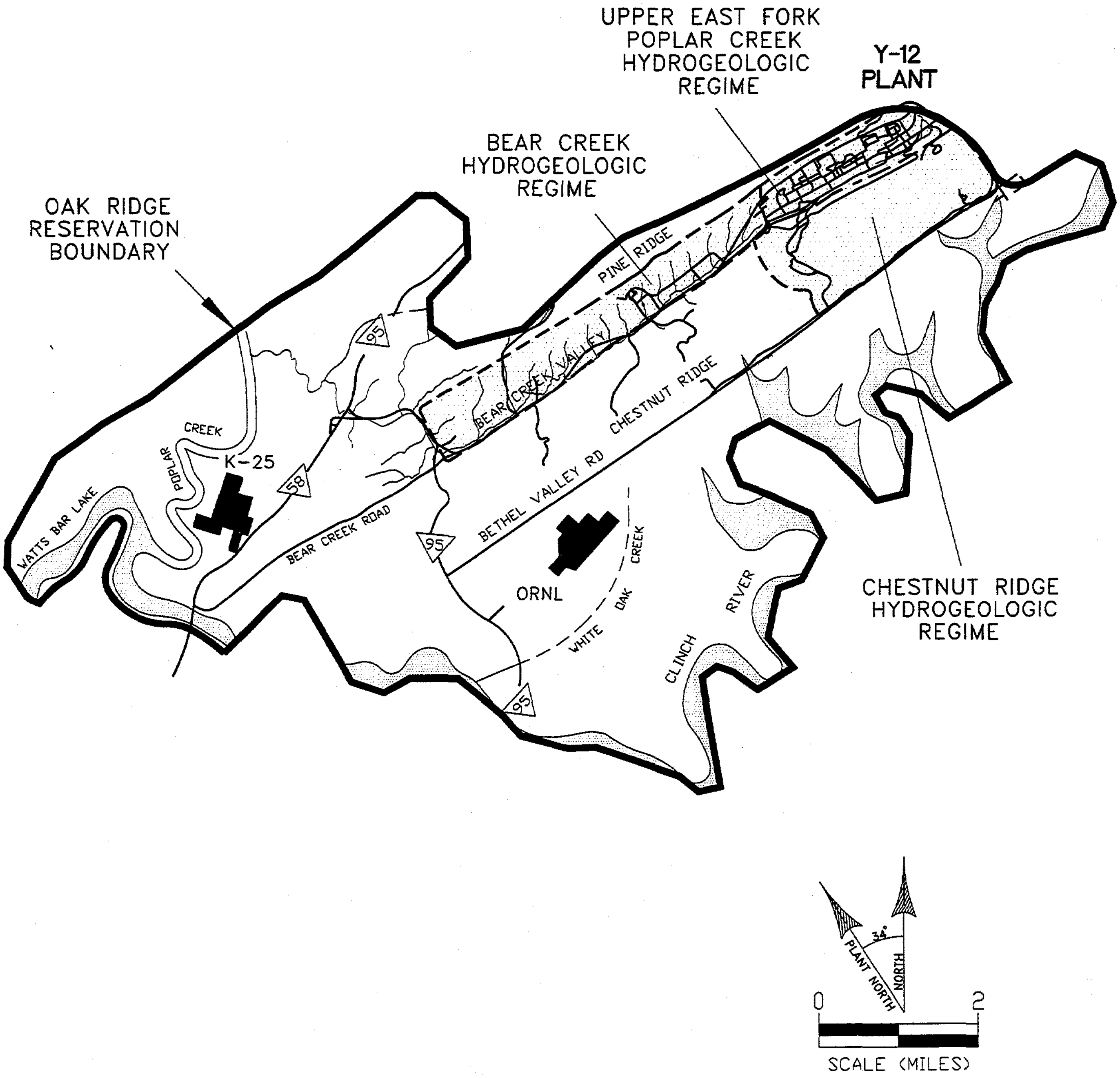
PREPARED FOR:
LOCKHEED MARTIN
ENERGY SYSTEMS, INC.

PREPARED BY:
AJA TECHNICAL
SERVICES, INC.

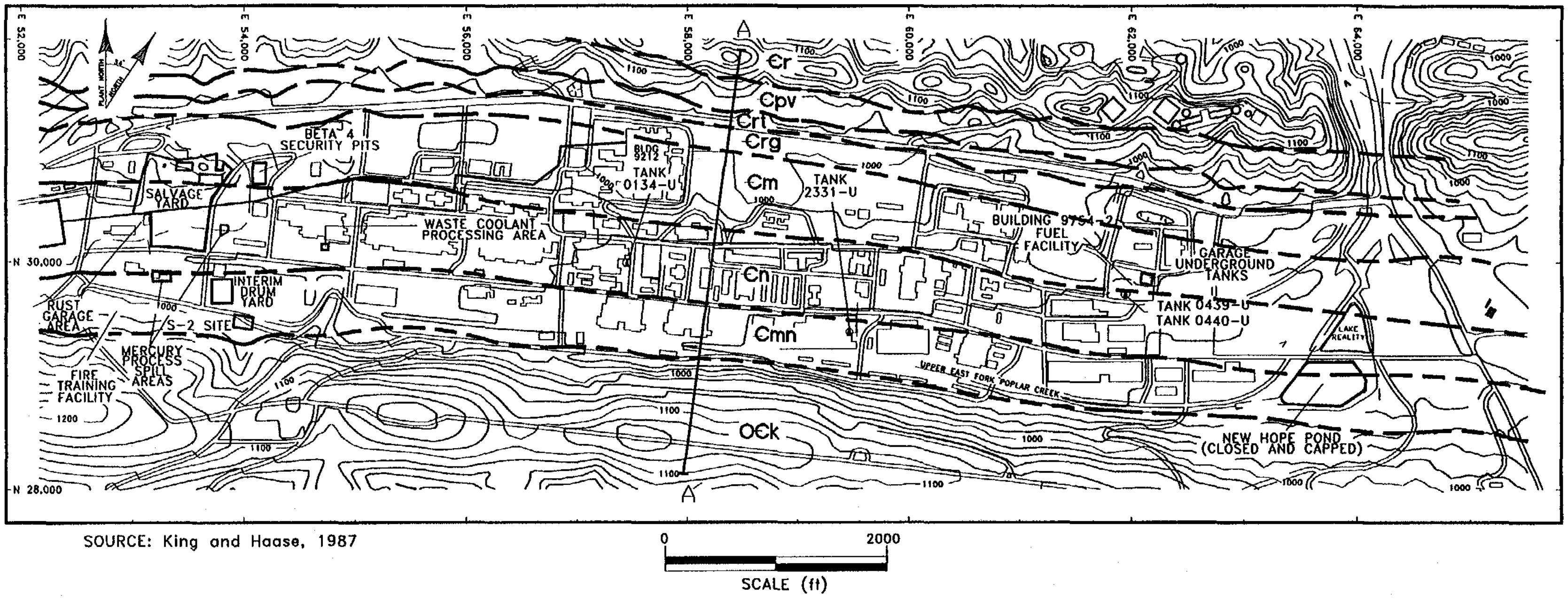
LOCATION:	Y-12 PLANT OAK RIDGE, TN.
DOC NUMBER:	96-D005
DWG ID.:	96-020
DATE:	6-20-96

FIGURE 1

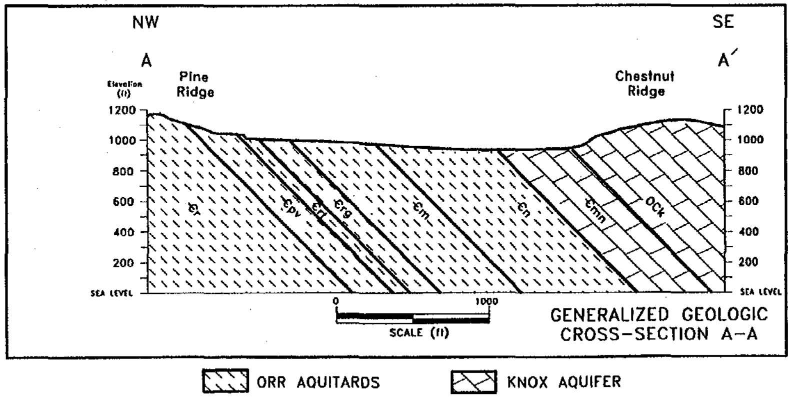
REGIONAL LOCATION OF THE Y-12 PLANT



PREPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	**FIGURE 2**
PREPARED BY: *AJA TECHNICIAL SERVICES, INC.*	DOC NUMBER:	96-D001	**HYDROGEOLOGIC REGIMES AT THE Y-12 PLANT**
	DWG ID.:	96-021	
	DATE:	6-20-96	



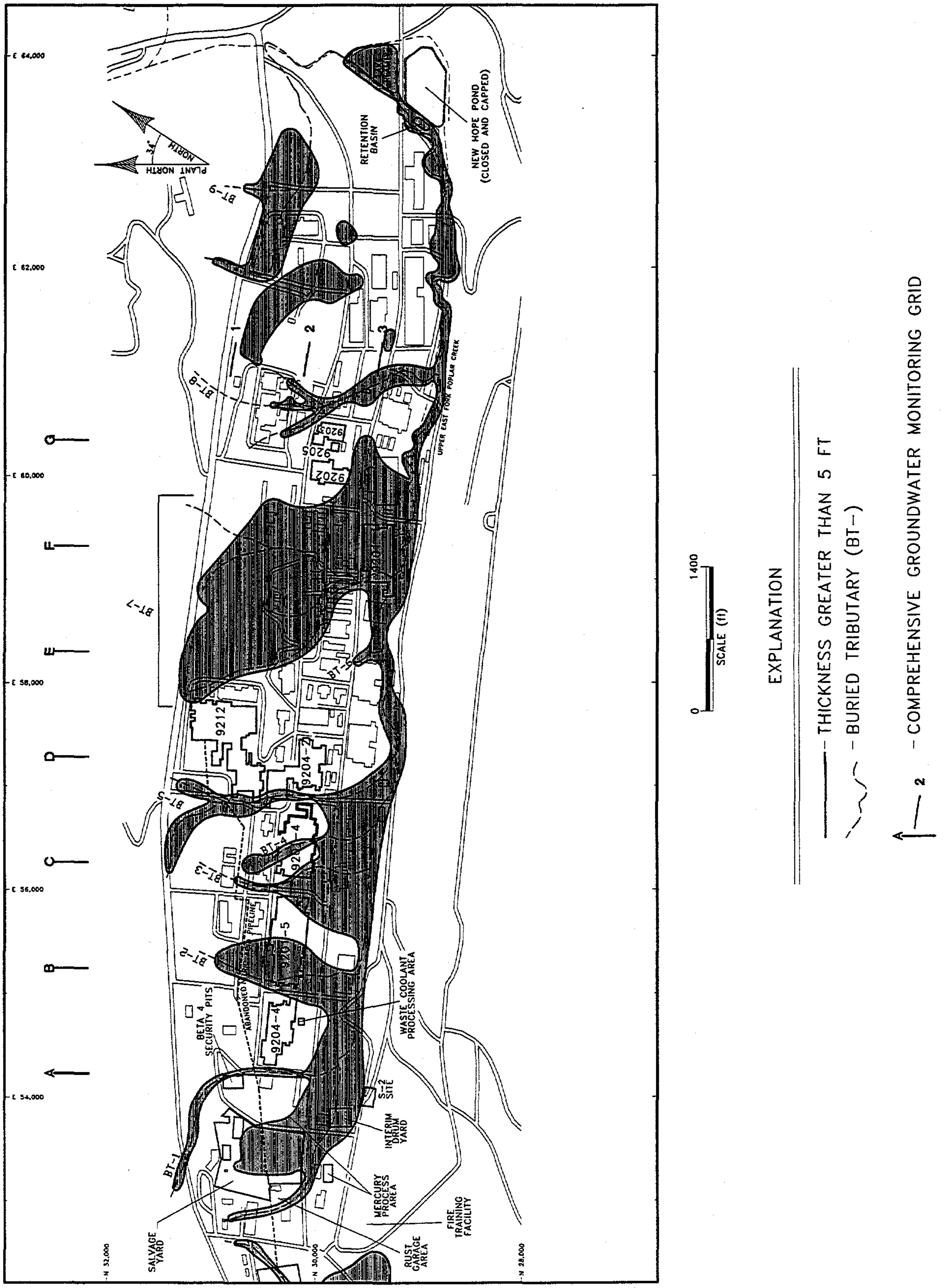
SOURCE: King and Haase, 1987



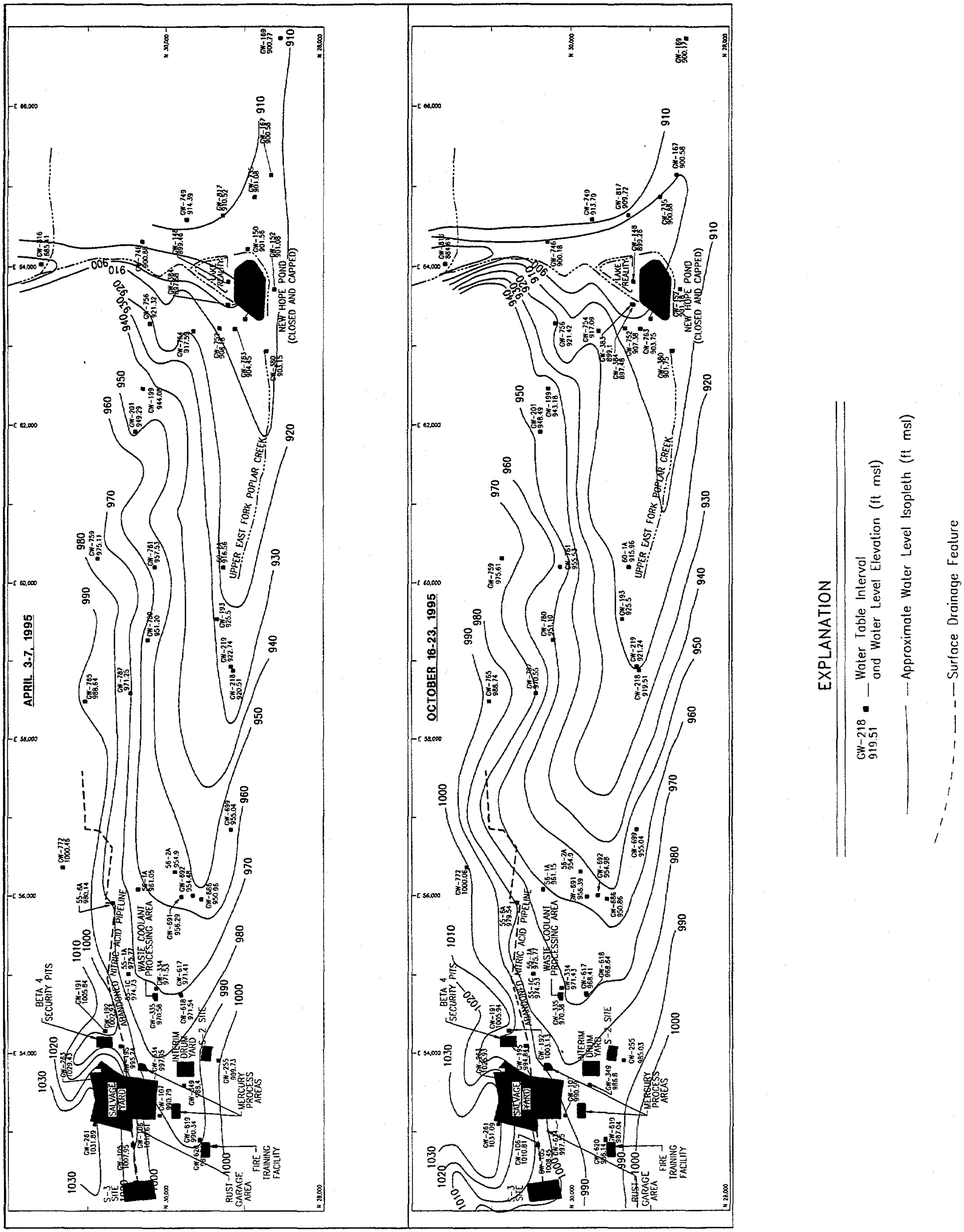
GENERALIZED GEOLOGIC CROSS-SECTION A-A

SYSTEM		GROUP	HYDRO UNIT	FORMATION	MAP SYMBOL	THICKNESS (ft)
CAMBRIAN	UPPER	KNOX	KNOX AQUIFER	COPPER RIDGE DOLOMITE	OꞒk	NOT DETERMINED
		CONASAUGA		MAYNARDVILLE LIMESTONE	Ꞓmn	418–450
	MIDDLE		ORR AQUITARDS	NOLICHUCKY SHALE	Ꞓn	422–550
				MARYVILLE LIMESTONE	Ꞓm	346–445
				ROGERSVILLE SHALE	Ꞓrg	90–120
				RUTLEDGE LIMESTONE	Ꞓrt	90–120
				PUMPKIN VALLEY SHALE	Ꞓpv	260–320
	LOWER			ROME FORMATION	Ꞓr	NOT DETERMINED

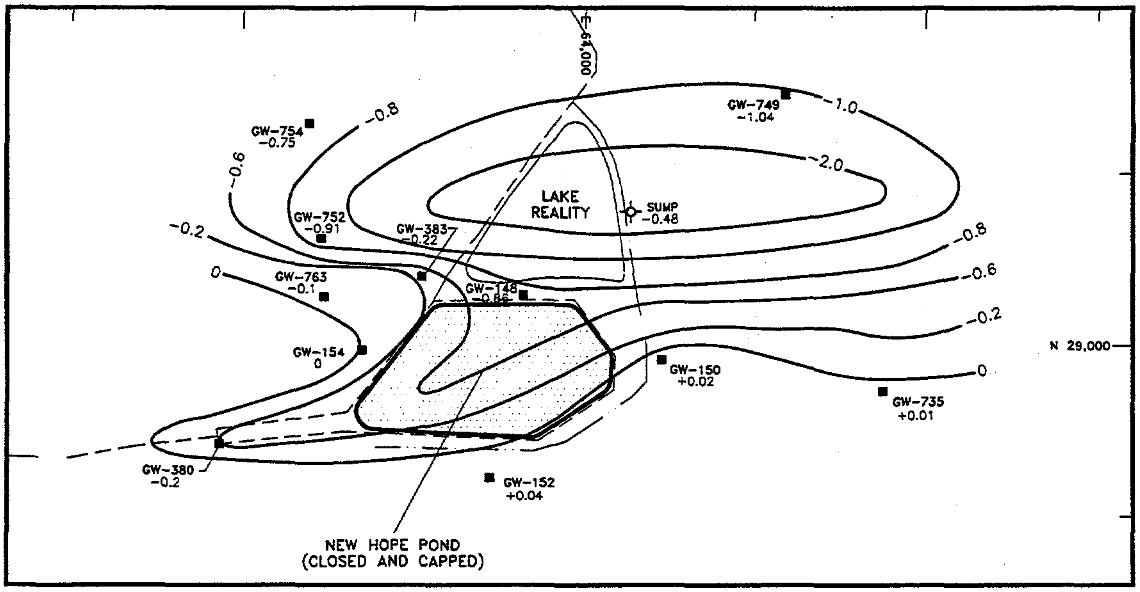
PREPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	**FIGURE 3**
PREPARED BY: *AJA TECHNICIAL SERVICES, INC.*	DOC NUMBER:	96-D007	**TOPOGRAPHY AND BEDROCK GEOLOGY IN THE EAST FORK REGIME**
	DWG ID.:	96-071	
	DATE:	7-15-96	



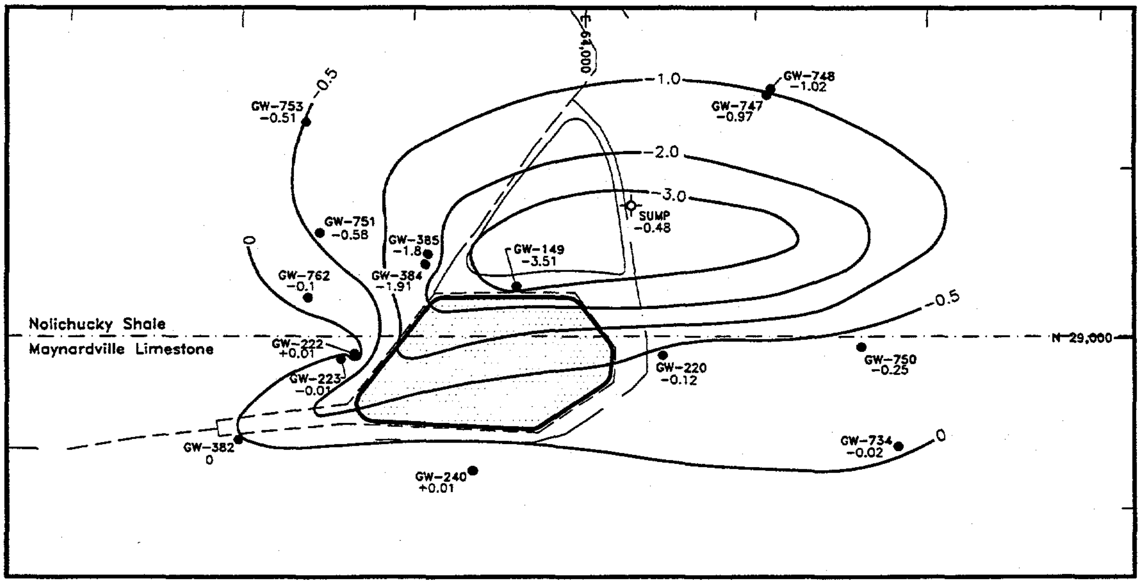
PREPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 4
PREPARED BY: *AJA TECHNICIAL SERVICES, INC.*	DOC NUMBER:	96-D007	FILL AREAS IN THE Y-12 PLANT AND PRE-CONSTRUCTION DRAINAGE FEATURES
	DWG ID.:	96-068	
	DATE:	7-10-96	



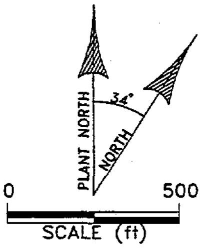
PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 5
PREPARED BY: AJA TECHNICIAL SERVICES, INC.	DOC NUMBER:	96-D007	GROUNDWATER ELEVATIONS IN THE EAST FORK REGIME, 1995
	DWG ID.:	96-072	
	DATE:	7-15-96	



WATER TABLE INTERVAL



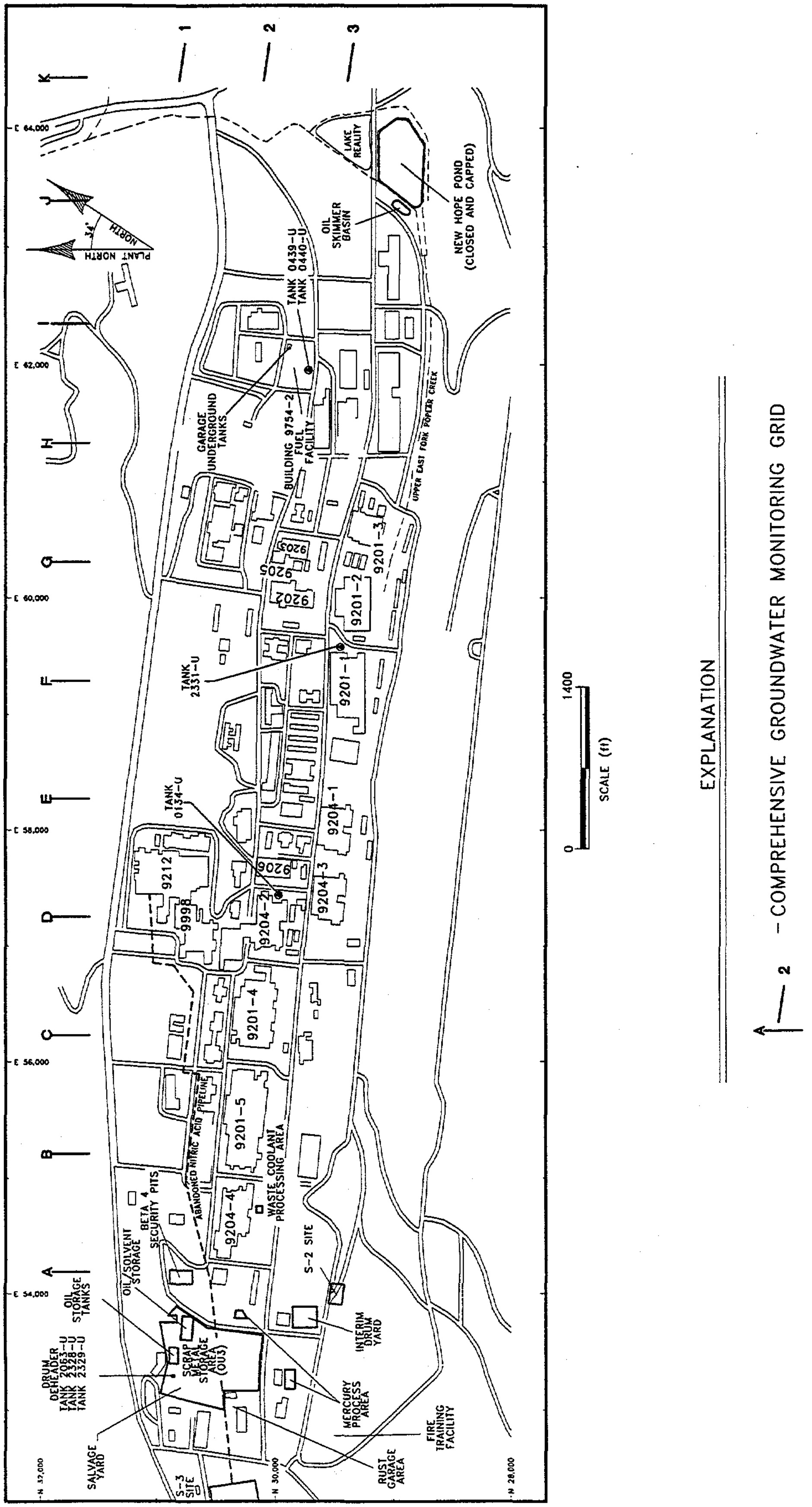
BEDROCK INTERVAL



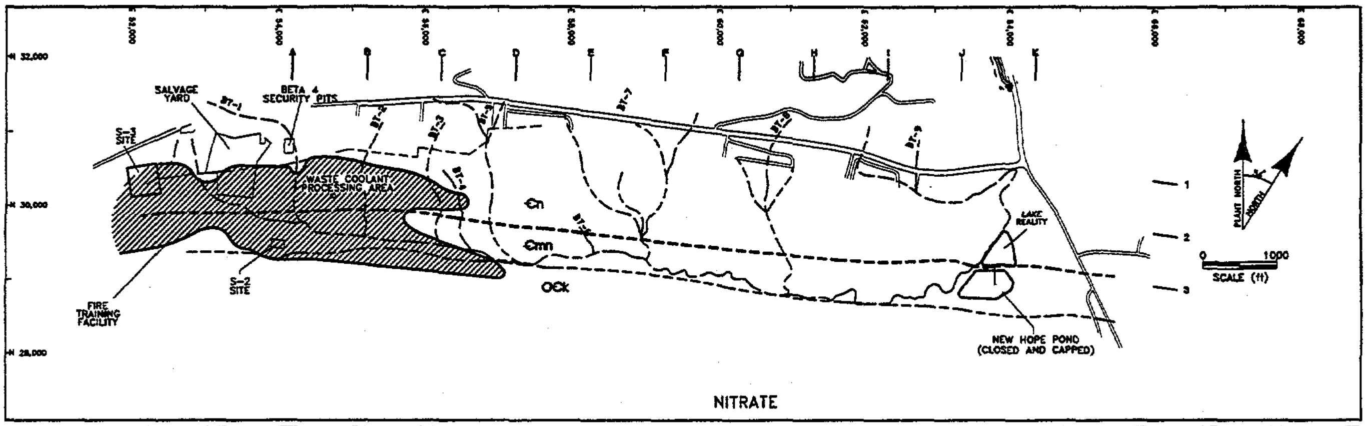
EXPLANATION

■	Water Table Interval Monitoring Well
●	Bedrock Interval Monitoring Well
— — —	Upper East Fork Poplar Creek
+3.51	Drawdown: Change in Water Level (ft) After 20 Days of Pumping From the Sump (+ Denotes a Water Level Increase)
-0.5	Approximate Line of Equal Drawdown in ft
— - —	Approximate Geologic Contact

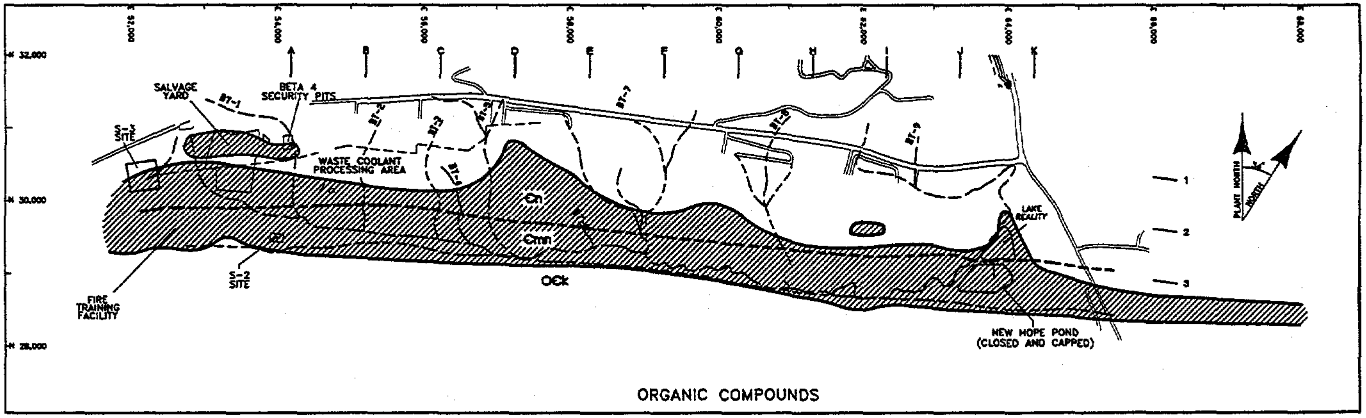
PREPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	**FIGURE 6**
PREPARED BY: *AJA TECHNICIAL SERVICES, INC.*	DOC NUMBER:	96-D007	**INFLUENCE ON GROUNDWATER FLOW DURING OPERATION OF OF THE LAKE REALITY SUMP**
	DWG ID.:	96-066	
	DATE:	7-9-96	



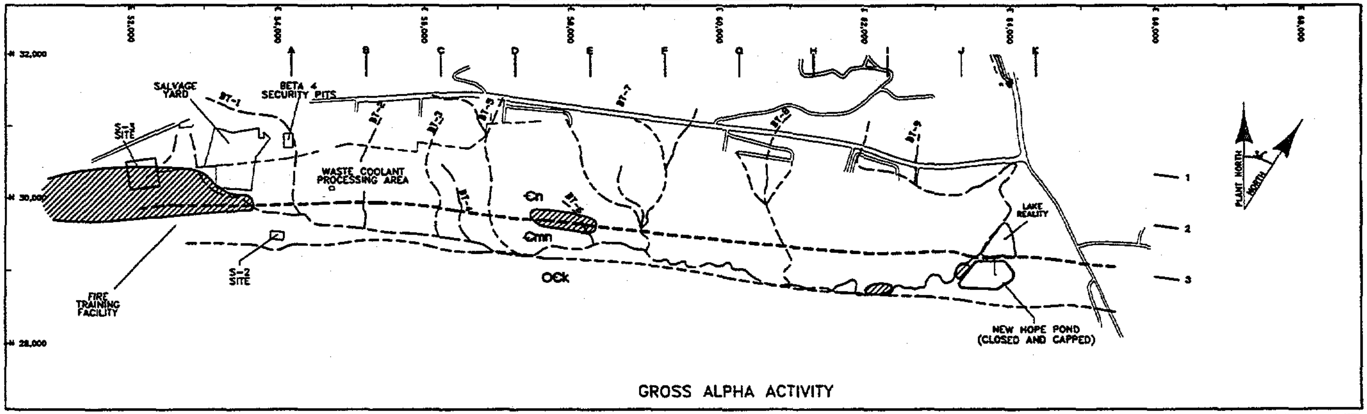
PREPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 7
PREPARED BY: *AJA TECHNICIAL SERVICES, INC.*	DOC NUMBER:	96-D007	POTENTIAL SOURCES OF GROUNDWATER CONTAMINATION IN THE EAST FORK REGIME
	DWG ID.:	96-070	
	DATE:	7-15-96	



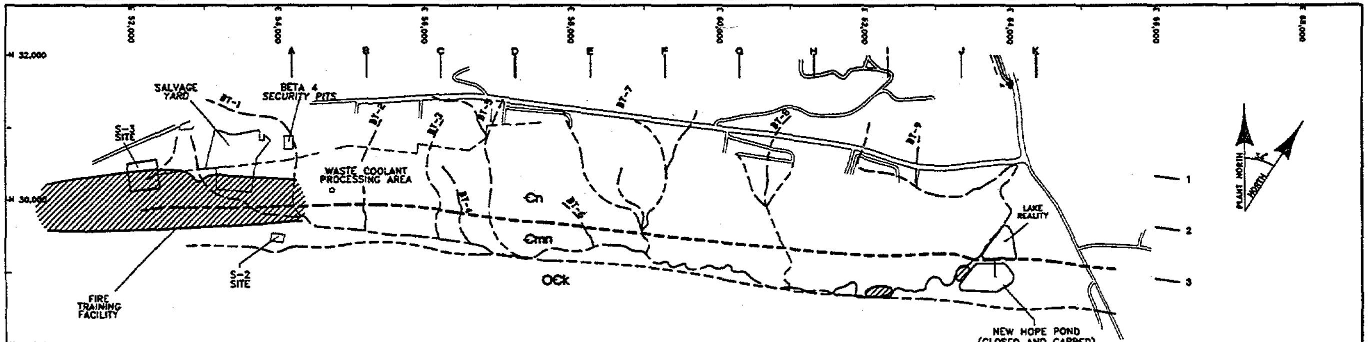
NITRATE



ORGANIC COMPOUNDS



GROSS ALPHA ACTIVITY



GROSS BETA ACTIVITY

EXPLANTION

▨ —PARAMETER CONCENTRATION/ACTIVITY EXCEEDS GROUNDWATER QUALITY STANDARDS

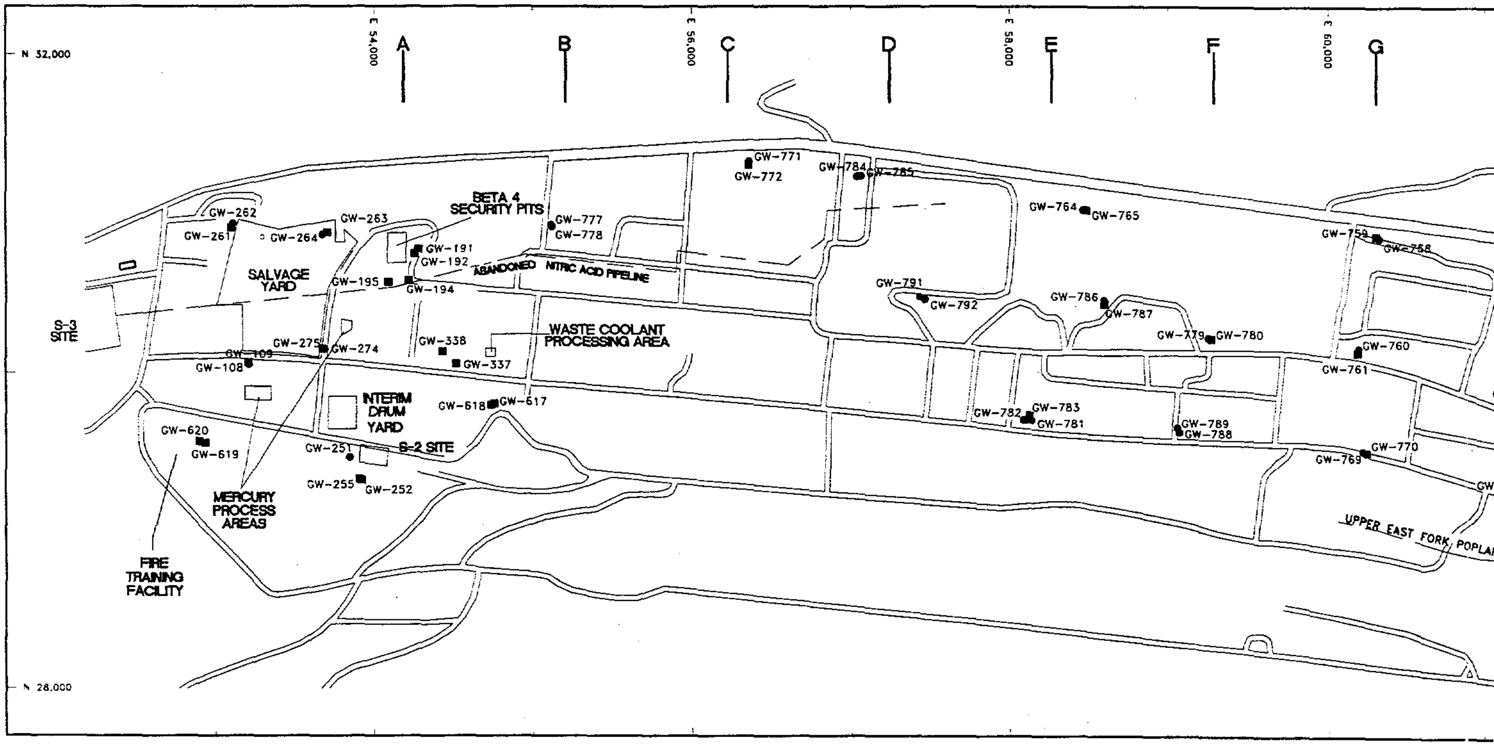
↑ — 3 —COMPREHENSIVE GROUNDWATER MONITORING GRID

Ꞓn —AQUITARD

- - - - —APPROXIMATE GEOLOGIC CONTACT

Ꞓmn —AQUIFER

PREPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	**FIGURE 8**
PREPARED BY: *AJA TECHNICIAL SERVICES, INC.*	DOC NUMBER:	96-D007	OVERALL EXTENT OF GROUNDWATER CONTAMINATION IN THE EAST FORK REGIME
	DWG ID.:	96-074	
	DATE:	7-17-96	



EXPLANATIO

GW-152 ■ — Water Table Zone Monit

GW-240 ● — Bedrock Zone Monitorin

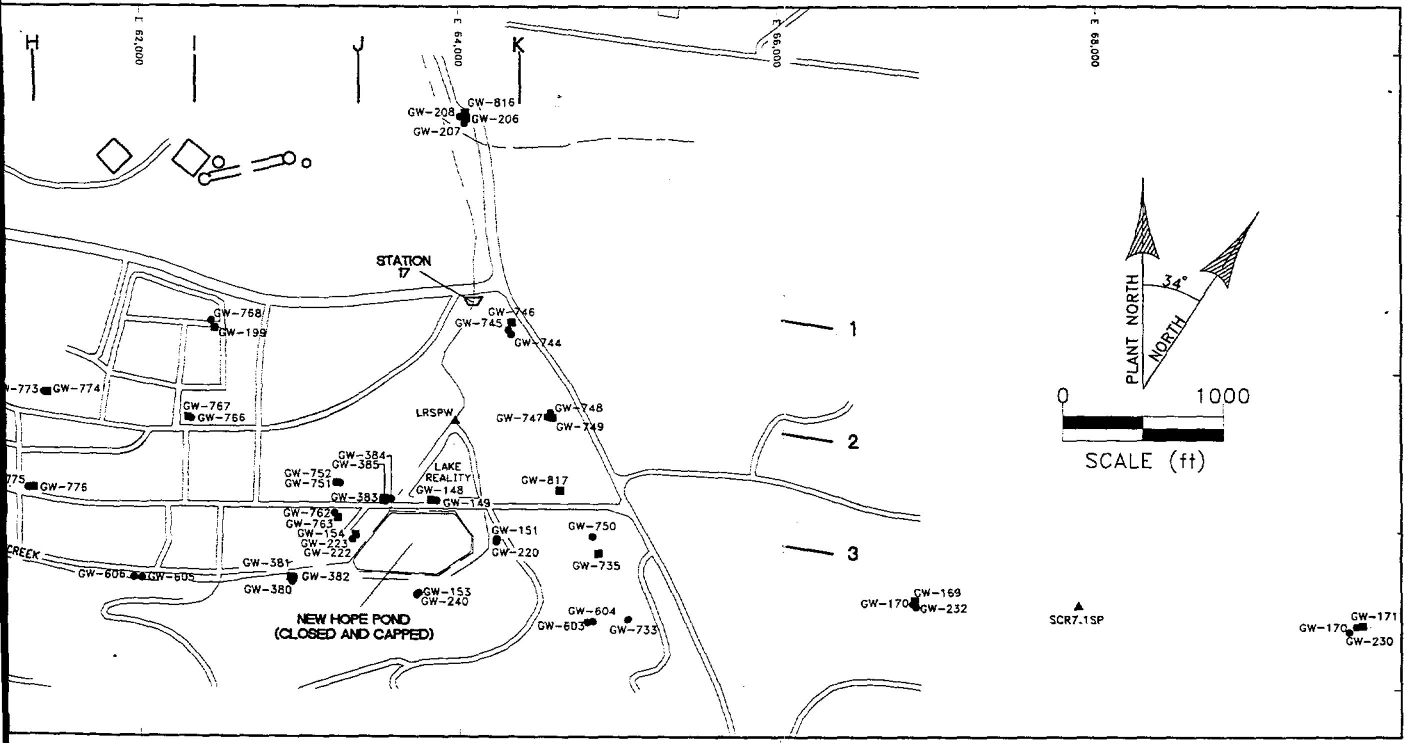
▲ — Surface Water Samplin

LRSPW — Lake Reality Emergency

▭ — NPDES Surface Water M

—— Boundary of Site

K 1 — Comprehensive Groundw



ring Well

Well

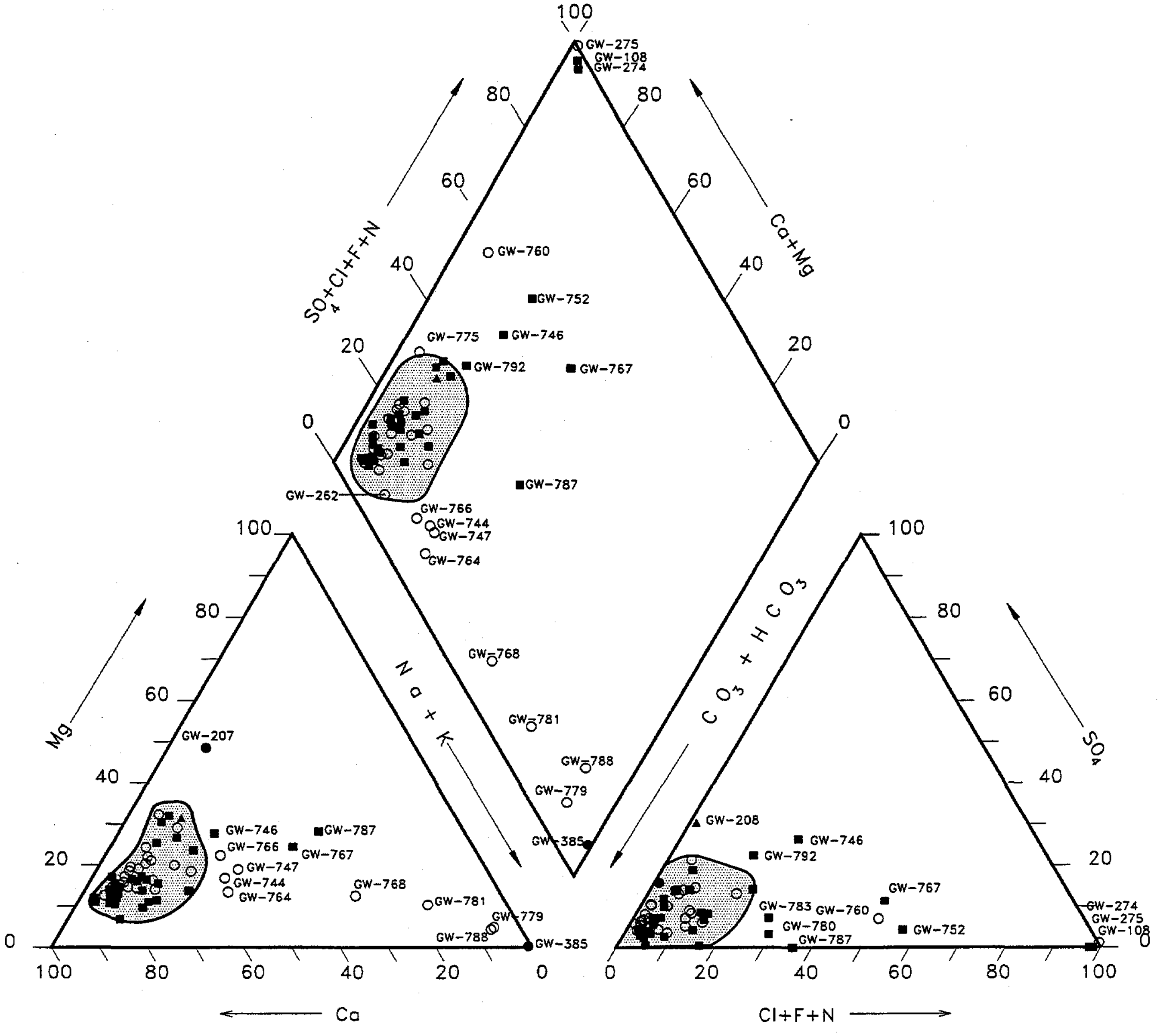
Location

Spillway

nitoring Location

ler Monitoring Grid

PREPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION: Y-12 PLANT OAK RIDGE, TN.	**FIGURE 9**
PREPARED BY: *AJA TECHNICAL SERVICES, INC.*	DOC NUMBER: 96-D006 DWG ID.: 96-075 DATE: 7-17-95	**GROUNDWATER SAMPLING LOCATIONS FOR CY 1995**



EXPLANATION

▨ — GROUNDWATER COMPOSITIONS CLUSTER IN THESE AREAS, 64 WELLS ARE PLOTTED

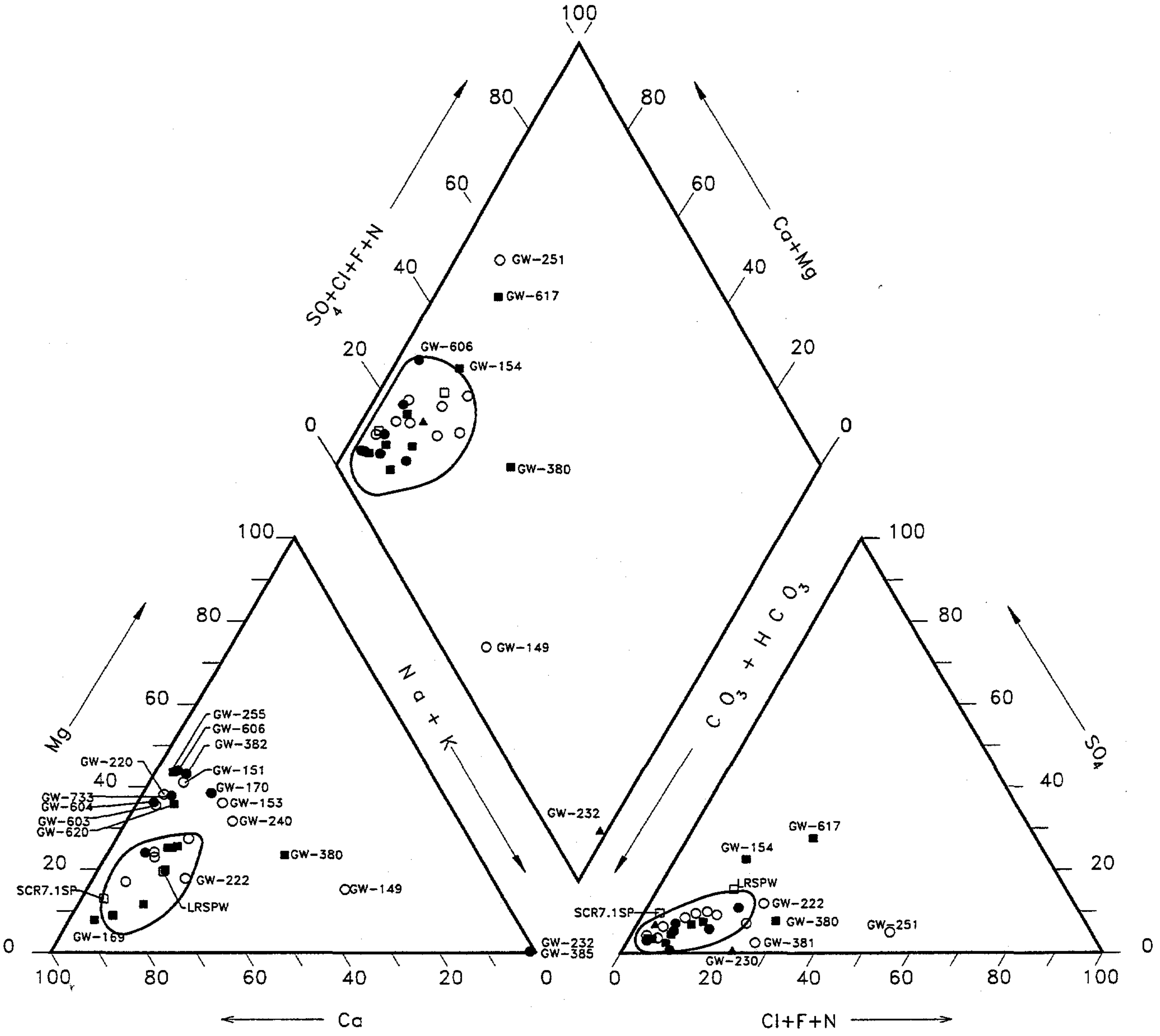
■ — WATER-TABLE MONITORING WELL

○ — BEDROCK MONITORING WELL, LESS THAN 100 FT DEEP

● — BEDROCK MONITORING WELL, 100 TO 300 FT DEEP

▲ — BEDROCK MONITORING WELL, GREATER THAN 300 FT DEEP

PREPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	**FIGURE 10**
PREPARED BY: *AJA TECHNICIAL SERVICES, INC.*	DOC NUMBER:	96-D007	**GROUNDWATER GEOCHEMISTRY IN THE AQUITARD**
	DWG ID.:	96-071	
	DATE:	7-17-96	



EXPLANATION

▨ — GROUNDWATER COMPOSITIONS CLUSTER IN THESE AREAS, 64 WELLS, ONE SPRING, AND ONE SURFACE WATER STATION ARE PLOTTED

□ — SURFACE WATER OR SPRING SAMPLING LOCATION

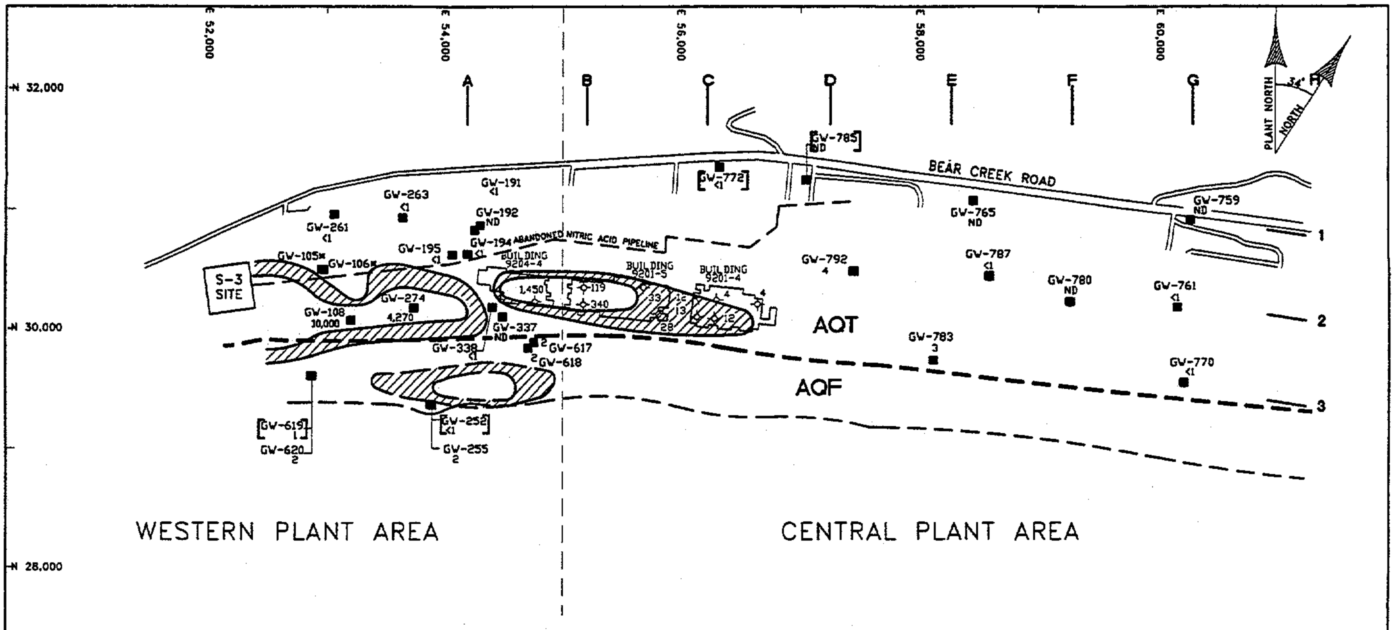
■ — WATER TABLE MONITORING WELL

○ — BEDROCK MONITORING WELL, LESS THAN 100 FT DEEP

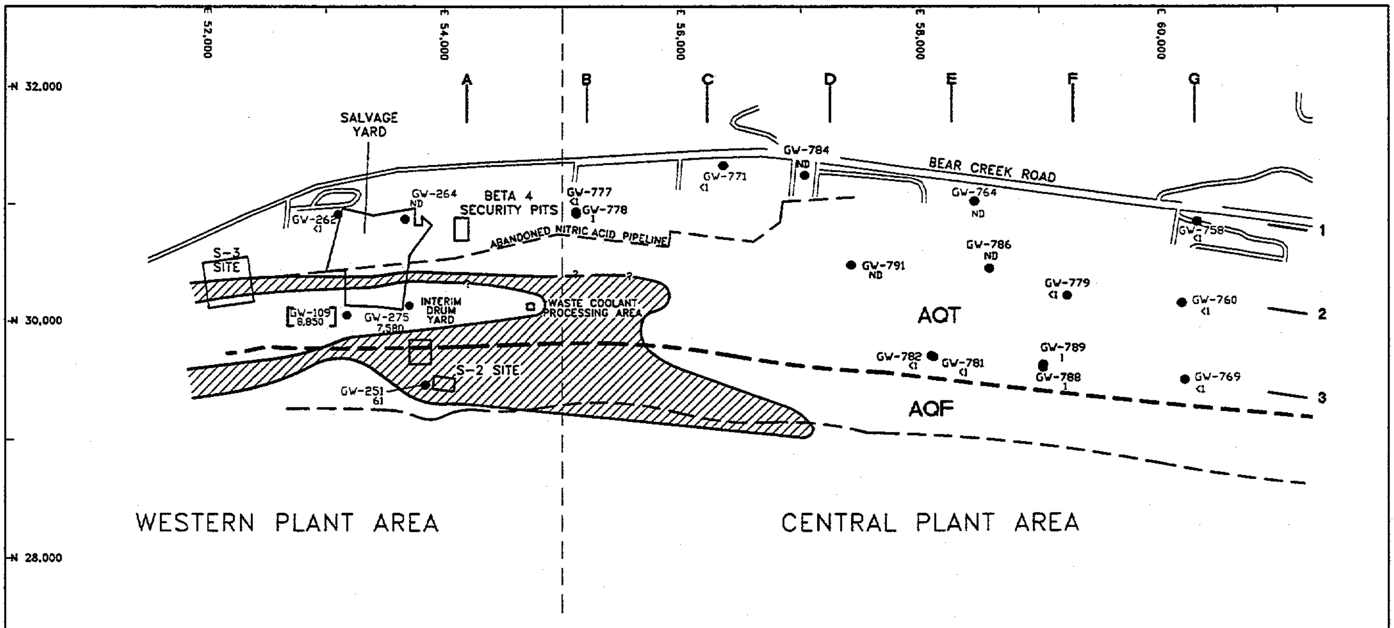
● — BEDROCK MONITORING WELL, 100 TO 300 FT DEEP

▲ — BEDROCK MONITORING WELL, GREATER THAN 300 FT DEEP

PREPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	**FIGURE 11**
PREPARED BY: *AJA TECHNICIAL SERVICES, INC.*	DOC NUMBER:	96-D007	**GROUNDWATER GEOCHEMISTRY IN THE AQUIFER**
	DWG ID.:	96-054	
	DATE:	7-17-96	



WATER TABLE INTERVAL



BEDROCK INTERVAL

EXPLANATION

■ — Water Table Monitoring Well

● — Bedrock Monitoring Well

✧ — Basement Sump Sampling Location Qualitative Data

AQT — Aquitard

– – – — Approximate Geologic Contact

AQF — Aquifer

A 2 — Comprehensive Groundwater Monitoring Grid

172 — CY 1995 Annual Average Nitrate Concentration (mg/L)

ND — Not Detected

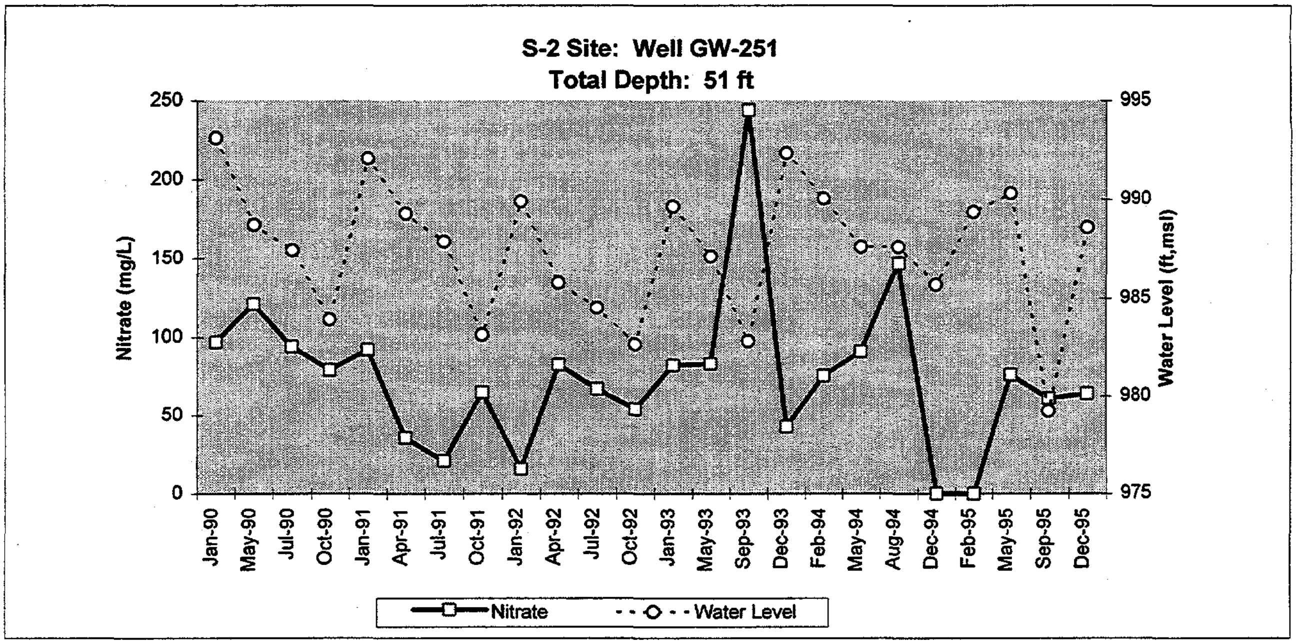
[ ]— Qualitative Data, Charge Balance Errors

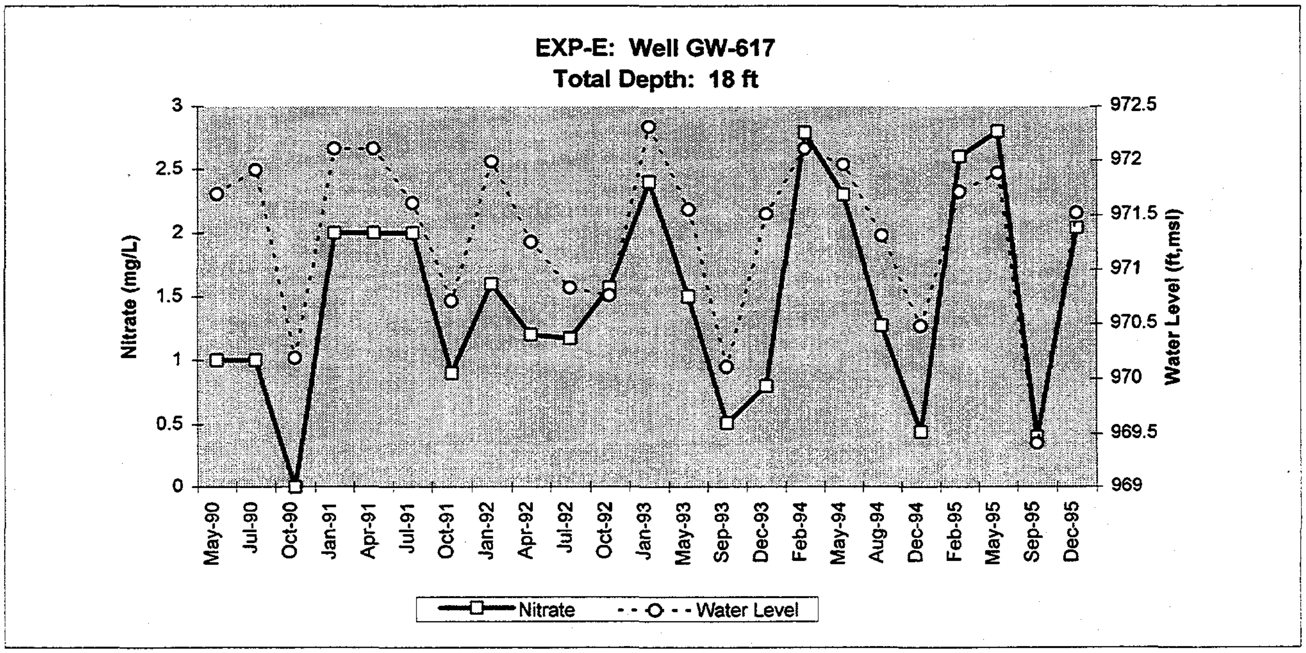
* — Not Sampled in CY 1995

▨ — 10
— 10–100 mg/L
— >100 mg/L

0 1000
SCALE (ft)

PREPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 12
PREPARED BY: *AJA TECHNICIAL SERVICES, INC.*	DOC NUMBER:	96-D006	NITRATE IN GROUNDWATER IN THE EAST FORK REGIME, 1995
	DWG ID.:	96-055	
	DATE:	6-24-96	





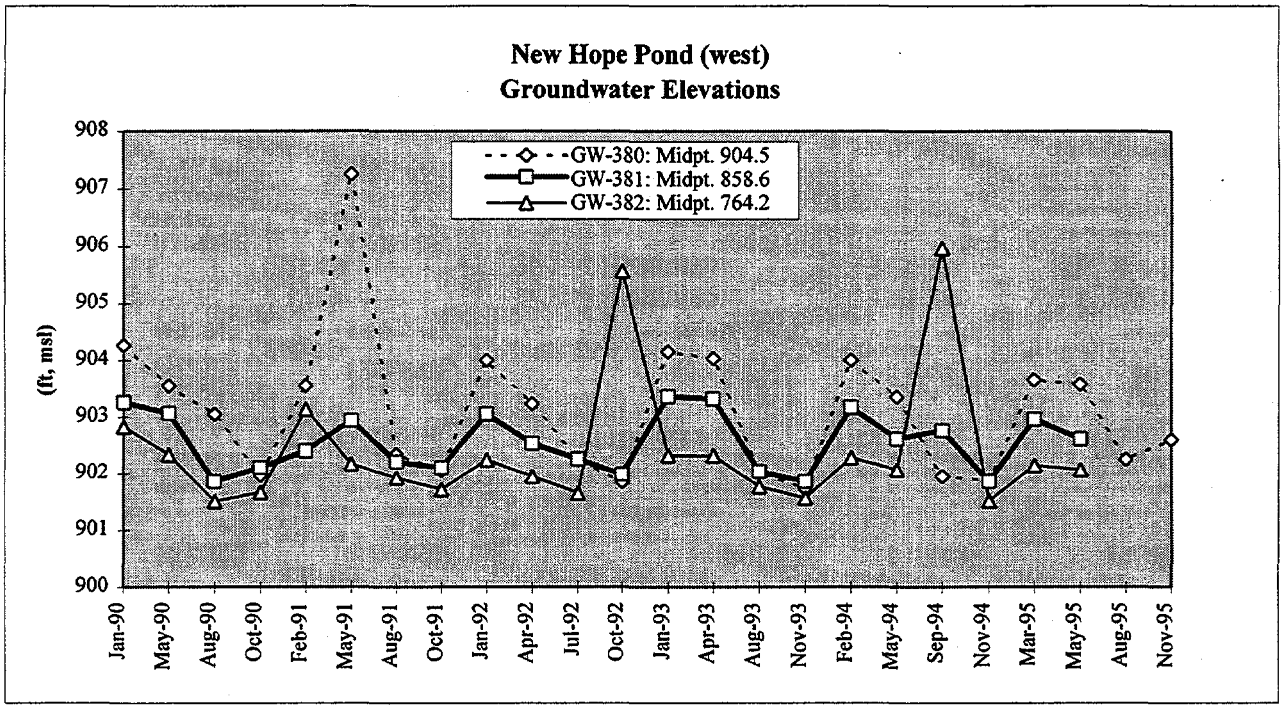
PREPARED FOR:
LOCKHEED MARTIN ENERGY SYSTEMS, INC.

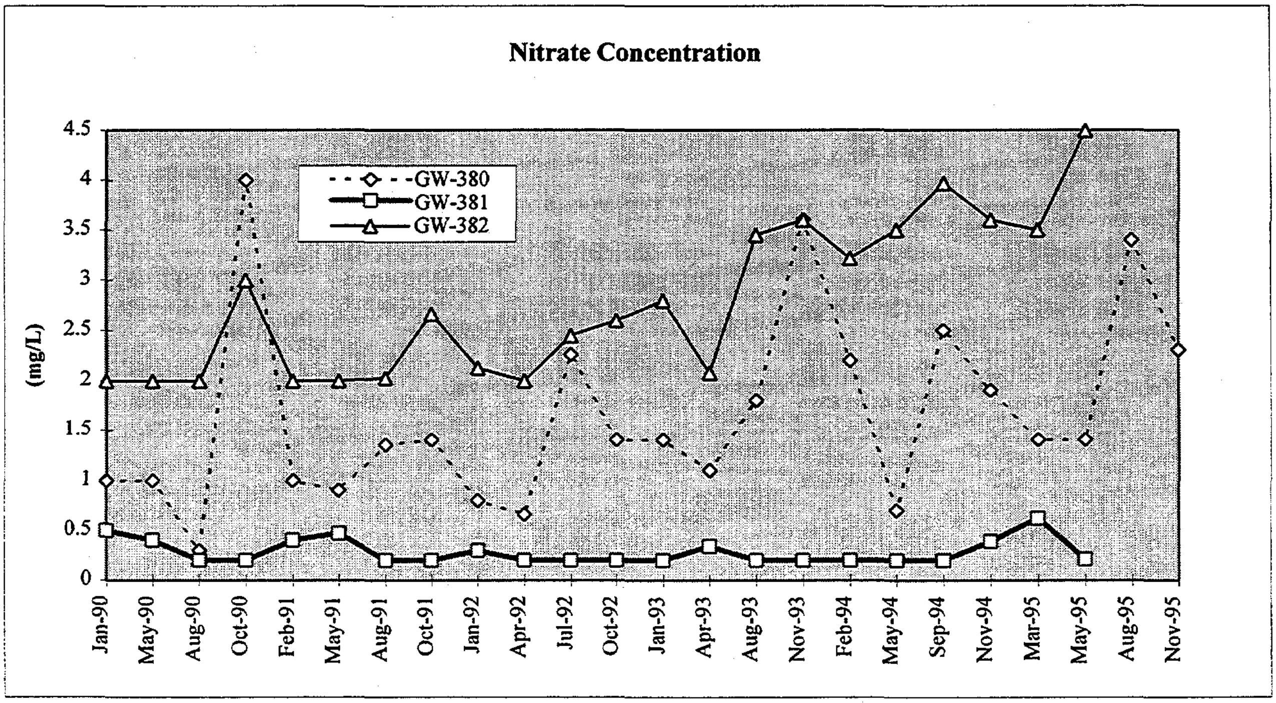
PREPARED BY:
AJA TECHNICIAL SERVICES, INC.

LOCATION:	Y-12 PLANT OAK RIDGE, TN.
DOC NUMBER:	96-D008
DWG ID.:	96-075
DATE:	7-18-96

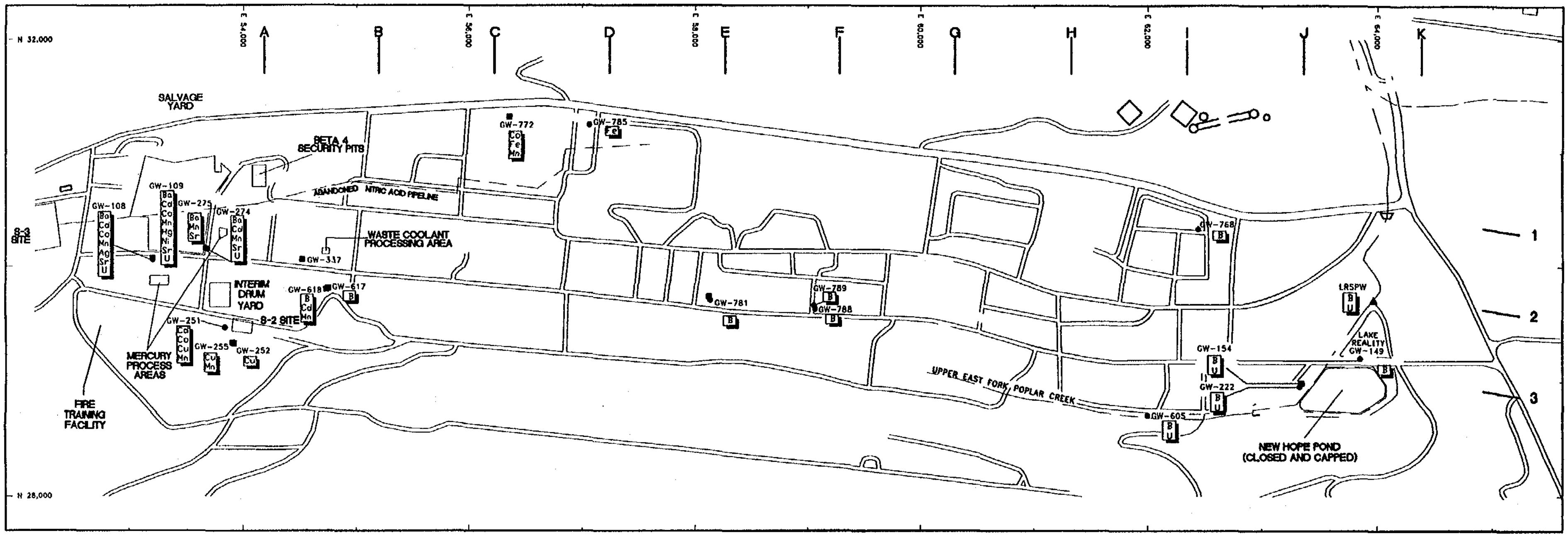
FIGURE 13

NITRATE CONCENTRATION TRENDS IN GROUNDWATER AT WELLS GW-251 AND GW-617





REPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 14
PREPARED BY: *AJA TECHNICIAL SERVICES, INC.*	DOC NUMBER:	96-D008	NITRATE CONCENTRATION TRENDS IN GROUNDWATER AT WELLS GW-380, GW-381, AND GW-382
	DWG ID.:	96-075	
	DATE:	7-18-96	



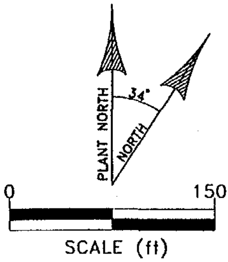
Note: Wells GW-171, GW-172, and GW-230 are located about 2,500 feet east of well GW-169.

EXPLANATION

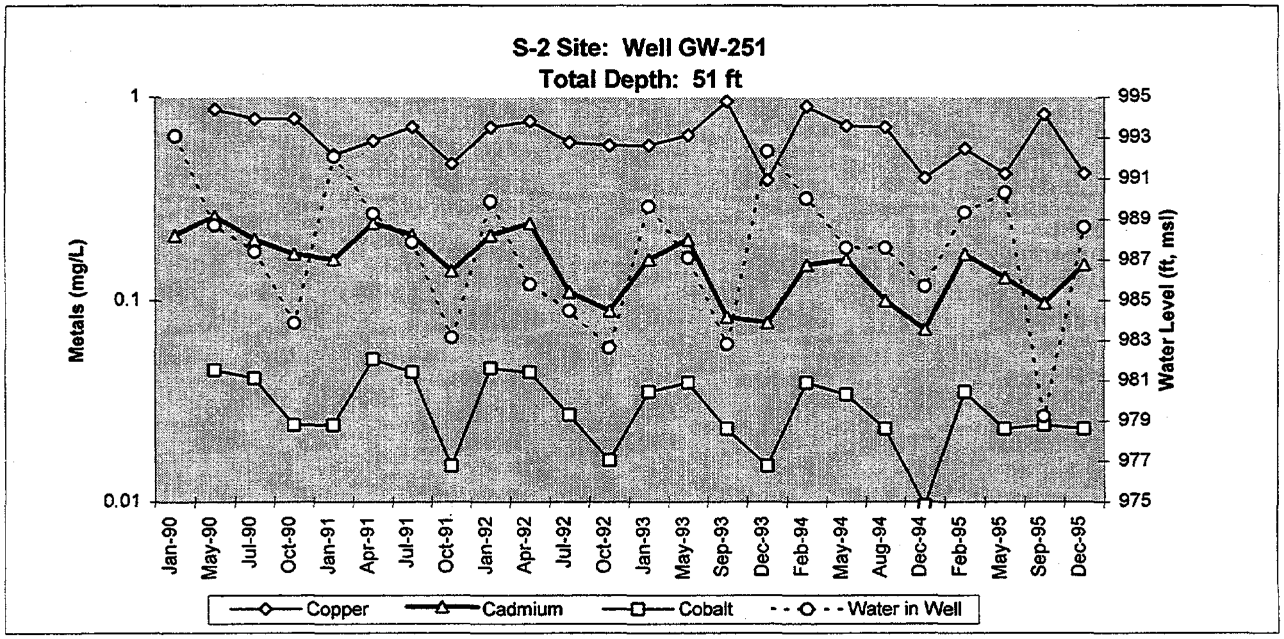
■ — Water Table Zone Monitoring Well
• — Bedrock Zone Monitoring Well
▲ — Surface Water Sampling Location
LRSPW — Lake Reality Emergency Spillway

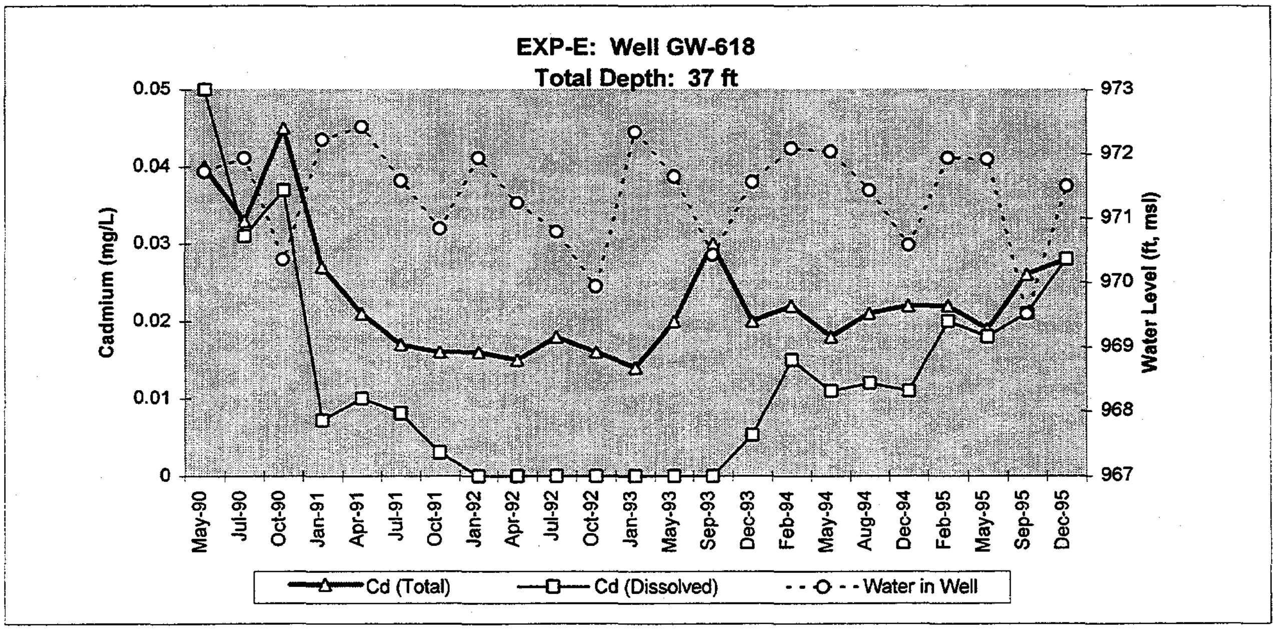
K 1 — Comprehensive Groundwater Monitoring Grid

Ba — Barium
Be — Beryllium
B — Boron
Cd — Cadmium (AAS)
Co — Cobalt
Cu — Copper
Mn — Manganese
Hg — Mercury
Ni — Nickel
Ag — Silver
Sr — Strontium
U — Uranium

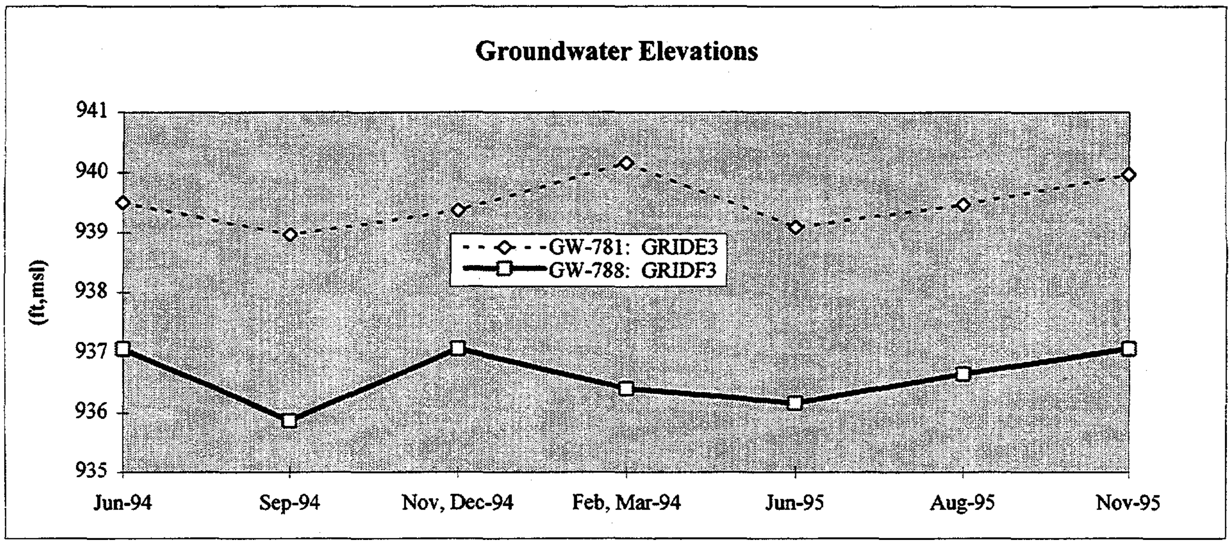


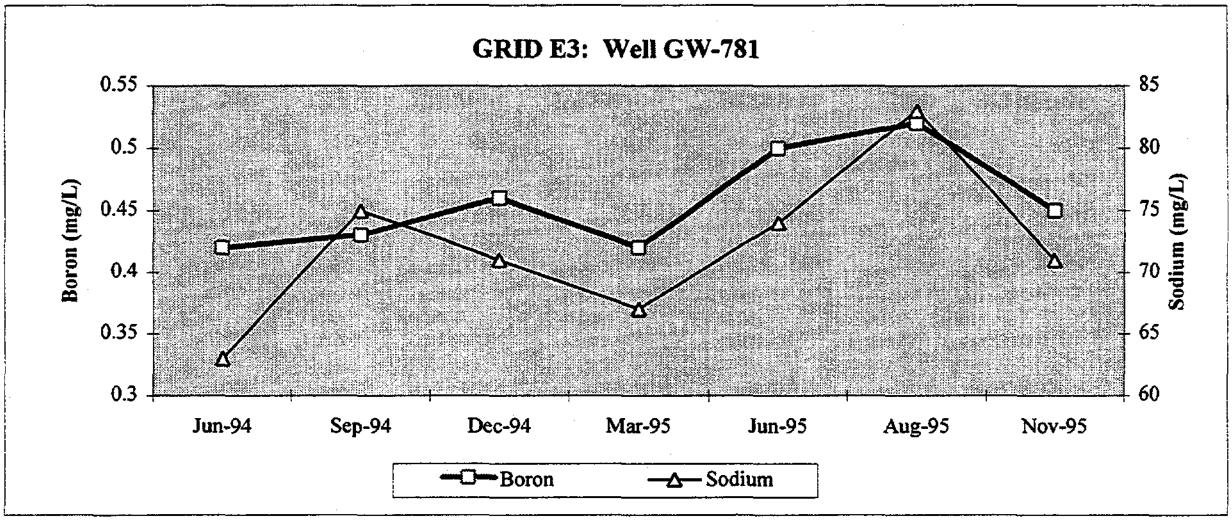
PREPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 15
PREPARED BY: *AJA TECHNICAL SERVICES, INC.*	DOC NUMBER:	96-D006	TRACE METALS IN GROUNDWATER IN THE EAST FORK REGIME, 1995
	DWG ID.:	96-064	
	DATE:	7-15-95	

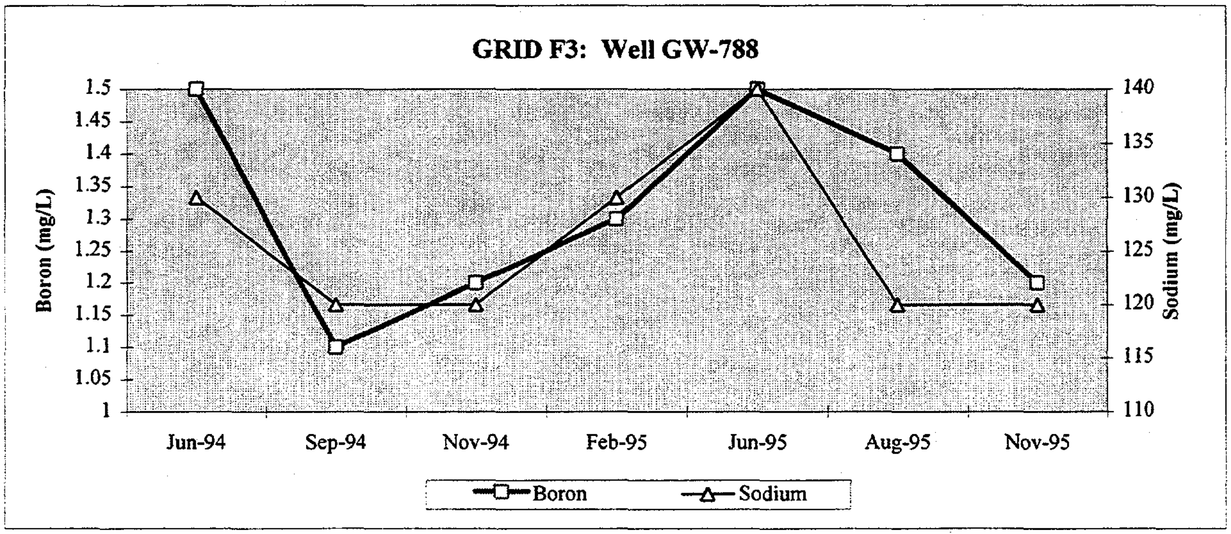




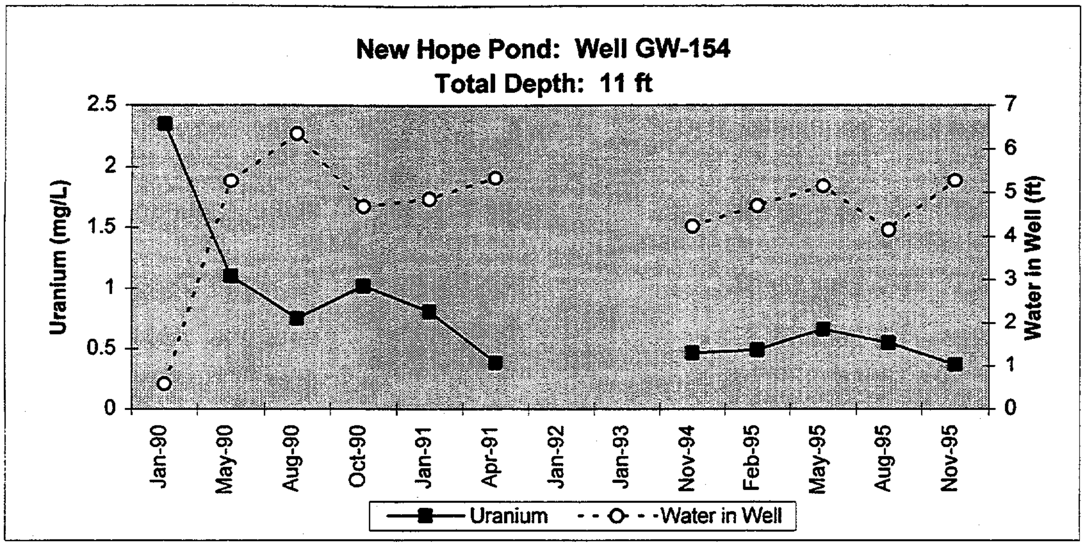
PREPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 16
PREPARED BY: *AJA TECHNICIAL SERVICES, INC.*	DOC NUMBER:	96-D008	TRACE METAL CONCENTRATION TRENDS IN GROUNDWATER AT WELLS GW-251 AND GW-618
	DWG ID.:	96-075	
	DATE:	7-18-96	

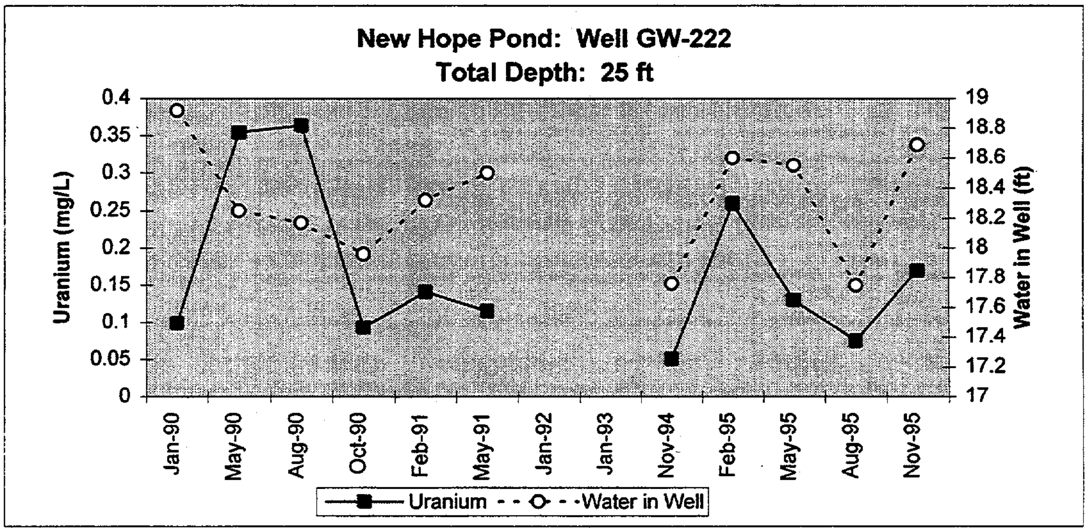


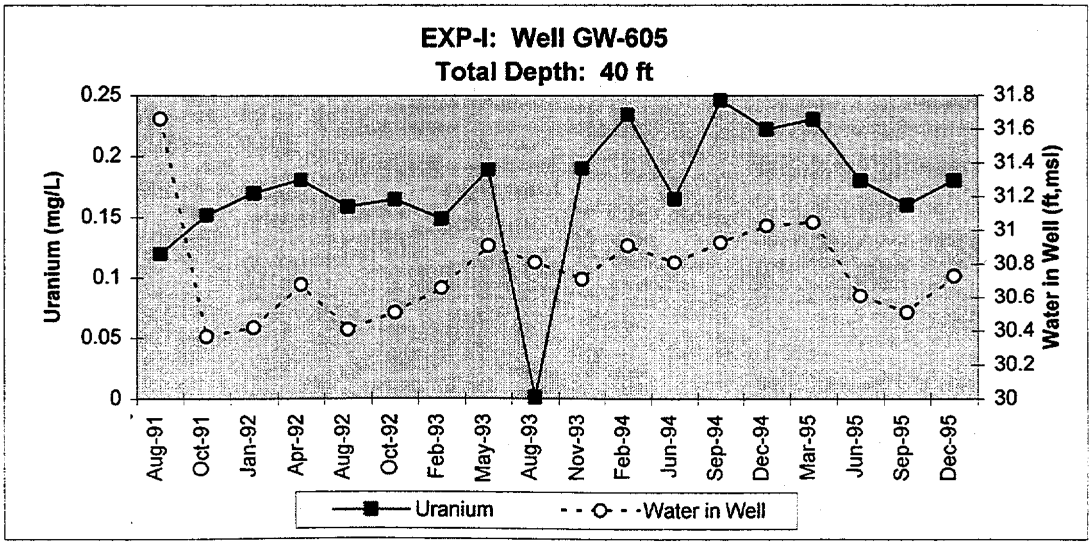




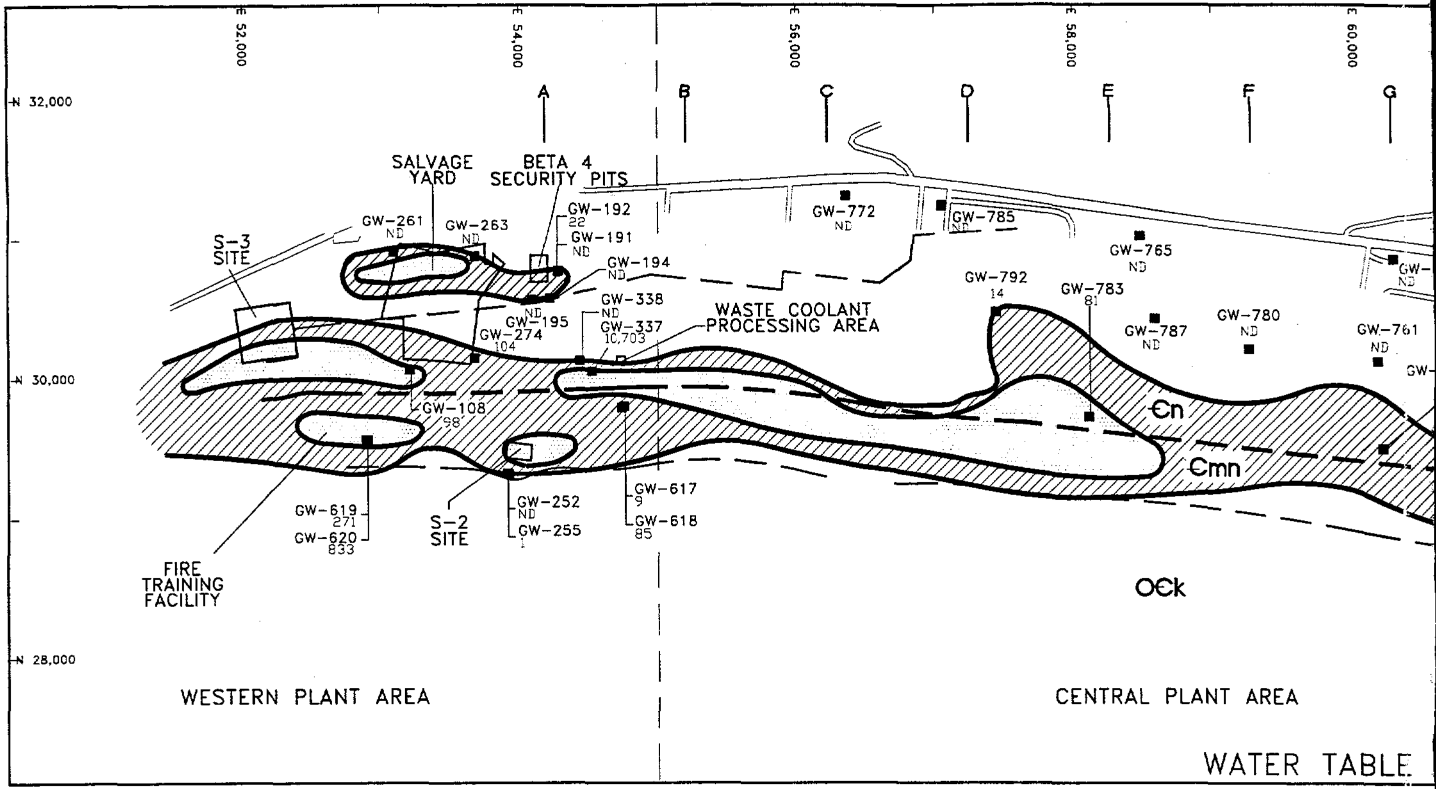
PREPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 17
PREPARED BY: *AJA TECHNICIAL SERVICES, INC.*	DOC NUMBER:	96-D008	BORON AND SODIUM CONCENTRATION TRENDS IN GROUNDWATER AT WELLS GW-781 AND GW-788
	DWG ID.:	96-075	
	DATE:	7-18-96	


New Hope Pond: Well GW-154
Total Depth: 11 ft

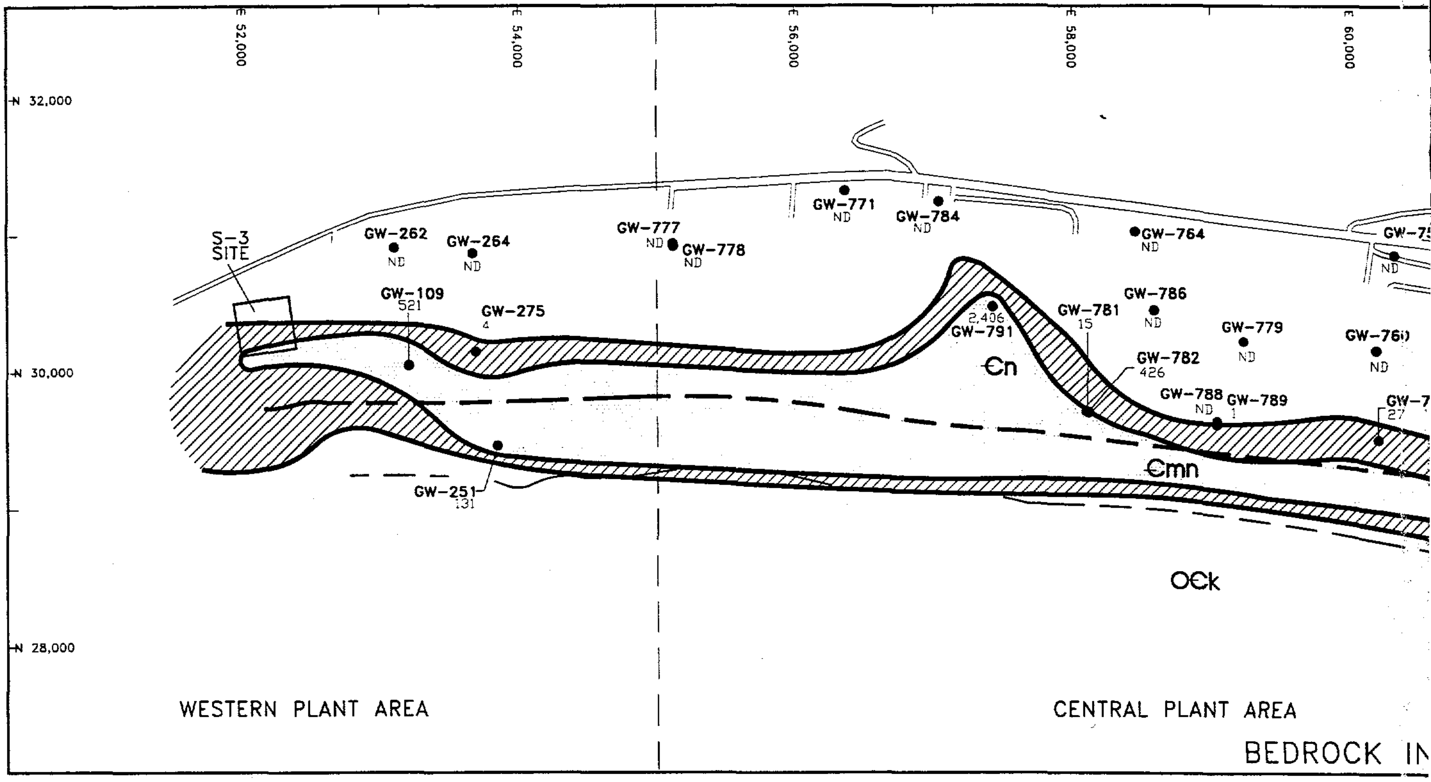

New Hope Pond: Well GW-222
Total Depth: 25 ft


EXP-I: Well GW-605
Total Depth: 40 ft

PREPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 18
PREPARED BY: *AJA TECHNICIAL SERVICES, INC.*	DOC NUMBER:	96-D008	URANIUM CONCENTRATION TRENDS IN GROUNDWATER AT WELLS GW-154, GW-222, AND GW-605
	DWG ID.:	96-075	
	DATE:	7-18-96	



WATER TABLE



BEDROCK IN

EXPLANATION

▲ — SURFACE WATER OR SPRING SAMPLING LOCATION

■ — WATER TABLE INTERVAL MONITORING WELL

● — BEDROCK INTERVAL MONITORING WELL

Ꞓn — NOLICHUCKY SHALE——— AQUITARD

Ꞓmn — MAYNARDVILLE LIMESTONE — AQUIFER

OꞒk — KNOX GROUP

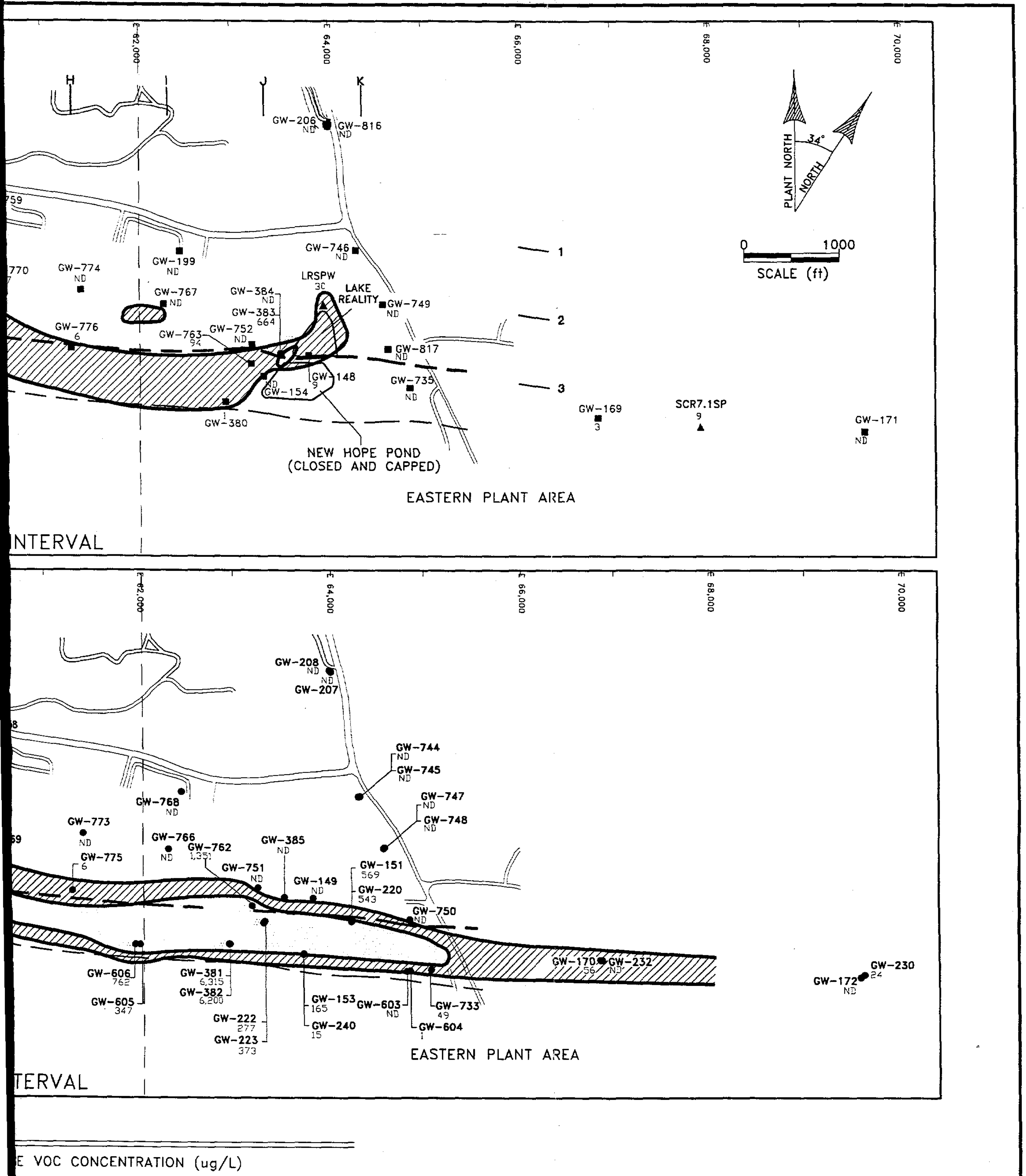
172 — SUMMED AVERA

ND — NOT DETECTED

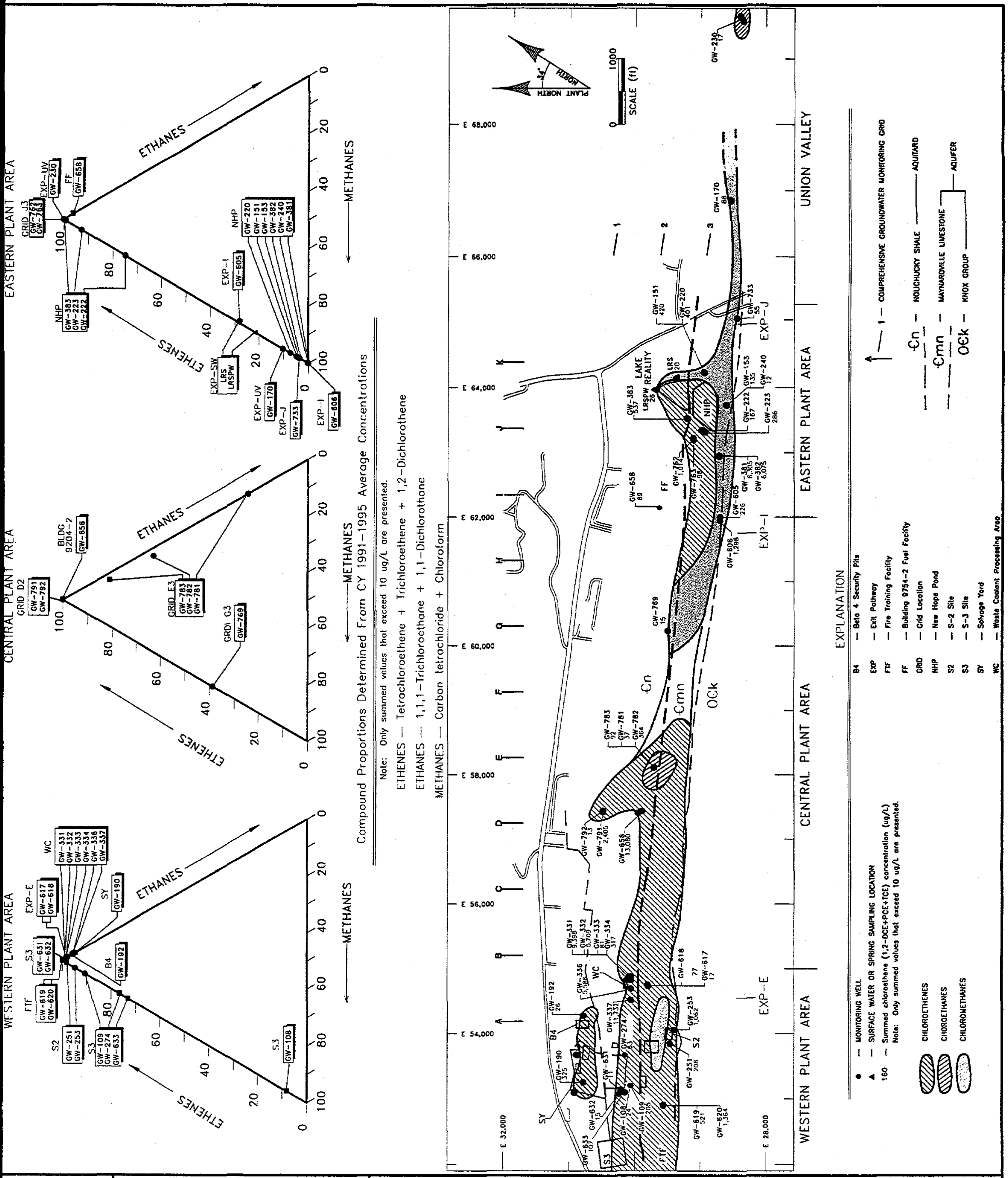
▨ — ND

— 0–100 ug/L

— >100 ug/L



PREPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	**FIGURE 19**
PREPARED BY: *AJA TECHNICIAL SERVICES, INC.*	DOC NUMBER:	96-D006	**VOCs IN GROUNDWATER AND SURFACE WATER IN THE EAST FORK REGIME, 1995**
	DWG ID.:	96-062	
	DATE:	6-20-96	



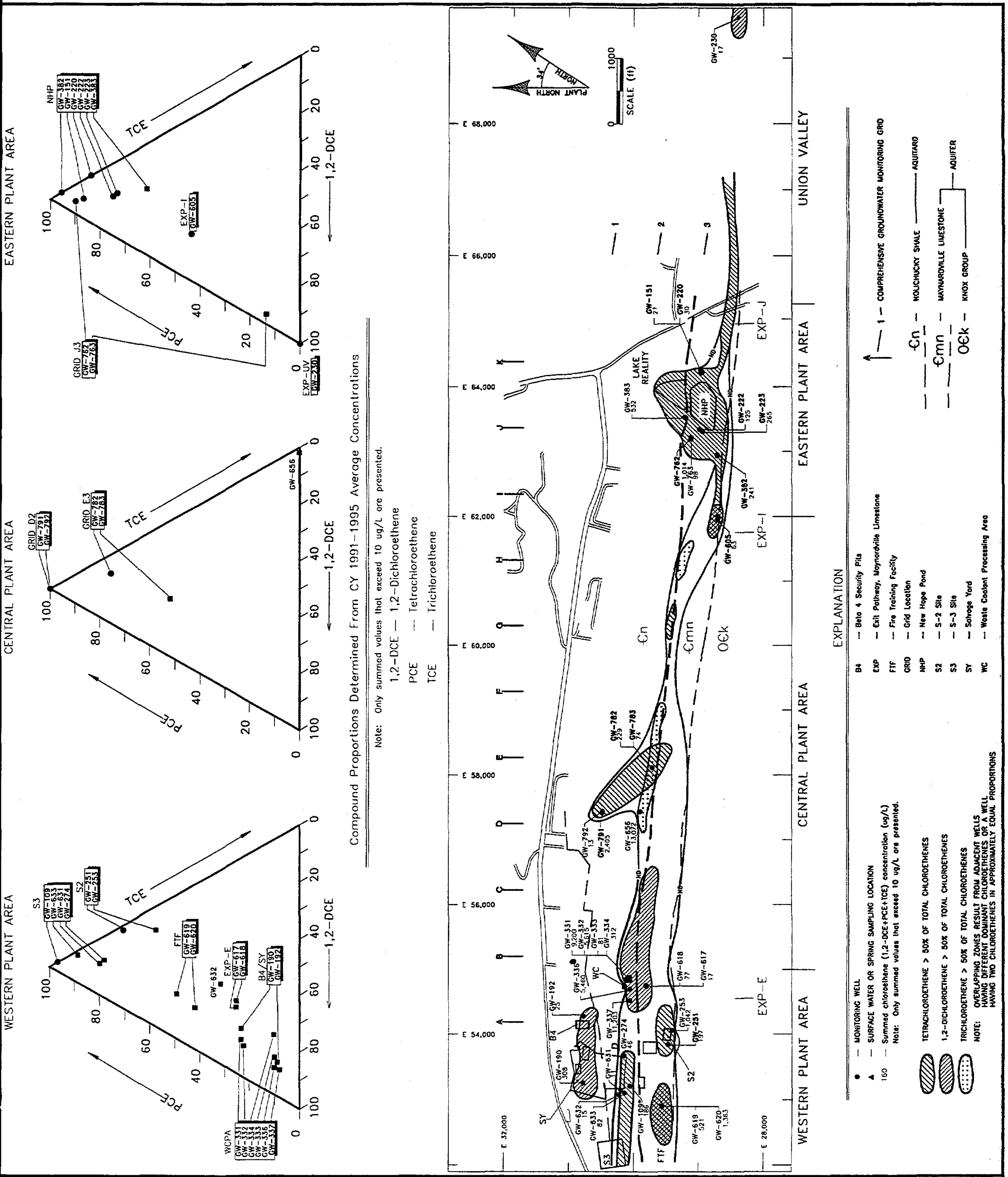
LOCATION: Y-12 PLANT
OAK RIDGE, TN.

DATE: 10-3-95

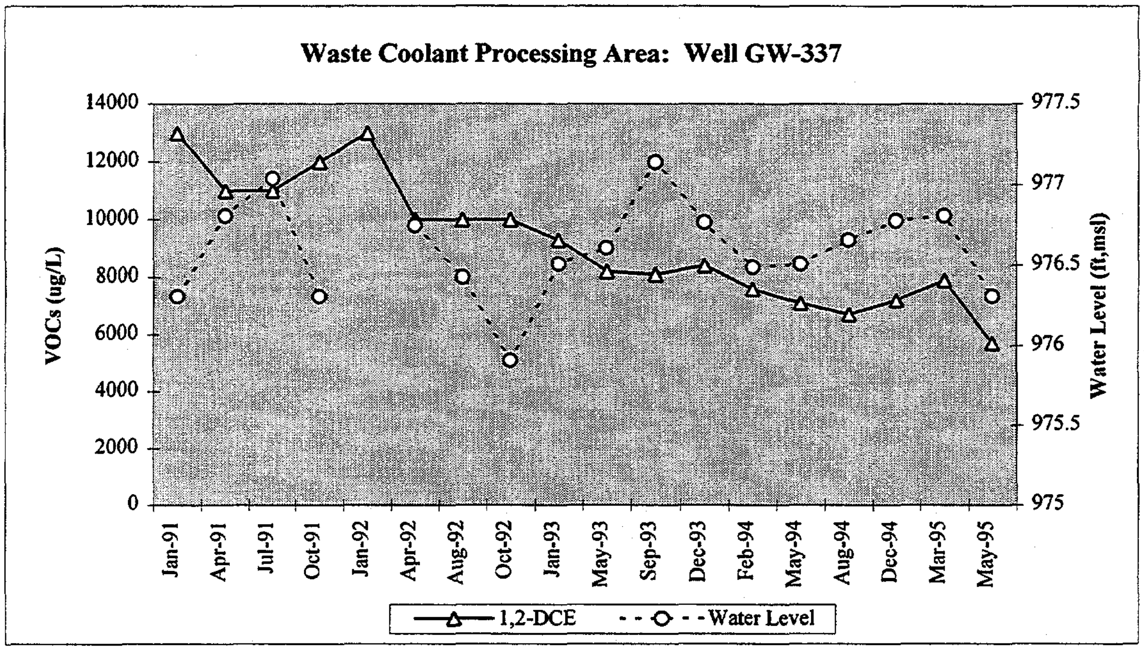
DWG ID.: 96-067

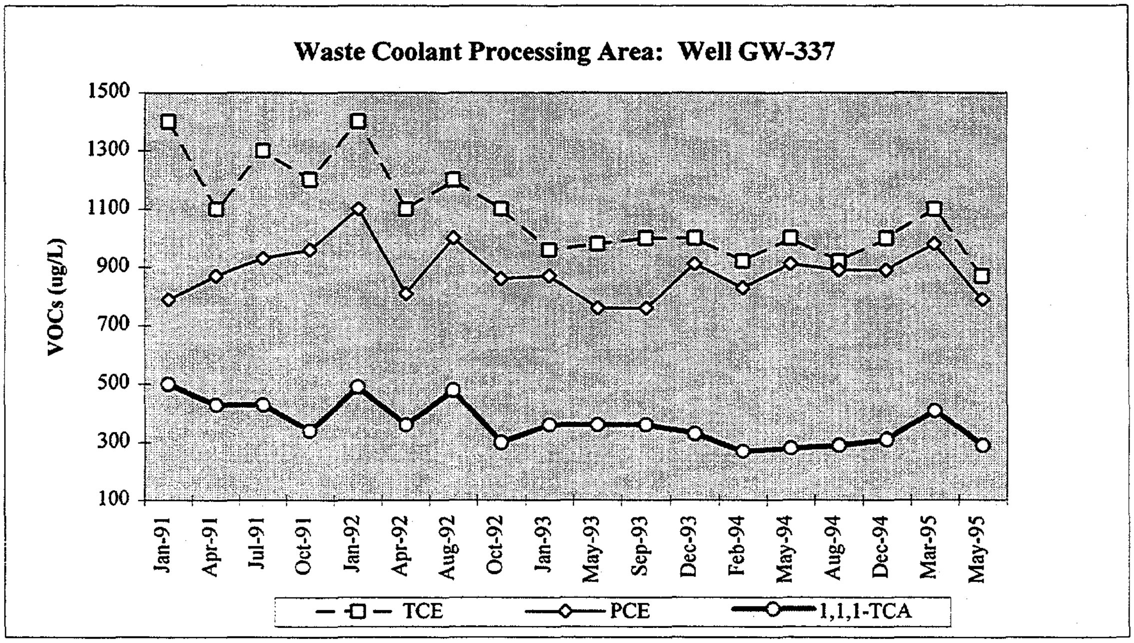
FIGURE 20

DISTRIBUTION OF CHLORINATED SOLVENTS IN GROUNDWATER, 1995

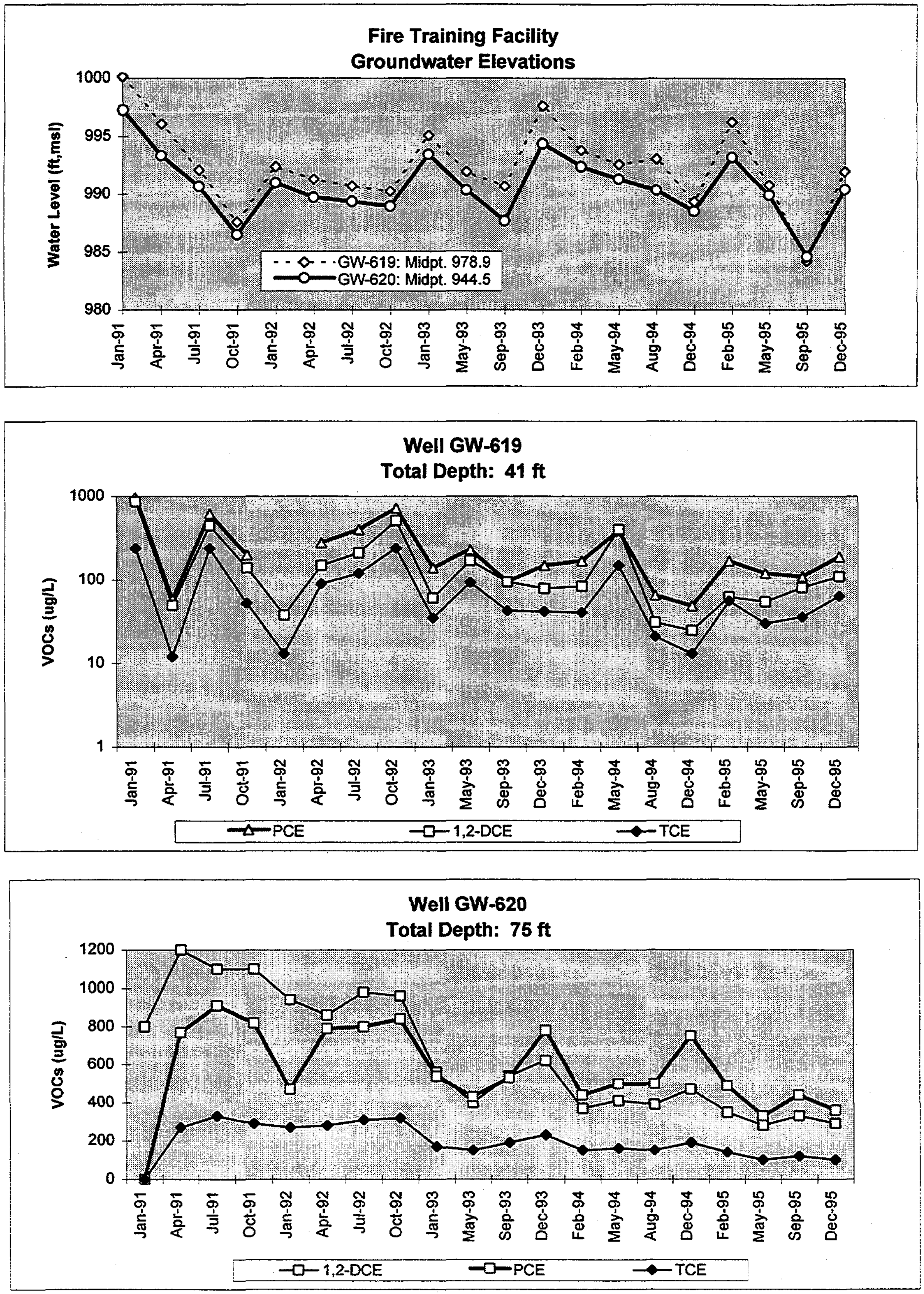


LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 21
DATE:	10-3-95	DISTRIBUTION OF CHLOROETHENES IN GROUNDWATER, 1995
DWG ID.:	TF620-DN	





PREPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 22
PREPARED BY: *AJA TECHNICIAL SERVICES, INC.*	DOC NUMBER:	96-D008	VOC CONCENTRATION TRENDS IN GROUNDWATER AT WELL GW-337
	DWG ID.:	96-075	
	DATE:	7-18-96	



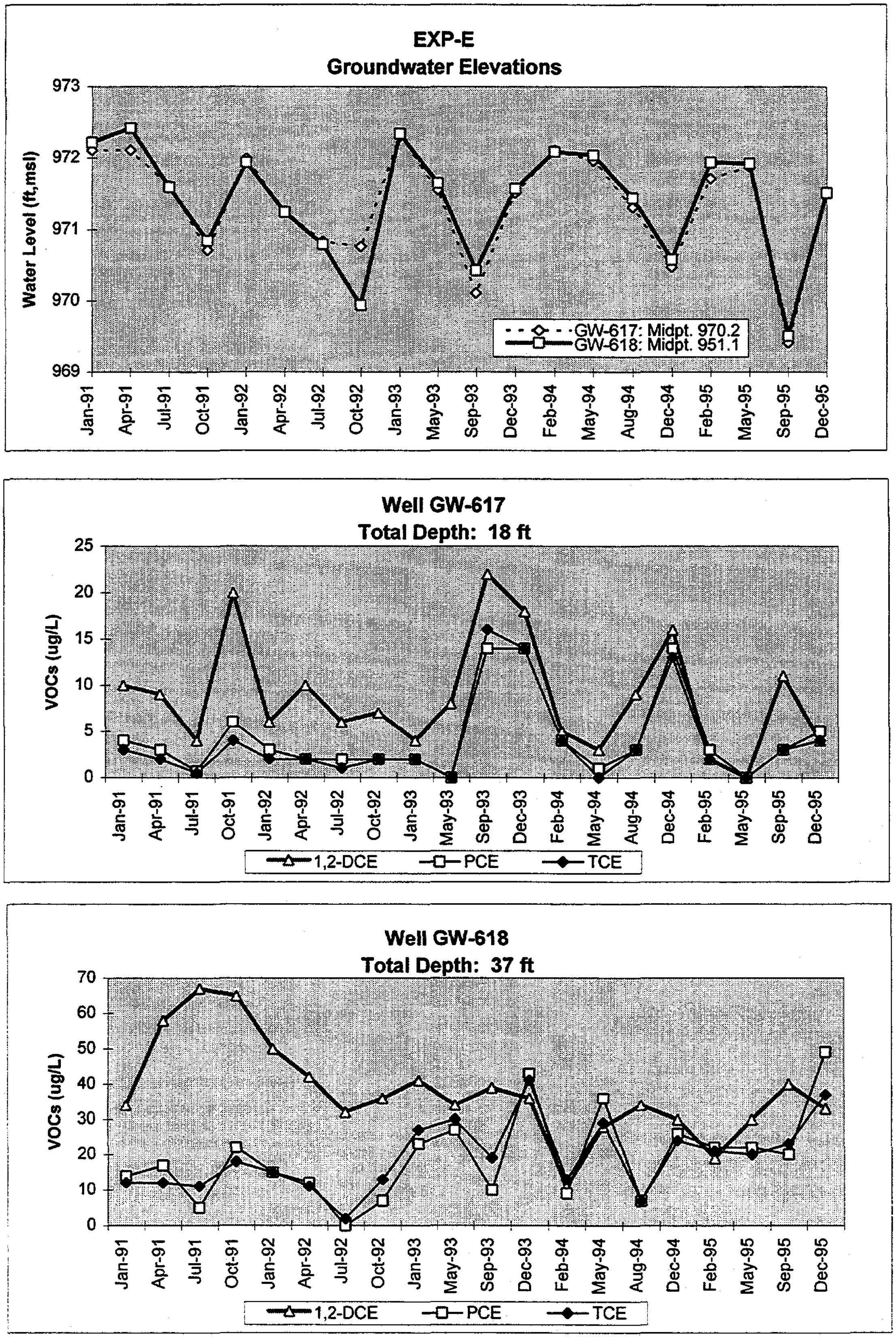
PREPARED FOR:
LOCKHEED MARTIN ENERGY SYSTEMS, INC.

PREPARED BY:
AJA TECHNICIAL SERVICES, INC.

LOCATION:	Y-12 PLANT OAK RIDGE, TN.
DOC NUMBER:	96-D008
DWG ID.:	96-075
DATE:	7-18-96

FIGURE 23

VOC CONCENTRATION TRENDS IN GROUNDWATER AT WELLS GW-619 AND GW-620

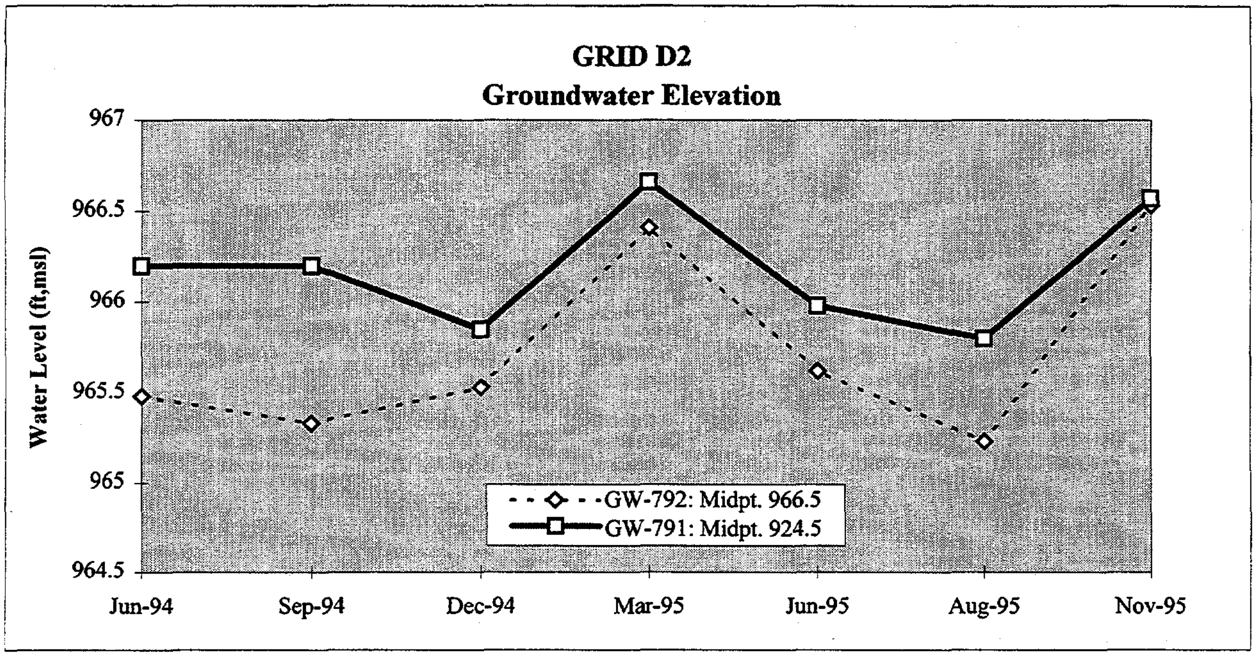


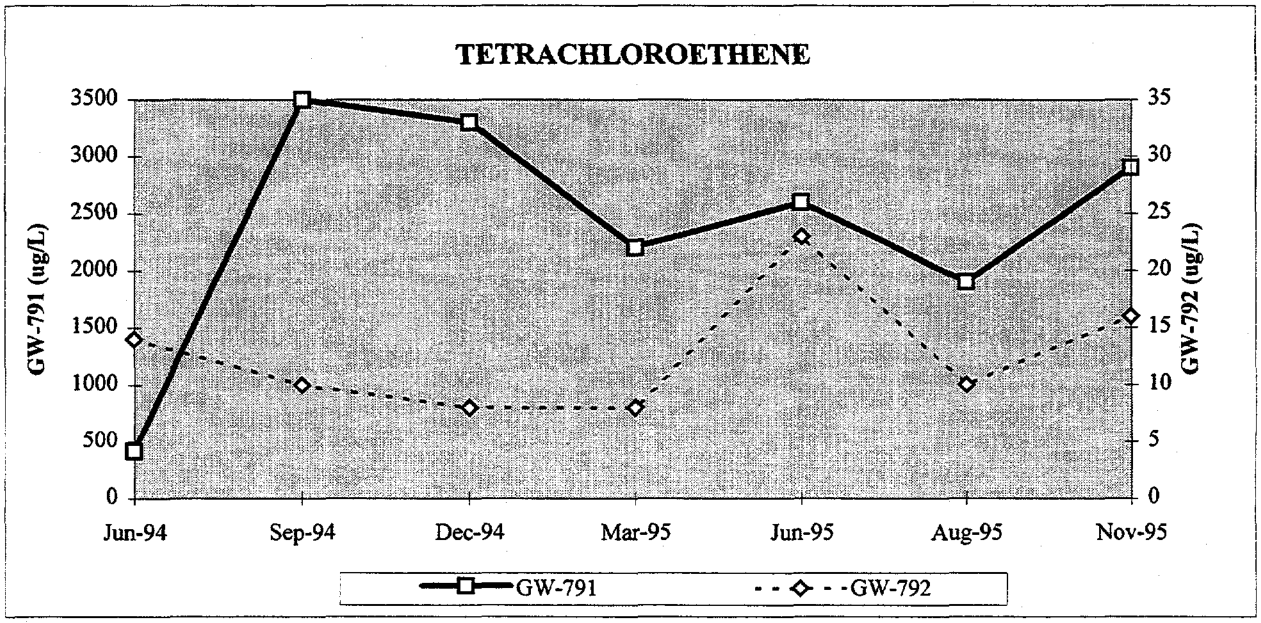
EXP-E
Groundwater Elevations

Well GW-617
Total Depth: 18 ft

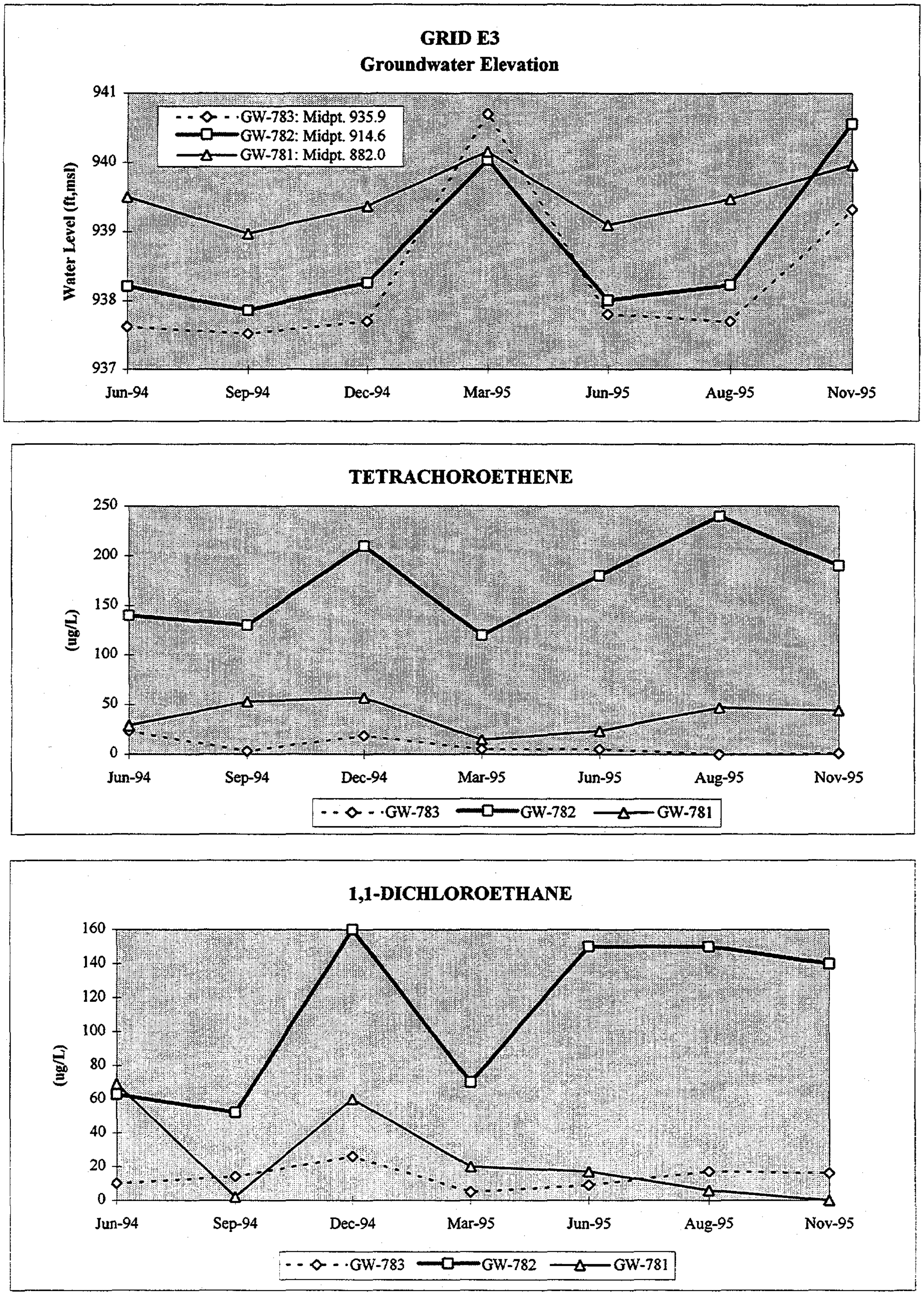
Well GW-618
Total Depth: 37 ft

PREPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 24
PREPARED BY: *AJA TECHNICIAL SERVICES, INC.*	DOC NUMBER:	96-D008	VOC CONCENTRATION TRENDS IN GROUNDWATER AT WELLS GW-617 AND GW-618
	DWG ID.:	96-075	
	DATE:	7-18-96	

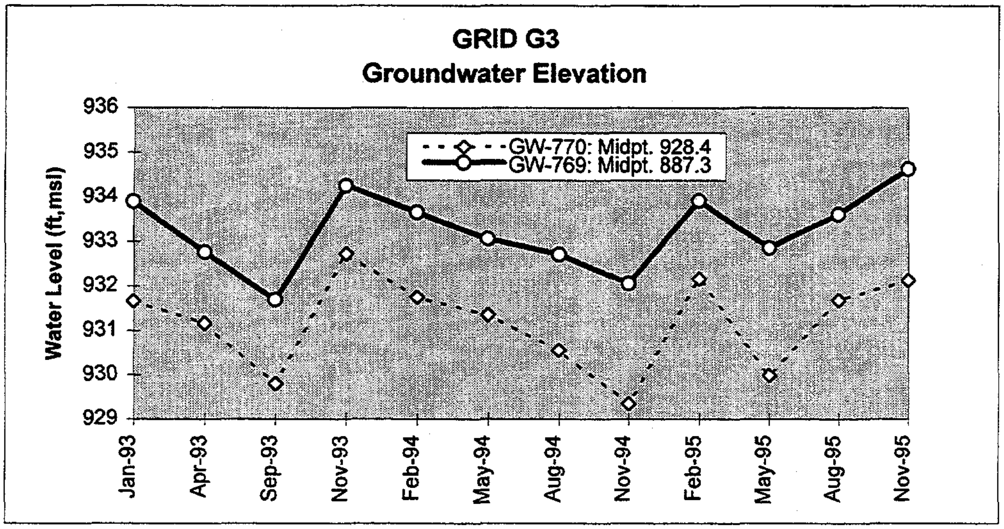


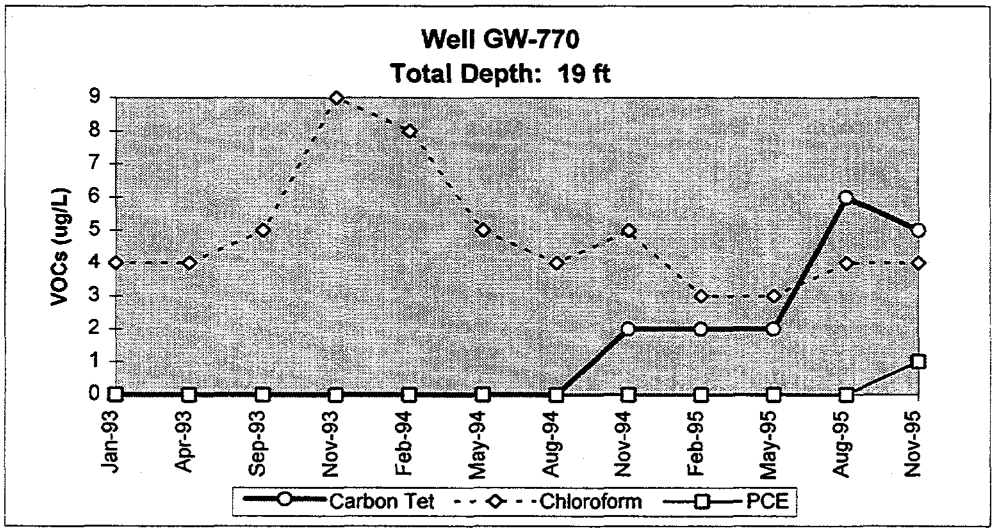


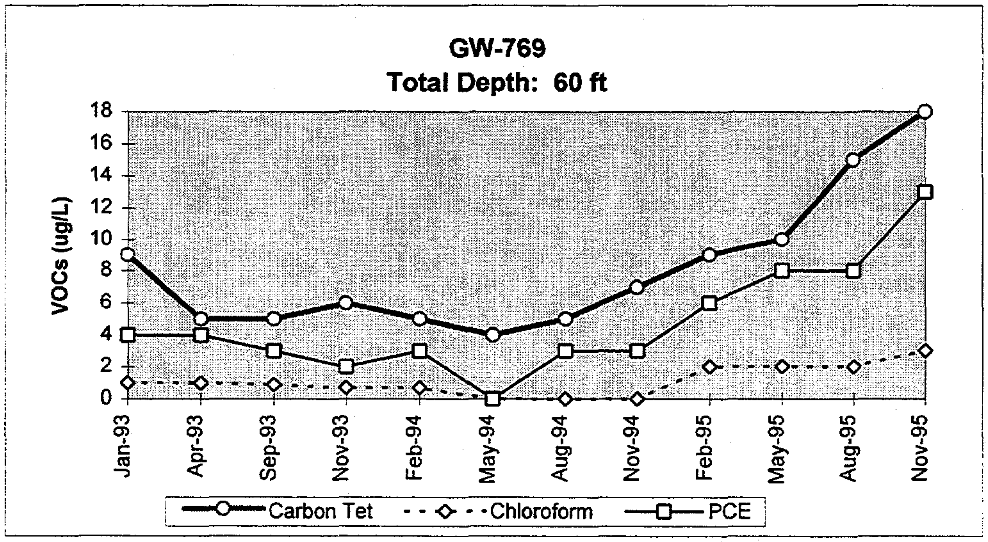
PREPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 25
PREPARED BY: *AJA TECHNICIAL SERVICES, INC.*	DOC NUMBER:	96-D008	PCE CONCENTRATION TRENDS IN GROUNDWATER AT WELLS GW-791 AND GW-792
	DWG ID.:	96-075	
	DATE:	7-18-96	



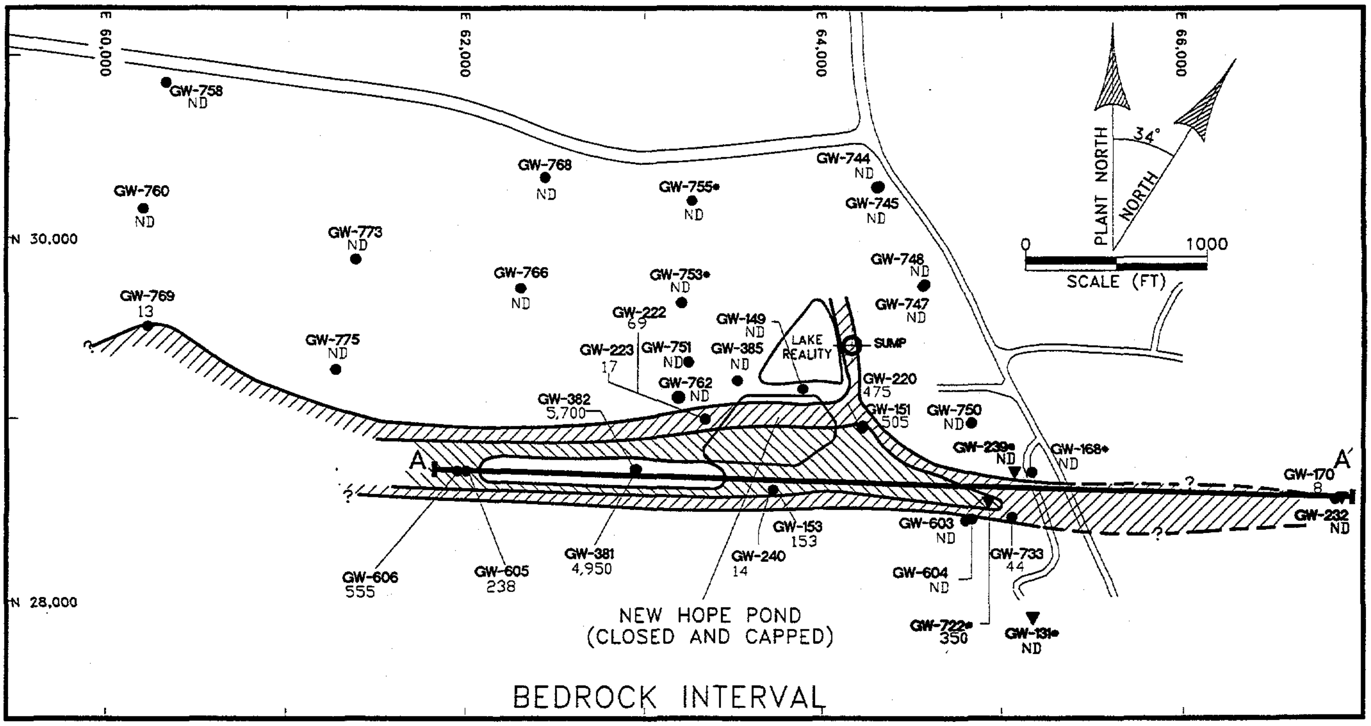
PREPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 26
PREPARED BY: *AJA TECHNICIAL SERVICES, INC.*	DOC NUMBER:	96-D008	PCE AND 1,1-DCA CONCENTRATION TRENDS IN GROUNDWATER AT WELLS GW-781, GW-782, AND GW-783
	DWG ID.:	96-075	
	DATE:	7-18-96	

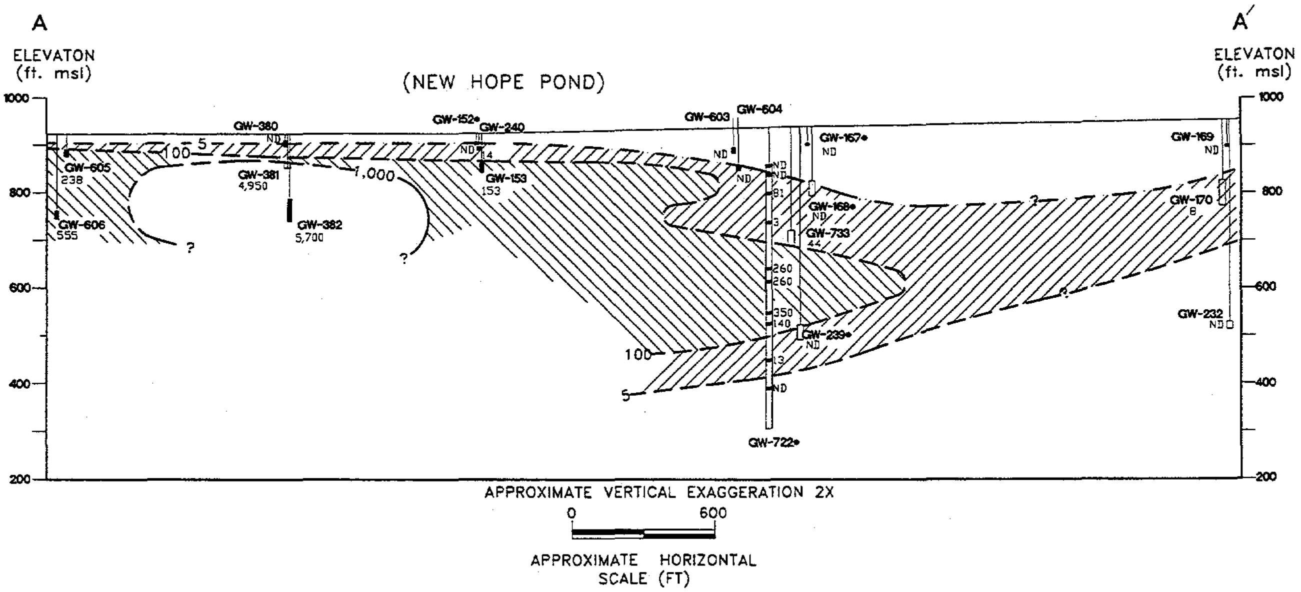

GRID G3
Groundwater Elevation


Well GW-770
Total Depth: 19 ft


GW-769
Total Depth: 60 ft

PREPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 27
PREPARED BY: *AJA TECHNICIAL SERVICES, INC.*	DOC NUMBER:	96-D008	VOC CONCENTRATION TRENDS IN GROUNDWATER AT WELLS GW-769 AND GW-770
	DWG ID.:	96-075	
	DATE:	7-18-96	





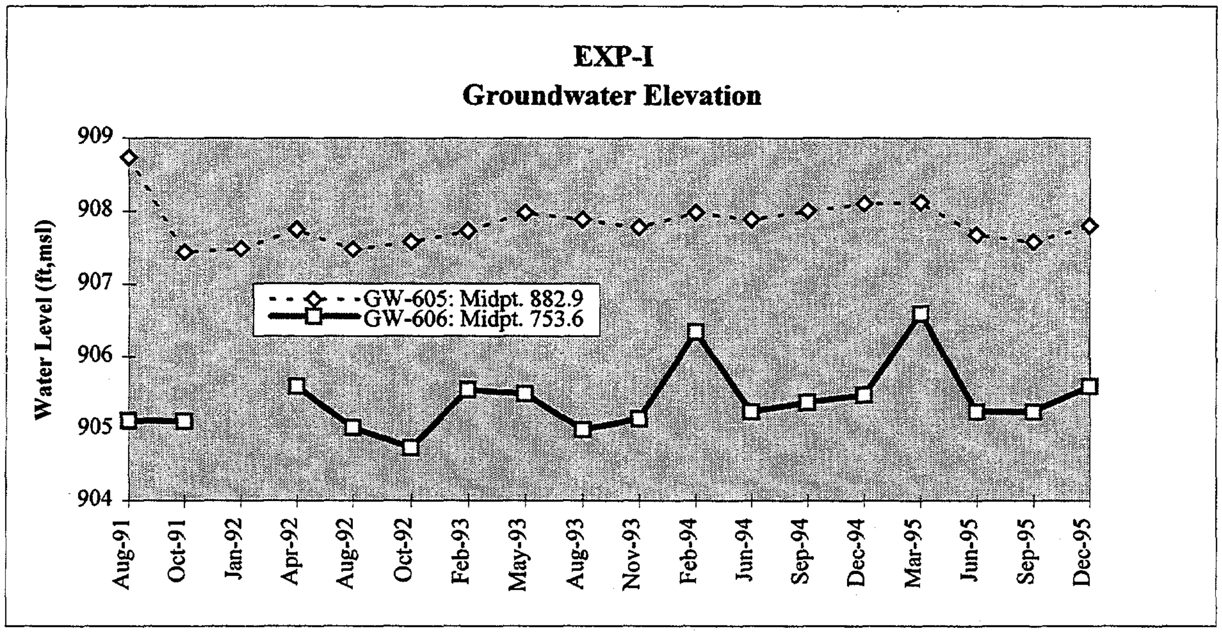
EXPLANATION

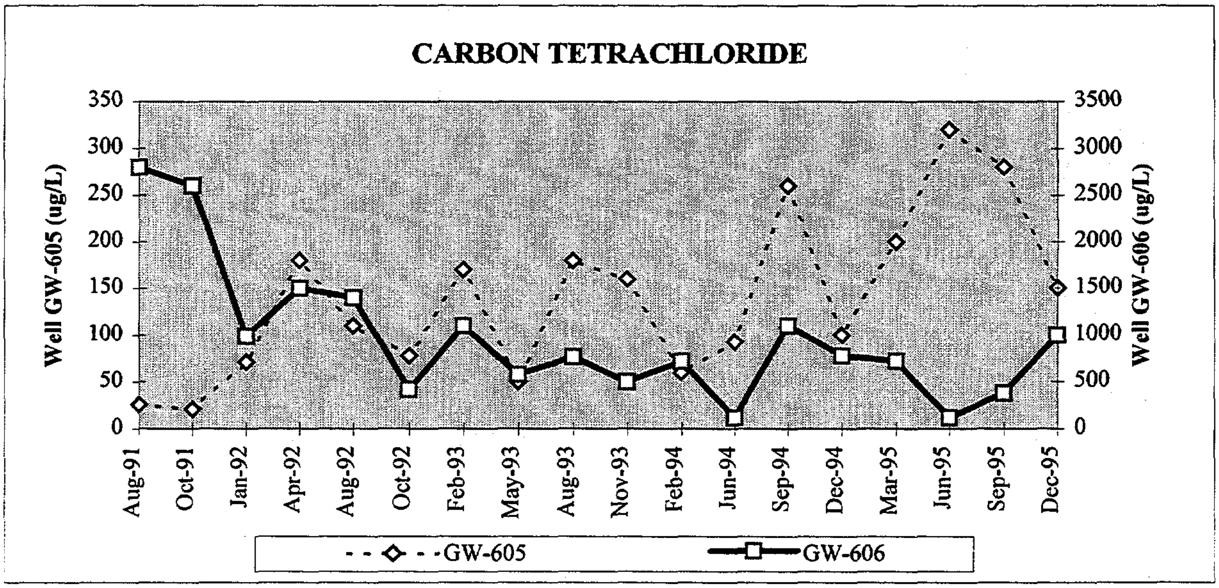
GW-606 ● — BEDROCK MONITORING WELL, < 300 FT
GW-131 ▼ — BEDROCK MONITORING WELL, > 300 FT
• — SAMPLED BEFORE 1995 (QUALITATIVE DATA)
| — SCREENED WELL CONSTRUCTION
▯ — OPEN-HOLE WELL CONSTRUCTION
┆ — WESTBAY SYSTEM SAMPLING PORTS SAMPLES COLLECTED IN MARCH 1994

ANNUAL AVERAGE CARBON TETRACHLORIDE CONCENTRATION (ug/L)

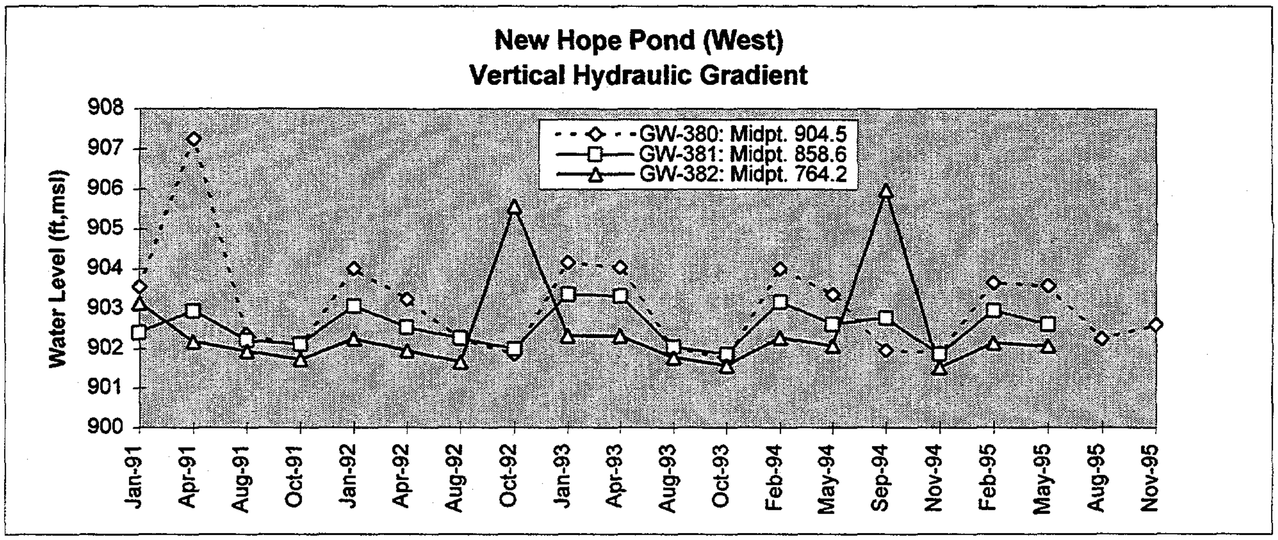
ND — NOT DETECTED
— 5
▨ — 5–100
▧ — 100–1,000
— > 1,000

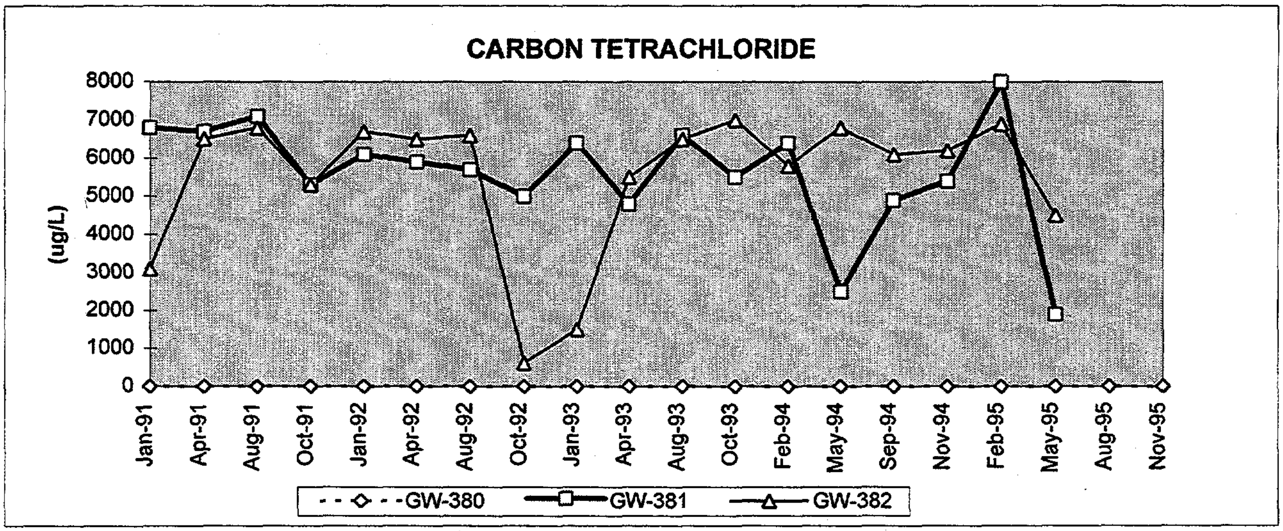
PREPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION:	Y–12 PLANT OAK RIDGE, TN.	FIGURE 28
PREPARED BY: *AJA TECHNICIAL SERVICES, INC.*	DOC NUMBER:	96–D007	CARBON TETRACHLORIDE IN GROUNDWATER IN THE EASTERN PLANT AREA
	DWG ID.:	96–024	
	DATE:	7–15–96	

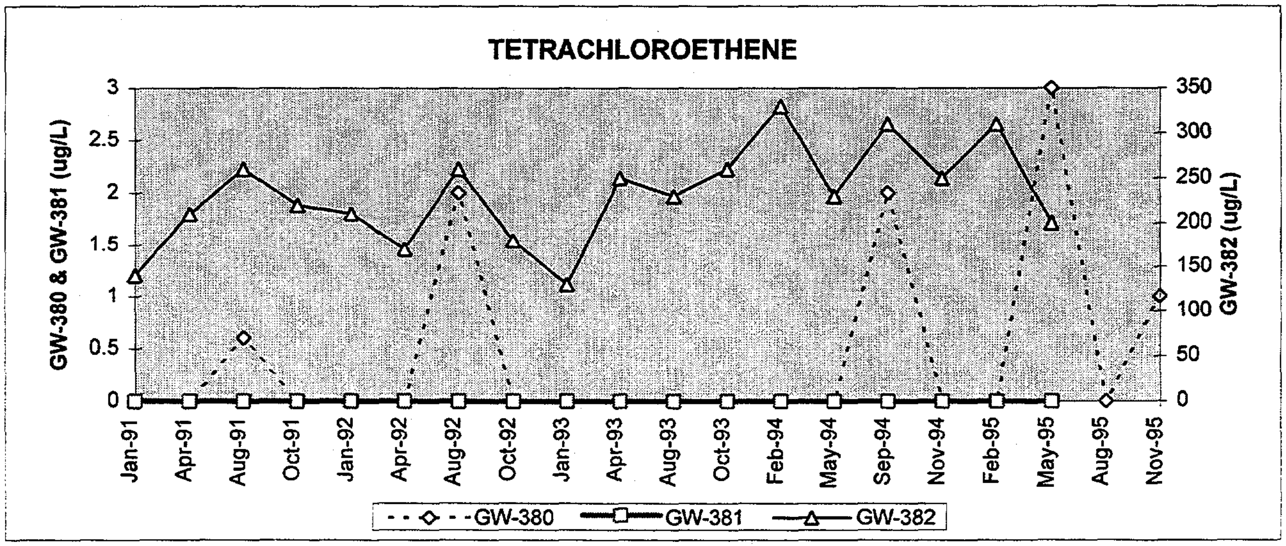




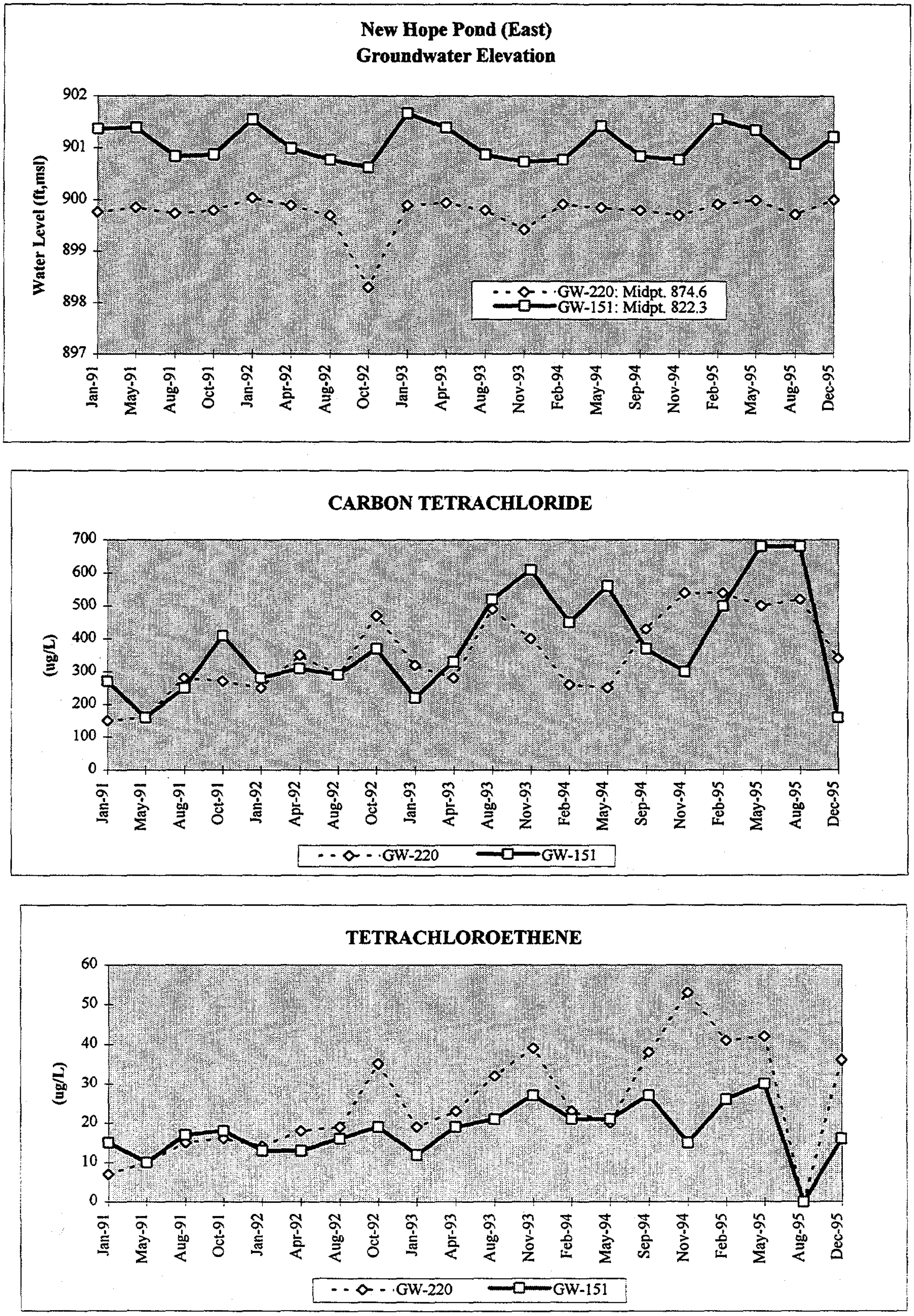
PREPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 29
PREPARED BY: *AJA TECHNICIAL SERVICES, INC.*	DOC NUMBER:	96-D008	CARBON TETRACHLORIDE CONCENTRATION TRENDS IN GROUNDWATER AT WELLS GW-605 AND GW-606
	DWG ID.:	96-075	
	DATE:	7-18-96	



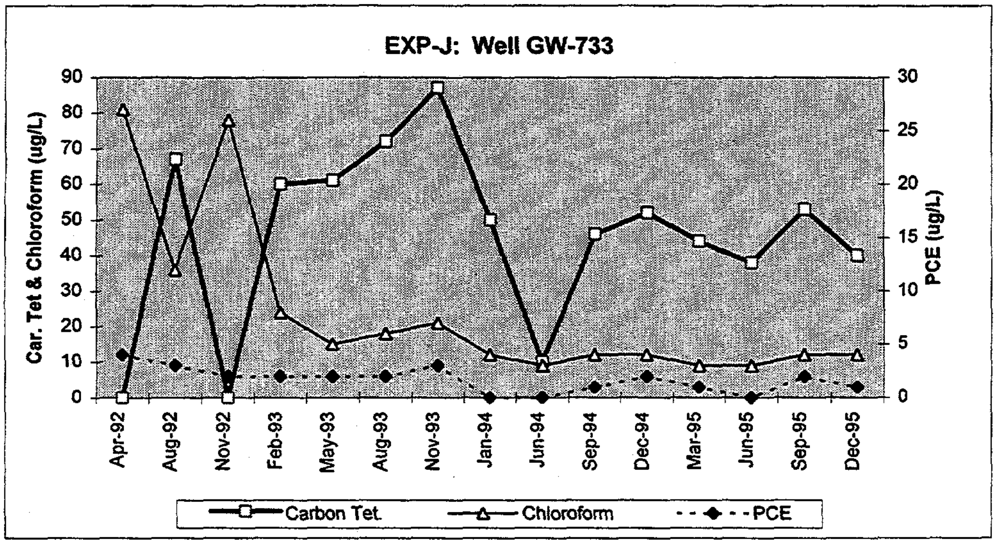


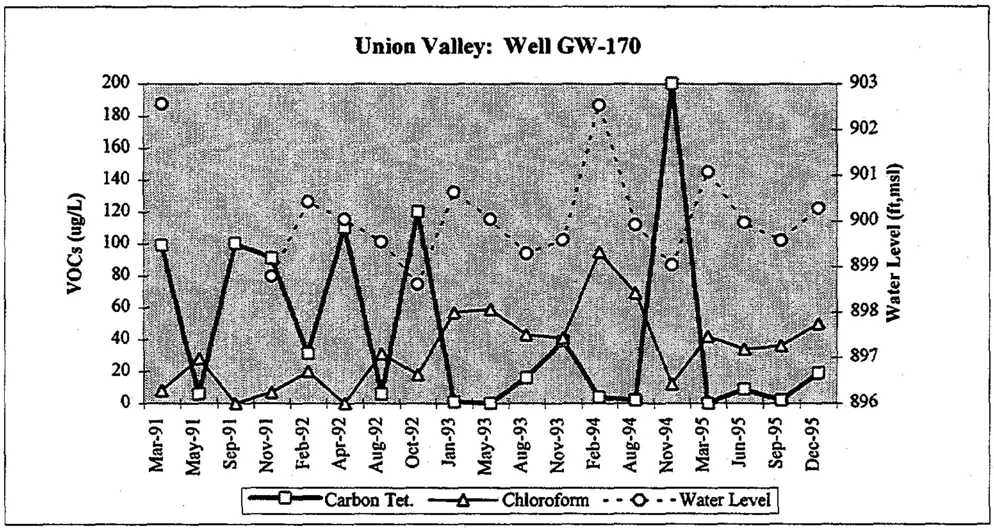


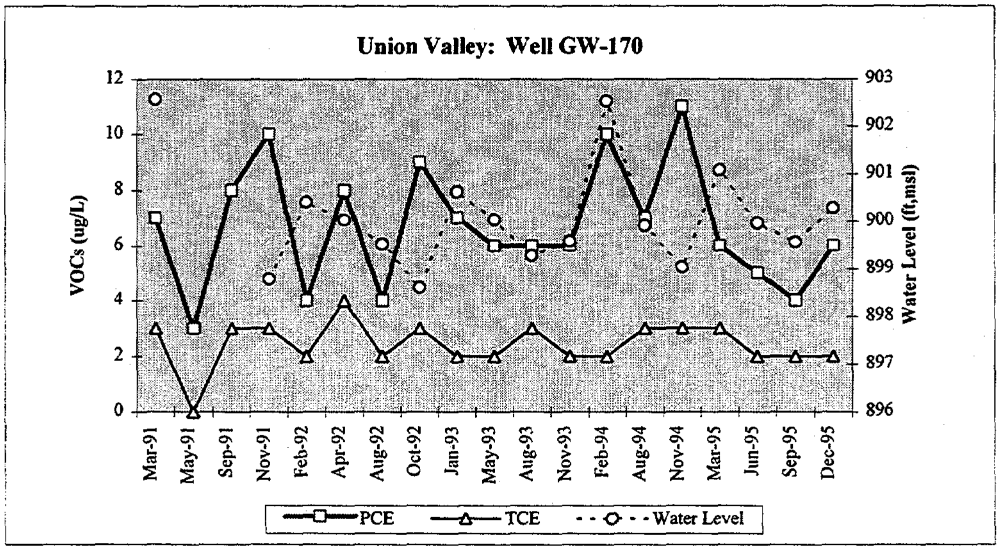
PREPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 30
PREPARED BY: *AJA TECHNICIAL SERVICES, INC.*	DOC NUMBER:	96-D008	CARBON TETRACHLORIDE AND PCE CONCENTRATION TRENDS IN GROUNDWATER AT WELLS GW-380, GW-381, AND GW-382
	DWG ID.:	96-075	
	DATE:	7-18-96	



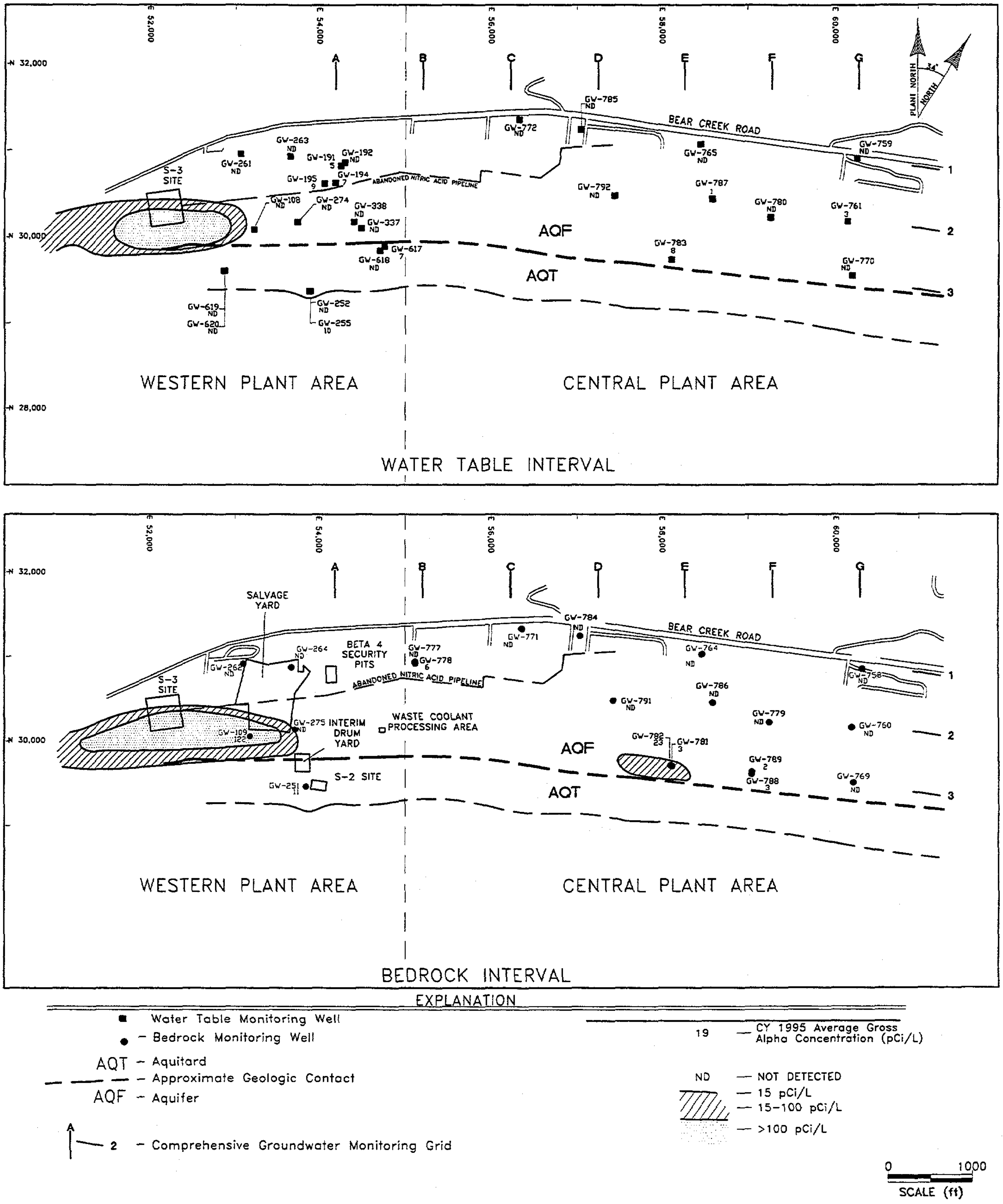
PREPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 31
PREPARED BY: *AJA TECHNICIAL SERVICES, INC.*	DOC NUMBER:	96-D008	CARBON TETRACHLORIDE AND PCE CONCENTRATION TRENDS IN GROUNDWATER AT WELLS GW-151 AND GW-220
	DWG ID.:	96-075	
	DATE:	7-18-96	



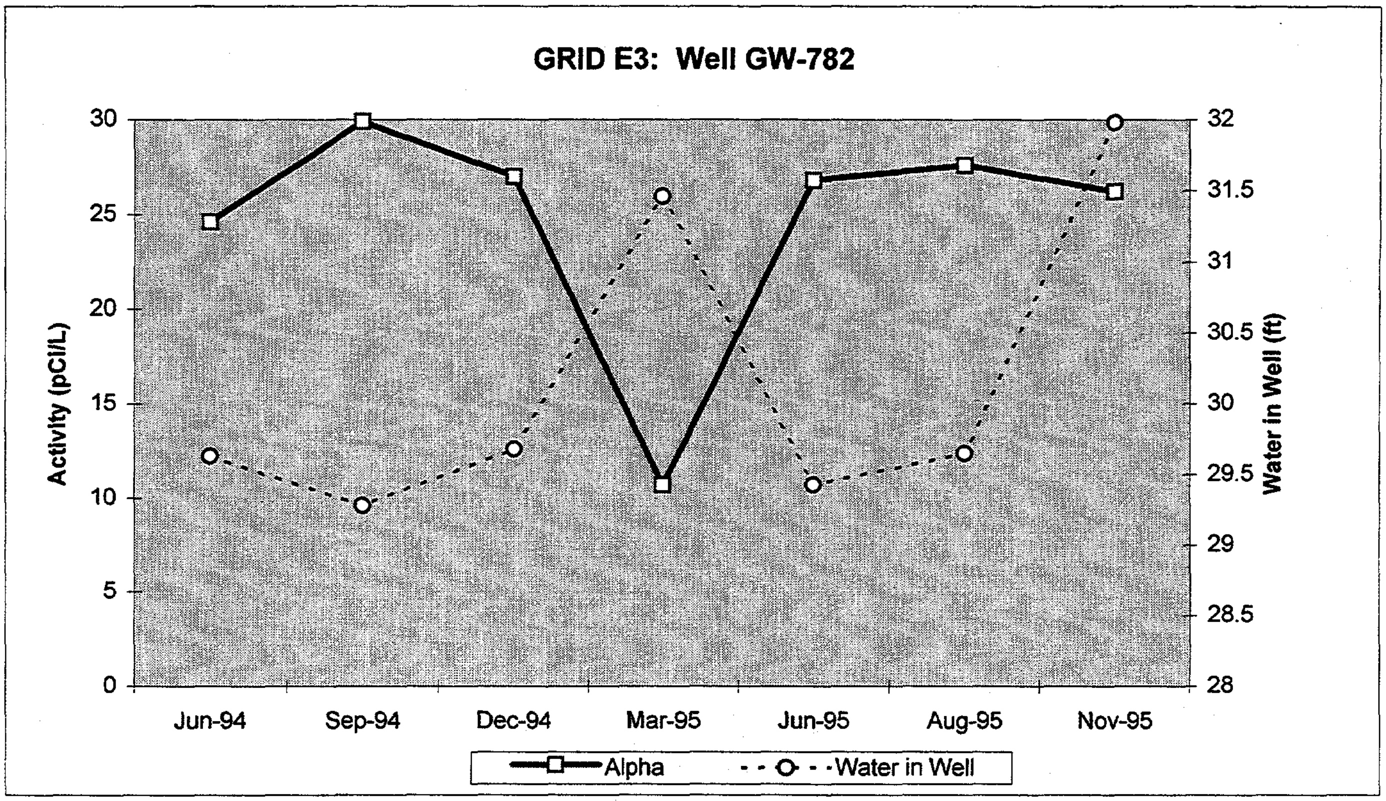




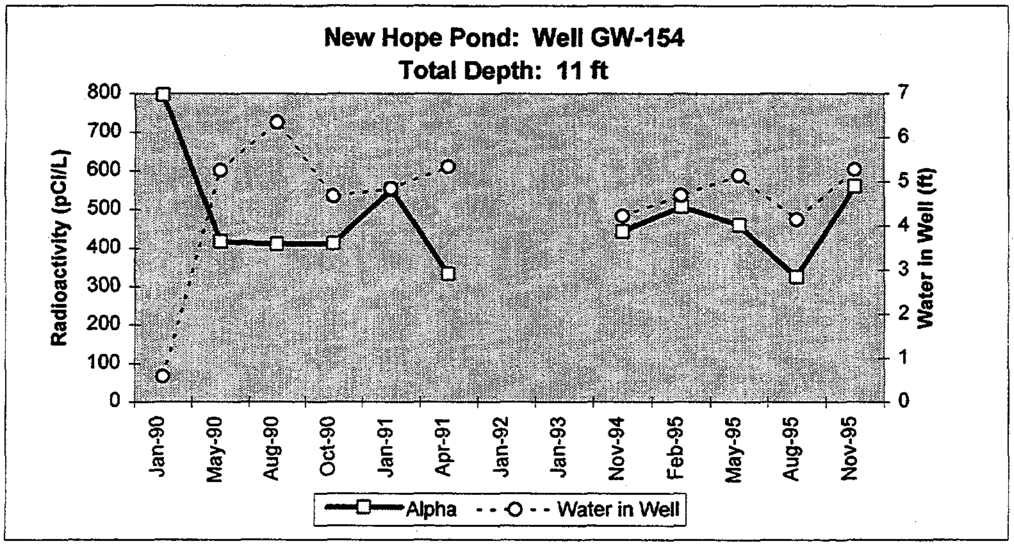
PREPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 32
PREPARED BY: *AJA TECHNICIAL SERVICES, INC.*	DOC NUMBER:	96-D001	VOC CONCENTRATION TRENDS IN GROUNDWATER AT WELLS GW-170 AND GW-733
	DWG ID.:	HG10	
	DATE:	4-28-96	

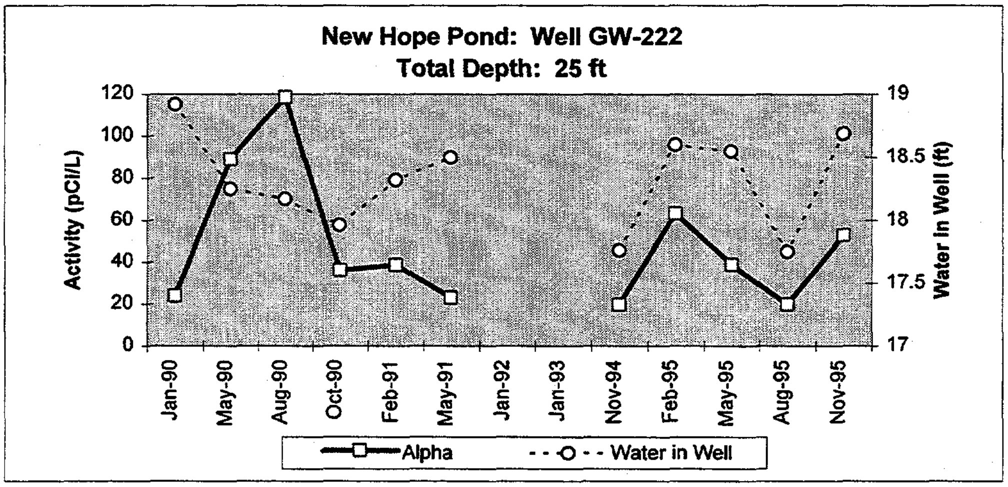


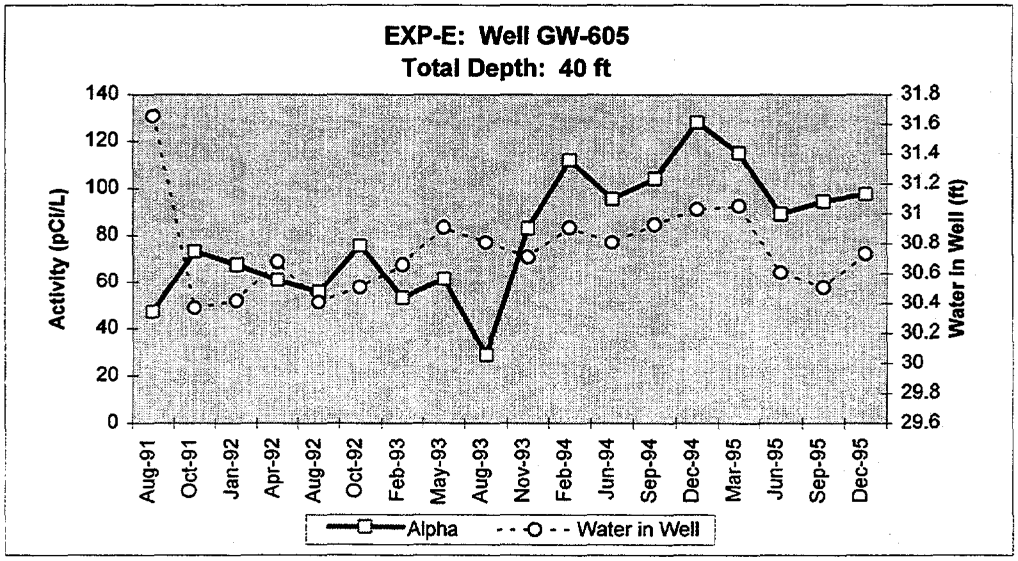
PREPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 33
PREPARED BY: *AJA TECHNICIAL SERVICES, INC.*	DOC NUMBER:	96-D006	GROSS ALPHA ACTIVITY IN GROUNDWATER IN THE EAST FORK REGIME, 1995
	DWG ID.:	96-057	
	DATE:	6-24-96	



PREPARED FOR: *LOCKHEED MARTIN ENERGY SYSTEMS, INC.*	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 34
PREPARED BY: *AJA TECHNICIAL SERVICES, INC.*	DOC NUMBER:	96-D008	GROSS ALPHA ACTIVITY TREND IN GROUNDWATER AT WELL GW-782
	DWG ID.:	96-075	
	DATE:	7-18-96	







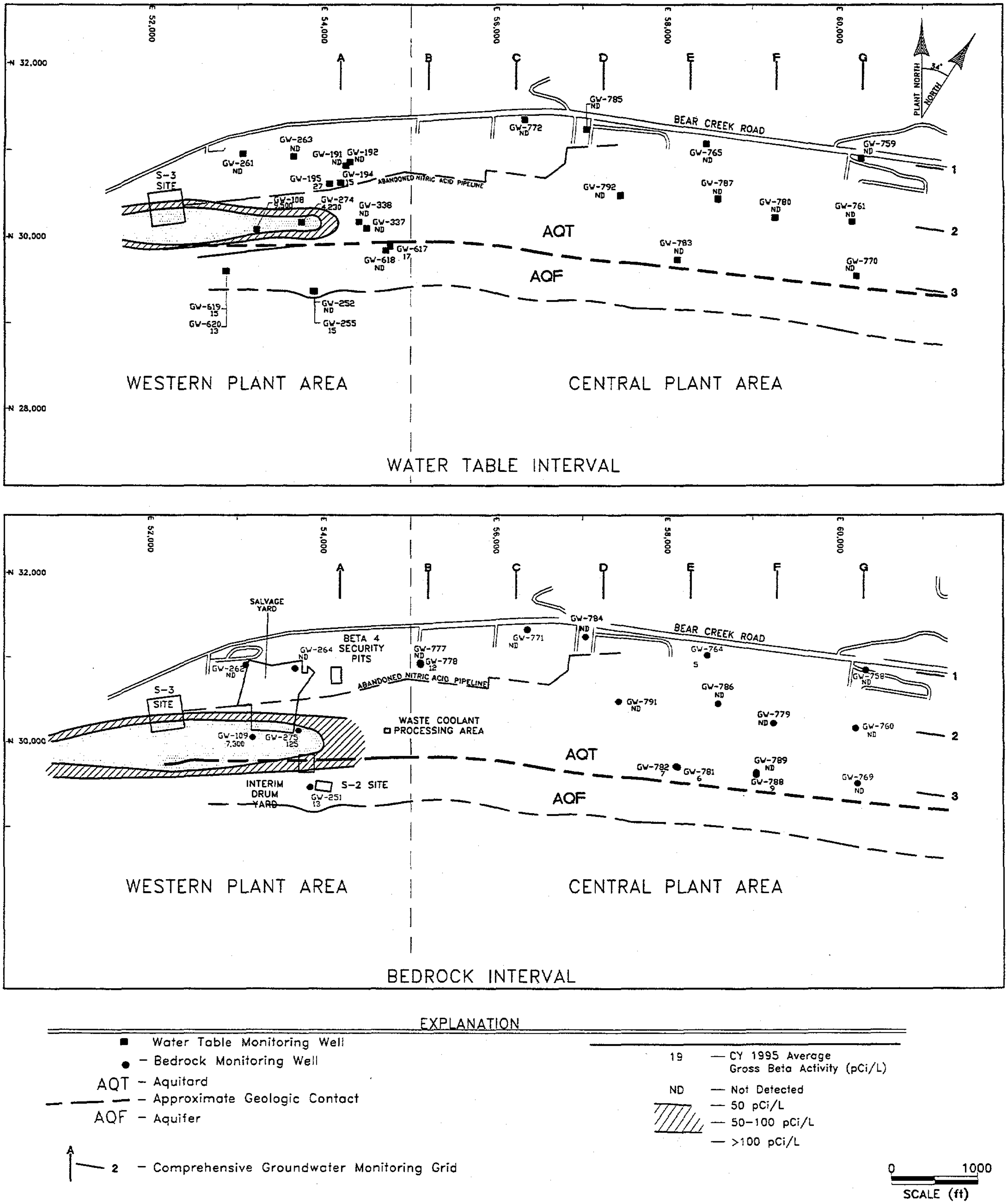
PREPARED FOR:
LOCKHEED MARTIN ENERGY SYSTEMS, INC.

PREPARED BY:
AJA TECHNICIAL SERVICES, INC.

LOCATION: Y-12 PLANT OAK RIDGE, TN.
DOC NUMBER: 96-D001
DWG ID.: HG16
DATE: 4-28-96

FIGURE 35

GROSS ALPHA ACTIVITY TRENDS IN GROUNDWATER AT WELLS GW-154, GW-222, AND GW-605



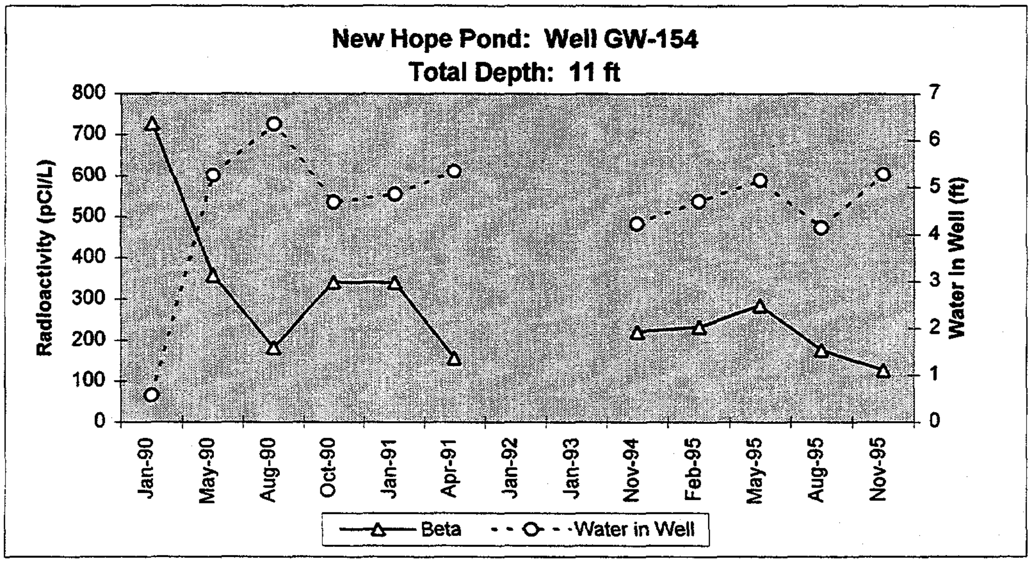
PREPARED FOR:
LOCKHEED MARTIN ENERGY SYSTEMS, INC.

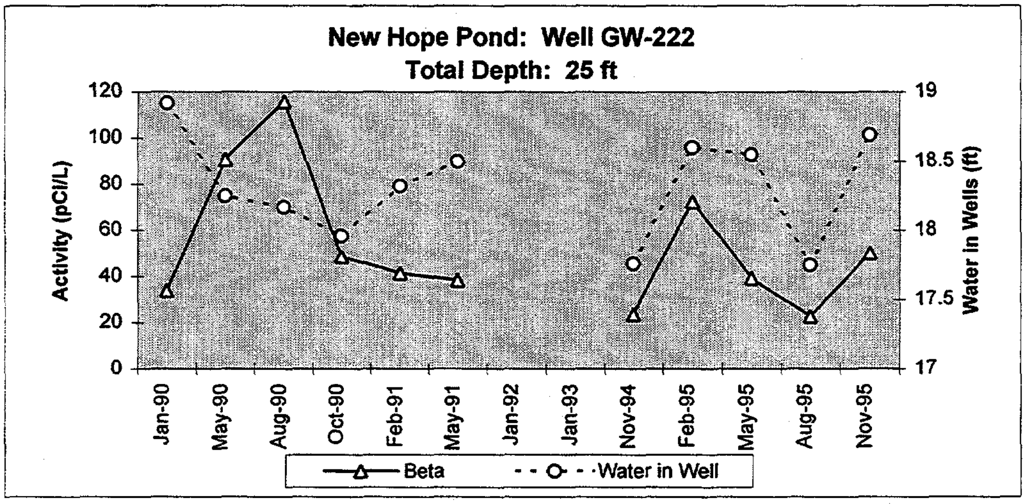
PREPARED BY:
AJA TECHNICAL SERVICES, INC.

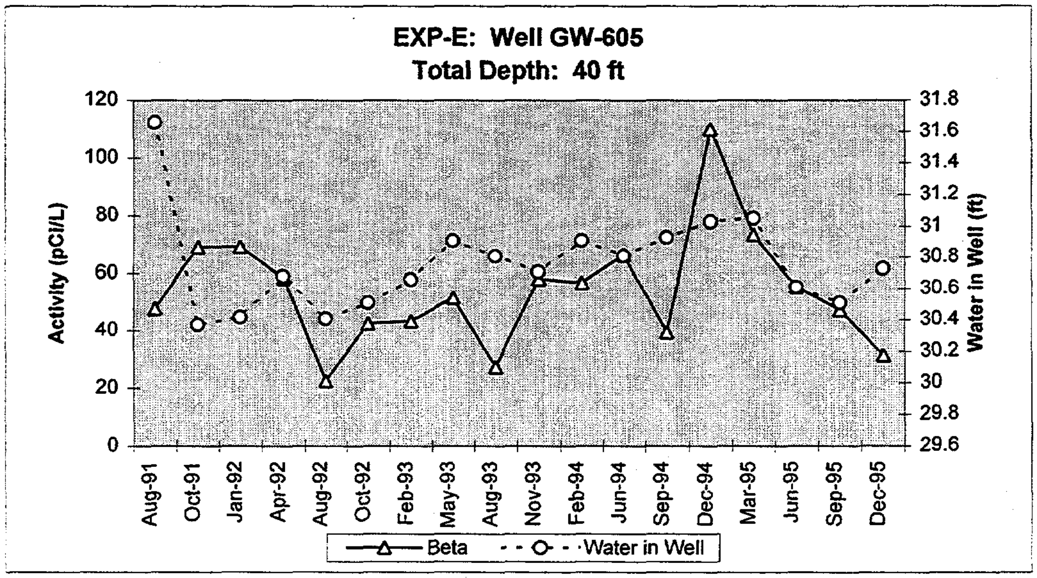
LOCATION:	Y-12 PLANT OAK RIDGE, TN.
DOC NUMBER:	96-D006
DWG ID.:	96-056
DATE:	6-18-96

FIGURE 36

GROSS BETA ACTIVITY IN GROUNDWATER IN THE EAST FORK REGIME, 1995







PREPARED FOR:
LOCKHEED MARTIN ENERGY SYSTEMS, INC.

PREPARED BY:
AJA TECHNICIAL SERVICES, INC.

LOCATION:	Y-12 PLANT OAK RIDGE, TN.
DOC NUMBER:	96-D008
DWG ID.:	96-075
DATE:	7-18-96

FIGURE 37

GROSS BETA ACTIVITY TRENDS IN GROUNDWATER AT WELLS GW-154, GW-222, AND GW-605

Table 1. Monitoring Programs Implemented During CY 1995

Sampling Point[1]	Location[2]	Date Sampled			
		1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
RCRA Interim Status Assessment Monitoring					
GW-151	NHP	02/28/95	05/24/95	08/29/95	12/04/95
GW-220	NHP	02/27/95	05/24/95	08/29/95	11/30/95
GW-240	NHP	02/27/95	05/24/95	08/24/95	11/30/95
GW-380	NHP	02/27/95	05/23/95	08/24/95	11/30/95
GW-381	NHP	03/06/95	05/27/95	.	.
GW-382	NHP	03/02/95	05/26/95	.	.
GW-383	NHP	02/28/95	05/25/95	08/29/95	12/05/95
GW-384	NHP	02/13/95	05/16/95	07/30/95	11/27/95
GW-385	NHP	02/02/95	05/16/95	07/24/95	11/20/95
Best-Management Practice Monitoring					
GW-108	S3	.	06/28/95	.	.
GW-109	S3	.	06/29/95	.	.
GW-148	NHP	02/22/95	05/18/95	08/22/95	11/27/95
GW-149	NHP	02/22/95	05/18/95	08/22/95	11/28/95
GW-153	NHP	02/22/95	05/22/95	08/23/95	11/28/95
GW-154	NHP	02/27/95	05/23/95	08/24/95	11/29/95
GW-222	NHP	02/23/95	05/22/95	08/23/95	11/29/95
GW-223	NHP	02/23/95	05/22/95	08/23/95	11/28/95
GW-274	SY	.	.	.	10/30/95
GW-275	SY	.	.	.	10/30/95
Exit Pathway and Perimeter Monitoring					
GW-169	EXP-UV	03/15/95	06/12/95	09/28/95	12/13/95
GW-170	EXP-UV	03/22/95	06/19/95	09/28/95	12/12/95
GW-171	EXP-UV	03/13/95	06/12/95	09/22/95	12/11/95
GW-172	EXP-UV	03/13/95	06/13/95	09/18/95	12/11/95
GW-206	EXP-SR	03/08/95	06/14/95	09/07/95	11/30/95
GW-207	EXP-SR	03/08/95	06/12/95	09/07/95	11/28/95
GW-208	EXP-SR	03/10/95	06/13/95	09/09/95	12/06/95
GW-230	EXP-UV	03/15/95	06/15/95	09/20/95	12/13/95
GW-232	EXP-UV	03/21/95	06/16/95	09/22/95	12/14/95
GW-603	EXP-J	03/10/95	06/14/95	09/09/95	12/06/95
GW-604	EXP-J	03/11/95	06/15/95	09/09/95	12/08/95
GW-605	EXP-I	03/13/95	06/18/95	09/27/95	12/12/95

Table 1 (cont'd)

Sampling Point[1]	Location[2]	Date Sampled			
		1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
Exit Pathway and Perimeter Monitoring (cont'd)					
GW-606	EXP-I	03/13/95	06/18/95	09/28/95	12/12/95
GW-617	EXP-E	02/23/95	05/25/95	09/12/95	12/06/95
GW-618	EXP-E	02/27/95	05/25/95	09/13/95	12/06/95
GW-733	EXP-J	03/12/95	06/17/95	09/27/95	12/11/95
GW-735	EXP-J	03/11/95	06/15/95	09/10/95	12/08/95
GW-750	EXP-J	03/11/95	06/16/95	09/10/95	12/08/95
GW-816	EXP-SR	03/08/95	06/14/95	09/07/95	11/30/95
SCR7.1SP	EXP-SW	.	.	.	12/13/95
LRSPW	EXP-SW	03/06/95	.	09/22/95	.
Surveillance Monitoring					
GW-191	B4	02/22/95	05/22/95	09/11/95	12/04/95
GW-192	B4	02/23/95	05/24/95	09/12/95	12/05/95
GW-194	B4	03/20/95	05/24/95	09/12/95	12/05/95
GW-195	B4	02/22/95	05/24/95	09/12/95	12/05/95
GW-199	GRIDI1	01/19/95	05/08/95	07/13/95	11/16/95
GW-251	S2	02/27/95	05/25/95	09/13/95	12/07/95
GW-252	S2	02/14/95	05/17/95	.	.
GW-255	S2	02/14/95	05/17/95	.	.
GW-261	SY	02/02/95	05/16/95	.	.
GW-262	SY	02/02/95	05/16/95	.	.
GW-263	SY	02/13/95	05/16/95	.	.
GW-264	SY	02/13/95	05/16/95	.	.
GW-337	WC	03/02/95	05/30/95	.	.
GW-338	WC	02/23/95	05/24/95	09/12/95	12/05/95
GW-619	FTF	02/28/95	05/30/95	09/13/95	12/07/95
GW-620	FTF	02/28/95	05/30/95	09/15/95	12/07/95
GW-744	GRIDK1	01/25/95	05/08/95	07/17/95	11/18/95
GW-745	GRIDK1	01/26/95	05/09/95	07/17/95	11/18/95
GW-746	GRIDK1	01/26/95	05/09/95	07/18/95	11/18/95
GW-747	GRIDK2	01/31/95	05/09/95	07/18/95	11/18/95
GW-748	GRIDK2	01/31/95	05/10/95	07/18/95	11/19/95
GW-749	GRIDK2	01/31/95	05/10/95	07/19/95	11/19/95
GW-751	GRIDJ3	01/23/95	05/08/95	07/17/95	11/17/95
GW-752	GRIDJ3	01/25/95	05/08/95	07/17/95	11/17/95

Table 1 (cont'd)

Sampling Point[1]	Location[2]	Date Sampled			
		1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
Surveillance Monitoring (cont'd)					
GW-758	GRIDG1	02/18/95	05/22/95	08/06/95	11/14/95
GW-759	GRIDG1	02/19/95	05/22/95	08/06/95	11/14/95
GW-760	GRIDG2	02/19/95	05/23/95	08/06/95	11/15/95
GW-761	GRIDG2	02/19/95	05/23/95	08/06/95	11/15/95
GW-762	GRIDJ3	02/20/95	05/17/95	.	.
GW-763	GRIDJ3	02/20/95	05/18/95	08/22/95	11/27/95
GW-764	GRIDE1	02/16/95	05/18/95	08/05/95	11/13/95
GW-765	GRIDE1	02/16/95	05/18/95	08/05/95	11/14/95
GW-766	GRIDI2	01/19/95	05/08/95	07/13/95	11/17/95
GW-767	GRIDI2	01/19/95	05/11/95	07/14/95	11/18/95
GW-768	GRIDI1	01/20/95	05/08/95	07/13/95	11/17/95
GW-769	GRIDG3	02/20/95	05/27/95	08/07/95	11/15/95
GW-770	GRIDG3	02/19/95	05/27/95	08/07/95	11/15/95
GW-771	GRIDC1	02/15/95	05/17/95	08/05/95	11/13/95
GW-772	GRIDC1	02/15/95	05/17/95	08/05/95	11/13/95
GW-773	GRIDH2	01/19/95	05/11/95	07/14/95	11/18/95
GW-774	GRIDH2	01/20/95	05/15/95	07/14/95	11/18/95
GW-775	GRIDH3	01/20/95	05/15/95	07/14/95	11/19/95
GW-776	GRIDH3	01/20/95	05/15/95	07/14/95	11/19/95
GW-777	GRIDB2	02/15/95	05/18/95	.	.
GW-778	GRIDB2	02/15/95	05/18/95	.	.
GW-779	GRIDF2	02/23/95	05/31/95	08/10/95	11/27/95
GW-780	GRIDF2	02/23/95	05/31/95	08/10/95	11/28/95
GW-781	GRIDE3	03/06/95	06/05/95	08/22/95	11/30/95
GW-782	GRIDE3	03/08/95	06/06/95	08/23/95	11/30/95
GW-783	GRIDE3	03/08/95	06/06/95	08/23/95	11/30/95
GW-784	GRIDD1	02/22/95	05/30/95	.	.
GW-785	GRIDD1	02/22/95	05/31/95	.	.
GW-786	GRIDE2	02/22/95	05/31/95	08/09/95	11/27/95
GW-787	GRIDE2	02/22/95	05/31/95	08/09/95	11/27/95
GW-788	GRIDF3	02/23/95	06/01/95	08/14/95	11/28/95
GW-789	GRIDF3	03/02/95	06/01/95	08/14/95	11/28/95
GW-791	GRIDD2	03/06/95	06/05/95	08/21/95	11/29/95
GW-792	GRIDD2	03/06/95	06/05/95	08/21/95	11/29/95
GW-817	GRIDK3	02/01/95	05/10/95	07/30/95	11/27/95

Table 1 (cont'd)

Notes:

1 Some monitoring locations were sampled to meet requirments of more than one programmatic driver during CY 1995.

2 B4 - Beta-4 Security Pits
EXP - Exit Pathway:
  - Maynardville Limestone Traverse (-E, -I, -J)
  - Surface water (LRSPW) or spring (SCR7.1SP) sampling location (-SW)
  - Along Scarboro Road in the gap through Pine Ridge (-SR)
  - Offsite in Union Valley (-UV)

FTF - Fire Training Facility
GRID - Comprehensive Groundwater Monitoring Plan Grid Location (see Figure 9)
NHP - New Hope Pond
S2 - S-2 Site
S3 - S-3 Site
SY - Y-12 Salvage Yard
WC - Waste Coolant Processing Area

Table 2. Construction Information for Monitoring Wells Sampled During CY 1995

Well[1]	Location[2]	Cluster Designation[3]	Aquifer[4]			Monitored Interval Depths[5]
			Unit	Form.	Interval	
GW-108	S3	3	AQT	Cn	WT	41.0 - 58.6
GW-109	S3	3	AQT	Cn	BDR	96.6 - 128.5
GW-148	NHP	1	AQF	Cmn	WT	4.6 - 11.1
GW-149	NHP	1	AQF	Cmn	BDR	36.0 - 50.5
GW-151	NHP	1	AQF	Cmn	BDR	85.0 - 96.5
GW-153	NHP	1	AQF	Cmn	BDR	45.0 - 60.0
GW-154	NHP	1	AQF	Cmn	WT	4.7 - 11.2
GW-169	EXP-UV	3	AQF	Cmn	WT	28.7 - 34.7
GW-170[a]	EXP-UV	1	AQF	Cmn	BDR	104.0 - 156.9
GW-171	EXP-UV	1	AQF	Cmn	WT	26.0 - 31.2
GW-172[a]	EXP-UV	1	AQF	Cmn	BDR	105.0 - 133.8
GW-191	B4	3	AQT	Cm	WT	45.0 - 60.5
GW-192	B4	3	AQT	Cm	WT	6.5 - 17.5
GW-194	B4	3	AQT	Cm	WT	6.5 - 12.6
GW-195	B4	3	AQT	Cm	WT	17.0 - 23.0
GW-199	GRIDI1	1	AQT	Crg	WT	16.5 - 22.5
GW-206	EXP-SR	1	AQT	Cr	WT	10.0 - 16.9
GW-207[a]	EXP-SR	1	AQT	Cr	BDR	100.0 - 109.6
GW-208[a]	EXP-SR	1	AQT	Cr	BDR	404.0 - 412.8
GW-220	NHP	1	AQF	Cmn	BDR	31.0 - 45.2
GW-222	NHP	1	AQF	Cmn	BDR	18.0 - 25.0
GW-223	NHP	1	AQF	Cmn	BDR	79.0 - 90.5
GW-230[a]	EXP-UV	1	AQF	Cmn	BDR	341.0 - 406.4
GW-232[a]	EXP-UV	10	AQF	Cmn	BDR	401.0 - 411.7
GW-240	NHP	1	AQF	Cmn	BDR	21.0 - 29.5
GW-251	S2	1	AQF	Cmn	BDR	35.0 - 51.0
GW-252	S2	3	AQF	Cmn	WT	40.2 - 49.0

Table 2 (cont'd)

Well[1]	Location[2]	Cluster Designation[3]	Aquifer[4]			Monitored Interval Depths[5]
			Unit	Form.	Interval	
GW-255	S2	4	AQF	Cmn	WT	66.3 - 81.5
GW-261	SY	3	AQT	Cm	WT	16.7 - 23.7
GW-262	SY	3	AQT	Cm	BDR	57.7 - 70.6
GW-263	SY	1	AQT	Cm	WT	23.0 - 30.8
GW-264	SY	1	AQT	Cm	BDR	58.5 - 71.0
GW-274	SY	3	AQT	Cn	WT	25.8 - 35.0
GW-275	SY	3	AQT	Cn	BDR	53.3 - 65.5
GW-337	WC	3	AQT	Cn	WT	15.0 - 22.1
GW-338	WC	3	AQT	Cn	WT	11.2 - 17.6
GW-380	NHP	1	AQF	Cmn	WT	2.8 - 15.5
GW-381[a]	NHP	1	AQF	Cmn	BDR	49.3 - 60.4
GW-382[a]	NHP	1	AQF	Cmn	BDR	125.0 - 173.0
GW-383	NHP	1	AQT	Cn	WT	16.6 - 23.6
GW-384[a]	NHP	1	AQT	Cn	WT	35.5 - 55.7
GW-385[a]	NHP	10	AQT	Cn	BDR	123.7 - 178.7
GW-603	EXP-J	1	AQF	Cmn	BDR	63.4 - 75.2
GW-604	EXP-J	4	AQF	Cmn	BDR	100.2 - 112.4
GW-605	EXP-I	1	AQF	Cmn	BDR	28.2 - 39.9
GW-606	EXP-I	1	AQF	Cmn	BDR	155.0 - 171.7
GW-617	EXP-E	1	AQF	Cmn	WT	6.8 - 18.0
GW-618	EXP-E	1	AQF	Cmn	WT	26.0 - 37.0
GW-619	FTF	3	AQF	Cmn	WT	26.8 - 40.8
GW-620	FTF	3	AQF	Cmn	WT	61.7 - 75.0
GW-733[a]	EXP-J	3	AQF	Cmn	BDR	240.1 - 256.5
GW-735	EXP-J	1	AQT	Cn	WT	67.5 - 79.2
GW-744	GRIDK1	3	AQT	Cpv	BDR	55.0 - 69.5
GW-745	GRIDK1	1	AQT	Cpv	BDR	21.2 - 32.8

Table 2 (cont'd)

Well[1]	Location[2]	Cluster Designation[3]	Aquifer[4]			Monitored Interval Depths[5]
			Unit	Form.	Interval	
GW-746	GRIDK1	3	AQT	Cpv	WT	3.2 - 15.2
GW-747	GRIDK2	3	AQT	Cm	BDR	67.4 - 79.6
GW-748	GRIDK2	1	AQT	Cm	BDR	14.8 - 27.2
GW-749	GRIDK2	1	AQT	Cm	WT	4.8 - 16.4
GW-750	EXP-J	1	AQT	Cn	BDR	61.2 - 72.7
GW-751	GRIDJ3	3	AQT	Cn	BDR	49.0 - 60.6
GW-752	GRIDJ3	3	AQT	Cn	WT	4.8 - 15.9
GW-758	GRIDG1	1	AQT	Crt	BDR	38.4 - 50.2
GW-759	GRIDG1	1	AQT	Crt	WT	18.0 - 30.2
GW-760	GRIDG2	1	AQT	Cm	BDR	48.3 - 60.1
GW-761	GRIDG2	3	AQT	Cm	WT	3.6 - 15.3
GW-762	GRIDJ3	1	AQT	Cn	BDR	46.4 - 58.7
GW-763	GRIDJ3	1	AQT	Cn	WT	4.0 - 16.0
GW-764	GRIDE1	3	AQT	Crg	BDR	53.9 - 65.0
GW-765	GRIDE1	1	AQT	Crg	WT	19.9 - 32.4
GW-766	GRIDI2	3	AQT	Cm	BDR	34.0 - 47.6
GW-767	GRIDI2	2	AQT	Cm	WT	6.7 - 18.0
GW-768	GRIDI1	3	AQT	Crg	BDR	53.3 - 65.0
GW-769	GRIDG3	1	AQT	Cn	BDR	48.2 - 60.3
GW-770	GRIDG3	3	AQT	Cn	WT	7.5 - 19.0
GW-771	GRIDC1	3	AQT	Crg	BDR	42.2 - 54.4
GW-772	GRIDC1	3	AQT	Crt	WT	3.8 - 17.0
GW-773	GRIDH2	3	AQT	Cm	BDR	46.1 - 59.6
GW-774	GRIDH2	3	AQT	Cm	WT	12.5 - 26.6
GW-775	GRIDH3	3	AQT	Cn	BDR	45.0 - 56.4
GW-776	GRIDH3	1	AQT	Cn	WT	10.6 - 23.0
GW-777	GRIDB2	3	AQT	Cm	BDR	46.1 - 59.0

Table 2 (cont'd)

Well[1]	Location[2]	Cluster Designation[3]	Aquifer[4]			Monitored Interval Depths[5]
			Unit	Form.	Interval	
GW-778	GRIDB2	3	AQT	Cm	BDR	7.8 - 21.9
GW-779	GRIDF2	10	AQT	Cm	BDR	50.7 - 62.9
GW-780	GRIDF2	1	AQT	Cn	WT	4.6 - 18.6
GW-781	GRIDE3	3	AQT	Cn	BDR	56.0 - 69.3
GW-782	GRIDE3	1	AQT	Cn	BDR	23.8 - 35.9
GW-783	GRIDE3	1	AQT	Cn	WT	3.6 - 16.3
GW-784	GRIDD1	1	AQT	Crg	BDR	52.0 - 63.4
GW-785	GRIDD1	2	AQT	Cm	WT	11.5 - 25.4
GW-786	GRIDE2	3	AQT	Cm	BDR	52.9 - 64.9
GW-787	GRIDE2	2	AQT	Cm	WT	5.3 - 18.1
GW-788	GRIDF3	1	AQT	Cn	BDR	55.9 - 67.8
GW-789	GRIDF3	3	AQT	Cn	BDR	10.7 - 23.8
GW-791	GRIDD2	1	AQT	Cm	BDR	57.5 - 70.6
GW-792	GRIDD2	2	AQT	Cm	WT	17.0 - 29.0
GW-816	EXP-SR	4	AQT	Cr	WT	2.9 - 15.8
GW-817	GRIDK3	3	AQT	Cn	WT	0.6 - 23.0

Notes:

1 Well construction information compiled from: *Updated Subsurface Data Base for Bear Creek Valley, Chestnut Ridge, and Parts of Bethel Valley on the U.S. Department of Energy Oak Ridge Reservation* (Jones et al. 1995).

2 B4 - Beta-4 Security Pits
EXP - Exit Pathway:
- Maynardville Limestone Traverse (-E, -I, -J)
- Surface water (LRSPW) or spring (SCR7.1SP) sampling location (-SW)
- Along Scarboro Road in the gap through Pine Ridge (-SR)
- Offsite in Union Valley (-UV)

FTF - Fire Training Facility
GRID - Comprehensive Groundwater Monitoring Plan Grid Location (see Figure 4)
NHP - New Hope Pond
S2 - S-2 Site
S3 - S-3 Site
SY - Y-12 Salvage Yard
WC - Waste Coolant Processing Area

Table 2 (cont'd)

Notes: (cont'd)

3 Cluster designation for trace metal data evaluation purpose.
Surface water stations LRSPW and 7UV7.1SP were assigned to cluster 3.

4 Unit: Hydrostratigraphic unit
AQF - Aquifer
AQT - Aquitard

Form.: Geologic Formation
Cmn - Maynardville Limestone
Cn - Nolichucky Shale
Cm - Maryville Limestone
Crg - Rogersville Shale
Crt - Rutledge Limestone
Cpv - Pumpkin Valley Shale
Cr - Rome Formation

Interval: determined from the placement of the top of the monitored interval
BDR - Bedrock (Shallow, Intermediate, and Deep Intervals)
WT - Water table Interval (above unweathered bedrock)

5 Depth in feet from the ground surface.

a Open-hole well construction.

Table 3. VOCs Detected in CY 1995 QA/QC Samples

Compound	Number of QA/QC Samples Containing Specified Compound (by Sample Type)				
	Laboratory Blanks	Trip Blanks	Field Blanks	Equipment Rinsates	Total
Laboratory Reagents					
Acetone	11	16	2	6	35
2-Butanone	7	10	.	7	24
Methylene Chloride	4	20	1	2	27
Toluene	2	2	.	.	4
VOC Plume Constituents					
1,1,1-Trichloroethane	.	135	2	22	159
1,2-Dichloroethene	.	2	.	.	2
Tetrachloroethene	1	1	.	.	2
1,2-Dichloroethane	1	.	.	.	1
Trichloroethene	.	1	.	.	1
Miscellaneous Compounds					
Xylenes	1	1	.	.	2
2-Hexanone	.	.	.	1	1
Data Summary					
Total Samples:	**113**	**165**	**4**	**37**	**319**
Samples with VOCs[1]:	**20**	**142**	**3**	**27**	**192**
Percent of Total Samples with VOCs:	**18%**	**86%**	**75%**	**73%**	**60%**

Notes:

[1] Some contaminated samples contain more than one compound.

Table 4. Elevated Trace Metal Concentrations in Groundwater and Surface Water, CY 1995

Metal[1]	Sampling Point	Location[2]	Cluster[3]	UTL/MCL[4] (mg/L)	CY 1995 Median[4] (mg/L)	Number of Results[5]
Western Plant Area						
Aluminum						
	GW-109	S3	3	2.4	21	1
	GW-191	B4	3	2.4	3.2	4
	GW-194	B4	3	2.4	3.8	4
	GW-195	B4	3	2.4	6.65	4
	GW-251	S2	1	2.4	2.6	4
	GW-255	S2	4	2.4	8.9	2
Barium						
	GW-108	S3	NA	2	120	1
	GW-109	S3	NA	2	53	1
	GW-274	SY	NA	2	37	1
	GW-275	SY	NA	2	96	1
Beryllium						
	GW-109	S3	NA	0.004	0.018	1
Boron						
	GW-109	S3	3	0.041	0.19	1
	GW-195	B4	3	0.041	0.0445	4
	GW-337	WC	3	0.041	0.08	2
	GW-617	EXP-E	1	0.12	0.415	4
	GW-618	EXP-E	1	0.12	0.16	4
	GW-620	FTF	3	0.041	0.05	4
Cadmium (AAS)						
	GW-109	S3	NA	0.005	4.4	1
	GW-251	S2	NA	0.005	0.14	4
	GW-274	SY	NA	0.005	0.0072	1
	GW-618	EXP-E	NA	0.005	0.024	4
Chromium (AAS)						
	GW-263	SY	NA	0.1	1.474	2
Cobalt						
	GW-108	S3	3	0.019	0.25	1
	GW-109	S3	3	0.019	1	1
	GW-251	S2	1	0.019	0.024	4
Copper						
	GW-195	B4	3	0.012	0.0225	4

Table 4 (cont'd)

Metal[1]	Sampling Point	Location[2]	Cluster[3]	UTL/MCL[4] (mg/L)	CY 1995 Median[4] (mg/L)	Number of Results[5]
Western Plant Area (cont'd)						
Copper (cont'd)						
	GW-251	S2	1	0.012	0.49	4
	GW-255	S2	4	0.012	0.427	2
	GW-263	SY	1	0.012	0.0665	2
	GW-337	WC	3	0.012	0.0165	2
Iron						
	GW-195	B4	3	8.7	9.55	4
	GW-255	S2	4	4.6	12.45	2
Manganese						
	GW-108	S3	3	1.7	110	1
	GW-109	S3	3	1.7	190	1
	GW-192	B4	3	1.7	2.05	4
	GW-194	B4	3	1.7	3.8	4
	GW-251	S2	1	1.7	3.75	4
	GW-255	S2	4	0.13	0.78	2
	GW-274	SY	3	1.7	88	1
	GW-275	SY	3	1.7	5.7	1
	GW-618	EXP-E	1	1.7	1.75	4
Mercury (CVAA)						
	GW-109	S3	NA	0.002	0.041	1
Nickel						
	GW-108	S3	NA	0.1	0.44	1
	GW-109	S3	NA	0.1	7.8	1
	GW-263	SY	NA	0.1	0.645	2
	GW-274	SY	NA	0.1	0.61	1
Selenium						
	GW-275	SY	NA	0.05	3.2	1
Silver						
	GW-108	S3	NA	0.05	0.15	1
Strontium						
	GW-108	S3	3	0.92	39	1
	GW-109	S3	3	0.92	29	1
	GW-274	SY	3	0.92	17	1
	GW-275	SY	3	0.92	50	1

Table 4 (cont'd)

Metal[1]	Sampling Point	Location[2]	Cluster[3]	UTL/MCL[4] (mg/L)	CY 1995 Median[4] (mg/L)	Number of Results[5]
Western Plant Area (cont'd)						
Uranium						
	GW-108	S3	3	0.005	0.015	1
	GW-109	S3	3	0.005	0.032	1
	GW-274	SY	3	0.005	0.013	1
Vanadium						
	GW-191	B4	3	0.005	0.0087	4
	GW-194	B4	3	0.005	0.0056	4
	GW-195	B4	3	0.005	0.0101	4
	GW-251	S2	1	0.005	0.006	4
	GW-255	S2	4	0.005	0.0184	2
	GW-619	FTF	3	0.005	0.0067	
	GW-778	GRIDB2	3	0.005	0.0448	2
Zinc						
	GW-109	S3	3	0.041	0.13	1
	GW-251	S2	1	0.041	0.079	4
Central Plant Area						
Aluminum						
	GW-765	GRIDE1	1	2.4	5.15	4
	GW-778	GRIDB2	3	2.4	20.3	2
	GW-788	GRIDF3	1	2.4	5.15	4
	GW-789	GRIDF3	3	2.4	4.45	4
Boron						
	GW-764	GRIDE1	3	0.041	0.0715	4
	GW-775	GRIDH3	3	0.041	0.0505	4
	GW-777	GRIDB2	3	0.041	0.0415	2
	GW-778	GRIDB2	3	0.041	0.0595	2
	GW-781	GRIDE3	3	0.041	0.475	4
	GW-788	GRIDF3	1	0.12	1.35	4
	GW-789	GRIDF3	3	0.041	0.0975	4
Chromium						
	GW-761	GRIDG2	NA	0.1	0.165	4
	GW-776	GRIDH3	NA	0.1	0.203	4
	GW-778	GRIDB2	NA	0.1	0.1075	2

Table 4 (cont'd)

Metal[1]	Sampling Point	Location[2]	Cluster[3]	UTL/MCL[4] (mg/L)	CY 1995 Median[4] (mg/L)	Number of Results[5]
Central Plant Area (cont'd)						
Chromium (AAS)						
	GW-760	GRIDG2	NA	0.1	0.21	4
	GW-783	GRIDE3	NA	0.1	0.61	4
Cobalt						
	GW-772	GRIDC1	3	0.019	0.057	4
Copper						
	GW-778	GRIDB2	3	0.012	0.05225	2
	GW-783	GRIDE3	1	0.012	0.018	4
	GW-788	GRIDF3	1	0.012	0.0185	4
	GW-789	GRIDF3	3	0.012	0.034	4
Iron						
	GW-772	GRIDC1	3	8.7	38.5	4
	GW-785	GRIDD1	2	8.7	32	2
Manganese						
	GW-772	GRIDC1	3	1.7	13	4
Nickel						
	GW-760	GRIDG2	NA	0.1	0.175	4
	GW-776	GRIDH3	NA	0.1	0.49	4
	GW-783	GRIDE3	NA	0.1	0.335	4
Vanadium						
	GW-765	GRIDE1	1	0.005	0.00625	4
	GW-788	GRIDF3	1	0.005	0.00915	4
	GW-789	GRIDF3	3	0.005	0.00725	4
Eastern Plant Area						
Aluminum						
	GW-169	EXP-UV	3	2.4	28.7	4
	GW-748	GRIDK2	1	2.4	4.4	4
	SCR7.1SP	EXP-SW	3	2.4	11	1
Boron						
	GW-149	NHP	1	0.12	0.47	4
	GW-154	NHP	1	0.12	0.135	4
	GW-208	EXP-SR	1	0.12	0.23	4
	GW-383	NHP	1	0.12	0.125	4
	GW-605	EXP-I	1	0.12	0.18	4

Table 4 (cont'd)

Metal[1]	Sampling Point	Location[2]	Cluster[3]	UTL/MCL[4] (mg/L)	CY 1995 Median[4] (mg/L)	Number of Results[5]
Eastern Plant Area (cont'd)						
Boron (cont'd)						
	GW-744	GRIDK1	3	0.041	0.06	4
	GW-746	GRIDK1	3	0.041	0.057	4
	GW-747	GRIDK2	3	0.041	0.0895	4
	GW-751	GRIDJ3	3	0.041	0.058	4
	GW-766	GRIDI2	3	0.041	0.0445	4
	GW-767	GRIDI2	2	0.028	0.052	4
	GW-768	GRIDI1	3	0.041	0.105	4
	GW-816	EXP-SR	4	0.028	0.037	4
	LRSPW	EXP-SW	3	0.041	0.0625	2
	SCR7.1SP	EXP-SW	3	0.041	0.075	1
Beryllium						
	GW-169	EXP-UV	NA	0.004	0.0049	4
Chromium (AAS)						
	GW-380	NHP	NA	0.1	0.34	4
Cobalt						
	GW-169	EXP-UV	3	0.019	0.028	4
Copper						
	GW-169	EXP-UV	3	0.012	0.041	4
	SCR7.1SP	EXP-SW	3	0.012	0.013	1
Iron						
	GW-169	EXP-UV	3	8.7	42.3	4
	GW-206	EXP-SR	1	8.7	23.5	4
	GW-763	GRIDJ3	1	8.7	19.5	4
	GW-816	EXP-SR	4	4.6	14	4
	SCR7.1SP	EXP-SW	3	8.7	13	1
Lead (AAS)						
	GW-169	EXP-UV	NA	0.05	0.077	4
Manganese						
	GW-169	EXP-UV	3	1.7	1.72	4
	GW-171	EXP-UV	1	1.7	9.7	4
	GW-199	GRIDI1	1	1.7	1.75	4
	GW-816	EXP-SR	4	0.13	1.35	4

Table 4 (cont'd)

Metal[1]	Sampling Point	Location[2]	Cluster[3]	UTL/MCL[4] (mg/L)	CY 1995 Median[4] (mg/L)	Number of Results[5]
Eastern Plant Area (cont'd)						
Nickel						
	GW-380	NHP	NA	0.1	0.36	4
	GW-603	EXP-J	NA	0.1	0.19	4
Strontium						
	GW-744	GRIDK1	3	0.92	1.1	4
	GW-816	EXP-SR	4	0.079	0.0885	4
Uranium						
	GW-154	NHP	1	0.012	0.52	4
	GW-222	NHP	1	0.012	0.15	4
	GW-605	EXP-I	1	0.012	0.18	4
	LRSPW	EXP-SW	3	0.005	0.017	2
Vanadium						
	GW-169	EXP-UV	3	0.005	0.0563	4
	GW-748	GRIDK2	1	0.005	0.0133	4
	SCR7.1SP	EXP-SW	3	0.005	0.02	1
Zinc						
	GW-169	EXP-UV	3	0.041	0.209	4
	GW-172	EXP-UV	1	0.041	0.525	4
	GW-199	GRIDI1	1	0.041	0.053	4
	GW-208	EXP-SR	1	0.041	1.35	4
	GW-230	EXP-UV	1	0.041	1.4	3
	GW-603	EXP-J	1	0.041	0.0695	4
	SCR7.1SP	EXP-SW	3	0.041	0.062	1

Notes:

1 Results obtained by ICP spectroscopy unless otherwise noted.

AAS - Atomic Absorption Spectrometry
PMS - Plasma Mass Spectrometry
CVAA - Cold Vapor Atomic Absorption Spectrometry

2 B4 - Beta-4 Security Pits
EXP - Exit Pathway:

- Maynardville Limestone Traverse (-E, -I, -J)
- Surface water (LRSPW) or spring (SCR7.1SP) sampling location (-SW)
- Along Scarboro Road in the gap through Pine Ridge (-SR)
- Offsite in Union Valley (-UV) EXP

Table 4 (cont'd)

Notes: (cont'd)

2 FTF - Fire Training Facility
GRID - Comprehensive Groundwater Monitoring Plan Grid Location
NHP - New Hope Pond
S2 - S-2 Site
S3 - S-3 Site
SY - Y-12 Salvage Yard
WC - Waste Coolant Processing Area

3 Cluster designation for trace metal data evaluation purposes (see Appendix C).
N/A - Not applicable for metal concentrations compared to MCLs.

4 Concentrations in milligrams per liter.

5 The number of results used to determine median values.

Table 5. Annual Average VOC Concentrations in Groundwater and Surface Water, CY 1995

		CY 1995 Average Concentration[4] (μg/L)				
Sampling Point		**GW-108**	**GW-109**	**GW-148**	**GW-151**	**GW-153**
Location[1]		**S3**	**S3**	**NHP**	**NHP**	**NHP**
Unit[2]	**MCL[3]**	**AQT**	**AQT**	**AQF**	**AQF**	**AQF**
Chloroethenes						
Tetrachloroethene	5	0	180	0	24	5.25
Trichloroethene	5	2	6	0	4	1
1,2-Dichloroethene	-	0	.	4.5	11.5	0
1,1-Dichloroethene	7	0	.	0	.	0
Vinyl chloride	2	0	.	0	.	0
Summed chloroethenes		**2**	**186**	**5**	**40**	**6**
Chloroethanes						
1,1,1-Trichloroethane	200	0	.	0	.	0
1,1-Dichloroethane	-	0	.	0	.	0
Summed chloroethanes		**0**	**0**	**0**	**0**	**0**
Chloromethanes						
Carbon tetrachloride	5	0	.	0	505	152.5
Chloroform	-	22	19	0	24	6.25
Methylene chloride	5	38	35	0	.	0
Summed chloromethanes		**60**	**54**	**0**	**529**	**159**
Data Summary						
Summed Average Concentration		**62**	**240**	**5**	**569**	**165**
% Chloroethenes		3%	78%	100%	7%	4%
% Chloroethanes		0%	0%	0%	0%	0%
% Chloromethanes		97%	23%	0%	93%	96%
Plume Delineation Value[5]		**98**	**521**	**9**	**569**	**165**

Table 5 (cont'd)

		CY 1995 Average Concentration[4] (µg/L)				
Sampling Point		**GW-169**	**GW-170**	**GW-192**	**GW-220**	**GW-222**
Location[1]		**EXP-UV**	**EXP-UV**	**B4**	**NHP**	**NHP**
Unit[2]	**MCL[3]**	**AQF**	**AQF**	**AQT**	**AQF**	**AQF**
Chloroethenes						
Tetrachloroethene	5	1.75	5.25	2.25	39.7	155.5
Trichloroethene	5	1	2.25	2.75	8	27.75
1,2-Dichloroethene	-	0	0	15.75	.	20.75
1,1-Dichloroethene	7	0	0	0	.	0
Vinyl chloride	2	0	0	0.25	.	0
Summed chloroethenes		**3**	**8**	**21**	**48**	**204**
Chloroethanes						
1,1,1-Trichloroethane	200	0	0	0	.	0
1,1-Dichloroethane	-	0	0	0.5	.	0
Summed chloroethanes		**0**	**0**	**1**	**0**	**0**
Chloromethanes						
Carbon tetrachloride	5	0	7.5	0	475	68.5
Chloroform	-	0	40.5	0	20.7	4.75
Methylene chloride	5	0	0	0	.	0
Summed chloromethanes		**0**	**48**	**0**	**496**	**73**
Data Summary						
Summed Average Concentration		**3**	**56**	**22**	**543**	**277**
% Chloroethenes		100%	14%	98%	9%	74%
% Chloroethanes		0%	0%	2%	0%	0%
% Chloromethanes		0%	86%	0%	91%	26%
Plume Delineation Value[5]		**3**	**56**	**22**	**543**	**277**

Table 5 (cont'd)

		CY 1995 Average Concentration[4] (µg/L)				
Sampling Point		GW-223	GW-230	GW-240	GW-251	GW-255
Location[1]		NHP	EXP-UV	NHP	S2	S2
Unit[2]	MCL[3]	AQF	AQF	AQF	AQF	AQF
Chloroethenes						
Tetrachloroethene	5	247.5	0	0	85.5	0
Trichloroethene	5	52	0	0	35	0
1,2-Dichloroethene	-	35	19	0	2	0
1,1-Dichloroethene	7	.	0	0	0	0
Vinyl chloride	2	.	4.5	0	0	0
Summed chloroethenes		**335**	**24**	**0**	**123**	**0**
Chloroethanes						
1,1,1-Trichloroethane	200	.	0	0	0	0
1,1-Dichloroethane	-	.	0	0	0	0
Summed chloroethanes		**0**	**0**	**0**	**0**	**0**
Chloromethanes						
Carbon tetrachloride	5	17.25	0	13.75	3	0
Chloroform	-	3.75	0	1.5	5.25	1
Methylene chloride	5	.	0	0	0	0
Summed chloromethanes		**21**	**0**	**15**	**8**	**1**
Data Summary						
Summed Average Concentration		**356**	**24**	**15**	**131**	**1**
% Chloroethenes		94%	100%	0%	94%	0%
% Chloroethanes		0%	0%	0%	0%	0%
% Chloromethanes		6%	0%	100%	6%	100%
Plume Delineation Value[5]		**373**	**24**	**15**	**133**	**1**

Table 5 (cont'd)

		CY 1995 Average Concentration[4] ($\mu g/L$)				
Sampling Point		**GW-274**	**GW-275**	**GW-337**	**GW-380**	**GW-381**
Location[1]		**SY**	**SY**	**WC**	**NHP**	**NHP**
Unit[2]	**MCL[3]**	**AQT**	**AQT**	**AQT**	**AQF**	**AQF**
Chloroethenes						
Tetrachloroethene	5	36	0	885	0.5	.
Trichloroethene	5	6	0	985	0	.
1,2-Dichloroethene	-	4	0	6,800	0	.
1,1-Dichloroethene	7	0	0	190	0	.
Vinyl chloride	2	0	0	130	0	.
Summed chloroethenes		**46**	**0**	**8,990**	**1**	**0**
Chloroethanes						
1,1,1-Trichloroethane	200	0	0	350	0	.
1,1-Dichloroethane	-	0	0	175	0	.
Summed chloroethanes		**0**	**0**	**525**	**0**	**0**
Chloromethanes						
Carbon tetrachloride	5	0	0	60	0	4950
Chloroform	-	17	1	.	0.5	1365
Methylene chloride	5	37	3	98	0	.
Summed chloromethanes		**54**	**4**	**158**	**1**	**6,315**
Data Summary						
Summed Average Concentration		**100**	**4**	**9,673**	**1**	**6,315**
% Chloroethenes		46%	0%	93%	50%	0%
% Chloroethanes		0%	0%	5%	0%	0%
% Chloromethanes		54%	100%	2%	50%	100%
Plume Delineation Value[5]		**104**	**4**	**10,703**	**1**	**6,315**

Table 5 (cont'd)

Sampling Point Location[1] Unit[2]	MCL[3]	CY 1995 Average Concentration[4] (µg/L) GW-382 NHP AQF	 GW-383 NHP AQT	 GW-604 EXP-J AQF	 GW-605 EXP-I AQF	 GW-606 EXP-I AQF
Chloroethenes						
Tetrachloroethene	5	255	402.5	0	36.5	7
Trichloroethene	5	.	152.5	0	12.75	0
1,2-Dichloroethene	-	.	105.75	0	30	0.5
1,1-Dichloroethene	7	.	0	0	0.7	0
Vinyl chloride	2	.	0	0	0	0
Summed chloroethenes		**255**	**661**	**0**	**80**	**8**
Chloroethanes						
1,1,1-Trichloroethane	200	.	0	0	0	0
1,1-Dichloroethane	-	.	0	0	1.7	0
Summed chloroethanes		**0**	**0**	**0**	**2**	**0**
Chloromethanes						
Carbon tetrachloride	5	5700	2	0	237.5	555
Chloroform	-	245	1	1.25	27.5	182.5
Methylene chloride	5	.	0	0	0	16.7
Summed chloromethanes		**5,945**	**3**	**1**	**265**	**754**
Data Summary						
Summed Average Concentration		**6,200**	**664**	**1**	**347**	**762**
% Chloroethenes		4%	100%	0%	23%	1%
% Chloroethanes		0%	0%	0%	0%	0%
% Chloromethanes		96%	0%	100%	76%	99%
Plume Delineation Value[5]		**6,200**	**664**	**1**	**347**	**762**

Table 5 (cont'd)

		CY 1995 Average Concentration[4] (μg/L)				
Sampling Point		**GW-617**	**GW-618**	**GW-619**	**GW-620**	**GW-733**
Location[1]		**EXP-E**	**EXP-E**	**FTF**	**FTF**	**EXP-J**
Unit[2]	**MCL[3]**	**AQF**	**AQF**	**AQF**	**AQF**	**AQF**
Chloroethenes						
Tetrachloroethene	5	2.75	28.25	147.5	405	1
Trichloroethene	5	2.25	25.25	46.5	115	0.5
1,2-Dichloroethene	-	4.25	30.5	77.25	312.5	0
1,1-Dichloroethene	7	0	0	0	.	0
Vinyl chloride	2	0	0.5	0	.	0
Summed chloroethenes		**9**	**85**	**271**	**833**	**2**
Chloroethanes						
1,1,1-Trichloroethane	200	0	0	0	.	0
1,1-Dichloroethane	-	0	0	0	.	0
Summed chloroethanes		**0**	**0**	**0**	**0**	**0**
Chloromethanes						
Carbon tetrachloride	5	0	0	0	.	43.75
Chloroform	-	0	0	0	.	3.5
Methylene chloride	5	0	0	0	.	0
Summed chloromethanes		**0**	**0**	**0**	**0**	**47**
Data Summary						
Summed Average Concentration		**9**	**85**	**271**	**833**	**49**
% Chloroethenes		100%	100%	100%	100%	3%
% Chloroethanes		0%	0%	0%	0%	0%
% Chloromethanes		0%	0%	0%	0%	97%
Plume Delineation Value[5]		**9**	**85**	**271**	**833**	**49**

Table 5 (cont'd)

Sampling Point Location[1] Unit[2]	MCL[3]	CY 1995 Average Concentration[4] ($\mu g/L$) GW-762 GRIDJ3 AQT	GW-763 GRIDJ3 AQT	GW-769 GRIDG3 AQT	GW-770 GRIDG3 AQT	GW-775 GRIDH3 AQT
Chloroethenes						
Tetrachloroethene	5	1,200	12.75	8.75	0	0
Trichloroethene	5	70	3.5	2	0	5.75
1,2-Dichloroethene	-	64.5	64.5	0	0	0
1,1-Dichloroethene	7	16	0.5	1	0	0
Vinyl chloride	2	.	12.25	0	0	0
Summed chloroethenes		**1,351**	**94**	**12**	**0**	**6**
Chloroethanes						
1,1,1-Trichloroethane	200	.	0	0	0	0
1,1-Dichloroethane	-	.	0	0	0	0
Summed chloroethanes		**0**	**0**	**0**	**0**	**0**
Chloromethanes						
Carbon tetrachloride	5	.	0	13	3.75	0
Chloroform	-	.	0	2.25	3.5	0
Methylene chloride	5	.	0	0	0	0
Summed chloromethanes		**0**	**0**	**15**	**7**	**0**
Data Summary						
Summed Average Concentration		**1,351**	**94**	**27**	**7**	**6**
% Chloroethenes		100%	100%	44%	0%	100%
% Chloroethanes		0%	0%	0%	0%	0%
% Chloromethanes		0%	0%	56%	100%	0%
Plume Delineation Value[5]		**1,351**	**94**	**27**	**7**	**6**

Table 5 (cont'd)

		CY 1995 Average Concentration[4] (μg/L)				
Sampling Point		GW-776	GW-781	GW-782	GW-783	GW-789
Location[1]		GRIDH3	GRIDE3	GRIDE3	GRIDE3	GRIDF3
Unit[2]	MCL[3]	AQT	AQT	AQT	AQT	AQT
Chloroethenes						
Tetrachloroethene	5	1.5	2.75	182.5	32.5	0
Trichloroethene	5	3.5	0	44	12.75	0.5
1,2-Dichloroethene	-	0	0	14.75	18	0
1,1-Dichloroethene	7	0	1	34.5	3.75	0
Vinyl chloride	2	0	0	2.5	0	0
Summed chloroethenes		**5**	**4**	**278**	**67**	**1**
Chloroethanes						
1,1,1-Trichloroethane	200	0	0	13	0.5	0
1,1-Dichloroethane	-	0	10.75	127.5	11.75	0
Summed chloroethanes		**0**	**11**	**141**	**12**	**0**
Chloromethanes						
Carbon tetrachloride	5	0	0	5.25	1	0
Chloroform	-	0.5	0	1.7	0.5	0.5
Methylene chloride	5	0	0	.	0	0
Summed chloromethanes		**1**	**0**	**7**	**2**	**1**
Data Summary						
Summed Average Concentration		**6**	**15**	**426**	**81**	**1**
% Chloroethenes		91%	26%	65%	83%	50%
% Chloroethanes		0%	74%	33%	15%	0%
% Chloromethanes		9%	0%	2%	2%	50%
Plume Delineation Value[5]		**6**	**15**	**426**	**81**	**1**

Table 5 (cont'd)

		CY 1995 Average Concentration[4] (μg/L)			
Sampling Point		**GW-791**	**GW-792**	**LRSPW**	**SCR7.1SP**
Location[1]		**GRIDD2**	**GRIDD2**	**EXP-SW**	**EXP-SW**
Unit[2]	**MCL[3]**	**AQT**	**AQT**		**AQF**
Chloroethenes					
Tetrachloroethene	5	2,400	14.25	5.5	0
Trichloroethene	5	6	0	1	3
1,2-Dichloroethene	-	.	0	0	0
1,1-Dichloroethene	7	.	0	0	0
Vinyl chloride	2	.	0	0	0
Summed chloroethenes		**2,406**	**14**	**7**	**3**
Chloroethanes					
1,1,1-Trichloroethane	200	.	0	0	0
1,1-Dichloroethane	-	.	0	0	0
Summed chloroethanes		**0**	**0**	**0**	**0**
Chloromethanes					
Carbon tetrachloride	5	.	0	21.5	6
Chloroform	-	.	0	2	0
Methylene chloride	5	.	0	0	0
Summed chloromethanes		**0**	**0**	**24**	**6**
Data Summary					
Total Solvent Concentration		**2,406**	**14**	**30**	**9**
% Chloroethenes		100%	100%	22%	33%
% Chloroethanes		0%	0%	0%	0%
% Chloromethanes		0%	0%	78%	67%
Plume Delineation Value[5]		**2,406**	**14**	**30**	**9**

Table 5 (cont'd)

Notes:

1 B4 - Beta-4 Security Pits
EXP - Exit Pathway:
- Maynardville Limestone Traverse (-E, -I, -J)
- Surface water (LRSPW) or spring (SCR7.1SP) sampling location (-SW)
- Along Scarboro Road in the gap through Pine Ridge (-SR)
- Offsite in Union Valley (-UV)

FTF - Fire Training Facility
GRID - Comprehensive Groundwater Monitoring Plan Grid Location
NHP - New Hope Pond
S2 - S-2 Site
S3 - S-3 Site
SY - Y-12 Salvage Yard
WC - Waste Coolant Processing Area

2 Unit: Hydrostratigraphic unit
AQF - Aquifer
AQT - Aquitard

3 MCL - Maximum Contaminant Level

4 All results are in micrograms per liter (μg/L).
0 - Not detected, false positive, or anomalous result.
. - Not detected at an elevated detection limit (diluted sample).

5 Plume delineation values may include miscellaneous compounds (e.g., acetone).

Table 6. Annual Average Gross Alpha Activity in Groundwater and Surface Water, CY 1995

Sampling Point	Location[1]	Gross Alpha[2]		No. of Results	
		Average Activity	Average Error	Exceeding MDA	Total Analyzed
Western Plant Area					
GW-109	S3	**122**	62	1	1
GW-191	B4	5	3	1	4
GW-194	B4	7	3	1	4
GW-195	B4	9	3	1	4
GW-251	S2	11	2	4	4
GW-255	S2	10	4	1	2
GW-617	EXP-E	7	4	1	4
GW-778	GRIDB2	6	3	1	2
Central Plant Area					
GW-761	GRIDG2	3	2	1	4
GW-781	GRIDE3	3	2	1	4
GW-782	GRIDE3	**23**	3	4	4
GW-783	GRIDE3	8	3	1	4
GW-787	GRIDF3	1	1	1	4
GW-788	GRIDF3	3	2	1	4
GW-789	GRIDF3	2	1	1	4
Eastern Plant Area					
GW-151	NHP	5	2	1	4
GW-153	NHP	2	2	1	4
GW-154	NHP	**463**	24	4	4
GW-169	EXP-UV	**18**	4	2	4
GW-199	GRIDI1	**34**	26	1	4
GW-207	EXP-SR	4	2	1	4
GW-222	NHP	**44**	4	4	4
GW-223	NHP	6	3	1	4
GW-605	EXP-I	**99**	6	4	4
GW-606	EXP-I	8	2	3	4
GW-733	EXP-J	2	1	1	4
GW-746	GRIDK1	6	2	2	4
GW-748	GRIDK2	5	3	1	4
GW-749	GRIDK2	4	3	1	4
LRSPW	EXP-SW	11	3	1	2

Table 6 (cont'd)

Notes:

1 B4 - Beta-4 Security Pits
EXP - Exit Pathway:
- Maynardville Limestone Traverse (-E, -I, -J)
- Surface water (LRSPW) or spring (SCR7.1SP) sampling location (-SW)
- Along Scarboro Road in the gap through Pine Ridge (-SR)
- Offsite in Union Valley (-UV) EXP

FTF - Fire Training Facility
GRID - Comprehensive Groundwater Monitoring Plan Grid Location (see Figure 9)
NHP - New Hope Pond
S2 - S-2 Site
S3 - S-3 Site
SY - Y-12 Salvage Yard
WC - Waste Coolant Processing Area

2 Average activity reported in picoCuries per liter. **Boldface type** indicates average activity above the 15 pCi/L water quality standard. Only results above the Minimum Detectable Activity (MDA) were used to calculate the average activity.

Table 7. Annual Average Gross Beta Activity in Groundwater and Surface Water, CY 1995

Sampling Point	Location[1]	Gross Beta[2]		No. of Results	
		Average Activity	Average Error	Exceeding MDA	Total Analyzed
Western Plant Area					
GW-108	S3	**9,500**	600	1	1
GW-109	S3	**7,300**	770	1	1
GW-194	B4	15	4	2	4
GW-195	B4	27	3	3	4
GW-251	S2	13	3	2	4
GW-255	S2	15	4	1	2
GW-274	SY	**4,230**	460	1	1
GW-275	SY	**125**	60	1	1
GW-617	EXP-E	17	6	1	4
GW-619	FTF	15	2	4	4
GW-620	FTF	13	2	2	4
GW-778	GRIDB2	12	3	1	2
Central Plant Area					
GW-764	GRIDE1	5	3	1	4
GW-776	GRIDH3	36	29	1	4
GW-781	GRIDE3	6	3	1	4
GW-782	GRIDE3	7	3	1	4
GW-788	GRIDF3	9	2	2	4
Eastern Plant Area					
GW-154	NHP	**205**	9	4	4
GW-169	EXP-UV	29	4	2	4
GW-199	GRIDI1	**74**	35	1	4
GW-206	EXP-SR	5	3	1	4
GW-207	EXP-SR	6	3	1	4
GW-222	NHP	46	3	4	4
GW-380	NHP	6	3	1	4
GW-603	EXP-J	6	3	1	4
GW-605	EXP-I	**52**	3	4	4
GW-606	EXP-I	5	3	1	4
GW-746	GRIDK1	11	3	1	4
GW-748	GRIDK2	11	3	1	4
GW-750	EXP-J	5	3	1	4

Table 7. (cont'd)

Sampling Point	Location[1]	Gross Beta[2]		No. of Results	
		Average Activity	Average Error	Exceeding MDA	Total Analyzed
GW-768	GRIDI1	5	3	1	4
GW-817	GRIDK3	5	3	1	4
LRSPW	EXP-SW	16	4	1	2
SCR7.1SP	EXP-SW	17	12	1	1

Notes:

1 B4 - Beta-4 Security Pits
EXP - Exit Pathway:
- Maynardville Limestone Traverse (-E, -I, -J)
- Surface water (LRSPW) or spring (SCR7.1SP) sampling location (-SW)
- Along Scarboro Road in the gap through Pine Ridge (-SR)
- Offsite in Union Valley (-UV)

FTF - Fire Training Facility
GRID - Comprehensive Groundwater Monitoring Plan Grid Location (see Figure 4)
NHP - New Hope Pond
S2 - S-2 Site
S3 - S-3 Site
SY - Y-12 Salvage Yard
WC - Waste Coolant Processing Area

2 Average activity reported in picoCuries per liter. **Boldface type** indicates average activity above the 50 pCi/L water quality standard. Only results above the Minimum Detectable Activity (MDA) were used to calculate the average activity.

Table 8. Radionuclide Activities that Exceed MDAs, Union Valley Exit Pathway Groundwater and Surface Water Samples, CY 1995

Isotope[1]	Sampling Point[2]	Date Sampled	Results[3] (pCi/L)		
			Activity	Error	MDA
Cesium 137					
	GW-232	12/14/95	5.78	2.2	3.9
Radium					
	GW-169	03/15/95	2.05	1.40	1.5
	GW-169	06/12/95	4.05	0.16	1.5
	GW-169	09/28/95	16.2	3.24	1.5
	GW-170	09/28/95	2.11	1.30	1.5
	GW-171	09/22/95	2.57	1.67	1.5
	GW-230	09/20/95	4.59	1.89	1.5
Strontium					
	GW-169	09/28/95	90.1	36	33
	GW-171	06/12/95	40	27	33
Thorium 228					
	SCR7.1SP	12/13/95	0.871	0.53	0.4249
	GW-169	12/13/95	0.358	0.26	0.1196
	GW-172	12/11/95	0.217	0.18	0.09619
Thorium 230					
	GW-169	12/13/95	0.321	0.26	0.2896
	GW-170	12/12/95	0.324	0.2	0.07982
Uranium 234					
	SCR7.1SP	12/13/95	0.552	0.29	0.2229
	GW-170	12/12/95	0.525	0.28	0.09477
	GW-172	12/11/95	0.427	0.3	0.329
	GW-230	12/13/95	0.3	0.22	0.1017
	GW-232	12/14/95	0.217	0.2	0.1177
Uranium 238					
	SCR7.1SP	12/13/95	0.509	0.27	0.0919

Notes:

1 Radium activity was converted from becquerels to picoCuries.

2 All sampling locations are in Union Valley, east of the ORR boundary. SCR7.1SP is a spring sampling location (see Figure 9).

3 Activity - reported in picoCuries per liter (pCi/L)
Error - counting error (two standard deviations)
MDA - minimum detectable activity

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List of Acronyms and Abbreviations

AAS	Atomic Absorption Spectroscopy
BQR	blank qualification result
CY	calendar year
DQO	data quality objective
GWPP	Groundwater Protection Program
ICP	Inductively Coupled Plasma (spectroscopy)
MCL	maximum contaminant level
MDA	minimum detectable activity
μg/L	micrograms per liter
mg/L	milligrams per liter
mrem/yr	millirem per year
pCi/L	picoCuries per liter
RPD	relative percent difference
TDS	total dissolved solids
TSS	total suspended solids
UTL	upper tolerance limit
VOC	volatile organic compound
1,1,1-TCA	1,1,1-trichloroethane

C.1 INTRODUCTION

Analysis and interpretation of the calendar year (CY) 1995 groundwater quality data were based on the standardized data screening and data evaluation process described in the following sections. Developed and refined over the past several years, this process has effectively reduced subjective interpretations of contamination in groundwater and surface water at the Y-12 Plant.

C.2 DATA SCREENING

Data screening refers to the process used to format the groundwater and surface water quality data for quantitative analysis, and exclude from analysis those results that do not meet data quality objectives (DQOs) of the Y-12 Groundwater Protection Program (GWPP). For both purposes, data screening assigns one of three surrogate values to applicable results: zero, the analytical reporting limit (or fraction of it), or a missing value (i.e., no analytical result). Screening criteria and associated surrogate values for each major group of analytical results are summarized in the following table.

Table C-1. Summary of Data Screening Criteria and Surrogate Value Designations.

Data Screening Criteria	Type of Surrogate Value: Zero (❑), Reporting Limit (▲), or Missing Value (●)				
	Principal Ions		Trace Metals	Organic Compounds	Radioanalytes
	Anions	Cations			
Less-than-Reporting-Limit Results	❑	❑	▲	❑	●
Original/Duplicate Sample Results	▲	▲	▲	●	.
Diluted Sample Results	❑	❑	❑	❑	.
Filtered/Unfiltered Sample Results	.	▲	▲	.	.
Ion Charge Balance	●	●	.	.	.
Analytical Methods	.	.	●	.	.
False Positive Results	.	.	.	❑	.
Counting Errors	.	.	.	.	●

The following sections provide details regarding the screening criteria and the selection of the respective surrogate values.

C.2.1 Less-than-Reporting-Limit Results

Less-than-reporting-limit results (i.e., censored data) for principal ions and volatile organic compounds (VOCs) were replaced with zero for the purposes of calculating ion charge balance errors (Section C.2.5), identifying false positive results for VOCs (Section C.2.7), and determining representative concentrations for monitoring station (Section C.3.1). To identify order-of-magnitude differences between results for original/duplicate samples (Section C.2.2) and filtered/unfiltered samples (Section C.2.4), censored data were replaced with zero (VOCs), or analytical reporting limits (principal ions and trace metals). Similarly, the median concentration of each trace metal (Section C.3.1) was calculated using half the analytical reporting limit as the surrogate value for censored by less-than-reporting limit results.

Missing values served as surrogates for radioanalyte results (i.e., gross alpha activity, gross beta activity, and radionuclide activity) that were less than the specified minimum detectable activity (MDA). The suite of MDAs, in picoCuries per liter (pCi/L), applicable to CY 1995 radiological results obtained for the purposes of the Y-12 Plant GWPP are summarized below.

Table C-2. Radioanalyte MDAs for Y-12 Plant GWPP Monitoring Purposes.

Radioanalyte	MDA (pCi/L)	Radioanalyte	MDA (pCi/L)
Americium-241	17	Ruthenium-106	26
Cesium-137	3.9	Strontium (Total)	33
Iodine-129	35	Technetium-99	110
Iodine-131	35	Thorium-234	250
Neptunium-237	52	Tritium (Total)	950
Plutonium-238	84	Uranium-234	55
Plutonium-239	52	Uranium-235	14
Potassium-40	190	Uranium-238	22
Protactinium-234m	700	Gross Alpha	4.7
Radium	1.5	Gross Beta	11

These MDAs universally apply to radiological analyses for each groundwater sample collected during the first three quarters of CY 1995. Beginning in October 1995, sample-specific MDAs were reported for each radioanalyte. The sample-specific MDAs were typically lower than those listed above.

C.2.2 Original/Duplicate Sample Results

As noted in Section 3.3 of the report, duplicate groundwater samples were collected from 25 monitoring wells. Data for the original/duplicate samples from each well were compared to identify order-of-magnitude differences between corresponding analytical results. Such differences occurred between original/duplicate results, in milligrams per liter (mg/L), for the samples listed in the following summary (these results were replaced with missing values).

Table C-3. Screened Results for Original/Duplicate Groundwater Samples.

Well Number	Date Sampled	Analyte	Original Sample (mg/L)	Duplicate Sample (mg/L)
GW-232	06/16/95	Iron	0.005	0.052
GW-255	05/17/95	Sulfate	< 1	13
GW-764	11/13/95	Aluminum	0.94	21
GW-764	11/13/95	Iron	1.8	30
GW-764	11/13/95	Total Suspended Solids (TSS)	48	489
GW-764	11/13/95	Turbidity	19	200

C.2.3 Diluted Sample Results

Groundwater samples collected from the monitoring wells listed below were diluted in the laboratory prior to analyses for the specified inorganic or organic analytes.

Table C-4. Groundwater Samples Diluted for Analytical Purposes.

Well Number	Date Sampled	Well Number	Date Sampled	Well Number	Date Sampled
Inorganic Analytes					
GW-108	06/28/95	GW-199	05/08/95	GW-274	10/30/95
GW-109	06/29/95	GW-207	09/07/95	GW-275	10/30/95
Organic Analyses					
GW-109	06/29/95	GW-381	03/06/95	GW-620	02/28/95
GW-151	02/28/95	GW-381	05/27/95	GW-620	05/30/95
GW-151	05/24/95	GW-382	03/02/95	GW-620	09/15/95
GW-151	08/29/95	GW-382	05/26/95	GW-620	12/07/95
GW-220	08/29/95	GW-383	05/25/95	GW-762	02/20/95
GW-220	11/30/95	GW-383	08/29/95	GW-762	05/17/95

Table C-4 (cont'd)

Well Number	Date Sampled	Well Number	Date Sampled	Well Number	Date Sampled
Organic Analyses					
GW-223	02/23/95	GW-383	05/25/95	GW-762	05/17/95
GW-223	05/22/95	GW-383	08/29/95	GW-782	03/08/95
GW-223	08/23/95	GW-383	12/05/95	GW-782	11/30/95
GW-223	11/28/95	GW-605	12/12/95	GW-791	03/06/95
GW-337	03/02/95	GW-606	03/13/95	GW-791	06/05/95
GW-337	05/30/95	GW-606	12/12/95	GW-791	11/29/95

Because the reporting limits for these samples were much higher than those for undiluted samples, censored data for these samples were replaced with zero.

C.2.4 Filtered/Unfiltered Sample Results

Filtered and unfiltered groundwater samples were analyzed for the principal cations (calcium, magnesium, potassium, and sodium) and trace metals. If the dissolved (filtered) cation or trace metal concentration exceeded the corresponding total (unfiltered) concentration by an order-of-magnitude or more, both results were replaced with missing values. As shown below in Table C-5, such differences occurred between the filtered/unfiltered results reported for samples from eight monitoring wells.

Table C-5. Screened Results for Filtered/Unfiltered Groundwater Samples.

Sampling Location	Date Sampled	Analyte	Unfiltered Sample (mg/L)	Filtered Sample (mg/L)
GW-232	06/16/95	Iron	< 0.005	0.083
GW-619	02/28/95	Manganese	0.0014	0.051
GW-619	12/07/95	Manganese	0.0012	0.014
GW-750	03/11/95	Zinc	0.0064	0.07
GW-752	01/25/95	Boron	0.0096	0.12
GW-759	11/14/95	Zinc	0.015	0.16
GW-774	01/20/95	Boron	0.019	0.28
GW-781	03/06/95	Zinc	0.011	0.13
GW-785	05/31/95	Boron	0.015	0.15

C.2.5 Ion Charge Balance

The calculated ion charge balance was used to screen the principal ion data. Charge balances were estimated by computing the relative percent difference (RPD) between summed milliequivalent concentrations (i.e., molecular weight of the ion divided by the net ionic charge) of the dissolved cations (which exclude digested cations), and the total anions, respectively. If the summed milliequivalent concentrations of the cations and anions differed by 10% or more, all the principal ion data were replaced with missing values. As summarized below in Table C-6, ion charge balance RPDs greater than 10% were calculated from the principal ion data for 25 groundwater samples collected from 12 monitoring wells.

Table C-6. Groundwater Samples with Unacceptable Charge Balance Errors.

Well Number	Date Sampled	Charge Balance RPD	Comments
GW-109	06/29/95	-63%	Very high nitrate (39,000 mg/L)
GW-169	09/28/95	12%	Turbid sample (TSS=4,720 mg/L)
GW-230	03/15/95	14%	Low Chloride (33 mg/L vs. 81mg/L Avg.)
GW-251	02/27/95	32%	Low nitrate (<0.2)
GW-251	05/25/95	-10%	High nitrate (76 mg/L)
GW-251	12/07/95	-14%	High nitrate (64 mg/L)
GW-252	02/14/95	34%	Low bicarbonate alkalinity (60 mg/L)
GW-252	05/17/95	-58%	High bicarbonate alkalinity (161mg/L)
GW-619	02/28/95	39%	Carbonate alkalinity 8-42 mg/L; pH 8.4-10.7
GW-619	05/30/95	34%	"
GW-619	09/13/95	42%	"
GW-619	12/07/95	32%	"
GW-620	02/28/95	27%	Bicarb (70 mg/L), Carb. (<1 mg/L); pH 9
GW-620	05/30/95	-12%	Bicarb(<1mg/L), Carb(24 mg/L); pH 11.6
GW-620	12/07/95	-16%	Bicarb(138mg/L),Carb.(<1 mg/L); pH 8.1
GW-746	05/09/95	19%	High Calcium & Magnesium
GW-767	05/11/95	-16%	High Chloride (15 mg/L)
GW-767	11/18/95	-11%	Low Cations
GW-772	02/15/95	-20%	Iron (33-39 mg/L); Mn (12-13 mg/L)
GW-772	05/17/95	-26%	"
GW-772	08/05/95	-17%	"
GW-772	11/13/95	-22%	"
GW-785	02/22/95	-41%	Iron (26-29 mg/L)
GW-785	05/31/95	-30%	"
GW-787	11/27/95	-31%	High bicarbonate alkalinity (25 mg/L)

The charge balance errors for these samples reflect: potential analytical or data transcription errors (GW-230, GW-252, GW-746, GW-767, GW-787); the effects of inorganic contaminants (GW-109, GW-251, GW-772, GW-785,); localized grout contamination (GW-619, GW-620); or highly turbid samples (GW-169).

C.2.6 Analytical Methods

Four spectroscopic analytical methods were used to determine concentrations of inorganic analytes: (1) Inductively Coupled Plasma (ICP) spectroscopy for aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, nickel, potassium, selenium, silver, sodium, strontium, thorium, vanadium, and zinc; (2) Cold Vapor Atomic Absorption spectroscopy for mercury; (3) ICP/mass spectroscopy for uranium (total); and (4) Atomic Absorption Spectroscopy (AAS) for cadmium, chromium, and lead. If required for the Y-12 Plant GWPP, the AAS data for cadmium, chromium, and lead were used for quantitative calculations instead of the ICP data, otherwise the ICP results for these metals were used.

C.2.7 False Positive Results

Laboratory blank and trip blank data associated with each groundwater sample were used to identify false positive VOC results (i.e., sampling and/or analytical artifacts). False positive VOC results were defined as concentrations reported for the groundwater samples that were less than the blank qualification result (BQR) for each compound. For each VOC detected in a groundwater water sample, the highest concentration in either associated blank sample was multiplied by a factor of five or ten and used as the BQR. A factor of five was used for all VOCs except acetone, methylene chloride, toluene, and 2-butanone; BQRs for these common laboratory reagents were calculated using a factor of ten (U.S. Environmental Protection Agency 1988). Zero served as the surrogate value for false positive VOC results.

As summarized below in Table C-7, the CY 1995 data included a total of 62 false positive results for eight VOCs.

Table C-7. Summary of False Positive Results for VOCs.

Compound	Number of False Positive Results Identified from:	
	Laboratory BQRs	Trip BQRs
Laboratory Reagents		
Acetone	10	7
2-Butanone	5	8
Methylene chloride	6	3
Toluene	7	0
Plume Constituents		
1,1,1-Trichloroethane	0	9
Tetrachloroethene	3	0
1,2-Dichloroethene	0	1
Miscellaneous		
Xylenes	3	0
Total	**34**	**28**

Most of these false positive results were estimated concentrations below respective reporting limits for each compound; the maximum false positive result was 46 micrograms per liter (μg/L) for acetone. The false positive results for 1,1,1-trichloroethane (1,1,1-TCA) probably reflect actual contaminant concentrations (1 to 15 μg/L) in the nine groundwater samples from four monitoring wells (GW-769, GW-781, GW-782, and GW-783), but were identified as false positives because of 1,1,1-TCA contamination in the deionized water used for trip blank samples throughout the year (see discussion in Section 3.5 of the report).

C.2.8 Counting Errors

The degree of analytical uncertainty associated with each gross alpha, gross beta, and radionuclide result is expressed by the corresponding counting error (defined as twice the sample standard deviation). Groundwater and surface water samples with gross alpha, gross beta, and/or radionuclide activities that exceeded the respective MDAs, but were less than the associated counting errors, are listed below in Table C-8.

Table C-8. Screened Results for Radioanalytes.

Radioanalyte	Well Number	Date Sampled	Activity ± Counting Error (pCi/L)
Gross Alpha	GW-108	06/28/95	28.6 ± 88
	GW-191	09/11/95	5.34 ± 18
	GW-192	09/12/95	16.9 ± 20
	GW-195	09/12/95	11.7 ± 19
	GW-338	09/12/95	7.77 ± 18
Gross Beta	GW-195	09/12/95	25.1 ± 36
Technetium-99	SCR7.1SP	12/13/95	16 ± 31
Thorium-230	GW-230	12/13/95	0.138 ± 0.16
	GW-232	12/14/95	0.159 ± 0.21
Uranium-235	GW-172	06/13/95	35 ± 47
Uranium-238	GW-169	12/13/95	0.136 ± 0.14
	GW-172	12/11/95	0.121 ± 0.14
	GW-232	12/14/95	0.13 ± 0.15

Most of these results are associated with samples collected on September 11 and 12 (gross activity), or during the fourth quarter sampling event, when lower sample-specific MDAs were obtained. These results were replaced with missing values.

C.3 DATA EVALUATION

Data evaluation refers to the process used to identify CY 1995 monitoring results that potentially reflect potential groundwater or surface water contamination. As described in the following sections, this process involved: calculating the representative concentration/activity of the inorganics, VOCs, and radioanalytes for each monitoring station; comparing the representative concentration/activity values to designated water-quality standards; and reviewing screened historical data for each applicable analyte and monitoring station to corroborate representative values that exceed the specified water quality standards.

C.3.1 Representative Concentration/Activity Values

Representative concentration/activity values for each monitoring well were: (1) results for annual samples, or (2) calculated from as many as four quarterly results depending on the number of samples collected and the outcome of the data screening process. Results for annual samples were the assumed representative values for the four monitoring wells and one spring that were sampled only once during CY 1995 (see Table 2 in Appendix B). Singular results also were assumed to be representative values if data screening replaced all other results for the analyte with missing values. Also, field data (e.g., depth-to-water) and other selected parameters (e.g., turbidity) were evaluated individually regardless of the number of available results. For sampling locations with multiple CY 1995 results, representative concentration/activity values for inorganics (principal ions and trace metals), VOCs, and radioanalytes (gross alpha, gross beta, and radionuclides) were calculated as specified below, using the designated surrogate values for censored and screened data.

Table C-9. Methods Used to Calculate Representative Concentration/Activity Values.

Analyte	Representative Value	Censored Data	Screened Data
Principal Ions	Annual average concentration.	Zero	Missing Values
Trace Metals	Annual median concentration.	½ Reporting Limits	Missing Values
VOCs	Annual average concentration.	Zero	Zero
Radioactivity	Annual average activity. Individual/summed dose equivalents.	Missing Values	Missing Values

Note that annual average concentrations/activities for principal ions, VOCs, and radioanalytes were used as representative values, but annual median concentrations were used for trace metals. This approach ensured comparability with the upper tolerance limits (UTLs) used as water quality standards for many of the trace metals. Additionally, average counting errors (in pCi/L) associated with each representative radioanalyte activity were calculated using the following formula:

$$e = \sqrt{\frac{E_1^2}{n^2} + \frac{E_2^2}{n^2} \ldots}$$

where $\mathbf{E}_1$, $\mathbf{E}_2$,... are the individual errors reported for each sample, and **n** is the number of samples (Evans 1955). Where applicable, dose equivalents were calculated using representative values for radionuclides, and corresponding dose factors issued by the U.S. Environmental Protection Agency (Federal Register, Vol. 56, No. 138, July 18, 1991). Individual dose equivalents for the radionuclides were summed to determine the cumulative dose for each applicable monitoring well.

C.3.2 Water Quality Standards

Two types of water quality standards were used for comparison to the representative concentration/activity values for each applicable monitoring well: statistically derived UTLs assumed to reflect uncontaminated groundwater concentrations at the Y-12 Plant, or federal maximum contaminant levels (MCLs) for drinking water.

The UTLs presented in HSW Environmental Consultants, Inc. et al. (1996) were used as the water quality standards for aluminum, antimony, boron, cobalt, copper, iron, manganese, molybdenum, strontium, thorium, uranium, vanadium, and zinc. Each UTL was statistically derived from median concentrations calculated from the groundwater quality data for over 400 monitoring wells at the Y-12 Plant. Based on analysis of the principal sources of geochemical variability, the data for these wells were classified into ten distinct groups (i.e., clusters) which, as summarized below, include six clusters of wells that monitor uncontaminated groundwater, and four clusters of wells that monitor contaminated groundwater.

Table C-10. Summary of UTL Well Cluster Characteristics.

Cluster No.	Description
1	Shallow groundwater with variable calcium-magnesium-bicarbonate geochemistry.
2	Shallow calcium-magnesium-bicarbonate groundwater with very low total dissolved solids (TDS).
3	Shallow groundwater with fairly uniform calcium-magnesium-bicarbonate geochemistry.
4	Calcium-magnesium bicarbonate groundwater with equal or nearly equal proportions of calcium and magnesium.
5	Shallow calcium-magnesium bicarbonate groundwater with nitrate and other inorganic contaminants.
6	Intermediate depth sodium-bicarbonate groundwater.
7	Nitrate-contaminated groundwater.
8	Nitrate-contaminated groundwater.
9	Nitrate-contaminated groundwater.
10	Deep, sodium-chloride bicarbonate groundwater with very high TDS.

Only data for wells assigned to Clusters 1, 2, 3, 4, 6, and 10 were used to calculate the UTLs; those applicable to the wells that comprise these clusters are summarized below.

Table C-11. UTLs Used as Water Quality Standards.

Trace Metal	Upper Tolerance Limit (mg/L)					
	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 6	Cluster 10
Aluminum	2.4	6.1	2.4	2.4	2.4	2.4
Antimony	0.05	0.05	0.05	0.05	0.05	0.05
Boron	0.12	0.028	0.041	0.028	3.1	3.1
Cobalt	0.019	0.019	0.019	0.019	0.019	0.019
Copper	0.012	0.012	0.012	0.012	0.012	0.012
Iron	8.7	8.7	8.7	4.6	11	6.9
Manganese	1.7	1.7	1.7	0.13	1.7	0.13
Molybdenum	0.018	0.018	0.018	0.018	0.018	0.018
Strontium	4.4	0.079	0.92	0.079	0.92	0.92
Thorium	0.2	0.2	0.2	0.2	0.2	0.2
Uranium	0.012	0.004	0.005	0.005	0.004	0.005
Vanadium	0.005	0.005	0.005	0.005	0.005	0.005
Zinc	0.041	0.043	0.041	0.041	0.041	0.040

Because they monitor contaminated groundwater, data for wells that comprise clusters 5, 7, 8, and 9 were excluded from the UTL calculations. Wells that comprise these clusters were assigned one of the above values as "surrogate" UTLs based on selected well construction information and water quality data (HSW Environmental Consultants, Inc. et al. 1996).

Federal MCLs adopted by the Tennessee Department of Environment and Conservation were used as water quality standards for the inorganics, organics, and radioanalytes listed below.

Table C-12. MCLs Used as Water Quality Standards.

Inorganics (mg/L)				VOCs (µg/L)		Radioanalytes	
Arsenic	0.05	Lead	0.05	Carbon Tetrachloride	5	Gross Alpha Activity	15 pCi/L
Beryllium	0.004	Mercury	0.002	1,1-dichloroethene	7	Gross Beta Activity	4 mrem/yr
Barium	2.0	Nickel	0.1	Methylene Chloride	5	Radium 226 + 228	5 pCi/L
Cadmium	0.005	Nitrate (as N)	10	Tetrachloroethene	5		
Chromium	0.1	Selenium	0.05	1,1,1-trichloroethene	200		
Fluoride	4	Silver	0.05	Trichloroethene	5		
				Vinyl Chloride	2		

Although MCLs have been adopted for the above listed VOCs, and results that exceed the MCLs were noted, evaluation of groundwater quality with respect to these compounds was based on representative concentrations that exceeded zero. Also, the four millirem per year (mrem/yr) dose equivalent MCL for gross beta activity applied only if samples were analyzed for radionuclides; otherwise, the Safe Drinking Water Act screening level (50 pCi/L) was used as the water quality standard for gross beta activity.

C.3.3 Data Corroboration

Representative VOC and trace metal concentrations that exceeded water quality standards were corroborated through review of historical data for each applicable monitoring well. Historical corroboration focused on VOC results and elevated trace metal concentrations because of the characteristic variability of the data for these analytes. Principal ion data are typically less variable and the ion charge balance criteria effectively screens spurious data; thus, historical comparisons were not performed. Because current DQOs render the bulk of the historical radioanalyte data unsuitable for corroboration purposes, historical comparisons also were not performed for the CY 1995 radioanalyte results.

Frequency-based criteria were used to identify anomalous VOC and trace metal results in the CY 1995 data: the detection frequency for VOCs (determined from the screened data for samples collected since CY 1991), and the frequency of elevated total metal concentrations (determined from screened data for samples collected since CY 1990). Anomalous results were defined as VOC or elevated total metal concentrations detected in 25% or less of the samples from each monitoring well. Depending on the location of the well relative to known or suspected sources of contamination in the East Fork Regime, anomalous results were either replaced with zero (VOCs) or missing values (trace metals), or accepted as qualitative data.

As shown in the following summary, the CY 1995 data included a total of 49 anomalous results reported for common laboratory reagents (e.g., 2-butanone), compounds that are primary components (e.g., trichloroethene) or associated degradation products (e.g., 1,1-dichloroethene) of dissolved VOC plumes in shallow groundwater in the East Fork Regime, and compounds that are neither laboratory reagents nor known plume constituents (e.g., bromomethane).

Table C-13. Anomalous Results for VOCs.

Compound	Sampling Point	Date Sampled	Anomalous Result (µg/L)
Laboratory Reagents			
Acetone	GW-149	05/18/95	2
	GW-170	12/12/95	23
	GW-604	03/11/95	12
	GW-733	09/27/95	6
	GW-816	06/14/95	5
2-Butanone	GW-191	12/04/95	10
	GW-251	12/07/95	9
	GW-263	02/13/95	9
	GW-380	05/23/95	10
	GW-604	09/09/95	10
	GW-604	12/08/95	10
	GW-733	09/27/95	9
	GW-745	11/18/95	15
	GW-746	11/18/95	14
	GW-747	11/18/95	13
	GW-758	02/18/95	7
	GW-772	08/05/95	8
	GW-783	08/23/95	10
	GW-788	06/01/95	9
	GW-792	08/21/95	9
Methylene Chloride	GW-207	06/12/95	4
Plume Constituents			
Chloroform	GW-380	05/23/95	1*
	GW-380	11/30/95	1*
	GW-775	05/15/95	1
	GW-789	08/14/95	1*
	GW-789	11/28/95	1*
1,1-Dichloroethene	GW-192	12/05/95	1
1,2-Dichloroethane	GW-764	11/13/95	4
	GW-771	08/05/95	4
1,2-Dichloroethene	GW-220	02/27/95	2
	GW-769	02/20/95	2
	GW-769	11/15/95	4
Tetrachloroethene	GW-148	02/22/95	4
	GW-240	08/24/95	1
	GW-240	11/30/95	1
	GW-380	05/23/95	3*
	GW-380	11/30/95	1*
	GW-770	11/15/95	1
Trichloroethene	GW-148	02/22/95	1
	GW-789	06/01/95	1*
	GW-789	08/14/95	1*
Vinyl chloride	GW-222	08/23/95	1
	GW-605	09/27/95	2
Miscellaneous Compounds			
Bromomethane	GW-763	05/18/95	9

Most of the above anomalous VOC results were considered probable sampling or analytical artifacts and have no effect on plume delineation; thus, they were replaced with zero as a surrogate value. The results flagged with an asterisk are for samples from wells near the downgradient boundaries of dissolved VOC plumes that contain these constituents. Because these results potentially indicate plume migration, these anomalous VOC results were not replaced with zero.

Sporadically elevated concentrations (i.e., anomalous results) are characteristic of the trace metal data for most wells at the Y-12 Plant. Few of these erratically fluctuating results display any clear spacial patterns or temporal relationships (although required monitoring protocols and sampling procedures may not generate data needed to recognize and characterize such relationships). Data obtained during CY 1995 reflect similar variability, and as summarized below in Table C-14, include a total of 18 anomalous trace metal results reported for 13 unfiltered samples collected from nine groundwater monitoring wells and one surface water station (LRSPW).

Table C-14. Anomalous Results for Trace Metals

Trace Metal	Date Sampled	Result (mg/L)	Trace Metal	Date Sampled	Result (mg/L)
Boron			Lead		
GW-207	03/08/95	0.15	GW-778	05/18/95	0.1
GW-207	09/07/95	0.13	Manganese		
GW-381	05/27/95	0.23	GW-778	05/18/95	3.8
Cobalt			Selenium		
GW-778	05/18/95	0.049	GW-251	09/13/95	0.079
Copper			LRSPW	09/22/95	0.1
GW-199	05/08/95	0.29	Vanadium		
GW-199	11/16/95	0.023	GW-263	05/16/95	0.0087
GW-261	02/02/95	0.04	Zinc		
GW-262	02/02/95	0.024	GW-255	02/14/95	0.098
Iron			GW-778	05/18/95	0.15
GW-251	09/13/95	13			
GW-263	02/13/95	0.85			
GW-778	05/18/95	79			

Many of these anomalous trace metal results reflect biased total concentrations caused by preservation of turbid groundwater samples: for instance, five anomalous results were identified in the sample collected in May from well GW-778, which had TSS above 1,200 mg/L. Other anomalous results, such as those for wells GW-251, GW-255, GW-261, GW-262, and GW-263, which are upgradient of potential sources of trace metal contamination, are probably analytical or data transcription errors. None of these anomalous trace metal concentrations are potentially indicative of groundwater contamination.

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