Y-12

OAK RIDGE
Y-12
PLANT

MARTIN MARIETTA

RE
DEC 2 8 1995
OSTI

Y/SUB/95-EAQ10C/2/P2

CALENDAR YEAR 1994 GROUNDWATER QUALITY REPORT FOR THE UPPER EAST FORK POPLAR CREEK HYDROGEOLOGIC REGIME Y-12 PLANT, OAK RIDGE, TENNESSEE

1994 Groundwater Quality Data Interpretations and Proposed Program Modifications

October 1995

Prepared by:

HSW ENVIRONMENTAL CONSULTANTS, INC.
Under Purchase Order 70Y-EAQ10C

for the

Environmental Management Department
Health, Safety, Environment, and Accountability Organization
Oak Ridge Y-12 Plant
Oak Ridge, Tennessee 37831

Managed by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under contract
DE-AC05-84OR21400

MANAGED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED dlc

Y/SUB/95-EAQ10C/2/P2

CALENDAR YEAR 1994 GROUNDWATER QUALITY REPORT FOR THE UPPER EAST FORK POPLAR CREEK HYDROGEOLOGIC REGIME Y-12 PLANT, OAK RIDGE, TENNESSEE

1994 Groundwater Quality Data Interpretations and Proposed Program Modifications

October 1995

Prepared by

HSW ENVIRONMENTAL CONSULTANTS, INC.
Under Purchase Order 70Y-EAQ10C

for the

Environmental Management Department
Health, Safety, Environment, and Accountability Organization
Oak Ridge Y-12 Plant
Oak Ridge, Tennessee 37831

Managed by

LOCKHEED MARTIN ENERGY SYSTEMS, INC.
for the U.S. Department of Energy
Under Contract No. DE-AC05-84OR21400

Dlc

TABLE OF CONTENTS

TABLE OF CONTENTS (cont'd)

TABLE OF CONTENTS (cont'd)

APPENDICES

LIST OF FIGURES

LIST OF FIGURES (cont'd)

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

AAS	Atomic Absorption Spectroscopy
ASO	Analytical Services Organization
BCV	Bear Creek Valley
bgs	below ground surface
BTEX	Benzene, toluene, ethylbenzene, and xylenes
BQR	Blank Qualification Result
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMP	Comprehensive Monitoring Plan
CY	Calendar Year
DOE	U.S. Department of Energy
DQO	data quality objectives
Energy Systems	Lockheed Martin Energy Systems, Inc.
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
ft	feet
ft/d	feet per day
ft^2/d	feet squared per day
gpm	gallons per minute
GWPP	Groundwater Protection Program
GWQR	Groundwater Quality Report
HSEA	Health, Safety, Environment, and Accountability (Organization)
HSWA	Hazardous and Solid Waste Amendment
ICP	Inductively Coupled Plasma (spectroscopy)
K-25	Oak Ridge K-25 Site
MCL	Maximum Contaminant Level
MDA	minimum detectable activity
MDL	method detection limit
μg/L	micrograms per liter
mg/L	milligrams per liter
msl	Mean Sea Level
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OU	Operable Unit
PCE	Tetrachloroethene
pCi/L	picocuries per liter
PCPA	Post-Closure Permit Application
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study

LIST OF ACRONYMS AND ABBREVIATIONS (cont'd)

RPD	relative percent difference
SESD	Sampling and Environmental Support Department
SWMU	Solid Waste Management Unit (RCRA)
TCE	Trichloroethene
TDEC	Tennessee Department of Environment and Conservation
TDS	total dissolved solids
TSD	Treatment, Storage, and Disposal (unit)
TSS	total suspended solids
UEFPC	Upper East Fork Poplar Creek
UST	Underground Storage Tank
UTL	upper tolerance limits
VOC	Volatile Organic Compound
1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethene
1,2-DCE	1,2-dichloroethene
1,2-DCP	1,2-dichloropropane
1,1,1-TCA	1,1,1-trichloroethane
1,1,2,2-TCA	1,1,2,2,-tetrachloroethane

1.0 INTRODUCTION

This groundwater quality report (GWQR) contains an evaluation of the groundwater quality data obtained during the 1994 calendar year (CY) at several waste-management facilities and a petroleum fuel underground storage tank (UST) site at 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 1994 Part 1 GWQR for the East Fork Regime to the TDEC in February 1995 (HSW Environmental Consultants, Inc. 1995a). Part 2 (this report) contains an evaluation of the data with respect to regime-wide groundwater quality, summarizes the status and findings of ongoing hydrogeologic studies, describes changes in monitoring priorities, and presents planned modifications to the groundwater sampling and analysis activities.

2.0 BACKGROUND INFORMATION

The East Fork Regime encompasses a portion of Bear Creek Valley (BCV) between a surface water and shallow groundwater divide located near the west end of the Y-12 Plant and the ORR boundary along Scarboro Road east of the plant (unless otherwise noted, all directions in this report are in reference to the Y-12 Plant grid system). 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 local topographic feature is a gap in Pine Ridge cut by UEFPC northeast of the Y-12 Plant. The Y-12 Plant operations and support facilities and structures occupy most of the East Fork Regime. A commercial industrial park lies in Union Valley east of the Y-12 Plant across Scarboro Road.

For the purposes of this report, the East Fork Regime is divided into three general areas: (1) the Western Plant Area, defined as the portion of the East Fork Regime west of the Y-12 Plant grid easting 55,000, (2) the Central Plant Area, defined as the part of the regime between grid eastings 55,000 and 62,000, and (3) the Eastern Plant Area, defined as the portion of the regime east of grid easting 62,000 (Figure 3).

2.1 Regulatory Framework

In 1984, the U.S. Environmental Protection Agency (EPA) and the TDEC determined that several of the waste management sites at the Y-12 Plant were hazardous waste treatment, storage, and disposal (TSD) units subject to regulation under RCRA. One of these TSD units, New Hope Pond, is located within the Eastern Plant Area and was granted RCRA interim status in CY 1986. Between CYs 1987 and 1989, several waste managements sites in the regime were identified as solid waste management units (SWMUs) subject to regulation under section 3004(u) of RCRA. A RCRA Facility Investigation, as required under the Hazardous and Solid Waste Amendment (HSWA) permit issued for the ORR by the EPA in CY 1986, was planned for these sites to determine if contaminant releases to the environment had occurred.

In November 1989, the ORR was added to the National Priority List and in January 1992, the DOE, the EPA, and the TDEC negotiated a Federal Facility Agreement (FFA) regarding environmental restoration at the ORR under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Although this agreement superseded the HSWA permit and changed the regulatory status of RCRA-regulated TSD units and SWMUs to CERCLA operable units (OUs), the TDEC did not waive the RCRA permitting, post-closure care, corrective action, and groundwater monitoring requirements applicable to some of these sites. The DOE appeal of this regulatory interpretation was formally resolved with an Agreed Order signed in April 1993 by DOE, the TDEC, and Energy Systems regarding a RCRA post-closure permit for the S-3 Site, a RCRA TSD unit/CERCLA OU located in the Bear Creek Hydrogeologic Regime (Bear Creek Regime) west of the Y-12 Plant. The Agreed Order allowed DOE to proceed with CERCLA as the lead regulatory program, with RCRA applied as an appropriate, relevant, and applicable requirement to the extent that post-closure maintenance and care of former TSD facilities will comply with the terms of RCRA post-closure permits. Groundwater monitoring is to be integrated with the CERCLA remedial investigation/feasibility study (RI/FS), and data reporting will comply with RCRA post-closure permit conditions as well as RI/FS requirements.

Efforts were initiated early in CY 1994 by DOE and Energy Systems to modify the FFA strategy for RI/FS implementation. The FFA defined two types of CERCLA OUs for which an RI/FS would be performed: (1) source control OUs comprised of individual or groups of waste-management sites, and (2) integrator OUs that encompass groundwater and surface water, independent of the source control OUs that may contribute to the contamination of these media. However, as the RIs for OUs within the Bear Creek Regime progressed, it became increasingly evident that separation of source control and integrator OUs was not the most technically feasible approach to implementation of the RI/FS process. An agreement was reached among regulatory agencies and the DOE to proceed with an integrated RI/FS approach whereby source and integrator OUs are addressed concurrently, and specific sites or locations of highest risk or concern are targeted for focused studies. An integrated RI/FS strategy also will be implemented for the East Fork Regime.

2.2 Site Descriptions

Groundwater quality monitoring in the East Fork Regime during CY 1994 was performed at: (1) sites comprising the CERCLA OUs defined in the FFA, (2) lower priority sites designated as Y-12 Study Areas, and (3) a petroleum UST site (Table 1). Locations of these sites are shown in Figure 3. General descriptions of each type of site are provided in the following sections. More detailed site descriptions and discussions of the regulatory status and groundwater monitoring history of each site are included in Section 2.0 of the Part 1 GWQR.

2.2.1 CERCLA Operable Units

The FFA established three source control OUs that lie within the East Fork Regime (Table 1): the Abandoned Nitric Acid Pipeline (formerly used to transport acidic wastes to the S-3 Site); several Mercury Process Spill Areas where large amounts of mercury were routinely handled; and a group of former RCRA-regulated SWMUs (several within the Y-12 Plant Salvage Yard, Tank 2063-U, the S-2 Site, and the Waste Coolant Processing Area) (Figure 3). Detailed descriptions and operational histories of these sites are provided in Section 2.0 of the Part 1 GWQR. Groundwater in the regime and surface water in UEFPC within the boundaries of the ORR comprise the integrator OU defined in the FFA for the East Fork Regime.

2.2.2 Y-12 Study Areas

Several sites that were not included in the source control OUs were designated in the FFA as Y-12 Study Areas (Table 1). These sites represent lower priority units that will be investigated under preliminary assessments/site investigations (U.S. Department of Energy 1994). Included are New Hope Pond (a closed RCRA TSD unit), and four formerly RCRA-regulated SWMUs: Tank 2328-U, Tank 2329-U, the Interim Drum Yard, and the Beta-4 Security Pits (Figure 3). New OUs or additions to established OUs may be necessary if results of further investigations at these sites indicate that a complete RI/FS is warranted.

2.2.3 Petroleum USTs

The Y-12 Plant GWPP performed long-term monitoring at four UST sites (Figure 3) through CY 1993. During CY 1994, monitoring for UST program purposes was performed only at the Rust Garage Facility (Table 1); however, monitoring at this site was discontinued after the first quarter in response to new guidance issued by the TDEC Division of USTs.

3.0 CY 1994 GROUNDWATER AND SURFACE WATER SAMPLING PROGRAM

The following sections describe the groundwater and surface water sampling activities performed during CY 1994 in the East Fork Regime under the lead of the Y-12 Plant GWPP. Included are brief descriptions of the monitoring programs for which the sampling was performed, detailed descriptions regarding the sampling (locations, frequency, and procedures), analytical parameters, and results of quality assurance/quality control (QA/QC) sampling.

3.1 Sampling Locations

A total of 99 monitoring wells and two surface water locations were sampled during CY 1994 (Figure 4 and Table 2). Monitoring wells were sampled to meet goals of the following monitoring programs:

- RCRA interim status assessment monitoring;
- best-management practice monitoring;
- DOE Order 5400.1 surveillance (grid well) monitoring; and
- DOE Order 5400.1 exit-pathway and perimeter monitoring.

Data regarding the monitored interval for each well are summarized in Table 3; detailed well construction information is contained in Appendix C of the Part 1 GWQR.

3.1.1 RCRA Interim Status Assessment Monitoring

Nine monitoring wells were used for RCRA interim status assessment monitoring at New Hope Pond (Figure 4 and Table 2). Upon TDEC approval of a RCRA post-closure permit for the site (expected in August 1996), interim status assessment monitoring will be replaced with either RCRA detection or corrective action monitoring; the RCRA post-closure permit application (PCPA) submitted to the TDEC in late February 1995 proposed a detection monitoring program (Geraghty & Miller, Inc. 1995).

3.1.2 Best-Management Practice Monitoring

Groundwater samples were collected from six monitoring wells near New Hope Pond as a best-management practice of the Y-12 Plant GWPP (Figure 4 and Table 2). These wells had not been sampled for several years and were added to the best-management practice monitoring program in CY 1994 to provide updated groundwater quality data needed for the RCRA PCPA for the site. Wells GW-148 and GW-149 were proposed for inclusion in the RCRA post-closure detection monitoring program.

3.1.3 Exit Pathway Monitoring

The exit pathway monitoring program consists of groundwater and surface water sampling where contamination is most likely to be transported beyond the ORR boundaries. Such monitoring is performed to comply with DOE revised Order 5400.1 requirements for protecting groundwater that is or could be affected by operations at DOE facilities. Exit pathway monitoring during CY 1994 included 21 sampling points: (1) 15 wells completed in the Maynardville Limestone (the principal subsurface migration pathway), six of which are located in Union Valley east of the ORR boundary, (2) four wells near UEFPC where it passes through the gap in Pine Ridge northeast of the Y-12 Plant, and (3) two surface water sampling stations located near Lake Reality (Figure 4 and Table 2).

3.1.4 Grid Well Monitoring

Phased installation of wells in a grid pattern was recommended in the *Comprehensive Groundwater Monitoring Plan for the Department of Energy Y-12 Plant* (Comprehensive Monitoring Plan; Geraghty & Miller, 1990) to efficiently determine the extent of groundwater contamination in the East Fork Regime. Surveillance monitoring, as defined in DOE Order

5400.1, drives the installation and sampling of these wells. Fifty-nine grid network wells were sampled during CY 1994 (Figure 4 and Table 2), including wells installed in the Central Plant Area during CY 1993 and first sampled in CY 1994.

3.1.5 UST Monitoring

Groundwater monitoring at petroleum USTs included six wells located near the Rust Garage Area (Figure 4 and Table 2); however, because monitoring objectives were achieved, sampling of these wells as part of the Y-12 Plant GWPP was discontinued after the first quarter of CY 1994.

3.2 Sampling Frequency

Groundwater samples were collected during each quarter of CY 1994. First through fourth quarter sampling events were performed January 14 to March 3, April 22 to June 16, July 29 to September 28, and October 25 to December 27, respectively. As shown in Table 2 and summarized below, the number of wells included in each quarterly sampling event varied depending on the requirements or status of the monitoring programs. For example, nine wells were sampled each quarter for RCRA assessment monitoring purposes, but the addition of new wells increased the grid well monitoring program after the first quarter of the year.

Monitoring Program	**Number of Sampling Points**			
	1st Qtr.	**2nd Qtr**	**3rd Qtr.**	**4th Qtr**
RCRA Interim Status Assessment Monitoring	9	9	9	9
Grid Well Monitoring	37	58	59	59
Best Management Practice Monitoring	.	.	.	6

Monitoring Program	**Number of Sampling Points**			
	1st Qtr	**2nd Qtr**	**3rd Qtr**	**4th Qtr**
Exit Pathway Monitoring	15	12	19	19
(stations LRS and LRSPW)	.	.	2	2
UST Monitoring	6	.	.	.
Total	**67**	**79**	**89**	**95**

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 and personnel from the Y-12 Plant HSEA Organization collected samples at surface water stations LRS and LRSPW. Sampling was performed in accordance with the most recent version of the technical procedures for groundwater (SESD-TP-8204) and surface water sampling approved by the Y-12 Plant GWPP Manager.

Filtered and unfiltered samples were collected from each monitoring well and surface water location; filtering was performed in the field with an in-line 0.45 micron filter. To minimize the potential for cross-contamination, samples were collected from the monitoring wells following a sequence that generally involved sampling from the least contaminated wells to the most contaminated wells at a site or in a sampling group (a series of monitoring wells grouped for sampling and data-tracking purposes). In areas where no groundwater contamination was present, samples were collected from the farthest upgradient wells first.

3.4 Laboratory Analysis

Groundwater and surface water samples were analyzed for a standard suite of analytes that included:

- principal cations and anions;

- trace metals (a term used to differentiate metals that are typically minor groundwater constituents, such as cobalt and nickel, from metals that are principal ionic compounds, such as magnesium and sodium);
- volatile organic compounds (VOCs);
- gross alpha activity and gross beta activity;
- total suspended solids (TSS), total dissolved solids (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 for trace metals only.

In addition to the standard suite of analyses, groundwater samples collected from some wells were analyzed for other compounds or parameters as required by TDEC regulations or as needed to assess groundwater quality as it leaves the ORR. For example, samples collected from wells GW-766 and GW-767 at Comprehensive Monitoring Plan (CMP) grid I3, located about 400 ft downgradient from a UST site, were analyzed for total petroleum hydrocarbons. Samples from exit pathway wells in Union Valley east of the ORR boundary were analyzed for semi-volatile organic compounds and radionuclides. The specific analytes for each well are presented in the Part 1 GWQR and the *Sampling and Analysis Plan for Groundwater and Surface Water Monitoring at the Y-12 Plant during Calendar Year 1994* (HSW Environmental Consultants, Inc. 1993).

The bulk of the analyses was performed by the K-25 Analytical Services Organization (ASO). Selected radiochemical analyses were performed by the Oak Ridge National Laboratory (ORNL) ASO. Analytical results for all groundwater and surface water samples are presented in Appendix E of the Part 1 GWQR.

3.5 Quality Assurance/Quality Control Sampling

Quality assurance/quality control samples included laboratory blanks, trip blanks, field blanks, equipment rinsates, and duplicate groundwater samples. A total of 100 laboratory blanks, 166 trip blanks, 4 field blanks, 37 equipment rinsate samples, and 33 duplicate samples were analyzed during CY 1994. Similar numbers of QA/QC samples were analyzed during each quarterly sampling event: 14 to 32 laboratory blanks, 36 to 46 trip blanks, 8 to 11 equipment rinsates, 1 field blank, and 7 to 9 duplicate samples (one per sampling group).

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 after samples were collected from selected wells. Equipment rinsates were samples of the deionized water that was 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 team collected groundwater samples at a site or within a sampling group, each collected an equipment rinsate sample.

Laboratory blanks, trip blanks, field blanks, and equipment rinsate samples were analyzed for VOCs; selected equipment rinsates were also analyzed for nitrate (as N), trace metals, gross alpha and gross beta activity, and radionuclides. Analytical results are summarized in Appendix I 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 groundwater samples are presented in Appendix F of the Part 1 GWQR.

Review of the CY 1994 data reported for the laboratory blanks, trip blanks, and equipment rinsates shows that the total number of samples that contained VOCs decreased to the lowest levels since CY 1991 (Figure 5). Overall, at least one of 16 VOCs were detected in 23% of the total QA/QC samples analyzed during CY 1994, including 20% of the laboratory blanks, 25% of the trip blanks, 25% of the field blanks, and 27% of the equipment rinsate samples (Table 4). In contrast, 25 compounds were detected in 71% of the total QA/QC samples analyzed during CY 1992, and 16 compounds were detected in 43% of the total QA/QC samples analyzed during CY 1993 (excluding field blanks, which were collected only in CY 1994). In general, four groups of VOCs have been detected in the QA/QC samples analyzed each CY: (1) common laboratory reagents, (2) suspected source water contaminants, (3) VOC plume constituents, and (4) miscellaneous compounds.

Common Laboratory Reagents

The common laboratory reagents detected in the QA/QC samples are methylene chloride, acetone, 2-butanone, 4-methyl-2-pentanone, toluene, and 2-hexanone. At least one of these compounds was detected in a laboratory blank, trip blank, equipment rinsate, or field blank sample analyzed each quarter of CY 1994 (Table 4). Methylene chloride and acetone are the laboratory reagents most commonly detected in the QA/QC samples, particularly laboratory blanks. In CY 1994, the percentage of contaminated laboratory blank samples containing methylene chloride decreased to less than 50% for the first time since the second quarter of CY 1992 (Figure 6). Also, a significant reduction in the overall percentage of QA/QC samples containing common laboratory reagents occurred during CY 1994. For example, methylene chloride was detected in seven (50%) of the laboratory blanks analyzed during the first quarter of the year but only two (7%) of the laboratory blanks analyzed in the fourth quarter.

Source Water Contaminants

Two groups of compounds are suspected contaminants of the deionized water used to prepare the QA/QC samples: laboratory blank source water contaminants and trip blank/equipment rinsate source water contaminants. Suspected contaminants of the deionized water used for laboratory blanks are 1,1,2,2-tetrachloroethane (1,1,2,2-TCA), 1,1,2-trichloroethane, and vinyl acetate (these compounds have rarely been detected in trip blanks or equipment rinsate samples). For example, 1,1,2,2-TCA has never been detected in trip blank or rinsate samples but was commonly detected in laboratory blanks analyzed during CY 1992 (Figure 5); however, these suspected contaminants were virtually eliminated from the source water used to prepare laboratory blanks after the fourth quarter of CY 1992. None of the laboratory blanks analyzed during CY 1993 contained these compounds. In CY 1994 vinyl acetate was detected in a first quarter laboratory blank sample and 1,1,2,2-TCA was detected in a second quarter sample.

Chloroform and 1,2-dichloropropane (1,2-DCP) are the suspected contaminants of the deionized water used to prepare trip blanks and decontaminate sampling equipment (both compounds have rarely been detected in laboratory blanks). At least one of these compounds was detected in 33% to 84% of the trip blanks and equipment rinsate samples analyzed between the first quarter of CY 1991 and the second quarter of CY 1992. Since then, however, the K-25 ASO has virtually eliminated both compounds from the source water used for these QA/QC samples; less than 1% of the trip blanks and equipment rinsates analyzed during CY 1993 and none in CY 1994 contained either of these compounds (1,2-DCP was detected in a field blank analyzed during the third quarter of CY 1994).

Results of Inductively Coupled Plasma (ICP) analyses reported (in milligrams per liter [mg/L]) for several of the CY 1994 equipment rinsate samples indicate that deionized water equipment was not always kept in proper working order. As summarized in the following table, the calcium, magnesium, potassium, and sodium concentrations reported for these equipment rinsate samples are uncharacteristic of deionized water:

Sample No.	Date Sampled	Concentration (mg/L)			
		Ca	Mg	K	Na
ER UST 1	3/3/94	31	8.6	1.5	4.6
ER EF 9	8/12/94	28	8.1	<12	8,200
ER EF 9	9/28/94	30	8.2	1.4	4
ER CR 9	11/17/94	5.8	1.2	0.77	0.61

Except for the potassium and sodium concentration reported for ER CR 9, these results are at least an order-of-magnitude greater than the respective concentrations reported for the other equipment rinsates that were analyzed for inorganic compounds.

VOC Plume Constituents

Five compounds known to be components of the VOC plumes in the groundwater in the East Fork Regime were detected in 19 of the QA/QC samples analyzed during CY 1994 (Table 4): benzene, chloroform, trichloroethene (TCE), tetrachloroethene (PCE), and 1,1,1-trichloroethane (1,1,1-TCA). One or more of these compounds were detected in two laboratory blanks, two trip blanks, and one field blank, but review of the analytical sequence, sampling dates and times, and data reported for the associated groundwater samples suggests that these results are analytical artifacts. For example, TCE was detected at an estimated concentration of 0.7 micrograms per liter (μg/L) in one laboratory blank analyzed during the third quarter of CY 1994 (Figure 6) but was not detected in the associated trip blank or two of the three associated groundwater samples. Although TCE was detected at 0.7 μg/L in the associated groundwater sample from well GW-191, this well has no prior history of TCE contamination.

Miscellaneous Compounds

Other compounds that have been detected in the QA/QC samples analyzed since CY 1991 are bromodichloromethane, carbon disulfide, styrene, and vinyl chloride. Of these, styrene and bromodichloromethane were detected in one trip blank (7 μg/L) and one field blank sample (2 μg/L), respectively, analyzed during the third quarter of 1994 (Table 4). Review of the historical data for these compounds indicates no clear pattern of occurrence, except that most of the QA/QC samples that contained these compounds were analyzed during CYs 1991 and 1992, and that carbon disulfide has been detected the most frequently.

4.0 INTERPRETIVE ASSUMPTIONS AND LIMITATIONS

Evaluation of groundwater quality in the East Fork Regime was based primarily on data collected during CY 1994; however, historical data were used to corroborate results, identify trends, and define concentration distributions within contaminant plumes. The following sections contain a description of the interpretive assumptions used and limitations regarding evaluation of the groundwater quality data.

4.1 General Assumptions

The following sections describe the interpretive assumptions made in the evaluation of less-than-detection limit results, diluted sample results, and duplicate groundwater sample results.

4.1.1 Less-than-Detection Limit Results

Less-than-detection limit results comprised a substantial proportion of the analytical data for many of the inorganic and organic analytes. Several approaches are described in the technical literature and EPA guidance documents regarding how these data should be treated in quantitative evaluations. Each approach involves replacing the less-than detection limit results with one of three types of surrogate values: zero, the analytical detection limit (or fraction thereof), or a missing value (i.e., no analytical result).

Organic Compounds

For the purposes of this report, zero was used as the surrogate value for less-than-detection limit results reported for organic compounds. Zero was selected as the surrogate value for VOCs because estimated concentrations below the specified analytical reporting limit are often reported for these compounds. Estimated results (reported by the K-25 ASO with a "J" qualifier) represent discernable but unquantified responses from the analytical instrumentation and were, therefore, considered qualitative.

Inorganic Compounds

For the purposes of geochemical evaluation, zero was used as the surrogate value for the less-than-detection limit results reported for the principal cations and anions. Half the specified analytical detection limit was used as the surrogate value for the less-than-detection limit results reported for each trace metal. This type of surrogate value was used to ensure comparability with the reference concentrations used to evaluate the CY 1994 trace metal data (see Section 4.2.2.3).

Beginning in the second quarter of CY 1994, the reporting limit for total and dissolved uranium changed from 0.001 to 0.015 mg/L. The reporting limit was increased in response to an assessment of the K-25 Uranium Fluorometry Laboratory performed by the K-25 ASO in January 1995. As part of this assessment, EPA contract laboratory program protocols were followed to recalculate the method detection limit (MDL) for total and dissolved uranium, which historically had been equal to the instrument detection limit (0.001 mg/L), at three times the new instrument detection limit of 0.005 mg/L. Because the new MDL did not comply with the data quality objectives (DQOs) of the Y-12 Plant GWPP, missing values were used as surrogates for these data. An alternative analytical method (ICP mass spectroscopy; EPA Method 200.8) was implemented in the first quarter of CY 1995. This method has a standard reporting limit of 0.0005 mg/L.

Radioanalytes

The detection limit for radioanalytes (i.e., gross alpha activity, gross beta activity, and radionuclide activity) is expressed as the minimum detectable activity (MDA) in picoCuries per liter (pCi/L). Radioanalytes results for samples collected during CY 1994 were evaluated with respect to the following method specific MDAs provided by the K-25 and ORNL ASOs (Jago 1995a).

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	950
Plutonium-238	84	Uranium-234	55
Plutonium-239	52	Uranium-235	14
Potassium-40	190	Uranium-238	22
Protactinium-234m	700	Gross Alpha Activity	4.7
Radium	1.5	Gross Beta Activity	11

For the purposes of this report, radioanalyte activities that were less than the specified MDA were considered unusable; missing values were used as surrogates for these results.

Results of recent inquires by the Y-12 Plant GWPP and other Energy Systems organizations indicate QA/QC deficiencies relating to MDAs associated with the radioanalytical results reported by the K-25 ASO (Jago 1995). The QA/QC concerns initially arose when it was determined that MDAs had neither been routinely reported by the K-25 ASO nor used on a consistent basis to qualify individual radiological results. Further inquiry determined that the method-specific MDAs currently obtained by the K-25 ASO for many parameters were too high to comply with: (1) the DQOs established for pending RI/FS-related risk assessments, (2) the DQOs needed for Y-12 Plant GWPP monitoring for compliance with existing regulatory requirements, operating or post-closure permit conditions, or (3) 4% of the DOE Order 5400.5 derived concentration guidelines. The QA/QC problems at the Y-12 Plant and elsewhere on the

ORR will be addressed by the Y-12 Plant GWPP, Energy Systems compliance and environmental restoration organizations from all three DOE facilities on the ORR and central and site ASO staff. A set of guidelines will describe a consistent process for determining radiological data needs for applicable projects and documenting the quality of a set of radiological data. These guidelines will be incorporated into applicable Y-12 Plant GWPP procedures and plans. This will result in much lower MDAs. Relevant QA/QC information will be reported along with individual results.

4.1.2 Diluted Sample Results

Groundwater samples collected from wells known or suspected to contain high concentrations of organic or inorganic contaminants were diluted in the laboratory to avoid obtaining results that exceed the calibration range of the analytical instrumentation. Consequently, analytical detection limits reported for the diluted samples were much higher than those reported for undiluted samples. Groundwater samples collected from the following wells during one or more quarters of CY 1994 were diluted by the K-25 ASO before analyses for VOCs:

GW-151
GW-220
GW-251
GW-337
GW-381
GW-382
GW-383
GW-508
GW-606
GW-619
GW-620
GW-632
GW-634
GW-762
GW-782
GW-791

The summed average VOC concentration determined for each of these wells was considered qualitative (see Section 4.2.1), and the data for these samples were excluded from the screening procedure for anomalous VOC results (see Section 4.2.1.2). The groundwater sample collected from well GW-633 during the first quarter of CY 1994 also was diluted before analyses for metals.

4.1.3 Duplicate Sample Results

Duplicate groundwater samples were collected during at least one quarter of CY 1994 from the following monitoring wells:

GW-171
GW-207
GW-208
GW-220
GW-230
GW-240
GW-251
GW-255
GW-262
GW-264
GW-384
GW-618
GW-633
GW-744
GW-751
GW-758
GW-762
GW-766
GW-771
GW-773
GW-775
GW-779
GW-784
GW-786

As part of the data verification process described in the Part 1 GWQR, the duplicate groundwater sample data for each well were reviewed to identify statistically significant differences between corresponding analytical results, and the appropriate analytical laboratory was then contacted to determine if reporting errors were responsible for such differences. All the significant differences identified in the CY 1994 duplicate sample data (except those summarized below) were attributed to laboratory reporting errors (Paradigm Data Services, Inc. 1994a, 1994b, 1995a, and 1995b).

Well	Date Sampled	Analyte(s)
GW-762	2/03/94	Gross Alpha activity
GW-633	3/03/94	Technetium-99 activity
GW-262	5/11/94	Total Al and Fe
GW-207	5/24/94	Gross Alpha activity
GW-618	8/21/94	Gross Beta activity
GW-230	9/28/94	Total Strontium activity

Because the differences for the compounds listed above could not be resolved, these results were assigned missing values as surrogates for the purposes of quantitative evaluation (e.g., calculation of mean annual gross alpha activity).

4.2 Specific Assumptions

The following sections describe the interpretive assumptions specific to the evaluation of CY 1994 data reported for VOCs, trace metals, major anions and cations, nitrate, and radiological parameters.

4.2.1 Volatile Organic Compounds

The extent of dissolved VOCs in groundwater was evaluated with respect to the summed annual average concentration of each VOC detected in samples from each monitoring well. In cases where elevated analytical detections limits were reported (i.e., diluted samples), the summed average VOC concentrations were considered qualitative. If estimated VOC concentrations alone were reported for the samples from a well, the highest reported concentration was used instead of the summed average concentration.

To determine the summed average VOC concentration for each well, the data were screened to identify probable artifacts of sampling or analysis (false positive results) and results that potentially reflect other extraneous factors unrelated to groundwater quality (anomalous results). False positive results were identified through evaluation of the VOC data reported for selected blanks associated with each groundwater and surface water sample. Anomalous results were identified from a review of CY 1991-1994 data for each well to quantify the frequency at which individual VOCs were detected (including estimated concentrations). Zero was used as the surrogate value for all false positive and anomalous VOC results for the purposes of calculating average VOC concentrations.

4.2.1.1 False Positive Results

False positive results were identified using a procedure developed by the EPA that involves determining the blank qualification result (BQR) for each VOC detected in the laboratory and trip blanks and comparing the BQRs to the VOC results reported for the associated groundwater samples. Blank qualification results were determined by multiplying the highest concentration of a VOC detected in either associated blank by a qualification factor. A factor of 5 was used to determine the BQR for most compounds, but a factor of 10 was used to determine the BQRs for the following common laboratory reagents: methylene chloride, acetone, 2-butanone, and toluene. The BQR determined for each compound was then compared to the corresponding result reported for the groundwater or surface water sample. If the compound was detected in the groundwater sample at a concentration less than or equal to the BQR, the result was screened as a false positive (U.S. Environmental Protection Agency 1988).

Eighteen VOCs were detected in the groundwater and surface water samples collected from sampling points in the East Fork Regime during CY 1994, and false positive results were identified for six of these compounds (Table 5): methylene chloride, 2-butanone, acetone, toluene, 1,1,1-TCA, and TCE. Of the 219 results for these compounds reported for the groundwater samples, 103 (47%) were screened as false positives, including 99 (83%) of the 119 results for methylene chloride, acetone, 2-butanone, and toluene. The four false positive results for 1,1,1-TCA and TCE were all screened by the BQR determined from data reported for one laboratory blank sample and occurred in groundwater samples from monitoring wells with no prior history of contamination by either compound.

About 53% of the false positive VOC results were less than 10 μg/L (the maximum screened concentration was 89 μg/L). Forty-eight of the false positive results for methylene chloride, 2-butanone, and acetone results exceeded 10 μg/L. The remaining 55 false positive results were estimated values below the analytical detection limit for each compound. Similar patterns also were evident in the false positive VOC data for CYs 1992 and 1993; more than

80% of the false positive results were less than 10 μg/L, most of which were less than analytical detection limits. False positive results greater than 10 μg/L were identified primarily for common laboratory reagents (methylene chloride, acetone, 2-butanone, and 4-methyl-2-pentanone).

The number of false positive results identified in the groundwater data decreased from 53 in the first quarter to one in the second quarter of CY 1994 then increased through the end of the year (Figure 5). Similar trends were also evident in the number of false positive VOC results for groundwater samples collected during CYs 1991, 1992, and 1993. An explanation for this persistent increase through the end of each CY is not readily apparent. It is not directly related to the number of samples analyzed for VOCs (i.e., more samples analyzed, more false positives identified), because substantial increases in the number of false positives occurred independent of the number of samples for which VOCs were analyzed. For instance, the total number of samples analyzed for VOCs increased by 2% from the third to the fourth quarter of 1994, but the number of false positive results increased 433% during this period. Additionally, increases in the number of false positives do not appear to be directly related to the number of laboratory blank and trip blank samples that contained VOCs, including the common laboratory reagents. For example, the number of laboratory blanks in which at least one VOC was detected increased from four in the third quarter to five in the fourth, but the number of false positive results increased from five to 30.

4.2.1.2 Anomalous Results

One characteristic of the VOC data collected for the purposes of the Y-12 Plant GWPP is the sporadic occurrence of typically low (less than 10 μg/L) concentrations of various compounds in samples from wells with no history of VOC contamination. Such results occur for compounds, such as methylene chloride, that otherwise are typically identified as false positives as well as compounds, such as PCE, that are in the groundwater near known VOC source areas. A decision rule based on frequency of detection has been used to identify these results in previous GWQRs; results for compounds detected (including estimated concentrations below the detection limit) in only one out of four consecutive undiluted samples collected each CY from a particular sampling point were considered anomalous and assigned a surrogate value of zero (i.e., considered the same as less-than-detection limit VOC results). This approach has effectively reduced overly subjective interpretations of the VOC data and avoided widely divergent annual assessments of the extent of VOC plumes.

Screening anomalous results from the VOC data has two primary drawbacks. First, it may negate evidence of groundwater contamination. For example, the apparently sporadic detection of a known plume constituent may be a sampling artifact; a compound present at very low concentrations in the groundwater may be occasionally volatilized during sample collection. Additionally, the infrequent detection of plume constituents may reflect transport during seasonal or episodic groundwater flow conditions. The second drawback is that a decreasing number of wells at the Y-12 Plant are being sampled at the quarterly frequency upon which the decision rule for identifying anomalous VOC results has historically been based.

To determine if evidence of VOC contamination or VOC plume migration has been negated in past GWQRs and to accommodate the reduced sampling frequency of most monitoring wells at the Y-12 Plant, the VOC data reported for all wells in the East Fork Regime sampled since CY 1991 were re-evaluated for anomalous results. For the purposes of this evaluation, anomalous results were defined as results (including estimated concentrations) for compounds detected in 25% or less of the undiluted samples from a particular location (i.e., 1 of 4 samples, 2 of 8 samples, 3 of 12 samples, etc.). Based on this decision rule, a total of 173 anomalous results have been reported for 27 compounds (Table 6): six laboratory reagents (72 results), three suspected blank source water contaminants (8 results), five miscellaneous compounds (9 results), and 13 VOC plume constituents (84 results).

Laboratory reagents, suspected blank source water contaminants, and miscellaneous compounds account for 89 (51%) of the 173 anomalous VOC results. Just over half of the anomalous results for these compounds were reported for samples collected between the third quarter of CY 1992 and the second quarter of CY 1993 (Figure 6). The increased frequency of anomalous results during this period generally corresponds with the addition of 30 new CMP grid monitoring wells to the Y-12 Plant GWPP, and the subsequent decrease coincides with the decrease in the number of VOC-contaminated QA/QC samples after the first quarter of CY 1993. Additionally, the total number of anomalous results for each of these compounds show an equal or nearly equal ratio with the number of wells for which they were reported (i.e., most were reported for only one sample from one well). These findings suggest that anomalous results for laboratory reagents, suspected blank source water contaminants, and miscellaneous compounds are probable sampling or analytical artifacts. Accordingly, for evaluation purposes in this report, anomalous results for these compounds identified in the CY 1994 VOC data were assigned zero as a surrogate value (Table 6).

Eighty-four anomalous results were identified for 13 known VOC plume constituents, primarily PCE (18 results), 1,2-dichloroethene (1,2-DCE) (10 results), and chloroform (10 results) (Table 6). Most of the anomalous results for the VOC plume constituents were reported for samples from wells located near confirmed source areas in which other constituents (e.g., TCE and carbon tetrachloride) have consistently been detected. Thus, screening these results as anomalous had no impact on the evaluation of the overall extent of the VOC plume in groundwater in these areas. Review of the remaining anomalous VOC results indicates that only those reported for samples collected from well GW-380 at New Hope Pond potentially represent groundwater contamination.

Chloroform and PCE were detected at low concentrations (2 μg/L or less) in samples collected from well GW-380 during the third quarters of CYs 1991, 1992, and 1994. This well lies near the southern boundary of the VOC plume in the groundwater near New Hope Pond, and these compounds are among the principal components of this plume. The occurence of these compounds in samples collected during the third quarter of these CYs possibly indicates a relationship with seasonal groundwater flow conditions.

4.2.2 Trace Metals

As required by the TDEC, evaluation of groundwater quality with respect to trace metals was based on total concentrations reported for unfiltered groundwater samples. Evaluation of these data included: (1) consideration of analytical methods, (2) comparison to corresponding dissolved metal concentrations reported for filtered groundwater samples, (3) identification of median trace metal concentrations that exceeded appropriate reference values, and (4) review of the elevated median concentrations to identify those potentially biased from contamination during laboratory analysis.

4.2.2.1 Analytical Methods

Four analytical methods were used to determine trace metal concentrations in the filtered and unfiltered groundwater samples: (1) Atomic Absorption Spectroscopy (AAS) for cadmium, chromium, and lead; (2) Cold Vapor Atomic Absorption spectroscopy for mercury; (3) fluorometry for uranium; and (4) ICP spectroscopy for aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, selenium, silver, strontium, thorium, vanadium, and zinc.

The AAS results for cadmium, chromium, and lead were evaluated in lieu of the ICP data because analytical interferences inherent to the ICP method can cause inaccurate results for these metals (U.S. Environmental Protection Agency 1986). However, the K-25 ASO reported that recent procedural improvements have generally eliminated analytical interferences that may be associated with ICP analyses for cadmium and chromium. This is supported by results of a statistical analysis of CY 1994 ICP and AAS data reported for these metals, which showed no statistically significant differences between data obtained by each respective analytical method (Paradigm Data Services, Inc. 1995c). Accordingly, continued AAS analyses for cadmium and chromium may not be necessary for the purposes of the Y-12 Plant GWPP.

4.2.2.2 Total/Dissolved Concentrations

To qualitatively gauge the accuracy of the total metal concentrations reported for unfiltered groundwater samples from each well, they were compared to the corresponding dissolved metal concentrations reported for filtered groundwater samples. If the dissolved metal concentration exceeded the corresponding total concentration by an order-of-magnitude or more, both results were considered unusable. Order-of-magnitude differences between total and dissolved metal concentrations are summarized below.

Sampling Point	Date Sampled	Trace Metal	Concentration (mg/L)	
			Dissolved	Total
GW-733	01/30/94	Copper	0.04	<0.004
GW-169	01/31/94	Copper	0.13	0.01
GW-765	05/05/94	Zinc	0.63	0.0031
GW-784	09/01/94	Boron	0.076	0.0043
GW-151	09/22/94	Iron	0.02	0.0091

These results were assigned missing values as surrogates for the purposes of quantitative evaluation.

4.2.2.3 Identification of Elevated Concentrations

Evaluation of groundwater quality with respect to trace metals was based on median total (unfiltered) concentrations determined from CY 1994 data for each well. The evaluation was based on median concentrations because, as described below, median values were used to calculate the reference concentrations used to evaluate the CY 1994 data for many of the trace metals. Medians were used to determine the reference concentrations because they are less sensitive to extreme values (outliers) and imply no assumptions regarding the distribution (i.e., normal or lognormal) of the data.

Reference concentrations used for comparison to the median trace metal concentrations were: (1) statistically-derived upper tolerance limits (UTLs) assumed to be representative of respective metal concentrations in uncontaminated groundwater, and (2) maximum contamination levels (MCLs) for drinking water.

Elevated concentrations of aluminum, antimony, boron, cobalt, copper, iron, manganese, molybdenum, strontium, thorium, uranium, vanadium and zinc were defined as median concentrations that exceeded respective UTLs determined from statistical evaluation of groundwater quality data obtained since CY 1986 from all monitoring wells at the Y-12 Plant (including wells monitoring contaminated groundwater). The technical approach used to determine the UTLs generally involved:

- principal component analysis to identify the dominant sources of variation in the groundwater chemistry data;
- cluster analysis to identify subsets of similar geochemical data;
- classification modeling to assign monitoring wells to the identified clusters;
- review of cumulative probability graphs to identify potentially biased results (i.e., sampling or analytical artifacts) and results indicative of contamination that were excluded from determination of the UTLs; and
- statistical analysis of the data for the wells in each cluster using parametric and nonparametric techniques, as appropriate, to determine the UTL for each inorganic compound applicable only to the wells in the cluster.

The principal component analysis identified carbonate and bicarbonate alkalinity, magnesium, sodium, nitrate (as N), and specific conductance as the primary sources of variation in the groundwater geochemistry data. Classification modeling using median concentrations of these parameters identified ten separate groups of wells (i.e., clusters) characterized by similar geochemical data (Figure 7). Cluster 1 is represented by data from shallow wells located throughout BCV. Cluster 2 is represented primarily by the data for shallow wells that monitor groundwater with very low dissolved solids. Cluster 3 is similar in many respects to Cluster 1 in that it is represented by the data for shallow wells located throughout BCV, but the geochemical data for these wells are less variable. Cluster 4 is represented almost exclusively by the data for wells completed in the Copper Ridge Dolomite of the Knox Group. Clusters 5, 7, 8, and 9 are represented chiefly by the data for wells that monitor nitrate-contaminated groundwater near the west end of the Y-12 Plant. Clusters 6 and 10 are represented by data for deeper monitoring wells at the Y-12 Plant; intermediate depth wells monitoring sodium-bicarbonate type groundwater (Cluster 6), and deep (>400 ft below ground surface [bgs]) wells monitoring sodium-chloride-bicarbonate type groundwater (Cluster 10). Reference concentrations for evaluating groundwater quality reported for wells classified as Cluster 1,2,3,4,6, or 10 were then determined using data for the wells in each cluster; details regarding the groundwater classification scheme and methods used to determine the UTLs for each cluster are included in a report to be issued in late-1995 (HSW Environmental Consultants, Inc. et al. 1995).

Wells installed during CY 1994 that were not included in the background study were assigned cluster designations using results reported for the parameters identified by the principal component analysis in conjunction with the decision criteria defined by the classification model (Figure 7). Additionally, wells in the East Fork Regime that were included in the contaminated groundwater clusters (Clusters 5, 7, 8, and 9) were re-assigned to the noncontaminated groundwater clusters (Clusters 1, 2, 3, 4, 6, and 10) based on a classification model that used selected well construction and water quality data as decision criteria (Figure 8). These surrogate cluster assignments were necessary because UTLs were not calculated using the data for the wells that monitor contaminated groundwater.

The cluster designations for the wells in the East Fork Regime that were sampled during CY 1994 are listed on Table 3; trace metal UTLs applicable to the wells in each cluster are listed in Table 8. These UTLs are generally lower than those used to evaluate trace metal data reported in previous GWQRs for the East Fork Regime. The lower UTLs may be attributable to using median values and differences in the data sets used to determine the reference levels. The UTLs used to evaluate the CY 1994 data were determined from median concentrations determined for a total of 430 monitoring wells located throughout the Y-12 Plant, whereas the UTLs presented in previous GWQRs were determined from data reported for 53 wells (14 in the East Fork Regime) located hydraulically upgradient of known contaminant sources. Regardless of the cause, the net effect was a lower UTL for every metal except cobalt; the 0.019 mg/L UTL determined for cobalt is slightly higher than the 0.011 mg/L UTL used in the CY 1993 GWQR. The most significant differences are with the reference levels for boron, strontium, and vanadium. The lowest UTL for each of these metals (the UTL for vanadium is the same for each well cluster) is more than an order-of-magnitude less than the respective UTLs for these metals presented in previous GWQRs.

Upper tolerance limits for the following metals were calculated as part of the background study outlined above. For the purposes of this report, elevated concentrations of these metals were defined as median concentrations that exceeded the drinking water MCL specified below:

Trace Metal	MCL (mg/L)	Trace Metal	MCL (mg/L)
Arsenic	0.05	Lead	0.05
Beryllium	0.004	Mercury	0.002
Barium	2.0	Nickel	0.1
Cadmium	0.005	Selenium	0.05
Chromium	0.10	Silver	0.05

The MCLs, rather than UTLs, are used to define elevated concentrations to maintain consistency with regulatory standards and historical evaluations of the data for these metals. The MCLs for beryllium and nickel were recently approved by the TDEC. Elevated concentrations of these two metals were identified in previous GWQRs based on a comparison to UTLs.

4.2.2.4 Potentially Biased Results

Individual trace metal concentrations that exceeded MCLs or UTLs were reviewed to determine if contamination may have occurred during laboratory analysis. For example, boron concentrations may be biased by traces of borax, which is commonly used to clean laboratory glassware. Trace metal results that reflect potential laboratory contamination are flagged by the K-25 ASO with a "c" qualifier. Results of this review show that potentially biased concentrations of aluminum (13 results), boron (23 results), copper (7 results), iron (7 results), nickel (10 results), and zinc (13 results) were reported for samples collected from 40 wells during CY 1994 (Table 9). These results were considered unusable; missing values were used as surrogates for quantitative evaluation purposes (e.g., calculation of median concentrations).

4.2.3 Principal Ions

Water is electrically neutral; therefore, the total charges on the principal anions (bicarbonate and carbonate alkalinity, chloride, fluoride, nitrate, and sulfate) and cations (calcium, magnesium, sodium, and potassium) should be equal. Total positive and negative charges were determined by summing the milliequivalents (i.e., molecular weight of the ion divided by the net ionic charge) of the dissolved cation concentrations (which exclude digested cations that do not contribute charge to the groundwater), and the total (unfiltered sample) anion concentrations. The charge balance error was expressed as the relative percent difference (RPD) between the respective summed milliequivalent concentrations of the principal cations and anions.

Principal ion data reported for samples in which the RPD exceeded 10% were excluded from further evaluation. Based on this criterion, principal ion data reported for 34 of the groundwater samples collected during CY 1994 were not evaluated. Unusually low alkalinity or unusually high calcium concentrations typically caused positive RPDs greater than 10%. High nitrate concentrations (probably reflecting contamination), high alkalinity, and high manganese concentrations (not included in the equation) typically caused negative RPDs greater than 10%. Charge balance errors for all groundwater and surface water samples collected in the East Fork Regime during CY 1994 are included in Appendix G of the Part 1 GWQR.

High dissolved concentrations of iron and manganese may be the cause of the charge balance errors consistently determined for the groundwater samples from wells GW-772 and GW-785. Including the charge contributions of manganese and iron reduces the charge balance errors for each of these samples except the fourth quarter sample from well GW-772 to within the acceptable range. It may be appropriate to include iron and manganese in the charge balance calculations for all wells in the regime.

4.2.4 Nitrate

Nitrate concentrations reported by the K-25 ASO are for nitrate nitrogen (i.e., nitrate as N). For the purposes of this report, "nitrate concentrations" and "nitrate (as N) concentrations" are synonymous. To evaluate groundwater quality with respect to nitrate, the annual average nitrate concentration was determined for each well and compared to the 10 mg/L MCL for drinking water. To determine the annual average nitrate concentration, missing values were used as surrogates for less-than-detection limit nitrate results. This procedure results in higher annual average values.

4.2.5 Radiochemical Parameters

The CY 1994 data reported for radioanalytes were evaluated with respect to: (1) negative values, (2) the respective MDAs reported by the K-25 and ORNL ASOs, and (3) the uncertainty associated with each result that exceeded the specified MDA. Radioanalyte activities reported by the ASOs are corrected for background; i.e., each result represents the total activity minus the background activity associated with the analytical environment. If the activity in a sample was below the background level, the result was reported as a negative value; otherwise, the radioanalyte activity reported for each groundwater sample was compared to each respective MDA listed in Section 4.1.1. Furthermore, the degree of analytical uncertainty associated with quantifying gross alpha, gross beta, and radionuclide activity in a sample is expressed by the counting error reported for each result which is defined as two times the sample standard deviation. Thus, if the radioanalyte activity was less than background, the MDA, or the associated counting error, it was considered unusable; missing values were used as a surrogate.

Only 14% of the CY 1994 radioanalyte data passed the evaluation criteria (Table 10). Of the data that failed the QA/QC criteria, 28% were negative values, 69% were less than the applicable MDA, and 3% exceeded the MDA but were less than the associated counting errors.

The annual average gross alpha and gross beta activities were determined using data that passed the validation criteria and the applicable surrogate values noted in the preceding paragraphs. The associated average counting error (e) was calculated using the following formula from Evans (1955):

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

where $\mathbf{E}_1$, $\mathbf{E}_2$, ... are the individual errors reported for each sample, and **n** is the number of samples that passed the validation criteria. This formula is appropriate for calculating the mean error of a series of errors.

4.3 Limitations

Groundwater quality data obtained during each quarter for most wells sampled during CY 1994 are generally not synchronous; sampling required 37, 56, 62, and 64 days during the first through fourth quarters of CY 1994, respectively (Figure 9). The first quarter data are generally the most concurrent; samples were collected during a 14 day time period between January 26 and February 8, 1994 from 61 of the 67 wells included in the first quarter monitoring schedule. Additionally, wells located in the Western Plant Area were usually sampled in the shortest time period each quarter (6 to 14 days), and wells in the Eastern Plant Area were usually sampled during the longest time period each quarter (14 to 64 days). Thus, comparison of quarterly data for wells in different areas of the plant with regard to concurrent concentration changes may not be valid.

Continuous water-level monitoring performed as part of the RI for the Bear Creek Regime show that water levels at shallow depths in the Conasauga Shales and throughout the Maynardville Limestone change significantly in response to precipitation events. Assuming similarly responsive water levels in the East Fork Regime, groundwater samples were probably collected under widely variable flow conditions during each quarterly sampling. For example, 30% of the 67 wells included in the first quarter sampling schedule were collected during or within two days of a 0.5-in or greater rainfall event, whereas only 15% of the 95 wells included in the fourth quarter sampling schedule were sampled during or within two days of similar rainfall events (Figure 9).

Evaluation of the current magnitude and extent of groundwater contamination in the East Fork Regime also is affected by the small number of wells sampled in CY 1994. For instance, most of the wells that have historically monitored contaminated groundwater in the Western Plant Area have not been sampled since CY 1990. Thus, the current maximum contaminant concentrations and extent of contamination in the groundwater in this area are unknown. Additionally, delineation of vertical plume boundaries is limited because the depth of most of the wells located within the regime is less than 100 ft bgs. Furthermore, delineation of horizontal plume boundaries in the Central Plant Area is limited by the spatial distribution of monitoring wells; most of the Phase 1 grid wells have been installed and sampled, but no current data (and limited historical data) are available for groundwater in the Maynardville Limestone in the Central Plant Area (Figure 4).

5.0 HYDROLOGIC FRAMEWORK

This section contains a general overview of the hydrogeologic system in the East Fork Regime. In past GWQRs, the hydrogeologic overview was based primarily on the conceptual framework and associated nomenclature presented in: *Status Report - A Hydrologic Framework for the Oak Ridge Reservation* (Solomon et al. 1992). However, the overview for this report has been revised because flow in the Maynardville Limestone, a key component of the groundwater flow system in the BCV, is not specifically addressed in Solomon et al. (1992), and some components of the ORR hydrogeologic framework (e.g., the stormflow zone) appear to be of lesser hydrologic significance at the Y-12 Plant than indicated for other areas on the ORR. In general, the revised description of the hydrogeologic system incorporates: (1) applicable aspects of the conceptual framework described in Solomon et al. (1992), (2) hydrologic characteristics evaluated by Moore (1988 and 1989), and (3) findings of the RI for the Bear Creek Characterization Area (Science Applications International Corporation 1995).

5.1 Geology

Geology on the ORR is generally characterized by thrust-faulted sequences of southeast-dipping, clastic (primarily shale and siltstone) and carbonate (limestone and dolostone) strata of Lower Cambrian to Lower Ordovician age. In the Y-12 Plant area, shale and siltstone beds of the Rome Formation form Pine Ridge to the north, BCV is underlain by limestone and shale formations of the Conasauga Group, and dolostone strata of the Knox Group form Chestnut Ridge to the south (Figure 10). Bedrock is overlain by any of several materials, including man-made fill, alluvium, colluvium, fine-grained residuum from the weathering of the bedrock, and saprolite (weathered bedrock), which in some areas retains primary textural features of the bedrock, including fractures (Solomon et al. 1992). The overall thickness of these materials is typically less than 40 ft in BCV (Geraghty & Miller, Inc. 1987).

The most important geologic unit with respect to groundwater contamination in the East Fork Regime is the Conasauga Group, which includes the following formations listed in sequence from youngest to oldest: Maynardville Limestone, Nolichucky Shale, Maryville Limestone, Rogersville Shale, Rutledge Limestone, and Pumpkin Valley Shale (Figure 10). The Maynardville Limestone is partially exposed along the axis of BCV at the base of Chestnut Ridge; the remaining formations are partially exposed successively to the north toward Pine Ridge (Figure 10).

The Maynardville Limestone consists of about 300 to 620 ft of fine- to coarse-grained, thin-bedded to massive limestone and dolostone (King and Haase 1987; Shevenell et al. 1993). Most of the basal portion of the formation (the Low Hollow member) is not present in an area southeast of the Bear Creek Burial Grounds WMA; this loss of stratigraphic section also is evident in the basal Maynardville exposed in a quarry located in Union Valley about two miles east of the Y-12 Plant (Watson 1995) and is believed to represent a lateral facies change (Shevenell et al. 1993). The underlying Nolichucky Shale and Maryville Limestone formations consist of 350 to 550 ft of primarily massive to thin-bedded mudstone with interbedded limestone (King and Haase 1987). Beneath the Maryville Limestone are the massive mudstones of the Rogersville Shale and the interbedded limestone and shale of the Rutledge Limestone. The thickness of each of these formations ranges from 90 to 120 ft (King and Haase 1987). The Pumpkin Valley Shale consists of 260 to 320 ft of massive shale and mudstone with thin beds of siltstone and sandstone (King and Haase 1987).

Strike and dip of bedding are generally N 55°E, and 45°SE, respectively (as referenced to true north); however, small-scale folding and faulting produce locally variable bedding orientations (King and Haase 1987). The bedrock is extensively fractured. Three major fracture orientations are evident: one that roughly parallels bedding, and two that dip more steeply, one generally parallel with and one perpendicular to bedding (Dreier et al. 1987). Most fractures are short, usually only tenths of inches to a few feet in length; fracture densities ranging from about 1 to 60/ft have been observed in rock outcrops near the ORNL (Dreier et al. 1987; Sledz and Huff 1981). Dissolution along fractures in carbonates, particularly in the Maynardville Limestone, has produced karst features ranging from less than an inch to tens of feet in thickness. These features tend to occur in strata near the top and bottom of the formation (Shevenell et al. 1993).

5.2 Groundwater System

Groundwater occurs in two basic hydrogeologic units in the East Fork Regime: the Maynardville Limestone, and the Conasauga Shales (Nolichucky Shale, Maryville Limestone, Rogersville Shale, Rutledge Limestone, and Pumpkin Valley Shale). These units are respectively analogous to the Knox Aquifer and the ORR Aquitards described by Solomon et al. (1992). The hydrologic boundary between these units corresponds with the geologic contact between the Nolichucky Shale and the Maynardville Limestone.

The Maynardville Limestone and Conasauga Shales each have distinctly different hydrologic characteristics, but both consist of three general subsystems: (1) the stormflow/vadose zone, (2) the groundwater zone, and (3) the aquiclude (Figure 11). The subsystems are vertically gradational in each unit, and are differentiated by groundwater flux, which decreases with depth. However, solutionally-enlarged flowpaths in the Maynardville Limestone are about ten times more permeable than in the Conasauga Shales (Solomon et al. 1992). Because of its greater permeability and its location along the floor of BCV, the Maynardville Limestone is the hydrologic low in the East Fork Regime and functions both as a drain for the groundwater flow system and the principal contaminant migration pathway.

5.2.1 Stormflow/Vadose Zone

Groundwater occurs intermittently above the water table in a shallow "stormflow zone" that extends from ground surface to a depth of about 6 ft bgs. The stormflow zone is thicker and more permeable in forested areas than in grassy or brushy areas, and is more permeable near the land surface than at deeper levels (Moore 1989). Lateral flow in the stormflow zone is intermittent, lasting only a few days or weeks after rainfall; some of the water is lost to evapotranspiration and recharge to the water table, and the remaining water discharges at nearby seeps, springs, and streams. Hydrologic characteristics of the stormflow zone are based primarily on information obtained in Bethel Valley and Melton Valley near ORNL (Moore 1988 and 1989). Although data obtained for RI purposes show that the shallow subsurface flow in the stormflow zone also occurs at the Y-12 Plant (Figure 12) (Science Applications International Corporation 1994), the significance of groundwater flux and contaminant transport in the stormflow zone in BCV has not been fully characterized, and may be less than indicated in Bethel Valley and Melton Valley.

The vadose zone occurs between the stormflow zone and the water table, which typically occurs at depths less than 20 ft bgs in the Conasauga Shales and the Maynardville Limestone. The vadose zone in undeveloped areas primarily occurs in regolith; the effective porosity (the porosity through which significant advective transport can occur) of the regolith is estimated at of 0.01 to 0.15 (Moore 1989). The vadose zone is unsaturated except in the capillary fringe above the water table and within wetting fronts during periods of vertical percolation from the stormflow zone (Moore 1989).

5.2.2 Groundwater Zone

Groundwater below the vadose zone in the Conasuaga Shales and Maynardville Limestone occurs within orthogonal sets of permeable, planar fractures that form water-producing zones within an essentially impermeable matrix. Water-producing zones commonly develop within a single layer of rock, and have an average thickness (assuming an average dip of 35°) of two ft or less (Dreier et al. 1987). Dissolution of carbonates has greatly increased permeability of the water-producing zones in the Maynardville Limestone; enlarged fractures and solution cavities in the Maynardville Limestone yield as much as 200 to 300 gallons per minute (gpm) (Shevenell et al. 1993), which is several orders-of-magnitude greater than the typical yield (0.25 gpm) of water-producing zones in the Conasauga Shales (Solomon et al. 1992). Additionally, stratiform fractures provide the principal flowpaths in both hydrogeologic units, and groundwater flows primarily in the direction of geologic strike (which may or may not correlate with the maximum hydraulic gradient) toward springs, seeps, and cross-cutting tributary streams (Moore and Toran 1992).

Because the frequency, aperture, and connectivity of permeable fractures decreases with depth, the bulk hydraulic conductivity of the Conasuaga Shales and the Maynardville Limestone is vertically gradational. Most of the groundwater flux in each unit occurs in a highly permeable zone (the water table interval) within the transitional horizon between regolith and unweathered bedrock; lower flux (and longer solute residence times) occurs at successively greater depths in the bedrock. Changes in the geochemistry of the groundwater suggest that active flow in the Conasauga Shales occurs at depths less than 100 ft bgs. Active groundwater flow occurs deeper in the Maynardville Limestone, as indicated by pressure responses to rainfall that are evident in some wells completed at depths of 200 to 400 ft bgs (Science Applications International Corporation 1995a).

The bulk of the groundwater flux in the Conasauga Shales and Maynardville Limestone occurs within the water table interval, which transmits an estimated 90% or more of the groundwater flow below the stormflow/vadose zone. This highly permeable zone is relatively thin in both units (3 to 15 ft), and the saturated thickness changes with cyclic variations in the water table elevation (Moore 1989). Transient saturation of permeable flowpaths in the water table interval during and immediately after rainfall causes rapid lateral groundwater movement (quickflow) toward nearby seeps, springs, and tributaries. Quickflow in the water table interval is reflected by stream hydrographs, which are characterized by rapid responses to rainfall and little or no change in baseflow before and after major storms (Science Applications International

Corporation 1995). For some wells screened in the water table interval, substantial decreases in TDS reported for samples collected after rainfall also indicate quickflow recharge.

Groundwater flux below the water table interval in the Conasauga Shales occurs primarily in the shallow bedrock (i.e., <100 ft bgs). Bedrock at shallow depths in the Conasauga Shales is characterized by heterogeneous permeability that varies over several orders-of-magnitude. For instance, results of 82 hydraulic conductivity tests performed in shallow Nolichucky Shale monitoring wells range from 0.001 to 4.6 feet per day (ft/d) (Geraghty & Miller, 1989a). The higher conductivity values represent permeable water-producing intervals and the lower conductivity values represent effectively less permeable matrix intervals (Moore 1989). Additionally, results of aquifer pumping tests suggest strongly anisotropic flow at shallow depths in the Conasauga Shales. Twenty five aquifer pumping tests have been performed in the Nolichucky Shale, each characterized by an elliptical cone of depression elongated parallel to geologic strike; transmissivity values (determined from Theis drawdown analysis) ranged from about 5 to 530 ft squared per day (ft^2/d) and averaged about 62 ft^2/d (Law Engineering Testing Company 1983; Geraghty & Miller, Inc. 1986; Golder Associates, Inc. 1987; Golder Associates, Inc. 1988). Results for some of the pumping tests also showed strike-parallel transmissivities as much as 30 times greater than strike-normal transmissivities (Golder Associates, Inc. 1988).

Decreasing groundwater flux with depth in the Conasauga Shales is clearly indicated by distinct changes in groundwater geochemistry, as well as hydraulic conductivity test results. The first transitional decrease generally occurs at a depth of 100 ft bgs and is indicated by a change from calcium-magnesium-bicarbonate groundwater to sodium-bicarbonate groundwater. This geochemical change is probably a function of longer groundwater residence time, which reflects lower hydraulic conductivity related to reduced fracture apertures or increased fracture spacings (Solomon et al. 1992). Results of eight hydraulic conductivity tests in wells completed at depths of 132 to 374 ft bgs in the Rutledge Limestone, Maryville Limestone, and Nolichucky Shale, as summarized in Geraghty & Miller, Inc. (1989a), range from 3×10^{-5} to 0.01 ft/d, and average about 0.004 ft/d. A second transitional decrease in groundwater flux generally occurs at approximately 400 ft bgs and is indicated by a change from sodium-bicarbonate groundwater to sodium-chloride groundwater accompanied by a general increase in specific conductance and TDS. Data obtained from straddle packer tests, slug tests, and slow-recovery analyses indicates that hydraulic conductivity in the deep bedrock of the Conasauga Shales is as low as 2.83×10^{-6} ft/d (Solomon et al. 1992).

The permeability of the shallow bedrock in the Maynardville Limestone also varies over several orders-of-magnitude, but overall is significantly greater than in the Conasauga Shales; hydraulic conductivity test results for wells less than 100 ft bgs in the Maynardville Limestone range from 0.13 to 99 ft/d, and average about 22 ft/d (Geraghty & Miller, Inc. 1989a). A comparable flow rate (25 ft/d) also was estimated from results of a dye tracer test performed in the Maynardville Limestone south of the Oil Landfarm WMA (Geraghty & Miller, Inc. 1989b). Additionally, aquifer pumping tests performed in the Maynardville Limestone produced generally symmetrical cones of depression, potentially indicating lower anisotropy compared to the Conasauga Shales. Transmissivity values obtained from these pumping tests (determined from Theis drawdown analysis) ranged from about 372 to 7,690 ft^2/d, with storage coefficients between 6×10^{-5} and 0.002 (Golder Associates, Inc. 1988). Results of some of these tests also indicated substantially greater strike-parallel transmissivity than strike-normal transmissivity.

Indications of decreasing groundwater flux in the Maynardville Limestone are less clearly evident than for the Conasauga Shales. For example, changes in groundwater geochemistry that occur with depth in the Conasauga Shales are not evident; calcium-magnesium bicarbonate groundwater is present in the Maynardville Limestone to depths of 1,000 ft bgs (Dreier et al. 1993). Moreover, decreased permeability with depth in the Maynardville Limestone has not been characterized because hydraulic conductivity tests have been performed primarily in shallow (<100 ft bgs) monitoring wells. As noted previously, however, active groundwater flow may occur to depths of 400 ft bgs in the Maynardville Limestone.

5.2.3 Aquiclude

The aquiclude is generally marked by the presence of saline water with TDS concentrations as high as 300,000 mg/L; the water in the aquiclude is a sodium-, calcium-, and chloride-rich brine that is chemically similar to brines associated with major sedimentary basins. Whereas saline water typically occurs at depths of about 600 to 700 ft bgs in Melton Valley (Solomon et al. 1992), it has not been encountered at depth in BCV. However, several wells completed at depths of about 500 to 1,000 ft bgs in the Conasauga Shales monitor groundwater with TDS concentrations ranging from several thousand to several tens of thousand mg/L. This highly mineralized groundwater may represent a mixing zone or diffusion zone between the fresh and saline groundwater, suggesting that the aquiclude is present at greater depth in the BCV than in Melton Valley (Solomon et al. 1992).

5.3 Groundwater Flow Directions

Directions of groundwater flow in the East Fork Regime were evaluated from static water level measurements obtained from 140 monitoring wells during January 1994 (the seasonally high water table) and from 105 wells in August 1994 (the seasonally low water table); these measurements and the calculated water-level elevations for each well are tabulated in Appendix M of the Part 1 GWQR. Water level fluctuations averaged about 3 ft in most of the wells, with the largest decreases occurring in shallow wells completed in the water table interval. Additionally, the pattern of water level decrease was the same in all wells; thus there were no significant changes in groundwater flow directions (i.e., no reversal of horizontal hydraulic gradients).

Groundwater elevations in the water table interval (Figure 13) and bedrock (shallow and intermediate) intervals (Figure 14) during seasonally high and seasonally low groundwater flow conditions reflect surface topography, with steep gradients along the flanks of Pine Ridge and

Chestnut Ridge and a gentle slope northeast down the axis of BCV. The horizontal hydraulic gradient averages about 0.038 across BCV (strike-normal) in the Conasauga Shales and about 0.011 along the axis of BCV (strike-parallel) in the Maynardville Limestone.

The pattern of groundwater flow in the Conasauga Shales is toward the Maynardville Limestone, the hydrologic drain for the groundwater flow system in the regime. Flow in the Maynardville Limestone is generally along strike toward the east end of the Y-12 Plant. At the east end of the regime, flow directions apparently diverge with a shallow component of flow to the north following UEFPC through a water gap in Pine Ridge, and a deeper flow component to the east along strike in the Maynardville Limestone (as indicated by the presence of VOCs in wells located in Union Valley east of New Hope Pond).

Groundwater flow near Lake Reality is influenced by the cone of depression created during operation of the Lake Reality Sump (Figure 4). This 6-ft diameter, 20 ft deep sump was installed in CY 1990 and has been pumped to reduce hydraulic pressure (resulting from an upward hydraulic gradient) that caused the synthetic liner in Lake Reality to rise (see Section 2.2.4 in the Part 1 GWQR). Operation of the sump pump, automatically controlled by a pressure switch, was suspended between September 1991 and October 1993, then was returned to automatic control until December 1994. The sump was deactivated in December 1994 due to concerns regarding contamination in the discharge and potential for the sump to be classified as an NPDES outfall.

Because the liner had again risen along the edge of Lake Reality, the sump was temporarily reactivated in July 1995. To determine the pumping and recovery rates, the water level in the sump was monitored throughout a complete on-off cycle. The pump was on for 43 seconds, dropping the water level 0.43 ft, and was off for the next 143 seconds, which allowed the water level to recover to the original position. Based on the pumping cycle and the dimensions of the sump, pumping and recovery rates are estimated at 91.2, and 38.3 gpm, respectively (Jago 1995).

In addition to the pump-cycle monitoring, the depth-to-water in 11 water table wells and 19 bedrock wells was measured immediately before pumping (July 13, 1995) and then after 20 days of pumping (August 4, 1995). As shown by data from two well pairs located 600 ft apart, the horizontal gradient toward Lake Reality changed little in the water table interval, but nearly doubled in the bedrock interval.

	Well Number/ Groundwater Elevation		Horizontal Hydraulic Gradient
Water Table Interval	**GW-152**	**GW-148**	
July 13, 1995	901.11	899.21	0.0032
August 4, 1995	901.15	898.35	0.0047
Bedrock Interval	**GW-240**	**GW-149**	
July 13, 1995	901.61	897.32	0.0072
August 4, 1995	901.62	893.81	0.0130
Vertical Hydraulic Gradient	**GW-152/240**	**GW-148/149**	
July 13, 1995	0.045 (U)	0.053 (D)	
August 4, 1995	0.042 (U)	0.13 (D)	

Changes in the static water levels in each well show that pumping created an area of depression in the water table and bedrock intervals elongated parallel to strike, and a surprisingly large zone of influence (Figure 15). This drawdown pattern would be expected based on the conceptual model of groundwater flow in the Nolichucky Shale and Maynardville Limestone (Section 5.1). Water levels in wells completed in the bedrock interval of the Nolichucky Shale were most affected by pumping from the sump because the Nolichucky Shale has lower hydraulic conductivity than the Maynardville Limestone. The largest drawdown (-3.51 ft) occurred in bedrock well GW-149, completed in the Nolichucky Shale south of Lake Reality (Figure 15). Water levels in wells completed in the Maynardville Limestone were less affected by operation of the sump; several wells had higher water levels after pumping (shown by "+" on Figure 15).

5.4 Groundwater Geochemistry

Groundwater geochemistry in the East Fork Regime was evaluated using trilinear plots (Piper diagrams) of average annual concentration (in millequivalents per liter) of the principal cations and anions determined for each groundwater and surface water sample collected during CY 1994 (excluding the samples with charge balance errors noted in Section 4.2.3). Separate Piper diagrams were prepared to evaluate the geochemistry of groundwater in the Conasauga Shales (Figure 16) and the Maynardville Limestone (Figure 17).

Results of this evaluation support the geochemical evaluation presented as part of the current hydrogeologic model (Section 5.2.2). Although there are exceptions, data for most wells completed in the Conasauga Shales show that calcium-magnesium-bicarbonate groundwater in the water table and shallow bedrock interval changes to sodium-bicarbonate groundwater at a depth of approximately 100 ft bgs (Figure 16). The sodium-bicarbonate groundwater typically grades to a sodium-chloride groundwater at depths greater than 400 ft bgs, and TDS concentration increases with depth. However, no wells completed at this depth in the Conasauga Shales were sampled in CY 1994. Data for wells completed in the Rome Formation (along Scarboro Road in the gap through Pine Ridge) show that calcium-magnesium-bicarbonate groundwater occurs to depths of at least 400 ft bgs, and that sulfate increases with depth in this formation (Figure 16). Nearly every well completed at depths less than 300 ft bgs in the Maynardville Limestone monitors calcium-magnesium-bicarbonate groundwater (Figure 17).

Most atypical geochemistry observed in the CY 1994 data reflect natural variations in the Conasauga Shales and Maynardville Limestone. For instance, several shallow bedrock wells completed between 65 and 80 ft bgs in the Conasauga Shales (GW-744, GW-747, GW-764, GW-768, GW-781, GW-788, and GW-779), have elevated sodium concentrations (Figure 16). This geochemistry may reflect mixing of calcium- and sodium-dominated groundwater within a transitional zone between the two groundwater types. Elevated sodium concentrations reported for samples from shallow bedrock well GW-149, completed from about 36 to 51 ft bgs, is atypical for groundwater in the Maynardville Limestone (Figure 17). Although well GW-149 was reported to be completed in the Maynardville Limestone (Jones et al. 1994), subsurface data obtained during the installation of new wells to the east (GW-735 and GW-750) and west (GW-762 and GW-763) suggest that well GW-149 is completed in the transition zone between the Nolichucky Shale and the Maynardville Limestone.

Two types of groundwater, defined by the proportion of magnesium, were identified for wells completed in the Maynardville Limestone (Figure 17). Samples from 12 wells (two water table interval and 10 bedrock interval) with magnesium proportions greater than 30% suggest hydraulic connection with the Copper Ridge Dolomite. The water table interval wells (GW-252 and GW-255) are located on the flank of Chestnut Ridge near the S-2 Site, and the bedrock interval wells are generally located along the flank of Chestnut Ridge near New Hope Pond. According to Shevenell (1994), geochemical characteristics of the groundwater monitored by seven of these wells (GW-151, GW-153, GW-220, GW-240, GW-603, GW-604, and GW-733) indicate high hydraulic conductivity (quickflow). Two wells (GW-382 and GW-606) have monitored intervals with solution cavities. Only well GW-170, located in Union Valley, had high magnesium groundwater without documented evidence for quickflow hydraulic connection with the Copper Ridge Dolomite.

Well GW-232, completed at a depth of 412 ft bgs in the Maynardville Limestone about 2,800 ft east of New Hope Pond, monitors a sodium-bicarbonate groundwater not usually present in this formation (Figure 17). Because the monitored interval does not intercept fractures or solution cavities (Jones et al. 1994), it is possible that the well monitors stagnant groundwater in less permeable zones within the Maynardville Limestone.

Atypical geochemistry observed in some shallow wells may reflect impacts on groundwater quality from waste disposal or other activities in the regime. Groundwater samples collected from several water table and shallow bedrock wells in the Conasauga Shales contain high proportions (more than 20%) of chloride (GW-505, GW-632, GW-752, GW-760, GW-780, and GW-787), sodium and chloride (GW-631, GW-767, and GW-787), or sulfate (GW-505, GW-746, GW-787, and GW-792) (Figure 16). Elevated concentrations of these constituents are unusual for groundwater at shallow depths, and these results probably reflect impacts from a variety of industrial activities and processes within the Y-12 Plant. For example, the source of the high levels of sodium and chloride in groundwater may be salt used to de-ice roads and paved areas. Surface runoff containing dissolved salt may infiltrate through roadside gravel or leak from subsurface storm drains near these wells.

Groundwater with high proportions (>20%) of chloride and sulfate was reported for samples from several wells in the Maynardville Limestone (Figure 17). Elevated chloride concentrations were reported for samples from wells GW-380 and GW-381 near New Hope Pond. Sulfate-enriched groundwater (>20%) is monitored by well GW-617 downgradient from the S-2 Site, and well GW-154 near New Hope Pond. The geochemistry of the groundwater in these wells may reflect impacts on groundwater quality by industrial sources in the Y-12 Plant.

Unusual groundwater geochemistry has consistently been detected in samples from paired wells GW-619 and GW-620 located near the Fire Training Facility. Of the 19 samples collected from each of these wells since 1990, the charge balance RPD exceeded ± 10 % in all but three samples from GW-619 and six samples from well GW-620. The pH of these samples has consistently exceeded 10, and potassium to sodium ratios (about 3:1) are higher than typically observed in samples from other wells. This chemical composition may indicate contamination by cement grout used to construct the wells.

5.5 Surface Water System

Upper East Fork Poplar Creek drainage extends to near the western edge of the Y-12 Plant as a surface water drainage system. Drainage is contained in a network of underground collection pipes that extend to near the central area of the Plant, where the stormdrain system emerges above ground. The creek then flows along the southern boundary of the Plant complex and enters Lake Reality. From the outfall at Lake Reality, UEFPC passes north through a gap in Pine Ridge and exits the ORR.

During construction of the Y-12 Plant, all of the north-south tributaries to UEFPC were filled or routed through storm drains. Additionally, UEFPC was altered by construction of the storm sewer system at its headwaters and straightening of the original channel along the southeastern portion of the Plant complex (PEER Consultants 1989).

Surface water runoff from the Y-12 Plant is discharged to UEFPC through an extensive array of storm drains. Flow monitoring data indicate that over 70% of dry weather flow in UEFPC is attributable to once-through noncontact cooling water, condensate, and cooling tower blowdown, and over 31% can be attributed to groundwater infiltration (CDM Federal Programs Corporation 1994). Surface-water quality in UEFPC is monitored at Station 17 located downstream of Lake Reality (Figure 4) as a best-management practice by the Y-12 Clean Water Program and the ORR Environmental Monitoring Program (U.S. Department of Energy 1995).

6.0 GROUNDWATER QUALITY EVALUATION

Groundwater quality data obtained during CY 1994 are generally consistent with historical data; primary groundwater contaminant types in the East Fork Regime are VOCs, trace metals, nitrate, and radionuclides. The interpretive assumptions described in Section 4.0, were taken into consideration in evaluation of the CY 1994 data. Results of the evaluation of the data for the major groups of groundwater contaminants (VOCs, trace metals, nitrate, and radionuclides) are described in the following sections.

6.1 Volatile Organic Compounds

Chlorinated solvents are the most prevalent VOCs in the East Fork Regime and, in general, have migrated downgradient and intermingled in the Maynardville Limestone creating a continuous VOC plume that extends from the Western Plant Area to about 2,000 ft beyond the ORR boundary east (downgradient) of New Hope Pond (Figure 18). An apparently separate plume of chlorinated solvents occurs in shallow groundwater in the northern part of the Y-12 Salvage Yard near the Oil/Solvent Drum Storage Area and the Salvage Yard Drum Deheader (Figure 18).

Petroleum hydrocarbons occur in groundwater in the East Fork Regime, but only in isolated areas immediately surrounding or downgradient of UST sites at the Rust Garage Area near the west end of the regime, and two sites (Tanks 0134-U and 2331-U) in the Central Plant Area. Preliminary corrective actions achieved TDEC clean-up levels at Tanks 0134-U and 2331-U, and monitoring for UST program purposes at these sites was discontinued in CY 1993.

6.1.1 Chlorinated Solvents

Three general groups of dissolved chlorinated solvents occur in the groundwater in the East Fork Regime: (1) chloroethenes, (2) chloroethanes, and (3) chloromethanes (Figure 19). Chloroethenes are pervasive in groundwater throughout the regime and chloromethanes occur in groundwater in the Central and Eastern plant areas (primarily near New Hope Pond). Chloroethanes occur in isolated locations throughout the regime.

6.1.1.1 Chloroethenes

Three primary chlorethenes occur in the groundwater in the East Fork Regime: 1,2-DCE, PCE, and TCE (Figure 20).

<u>**Western Plant Area**</u>

Historic and CY 1994 data show that the primary chloroethenes in the Western Plant Area are 1,2-DCE and PCE (Figure 20) and that sources are located at the Fire Training Facility, the S-2 Site, the Oil/Solvent Drum Storage Area and the Salvage Yard Drum Deheader at the Salvage Yard, and the Waste Coolant Processing Area (Figure 21 and Table 11). Trichloroethene is a component of the VOC plume at many of these sites, but concentrations are generally much lower than concentrations of 1,2-DCE and PCE (Table 11). Samples from two wells at the Rust Garage Area (GW-631 and GW-633) have historically had PCE concentrations of 100 μg/L or less but, as shown by trace metal and radionuclide data (Sections 6.3.1 and 6.5), the source is apparently the S-3 Site in the Bear Creek Regime.

The CY 1994 data reported for wells GW-619 and GW-620 show that PCE and 1,2-DCE are the primary chloroethenes in the groundwater at the Fire Training Facility. While concentrations increased from those reported for the wells during CY 1993, an overall decreasing concentration trend since CY 1990 is still apparent. The more rapid decrease is observed for the groundwater monitored by well GW-619 (Figure 22). Well GW-619 is completed in the water table interval at a depth of about 41 ft bgs, and well GW-620 is completed in the shallow bedrock interval at a depth of 75 ft bgs. The more rapid concentration decrease in the shallower groundwater may be attributable to removal of the surficial source, dilution from stormwater, and vertical migration.

Results reported in CY 1994 and historic data for wells GW-251 and GW-253 indicate that the S-2 Site is a source of PCE and to a lesser extent TCE (Figure 20). The highest PCE concentrations have been detected in the groundwater at well GW-253, located less than 100 ft from the site; a concentration of 660 μg/L was detected during the second quarter of CY 1991 (the last time the well was sampled). Based on PCE and TCE data for bedrock well GW-251, concentrations at the site have consistently fluctuated, but have generally decreased since CY 1991 (Figure 22). Higher concentrations of PCE and TCE have been detected in wells of similar depths located west of this site, suggesting migration along strike from the Fire Training Facility; however, water-level elevations are generally 4 to 10 ft higher in these wells indicating that the S-2 Site is hydraulically upgradient.

A separate plume of mostly 1,2-DCE extends downgradient in the water-table interval from the Salvage Yard for about 1,000 ft east to the Beta 4 Security Pits (Figure 21). Although not sampled in CY 1994, 1,2-DCE has historically been detected in samples from water-table well GW-190 at the Salvage Yard. Concentrations have fluctuated from below the analytical detection limit to 1,100 μg/L since CY 1991, (Figure 23). This same compound has consistently been detected in samples from water-table well GW-192 at the Beta 4 Security Pits downgradient of well GW-190, but at concentrations generally an order of magnitude lower. In CY 1994, 1,2-DCE concentrations ranged from 15 to 23 μg/L.

The highest concentrations of chloroethenes occur in the groundwater located at the Waste Coolant Processing Area. For example, 1,2-DCE concentrations reported for well GW-337 ranged from 6,700 μg/L in the third quarter to 7,600 μg/L in the first quarter, whereas the highest 1,2-DCE concentration reported for the other wells in the Western Plant Area was

470 μg/L in the fourth quarter sample collected from well GW-620. The CY 1994 results reported for well GW-337 are consistent with historical data and show that chloroethene concentrations have remained relatively constant since the first quarter of CY 1991 (Figure 23).

Wells GW-617 and GW-618 are exit pathway wells that monitor groundwater in the water table interval about 300 ft downgradient of the Waste Coolant Processing Area. Tetrachloroethene, TCE, and 1,2-DCE concentrations for these wells were generally below 25 μg/L during CY 1994, but were about an order of magnitude higher in samples from well GW-618 than samples from well GW-617 (Table 11). Well GW-617 monitors groundwater between 6.8 and 18.0 ft bgs and well GW-618 monitors groundwater between 26.0 and 37.0 ft bgs, suggesting that migration of VOCs from the Waste Coolant Processing Area occurs primarily at deeper intervals.

Central Plant Area

Chloroethenes (primarily PCE) were detected in samples from nine wells in the Central Plant Area including five CMP grid wells (GW-781, GW-782, GW-783, GW-789, GW-791, and GW-792) installed in CY 1994 (Figure 20). Based on these results, potential source areas in the Central Plant Area are the Building 9204-2 and 9212 (Figure 21).

The highest PCE concentrations (420 to 3,500 μg/L) were reported for samples from well GW-791 at CMP grid D2. Conversely, PCE concentrations in samples from nearby well GW-792 were much lower, ranging from 8 to 14 μg/L. Well GW-791 monitors groundwater from 57.5 to 70.6 ft bgs and well GW-792 monitors groundwater from 17.0 to 29.0 ft bgs, suggesting that the source of the PCE is not within the immediate vicinity of these wells, but upgradient along strike to the west or updip to the north near Building 9212.

Tetrachloroethene, TCE, and 1,2-DCE are the primary component of the VOC plume in the groundwater at grid E3 (wells GW-781, GW-782, and GW-783), but 1,1-dichloroethene (1,1-DCE) and vinyl chloride are also present along with several chloroethanes and chloromethanes (Table 11). This particular plume composition is unique to these sampling locations suggesting that a separate source area is located nearby, probably at Building 9204-2 west of these wells. The Building 9204-2 area was suspected as a probable source of VOCs based on historic data for well GW-656 that showed TCE concentrations ranged from 8,600 to 17,000 μg/L and 1,1-DCE concentrations ranged from 1,500 to 3,300 μg/L.

Low concentrations of PCE and TCE (5 μg/L or less) have consistently been detected in samples from wells at grids G3 and H3 (Table 11) and may reflect eastward migration along strike from Building 9202.

Eastern Plant Area

Tetrachloroethene, TCE, and 1,2-DCE are pervasive in the groundwater near New Hope Pond (Figure 20 and 21). However, as shown on the following table, PCE concentrations are higher in the groundwater upgradient of this site, which indicates that a source of these compounds other than New Hope Pond may exist.

	Annual Average PCE Concentrations (μg/L)				
Well	**CY 1990**	**CY 1991**	**CY 1992**	**CY 1993**	**CY 1994**
Upgradient of New Hope Pond					
GW-222	30	13	.	.	6
GW-223	220	175	.	.	15
GW-382	125	208	205	217.5	280
GW-383	214	315	365	253	292.5
GW-762	.	.	840	955	755
GW-763	.	.	11	20.3	7.8

	Annual Average PCE Concentrations (μg/L)				
Well	**CY 1990**	**CY 1991**	**CY 1992**	**CY 1993**	**CY 1994**
Downgradient of New Hope Pond					
GW-151	16	15	15	20	21
GW-153	5	3	.	.	4
GW-220	9	12	22	28	33.5

Results for upgradient wells GW-222 and GW-223 suggest decreasing PCE concentrations, whereas results for the other upgradient wells indicate fluctuating but generally stable concentrations. Decreasing VOC concentrations in the groundwater at wells GW-222 and GW-223 is probably related to the closure of a 25 x 40 ft oil skimmer basin that received oils and floating debris diverted by a boom across the pond inlet. Direct hydraulic connection to the oil skimmer basin was observed during installation of these wells in CY 1988 (Geraghty & Miller, Inc. 1989c). PCE concentrations of 390 and 510 μg/L were reported for samples collected from wells GW-222 and GW-223, respectively, in the first quarter of CY 1988, but by the second quarter of CY 1991 the concentrations had decreased to 15 and 160 μg/L.

Data for well GW-762 suggest that another chloroethene source area other than the oil skimmer basin may be present within machining and storage facilities located in the Eastern Plant Area upgradient of New Hope Pond. This well is located upgradient of the oil skimmer basin and monitors groundwater with higher chloroethene concentrations (particularly PCE) than the wells located near the oil skimmer basin (Table 11). In addition, the screened interval for this well is in the Nolichucky Shale, whereas the screened intervals for wells GW-222 and GW-223 are in the Maynardville Limestone. Furthermore, 1,1-DCE and vinyl chloride were detected in the samples from well GW-762, but not in samples from GW-222 and GW-223.

Both PCE and TCE were detected in the samples collected during CY 1994 from a paired well cluster (GW-169 and GW-170) located in Union Valley about 1,000 ft east of the ORR boundary (Figure 21), which suggests a hydraulic connection with the VOC plume in the bedrock at the eastern end of the East Fork Regime. Historically, concentrations reported for both wells have generally remained below 10 μg/L with no apparent trend.

Evaluation of data reported for samples collected from 20 seeps and springs in October 1994 for an interim study of Union Valley also indicates that chlorinated solvents have migrated beyond the ORR boundary (CDM Federal Programs Corporation 1995a). Samples from three springs located about 1,000 feet east of wells GW-169 and GW-170 contained VOCs representative of those found upgradient in the East Fork Regime; TCE was detected in the sample from location SCR7.1SP and PCE was detected in the samples from locations SCR7.8NSP and SCR7.8SSP (Figure 21). Concentrations were estimated and ranged from 2 to 6 μg/L.

Although 1,2-DCE was detected in the groundwater samples collected during CY 1994 from well GW-230 (Table 11), located about 3,500 ft east of the ORR boundary, data reported for nearby well GW-232 and several spring/surface water samples suggest that the occurrence of this compound is not related to the VOC plume in the East Fork Regime. Both wells have similar screened intervals (341.0 to 406.4 ft bgs and 401.0 to 411.7 ft bgs, respectively), and no VOCs, other than false positive results for laboratory reagents, have historically been detected in samples from well GW-232. In addition, VOC concentrations reported for the samples from the spring and surface water sample locations near this well did not exceed analytical detection limits. Low concentrations of 1,2-DCE were detected in samples from wells (GW-169 and GW-170) clustered with well GW-232; however, these wells monitor groundwater above 156 ft bgs. A groundwater flow divide west of well GW-230, coincident with Scarboro Creek and a gap in Chestnut Ridge, probably restricts transport of VOCs from the ORR further east.

6.1.1.2 Chloroethanes

Concentrations of 1,1,1-TCA and 1,1-DCA were detected in samples from wells located in each part of the regime: wells GW-337 and GW-192 in the Western Plant Area, wells GW-781, GW-782, and GW-783 at CMP grid E3 in the Central Plant Area, and wells GW-151, GW-605, GW-658, and GW-762 in the Eastern Plant Area (Figure 21). Summed average concentrations determined for well GW-337, the wells at CMP grid E3, and well GW-658 generally exceeded 10 μg/L; however, concentrations reported for the other wells were lower (<2 μg/L) (Table 11). Probable sources of these compounds in the Western Plant Area are the Y-12 Salvage Yard Drum Deheader and the Waste Coolant Processing Area (Figure 21). The source of 1,1,1-TCA and 1,1-DCA in the groundwater at wells in the Central Plant Area and near New Hope Pond is most likely located near buildings 9204-2 and 9206 (Figure 21). A separate source of chloroethanes near the Building 9754-2 Fuel Facility has been confirmed by the consistent detection of 1,2-DCA in groundwater samples collected from well GW-658 since the fourth quarter of CY 1991 (Figure 21).

6.1.1.3 Chloromethanes

Carbon tetrachloride and chloroform are the primary chloromethanes in the groundwater in the East Fork Regime (Figure 24).

<u>**Western Plant Area**</u>

Carbon tetrachloride and chloroform were detected at low concentrations (<13 μg/L) in samples collected during CY 1994 from only one well (GW-251) in the Western Plant Area (Table 11). This well monitors groundwater at the S-2 Site which, as previously discussed, is a source of other VOCs. Low concentrations of chloroform have consistently been detected in samples collected since CY 1991 from well GW-255, which is located on the southern side of the S-2 Site (Figure 24). Carbon tetrachloride was previously detected in groundwater monitored by a three well cluster (GW-278, GW-279, and GW-280) near the Interim Drum Yard. These wells were last sampled in 1987, and concentrations ranged from 62 μg/L in the second quarter sample collected from the water-table well (GW-278) to 820 μg/L in the shallow bedrock well (GW-279).

Central Plant Area

Carbon tetrachloride was detected in samples collected during CY 1994 from three wells (GW-769, GW-782, and GW-783) and chloroform was detected in samples from six wells (GW-769, GW-770, GW-776, GW-782, GW-783, and GW-789) located within the Central Plant Area (Table 11). Except for the carbon tetrachloride concentrations (18 μg/L and 16 μg/L) reported for well GW-782, all of the concentrations for both compounds were below 10 μg/L. Buildings 9204-2, 9202, 9203, and 9205 are probable sources of VOCs within the Central Plant Area.

Methylene chloride has been detected in samples from wells GW-193 and GW-708 at tank 2331-U near building 9201-2; concentrations in these samples are generally below 100 μg/L, but have been as high as 1,600 μg/L. It is possible that a source of methylene chloride is nearby, but the results are always reported for diluted samples, indicating laboratory contamination may be causing false positive results.

Eastern Plant Area

Carbon tetrachloride and chloroform are the most prevalent VOC compounds in the Eastern Plant Area, and occur mostly in groundwater in the Maynardville Limestone (Figure 25). The most likely sources are 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); spills along the railway that roughly parallels the UEFPC are also likely sources. As shown on the following table, annual average carbon tetrachloride concentrations determined for wells downgradient of New Hope Pond have generally increased, whereas the opposite trend is evident for wells upgradient of the site.

	Annual Average Carbon Tetrachloride Concentrations (μg/L)				
Well	**CY 1990**	**CY 1991**	**CY 1992**	**CY 1993**	**CY 1994**
Upgradient of New Hope Pond					
GW-222	5	0	.	.	0
GW-223	48.8	28	.	.	1.0
GW-381	6,850	6,475	5,675	5,825	4,800
GW-382	5,322	5,425	5,105	5,125	6,225
GW-383	15.3	8.3	4.3	1.8	1.5
GW-605	.	23.5	110	140	128
GW-606	.	2700	1078	738	680
Downgradient of New Hope Pond					
GW-151	358	272.5	312.5	420	420
GW-153	168	81	.	.	100
GW-220	150	215	340	372.5	370
GW-240	14.3	9.8	10.3	10.8	10.8
GW-733	.	.	22.3	70	39.5

The substantially higher carbon tetrachloride and chloroform concentrations reported for upgradient wells GW-381 and GW-382 indicate that New Hope Pond is not the principal source of these compounds. Evidence of upgradient sources also is provided by CY 1994 results from wells GW-605, GW-606, GW-769, GW-770, GW-782, and GW-783 (Table 11). These wells monitor groundwater 1,500 to 5,000 ft upgradient from New Hope Pond and, except for wells GW-782 and GW-783, monitor groundwater containing VOCs dominated by carbon tetrachloride and chloroform (Table 11).

Note that the carbon tetrachloride concentrations in the groundwater monitored by wells GW-151 and GW-220 have generally increased since CY 1991. This concentration increase coincides with the operational history of the Lake Reality Sump. Groundwater has been pumped intermittently from a depth of about 20 ft bgs in the sump to reduce hydrostatic pressure below the synthetic liner installed in Lake Reality. As noted in Section 5.3, pumping has induced groundwater flow toward the sump and consequently increased VOC concentrations in the groundwater monitored by wells GW-151 and GW-220. The Lake Reality sump was temporarily reactivated in July 1995 in response to a rise in the liner along the edge of Lake Reality. To determine if operation of the sump was affecting the migration of the VOC plume, groundwater samples were collected from the sump after one day of pumping (July 14, 1995) and after 34 days of pumping (August 17, 1995). Carbon tetrachloride concentrations increased over this time period from an estimated value of 2 μg/L to 13 μg/L. Although not initially detected, chloroform and PCE also were detected in the sample collected in August at estimated concentrations of 2 and 5 μg/L, respectively. These concentration increases corroborate the data reported for well GW-220 and GW-151.

Carbon tetrachloride and chloroform also have been historically detected in samples from well GW-170 in Union Valley; carbon tetrachloride concentrations have remained fairly stable, averaging 74 μg/L in CY 1991 and 68.7 μg/L in CY 1994. In contrast, average chloroform concentrations increased during the same time period from 9.0 to 58.7 μg/L, which may be related to degration of the carbon tetrachloride.

Carbon tetrachloride also was detected in surface water samples from spring location SCR7.1SP (Figure 25). Concentrations were reported as estimated values and ranged from 2 to 6 μg/L (CDM Federal Programs Corporation 1995a). The presence of these VOCs further suggest a hydraulic connection with the VOC plume at the east end of East Fork Regime.

The vertical extent of VOCs in the Eastern Plant Area is indicated by data from 10 sampling ports within well GW-722 that monitor discrete vertical intervals within the Maynardville Limestone. These data show that VOC concentrations vary with depth, and, as shown by carbon tetrachloride data, the lower boundary of the VOC plume generally occurs at 560 ft bgs (Figure 25). Data reported for wells GW-170 and GW-232 indicate that the vertical extent of VOCs is shallower to the east of the ORR boundary; VOCs were detected in the groundwater at well GW-170, screened from 104.0 to 156.9 ft bgs, but not in the groundwater at nearby well GW-232, which is screened from 401.0 and 411.7 ft bgs.

6.1.2 Petroleum Hydrocarbons

In CY 1994, petroleum hydrocarbons (benzene, toluene, ethylbenzene, and xylenes [BTEX]) were detected in samples collected during the first quarter of CY 1994 from wells GW-508, GW-632, GW-633, and GW-634 located near USTs at the Rust Garage Area. Summed BTEX concentrations were 51,200 μg/L, 20,850 μg/L, 11 μg/L, and 3,830 μg/L, respectively (Figure 19). Historical data for well GW-633 show fairly stable summed BTEX concentrations ranging between 2 μg/L (second quarter of CY 1991) and 24 μg/L (third quarter of CY 1993). In contrast, summed average BTEX concentrations determined for nearby wells GW-508 and GW-634 have decreased from CY 1991 highs of 113,600 and 11,200 μg/L, respectively, whereas summed BTEX concentrations determined for well GW-632 have increased over this same period from a CY 1991 low of 7,979 μg/L to a high of 20,850 μg/L in CY 1994.

6.2 Semi-Volatile Organic Compounds

Samples collected during the third and fourth quarters of CY 1994 from six exit pathway wells in Union Valley and two surface water stations 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. Four compounds were detected (Table 12): di-n-butylphthalate in samples from all eight sampling locations, bis(2-ethylhexyl)phthalate and pentachlorophenol in the fourth quarter sample from well GW-172, and phenol in the third quarter samples from wells GW-169, GW-170, and GW-232. However, compounds detected in all but the fourth quarter sample from well GW-172 also were detected in the associated laboratory blank samples (Table 12). The occurrence of these compounds in the associated laboratory blanks indicates that these results are probably analytical artifacts (QA/QC sample data needed to identify false positive results were not available). Estimated concentrations below the respective analytical detection limits were reported for bis(2-ethylhexyl)phthalate (3 μg/L) and pentachlorophenol (2 μg/L) in the fourth quarter sample from well GW-172, but neither compound was detected in the sample collected in the third quarter, suggesting that these results also are probable laboratory artifacts or anomalous.

6.3 Trace Metals

As described in Section 4.2.2.3, evaluation of groundwater quality with respect to trace metal concentrations was based on median concentrations compared to one of two types of reference values: calculated UTLs or MCLs for drinking water. Results of this comparison, summarized below, show that the median concentration of 15 metals determined for samples from 55 wells and two surface water points in the East Fork Regime exceeded the applicable reference value.

Metal	Number of Wells	Metal	Number of Wells
Boron	27	Uranium	6
Vanadium	16	Chromium	5
Manganese	12	Strontium	3
Zinc	10	Cadmium	2
Iron	9	Lead	1
Cobalt	7	Barium	1
Copper	7	Mercury	1
Aluminum	7		

Review of the data for these metals suggests that few of the elevated median concentrations reflect groundwater contamination. For example, the apparent widespread occurrence of elevated boron and vanadium concentrations is probably the result of overly conservative reference concentrations applicable to most of the wells in the regime (Table 8). Additionally, the elevated median concentrations determined for some of the other metals listed above reflect probable sampling or analytical artifacts relating to: (1) preservation (acidification) of turbid groundwater samples; (2) potential analytical interferences; and (3) corrosion of steel and stainless steel well casing and screen. Similar conclusions regarding sampling and analytical artifacts were reached from a detailed analysis of CY 1990 through CY 1993 trace metal data (HSW Environmental Consultants, Inc. 1994). Trace metal results reported for the wells sampled during CY 1994 are consistent with this interpretation of the historical data, but also indicate that total boron concentrations reported for several wells, including three new CMP grid wells, may reflect impacts on groundwater quality.

6.3.1 Western Plant Area

Elevated trace metal concentrations have consistently been reported for 18 wells located within the Western Plant Area, most of which are located east of the S-3 Site in the general vicinity of the Y-12 Plant Salvage Yard, or near the S-2 Site (Table 13).

Y-12 Plant Salvage Yard

Groundwater in the vicinity of the Y-12 Plant Salvage Yard has been impacted by disposal of acidic wastewater at the S-3 Site; the pH of the groundwater samples collected from wells in this area is typically less than 5.5. Monitoring data obtained since CY 1990 indicate that the principal trace metal contaminants in the groundwater are barium, boron, cadmium, cobalt, copper, mercury, strontium, and uranium. Some of these metals (e.g., uranium) were probably entrained in the acidic wastewater disposed at the site, and others (e.g., barium) were probably dissolved from the underlying saprolite and bedrock (particularly carbonates). The low pH groundwater in this area also is characterized by dissolved metal concentrations that exceed applicable MCLs or UTLs; dissolved metal concentrations in groundwater elsewhere in the regime rarely exceed analytical detection limits. Thus, the Western Plant Area is probably the only part of the East Fork Regime where an actual plume of dissolved metal ions and/or ionic complexes is present in the groundwater.

Six monitoring wells near the Y-12 Plant Salvage Yard, each located at the Rust Garage Area (GW-505, GW-508, GW-631, GW-632, GW-633, and GW-634), were sampled for UST monitoring purposes during the first quarter of CY 1994 (Table 2). Elevated concentrations of one or more of the following metals were reported for these samples (Table 14): barium (GW-633), cobalt (GW-508, GW-631, GW-632, and GW-634), strontium (GW-633), and uranium (GW-505 and GW-633). These CY 1994 results, in conjunction with historical data for other wells in the area (GW-105, GW-108, GW-109, GW-274, and GW-275) that were not sampled during CY 1994, show overall decreasing concentrations since closure of the S-3 Site in CY 1988. This decreasing trend is illustrated by total barium and strontium concentrations reported for samples collected from well GW-633 (Figure 26). Additionally, concentrations of both metals have decreased more rapidly in the shallow groundwater than in the groundwater at greater depths. This pattern would be expected based on the conceptual model of groundwater flow in the Conasauga Shales; flushing by natural recharge and discharge cycles in the more permeable and hydrologically active water table interval would tend to more quickly reduce contaminant concentrations in the shallow groundwater system (Shevenell et al. 1994).

S-2 Site

A detailed evaluation of historical groundwater monitoring data showed that the groundwater in wells at the S-2 Site contains elevated concentrations of one or more of the following metals: cadmium, cobalt, copper, lead, mercury, and uranium (HSW Environmental Consultants, Inc. 1994). Wells GW-251, GW-252, and GW-255 at the S-2 Site were sampled during CY 1994 (Table 2), and elevated trace metal concentrations were reported for the samples collected from well GW-251 (cadmium, cobalt, and copper) and well GW-255 (copper) (Table 14). Results of a preliminary investigation performed in CY 1986 showed that cadmium, cobalt, and copper, concentrations exceed 800, 150, and 60,000 micrograms per gram (μg/g), respectively, in soils at the site (Gianfrancesco et al. 1988).

Total cadmium concentrations (AAS analyses) reported for well GW-251 decreased from 0.15 mg/L in the first quarter of CY 1994 to 0.072 mg/L in the fourth quarter (the median concentration was 0.125 mg/L). Historical data show that total cadmium concentrations reported for every unfiltered sample collected from well GW-251 since the first quarter of CY 1990 have exceeded the 0.005 mg/L MCL. Review of these data indicate that the cadmium concentrations have generally decreased and show apparent seasonal fluctuations; concentrations are generally highest in samples collected during the second quarter of each year, and lowest in samples collected during the fourth quarter of the year (Figure 26). Total cobalt concentrations reported for well GW-251 show a similar trend; concentrations decreased from 0.039 mg/L in the first quarter to 0.0096 in the fourth quarter of CY 1994 (the median concentration was 0.0285 mg/L), and the concentrations reported since CY 1990 display apparent seasonal fluctuations (Figure 26).

Only wells at the S-2 Site consistently yield groundwater samples with elevated total copper concentrations. Median copper concentrations determined from CY 1994 results were 0.71 mg/L for well GW-251, and 0.071 mg/L for well GW-255. Total copper concentrations reported for well GW-251 have consistently exceeded the 0.012 mg/L UTL, and concentration fluctuations are generally similar to those for total cadmium and cobalt concentrations (Figure 26). Total copper concentrations reported for well GW-255 have exceeded the UTL in all five of the samples collected from the well since the third quarter of CY 1993.

Total cadmium concentrations reported for each sample collected from well GW-618 during CY 1994 exceeded the 0.005 mg/L MCL for drinking water; concentrations ranged from 0.018 to 0.022 mg/L (the median concentration was 0.022 mg/L). Similar dissolved cadmium concentrations were also reported for the filtered groundwater samples collected from this well. The S-2 Site, located about 700 ft directly west of well GW-618, may be the source of the cadmium. Well GW-618 is completed at a depth of 37 ft bgs in the Maynardville Limestone, and the elevation of the midpoint of the monitored interval (951.1 ft msl) is very close to that of well GW-251 (958.6 ft msl). Seasonal water level elevations in well GW-618 are typically about 20 ft lower than in well GW-251, indicating a fairly steep horizontal hydraulic gradient (about 0.03) between the wells. Cobalt and copper concentrations reported for well GW-618 do not exceed the applicable UTLs, and total and dissolved cadmium concentrations reported for well GW-617, a shallower well (18 ft bgs) paired with GW-618, rarely exceed the analytical detection limit. If the elevated cadmium concentrations occur in the groundwater monitored by well GW-618 as a result of transport from the S-2 Site, the lack of elevated cobalt and copper concentrations suggests that these metals are less mobile than cadmium. Additionally, the low total and dissolved cadmium concentrations reported for well GW-617 suggest that contaminants from the S-2 Site may travel along deeper migration pathways in the Maynardville Limestone.

The median boron concentration determined for wells GW-617 (0.33 mg/L) and GW-618 (0.19 mg/L) exceeded the Cluster 1 UTL (0.12 mg/L). Boron concentrations reported for these wells have generally increased since the second quarter of CY 1990, and have exceeded the 0.12 mg/L UTL since the second quarter of CY 1994 (Figure 27). The S-2 Site is probably not the source of the boron in the groundwater monitored by these wells because total boron concentrations reported for wells at the site are much lower, typically 0.057 mg/L or less.

6.3.2 Central Plant Area

A detailed evaluation of trace metal data reported for wells in the Central Plant Area that were sampled between CY 1990 and CY 1993 indicated possible trace metal contamination in the groundwater monitored by the following wells: GW-193 at Tank 2331-U (uranium), GW-204 at Tank 0143-U (cobalt), and GW-282 (cadmium) and GW-284 (cobalt) at the Building

9754-2 Fuel Facility (HSW Environmental Consultants, Inc. 1994). None of these wells were sampled during CY 1994.

Results reported for wells that were sampled during CY 1994 suggest elevated total boron concentrations in wells GW-781, GW-788, and GW-789 potentially reflect impacts on groundwater in the vicinity of CMP grids E3 and F3 (Table 14). Total boron concentrations reported for these wells ranged from 0.075 to 1.5 mg/L. The highest median boron concentration (1.2 mg/L) was determined for well GW-788 at CMP grid F3 and is an order-of-magnitude higher than median boron values determined for all other wells in the East Fork Regime that were sampled during CY 1994. The median boron concentration determined for well GW-789 (0.12 mg/L), a shallower well paired with GW-788, is much lower, but is nevertheless one of the highest values that exceed the UTL for Cluster 3 wells (0.041 mg/L). The highest median boron concentration (0.43 mg/L) among wells in Cluster 3 was determined for well GW-781 at CMP grid E3. The median boron concentrations for the two shallower wells (GW-782 and GW-783) at CMP grid E3 did not exceed the UTL. Only three samples have been collected from these wells and continued monitoring will be necessary to discern any concentration trends.

6.3.3 Eastern Plant Area

Detailed evaluation of historical trace metal data for wells in the Eastern Plant Area sampled between CY 1990 and CY 1993 indicated elevated concentrations in six wells for the following trace metals: lead (GW-167 and GW-169), mercury (GW-222), strontium (GW-744), and uranium (GW-154, GW-222, and GW-605) (HSW Environmental Consultants, Inc. 1994). The CY 1994 data are consistent with these findings with the exception of the mercury results for well GW-222, and lead data for wells GW-154 and GW-169. Additionally, elevated concentrations of boron were reported for several wells during CY 1994 and may reflect impacts on groundwater quality.

The median mercury concentrations determined for samples collected during CY 1994 from well GW-154 at New Hope Pond exceeded the MCL (0.002 mg/L). Total mercury concentrations reported for this well have increased from below the detection limit (0.0002 mg/L) in the fourth quarter of CY 1990 to 0.019 mg/L in the fourth quarter of CY 1994 (Figure 28). In contrast, mercury concentrations reported for well GW-222 (a deeper well paired with GW-154) decreased from 0.00361 mg/L in the fourth quarter of CY 1990 to below the analytical detection limit in all samples collected since the first quarter of CY 1991 (Figure 28). The source of mercury in groundwater monitored by the well GW-154 is probably the UEFPC; direct hydraulic connection with a basin located north of the inlet to New Hope Pond was observed during installation of the well (see Section 6.1).

Median strontium concentration determined for CMP grid well GW-744 (1.0 mg/L) exceeded the Cluster 3 UTL (0.92 mg/L). Total strontium concentrations reported for this well GW-744 have increased since the fourth quarter of CY 1992, and exceeded the UTL in all the samples collected during CY 1994 (Figure 27). Gross beta activity reported for well GW-744 is low (less than 10 pCi/L) and does not show an increasing trend similar to the trend observed for strontium concentrations; therefore, the elevated concentrations may reflect strontium locally dissolved from the bedrock. As shown by data from the two shallower wells also located at grid K1, strontium concentration in groundwater appears to increase with depth (Figure 27). Strontium concentrations reported for bedrock well GW-745 (about 47 ft shallower than GW-744) have increased similarly to GW-744, but are consistently lower. Furthermore, concentrations reported for water table well GW-746 have been an order-of-magnitude lower than the strontium concentrations reported for well GW-745 (Figure 27).

The median strontium concentration for exit pathway well GW-816 (0.089 mg/L), located along Scarboro Road in the gap in Pine Ridge, exceeded the Cluster 4 UTL of 0.079 mg/L (Table 14). Gross beta activity in the third quarter sample from the well (16.1 ± 6.4 pCi/L) passed the evaluation criteria, although it did not exceed the 50 pCi/L MCL. Water table interval well GW-816 was installed in CY 1994 to replace well GW-206, both of which are within 20 ft of each other, adjacent to UEFPC, have similarly shallow monitored intervals and median strontium concentrations (CY 1994 median determined for GW-206 is 0.104 mg/L).

The highest median uranium concentrations were determined for wells GW-154 (0.465 mg/L), GW-222 (0.051 mg/L), and GW-605 (0.228 mg/L). These results are consistent with findings of previous assessments, and samples from these wells also have elevated gross alpha activity (see Section 6.5). The source of the uranium in the groundwater monitored by well GW-605 is most likely located within the Central Plant Area upgradient (west) of the well. As with elevated mercury concentrations, the source of uranium in groundwater monitored by wells GW-154 and GW-222 is probably the former basin located north of the inlet to New Hope Pond that was observed to be hydraulically connected with these wells. Total uranium concentrations reported for wells GW-154 and GW-222 have decreased since CY 1990 (Figure 28).

Median boron concentrations determined for exit pathway wells GW-208 (0.22 mg/L) and GW-605 (0.19 mg/L) exceeded the Cluster 1 UTL (0.12 mg/L). Furthermore, median boron concentrations determined for exit pathway wells (GW-744, GW-747, GW-752, and GW-768) and two surface water sampling points (LRS and LRSPW) exceeded the Cluster 3 boron UTL of 0.41 mg/L, and Scarboro Road exit pathway well GW-816 (0.044 mg/L) exceeded the Cluster 4 boron UTL (0.028 mg/L). Whether the results reported for these sampling points represent overly conservative UTLs, potential analytical artifacts, or actual groundwater quality conditions is unclear based on available data.

6.4 Nitrate

Nitrate is pervasive only in the groundwater in the Western Plant Area near the primary source areas (the S-3 Site and the S-2 Site). Although the S-3 Site lies west of the groundwater flow divide that separates the Bear Creek Regime and the East Fork Regime, operation of the site created a mound in the water table that enabled contaminants (chiefly nitrate, metals, and radionuclides) to migrate across the divide. During transport along preferential flow paths (along-strike and downdip), nitric acid from the S-3 Site probably enhanced permeability in the Nolichucky Shale by dissolving secondary calcite in pore spaces and etching fracture walls. Since termination of waste disposal at the S-3 Site in CY 1984, the mound in the water table is no longer present (Figure 13), and nitrate introduced into the intermediate and deep bedrock intervals downdip of the S-3 Site is now relatively immobile.

Many of the wells that monitor nitrate contaminated groundwater in the Western Plant Area were not sampled during CY 1994. Comparison of the maximum nitrate concentrations reported for samples collected from these wells during CY 1986 to the most recent data for these wells (January 1990) indicates decreasing concentration trends, particularly in the groundwater monitored by water table wells GW-105, GW-107, and GW-270.

Well	**Interval**	**Nitrate Concentration (mg/L)**		**% Decrease**
		CY 1986	**CY 1990**	
GW-105	WT	2,619	921	65
GW-106	WT	1,158	706	39
GW-107	WT	43	21	51
GW-108	WT	16,889	13,100	22
GW-109	BDR	11,700	9,960	15
GW-270	WT	549	136	75
GW-274	WT	15,800	10,900	31
GW-275	BDR	9,400	8,770	7

Shevenell et al. (1994) interpret the decreasing nitrate concentrations to indicate that the primary source of the nitrate essentially lies within the unfractured rock matrix near the S-3 Site. The large mass of nitrate introduced into the groundwater system during site operations produced a significant concentration gradient between contaminated water in the fractures and the water in the less permeable, but more porous, rock matrix. This concentration gradient induced molecular diffusion of nitrate (and probably other contaminants) from the fractures into the rock matrix. The concentration gradient between groundwater in the fractures and the rock matrix subsequently reversed after waste disposal was discontinued in CY 1984. Nitrate (and other contaminants) now diffuses from the matrix into the fractures and is subsequently flushed out of the shallow groundwater flow system by natural recharge and discharge cycles (Shevenell et al. 1994).

Average nitrate concentrations determined for two wells sampled during CY 1994 exceeded the 10 mg/L MCL: water table interval well GW-633 (861 mg/L) located at the Rust Garage Area about 700 ft east of the S-3 Site, and bedrock monitoring well GW-251 (104 mg/L), located near the S-2 Site. The nitrate concentration reported for well GW-633, which was sampled only during the first quarter of CY 1994, was similar to the fourth quarter 1993 result (846 mg/L), both of which reflect a sharp decrease in nitrate concentrations from previous sampling events; nitrate concentrations ranged from about 3,300 to 5,500 mg/L in samples collected from this well between the first quarter of CY 1991 and the third quarter of CY 1993 (Figure 29). Nitrate concentrations reported for samples from well GW-251 also decreased sharply from 244 mg/L during the third quarter of CY 1994 to below the detection limit of 0.2 mg/L in the fourth quarter (Figure 29). The significant reduction in nitrate concentrations for both of these wells appears unrelated to flow conditions. For example, the highest and lowest nitrate concentrations in groundwater at well GW-251 occurred when the water level in the well was relatively low.

The nitrate plume in the water table interval extends eastward from the S-3 Site to beyond the Waste Coolant Processing Area, and southeastward to a topographic high located east of the S-2 Site (Figure 30). The shape of the nitrate plume in the water table interval indicates that buried stream channels that were formerly part of the headwaters of UEFPC before construction of the Y-12 Plant significantly influence the movement of nitrate in the shallow groundwater east of the S-3 Site (Figure 30). For example, the groundwater sample collected from water table well GW-105 during the first quarter of CY 1990 had a nitrate concentration of 921 mg/L; however, nitrate concentrations reported for samples from well GW-505, which is located about 200 ft immediately downgradient of well GW-105, have not exceeded 3 mg/L. The abrupt decrease in the nitrate concentration over this short distance is probably caused by a buried stream channel believed to be located between the wells. This filled drainage feature apparently forms a highly permeable flow path that channels the shallow groundwater to the southeast toward well GW-633 (HSW Environmental Consultants, Inc. 1991).

Nitrate concentrations exceeded 100 mg/L in samples collected during CY 1994 from basement sumps in three buildings (9204-4, 9201-5, and 9201-4) located north and northeast of the Waste Coolant Processing Area (Figure 30). These samples were collected to assess the quality of the water discharged by these sumps to UEFPC (CDM Federal Programs Corporation 1995b). The configuration of the nitrate plume beneath these buildings suggests two possible source areas: eastward, along-strike migration from the S-3 Site, and/or a leak from the Abandoned Nitric Acid Pipeline north of Building 9204-4.

In the bedrock interval, the nitrate plume extends for a similar distance east of the S-3 Site in the Nolichucky Shale (Figure 30). However, in the Maynardville Limestone, the nitrate plume may extend beneath the topographic high that apparently defines the eastward extent of the plume in the water table interval. The most recent data (first quarter of 1990) available for wells GW-109 and GW-275 indicate that nitrate concentrations exceed 5,000 mg/L in the bedrock along strike east of the S-3 Site.

6.5 Radioactivity

As noted in Section 4.2.5, only 10% of the CY 1994 radioanalyte data passed the data evaluation criteria regarding negative values, MDAs, and counting errors; consequently, gross alpha and gross beta activity plume maps are not presented as in previous years. However, CY 1994 results are generally similar to historical data, indicating that the principal source of alpha- and beta-emitting radioisotopes in the East Fork Regime are the S-3 Site and the S-2 Site. Because these sites also are the principal sources for highly mobile nitrate in groundwater, the extent of nitrate in the water table and bedrock intervals (Figure 30) is a conservative representation of the extent of alpha- and beta-emitting radioisotopes in the Western Plant Area. Evidence for one or more unidentified sources of radionuclides within the Central Plant Area (not associated with nitrate concentrations) is provided by elevated gross alpha and gross beta activities in samples from monitoring wells located hydraulically upgradient from New Hope Pond.

6.5.1 Alpha Radioactivity

As shown in the following table, annual average gross alpha activity determined for samples from six wells exceeded 15 pCi/L during CY 1994.

Sampling Point	Location	CY 1994 Annual Average Gross Alpha Activity	Number of Samples	
			Passed Criteria	Total Collected
GW-154	NHP	443 ± 51	1	1
GW-206	EXP-SR	26 ± 6	1	4
GW-222	NHP	20 ± 5	1	1
GW-505	RG	15 ± 4	1	1
GW-605	EXP-I	110 ± 44	4	4
GW-782	GRIDE3	27 ± 10	3	3

Only one of four quarterly samples from well GW-206 met evaluation criteria, and the gross alpha activity reported for this sample was most likely caused by analytical interferences associated with the excessive amounts of particulates in this sample. The TSS concentration reported for the first quarter sample was 1,384 mg/L, compared to 55 to 156 mg/L for the other samples collected from this well during CY 1994. Furthermore, total uranium concentrations reported for well GW-206 were very low (less than or equal to the reporting limit).

High TSS concentrations (greater than 1,000 mg/L) reported for well GW-206 since CY 1991 (Figure 31) probably result from an inadequate annular seal that allows surface runoff to enter the well. Well GW-816, located about 25 ft southeast of well GW-206, monitors a similar depth interval (Table 3) and was installed in CY 1994 to potentially replace well GW-206. Gross alpha activities reported for well GW-816 through the second quarter of CY 1995 have not exceeded 15 pCi/L, and the TSS concentrations are consistently lower than the levels reported for well GW-206 (Figure 31).

The CY 1994 first quarter sample from well GW-505 had gross alpha activity similar to the annual average activity for CYs 1991 through 1993 (13 ± 1 pCi/L to 16 ± 3 pCi/L). Results for this well suggest that alpha-emitting radionuclides have migrated in the water table interval about 700 ft eastward from the S-3 Site.

The source of elevated gross alpha activity in the groundwater monitored by well GW-782, installed at CMP grid E3 in CY 1994, has not been identified. However, elevated gross alpha activity (62 ± 4 pCi/L) was reported for CY 1993 samples from well GW-204, located at Tank 0134-U about 700 ft hydraulically upgradient from well GW-782. Gross alpha activity in samples from these wells may indicate migration from a common source within the Central Plant Area.

The annual average gross alpha activity determined for bedrock interval well GW-605 shows that radionuclides occur in groundwater at a depth of 40 ft bgs in the Maynardville Limestone hydraulically upgradient of New Hope Pond. Results for well GW-606, which is paired with well GW-605 and is completed from about 155 to 172 ft bgs, further suggest that gross alpha activity (6 ± 1 pCi/L) in groundwater decreases with depth in the Maynardville Limestone.

Paired wells GW-154 (water table interval) and GW-222 (shallow bedrock interval) are located upgradient and next to New Hope Pond (Figure 4). Gross alpha activities reported for these wells (sampled only in the fourth quarter of CY 1994) were an order-of magnitude higher in the water table interval (443 ± 51 pCi/L) than in the shallow bedrock interval (19.7 ± 5.1 pCi/L). As described in Section 6.1, direct hydraulic connection with an oil-skimmer basin located north of the former inlet to New Hope Pond was observed during installation of these wells. Elevated gross alpha activity in the samples from these wells indicate that alpha-emitting radioisotopes may have been contained in the oils skimmed from UEFPC and collected in this basin.

6.5.2 Beta Radioactivity

Average annual gross beta activity determined for samples from three wells exceeded 50 pCi/L during CY 1994. As shown on the following table, the gross beta results for each of the samples from these wells passed the data evaluation criteria:

Sampling Point	Location	CY 1994 Annual Average Gross Beta Activity	Number of Samples	
			Passed Criteria	Total Collected
GW-154	NHP	221 ± 24	1	1
GW-605	EXP-I	68 ± 4	4	4
GW-633	RG	261 ± 45	1	1

Gross beta activity reported for water table interval well GW-633 at the Rust Garage Area is similar to the annual average gross beta activity determined in CY 1993 (266 ± 77 pCi/L). Results for well GW-633, and historical results for nearby monitoring wells not sampled during CY 1994, show that gross beta activity above 50 pCi/L occurs primarily in groundwater in the western end of the East Fork Regime.

Elevated gross beta activity in samples from wells GW-605 and GW-154 is associated with elevated gross alpha activity, as previously discussed. Similar patterns of distribution also are evident: gross beta activity decreases with depth in groundwater near these wells (paired wells completed at greater depths have gross beta activities below the MDA), and the source of these radionuclides is probably within the Central Plant Area.

The drinking-water MCL for gross beta radioactivity is a dose equivalent standard of 4 millirems per year that is based on an assumed 2 liter per day drinking water intake. Dose equivalents are calculated using dose factors proposed by the EPA for beta-emitting isotopes. However, these calculations were not performed for the wells sampled during CY 1994 which exceeded the 50 pCi/L screening level because none were analyzed for beta-emitting radionuclides.

Strontium activity reported for the third quarter sample from exit pathway well GW-171 (267 ± 45 pCi/L), located about 2,000 ft east of the ORR boundary, exceeded the EPA dose factor for ^{90}Sr (42 pCi/L). However, the strontium activity in the fourth quarter sample from GW-171 (20 ± 26 pCi/L) was below the MDA for strontium activity. The third quarter sample from well GW-230, clustered with well GW-171 and sampled the next day, had strontium activity (65 ± 34 pCi/L) that was significantly greater than the strontium activity reported for the duplicate sample from this well (-53.8 ± 26 pCi/L); therefore, both results were considered unusable (see Section 4.1.2). Additionally, the rinsate sample (presumably deionized water from a thoroughly decontaminated pump) collected after sampling well GW-230 had strontium activity of 216 ± 43 pCi/L (see Section 3.5). These samples with atypically elevated strontium activity were analyzed on the same day (November 7, 1995) and may be analytical artifacts. The results were not supported by subsequent sampling; the associated gross beta activities were below the MDA and the rinsate sample had higher activity than the associated groundwater samples.

7.0 CONCLUSIONS

Data obtained during CY 1994 support previous monitoring results. The primary groundwater contaminants in the East Fork Regime are VOCs, nitrate, trace metals, and radionuclides. The following items summarize the CY 1994 evaluation process and findings.

- Several of the interpretive assumptions used in the evaluation of the CY 1994 data differed from those used in previous GWQRs. The changes primarily involved: (1) modification of the decision rule used to identify anomalous results for VOCs, (2) use of more conservative reference values for identification of elevated trace metal concentrations, and (3) application of updated QA/QC criteria relating to background corrected values, counting uncertainty, and MDAs for radioanalyte results. These modifications had little impact on the evaluation of the data reported for VOCs or trace metals. However, only about 10% of the CY 1994 results for radioanalytes were suitable for evaluation based on the revised interpretive assumptions.

- A variety of VOCs, primarily methylene chloride and acetone, were detected in 20% of the laboratory blanks, 25% of the trip blanks, 25% of the field blanks, and 27% of the equipment rinsate samples analyzed during CY 1994. These results reflect a continued reduction in the percentage of VOC-contaminated QA/QC samples evident since the fourth quarter of CY 1992. The results reported for laboratory and trip blanks were used to identify a total of 103 false positive VOC results in the CY 1994 groundwater samples. Ninety-six percent of the false positives were for common laboratory reagents (methylene chloride, acetone, toluene, and 2-butanone), that were most frequently detected in laboratory blanks.

- The CY 1994 results reported for major cations and anions show that calcium-magnesium bicarbonate groundwater typically occurs at shallow depths in the Conasauga Shales and the Maynardville Limestone throughout the East Fork Regime. However, geochemical differences exist between the two units in the bedrock interval below about 100 ft bgs. Elevated concentrations of chloride, sulfate, and sodium reported for some shallow wells probably reflect impacts from a variety of industrial activities and processes within the Y-12 Plant, and contamination from grout used to install the wells.

- Data obtained during 1994 show that VOCs in the East Fork Regime generally occur in a continuous plume from the western end of the regime to about 1,500 to 2,000 ft beyond the ORR boundary. Chlorinated solvents are the most pervasive VOCs. Petroleum hydrocarbons are also present, but in isolated areas in the immediate vicinity or downgradient of UST sites.

- Principal components of the chlorinated solvent plume are PCE, TCE, 1,2-DCE, carbon tetrachloride, and chloroform, and the highest summed average concentrations (880 μg/L, 960 μg/L, and 7,150 μg/L) were reported for well GW-337 at the Waste Coolant Processing Area. Tetrachloroethene, TCE, and 1,2-DCE are generally the most commonly detected chlorinated solvents throughout the regime except at New Hope Pond; most of the groundwater samples from wells near this site contain carbon tetrachloride. Operation of the Lake Reality Sump has induced transport of carbon tetrachloride toward Lake Reality. Data from wells installed during CY 1994 within the Central Plant Area further confirm that other sources upgradient of New Hope Pond are contributing chlorinated solvents to the groundwater in this area.

- Samples from wells located about 1,000 ft east of the ORR boundary have contained PCE, TCE, carbon tetrachloride, and chloroform. Samples from springs located about 2,000 ft east of the ORR boundary had low concentrations of PCE, TCE, and carbon tetrachloride.

- Benzene, toluene, ethylbenzene, and xylenes were detected in samples from only four wells that monitor USTs at the Rust Garage Area. The highest summed BTEX concentration was determined for well GW-508 (51,200 μg/L).

- Annual average nitrate concentrations exceeded the drinking-water MCL (10 mg/L) only in groundwater samples collected during CY 1994 from wells located in the Western Plant Area near the primary source areas (the S-3 Site and the S-2 Site). These results are consistent with previous findings. Data from basement sumps show that the nitrate plume in the water table interval extends beneath Buildings 9204-4, 9201-5, and 9201-4. Review of nitrate concentrations reported over the past several years for the wells near source areas show that concentrations have generally decreased in the groundwater at shallow depths.

- Groundwater quality with respect to trace metal concentrations was evaluated through comparison with one of two types of reference concentrations: available MCLs for drinking water, or UTLs determined from statistical analysis of groundwater quality data obtained since CY 1986. Median concentrations determined from the CY 1994 data for aluminum, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, strontium, uranium, vanadium, and zinc exceeded the applicable reference concentration. However, elevated median concentrations for most of these metals were probably biased by sampling or analytical artifacts. Additionally, the UTL for some of the metals, particularly boron and vanadium, appears to be too conservative for the purposes of the Y-12 Plant GWPP. Evaluation of the CY 1994 data based on these considerations showed elevated median concentrations of barium, boron, cadmium, cobalt, copper, mercury, strontium, and uranium potentially reflect impacts on groundwater quality in the East Fork Regime. Most of the wells that consistently yield samples with elevated concentrations of these metals are located in the Western Plant Area downgradient of known source areas (the S-3 Site and the S-2 Site).

- Review of the useable radioanalyte results reported for wells sampled during CY 1994 show that annual average gross alpha and gross beta activities were consistent with results of previous assessments. The S-3 Site is the primary source of gross alpha- and gross beta-emitting radionuclides in groundwater in the Western Plant Area. Gross alpha and gross beta activity exceeding regulatory guidelines also occurs in groundwater downgradient of Tank 0134-U and upgradient from New Hope Pond.

8.0 PLANNED AND PROPOSED MONITORING CHANGES

Changes to the groundwater monitoring program in the East Fork Regime are currently planned by the Y-12 Plant GWPP for implementation in CY 1996. Other modifications also are proposed based on the monitoring results obtained during CY 1994.

8.1 Sampling Locations, Frequency, and Analytical Parameters

Requirements of the groundwater monitoring programs for sites in the East Fork Regime have not changed, and thus few changes to the monitoring well network are planned for CY 1996 (Figure 32). A total of 79 monitoring wells will be sampled during CY 1996 for the purposes of the following programs:

Monitoring Program	No. of Wells
RCRA Interim Status Assessment	7
Grid Well Monitoring	47
Best-Management Practice Monitoring	6
Exit Pathway Monitoring	19
Total	**79**

Exit pathway surface water station LRSPW will be sampled semi-annually to collect data during high and low flow conditions. Groundwater and surface water samples will be collected in the sequence shown on Table 18 and analyzed for the parameters and constituents specified in the *Sampling and Analysis Plan for Groundwater and Surface Water Monitoring at the Y-12 Plant During Calendar Year 1996* (HSW Environmental Consultants, Inc. 1995b).

8.2 Proposed Modifications

Proposed modifications to the monitoring programs implemented in CY 1994 involve data management and metals analyses. The following items describe the proposed changes:

- Dissolved iron and manganese concentrations should be included in charge balance determinations because these metals are common soil and bedrock constituents. The charge contributed by these cations is negligible in most samples, but omitting these cations in some instances causes consistently negative charge balance errors greater than 10%.
- The QA/QC analytical results for semi-volatile (base, neutral, and acid-extractable) organic compounds should be transmitted (electronically and printed) so that false positive results can be identified in groundwater and surface water samples.
- Analyses for cadmium and chromium by AAS should be discontinued if not a site-specific or well-specific requirement. Statistical evaluation of the CY 1994 data showed no significant difference between results obtained by ICP and AAS methods for these metals.
- The reference concentrations for boron and vanadium are too conservative and should be re-evaluated.
- Results of a comparison of groundwater quality data from wells GW-206 and GW-816 should be submitted to DOE and the TDEC-TOA for approval to plug and abandon well GW-206. Upon receipt of this approval, well GW-816 should then be designated as an ORR perimeter monitoring well.
- Twelve monitoring wells at six upgradient grid locations have been sampled for at least eight consecutive quarters by the end of CY 1994, and should be dropped from the monitoring program:

Location	Wells	First Sampled (quarter/year)
GRID C1	GW-771, GW-772	Q1 / 1993
GRID E1	GW-764, GW-765	Q3 / 1992
GRID G1	GW-758, GW-759	Q3 / 1992
GRID G2	GW-760, GW-761	Q3 / 1992
GRID H2	GW-773, GW-774	Q1 / 1993
GRID I1	GW-199, GW-768	Q1 / 1993

- The following wells have not been sampled in several years, or have not been analyzed for the standard suite of parameters; more current data for these wells will better characterize the extent of nitrate (NO_3) and/or VOC plumes:

Well	Formation	Location	Interval	Rationale
55-1A	Cn	Y12	WT	NO3/VOC
55-1C	Cn	Y12	BDR	NO3/VOC
55-2B	Cn	Y12	WT	NO3/VOC
55-2C	Cn	Y12	BDR	NO3/VOC
56-4C	Cn	Y12	BDR	VOC
55-6A	Cm	Y12	WT	NO3
GW-218	Cmn	UOV	WT	VOC
GW-253	Cmn	S2	WT	VOC
GW-690	Cmn	CPT	BDR	NO3/VOC
GW-691	Cmn	CPT	WT	NO3/VOC
GW-692	Cmn	CPT	BDR	NO3/VOC
GW-698	Cmn	B8110	BDR	VOC
GW-700	Cmn	B8110	WT	VOC

9.0 REFERENCES

CDM Federal Programs Corporation. 1994. Water Balance Report for the Oak Ridge Y-12 Plant. Prepared by CDM Federal Programs Corporation and Envirosoft Engineering, Inc. (SUB/28B-99920C/94-2).

CDM Federal Programs Corporation. 1995a. Union Valley Interim Study Remedial Site Evaluation. Prepared for Martin Marietta Energy Systems, Inc. (Y/ER-206/R-1).

CDM Federal Programs Corporation. 1995b. Data Adequacy Report for Upper East Fork Poplar Creek Operable Unit at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee. Prepared by CDM Federal Programs Corporation. (Y/ER-208/R1).

ChemRisk. 1993. Oak Ridge Health Studies Phase I Report. Volume II - Part A - Dose Reconstruction Feasibility Study. A Summary of Historical Activities on the Oak Ridge Reservation with Emphasis on Information Concerning Off-Site Emissions of Hazardous Materials.

Dreier, R.B., K.D. Solomon, and C.M. Beaudoin. 1987. Fracture Characterization in the Unsaturated Zone of a Shallow Land Burial Facility. In: Flow and Transport through Fractured Rock, American Geophysical Union Monograph 42.

Dreier, R.B., T.O. Early, and H.L. King. 1993. Results and Interpretation of Groundwater Data Obtained from Multiport-Instrumented Coreholes (GW-131 through GW-135), Fiscal Years 1990 and 1991. Martin Marietta Energy Systems, Inc. (Y/TS-803).

Evans, R.D. 1955. The Atomic Nucleus. McGraw - Hill, New York, N.Y.

Geraghty & Miller, Inc. 1986. Aquifer Test Data and Design of Recovery Wells, S-3 Ponds. Plant. Prepared for Martin Marietta Energy Systems, Inc. (Y/SUB/86-00206C/2).

Geraghty & Miller, Inc. 1987. Hydrogeologic Investigations of the S-3 Ponds Area at the Y-12 Plant. Prepared for Martin Marietta Energy Systems, Inc. (Y/SUB/87-002606C/18).

Geraghty & Miller, Inc. 1989a. Development of Ground-Water Flow Models for the S-3 Waste Management Area, Y-12 Plant, Oak Ridge, Tennessee. Prepared for Martin Marietta Energy Systems, Inc. (Y/SUB/89-00206C/1).

Geraghty & Miller, Inc. 1989b. Tracer Study of the Hydrologic System of Upper Bear Creek, Y-12 Plant, Oak Ridge, Tennessee. Prepared for Martin Marietta Energy Systems, Inc. (Y/SUB/89-00206C/4).

Geraghty & Miller, Inc. 1989c. Ground-Water Quality Assessment for New Hope Pond at the Y-12 Plant, 1988. Prepared for Martin Marietta Energy Systems, Inc. (Y/SUB/89-00206C/5).

Geraghty & Miller, Inc. 1990. Comprehensive Groundwater Monitoring Plan for the Oak Ridge Y-12 Plant. Prepared for Martin Marietta Energy Systems, Inc. (Y/SUB/90-00206C/5).

Geraghty & Miller, Inc. 1995. Post-Closure Permit Application for the Upper East Fork Poplar Creek Hydrogeologic Regime at the Y-12 Plant: New Hope Pond and Eastern S-3 Ponds Plume. Prepared for Martin Marietta Energy Systems, Inc. (Y/ER/SUB/91-ALV96/6, Rev. 2)

Gianfrancesco, C.M., C.S. Haase, and H.L. King. 1988. Preliminary Hydrological and Hydrochemical Assessment of the S-2 Site at the Oak Ridge Y-12 Plant. Prepared by E.C. Jordan Co. for the Oak Ridge Y-12 Plant (Y/TS-321).

Golder Associates, Inc. 1987. Aquifer Pump Tests with Tracers. Prepared for Martin Marietta Energy Systems, Inc. (ORNL/SUB/86-3213612).

Golder Associates, Inc. 1988. Final Report on Contaminant Transport Model Validation; Site Characterization and Groundwater Flow Computer Model Application. Prepared for Martin Marietta Energy Systems, Inc.

HSW Environmental Consultants, Inc. 1991. Groundwater Quality Assessment for the Upper East Fork Poplar Creek Hydrogeologic Regime at the Y-12 Plant: 1990 Data Interpretations and Proposed Program Modifications. Prepared for Martin Marietta Energy Systems, Inc. (Y/SUB/91-YP507C/2 Part 2).

HSW Environmental Consultants, Inc. 1993. Sampling and Analysis Plan for Groundwater and Surface Water Monitoring at the Y-12 Plant During Calendar Year 1994. Prepared for Martin Marietta Energy Systems, Inc. (Y/SUB/93-YP507C/4).

HSW Environmental Consultants, Inc. 1994. Groundwater Quality Report for the Upper East Fork Poplar Creek Hydrogeologic Regime at the Y-12 Plant: 1993 Data Interpretations and Proposed Program Modifications. Prepared for Martin Marietta Energy Systems, Inc. (Y/SUB/94-EAQ10C/2/P1).

HSW Environmental Consultants, Inc. 1995a. Calendar Year 1994 Groundwater Quality Report for the Upper East Fork Poplar Creek Hydrogeologic Regime, Y-12 Plant, Oak Ridge, Tennessee. 1994 Groundwater Quality Data and Calculated Rate of Contaminant Migration. Prepared for Martin Marietta Energy Systems, Inc. (Y/SUB/95-EAQ10C/2/P1).

HSW Environmental Consultants, Inc. 1995b. Sampling and Analysis Plan for Groundwater and Surface Water Monitoring at the Y-12 Plant During Calendar Year 1996. Prepared for Lockheed Martin Energy Systems, Inc. (Y/SUB/95-EAQ10C/4).

HSW Environmental Consultants, Inc., Paradigm Data Services, Inc., and the Environmental Science Division of the Oak Ridge National Laboratory. 1995. Determination of Reference Concentrations for Inorganic Analytes in Groundwater at the Department of Energy Y-12 Plant, Oak Ridge, Tennessee. Prepared for Lockheed Martin Energy Systems, Inc. Groundwater Program Office (in preparation).

Jago, W.K. 1995a. Radiological Data Issues for the Y-12 Plant GWPP Historical Data Base. Letter to J.R. Walker, HSW Environmental Consultants, Inc. dated June 12, 1995.

Jago, W.K. 1995b. Provided a copy of field notes and calculations from water-level monitoring during operation of the Lake Reality Sump.

Jones, S.B., B.K. Thompson and S.M. Field. 1994. 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. Martin Marietta Energy Systems, Inc. (Y/TS-881/R2).

King, H.L. and C.S. Haase. 1987. Subsurface-Controlled Geological Maps for the Y-12 Plant and Adjacent Areas of Bear Creek Valley. Oak Ridge National Laboratory (ORNL/TM1-0112).

Law Engineering Testing Company. 1983. Results of Ground-Water Monitoring Studies. Prepared for Union Carbide Corporation, Nuclear Division (Y/SUB/83-47936/1).

Moore, G.K. 1988. Concepts of Groundwater Occurence and Flow Near Oak Ridge National Laboratory. (ORNL/TM-10969).

Moore, G.K. 1989. Groundwater Parameters and Flow System Near Oak Ridge National Laboratory. Environmental Sciences Division, Oak Ridge National Laboratory (ORNL/TM-11368).

Moore, G.K. and L.E. Toran. 1992. Supplement to a Hydrogeologic Framework for the Oak Ridge Reservation, Oak Ridge, Tennessee. Oak Ridge National Laboratory (ORNL/TM-12191).

PEER Consultants. 1989. RCRA Facility Investigation Plan for East Fork Poplar Creek and the Oak Ridge Sewer Line Beltway, Oak Ridge Y-12 Plant, Oak Ridge, Tennessee. Prepared for Martin Marietta Energy Systems, Inc. (Y/TS-366 R1).

Paradigm Data Services, Inc. 1994a. 1st Quarter 1994 Groundwater Data Evaluation Report. Letter report to HSW Environmental Consultants, Inc. dated July 20, 1994.

Paradigm Data Services, Inc. 1994b. 2nd Quarter 1994 Groundwater Data Evaluation Report. Letter report to HSW Environmental Consultants, Inc. dated December 14, 1994.

Paradigm Data Services, Inc. 1995a. 3rd Quarter 1994 Groundwater Data Evaluation Report. Letter report to HSW Environmental Consultants, Inc. dated January 16, 1995.

Paradigm Data Services, Inc. 1995b. 4th Quarter 1994 Groundwater Data Evaluation Report. Letter report to HSW Environmental Consultants, Inc. dated April 27, 1995.

Paradigm Data Services, Inc. 1995c. Letter to J.R. Walker, HSW Environmental Consultants, Inc. June 13, 1995.

Science Applications International Corporation. 1994. Letter from P.D. Moss to J. Hodges, Martin Marietta Energy Systems, Inc., July 19, 1994.

Science Applications International Corporation. 1995a. Letter to H.L. King, Lockheed Martin Energy Systems Subject: SAS Datasets requested for HSW dated May 30, 1995. Analytical Results of sampling for the Bear Creek Valley Remedial Investigation Report (in progress).

Science Applications International Corporation. 1995b. Telephone conversation between P.D. Moss and J.R. Walker, July 1995.

Shevenell, L.A., R.B. Dreier, and W.K. Jago. 1993. Summary of Fiscal Year 1991 and 1992 Construction, Hydrologic, and Geologic Data Obtained from the Maynardville Limestone Exit Pathway Monitoring Program. Oak Ridge National Laboratory (Y/TS-814).

Shevenell, L.A. 1994. Chemical Characteristics of Water in Karst Formations at the Oak Ridge Y-12 Plant. Prepared for Martin Marietta Energy Systems, Inc. (Y/TS-1001).

Shevenell, L.A., G.K. Moore, and R.B. Dreier. 1994. Contaminant Spread and Flushing in Fractured Rocks near Oak Ridge, Tennessee. Groundwater Monitoring Review, Spring 1994, pp. 120-129.

Sledz, J.S. and D.D. Huff. 1981. Computer Model for Determining Fracture Porosity and Permeability in the Conasauga Group, Oak Ridge National Laboratory, Tennessee. Environmental Sciences Division Publication No. 1677 (ORNL/TN-7695).

Solomon, D.K., G.K. Moore, L.E. Toran, R.B. Dreier, and W.M. McMaster. 1992. Status Report - A Hydrologic Framework for the Oak Ridge Reservation. Oak Ridge National Laboratory (ORNL/TM-12053).

U.S. Department of Energy. 1994. Oak Ridge Reservation Site Management Plan for the Environmental Restoration Program. U.S. Department of Energy Oak Ridge Field Office (DOE/OR-1001/R3).

U.S. Department of Energy. 1995. Environmental Monitoring Plan for the Oak Ridge Reservation. U.S. Department of Energy Oak Ridge Field Office (DOE/OR-1066/R1).

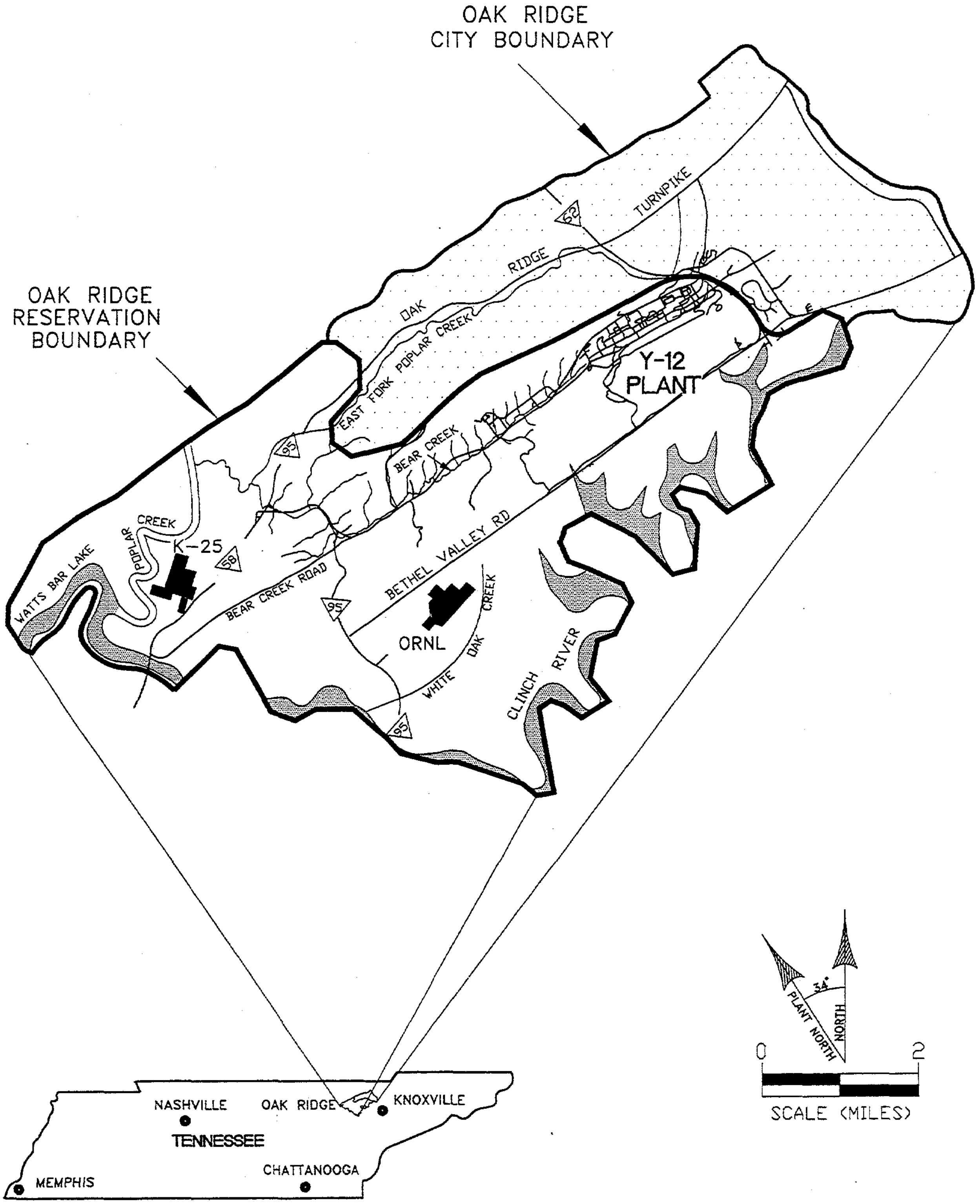
U.S. Environmental Protection Agency. 1986. Test Methods for Solid Waste Evaluation, Vol. 1A: Laboratory Manual of Physical/Chemical Methods.

U.S. Environmental Protection Agency. 1988. Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses. U.S. EPA, Office of Solid Waste.

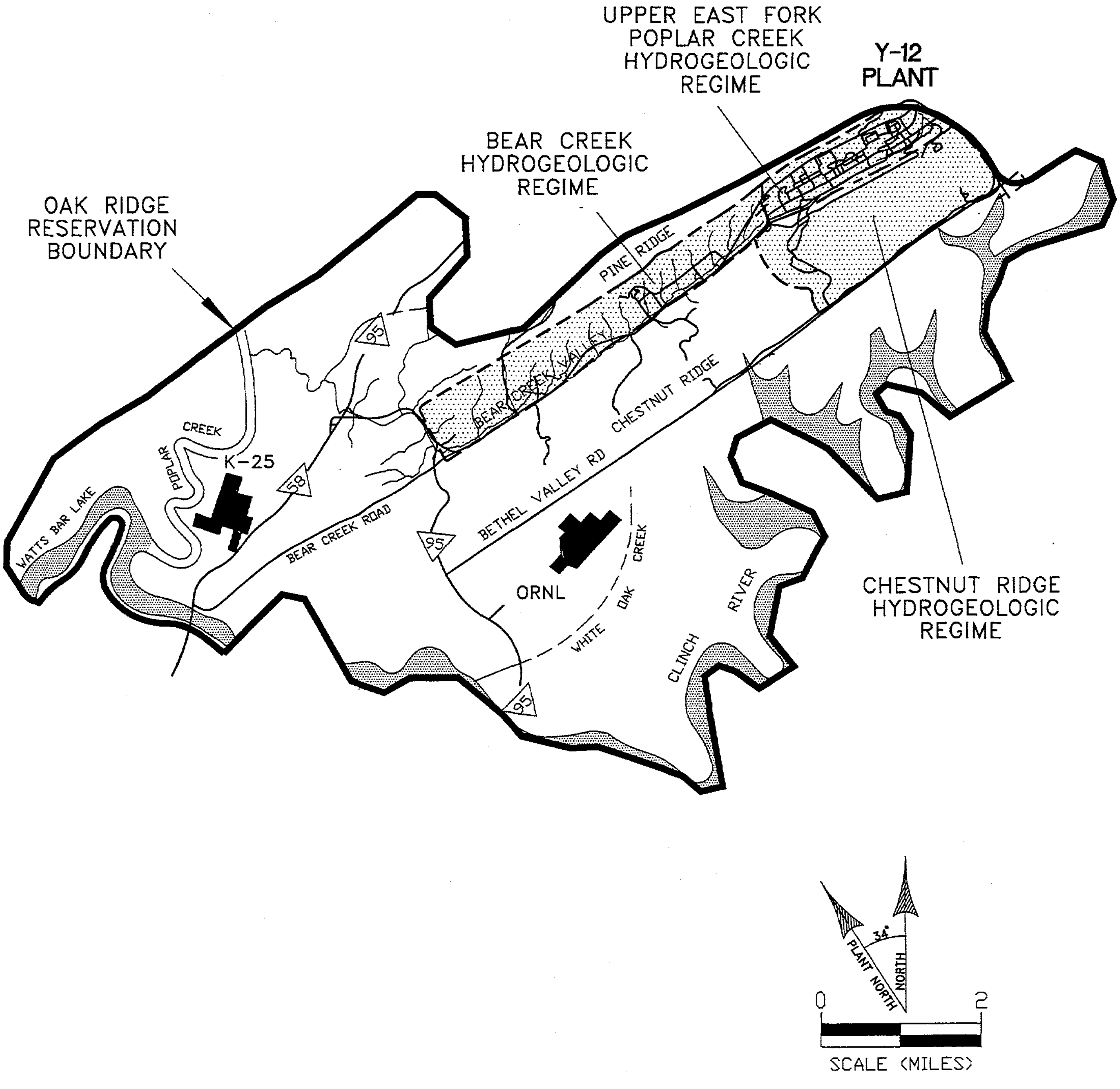
Watson, D.B. 1995. Telephone conversation with J.R. Walker, July 1995.

APPENDIX A

Figures



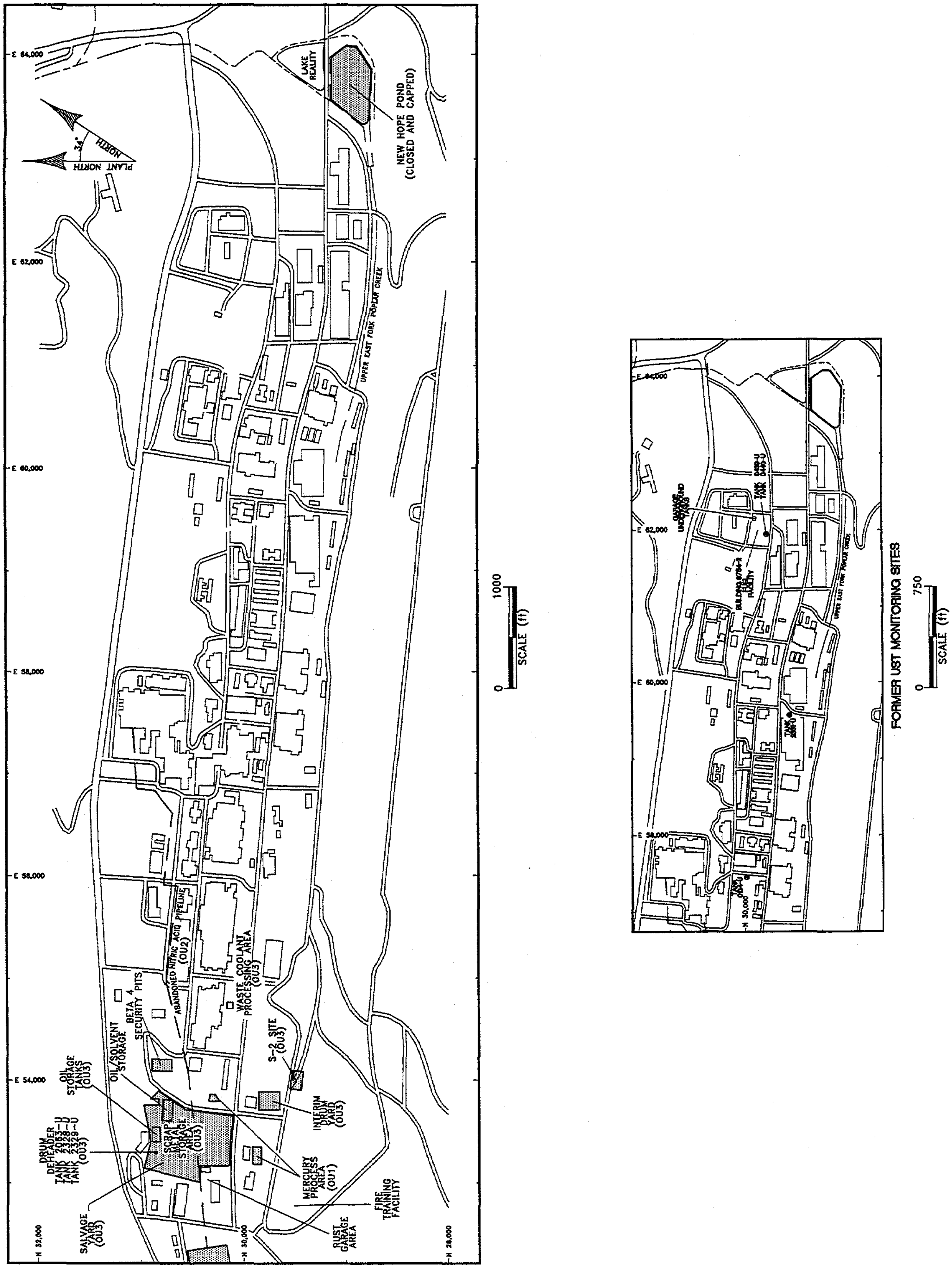
LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 1
DATE:	7-12-95	REGIONAL LOCATION OF THE Y-12 PLANT
DWG ID.:	OR250-HC	



LOCATION:	Y-12 PLANT OAK RIDGE, TN.
DATE:	9-8-95
DWG ID.:	OR321-HC

FIGURE 2

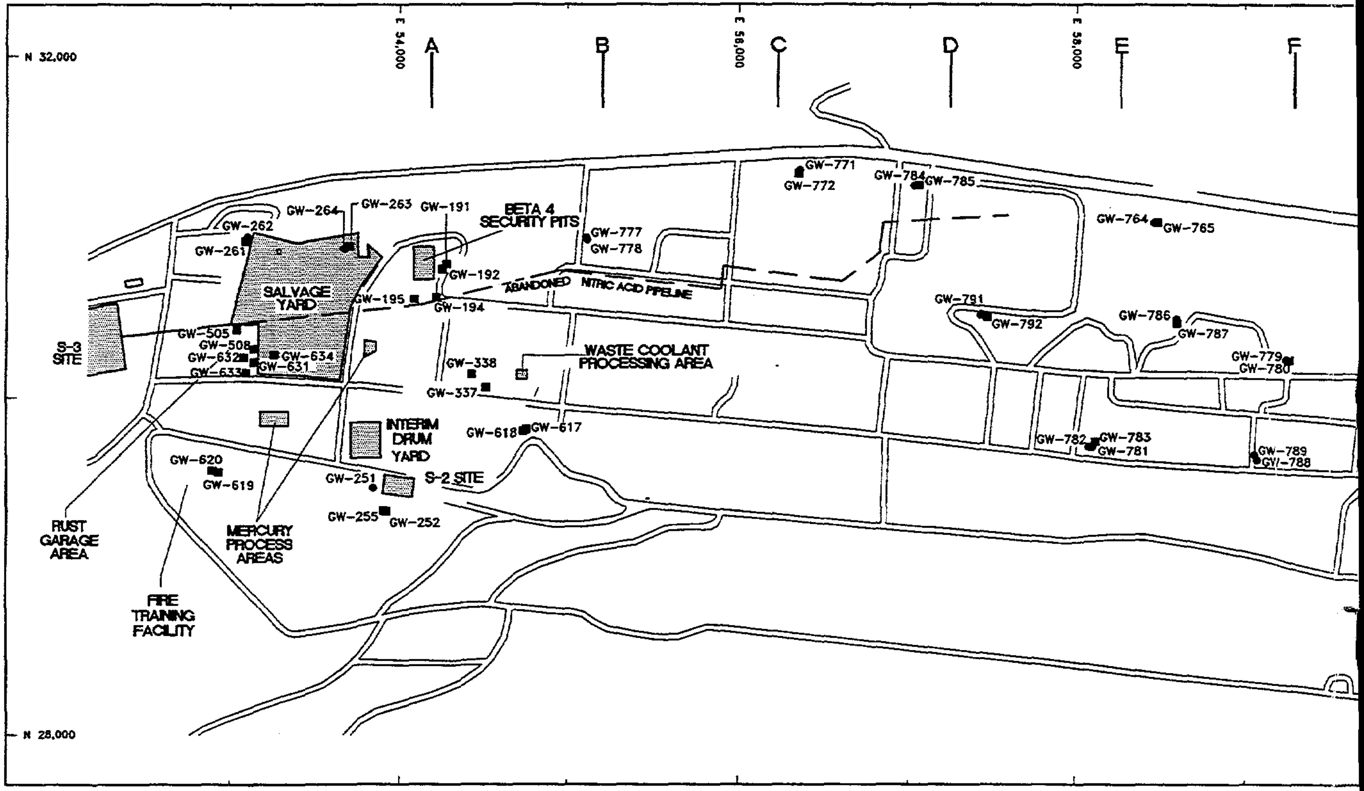
HYDROGEOLOGIC REGIMES
AT THE Y-12 PLANT



LOCATION:	Y-12 PLANT OAK RIDGE, TN.
DATE:	7-12-95
DWG ID.:	OR171-HC

FIGURE 3

WASTE-MANAGEMENT SITES,
CERCLA OPERABLE UNITS, AND USTs LOCATED IN THE
UPPER EAST FORK POPLAR CREEK HYDROGEOLOGIC REGIME



EXPLANATION

GW-152 ■ — Water Table Zone Monitoring Well

GW-240 ● — Bedrock Zone Monitoring Well

▲ — Surface Water Sampling Location

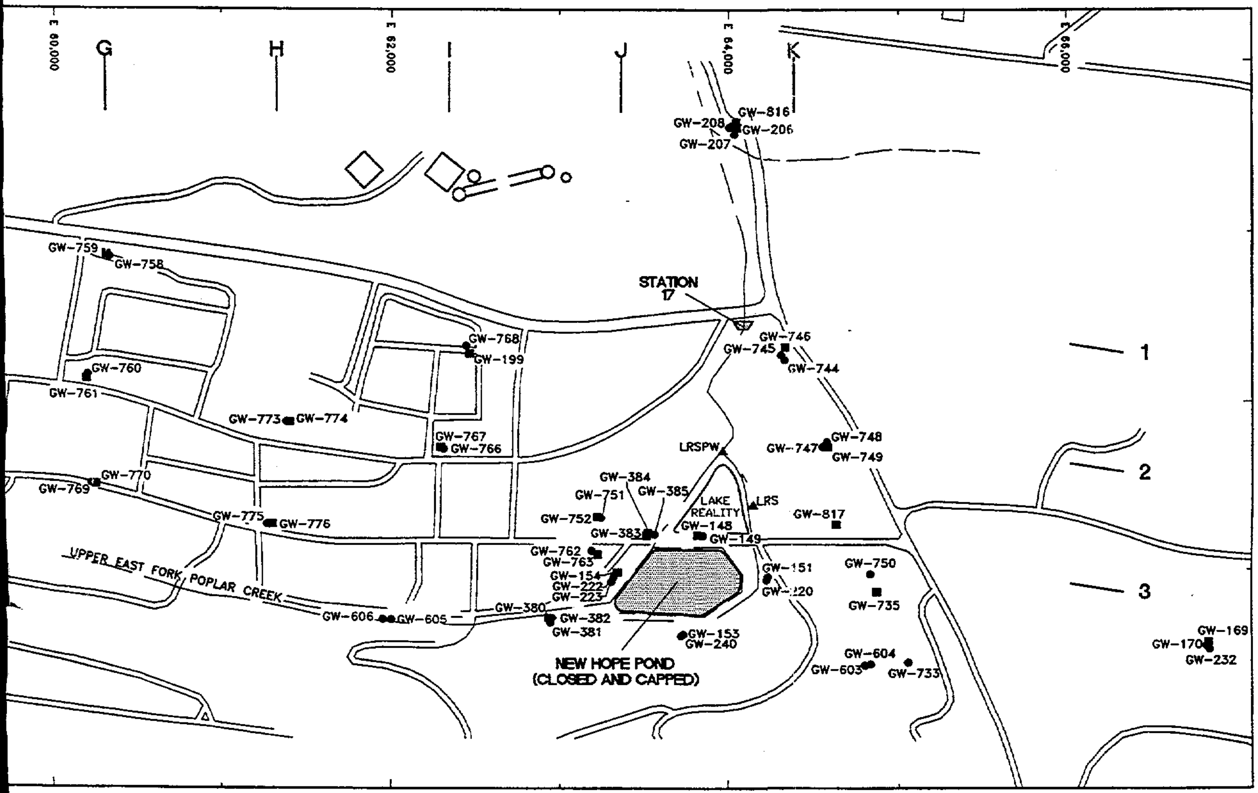
LRSPW — Lake Reality Emergency Spillway

LRS — Lake Reality Sump

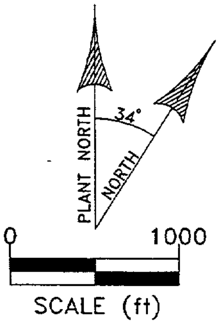
▽ — NPDES Surface Water Monitoring

—— Boundary of Site

K — 1 — Comprehensive Groundwater Monit



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

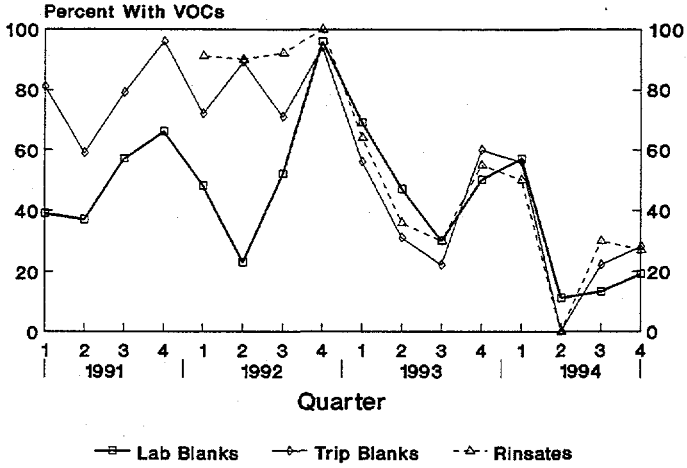


ocation

ring Grid

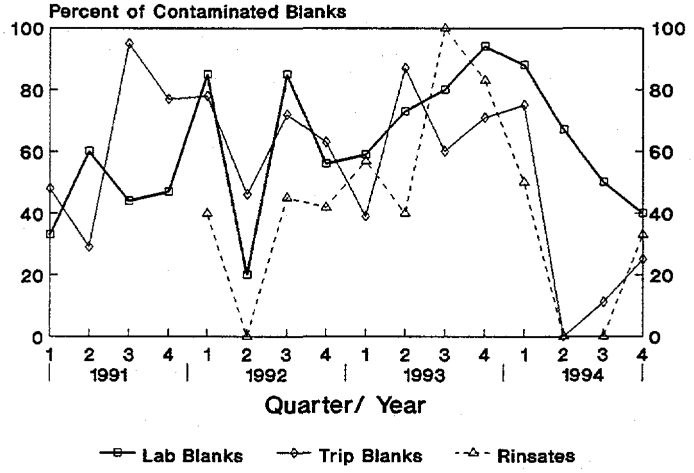
LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 4
DATE:	7-12-95	SAMPLING LOCATIONS FOR GROUNDWATER AND SURFACE WATER MONITORING DURING CY 1994
DWG ID.:	OR429-HC	

All Compounds



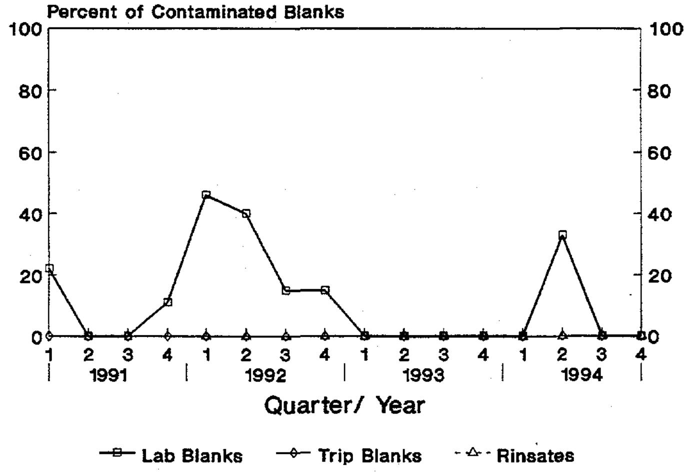
Laboratory Reagent

Methylene Chloride

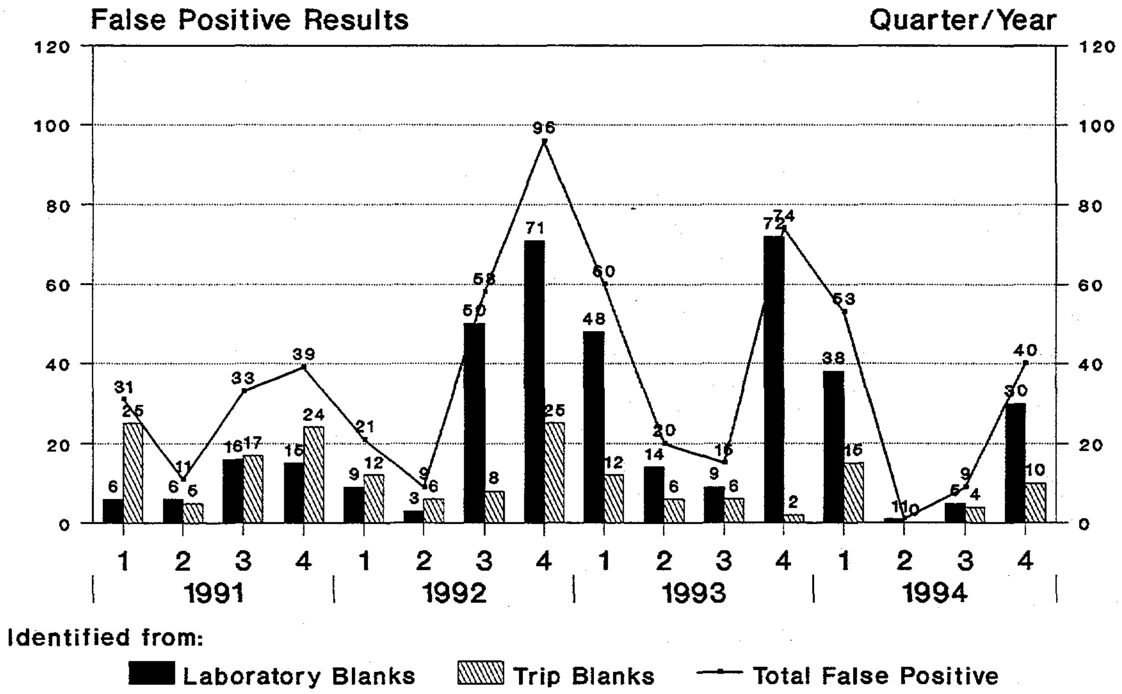


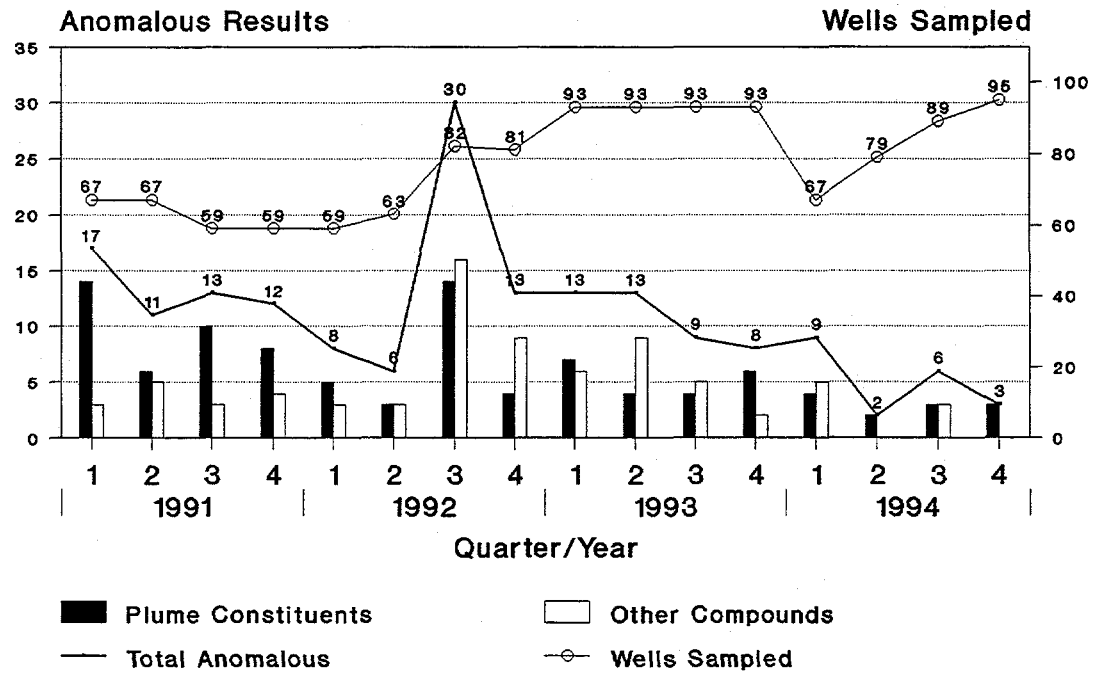
Source Water Contaminant

1,1,2,2-TCA

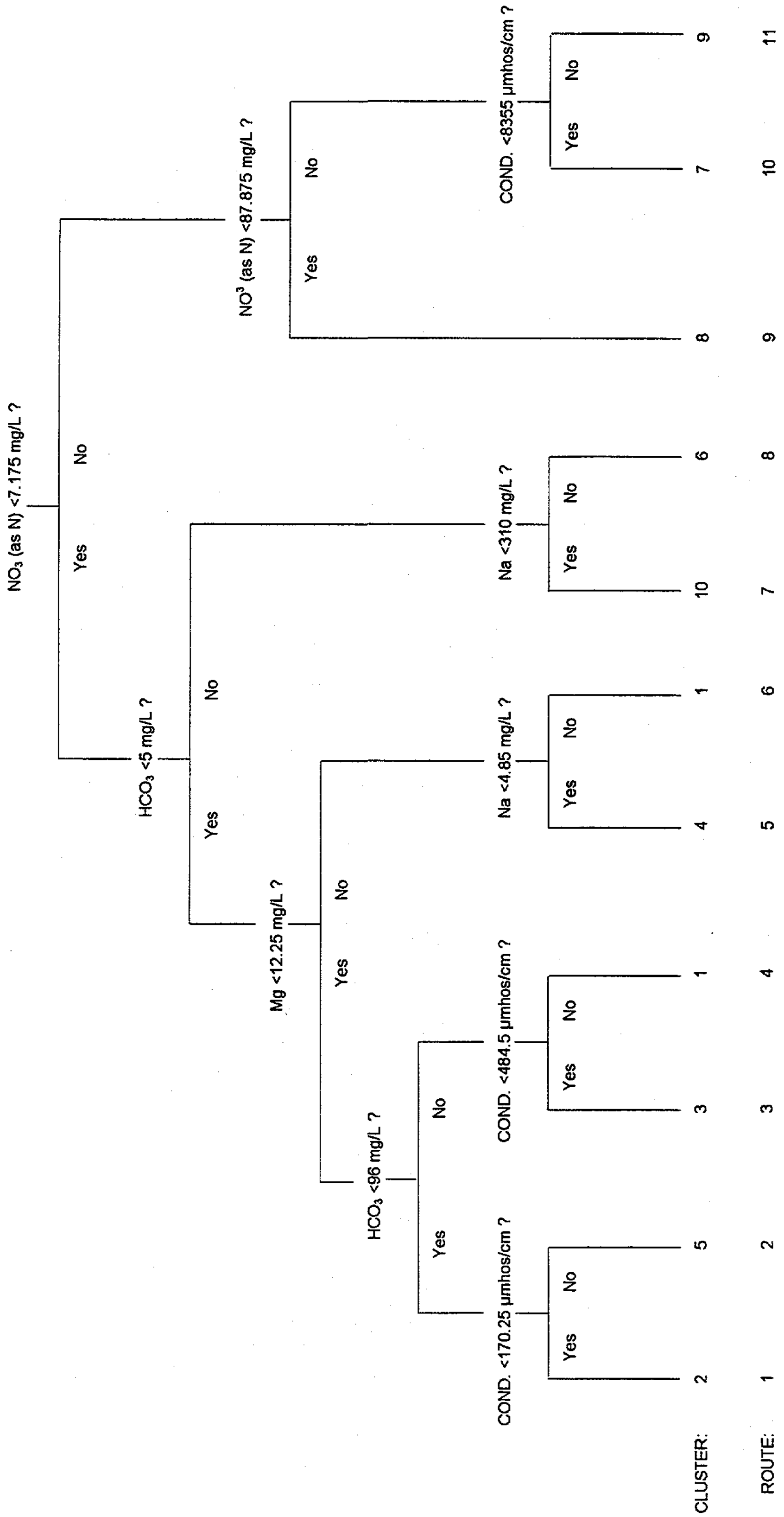


LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 5
DATE:	8-6-95	VOCs IN QA/QC SAMPLES, 1991 - 1994
DWG ID.:	HG7	





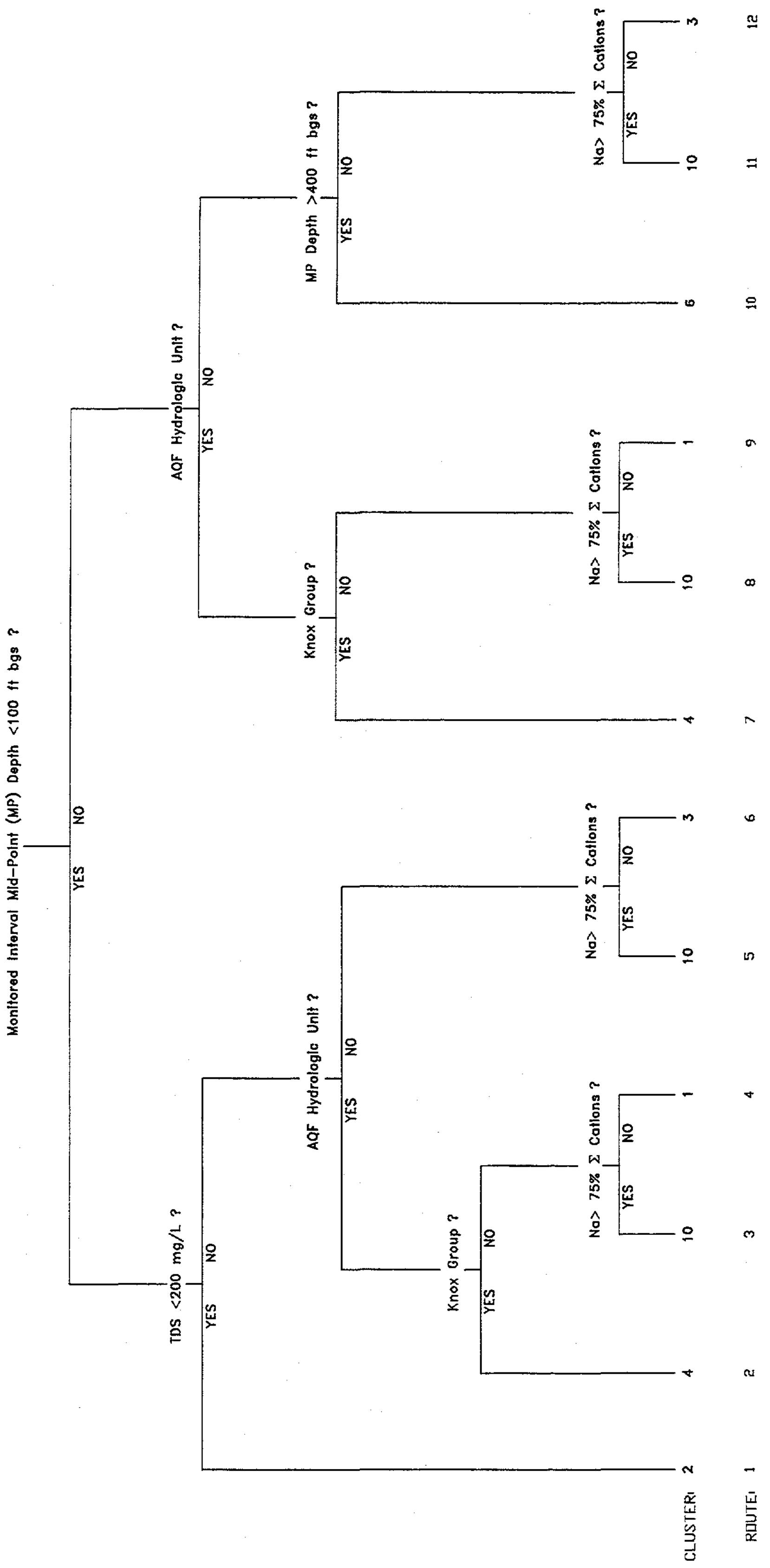
LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 6
DATE:	8-6-95	FASLE POSITIVE AND ANOMALOUS VOC RESULTS, 1991-1994
DWG ID.:	HG7	



LOCATION:	Y-12 PLANT OAK RIDGE, TN.
DATE:	7-12-95
DWG ID.:	24

FIGURE 7

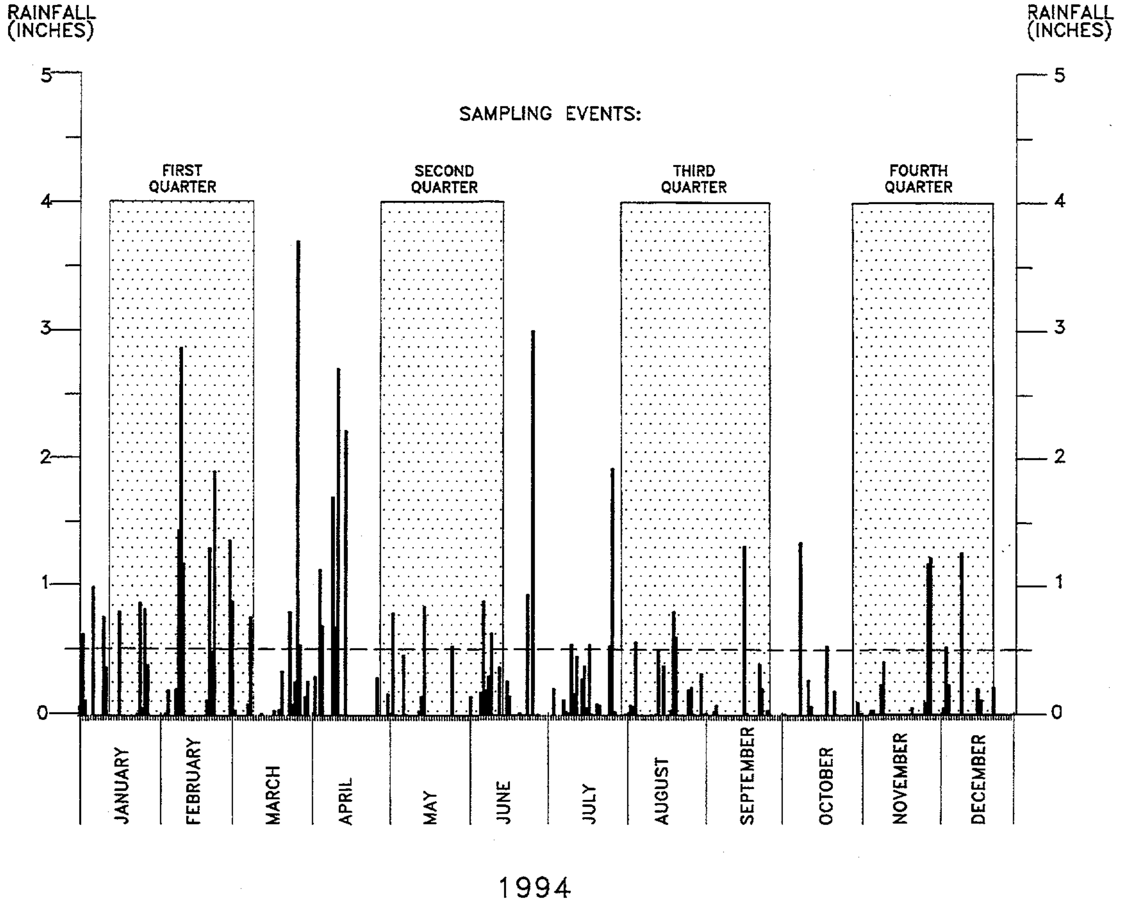
CLASSIFICATION MODEL FOR DETERMINING TRACE METAL UTLs



LOCATION:	Y-12 PLANT OAK RIDGE, TN.
DATE:	7-12-95
DWG ID.:	FIG8

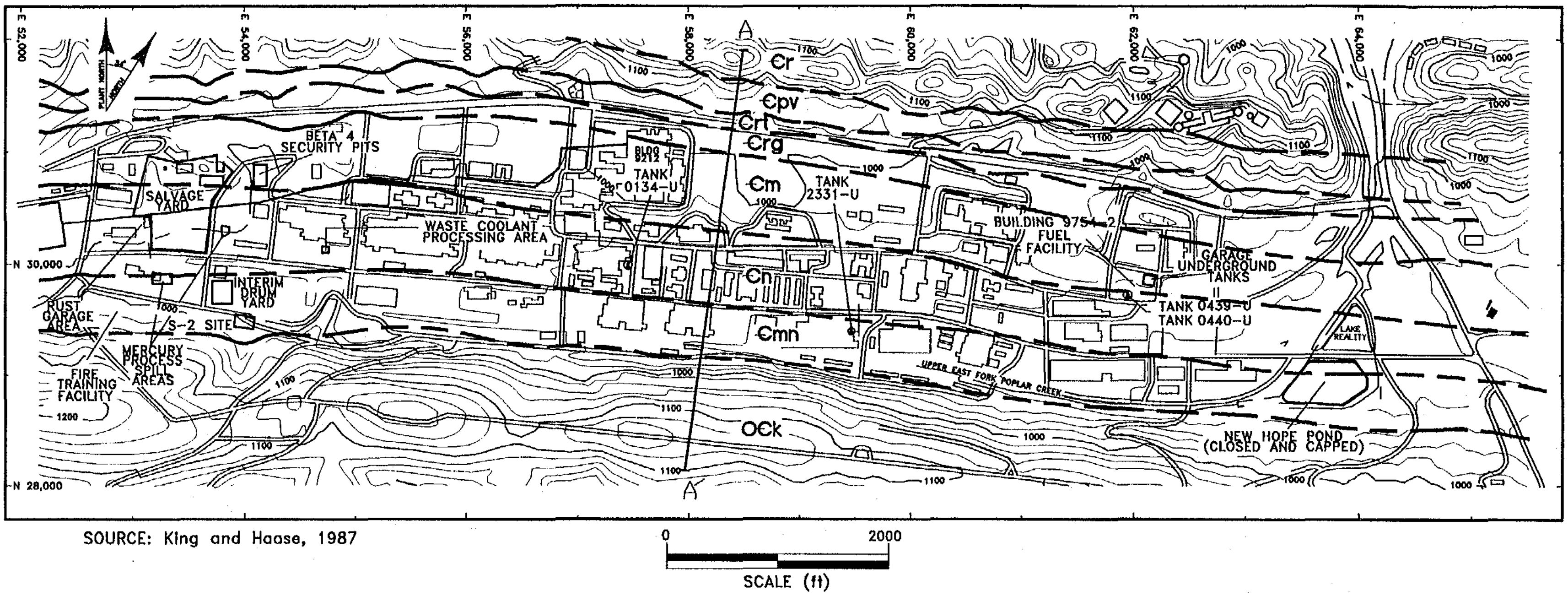
FIGURE 8

SURROGATE CLUSTER
CLASSIFICATION MODEL

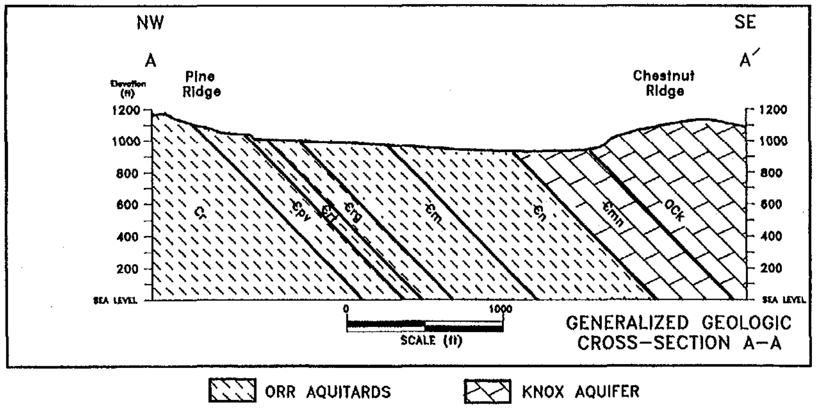


SOURCE: National Oceanic and Atmospheric Administration

LOCATION:	Y-12 PLANT OAK RIDGE, TN.	**FIGURE 9**
DATE:	10-3-95	**RAINFALL DURING SAMPLING EVENTS IN CY 1994**
DWG ID.:	CRRAIN2	



SOURCE: King and Haase, 1987



GENERALIZED GEOLOGIC CROSS-SECTION A-A

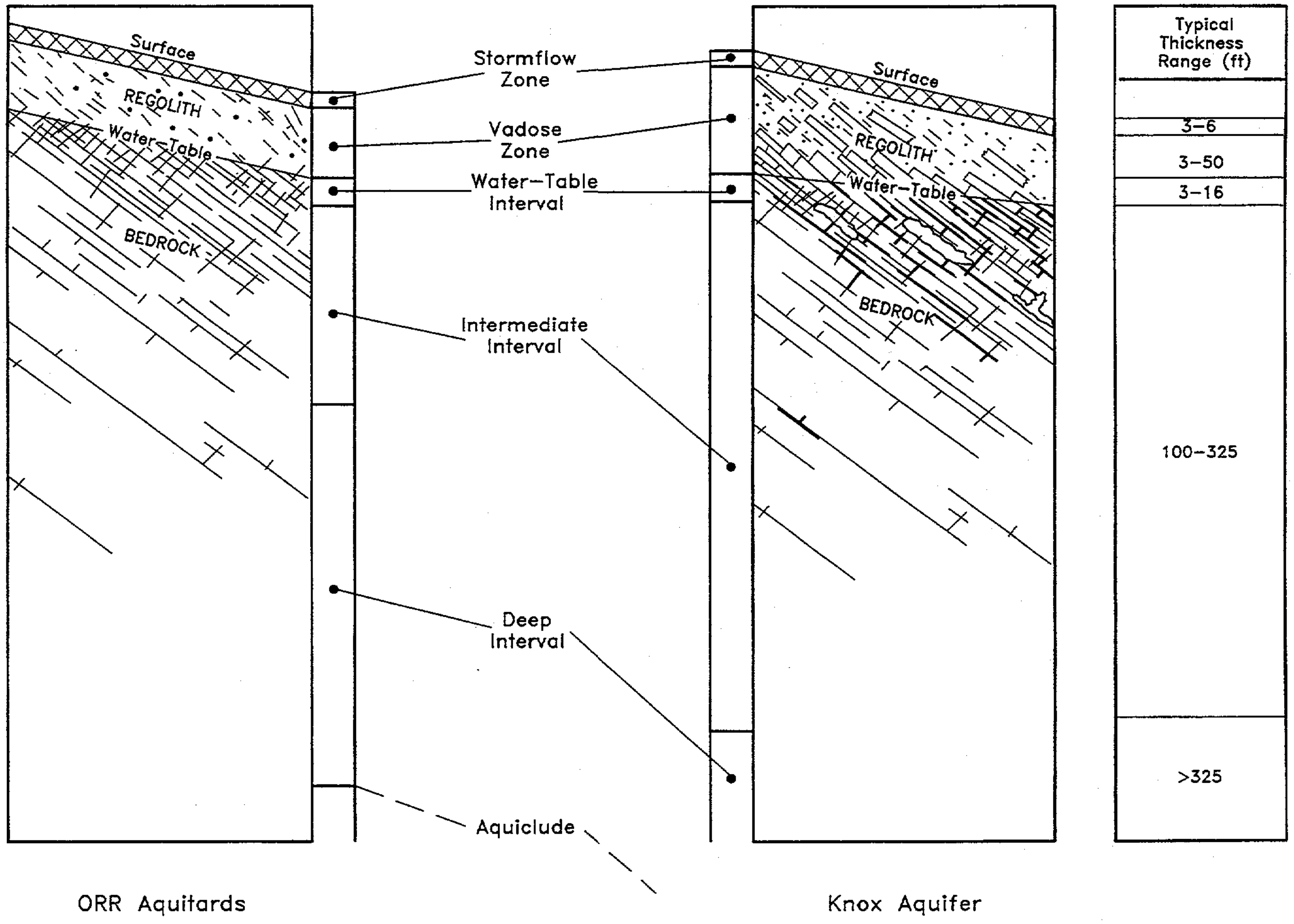
SYSTEM		GROUP	HYDRO UNIT	FORMATION	MAP SYMBOL	THICKNESS (ft)
CAMBRIAN	UPPER	KNOX	KNOX AQUIFER	COPPER RIDGE DOLOMITE	O€k	NOT DETERMINED
		CONASAUGA		MAYNARDVILLE LIMESTONE	€mn	418–450
	MIDDLE		ORR AQUITARDS	NOLICHUCKY SHALE	€n	422–550
				MARYVILLE LIMESTONE	€m	346–445
				ROGERSVILLE SHALE	€rg	90–120
				RUTLEDGE LIMESTONE	€rt	90–120
				PUMPKIN VALLEY SHALE	€pv	260–320
	LOWER			ROME FORMATION	€r	NOT DETERMINED

LOCATION:	Y-12 PLANT OAK RIDGE, TN.
DATE:	7-16-95
DWG ID.:	OR172-HC

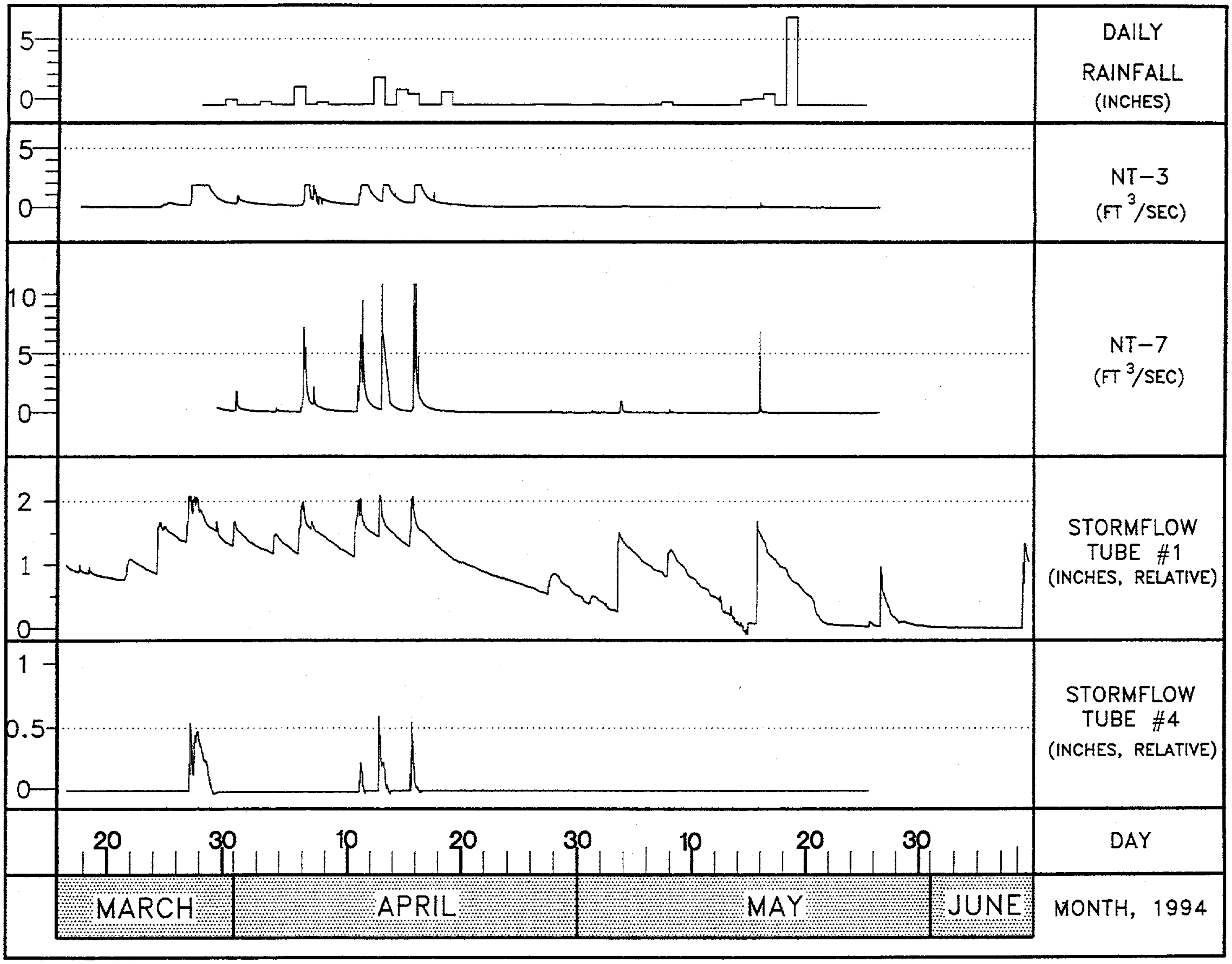
FIGURE 10

TOPOGRAPHY AND BEDROCK GEOLOGY IN THE UPPER EAST FORK POPLAR CREEK HYDROGEOLOGIC REGIME

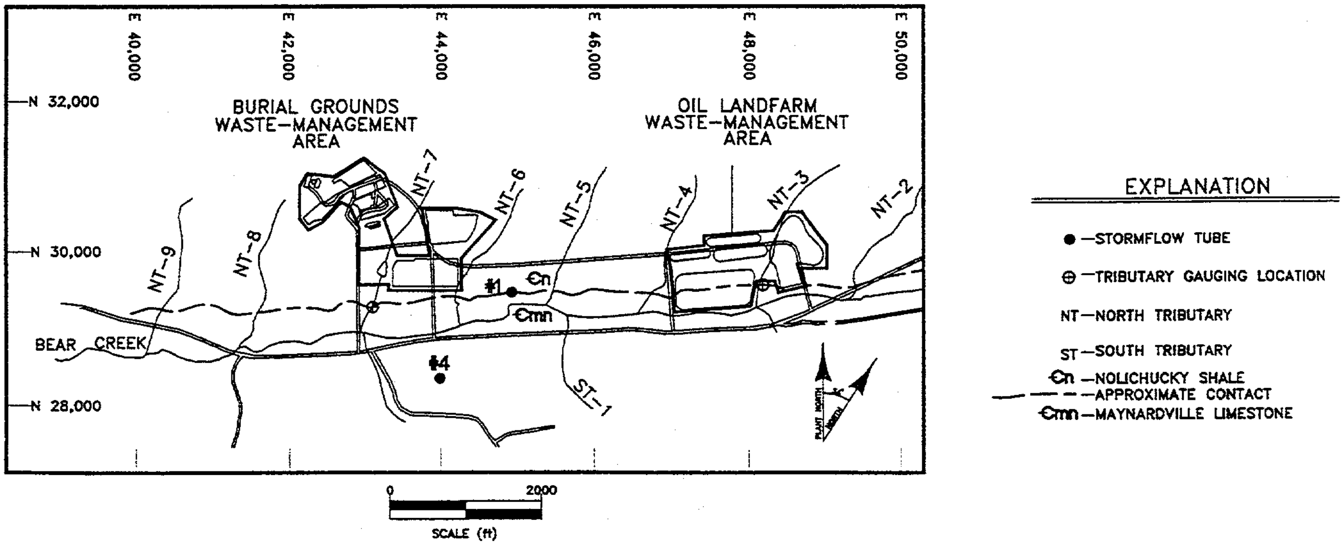
HYDROSTRATIGRAPHIC UNITS
PROPOSED BY SOLOMON et al. (1992)



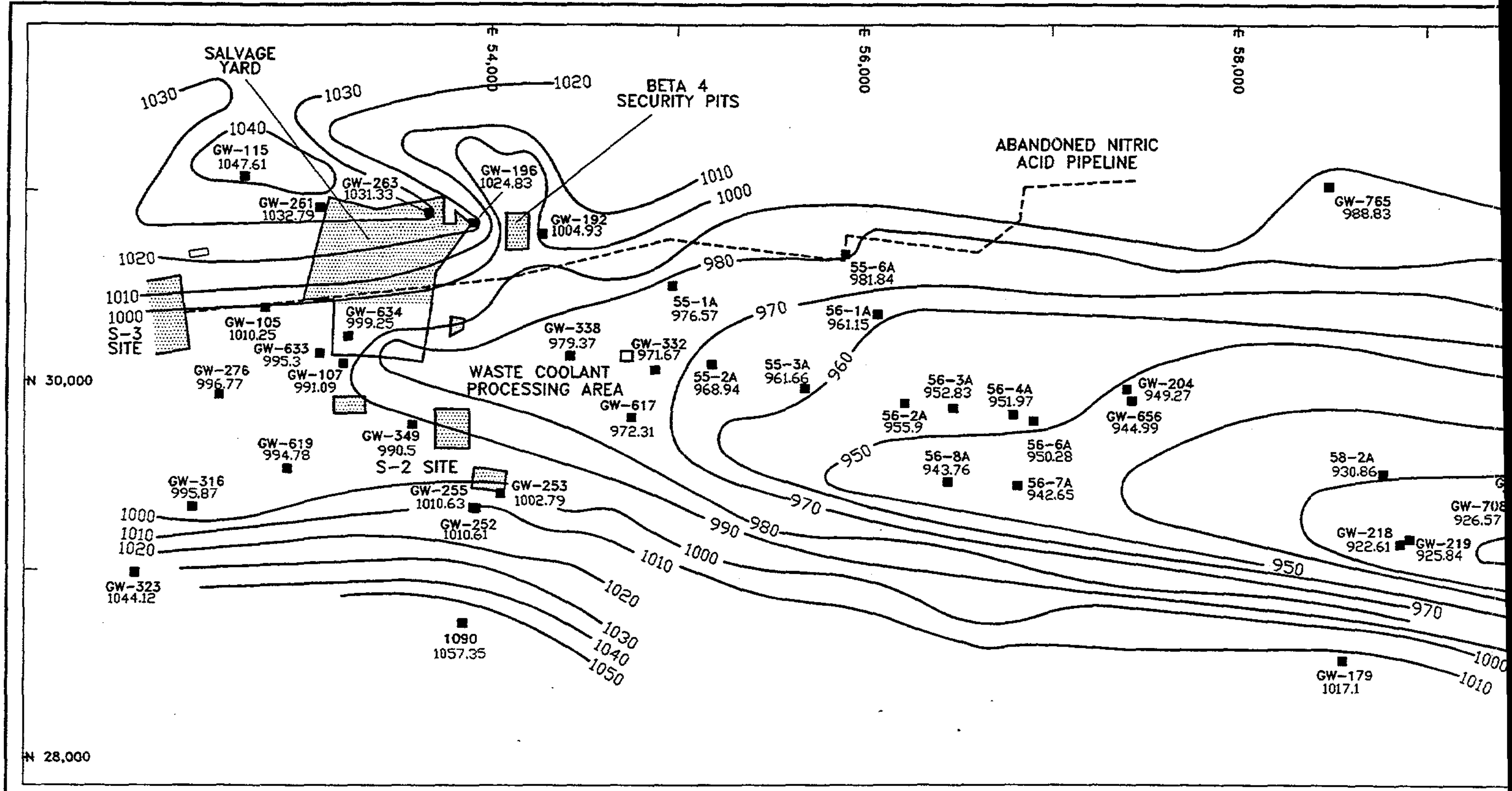
LOCATION:	Y-12 PLANT OAK RIDGE, TN.	**FIGURE 11**
DATE:	5-9-94	**SCHEMATIC PROFILE OF HYDROSTRATIGRAPHIC UNITS IN THE UPPER EAST FORK POPLAR CREEK HYDROGEOLOGIC REGIME**
DWG ID.:	OR213-HC	



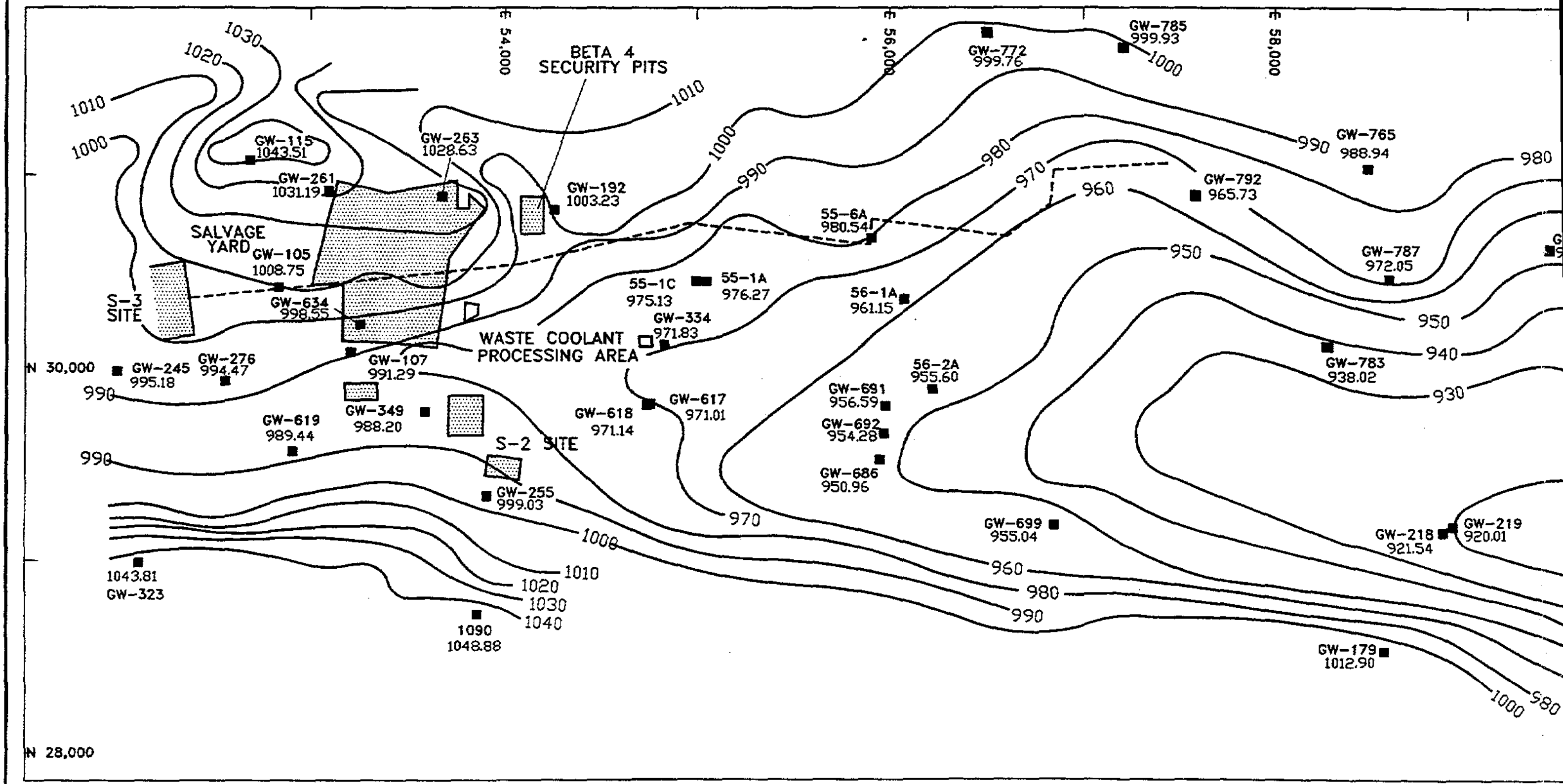
SOURCE: SAIC, 1994.



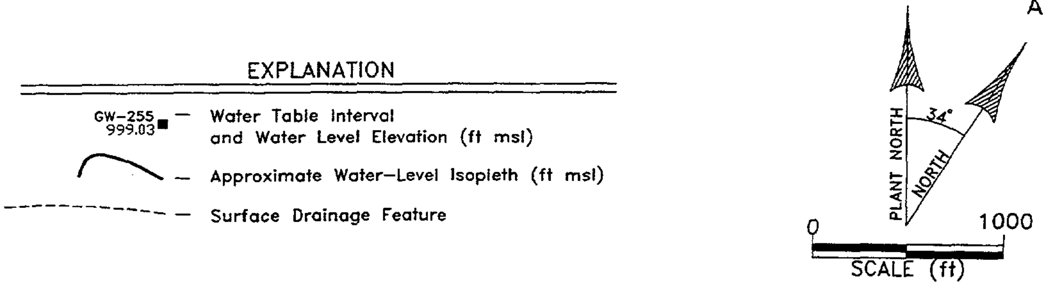
LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 12
DATE:	2-13-95	RAINFALL RESPONSES IN THE STORMFLOW ZONE
DWG ID.:	OR414-HC	

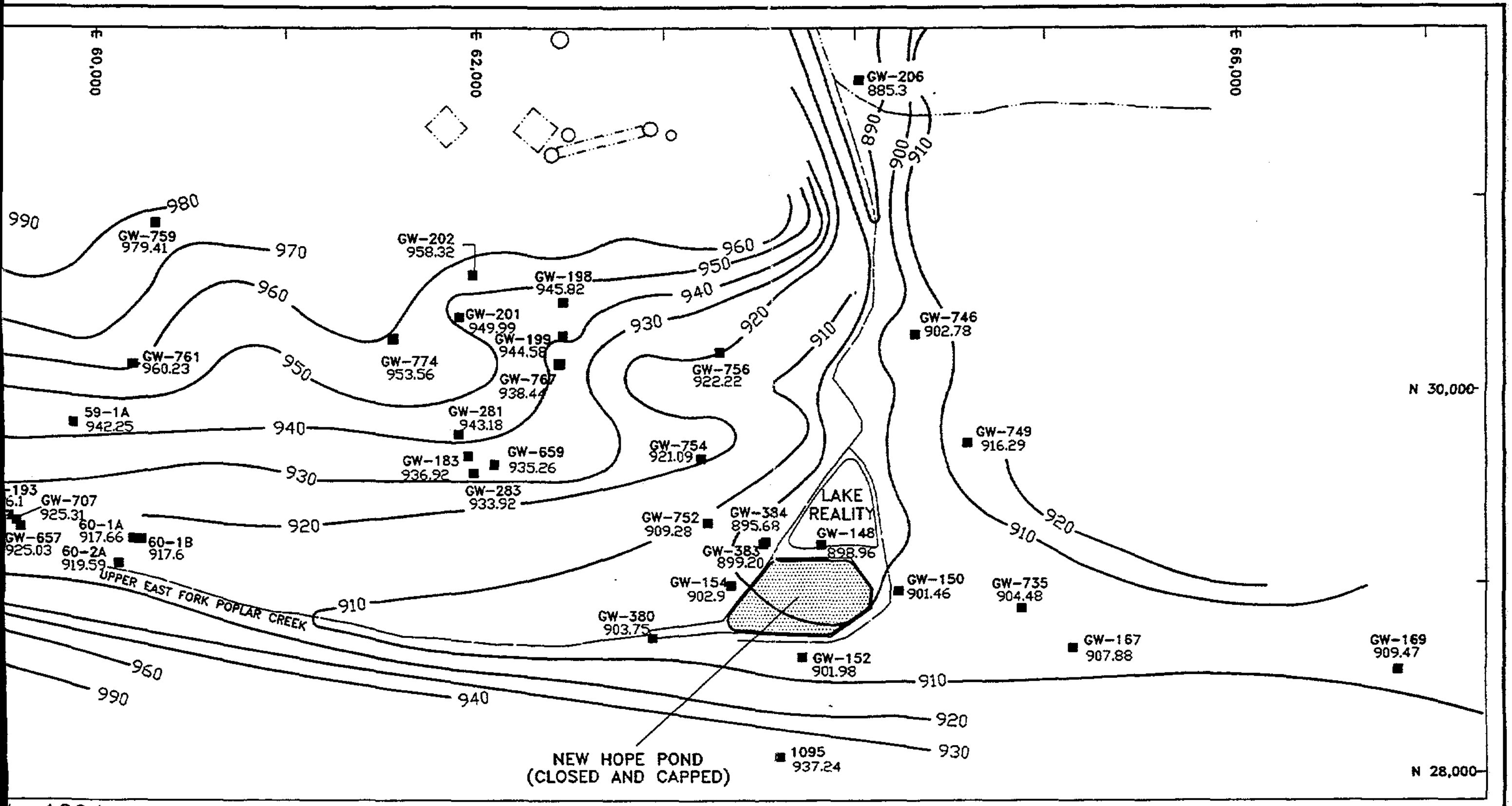


JANUARY 10–2

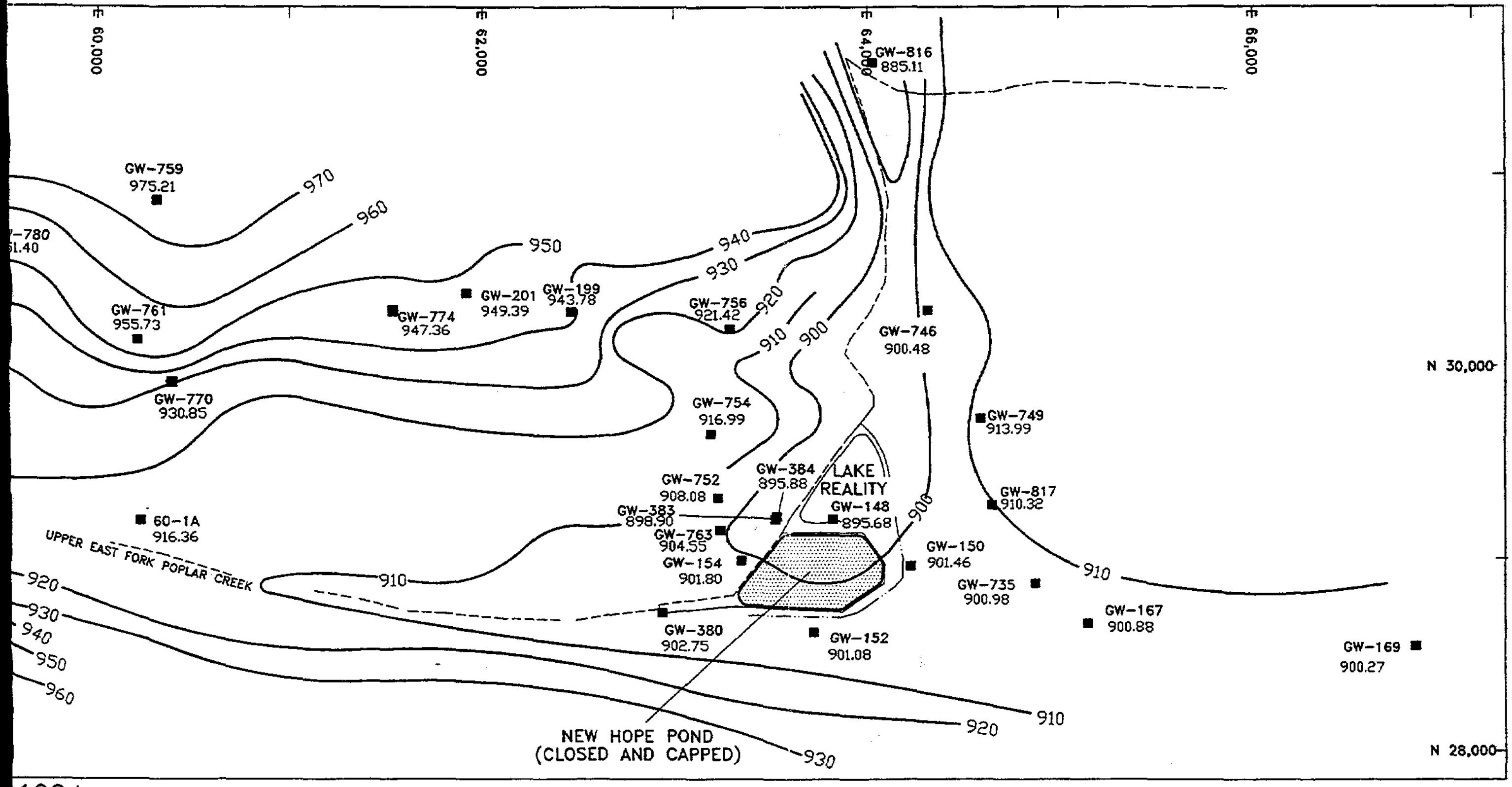


AUGUST 22–31,



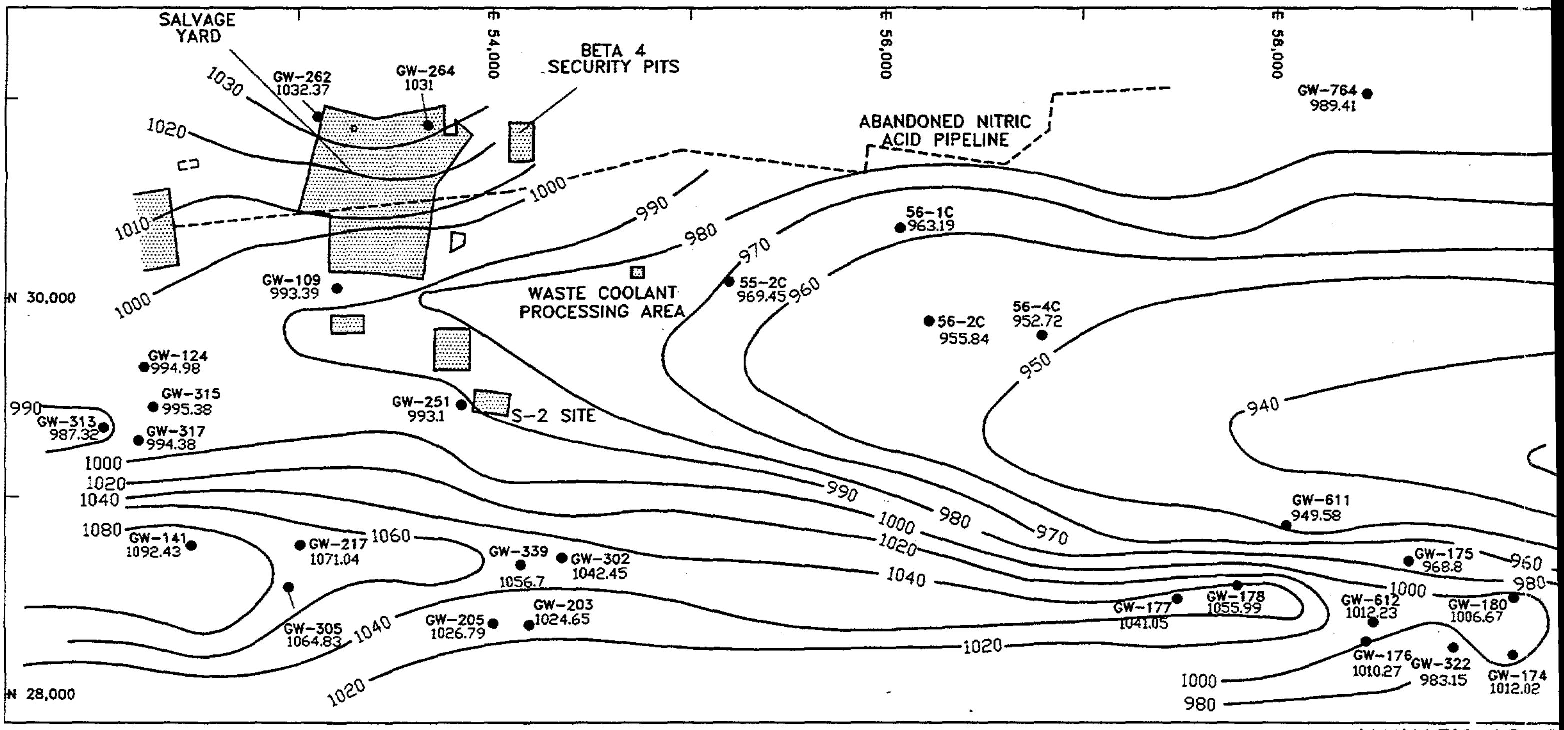


4, 1994

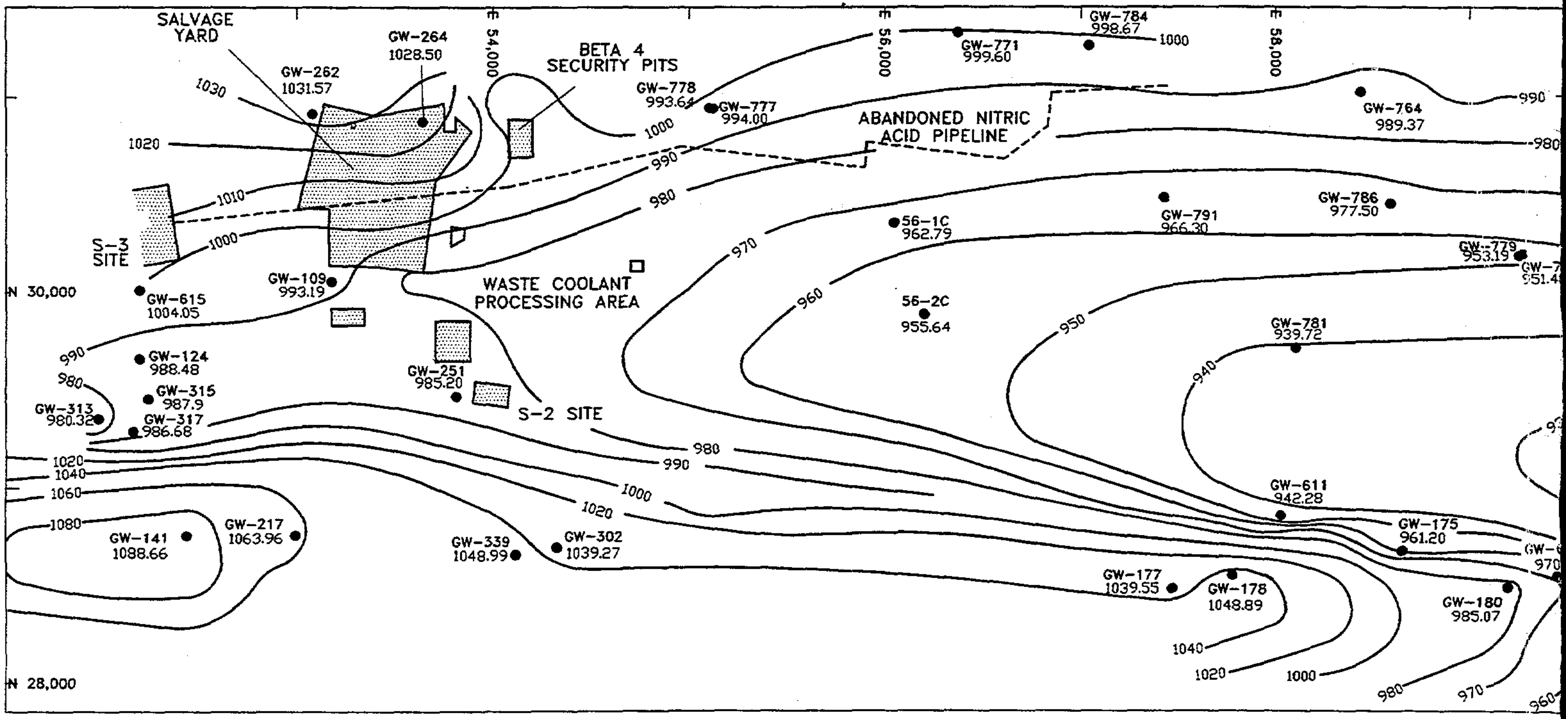


1994

LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 13
DATE:	5-9-95	GROUNDWATER ELEVATIONS IN THE WATER TABLE INTERVAL
DWG ID.:	OR464-HC	



JANUARY 10-2



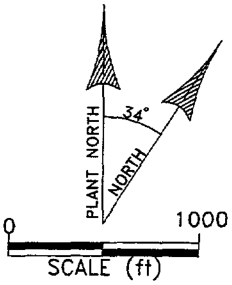
AUGUST 22-

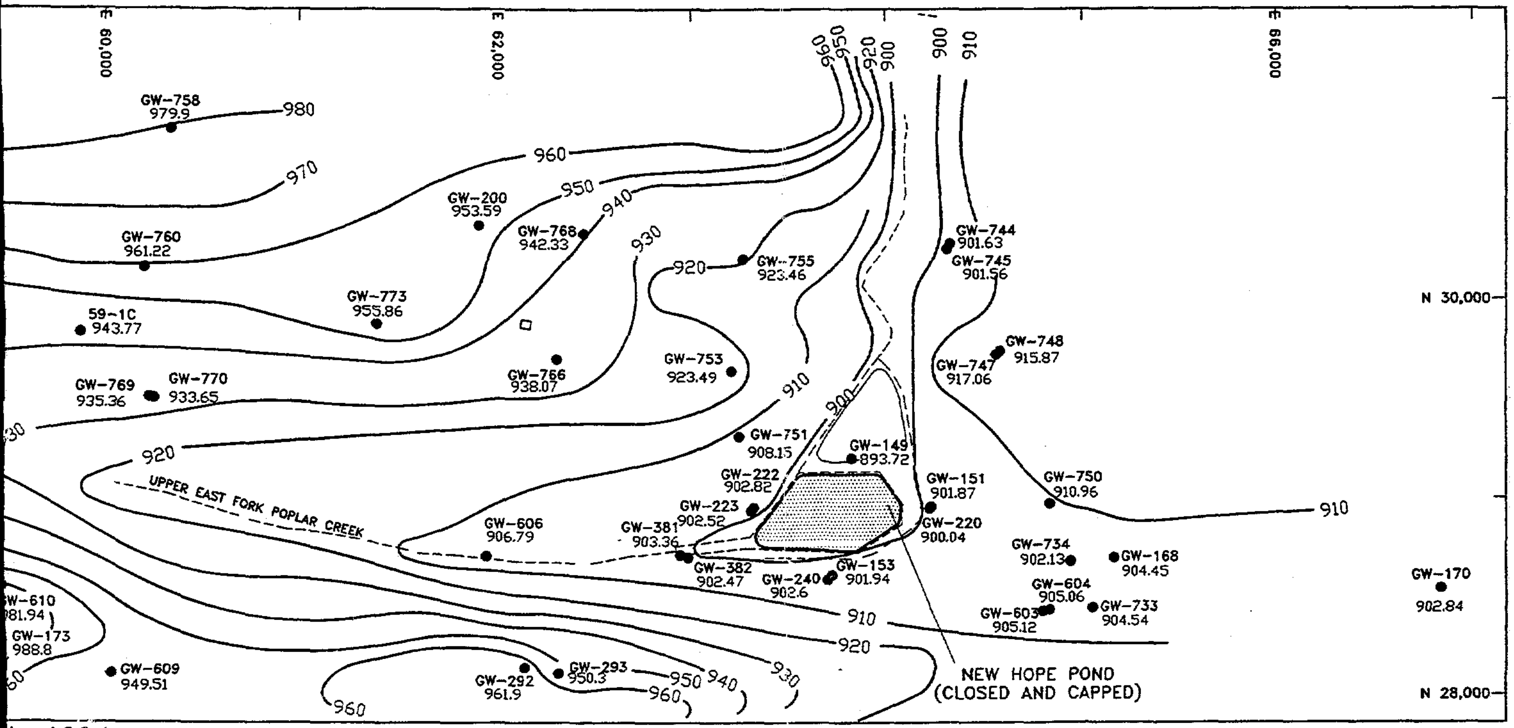
EXPLANATION

GW-339 1048.99 ● — Bedrock Monitoring Well and Water Level Elevation (ft msl)

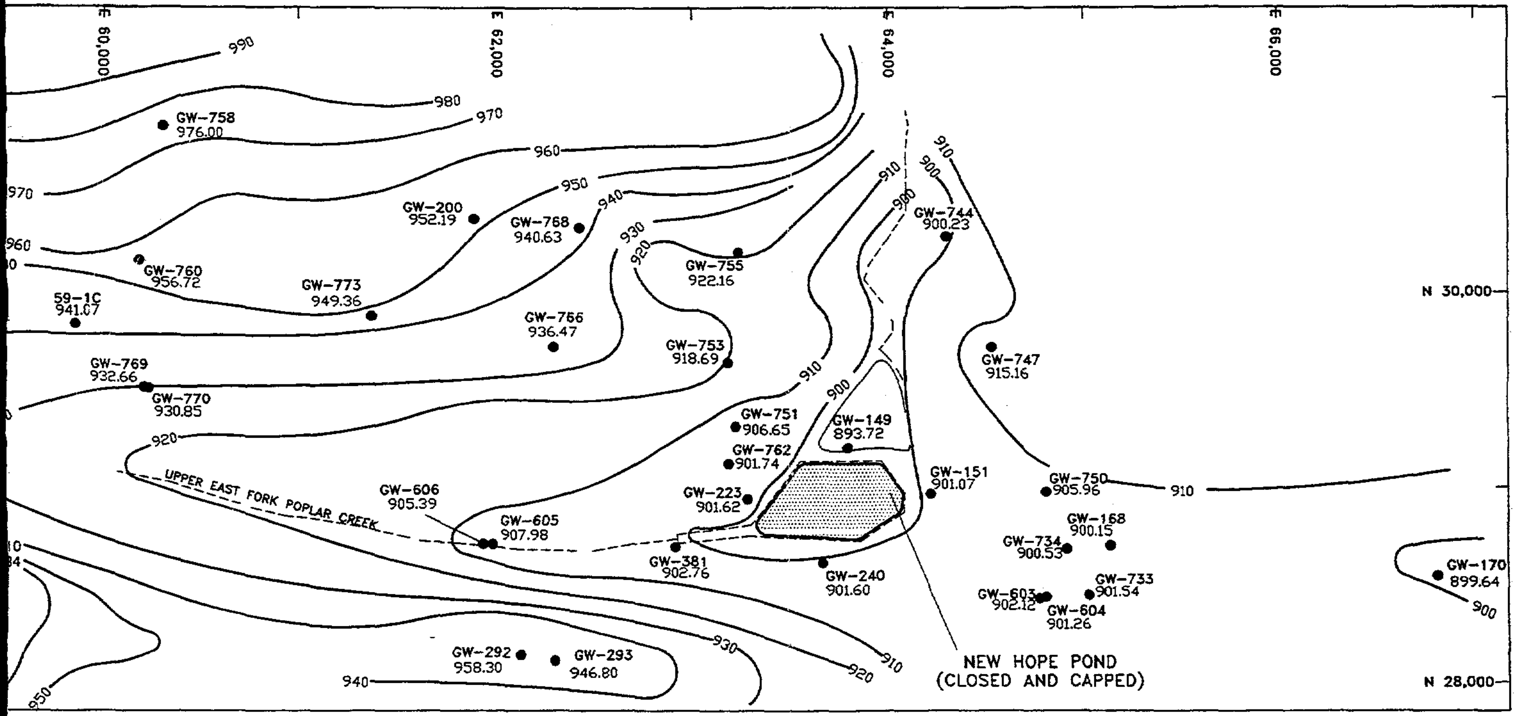
⌒ — Approximate Water-Level Isopleth (ft msl)

- - - - — Surface Drainage Feature



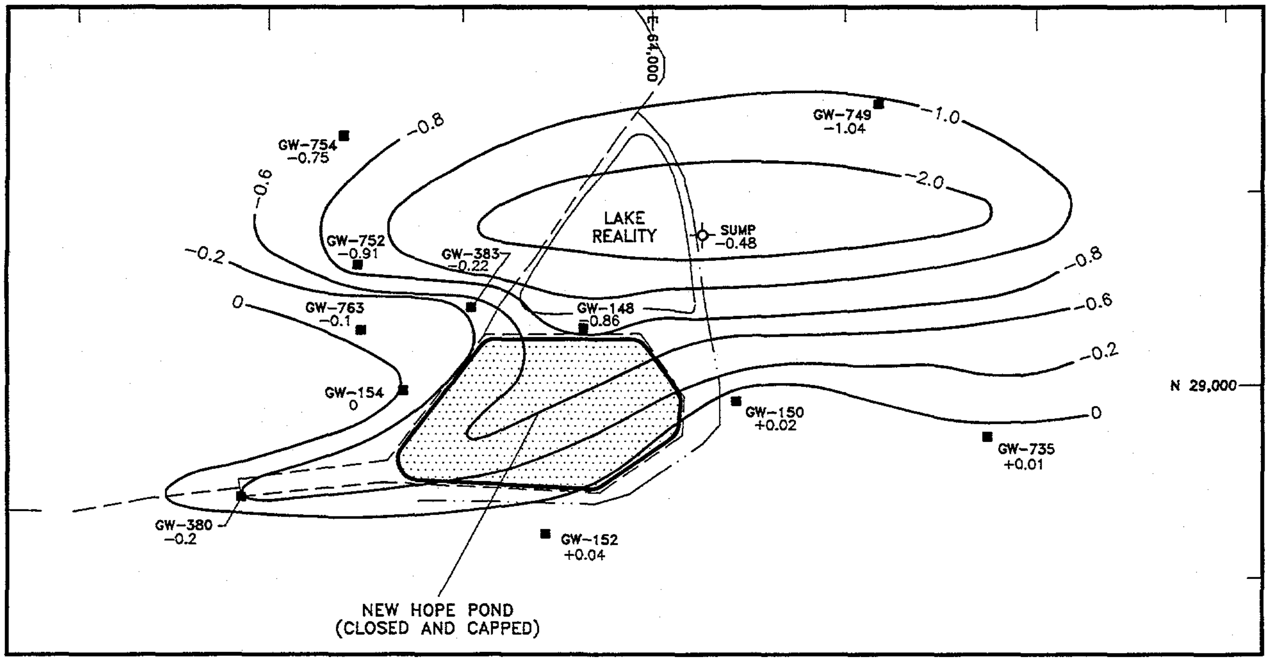


4, 1994

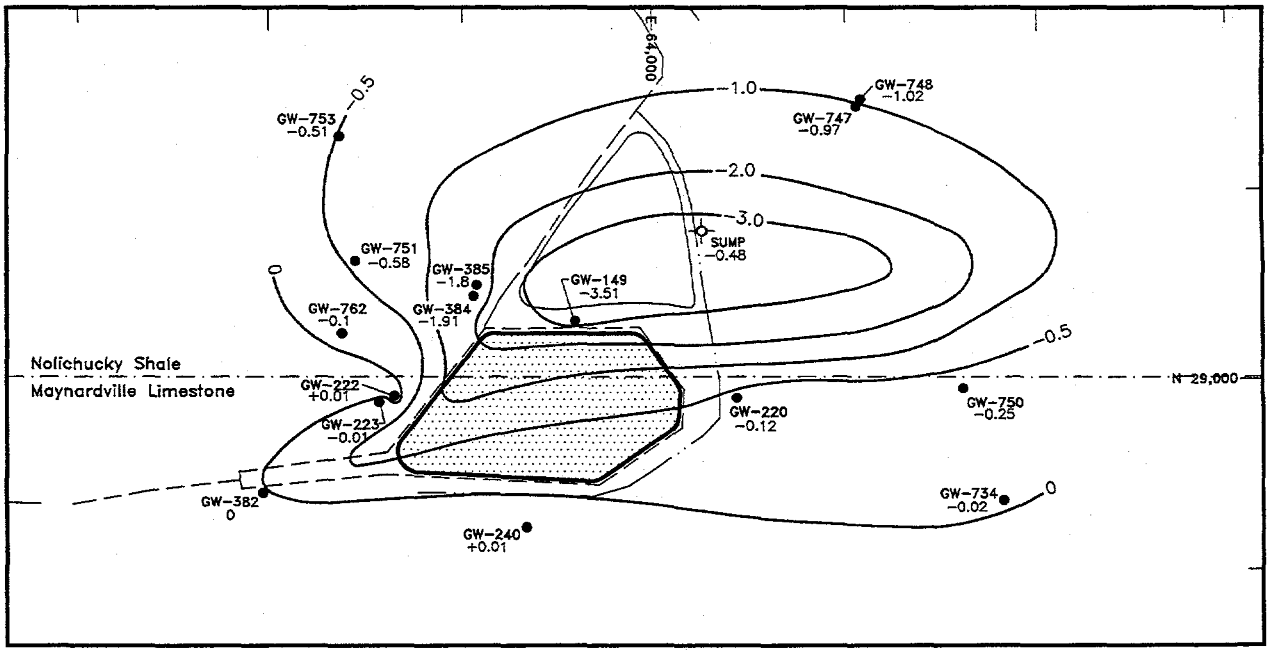


1, 1994

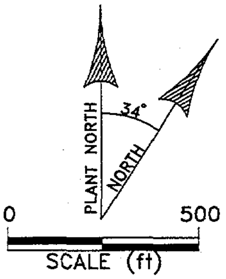
LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 14
DATE:	5-2-95	GROUNDWATER ELEVATIONS IN THE SHALLOW AND INTERMEDIATE BEDROCK INTERVALS
DWG ID.:	OR463-HC	



WATER TABLE INTERVAL



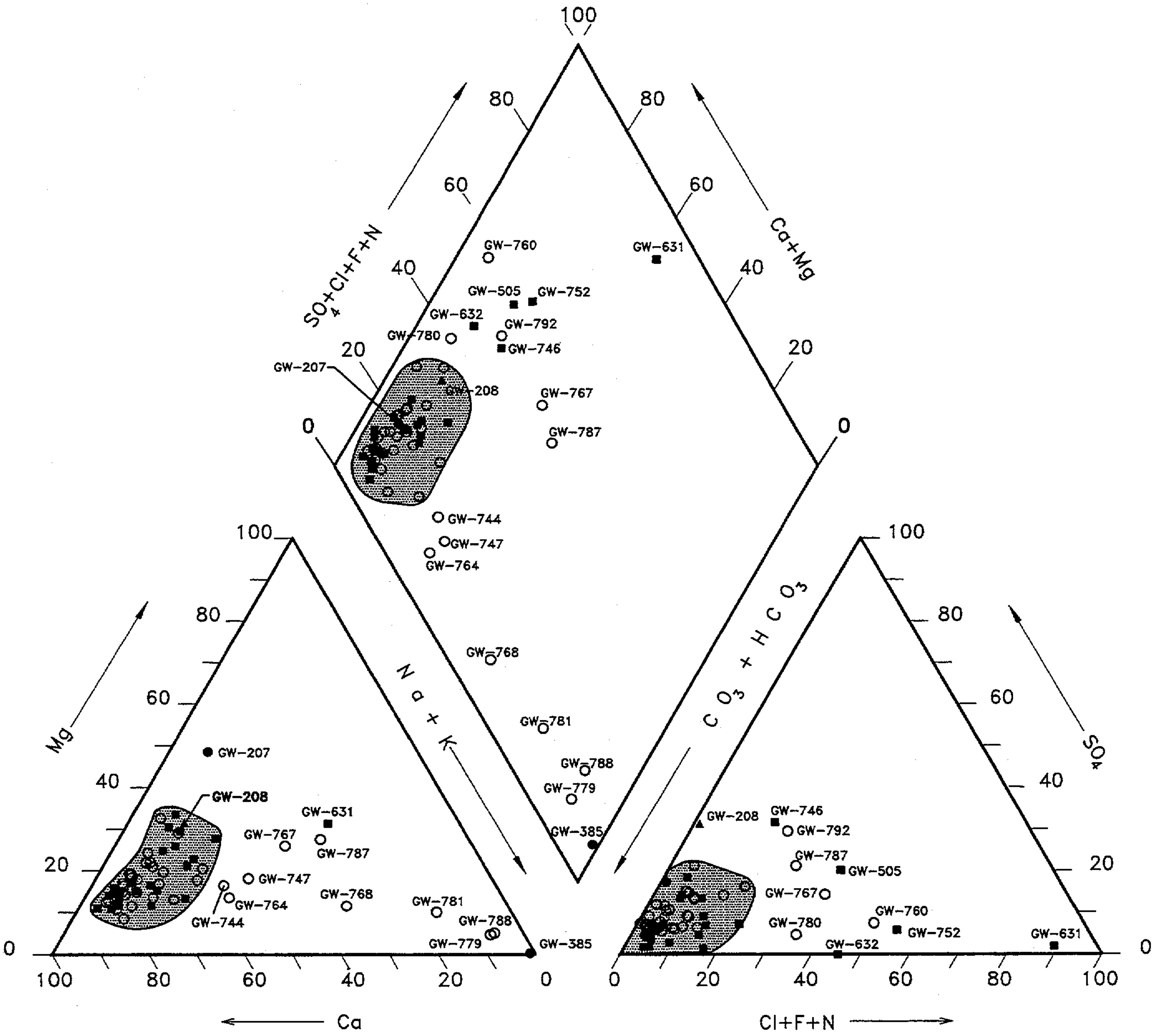
BEDROCK INTERVAL



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

LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 15
DATE:	9-24-95	INFLUENCE ON GROUNDWATER FLOW DURING OPERATION OF THE LAKE REALITY SWMP
DWG ID.:	ORGWELV	



EXPLANATION

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

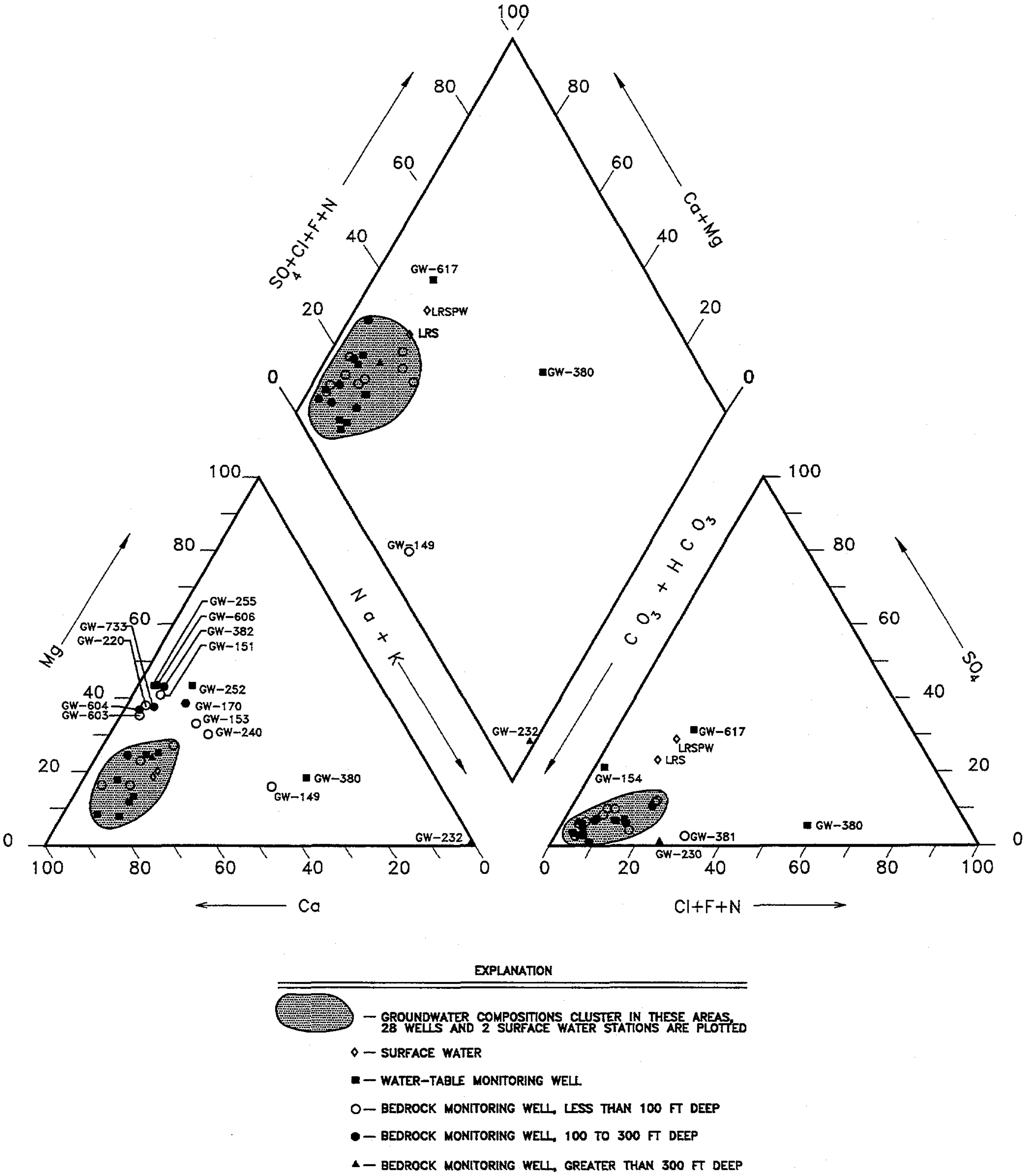
■ — WATER-TABLE MONITORING WELL

○ — BEDROCK MONITORING WELL, LESS THAN 100 FT DEEP

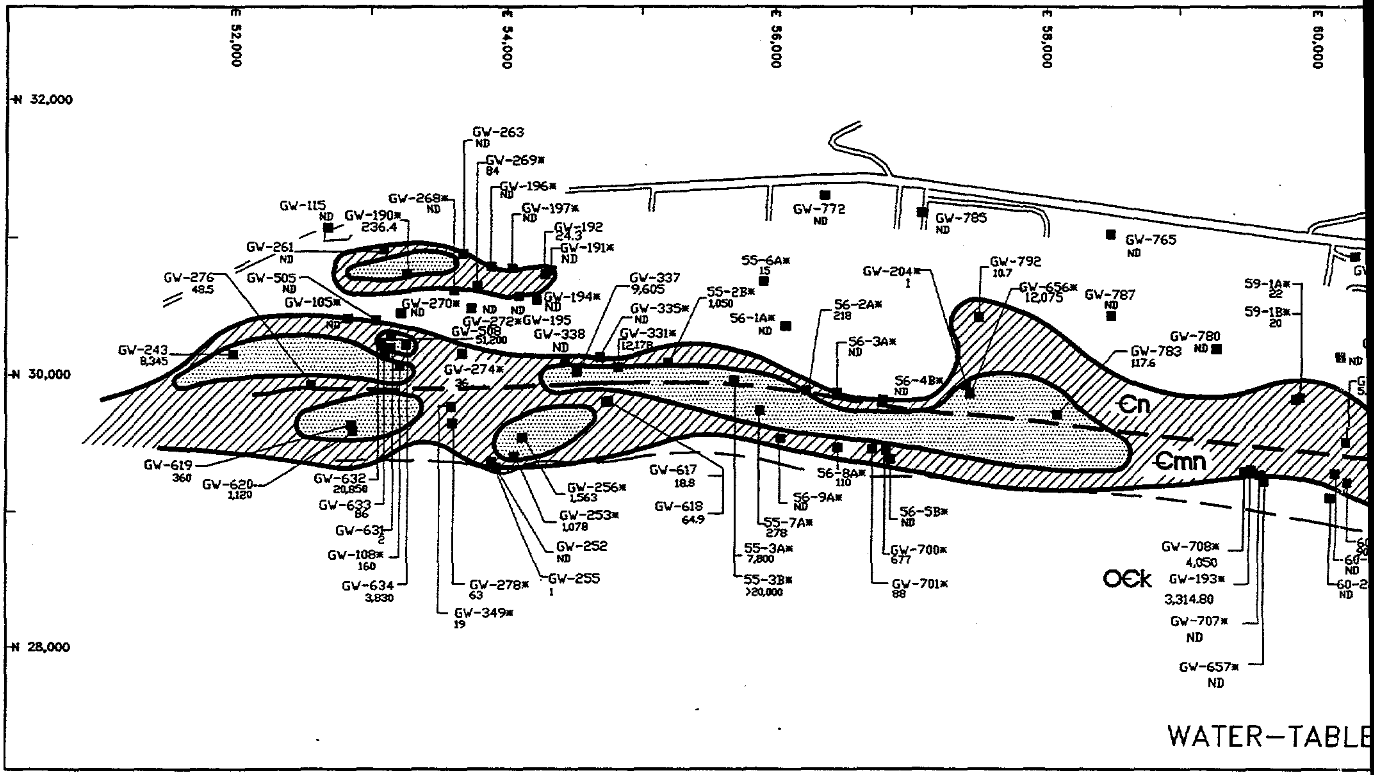
● — BEDROCK MONITORING WELL, 100 TO 300 FT DEEP

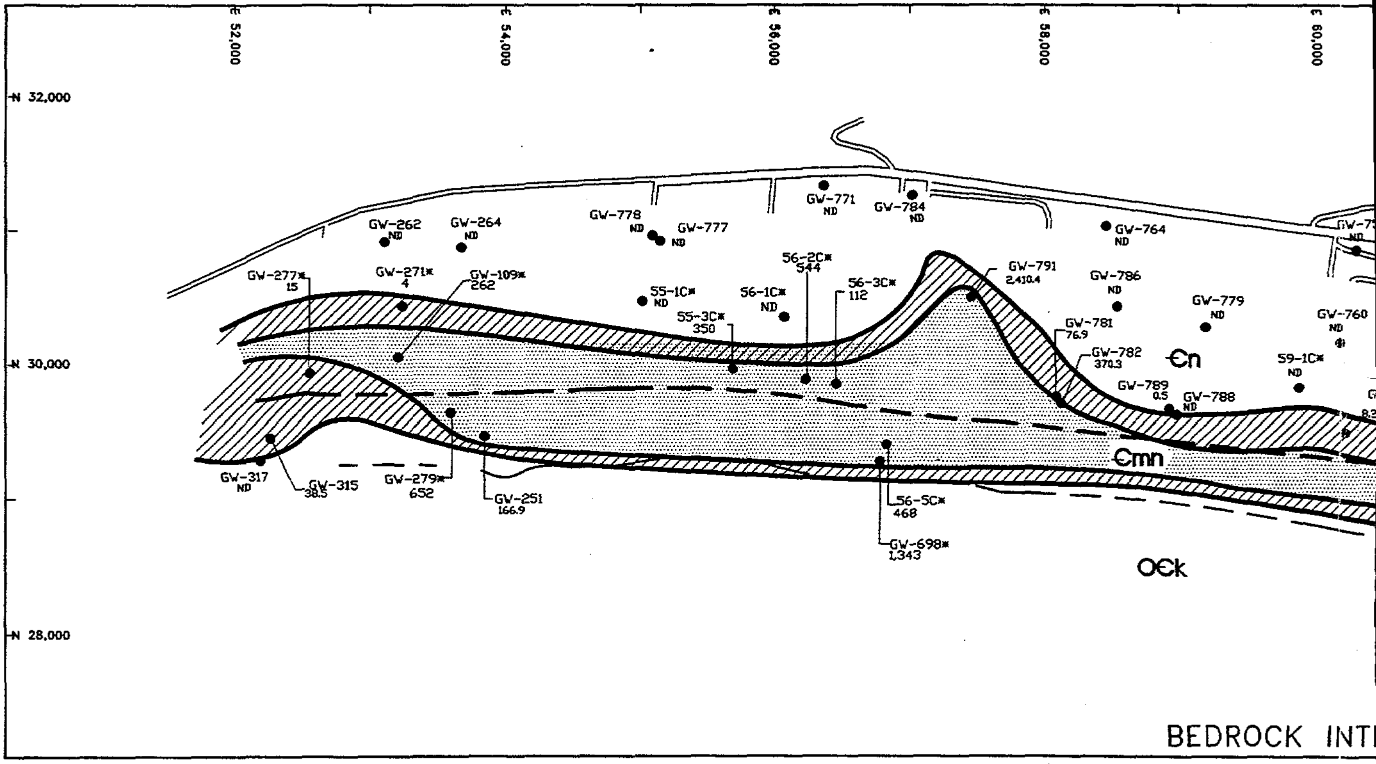
▲ — BEDROCK MONITORING WELL, GREATER THAN 300 FT DEEP

LOCATION:	Y-12 PLANT OAK RIDGE, TN	FIGURE 16
DATE:	6-27-95	GROUNDWATER GEOCHEMISTRY IN THE CONASAUGA SHALES
DWG ID.:	OR490-HC	



LOCATION:	Y-12 PLANT OAK RIDGE, TN	FIGURE 17
DATE:	6-27-95	GROUNDWATER GEOCHEMISTRY IN THE MAYNARDVILLE LIMESTONE
DWG ID.:	OR489-HC	





EXPLANATION

▲ — SURFACE-WATER SAMPLING LOCATION

■ — WATER TABLE INTERVAL MONITORING WELL

● — BEDROCK INTERVAL MONITORING WELL

Ꞓn — NOLICHUCKY SHALE — ORR AQUITARD

Ꞓmn — MAYNARDVILLE LIMESTONE — KNOX AQUIFER

OꞒk — KNOX GROUP — KNOX AQUIFER

172 — SUMMED AVERAGE VOC CONCENTRATION (ug/L

≤ — QUALITATIVE VOC CONCENTRATION (ug/L)

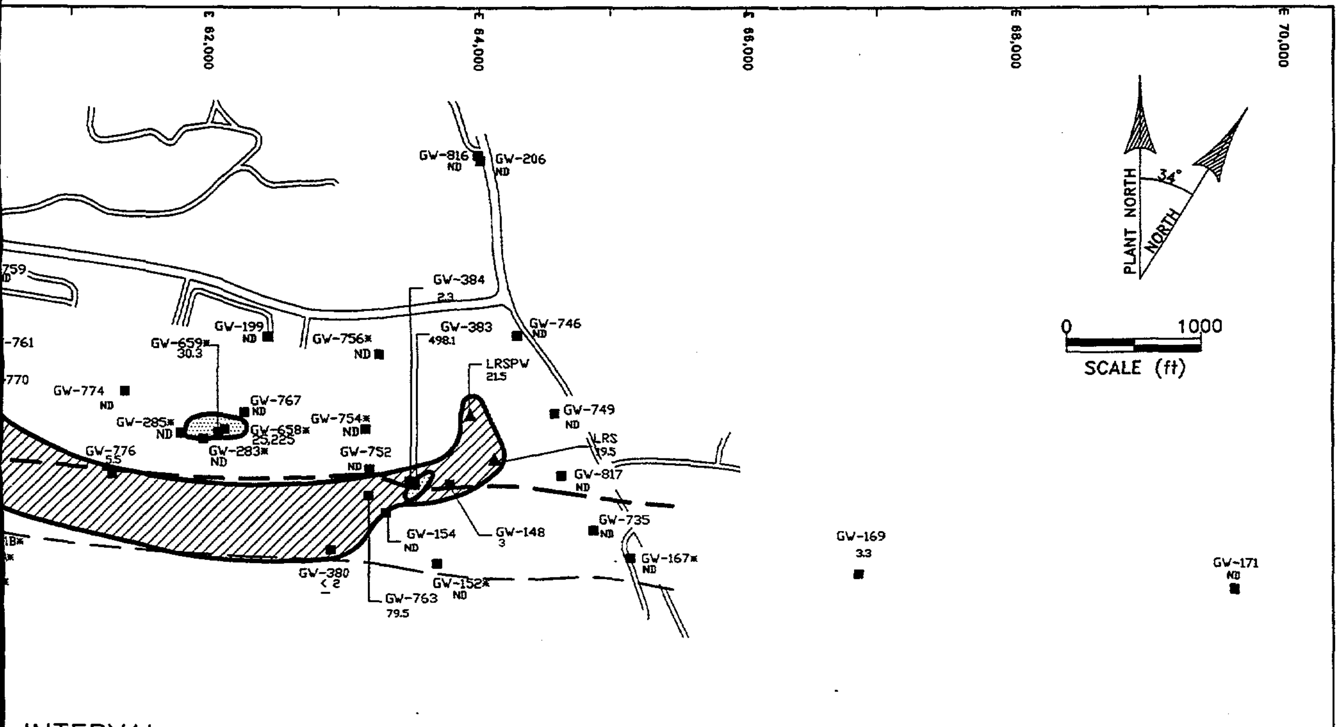
ND — NOT DETECTED

* — INDICATES A WELL SAMPLED BEFORE 1994

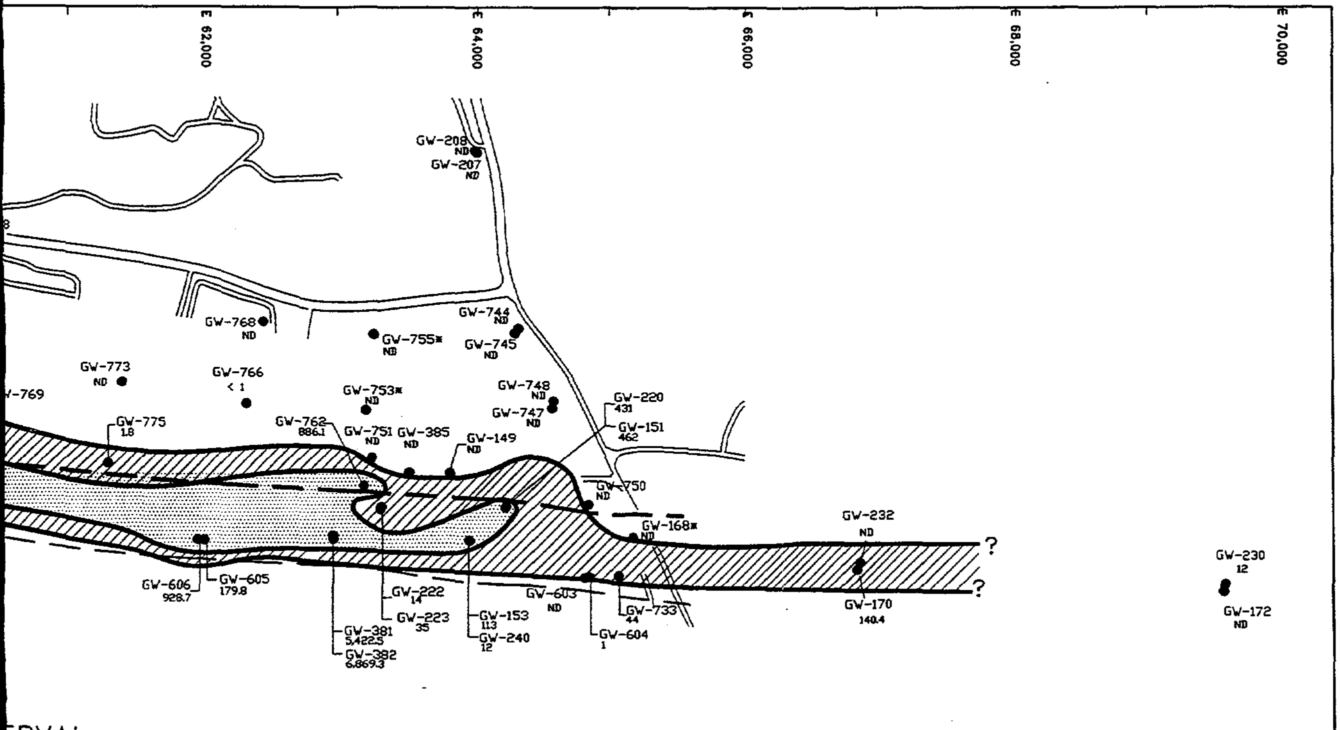
— ND

▨ — 0–100 ug/L

░ — >100 ug/L

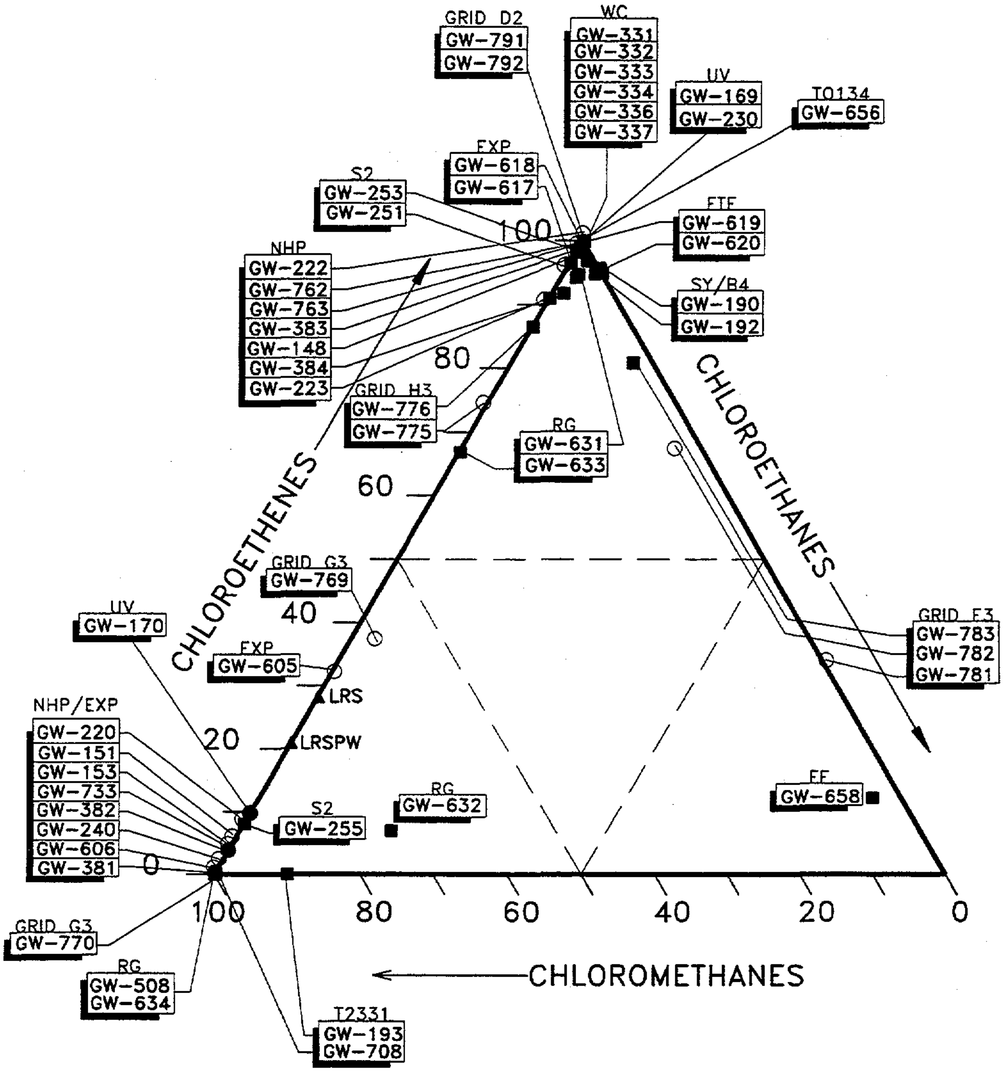


INTERVAL



ERVAL

LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 18
DATE:	7-16-95	VOCS IN GROUNDWATER IN THE UPPER EAST FORK POPLAR CREEK HYDROGEOLOGIC REGIME
DWG ID.:	ANVOC	



EXPLANATION

WELL LOCATION

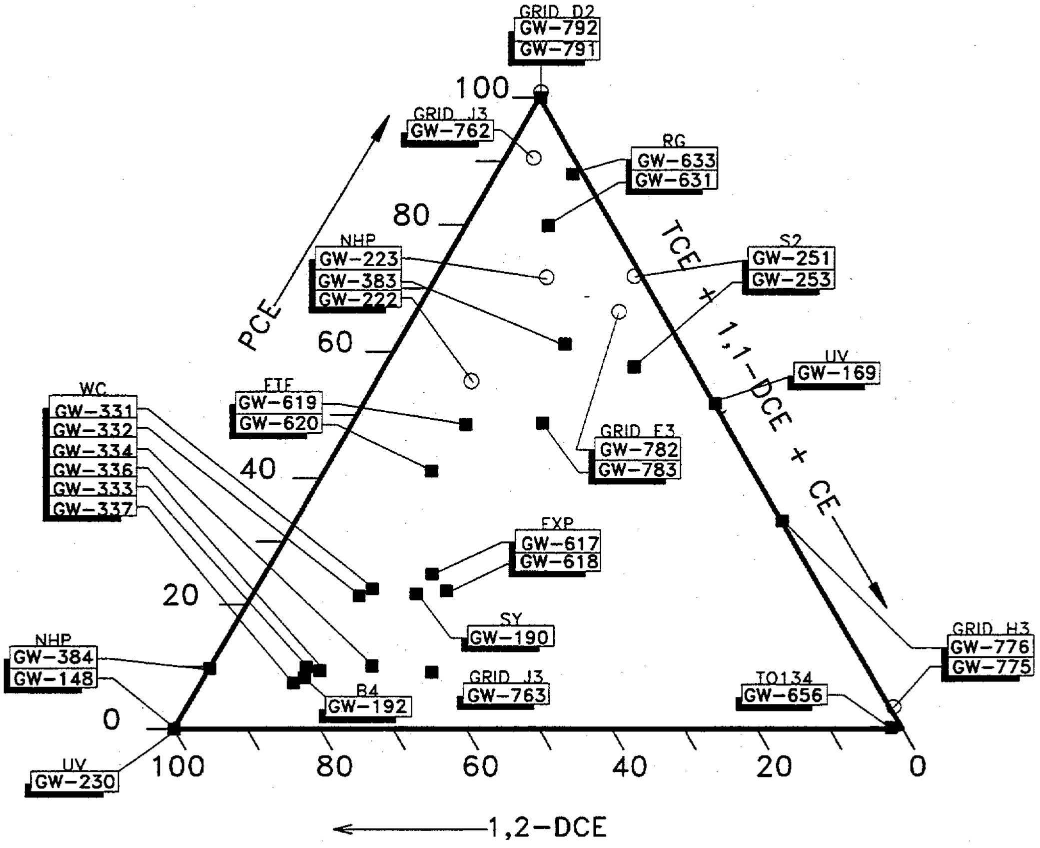
B4	Beta-4 Security Pits
EXP	Exit Pathway
FF	Building 9754-2 Fuel Facility
FTF	Fire Training Facility
GRID	Grid Location
NHP	New Hope Pond
RG	Rust Garage Area
S2	S-2 Site
SY	Y-12 Salvage Yard
T0134	Tank 0134-U
T2331	Tank 2331-U
UV	Union Valley
WC	Waste Coolant Processing Area

▲ — SURFACE WATER
■ — WATER TABLE INTERVAL MONITORING WELL
○ — BEDROCK INTERVAL MONITORING WELL, <100 FT DEEP
● — BEDROCK INTERVAL MONITORING WELL, 100 TO 300 FT DEEP
▼ — BEDROCK INTERVAL MONITORING WELL, >300 FT DEEP

Compound Proportions Determined from CY 1991-1994 Average Concentrations.

CHLOROETHENES: PCE, TCE, 1,2-DCE, 1,1-DCE, VINYL CHLORIDE
CHLOROETHANES: 1,1,1-TCA, 1,1-DCA, 1,2-DCA, 1,1,2-TCA
CHLOROMETHANES: CARBON TETRACHLORIDE, CHLOROFORM, METHYLENE CHLORIDE

LOCATION:	Y-12 PLANT OAK RIDGE, TN	FIGURE 19 DISTRIBUTION OF DISSOLVED CHLORINATED SOLVENTS IN GROUNDWATER
DATE:	9-26-95	
DWG ID.:	SOLVENTS	



EXPLANATION

WELL LOCATION

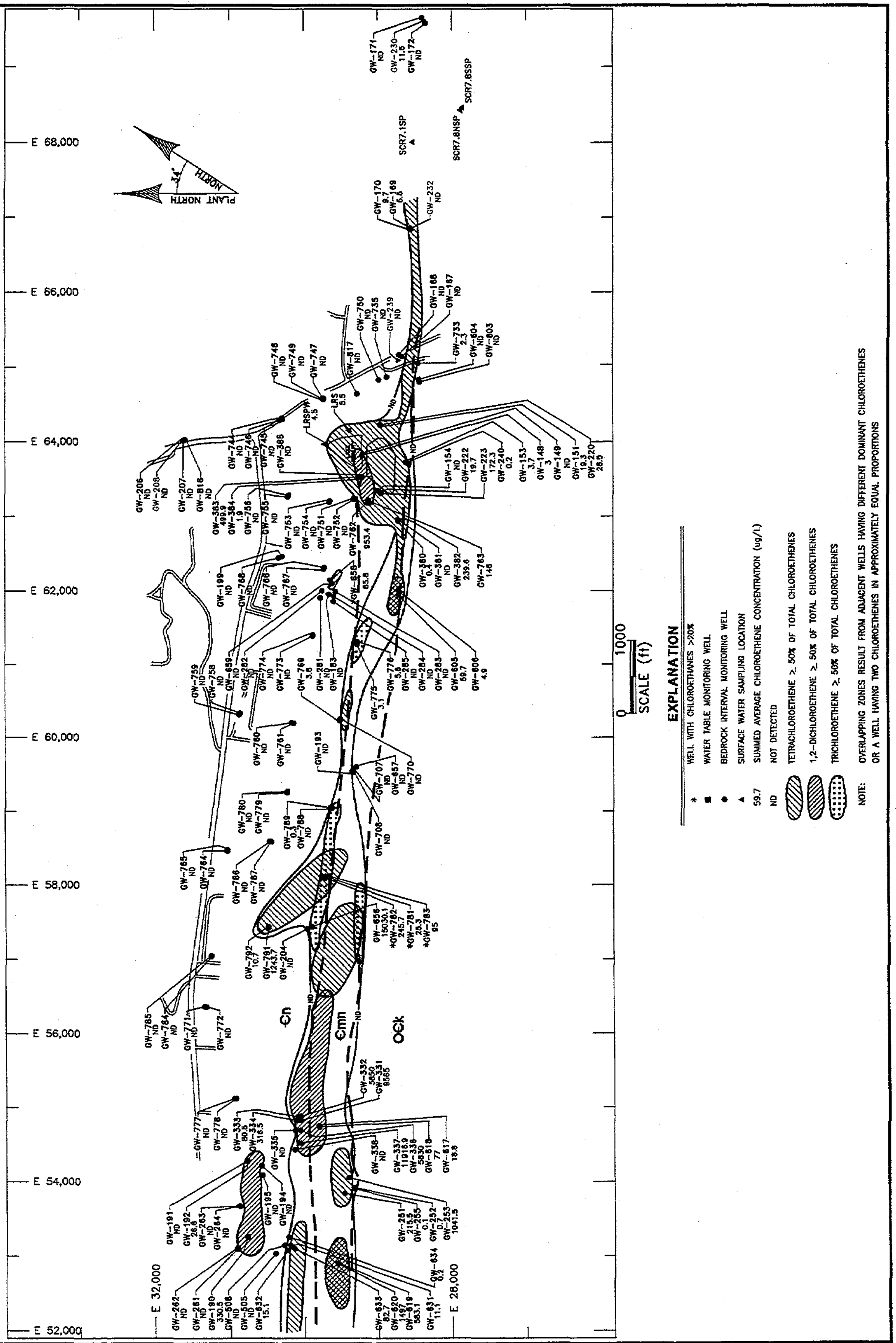
B4	Beta-4 Security Pits
EXP	Exit Pathway
FF	Building 9754-2 Fuel Facility
GRID	Grid Location
NHP	New Hope Pond
RG	Rust Garage Area
S2	S-2 Site
SY	Y-12 Salvage Yard
T0134	Tank 0134-U
UV	Union Valley
WC	Waste Coolant Processing Area

■ — WATER TABLE INTERVAL MONITORING WELL
○ — BEDROCK INTERVAL MONITORING WELL, <100 FT DEEP
▼ — BEDROCK INTERVAL MONITORING WELL, >300 FT DEEP

Compound Proportions Determined from CY 1991-1994 Average Concentrations.

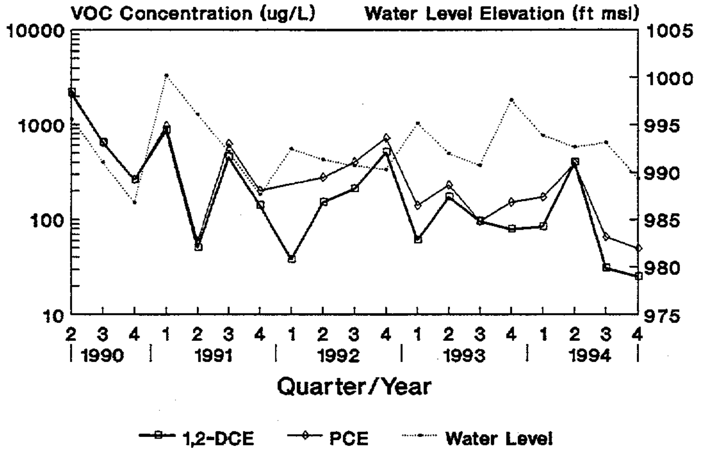
PCE - Tetrachloroethene
TCE - Trichloroethene
1,2-DCE - 1,2-Dichloroethene
1,1-DCE - 1,1-Dichloroethene
CE - Vinyl Chloride

LOCATION:	Y-12 PLANT OAK RIDGE, TN	FIGURE 20
DATE:	9-26-95	DISTRIBUTION OF DISSOLVED CHLOROETHENES IN GROUNDWATER
DWG ID.:	ETHENES	

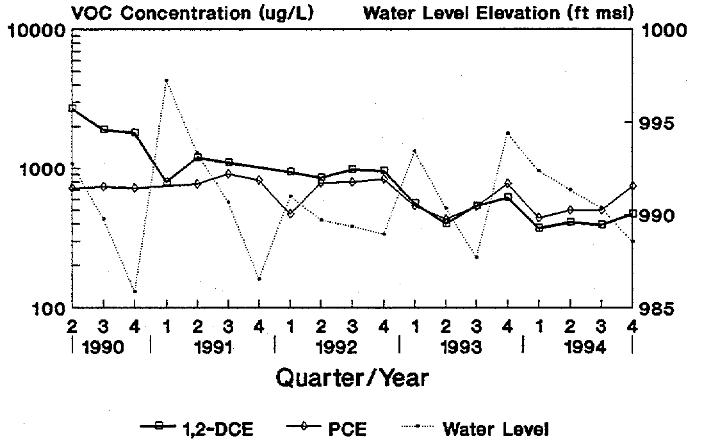


LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 21
DATE:	10-3-95	CHLOROETHENES AND CHLOROETHANES IN GROUNDWATER IN THE UPPER EAST FORK CREEK HYDROGEOLOGIC REGIME, CYs 1991 - 1994
DWG ID.:	TF620-DN	

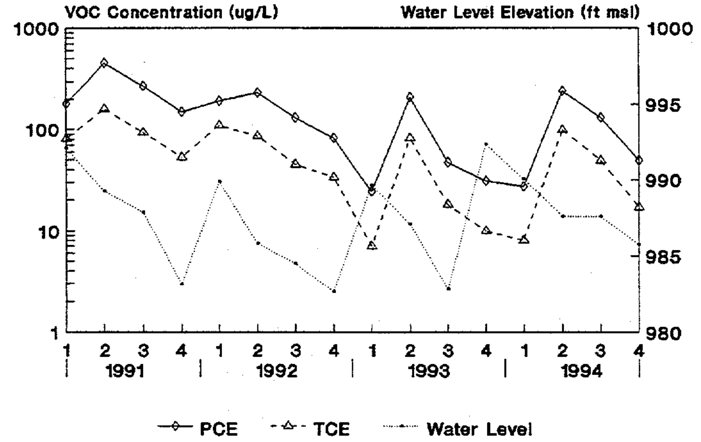
GW-619
Fire Training Facility



GW-620
Fire Training Facility

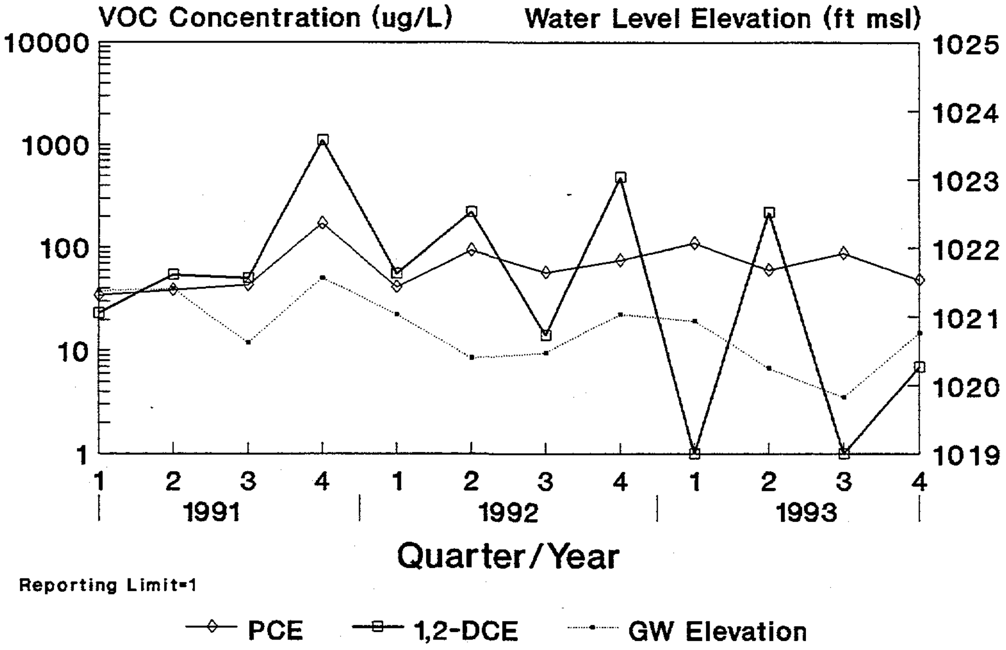


GW-251
S-2 Site



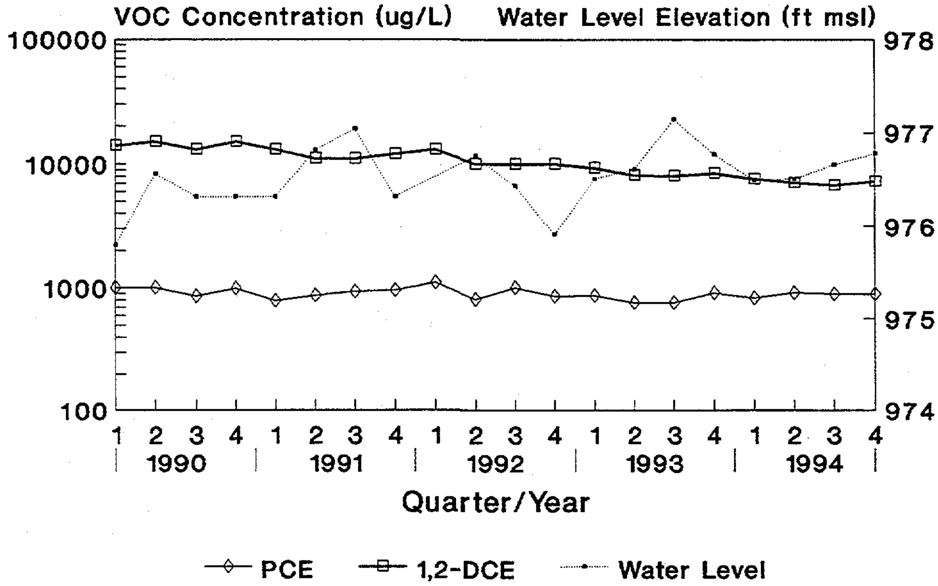
LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 22
DATE:	9-20-95	PCE AND 1,2-DCE CONCENTRATIONS IN WELLS GW-619, GW-620, AND GW-251, 1991 - 1994
DWG ID.:	22	

GW-190
Y-12 Salvage Yard

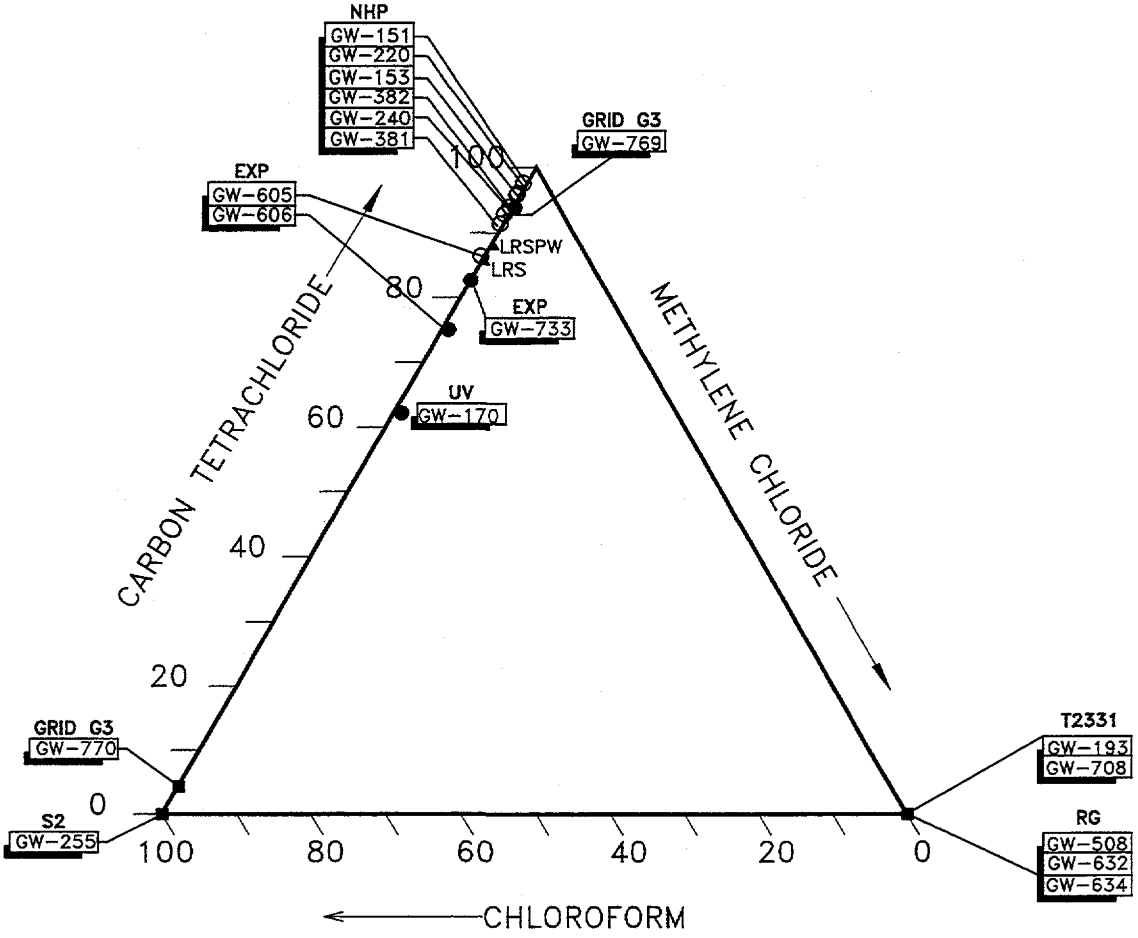


Note: Reporting Limit=1

GW-337
Waste Coolant Processing Area



LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 23
DATE:	9-20-95	PCE AND 1,2-DCE CONCENTRATIONS IN WELLS GW-190 AND GW-337, 1991 - 1994
DWG ID.:	23	



EXPLANATION

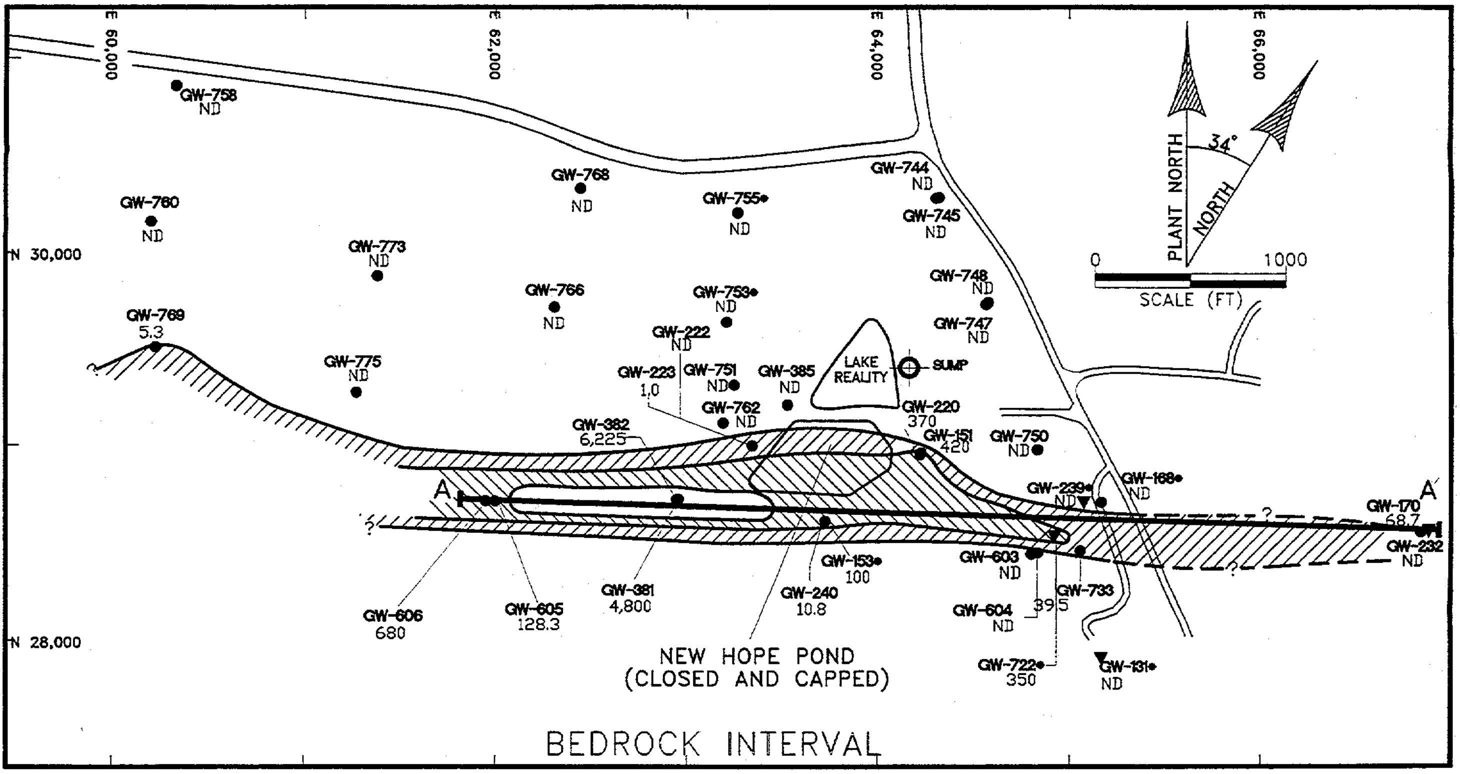
WELL LOCATION

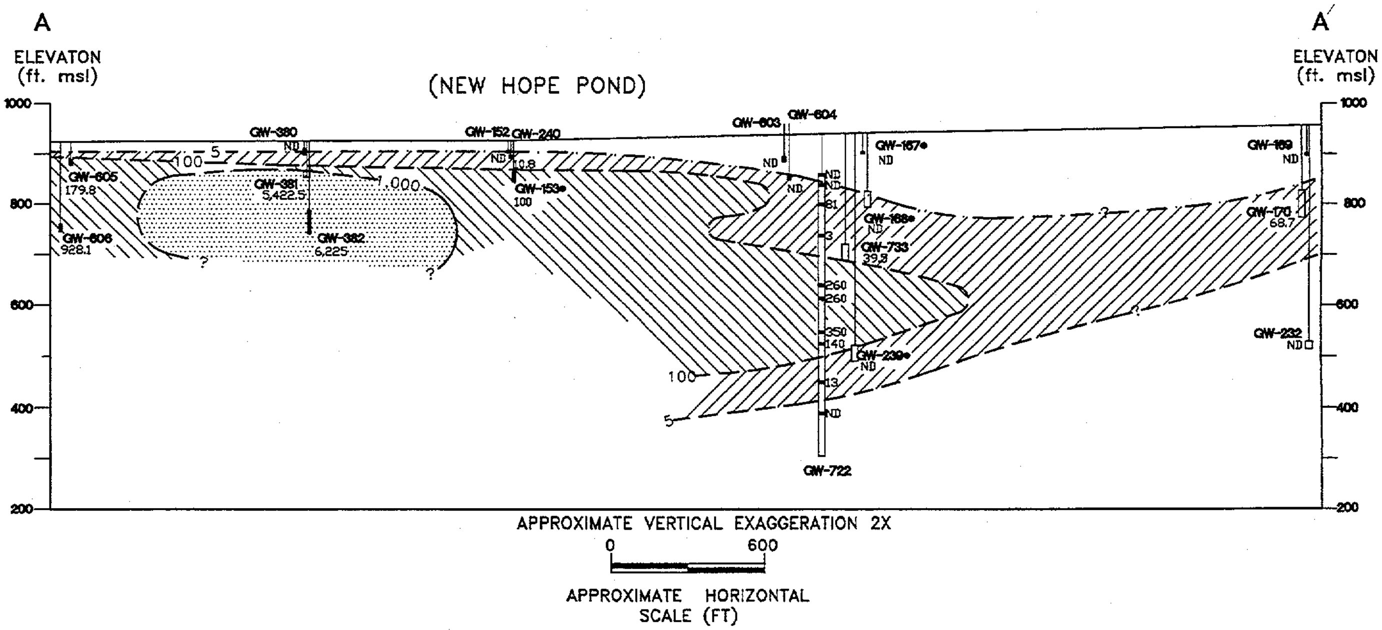
EXP	Exit Pathway
GRID	Grid Location
NHP	New Hope Pond
RG	Rust Garage Area
S2	S-2 Site
T2331	Tank 2331-U
UV	Union Valley

▲— SURFACE WATER
■— WATER TABLE INTERVAL MONITORING WELL
○— BEDROCK INTERVAL MONITORING WELL, <100 FT DEEP
●— BEDROCK INTERVAL MONITORING WELL, 100 TO 300 FT DEEP

Compound Proportions Determined from CY 1991-1994 Average Concentrations.

LOCATION:	Y-12 PLANT OAK RIDGE, TN	FIGURE 24
DATE:	9-10-95	DISTRIBUTION OF DISSOLVED CHLOROMETHANES IN GROUNDWATER
DWG ID.:	METHANES	





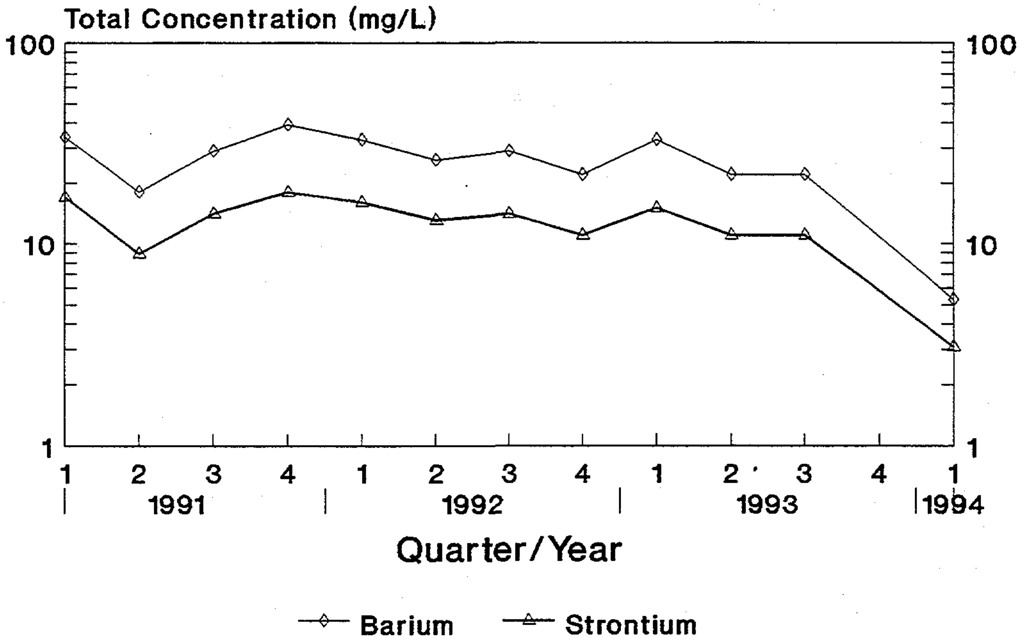
EXPLANATION

GW-606 ● — BEDROCK MONITORING WELL, < 300 FT
GW-232 ▼ — BEDROCK MONITORING WELL, > 300 FT
• — SAMPLED BEFORE 1994 (QUALITATIVE DATA)
| — SCREENED WELL CONSTRUCTION
▯ — OPEN-HOLE WELL CONSTRUCTION
▯ — WESTBAY SYSTEM SAMPLING PORTS SAMPLES COLLECTED IN MARCH 1994

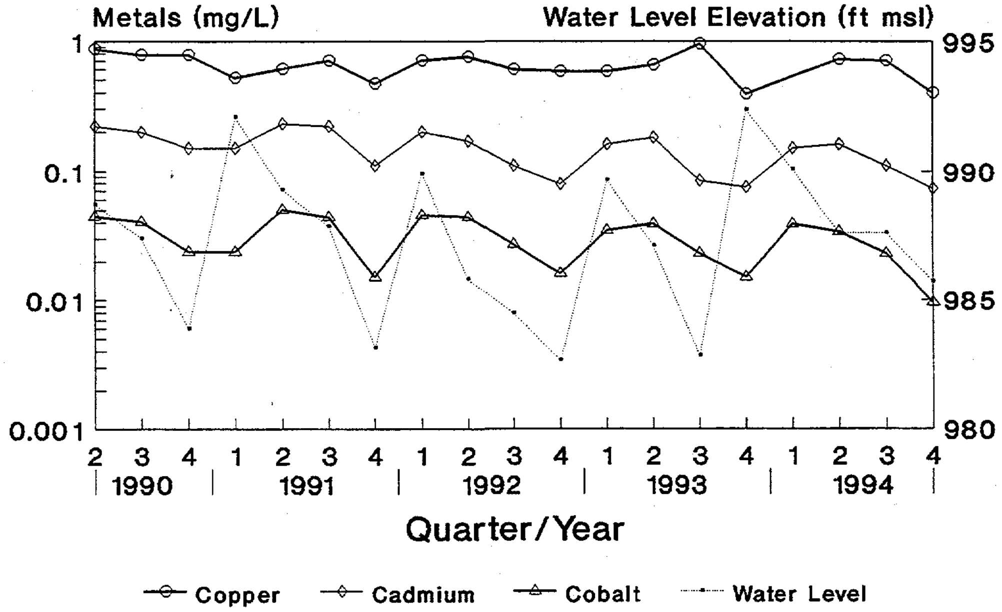
ANNUAL AVERAGE CARBON TETRACHLORIDE CONCENTRATION (ug/L)

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

LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 25
DATE:	9-21-95	CARBON TETRACHLORIDE IN GROUNDWATER, EASTERN Y-12 PLANT AREA
DWG ID.:	OR421-HC	



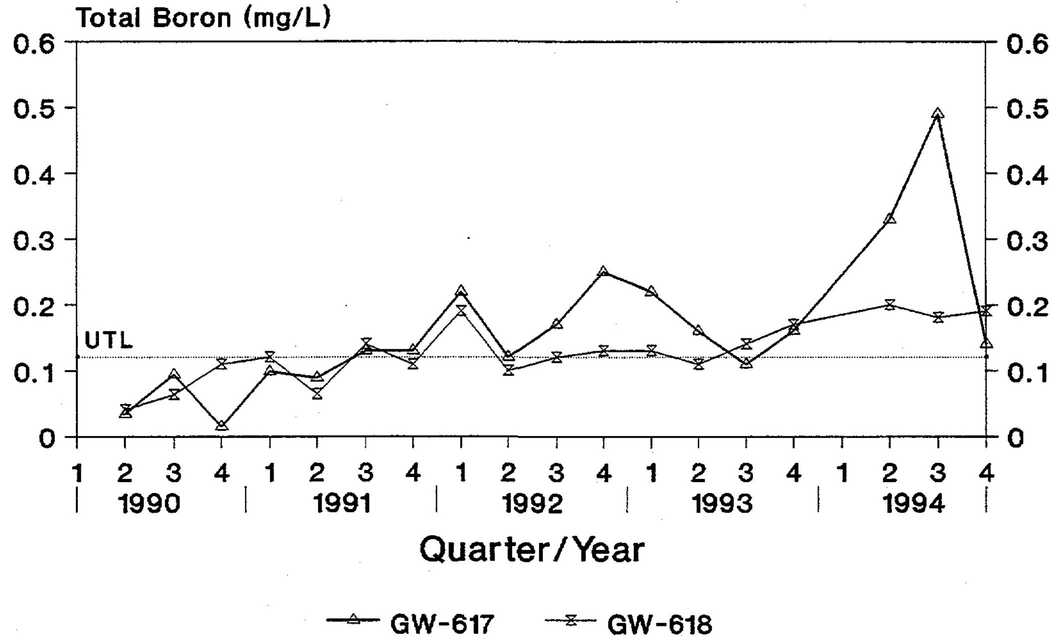
GW-633
Rust Garage Area



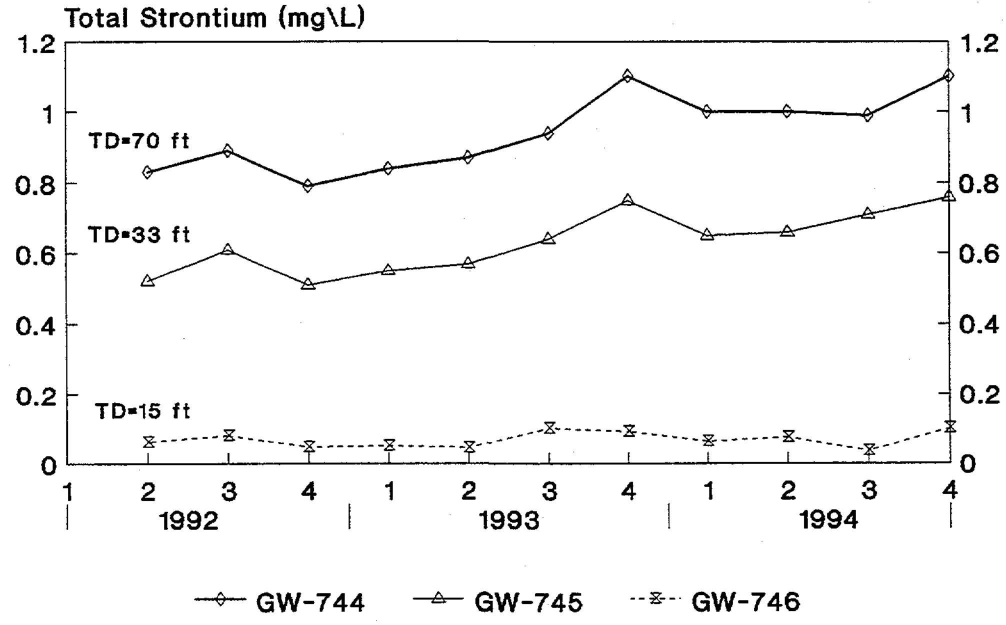
GW-251
S-2 Site

LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 26
DATE:	9-20-95	CONCENTRATIONS OF SELECTED METALS IN WELLS GW-633 AND GW-251
DWG ID.:	26	

Boron
Exit Pathway

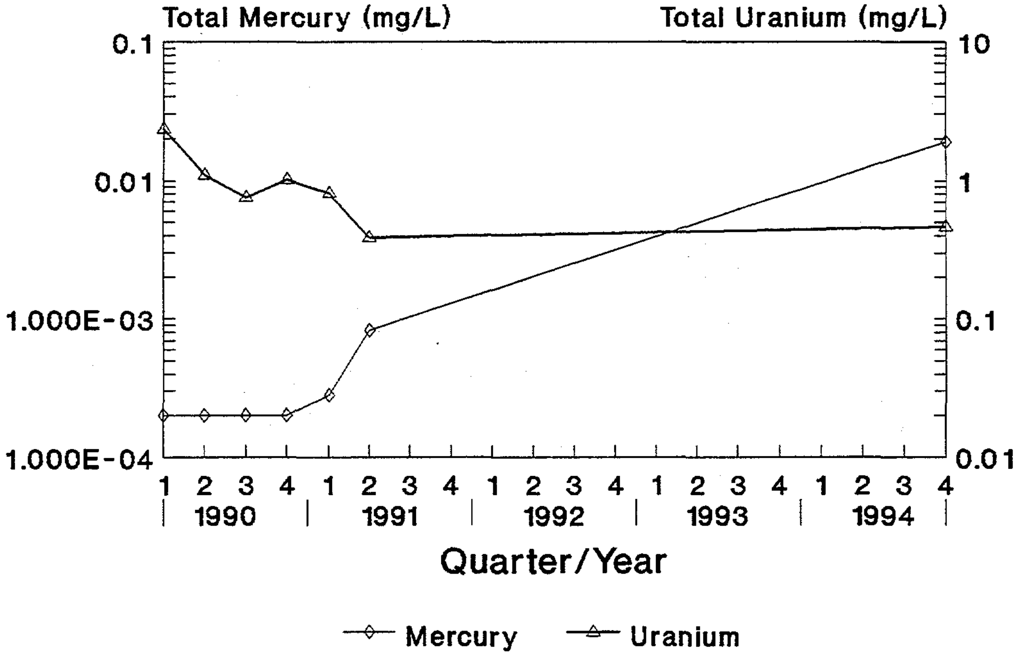


Strontium
Grid K1

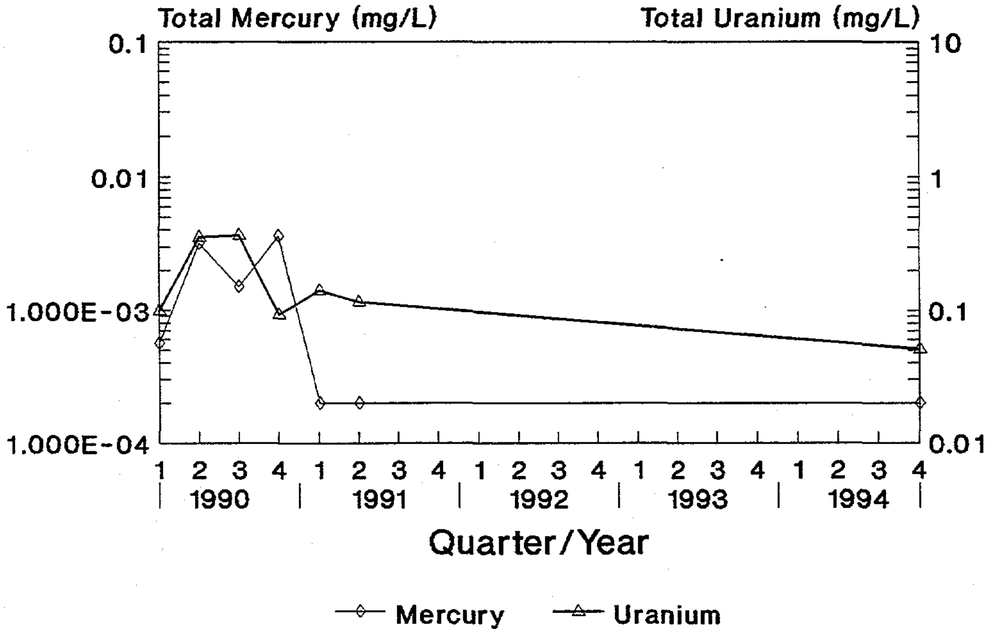


LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 27
DATE:	9-20-95	BORON CONCENTRATIONS IN WELLS GW-617 AND GW-618 AND STRONTIUM CONCENTRATIONS IN WELLS AT GRID K1
DWG ID.:	27	

GW-154
New Hope Pond

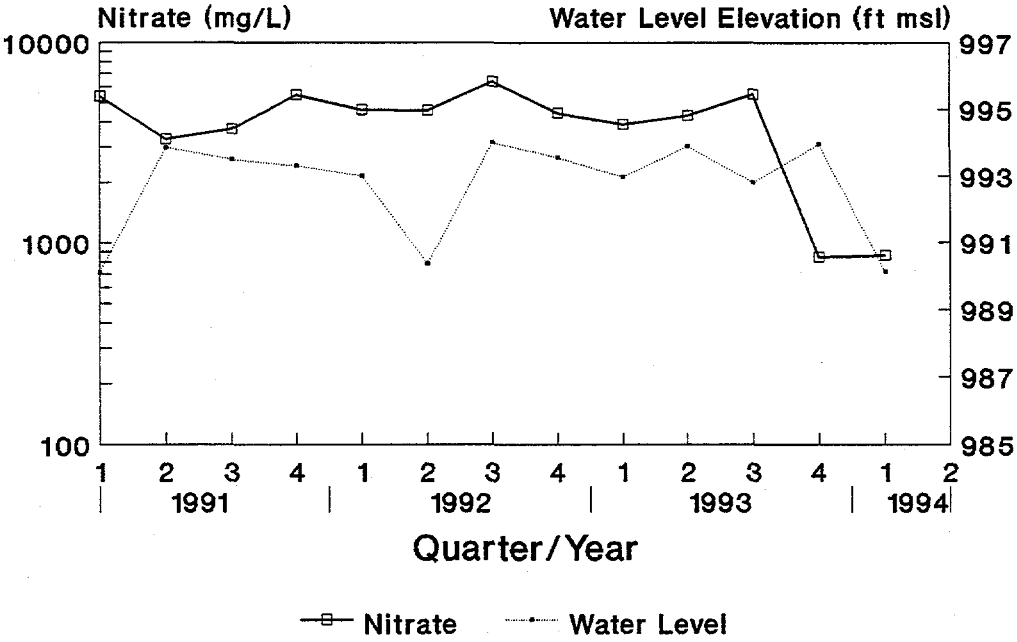


GW-222
New Hope Pond

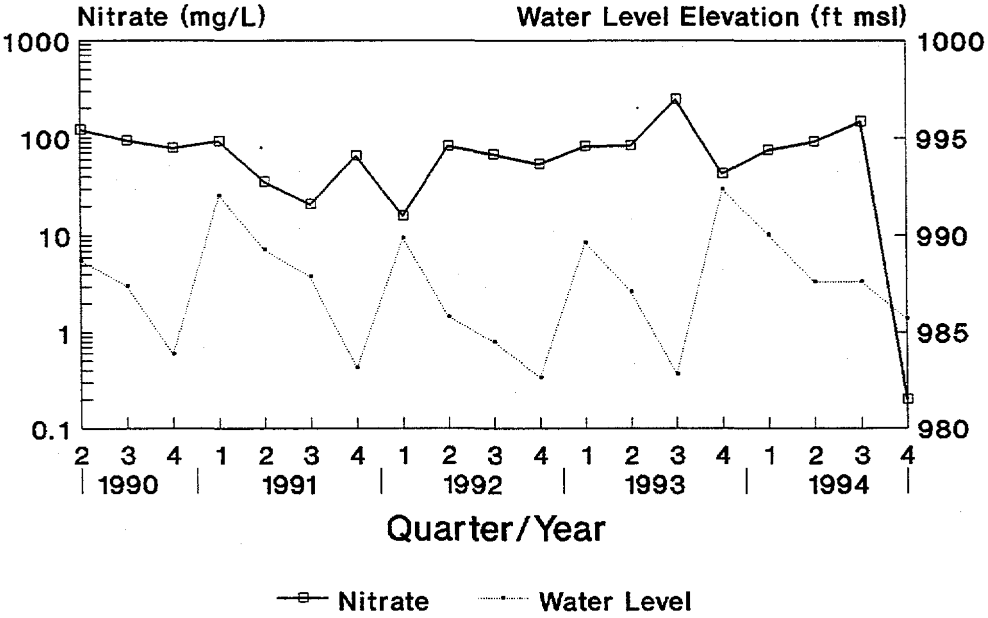


LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 28
DATE:	9-20-95	MERCURY AND URANIUM CONCENTRATIONS IN WELLS GW-154 AND GW-222, 1990 - 1994
DWG ID.:	28	

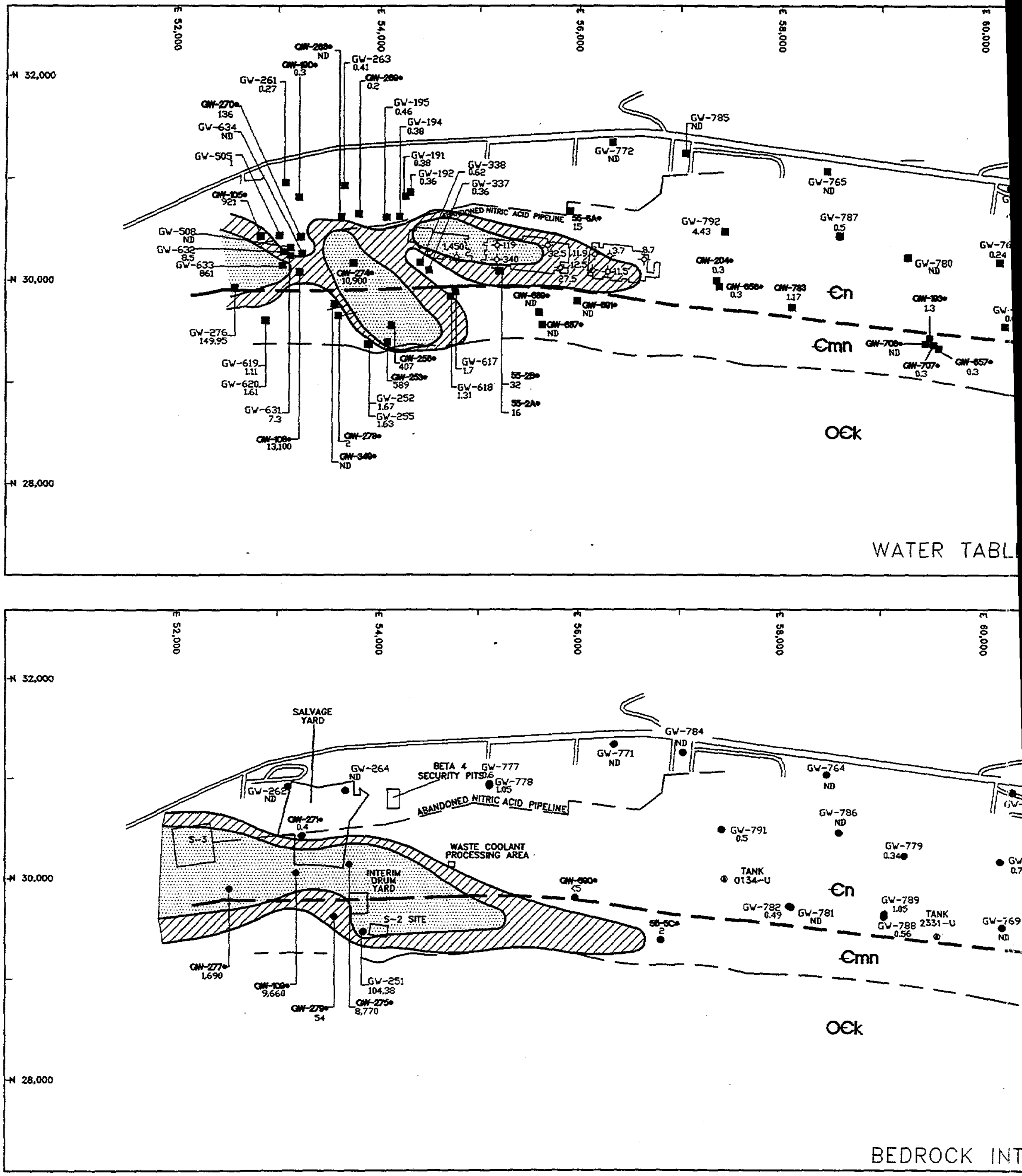
GW-633
Rust Garage Area



GW-251
S-2 Site



LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 29
DATE:	9-20-95	NITRATE CONCENTRATIONS IN WELLS GW-633 AND GW-251
DWG ID.:	29	



EXPLANATION

▲ — SURFACE WATER SAMPLING LOCATION

■ — WATER TABLE INTERVAL MONITORING WELL

● — BEDROCK INTERVAL MONITORING WELL

Єn — NOLICHUCKY SHALE

Єmn — MAYNARDVILLE LIMESTONE

OЄk — KNOX GROUP

172 — ANNUAL AVERAGE NITRATE CONCENTRATION

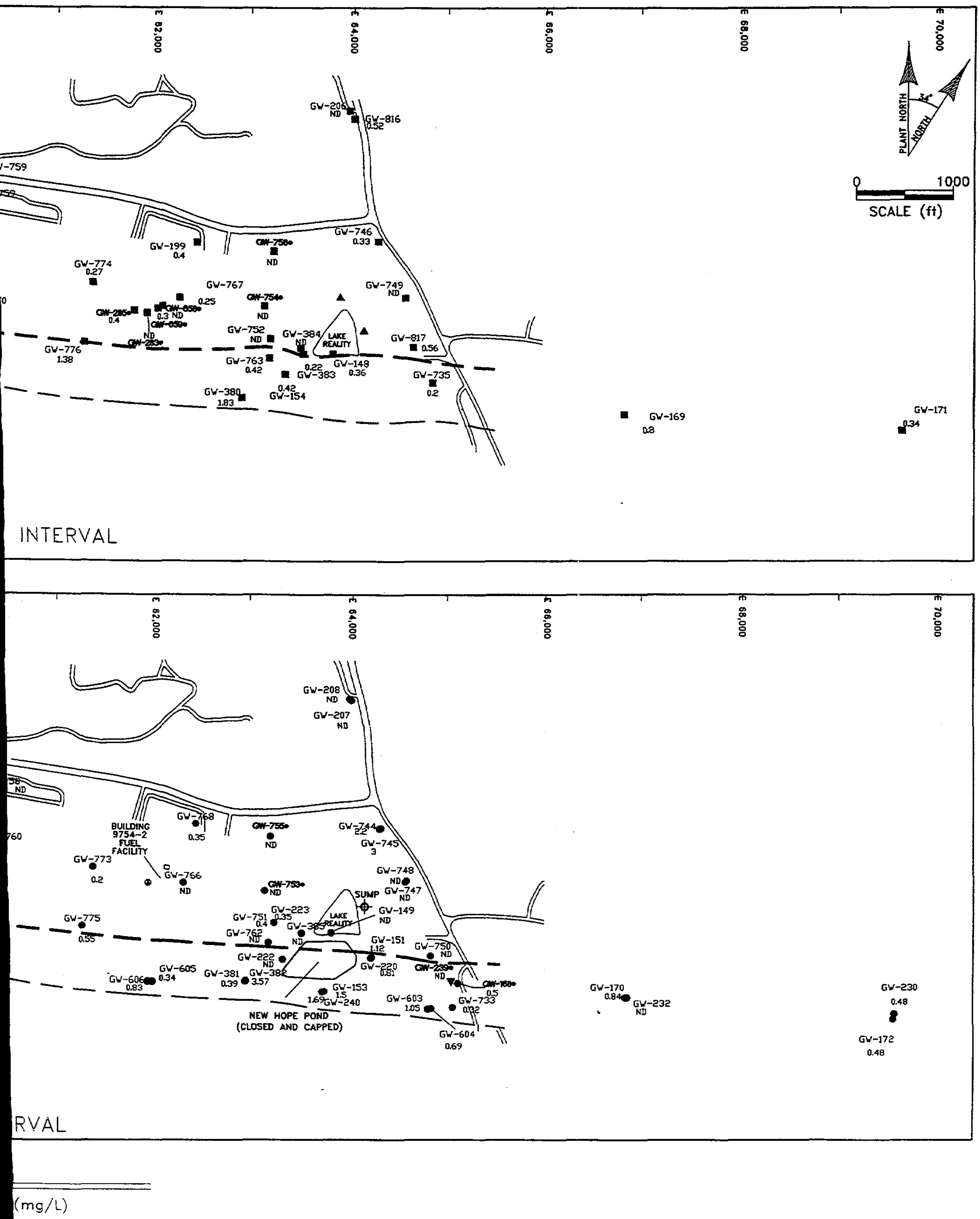
ND — NOT DETECTED

* — INDICATES A WELL SAMPLED BEFORE 1994

— 10

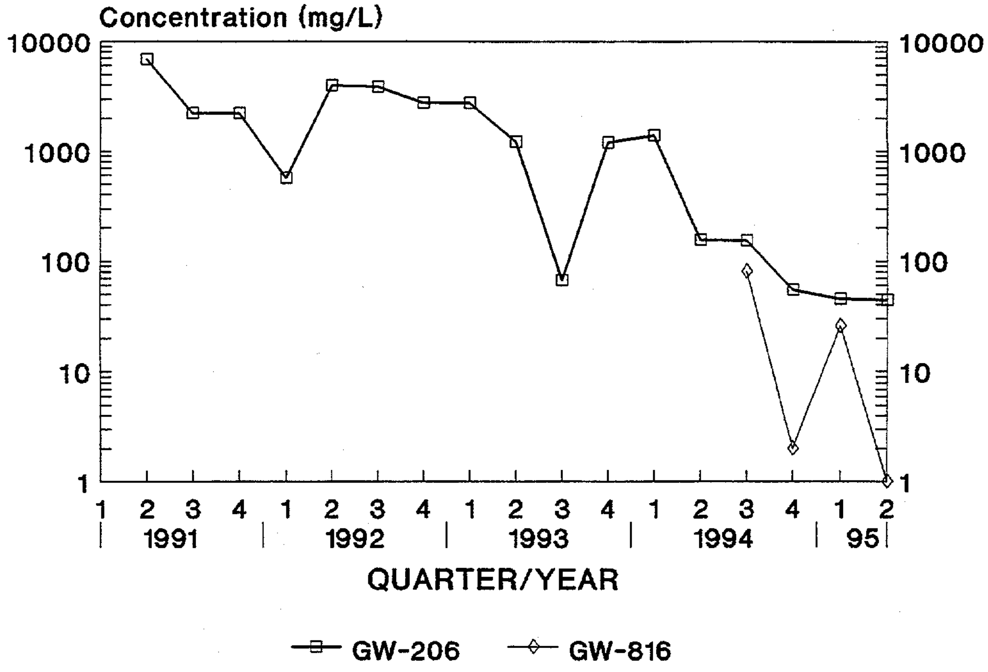
▨ — 10–100 mg/L

░ — >100 mg/L

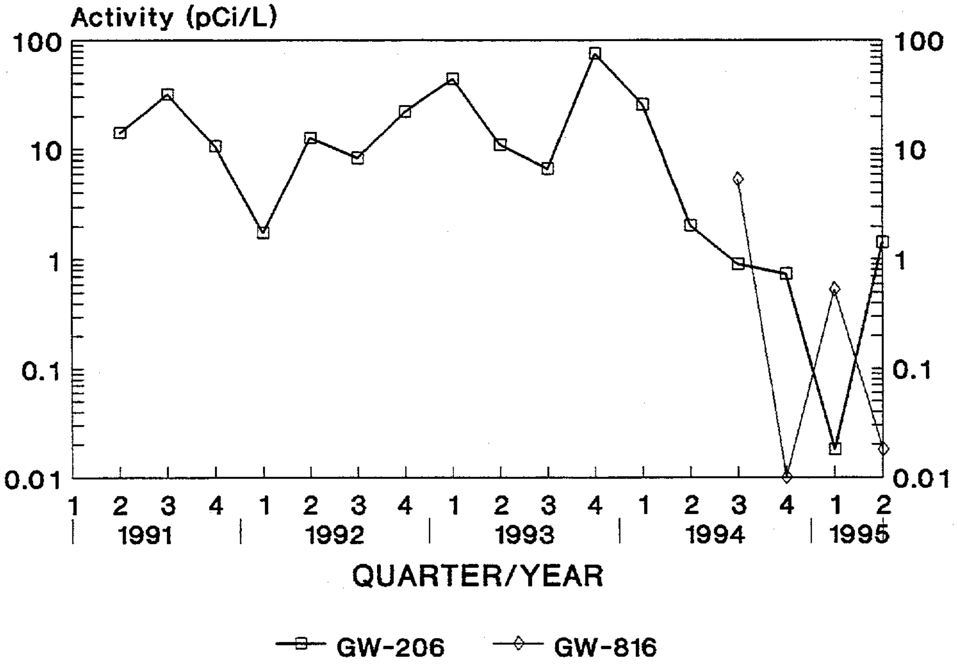


LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 30
DATE:	10-3-95	NITRATE IN GROUNDWATER IN THE UPPER EAST FORK POPLAR CREEK HYDROGEOLOGIC REGIME
DWG ID.:	OR399-HC	

Total Suspended Solids

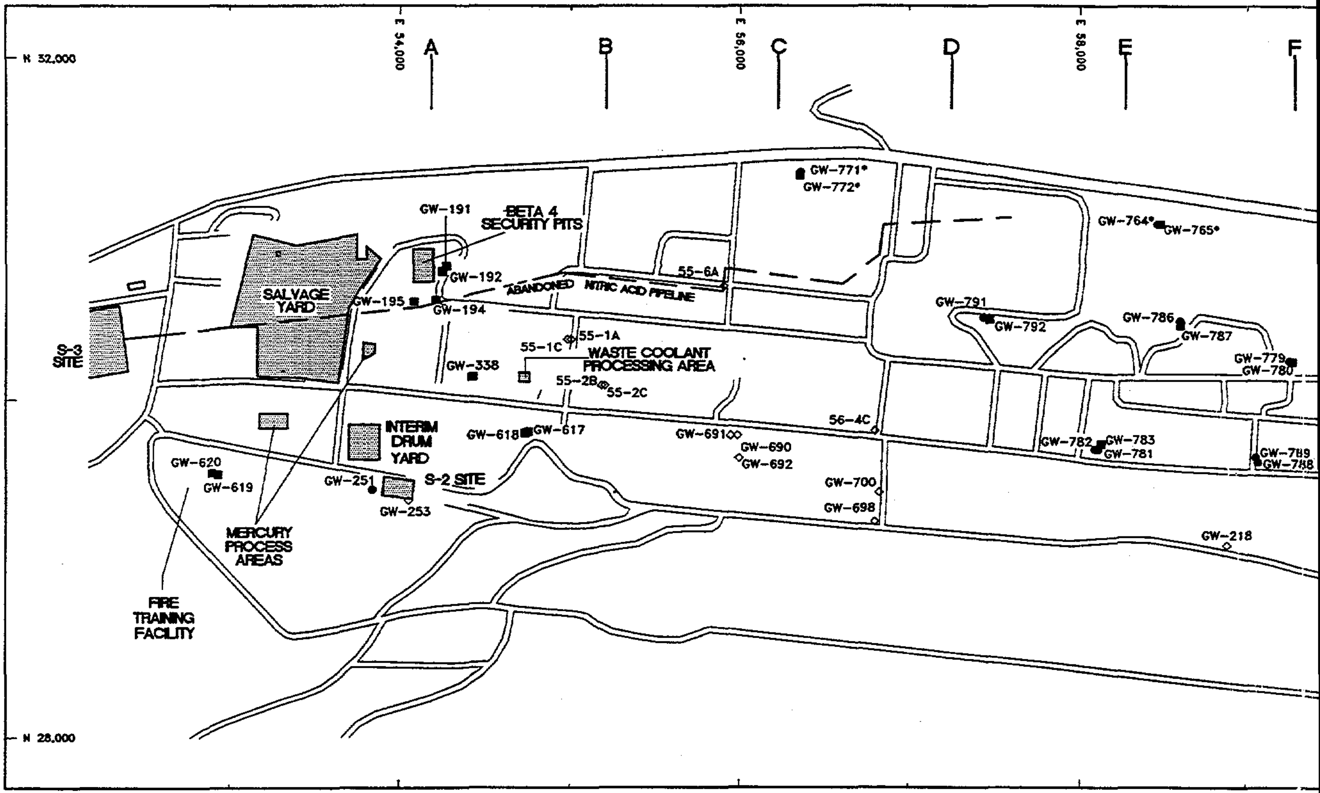


Gross Alpha



Note: Reporting limit = 0.01 pCi\L

LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 31
DATE:	9-20-95	TSS CONCENTRATIONS AND GROSS ALPHA ACTIVITIES IN WELLS GW-206 AND GW-816
DWG ID.:	31	



EXPLANATION

■ — Water Table Zone Monitoring Well

● — Bedrock Zone Monitoring Well

▲ — Surface Water Sampling Location

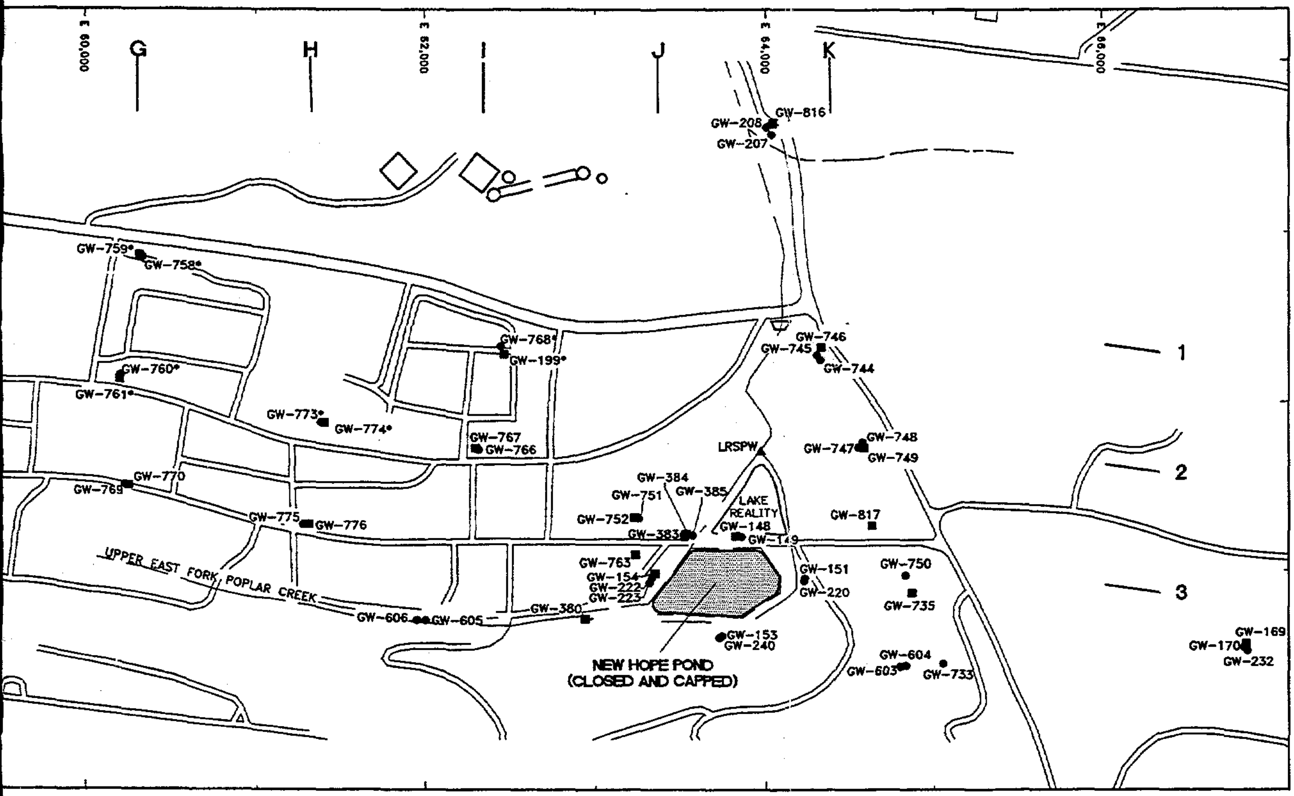
◇ — Well Proposed to be Sampled once for Plume

• — Well Proposed to be Dropped from the Monit

LRSPW — Lake Reality Emergency Spillway

——— Boundary of Site

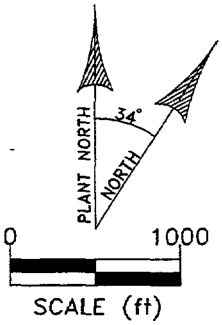
K 1 — Comprehensive Groundwater Monitoring Grid



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

Characterization

ring Program



LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 32
DATE:	9-29-95	SAMPLING LOCATIONS PLANNED FOR GROUNDWATER AND SURFACE WATER MONITORING DURING CY 1996
DWG ID.:	OR429-HC	

APPENDIX B

Tables

Table 1. Waste-Management Sites, CERCLA Operable Units, and Underground Storage Tanks Included in the CY 1994 Groundwater Protection Program

Site Name	Regulatory Classification	
	Historical[1]	Current[2]
New Hope Pond	TSD Unit	TSD Unit/Y-12 SA
Mercury Process Spill Areas	SWMU	UEFPC OU 01
Abandoned Nitric Acid Pipeline	SWMU	UEFPC OU 02
Salvage Yard Scrap Metal Storage Area	SWMU	UEFPC OU 03
Salvage Yard Oil/Solvent Drum Storage Area	SWMU	UEFPC OU 03
Salvage Yard Oil Storage	SWMU	UEFPC OU 03
Salvage Yard Drum Deheader	SWMU	UEFPC OU 03
Tank 2063-U	SWMU	UEFPC OU 03
S-2 Site	SWMU	UEFPC OU 03
Waste Coolant Processing Area	SWMU	UEFPC OU 03
Tank 2328-U	SWMU	Y-12 SA
Tank 2329-U	SWMU	Y-12 SA
Interim Drum Yard	SWMU	Y-12 SA
Beta-4 Security Pits	SWMU	Y-12 SA
Rust Garage Area	SWMU/UST	Y-12 SA/UST

Notes:

1 Regulatory status before 1992 Federal Facility Agreement.

TSD Unit - RCRA-regulated land-based treatment, storage, or disposal unit
SWMU - RCRA-regulated Solid Waste Management Unit
UST - Non-RCRA Underground Storage Tank

2 Modified from: *Oak Ridge Reservation Site Management Plan for the Environmental Restoration Program.* (U.S. Department of Energy 1994)

UEFPC OU 01 - Upper East Fork Poplar Creek Operable Unit 01 (Integrator)
UEFPC OU 02 - Upper East Fork Poplar Creek Operable Unit 02 (Source Control)
UEFPC OU 03 - Upper East Fork Poplar Creek Operable Unit 03 (Source Control)
Y-12 SA - Y-12 Plant Study Area

Table 2. Monitoring Programs Implemented During CY 1994

Monitoring Program	Sampling Point	Location[1]	Quarter Sampled[2]			
			1st	2nd	3rd	4th
RCRA Interim Status Assessment Monitoring						
	GW-151	NHP	■	■	■	■
	GW-220	NHP	■	■	■	■
	GW-240	NHP	■	■	■	■
	GW-380	NHP	■	■	■	■
	GW-381	NHP	■	■	■	■
	GW-382	NHP	■	■	■	■
	GW-383	NHP	■	■	■	■
	GW-384	NHP	■	■	■	■
	GW-385	NHP	■	■	■	■
Best-Management Practice Monitoring						
	GW-148	NHP	.	.	.	■
	GW-149	NHP	.	.	.	■
	GW-153	NHP	.	.	.	■
	GW-154	NHP	.	.	.	■
	GW-222	NHP	.	.	.	■
	GW-223	NHP	.	.	.	■
Exit Pathway Monitoring						
	GW-169	EXP-UV	■	.	■	■
	GW-170	EXP-UV	■	.	■	■
	GW-171	EXP-UV	.	.	■	■
	GW-172	EXP-UV	.	.	■	■
	GW-206	EXP-SR	■	■	■	■
	GW-207	EXP-SR	■	■	■	■
	GW-208	EXP-SR	■	■	■	■

Table 2 (cont'd)

Monitoring Program	Sampling Point	Location[1]	Quarter Sampled[2]			
			1st	2nd	3rd	4th
Exit Pathway Monitoring (cont'd)						
	GW-230	EXP-UV	.	.	■	■
	GW-232	EXP-UV	■	.	■	■
	GW-603	EXP-J	■	■	■	■
	GW-604	EXP-J	■	■	■	■
	GW-605	EXP-I	■	■	■	■
	GW-606	EXP-I	■	■	■	■
	GW-617	EXP-E	■	■	■	■
	GW-618	EXP-E	■	■	■	■
	GW-733	EXP-J	■	■	■	■
	GW-735	EXP-J	■	■	■	■
	GW-750	EXP-J	■	■	■	■
	GW-816	EXP-SR	.	.	■	■
	LRS	EXP-SW	.	.	■	■
	LRSPW	EXP-SW	.	.	■	■
Grid Well Monitoring						
	GW-191	B4	■	■	■	■
	GW-192	B4	■	■	■	■
	GW-194	B4	■	■	■	■
	GW-195	B4	■	■	■	■
	GW-199	GRIDI1	■	■	■	■
	GW-251	S2	■	■	■	■
	GW-252	S2	.	■	■	■
	GW-255	S2	.	■	■	■
	GW-261	SY	.	■	■	■
	GW-262	SY	.	■	■	■
	GW-263	SY	.	■	■	■

Table 2 (cont'd)

Monitoring Program	Sampling Point	Location[1]	Quarter Sampled[2]			
			1st	2nd	3rd	4th
Grid Well Monitoring (cont'd)						
	GW-264	SY		■	■	■
	GW-337	WC	■	■	■	■
	GW-338	WC	■	■	■	■
	GW-619	FTF	■	■	■	■
	GW-620	FTF	■	■	■	■
	GW-744	GRIDK1	■	■	■	■
	GW-745	GRIDK1	■	■	■	■
	GW-746	GRIDK1	■	■	■	■
	GW-747	GRIDK2	■	■	■	■
	GW-748	GRIDK2	■	■	■	■
	GW-749	GRIDK2	■	■	■	■
	GW-751	GRIDJ3	■	■	■	■
	GW-752	GRIDJ3	■	■	■	■
	GW-758	GRIDG1	■	■	■	■
	GW-759	GRIDG1	■	■	■	■
	GW-760	GRIDG2	■	■	■	■
	GW-761	GRIDG2	■	■	■	■
	GW-762	GRIDJ3	■	■	■	■
	GW-763	GRIDJ3	■	■	■	■
	GW-764	GRIDE1	■	■	■	■
	GW-765	GRIDE1	■	■	■	■
	GW-766	GRIDI2	■	■	■	■
	GW-767	GRIDI2	■	■	■	■
	GW-768	GRIDI1	■	■	■	■
	GW-769	GRIDG3	■	■	■	■
	GW-770	GRIDG3	■	■	■	■
	GW-771	GRIDC1	■	■	■	■

Table 2 (cont'd)

Monitoring Program	Sampling Point	Location[1]	Quarter Sampled[2]			
			1st	2nd	3rd	4th
Grid Well Monitoring (cont'd)						
	GW-772	GRIDC1	■	■	■	■
	GW-773	GRIDH2	■	■	■	■
	GW-774	GRIDH2	■	■	■	■
	GW-775	GRIDH3	■	■	■	■
	GW-776	GRIDH3	■	■	■	■
	GW-777	GRIDB2	.	■	■	■
	GW-778	GRIDB2	.	■	■	■
	GW-779	GRIDF2	.	■	■	■
	GW-780	GRIDF2	.	■	■	■
	GW-781	GRIDE3	.	■	■	■
	GW-782	GRIDE3	.	■	■	■
	GW-783	GRIDE3	.	■	■	■
	GW-784	GRIDD1	.	■	■	■
	GW-785	GRIDD1	.	■	■	■
	GW-786	GRIDE2	.	■	■	■
	GW-787	GRIDE2	.	■	■	■
	GW-788	GRIDF3	.	■	■	■
	GW-789	GRIDF3	.	■	■	■
	GW-791	GRIDD2	.	■	■	■
	GW-792	GRIDD2	.	■	■	■
	GW-817	GRIDK3	.	.	■	■
UST Monitoring						
	GW-505	RG	■	.	.	.
	GW-508	RG	■	.	.	.
	GW-631	RG	■	.	.	.
	GW-632	RG	■	.	.	.
	GW-633	RG	■	.	.	.
	GW-634	RG	■	.	.	.

Table 2 (cont'd)

Notes:

1	B4	-	Beta-4 Security Pits
	EXP	-	Exit Pathway: Maynardville Limestone Transverse (-E, -I, -J) Offsite, in Union Valley (-UV) Along Scarboro Road in the gap through Pine Ridge (-SR) Surface Water Sampling Location (-SW)
	FTF	-	Fire Training Facility
	GRID	-	Comprehensive Groundwater Monitoring Plan Grid Location (see Figure 4)
	NHP	-	New Hope Pond
	RG	-	Rust Garage Area
	S2	-	S-2 Site
	SY	-	Y-12 Salvage Yard
	WC	-	Waste Coolant Processing Area

2 ■ - sample collected during specified quarter of CY 1994

. - sample not collected

First Quarter:	January 14 - March 3
Second Quarter:	April 22 - June 16
Third Quarter:	July 29 - September 28
Fourth Quarter:	October 25 - December 27

Table 3. Construction Information[1] for Monitoring Wells Sampled During CY 1994

Well	Location[2]	Cluster Designation[3]	Aquifer[4]			Monitored Interval Depths[5]
			Unit	Form.	Interval	
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
GW-255	S2	4	AQF	Cmn	WT	66.3 - 81.5
GW-261	SY	3	AQT	Cm	WT	16.7 - 23.7

Table 3 (cont'd)

Well	Location[2]	Cluster Designation[3]	Aquifer[4]			Monitored Interval Depths[5]		
			Unit	Form.	Interval			
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-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-505	RG	3	AQT	Cn	WT	1.5	-	13.5
GW-508	RG	2	AQT	Cn	WT	1.3	-	15.0
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-631	RG	3	AQT	Cn	WT	4.0	-	16.0
GW-632	RG	3	AQT	Cn	WT	3.5	-	15.0
GW-633	RG	3	AQT	Cn	WT	3.5	-	15.0
GW-634	RG	2	AQT	Cn	WT	3.5	-	15.0
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

Table 3 (cont'd)

Well	Location[2]	Cluster Designation[3]	Aquifer[4]			Monitored Interval Depths[5]		
			Unit	Form.	Interval			
GW-744	GRIDK1	3	AQT	Cpv	BDR	55.0	-	69.5
GW-745	GRIDK1	1	AQT	Cpv	BDR	21.2	-	32.8
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	Crg	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

Table 3 (cont'd)

Well	Location[2]	Cluster Designation[3]	Aquifer[4]			Monitored Interval Depths[5]		
			Unit	Form.	Interval			
GW-776	GRIDH3	1	AQT	Cn	WT	10.6	-	23.0
GW-777	GRIDB2	3	AQT	Cm	BDR	46.1	-	59.0
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. 1994).

Table 3 (cont'd)

Notes: (cont'd)

2

B4	-	Beta-4 Security Pits
EXP	-	Exit Pathway: Maynardville Limestone Transverse (-E, -I, -J) Offsite in Union Valley (-UV) Along Scarboro Road in the gap through Pine Ridge (-SR)
FTF	-	Fire Training Facility
GRID	-	Comprehensive Groundwater Monitoring Plan Grid Location (see Figure 4)
NHP	-	New Hope Pond
RG	-	Rust Garage Area
S2	-	S-2 Site
SY	-	Y-12 Salvage Yard
WC	-	Waste Coolant Processing Area

3 Cluster designation for trace metal data evaluation purposes (see Table 8). Surface water stations LRS and LRSPW were assigned to cluster 3.

4 Unit: Hydrostratigraphic unit

AQF	-	Conasauga Shales
AQT	-	Maynardville Limestone

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 4. VOCs Detected in QA/QC Samples During CY 1994

Compound	Number of QA/QC Samples Containing Specified Compound (by Sample Type)				
	Laboratory Blanks	Trip Blanks	Field Blanks	Equipment Rinsates	Total
Total Samples	100	166	4	37	307
Laboratory Reagents					
Acetone	9	24	1	6	40
Methylene Chloride	13	19	.	3	35
2-Butanone	6	12	.	3	21
Toluene	4	9	.	3	16
2-Hexanone	2	.	.	.	2
4-Methyl-2-pentanone	1	.	.	.	1
Source Water Contaminants					
1,2-Dichloropropane	.	.	1	.	1
1,1,2,2-Tetrachloroethane	1	.	.	.	1
Vinyl Acetate	1	.	.	.	1
VOC Plume Constituents					
Chloroform	1	1	1	.	3
1,1,1-Trichloroethane	1	1	1	.	3
Trichloroethene	1	1	.	.	2
Benzene	.	1	.	.	1
Tetrachloroethene	.	1	.	.	1
Miscellaneous Compounds					
Bromodichloromethane	.	.	1	.	1
Styrene	.	1	.	.	1
Total Number of Contaminated Samples:	**20**	**41**	**1**	**10**	**72**
Percent of Total Samples:	**20%**	**25%**	**25%**	**27%**	**23%**

Table 5. Summary of False Positive VOC Results for CY 1994 Groundwater and Surface Water Samples

Compound	Groundwater and Surface Water Sample Results[1]	False Positive Results Identified From[2]		Total False Positive Results	Percent of Groundwater Results
		Laboratory Blanks	Trip Blanks		
Laboratory Reagents					
Methylene Chloride	41	32 (9)	3 (3)	35	85
2-Butanone	27	12 (4)	14 (4)	26	96
Acetone	28	10 (5)	12 (6)	22	79
Toluene	23	16 (4)	0	16	70
Source Water Contaminant					
1,1,2,2-Tetrachloroethane	1	0	0	0	0
Bromoform	1	0	0	0	0
VOC Plume Constituents					
1,1,1-Trichloroethane	17	3 (1)	0	3	18
Trichloroethene	83	1 (1)	0	1	1
Tetrachloroethene	97	0	0	0	0
Chloroform	65	0	0	0	0
1,2-Dichloroethene	58	0	0	0	0
Carbon Tetrachloride	57	0	0	0	0
1,1-Dichloroethane	18	0	0	0	0
1,1-Dichloroethene	16	0	0	0	0
Vinyl Chloride	9	0	0	0	0
Benzene	4	0	0	0	0
Ethylbenzene	4	0	0	0	0
Xylenes	4	0	0	0	0
Total Results:	553	74	29	103	19

Notes:

1 The number of groundwater and surface water samples in which the compound was detected.

2 The number of false positive results in groundwater and surface water samples identified by each type of blank. The number in parentheses indicates the number of blank samples from which false positive results were identified (i.e., more than one sample may be associated with each blank sample).

Table 6. Summary of Anomalous VOC Results, CY 1991 - CY 1994

Compound	No. Of Anomalous Results[1]	No. Of Wells	Maximum Concentration[2] (μg/L)
Laboratory Reagents			
Methylene chloride	26	24	20.0
Acetone	20	18	170.0
Toluene	13	9	56.0
4-Methyl-2-pentanone	7	6	4.0
2-Hexanone	3	2	6.0
2-Butanone	3	3	14.0
Source Water Contaminants			
Vinyl acetate	5	5	10.0
1,1,2-Trichloroethane	2	2	2.0
1,2-Dichloropropane	1	1	2.0
VOC Plume Constituents			
Tetrachloroethene	18	9	150.0
1,2-Dichloroethene	10	6	3.0
Chloroform	10	5	7.0
Ethylbenzene	9	6	130.0
Vinyl chloride	7	3	3.0
Trichloroethene	7	6	2.0
1,1-Dichloroethene	6	4	1.0
Benzene	4	2	120.0
Carbon tetrachloride	4	4	2.0
1,1-Dichloroethane	3	2	3.0
Xylenes	3	3	21.0
1,1,1-Trichloroethane	2	1	0.8
1,2-Dichloroethane	1	1	7.0

Table 6 (cont'd)

Compound	No. Of Anomalous Results[1]	No. Of Wells	Maximum Concentration[2] (μg/L)
Miscellaneous Compounds			
Chloromethane	3	3	27.0
Styrene	3	3	18.0
Bromomethane	1	1	1.0
Carbon disulfide	1	1	4.0
Chloroethane	1	1	11.0

Notes:

1	Total samples analyzed:	1,239	
	Samples with anomalous results:	124	(10% of total)
	Total anomalous results:	173	

2 Concentration in micrograms per liter

Table 7. Anomalous VOC Results Reported for CY 1994 Groundwater Samples

Compound	Monitoring Well	Location[1]	Date Sampled	Anomalous Result[2] (μg/L)	Surrogate Value[3]
Laboratory Regents					
Acetone	GW-775	GRIDH3	1/31/94	17.0	0
	GW-195	B4	2/5/94	7.0	0
	GW-338	WC	2/5/94	10.0	0
	GW-192	B4	2/5/94	12.0	0
	GW-264	SY	8/13/94	15.0	0
2-Butanone	GW-380	NHP	2/4/94	14.0	0
Methylene chloride	GW-775	GRIDH2	8/11/94	3.0	0
	GW-338	WC	8/20/94	2.0	0
Toluene	GW-766	GRIDI2	1/27/94	1.0	N/A
	GW-206	EXP-SR	6/15/94	0.4	0
VOC Plume Constituents					
Tetrachloroethene	GW-380	NHP	9/21/94	2.0	N/A
	GW-240	NHP	9/22/94	1.0	0
	GW-384	NHP	11/2/94	2.0	0
1,2-Dichloroethene	GW-170	EXP-UV	2/2/94	0.9	0
	GW-220	NHP	5/12/94	1.0	0
Ethylbenzene	GW-745	GRIDK1	1/27/94	1.0	0
Xylenes	GW-766	GRIDI2	1/27/94	0.7	N/A
Chloroform	GW-380	NHP	9/21/94	1.0	N/A
Carbon tetrachloride	GW-770	GRIDG3	11/7/94	2.0	0
Vinyl chloride	GW-383	NHP	11/17/94	2.0	0

Table 7 (cont'd)

Notes:

1 B4 - Beta-4 Security Pits
EXP - Exit Pathway:
  Offsite, in Union Valley (-UV)
  Along Scarboro Road in the gap through Pine Ridge (-SR)
GRID - Comprehensive Groundwater Monitoring Plan Grid Location (see Figure 4)
NHP - New Hope Pond
SY - Y-12 Salvage Yard
WC - Waste Coolant Processing Area

2 Concentration (in micrograms per liter) of a compound detected in 25 percent or less of the samples collected from a well.

3 Most anomalous results were replaced with zero as a surrogate value for the purposes of determining summed average VOC concentrations. Results considered potentially representative of groundwater contamination were not replaced with a surrogate value; these results are denoted with "N/A".

Table 8. Upper Tolerance Limits for Selected Trace Metals

Trace Metal	Upper Tolerance Limit (mg/L)[1]				
	Cluster 1 Sampling Point	Cluster 2 Sampling Point	Cluster 3 Sampling Point	Cluster 4 Sampling Point	Cluster 10 Sampling Point
Aluminum	2.4	6.1	2.4	2.4	2.4
Antimony	0.05[a]	0.05[a]	0.05[a]	0.05[a]	0.05[a]
Beryllium	0.00045	0.00045	0.00045	0.00045	0.00045
Boron	0.12	0.028	0.041	0.028	3.1
Cobalt	0.019	0.019	0.019	0.019	0.019
Copper	0.012	0.012	0.012	0.012	0.012
Iron	8.7	8.7	8.7	4.6	6.9
Manganese	1.7	1.7	1.7	0.13	0.13
Molybdenum	0.018	0.018	0.018	0.018	0.018
Nickel	0.06	0.06	0.02	0.02	0.02
Strontium	4.4	0.079	0.92	0.079	0.92
Thorium	0.2[a]	0.2[a]	0.2[a]	0.2[a]	0.2[a]
Uranium	0.012	0.004	0.005	0.005	0.005
Vanadium	0.0044[b]	0.0044[b]	0.0044[b]	0.0044[b]	0.0044[b]
Zinc	0.041	0.043	0.041	0.041	0.040

Note:

1 - Concentration values assumed to be representative of uncontaminated groundwater at the Y-12 Plant. Results in milligrams per liter.

a - Analytical detection limit.

b - Below the analytical detection limit (0.005 mg/L).

Table 9. Potentially Biased Trace Metal Concentrations

Well	Date Sampled	Trace Metal Concentration (mg/L)[1]					
		Aluminum	Boron	Copper	Iron	Nickel	Zinc
GW-169	1/31/94	4.5	.	.	.	.	.
GW-194	2/4/94	3.4	.	.	.	.	.
GW-195	2/5/94	14	0.13	0.032	16	0.021	.
GW-199	1/14/94	2.7	.	.	.	.	0.086
GW-206	1/30/94	30	.	0.072	80	.	0.11
GW-208	1/30/94	.	0.21	0.013	.	.	2.4
GW-220	2/5/94	2.9	.	.	.	.	.
GW-251	2/7/94	8.6	.	0.9	11	0.066	0.12
GW-337	2/8/94	.	0.042	.	.	.	0.062
GW-380	2/4/94	2.8	.	0.026	13	0.31	0.057
GW-505	3/1/94	7	0.071	0.015	.	0.076	.
GW-508	3/2/94	.	0.068	.	.	0.063	0.088
GW-603	1/31/94	.	.	.	.	0.061	.
GW-604	2/1/94	.	0.13	.	.	.	.
GW-605	2/2/94	.	0.2	.	.	.	.
GW-617	2/5/94	.	0.25	.	.	.	.
GW-618	2/7/94	.	0.17	.	.	.	.
GW-620	2/7/94	.	0.075	.	.	.	.
GW-631	3/1/94	14	0.089	0.032	19	0.043	0.18
GW-632	3/2/94	.	.	.	.	.	0.062
GW-633	3/3/94	.	.	.	.	0.12	0.095
GW-634	3/1/94	.	0.083	.	.	.	0.045
GW-744	1/27/94	.	0.13	.	.	.	.
GW-746	1/27/94	.	0.081	.	.	.	.
GW-747	1/28/94	.	0.11	.	.	.	.

Table 9 (cont'd)

Well	Date Sampled	Trace Metal Concentration (mg/L)[1]					
		Aluminum	Boron	Copper	Iron	Nickel	Zinc
GW-750	1/30/94	.	0.14	.	.	.	.
GW-751	1/26/94	.	0.14	.	.	.	.
GW-752	1/26/94	.	0.045	.	.	.	.
GW-760	2/8/94	.	.	.	.	0.14	.
GW-763	2/3/94	.	.	.	28	.	.
GW-764	2/3/94	.	0.069	.	.	.	.
GW-765	2/4/94	4.2	.	.	.	.	.
GW-766	1/27/94	.	0.052	.	.	.	.
GW-767	1/27/94	.	0.09	.	.	.	0.053
GW-768	1/26/94	.	0.21	.	.	.	.
GW-770	2/8/94	.	.	.	.	.	0.071
GW-772	2/3/94	.	.	.	30	.	.
GW-773	1/28/94	.	0.058	.	.	.	.
GW-774	1/28/94	2.7	.	.	.	.	.
GW-776	1/31/94	2.6	.	.	.	0.11	.

Notes:

1 Concentration in milligrams per liter.

Table 10. Summary of CY 1994 Radioanalyte Data

Analyte	Total Results Reported	Results that Failed Evaluation Criteria			Results that Passed Evaluation Criteria	
		Negative Results	Less Than MDA[1]	Error Exceeds Activity	Total Number	Percent of Total Results
Thorium-234	6	0	2	2	2	33
Potassium-40	3	0	0	2	1	33
Strontium	12	4	6	0	2	17
Gross Alpha	330	80	206	4	40	12
Gross Beta	330	18	279	2	31	9
Uranium-235	12	4	2	5	1	8
Radium	12	1	10	0	1	8
Tritium	12	3	8	0	1	8
Iodine-129	12	0	12	0	0	0
Iodine-131	3	0	3	0	0	0
Uranium-234	12	2	10	0	0	0
Neptunium-237	12	7	5	0	0	0
Plutonium-238	12	6	6	0	0	0
Uranium-238	12	0	12	0	0	0
Plutonium-239	12	0	12	0	0	0
Americium-241	12	1	11	0	0	0
Technetium-99	12	1	11	0	0	0
Total	**816**	**127**	**595**	**15**	**79**	**10**

Notes:

1 Results less than the minimum detectable activity.

Table 11. Annual Average Chlorinated Solvent Concentrations in CY 1994 Groundwater and Surface Water Samples

		Average VOC Concentration[4] (μg/L)							
Sampling Point[1]	**MCL[3]**	**GW-148**	**GW-151**	**GW-153**	**GW-169**	**GW-170**	**GW-192**	**GW-220**	**GW-222**
Location[2]		**NHP**	**NHP**	**NHP**	**EXP-UV**	**EXP-UV**	**B4**	**NHP**	**NHP**
Chloroethenes									
Tetrachloroethene	5	0	21.0	4.0	1.7	9.3	1.8	33.5	6.0
Trichloroethene	5	0	1.5	1.0	1.6	2.7	2.5	6.5	2.0
1,2-Dichloroethene	-	3.0	0.8	0	0	0	18.5	0	6.0
1,1-Dichloroethene	7	0	0	0	0	0	0	0	0
Vinyl chloride	2	0	0	0	0	0	0	0	0
Chloroethanes									
1,1,1-Trichloroethane	200	0	0.3	0	0	0	0	0	0
1,1-Dichloroethane	-	0	0	0	0	0	1.5	0	0
Chloromethanes									
Carbon tetrachloride	5	0	420.0	100.0	0	68.7	0	370.0	0
Chloroform	-	0	18.5	8.0	0	58.7	0	21.0	0
Methylene chloride	-	0	0	0	0	1.0	0	0	0
Summed Average VOCs		**[3.0]**	**(462.1)**	**113.0**	**[3.3]**	**140.4**	**24.3**	**(431.0)**	**[14.0]**

Table 11 (cont'd)

		Average VOC Concentration[4] (μg/L)							
Sampling Point[1]	**MCL[3]**	**GW-223**	**GW-230[a]**	**GW-240**	**GW-251**	**GW-255**	**GW-337**	**GW-380**	**GW-381**
Location[2]		**NHP**	**EXP-UV**	**NHP**	**S2**	**S2**	**WC**	**NHP**	**NHP**
Chloroethenes									
Tetrachloroethene	5	15.0	0	0	111.5	0	880.0	0.5	0
Trichloroethene	5	4.0	0	0	43.3	0	960.0	0	0
1,2-Dichloroethene	-	15.0	11.5	0	1.3	0	7,150.0	0	0
1,1-Dichloroethene	7	0	0	0	0	0	137.5	0	0
Vinyl chloride	2	0	0	0	0	0	70.0	0	0
Chloroethanes									
1,1,1-Trichloroethane	200	0	0	0	0	0	287.5	0	0
1,1-Dichloroethane	-	0	0	0	0	0	120.0	0	0
Chloromethanes									
Carbon tetrachloride	5	1.0	0	10.8	5.0	0	0	0	4,800.0
Chloroform	-	0	0	1.3	5.8	1.0	0	0.3	622.5
Methylene chloride	-	0	0	0	0	0	0	0	0
Summed Average VOCs		**35.0**	**12.0**	**12.1**	**(166.9)**	**[1.0]**	**(9,605.0)**	**[0.8]**	**(5,422.5)**

Table 11 (cont'd)

Sampling Point[1]	MCL[3]	Average VOC Concentration[4] (μg/L)							
		GW-382[a]	GW-383	GW-384	GW-604	GW-605	GW-606	GW-617	GW-618
Location[2]		NHP	NHP	NHP	EXP-J	EXP-I	EXP-I	EXP-E	EXP-E
Chloroethenes									
Tetrachloroethene	5	280.0	292.5	0	0	14.5	4.8	5.5	19.5
Trichloroethene	5	21.8	114.5	0	0	4.5	0	5.0	18.3
1,2-Dichloroethene	-	0	87.8	2.3	0	14.3	0.3	8.3	25.8
1,1-Dichloroethene	7	0	0.8	0	0	0	0	0	0
Vinyl chloride	2	0	0	0	0	0	0	0	1.3
Chloroethanes									
1,1,1-Trichloroethane	200	0	0	0	0	0	0	0	0
1,1-Dichloroethane	-	0	0	0	0	0.7	0	0	0
Chloromethanes									
Carbon tetrachloride	5	6,225.0	1.5	0	0	128.3	680.0	0	0
Chloroform	-	220.0	1.0	0	1.0	17.5	229.3	0	0
Methylene chloride	-	0	0	0	0	0	14.3	0	0
Summed Average VOCs		**(6,869.3)**	**(498.1)**	**[2.3]**	**[1.0]**	**179.8**	**(928.7)**	**18.8**	**64.9**

Table 11 (cont'd)

Sampling Point[1]	MCL[3]	Average VOC Concentration[4] (μg/L)							
		GW-619	GW-620	GW-631	GW-633[a]	GW-733	GW-762	GW-763	GW-769
Location[2]		FTF	FTF	RG	RG	EXP-J	GRIDJ3	GRIDJ3	GRIDG3
Chloroethenes									
Tetrachloroethene	5	168.75	547.5	2.0	57.0	0.8	755.0	7.8	2.3
Trichloroethene	5	56.25	162.5	0	4.0	0	46.5	2.3	0.4
1,2-Dichloroethene	-	135.0	410.0	0	0	0	48.0	45.3	0
1,1-Dichloroethene	7	0	0	0	1.0	0	3.3	0.3	0
Vinyl chloride	2	0	0	0	0	0	0	24.0	0
Chloroethanes									
1,1,1-Trichloroethane	200	0	0	0	0	0	0.8	0	0
1,1-Dichloroethane	-	0	0	0	0	0	0	0	0
Chloromethanes									
Carbon tetrachloride	5	0	0	0	0	39.5	0	0	5.3
Chloroform	-	0	0	0	12.0	3.8	0	0	0.2
Methylene chloride	-	0	0	0	0	0	32.5	0	0
Summed Average VOCs		**(360.0)**	**(1,120.0)**	**[2.0]**	**86.0**	**44.1**	**(886.1)**	**79.7**	**[8.2]**

Table 11 (cont'd)

		Average VOC Concentration[4] (μg/L)							
Sampling Point[1]	MCL[3]	GW-770	GW-775	GW-776	GW-781	GW-782	GW-783	GW-789	GW-791
Location[2]		GRIDG3	GRIDH3	GRIDH3	GRIDE3	GRIDE3	GRIDE3	GRIDF3	GRIDD2
Chloroethenes									
Tetrachloroethene	5	0	0	1.5	15.3	160.0	46.3	0	2,406.7
Trichloroethene	5	0	1.8	3.8	2.3	36.0	18.3	0.3	3.7
1,2-Dichloroethene	-	0	0	0	0.3	16.0	24.0	0	0
1,1-Dichloroethene	7	0	0	0	7.0	33.3	6.3	0	0
Vinyl chloride	2	0	0	0	0.3	0.3	0	0	0
Chloroethanes									
1,1,1-Trichloroethane	200	0	0	0	8.0	17.0	2.7	0	0
1,1-Dichloroethane	-	0	0	0	43.7	91.7	16.7	0	0
Chloromethanes									
Carbon tetrachloride	5	0	0	0	0	13.0	2.0	0	0
Chloroform	-	5.5	0	0.3	0	3.0	1.3	0.2	0
Methylene chloride	-	0	0	0	0	0	0	0	0
Summed Average VOCs		**5.5**	**[1.8]**	**[5.6]**	**76.9**	**(370.3)**	**117.6**	**[0.5]**	**(2,410.4)**

Table 11 (cont'd)

Sampling Point[1]	MCL[3]	Average VOC Concentration[4] (μg/L) GW-792	 LRS	 LRSPW
Location[2]		GRIDD2	EXP-SW	EXP-SW
Chloroethenes				
Tetrachloroethene	5	10.7	5.0	4.0
Trichloroethene	5	0	0.5	0.5
1,2-Dichloroethene	-	0	0	0
1,1-Dichloroethene	7	0	0	0
Vinyl chloride	2	0	0	0
Chloroethanes				
1,1,1-Trichloroethane	200	0	0	0
1,1-Dichloroethane	-	0	0	0
Chloromethanes				
Carbon tetrachloride	5	0	12.0	15.0
Chloroform	-	0	2.0	2.0
Methylene chloride	-	0	0	0
Summed Average VOCs		**10.7**	**19.5**	**21.5**

Table 11 (cont'd)

Notes:

1 GW - Monitoring Well
LRS - Lake Reality Sump
LRSPW - Lake Reality Emergency Spillway

2 B4 - Beta-4 Security Pits
EXP - Exit Pathway:
    Maynardville Limestone Transverse (-E, -I, -J)
    Offsite in Union Valley (-UV)
    Along Scarboro Road in the gap through Pine Ridge (-SR)
    Surface Water Sampling Location (-SW)
FTF - Fire Training Facility
GRID - Comprehensive Groundwater Monitoring Plan Grid Location (see Figure 4)
NHP - New Hope Pond
RG - Rust Garage Area
S2 - S-2 Site
WC - Waste Coolant Processing Area

3 MCL - Maximum Contaminant Level

4 All results in micrograms per liter.
0 - Not detected, false positive, or anomalous.
[ ] - Qualitative results; summed average determined exclusively from estimated concentrations (including anomalous results reported for well GW-380).
( ) - Qualitative results; diluted samples with elevated detection limits.
a - Summed average includes compounds not shown on table:
    Acetone (GW-382), Bromoform and BTEX (GW-633), and Toluene (GW-230).

Table 12. Semi-Volatile Organic Compounds in CY 1994 Groundwater and Surface Water Samples

Compound	Sampling Point	Location[1]	Concentration[2] (μg/L)	
			3rd	4th
di-n-butylphthalate	GW-169	EXP-UV	[4]	-
	GW-170	EXP-UV	[4]	[2]
	GW-171	EXP-UV	-	[3]
	GW-172	EXP-UV	-	3
	GW-230	EXP-UV	-	[3]
	GW-232	EXP-UV	[3]	[2]
	LRS	EXP-SW	NA	[8]
	LRSPW	EXP-SW	NA	[8]
bis(2-ethylhexyl)phthalate	GW-172	EXP-UV	-	3
pentachlorophenol	GW-172	EXP-UV	-	2
phenol	GW-169	EXP-UV	[4]	-
	GW-170	EXP-UV	[3]	-
	GW-232	EXP-UV	[4]	-

Notes:

1	EXP-SW	-	Exit pathway (surface water sampling location)
	EXP-UV	-	Exit pathway (off site in Union Valley)
2	μg/L	-	Concentrations in micrograms per liter
	-	-	Less than the reported detection limit
	NA	-	Not Analyzed
	[ ]	-	Compound detected in the associated laboratory blank sample

Table 13. Consistently Elevated Trace Metal Contaminants in the East Fork Regime[1]

Well	Last Sampled (Qtr/Yr)	Barium	Boron	Cadmium	Cobalt	Copper	Lead	Mercury	Strontium	Uranium
Western Plant Area[2]										
GW-105	1st/90	■	.	.	.	.	.	.	.	.
GW-108	1st/90	■	.	.	.	.	.	.	.	.
GW-109	1st/90	■	.	■	.	.	.	■	.	.
GW-251	4th/94	.	.	■	■	■	.	.	.	.
GW-253	2nd/90	.	.	■	■	■	■	■	.	■
GW-255	4th/94	.	.	.	.	■	.	.	.	.
GW-274	1st/90	■	.	■	.	.	.	■	.	.
GW-275	1st/90	■	.	.	.	.	.	■	.	.
GW-331	2nd/91	.	.	.	■	.	.	.	.	.
GW-333	2nd/91	.	.	.	■	.	.	.	.	.
GW-505	1st/94	.	.	.	.	.	.	.	.	■
GW-508	1st/94	.	.	.	■	.	.	.	.	.
GW-617	4th/94	.	■	.	.	.	.	.	.	.
GW-618	4th/94	.	■	■	.	.	.	.	.	.
GW-631	1st/94	.	.	.	■	.	.	.	.	.
GW-632	1st/94	.	.	.	■	.	.	.	.	.
GW-633	1st/94	■	.	.	.	.	.	.	■	■
GW-634	1st/94	.	.	.	■	.	.	.	.	.

Table 13 (cont'd)

Well	Last Sampled (Qtr/Yr)	Barium	Boron	Cadmium	Cobalt	Copper	Lead	Mercury	Strontium	Uranium
Central Plant Area[2]										
GW-193	4th/93	.	.	.	.	.	.	.	.	■
GW-204	4th/93	.	.		■	.	.	.	.	.
GW-282	3rd/92	.	.	■	.	.	.	.	.	.
GW-284	4th/93	.	.	.	■	.	.	.	.	.
GW-781	4th/94	.	■	.	.	.	.	.	.	.
GW-788	4th/94	.	■	.	.	.	.	.	.	.
GW-789	4th/94	.	■	.	.	.	.	.	.	.
Eastern Plant Area[2]										
GW-154	4th/94	.	.	.	.	.	■	■	.	■
GW-167	3rd/91	.	.	.	■	.	■	.	.	.
GW-169	4th/94	.	.	.	.	.	■	.	.	.
GW-222	4th/94	.	.	.	.	.	.	■	.	■
GW-605	4th/94	.	.	.	.	.	.	.	.	■
GW-744	4th/94	.	.	.	.	.	.	.	■	.
GW-816	4th/94	.	.	.	.	.	.	.	■	.

Table 13 (cont'd)

Notes:

1 Modified from HSW Environmental Consultants, Inc. 1994

2 Western Plant Area: west of Y-12 Grid 55,000
Central Plant Area: between Y-12 Grid 55,000 and 62,000
Eastern Plant Area: east of Y-12 Grid 62,000

Table 14. Selected Median Trace Metal Concentrations that Exceed UTLs and MCLs, CY 1994

Metal[1]	Sampling Point	Location[2]	Cluster[3]	UTL/ MCL (mg/L)	CY 1994 Median Concentration[4] (mg/L)	Number of Samples[5]
Western Plant Area[6]						
Barium						
	GW-633	RG	NA.	2.0	5.3	1
Boron						
	GW-617	EXP-E	1	0.12	0.33	3
	GW-618	EXP-E	1	0.12	0.19	3
Cadmium						
	GW-251	S2	NA	0.005	0.125	4
	GW-618	EXP-E	NA	0.005	0.0215	4
Cobalt						
	GW-251	S2	1	0.019	0.0285	4
	GW-508	RG	2	0.019	0.14	1
	GW-631	RG	3	0.019	0.038	1
	GW-632	RG	3	0.019	0.086	1
	GW-634	RG	2	0.019	0.061	1
Copper						
	GW-251	S2	1	0.012	0.71	3
	GW-255	S2	4	0.012	0.071	3
Strontium						
	GW-633	RG	3	0.92	3.1	1
Uranium (flour)						
	GW-505	RG	3	0.005	0.028	1
	GW-633	RG	3	0.005	0.011	1
Central Plant Area[6]						
Boron						
	GW-781	GRIDE3	3	0.041	0.43	3

Table 14 (cont'd)

Metal[1]	Sampling Point	Location[2]	Cluster[3]	UTL/ MCL (mg/L)	CY 1994 Median Concentration[4] (mg/L)	Number of Samples[5]
Boron (cont'd)						
	GW-788	GRIDF3	1	0.12	1.2	3
	GW-789	GRIDF3	3	0.041	0.12	3
Eastern Plant Area[6]						
Boron						
	GW-208	EXP-SR	1	0.12	0.22	3
	GW-605	EXP-I	1	0.12	0.19	3
	GW-744	GRIDK1	3	0.041	0.11	3
	GW-747	GRIDK2	3	0.041	0.088	3
	GW-752	GRIDJ3	3	0.041	0.06	3
	GW-768	GRIDI1	3	0.041	0.14	3
	GW-816	EXP-SR	4	0.028	0.044	2
	LRS	EXP-SW	3	0.041	0.0765	2
	LRSPW	EXP-SW	3	0.041	0.107	2
Mercury (CVAA)						
	GW-154	NHP	NA	0.002	0.019	1
Lead (AAS)						
	GW-154	NHP	NA	0.05	0.056	1
Strontium						
	GW-744	GRIDK1	3	0.92	1	4
	GW-816	EXP-SR	4	0.079	0.089	2
Uranium (fluor)						
	GW-154	NHP	1	0.012	0.465	1
	GW-222	NHP	1	0.012	0.051	1
	GW-605	EXP-I	1	0.012	0.228	4

Table 14 (cont'd)

Notes:

1 Results obtained by ICP spectroscopy unless otherwise noted.

AAS - Atomic Absorption Spectroscopy
CVAA - Cold Vapor Atomic Absorption Spectroscopy
fluor - Fluorometric Analysis

2 EXP - Exit Pathway:
Maynardville Limestone Transverse (-E, -I, -J)
Along Scarboro Road in the gap through Pine Ridge (-SR)
GRID - Comprehensive Groundwater Monitoring Plan Grid Location (see Figure 4)
NHP - New Hope Pond
RG - Rust Garage Area
S2 - S-2 Site

3 Cluster designation for trace metal data evaluation purposes (see Section 4.2.2.3).
N/A - Not applicable for metal concentrations compared to MCLs.

4 Concentrations in milligrams per liter.

5 The number of samples used to determine median concentrations, excluding samples potentially contaminated in the laboratory (see Section 4.2.2.4).

6 Western Plant Area:	west of Y-12 Grid 55,000
Central Plant Area:	between Y-12 Grid 55,000 and 62,000
Eastern plant Area:	east of Y-12 Grid 62,000

Table 15. Gross Alpha and Beta Activities That Meet Evaluation Criteria

Sampling Point	Location[1]	Date Sampled	Activity[2] (pCi/L)	
			Gross Alpha	Gross Beta
GW-148	NHP	11/14/94	5.13 ± 3.4	12.5 ± 3.7
GW-149	NHP	11/14/94	.	11.3 ± 3.6
GW-154	NHP	11/15/94	443 ± 51	221 ± 24
GW-194	B4	2/4/94	5.32 ± 3	14.5 ± 3.5
GW-195	B4	2/5/94	10.5 ± 3.8	38 ± 4.5
		5/4/94	.	11.4 ± 3.1
		8/20/94	.	12.9 ± 6.5
		12/1/94	.	21.8 ± 4.2
GW-206	EXP-SR	1/30/94	25.6 ± 6	31.9 ± 4.2
GW-222	NHP	11/15/94	19.7 ± 5.1	23.7 ± 4.6
GW-240	NHP	5/11/94	.	11.5 ± 3.2
		11/16/94	5.82 ± 2.5	.
GW-251	S2	2/7/94	9.09 ± 3.6	.
		5/9/94	9.66 ± 3.3	.
		8/22/94	9.75 ± 3.6	.
		12/3/94	7.89 ± 2.7	.
GW-255	S2	10/29/94	4.78 ± 2	.
GW-263	SY	10/31/94	14.1 ± 4.5	26.5 ± 4.6
GW-380	NHP	2/4/94	7.97 ± 5	.
		11/15/94	.	12.6 ± 3.3
GW-505	RG	3/1/94	15.3 ± 3.9	.

Table 15 (cont'd)

Sampling Point	Location[1]	Date Sampled	Activity[2] (pCi/L)	
			Gross Alpha	Gross Beta
GW-605	EXP-I	2/2/94	112 ± 8.8	56.7 ± 5
		6/3/94	95.3 ± 13	66.4 ± 8.4
		9/25/94	104 ± 14	39.5 ± 5.8
		12/6/94	128 ± 16	110 ± 13
GW-606	EXP-I	2/3/94	7.82 ± 2.9	.
		6/6/94	5.84 ± 2.3	.
		9/25/94	5.07 ± 2.5	.
GW-617	EXP-E	8/21/94	10.4 ± 9.4	46.3 ± 14
GW-619	FTF	2/7/94	.	14.9 ± 3.4
		5/9/94	.	15.2 ± 3.5
		12/3/94	.	15.3 ± 3.6
GW-620	FTF	2/7/94	.	26 ± 4.4
		5/9/94	.	12.7 ± 3.3
		8/23/94	.	14.8 ± 3.5
		12/3/94	.	11.1 ± 3.2
GW-631	RG	3/1/94	.	12 ± 3.7
GW-633	RG	3/3/94	.	261 ± 45
GW-735	EXP-J	12/5/94	9.03 ± 3.6	14.7 ± 3.6
GW-746	GRIDK1	10/27/94	5.21 ± 2.7	13.4 ± 3.4
GW-749	GRIDK2	1/30/94	5.1 ± 2.5	.
		5/31/94	6.98 ± 2.8	.
GW-758	GRIDG1	11/2/94	4.87 ± 2.7	.
GW-764	GRIDE1	11/1/94	8.35 ± 3.2	.
GW-765	GRIDE1	2/4/94	5.2 ± 3.1	.
GW-771	GRIDC1	11/1/94	7.22 ± 2.9	15.9 ± 3.9

Table 15 (cont'd)

Sampling Point	Location[1]	Date Sampled	Activity[2] (pCi/L)	
			Gross Alpha	Gross Beta
GW-776	GRIDH3	1/31/94	4.81 ± 2.5	.
GW-782	GRIDE3	6/16/94	24.6 ± 5.1	.
		9/12/94	29.9 ± 5.7	.
		12/2/94	27 ± 5.4	.
GW-816	EXP-SR	9/21/94	5.34 ± 4.4	16.1 ± 6.4
LRS	EXP-SW	9/7/94	5.59 ± 2.4	.
		12/27/94	7 ± 2.4	.
LRSPW	EXP-SW	9/7/94	5.59 ± 2.5	.
		12/27/94	6.25 ± 2.2	.

Notes:

1 B4 - Beta-4 Security Pits
EXP - Exit Pathway:
Maynardville Limestone Transverse (-E, -I, -J)
Along Scarboro Road in the gap through Pine Ridge (-SR)
Surface Water Sampling Location (-SW)
FTF - Fire Training Facility
GRID - Comprehensive Groundwater Monitoring Plan Grid Location (see Figure 4)
NHP - New Hope Pond
RG - Rust Garage Area
S2 - S-2 Site
SY - Y-12 Salvage Yard

2 Activity reported in picoCuries per liter
. - results did not meet evaluation criteria

Table 16. CY 1994 Radionuclide Results that Meet Evaluation Criteria

Isotope	Sampling Point	Location[1]	Date Sampled	Activity[2]
Potassium-40				
	GW-232	EXP-UV	11/17/94	789 ± 370
Radium (total)				
(Bq/L)	GW-172	EXP-UV	11/14/94	0.065 ± 0.049
Strontium (total)				
	GW-171	EXP-UV	9/27/94	267 ± 45
Thorium-234				
	GW-230	EXP-UV	9/28/94	367 ± 360
	GW-232	EXP-UV	11/17/94	508 ± 420
Tritium				
(Bq/L)	GW-169	EXP-UV	12/6/94	70 ± 31
Uranium-235				
	GW-230	EXP-UV	9/28/94	54.9 ± 51

<u>Notes</u>:

1 EXP-UV - Exit Pathway Offsite, in Union Valley

2 Activity reported in picoCuries per liter unless noted otherwise.
Bq/L - Becquerels per liter

Table 17. Sampling Frequency and Sequence Proposed for CY 1996

Sample Group[1]	Location[2]	Sampling Point[3]	Monitoring Program[4]
EF-1	B4	GW-191	GMP
	B4	GW-194	GMP
	B4	GW-195	GMP
	WC	GW-338	GMP
	B4	GW-192	GMP
	EXP-E	GW-617	EXP
	EXP-E	GW-618	EXP
	S2	GW-251	GMP
	FTF	GW-619	GMP
	FTF	GW-620	GMP
EF-2	GRID E2	GW-786	GMP
	GRID E2	GW-787	GMP
	GRID F2	GW-779	GMP
	GRID F2	GW-780	GMP
	GRID F3	GW-788	GMP
	GRID F3	GW-789	GMP
	GRID D2	GW-791	GMP
	GRID D2	GW-792	GMP
	GRID E3	GW-781	GMP
	GRID E3	GW-782	GMP
	GRID E3	GW-783	GMP
EF-3	GRID I2	GW-766	GMP
	GRID I2	GW-767	GMP

Table 17 (cont'd)

Sample Group[1]	Location[2]	Sampling Point[3]	Monitoring Program[4]
EF-3 (cont'd)	GRID H3	GW-775	GMP
	GRID H3	GW-776	GMP
	GRID G3	GW-770	GMP
	GRID G3	GW-769	GMP
EF-4	GRID JP	GW-763	GMP
	NHP	GW-148	BMP
	NHP	GW-149	BMP
	NHP	GW-153	BMP
	NHP	GW-223	BMP
	NHP	GW-222	BMP
	NHP	GW-154	BMP
	NHP	GW-380	AMP
	NHP	GW-240	AMP
	NHP	GW-220	AMP
	NHP	GW-151	AMP
	NHP	GW-383	AMP
EF-5 (Q1,Q3)	EXP-SW	LRSPW	EXP
EF-6	GRID J3	GW-751	GMP
	GRID J3	GW-752	GMP
	GRID K1	GW-744	GMP
	GRID K1	GW-745	GMP
	GRID K1	GW-746	GMP
	GRID K2	GW-747	GMP

Table 17 (cont'd)

Sample Group[1]	Location[2]	Sampling Point[3]	Monitoring Program[4]
EF-6 (cont'd)	GRID K2	GW-748	GMP
	GRID K2	GW-749	GMP
	GRID K3	GW-817	GMP
	NHP	GW-385	AMP
	NHP	GW-384	AMP
EF-7	EXP-SR	GW-207	EXP
	EXP-SR	GW-208	EXP
	EXP-SR	GW-816	EXP
	EXP-J	GW-603	EXP
	EXP-J	GW-604	EXP
	EXP-J	GW-735	EXP
	EXP-J	GW-750	EXP
	EXP-J	GW-733	EXP
	EXP-I	GW-605	EXP
	EXP-I	GW-606	EXP
EF-8	EXP-UV	GW-171[a]	EXP
	EXP-UV	GW-172[a]	EXP
	EXP-UV	GW-230[a]	EXP
	EXP-UV	GW-169[a]	EXP
	EXP-UV	GW-232[a]	EXP
	EXP-UV	GW-170[a]	EXP
EF-9 (Q2)	GRID C2	55-6A	BMP
	GRID B2	55-1A	BMP

Table 17 (cont'd)

Sample Group[1]	Location[2]	Sampling Point[3]	Monitoring Program[4]
EF-9 (cont'd)	GRID B2	55-1C	BMP
	UOV	GW-218	BMP
	CPT	GW-690	BMP
	CPT	GW-691	BMP
	CPT	GW-692	BMP
	B8110	GW-700	BMP
	B8110	GW-698	BMP
	GRID C3	56-4C	BMP
	GRID B3	55-2C	BMP
	GRID B3	55-2B	BMP
	S2	GW-253	BMP

Notes:

1 Samples will be collected quarterly unless specific sampling quarters are identified.

2
B4 - Beta-4 Security Pits
EXP - Exit Pathway:
Maynardville Limestone Transverse (-E, -I, -J)
Offsite, in Union Valley (-UV)
Along Scarboro Road in the gap through Pine Ridge (-SR)
Surface Water Sampling Location (-SW)
FTF - Fire Training Facility
GRID - Comprehensive Monitoring Plan Grid Location
NHP - New Hope Pond
S2 - S-2 Site
UOV - Uranium Oxide Vault
WC - Waste Coolant Processing Area

3
GW - Monitoring Well
LRSPW - Lake Reality Emergency Spillway

Table 17 (cont'd)

Notes: (cont'd)

4 AMP - RCRA Assessment Monitoring Program
BMP - Best-Management Practice Monitoring
EXP - Exit Pathway Monitoring Program
GMP - Grid Well Monitoring Program

[a] Offsite wells located about 2,000 to 4,000 ft east of New Hope Pond

DISTRIBUTION

DEPARTMENT OF ENERGY
P.A. Hoffman
P.J. Gross
L.M. Sparks
L.L. Radcliffe

HEALTH, SAFETY, ENVIRONMENT, AND ACCOUNTABILITY ORGANIZATION
D.E. Bohrman
C.C. Hill
W.K. Jago
S.B. Jones
J.E. Powell
E.B. Rundle
L.O. Vaughan
S.W. Wiley
GWPP-File-RC (4)

ENVIRONMENTAL RESTORATION PROGRAM
H. King (2)
C.T. Rightmire
C.S. Walker
D.B. Watson

UNIVERSITY OF TENNESSEE
B.W. McMaster

UNIVERSITY OF NEVADA, RENO
L.A. Shevenell

ORISE
S.M. Field

ENVIRONMENTAL SCIENCES DIVISION
R.B. Dreier
D.D. Huff
R.R. Turner

WASTE MANAGEMENT ORGANIZATION
K.D. Delius
C.W. Hutzler
I.W. Jeter
J.E. Stone

ENGINEERING ORGANIZATION
W.E. Manrod

QUALITY AND TECHNICAL SERVICES
L.P. Burnett
J.M. LaBauve

HSW ENVIRONMENTAL CONSULTANTS
J.R. Walker

H&R TECHNICAL ASSOCIATES
P.W. Ezell

SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
S. Selecman/W.P. Kegley

Y-12 Central Files
A.K. Lee/DOE-OSTI (2)