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OAK RIDGE Y-12 PLANT

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CALENDAR YEAR 1995
GROUNDWATER QUALITY REPORT
FOR THE
CHESTNUT RIDGE HYDROGEOLOGIC REGIME
Y-12 PLANT, OAK RIDGE, TENNESSEE

Part 2: 1995 Groundwater Quality Data
Interpretations and Proposed Program
Modifications

August 1996

Prepared by

AJA TECHNICAL SERVICES, INC.
Under Subcontract 70Y-KDS15V

for the

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

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List of Acronyms and Abbreviations

ASO	Analytical Services Organization
BCV	Bear Creek Valley
bgs	below ground surface
CA	Characterization Area
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Chestnut Ridge Regime	Chestnut Ridge Hydrogeologic Regime
CY	calendar year
DOE	U.S. Department of Energy
Energy Systems	Lockheed Martin Energy Systems, Inc.
EPA	U.S. Environmental Protection Agency
DNAPLs	dense, non-aqueous phase liquids
ft	feet
ft/d	feet per day
GWPP	Groundwater Protection Program
GWQR	Groundwater Quality Report
HSEA	Health, Safety, Environment, and Accountability (Organization)
K-25	Oak Ridge K-25 Site
MCL	maximum contaminant level (for drinking water)
MDA	minimum detection activity
$\mu\text{g/L}$	micrograms per liter
mg/L	milligrams per liter
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OU	operable unit
PCE	tetrachloroethene
pCi/L	picoCuries per liter
ppm	parts per million
QA/QC	quality assurance/quality control
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
ROD	record of decision
Security Pits	Chestnut Ridge Security Pits
Sediment Disposal Basin	Chestnut Ridge Sediment Disposal Basin
SESD	Sampling and Environmental Support Department
SWDF	solid waste disposal facility (non-RCRA)
TDEC	Tennessee Department of Environment and Conservation
TDS	total dissolved solids
TSD	treatment, storage, and disposal (unit)

List of Acronyms and Abbreviations (cont'd)

TSS	total suspended solids
UTL	upper tolerance limit
VOC	volatile organic compound
1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethene
1,2-DCE	1,2-dichloroethene
1,1,1-TCA	1,1,1-trichloroethane

1.0 INTRODUCTION

This groundwater quality report (GWQR) contains an evaluation of the groundwater monitoring data obtained during calendar year (CY) 1995 from monitoring wells and springs located at or near several hazardous and non-hazardous waste management facilities associated with the U.S. Department of Energy (DOE) Y-12 Plant (Figure 1). These sites are within the boundaries of the Chestnut Ridge Hydrogeologic Regime (Chestnut Ridge Regime), which is one of three hydrogeologic regimes defined for the purposes of the Y-12 Plant Groundwater Protection Program (GWPP) (Figure 2). Directed by the Environmental Management Department of the Y-12 Plant Health, Safety, Environment, and Accountability (HSEA) Organization, the objectives of the GWPP are to provide the monitoring data necessary for compliance with applicable federal, state, and local regulations, DOE Orders, and Lockheed Martin Energy Systems, Inc. (Energy Systems) corporate policy.

The data obtained during CY 1995 for the purposes of the Y-12 Plant GWPP are presented in: *Calendar Year 1995 Groundwater Quality Report for the Chestnut Ridge Hydrogeologic Regime, Y-12 Plant, Oak Ridge, Tennessee: 1995 Groundwater Quality Data and Calculated Rate of Contaminant Migration* (Lockheed Martin Energy Systems, Inc. 1996), which is hereafter referred to as the Part 1 GWQR. The following evaluation of the data is organized into background regulatory information and site descriptions (Section 2.0), an overview of the hydrogeologic framework (Section 3.0), a summary of the CY 1995 groundwater monitoring programs and associated sampling and analysis activities (Section 4.0), analysis and interpretation of the data for inorganic, organic, and radiological analytes (Section 5.0), a summary of conclusions and recommendations (Section 6.0), and a list of cited references (Section 7.0). Appendix A contains supporting maps, cross sections, diagrams, and graphs; data tables and summaries are in Appendix B. Detailed descriptions of the data screening and evaluation criteria are included in Appendix C.

2.0 SITE DESCRIPTIONS

The Chestnut Ridge Regime lies south of the Y-12 Plant, and is flanked to the north by Bear Creek Valley (BCV) and to the south by Bethel Valley (unless otherwise noted, directions are in reference to the Y-12 Plant grid system). The regime encompasses Chestnut Ridge west of Scarboro Road and east of an unnamed drainage feature southwest of the Y-12 Plant (Figure 3). Groundwater quality monitoring in the Chestnut Ridge Regime was performed during CY 1995 at three classes of waste-management facilities (Table 1).

- Operable units (OUs) subject to regulation under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), or lower priority Study Areas that may warrant a future CERCLA remedial investigation/feasibility study (RI/FS).
- Resource Conservation and Recovery Act (RCRA) hazardous waste treatment, storage, and disposal (TSD) units, some of which also are subject to regulation under CERCLA.
- Nonhazardous solid waste disposal facilities (SWDFs).

General descriptions of each site are provided in the following sections; more detailed descriptions, and discussions of the regulatory status and the groundwater monitoring history of each site, are included in Section 2.0 of the Part 1 GWQR.

2.1 CERCLA Operable Units and Study Areas

Four sites are designated as CERCLA OUs, including one RCRA TSD unit (the Chestnut Ridge Security Pits [Security Pits]) and three former RCRA solid waste management units (the Ash Disposal Basin, the United Nuclear Corporation Site, and Rogers Quarry). Additionally, the Chestnut Ridge Borrow Area Waste Pile is currently listed as a Study Area to be investigated under CERCLA (Table 1).

The Security Pits (Chestnut Ridge OU 01) are located on the crest of Chestnut Ridge south of the central portion of the Y-12 Plant (Figure 3). A closed RCRA TSD unit that began operations in 1973 and was granted RCRA interim status in 1986, the Security Pits consist of two areas, each containing a series of east-west oriented trenches that are about 8 to 10 feet (ft) wide, 10 to 18 ft

deep, and 700 to 800 ft long, that were used for disposal of hazardous waste until December 1984, and for disposal of nonhazardous waste until November 1988 (Energy Systems 1988). Closure of the site per RCRA requirements was completed in 1989 and involved installation of a low-permeability cap over the disposal trenches. Quarterly groundwater quality assessment monitoring was initiated at the Security Pits in January 1988, and was performed in accordance with applicable RCRA interim status regulatory requirements through 1995. As specified in the RCRA post-closure permit issued by the Tennessee Department of Environment and Conservation (TDEC) on March 8, 1996, which incorporated several regulatory-driver agreements between DOE, the U.S. Environmental Protection Agency (EPA), and the TDEC, semiannual post-closure corrective action monitoring is currently in progress. Additionally, an RI work plan was submitted for EPA and TDEC approval in CY 1993 (U.S. Department of Energy 1993a), but no actions under CERCLA are currently planned.

The Ash Disposal Basin (Chestnut Ridge OU 02), also known as the Filled Coal Ash Pond, is on the southern flank of Chestnut Ridge about one-half mile south of the Y-12 Plant (Figure 3). Construction of an earthen dam across a northern tributary of McCoy Branch created the basin in 1955, which by 1967 was filled with fly-ash slurry pumped from the Y-12 Steam Plant (Battelle Columbus Division 1988). Field activities for the RI were completed in June 1993; the RI report was issued in August 1994 (U.S. Department of Energy 1994), followed by the FS in January 1995 (U.S. Department of Energy 1995). Corrective actions at the site are ongoing and include dam stabilization and wetlands construction in accordance with an approved CERCLA record of decision (ROD). Semiannual groundwater monitoring is performed at the site as a best-management practice.

The United Nuclear Corporation Site (Chestnut Ridge OU 03) lies on the crest of Chestnut Ridge southeast of the west end of the Y-12 Plant (Figure 3). The site was used to landfill 11,000 drums (55-gallon) of sludge fixed in cement, 18,000 drums of contaminated soil, and 288 boxes of contaminated process and demolition materials (U.S. Department of Energy 1993b). Waste disposal ceased in 1984 (Grutzeck 1987), and the site was capped and closed in CY 1992 in accordance with a CERCLA ROD (U.S. Department of Energy 1991) and a RCRA closure plan. Post-closure semiannual groundwater monitoring has been performed (in accordance with the ROD)

as a service to the Y-12 Plant Environmental Restoration Surveillance and Maintenance Program (Martin Marietta Energy Systems, Inc. 1992).

Rogers Quarry (Chestnut Ridge OU 04) is in the southwest portion of the Chestnut Ridge Regime about three miles west of Kerr Hollow Quarry (Figure 3). The site served as a source of stone construction material from the 1940s through the late-1950s, and was abandoned in the early 1960s when it filled with water. Beginning in 1967, the site received fly-ash slurry from the Y-12 Steam Plant that bypassed the filled Ash Disposal Basin through an emergency spillway and discharged directly into McCoy Branch (King *et al.* 1989); disposal of fly ash in Rogers Quarry ceased in July 1993 per agreement with the TDEC. Semiannual groundwater monitoring is performed at the site as a best-management practice pending the outcome of the RI/FS process and the CERCLA ROD. An RI work plan for this OU was submitted for review by the EPA and TDEC in CY 1993 (U.S. Department of Energy 1993c).

The Chestnut Ridge Borrow Area Waste Pile, also known as the Civic Center Spoil Pile, is currently listed as a Study Area to be investigated under CERCLA. Located near the eastern end of the Chestnut Ridge Regime (Figure 3), the site was built as a temporary storage area for low-level mercury contaminated soils removed from the City of Oak Ridge. Semiannual groundwater monitoring at this site continued during CY 1995 as a best-management practice of the Y-12 Plant GWPP.

2.2 RCRA Treatment, Storage, or Disposal Facilities

Three RCRA-regulated hazardous waste TSD facilities not designated as CERCLA OUs are the Chestnut Ridge Sediment Disposal Basin (Sediment Disposal Basin), Kerr Hollow Quarry, and East Chestnut Ridge Waste Pile (Table 1). The Sediment Disposal Basin and Kerr Hollow Quarry are also considered low priority Study Areas under CERCLA.

The Sediment Disposal Basin is located on Chestnut Ridge, southeast of the east end of the Y-12 Plant (Figure 3). It was used between 1973 and 1988 for the disposal of contaminated soils and sediments removed from various areas within the Y-12 Plant and dredged from New Hope Pond. Granted RCRA interim status in CY 1986, the site was closed in CY 1989 in accordance with an approved RCRA closure plan; the TDEC issued a RCRA post-closure permit for the site

in September 1995. In October 1995, semiannual post-closure detection monitoring was initiated, replacing the RCRA interim status detection monitoring program conducted at the site since CY 1987.

Kerr Hollow Quarry is in the southeastern portion of the Chestnut Ridge Regime (Figure 3) and served as a source of stone construction material until it filled with water and was abandoned in the late 1940s. From the early-1950s until November 1988, the site was used for the disposal of reactive materials from the Y-12 Plant and the Oak Ridge National Laboratory (ORNL). Wastes were removed from the quarry between mid-1990 and late-1993 to obtain certified clean-closure status from the TDEC, but the site was finally closed with some remaining wastes in place. Because clean closure of the site was not achieved, an application for a RCRA post-closure permit was prepared for the site and submitted for review by the TDEC in June 1995; a CERCLA ROD issued in September 1995 defined administrative controls for the site following waste removal actions. Detection monitoring per RCRA interim status requirements has been in progress at the Kerr Hollow Quarry since CY 1988. A RCRA post-closure permit for the site was issued in June 1996; therefore, the site is now under a post-closure detection monitoring program.

The East Chestnut Ridge Waste Pile is a lined, hazardous waste management facility constructed in CY 1987 as a storage site for contaminated soils from the Y-12 Plant. The site is in the eastern portion of the Chestnut Ridge Regime near the Sediment Disposal Basin (Figure 3). As a lined facility, the East Chestnut Ridge Waste Pile is exempt from groundwater monitoring requirements under RCRA. Nevertheless, groundwater monitoring has been performed at the site since CY 1987 as a best-management practice of the Y-12 Plant GWPP.

2.3 Solid Waste Disposal and Storage Facilities

Five nonhazardous waste landfills are in the Chestnut Ridge Regime: Industrial Landfills II, IV, and V, and Construction/Demolition Landfills VI and VII (Table 1). These sites are classified as either Class II or Class IV facilities, as defined in the TDEC solid waste management regulations. The facilities have operating permits issued by the TDEC and are currently used for disposal of either sanitary solid wastes, industrial wastes, or demolition wastes generated at the Y-12 Plant and elsewhere on the Oak Ridge Reservation (ORR). Semiannual detection monitoring

is performed at each site in accordance with applicable regulatory requirements and specific permit conditions.

3.0 HYDROGEOLOGIC FRAMEWORK

This section contains a general description of the complex hydrogeologic system in the Chestnut Ridge Regime. 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 BCV characterization area (CA) (Science Applications International Corporation 1996).

3.1 Geology

The 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, the sandstone and shales of the Rome Formation form Pine Ridge to the north, interbedded limestone and shale formations of the Conasauga Group directly underlie the plant complex in BCV, primarily dolostone strata of the Knox Group form Chestnut Ridge to the south, and the argillaceous limestones and interbedded shales of the Chickamauga Group underlie Bethel Valley (Figure 4). Strike and dip of bedding in the area is generally N 55°E and 45°SE, respectively (as referenced to true north).

All sites in the Chestnut Ridge Regime except Kerr Hollow Quarry and Rogers Quarry are directly underlain by reddish-brown to yellow-orange residuum overlying the Knox Group. The residuum is characteristically acidic, predominantly composed of clays and iron sesquioxides, and contains semi-continuous, relict beds of fractured chert and other lithologic inhomogeneities (such as silt bodies) that provide a weakly connected network through which saturated flow can occur (Solomon *et al.* 1992). The residuum is thin or nonexistent near karst features such as dolines (sink holes), swallets (sinking streams), and solution pan features (Ketelle and Huff 1984). Depth to bedrock varies throughout the Chestnut Ridge Regime, but is usually less than 100 ft below ground surface (bgs).

All but the southernmost portion of the Chestnut Ridge Regime is underlain by the Knox Group. The Knox Group consists of about 2,600 to 3,300 ft of gray to blue-gray, thin- to

thick-bedded cherty dolostones with interbedded limestones that have been divided into five formations (listed from oldest to youngest): Copper Ridge Dolomite, Chepultepec Dolomite, Longview Dolomite, Kingsport Formation, and Mascot Dolomite. Formational boundaries in the Chestnut Ridge Regime have not been mapped, but topographic and stratigraphic relationships suggest that the Copper Ridge Dolomite forms the steep northern flank of the ridge, the Longview Dolomite forms prominent hills about midway down the broad southern flank of the ridge (Hatcher *et al.* 1992), and the Mascot Dolomite disconformably underlies the Chickamauga Group along the southern boundary of the regime (Figure 4). The Chickamauga Group, which is exposed in Rogers Quarry, generally consists of thin- to medium-bedded argillaceous limestone and interbedded calcareous shales.

The most pervasive structural features in the Chestnut Ridge Regime are extensional, hybrid, and shear fractures (Solomon *et al.* 1992). Three major joint orientations are evident: one that roughly parallels bedding, one steeply dipping set that parallels geologic strike, and one steeply dipping set oriented perpendicular to strike (Dreier *et al.* 1987). Fracture densities ranging from about 1 to 60 per foot have been observed in rock outcrops near the ORNL (Dreier *et al.* 1987; Sledz and Huff 1981). Most fractures are short, ranging from tenths of inches to a few feet in length (Solomon *et al.* 1992).

The dissolution of carbonates along fractures has produced many surface karst features on Chestnut Ridge. Smith *et al.* (1983) identified a series of sinkholes along the crest of the ridge that show a prominent alignment parallel to strike. This linear trend may result from dissolution along a bedding plane or joint set (Ketelle and Huff 1984; Smith *et al.* 1983).

3.2 Groundwater System

Solomon *et al.* (1992) divide the groundwater system underlying the ORR into two basic hydrogeologic units with fundamentally different hydrologic characteristics: the Knox Aquifer and the ORR Aquitards. Near the Y-12 Plant, the Knox Aquifer consists of the Knox Group and the underlying Maynardville Limestone Formation of the Conasauga Group. The remaining formations of the Conasauga Group (collectively referred to in this report as the Conasauga Shales), the underlying Rome Formation, and the Chickamauga Group comprise the ORR Aquitards.

In general, both the Knox Aquifer and the ORR Aquitards are divided by Solomon *et al.* (1992) into four parts: (1) the stormflow zone, (2) the vadose zone, (3) the groundwater zone and (4) the aquiclude (Figure 5). The divisions are based on how much water is transmitted by each subsystem (i.e., flux), which decreases with depth. The flow system is vertically gradational with no discrete boundaries separating the subsystems. However, the bulk permeability of the Knox Aquifer is about ten times greater than that of the ORR Aquitards (Solomon *et al.* 1992).

3.2.1 Stormflow Zone

Investigations in Bethel Valley and Melton Valley near ORNL show that groundwater occurs intermittently above the water table in the ORR Aquitards in a shallow "stormflow zone" that extends from ground surface to a depth of about 6 ft (Moore 1989). Channels for lateral flow in the stormflow zone include macropores and mesopores, which are connected voids created by various processes, including biochanneling, cracking, and soil particle aggregation (Moore 1989). The stormflow zone is thicker and more permeable in forested areas than in grassy or brushy areas, and is more permeable near the ground surface than at deeper intervals (Moore 1989). Lateral flow in the stormflow zone is intermittent, creating a perched water table lasting only a few days or weeks after rainfall. Most groundwater within the stormflow zone is either lost to evapotranspiration or recharge to the water table and the remaining water discharges at nearby seeps, springs, or streams. Detailed studies of the stormflow zone have not been conducted in the Chestnut Ridge Regime. However, as part of the RI/FS in progress for the BCV CA, stormflow tubes installed at six sites (three along the northern flank of Chestnut Ridge) have all showed brief periods of soil saturation in response to rainfall (Science Applications International Corporation 1996). These findings suggest that stormflow also occurs in BCV, although capping of the waste management areas has probably altered the stormflow zone in some areas of the Bear Creek Regime. Additionally, the significance of groundwater flux and contaminant transport in the stormflow zone in BCV is not fully understood, and may not be as great as in Bethel Valley and Melton Valley.

3.2.2 Vadose Zone

The vadose zone occurs between the stormflow zone and the water table. The geometric mean depth to the water table beneath Chestnut Ridge is about 100 ft. Water is added to the vadose zone by percolation from the stormflow zone and is removed by transpiration and recharge to the water table. 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). Most recharge through the vadose zone is episodic and occurs along discrete permeable fractures that become saturated, although surrounding micropores remain unsaturated (Solomon *et al.* 1992).

Results of slug tests in wells at the United Nuclear Corporation Site (Mishu 1982), and in areas several miles west of the Chestnut Ridge Regime (Woodward-Clyde Consultants, Inc. 1984) provide estimates of the hydraulic conductivity of the unsaturated residual soils on Chestnut Ridge. Little variation was observed with depth, but conductivities determined by field and laboratory tests varied by approximately two orders-of-magnitude for comparable depth intervals. Mean field conductivities ranged from 0.0057 to 0.49 feet per day (ft/d) and mean laboratory conductivities ranged from 2.8×10^{-5} to 9.1×10^{-3} ft/d. Results of the slug tests are similar to those obtained from infiltrometer tests. Moore (1988) reported a geometric mean hydraulic conductivity of about 0.006 ft/d for residuum on Chestnut Ridge based on results of infiltrometer studies near ORNL reported by Watson and Luxmoore (1986) and Wilson and Luxmoore (1988).

The hydraulic conductivity of the residuum overlying the Knox Group varies with saturation (Luxmoore 1982; Daniels and Broderick 1983). Luxmoore (1982) showed that hydraulic conductivity decreases by approximately one order-of-magnitude with a volumetric water content decrease to 90% of saturation, and two orders-of-magnitude with a volumetric water content decrease to 75% of saturation. Daniels and Broderick (1983), as summarized in Ketelle and Huff (1984), reported that hydraulic conductivity decreases by roughly one order-of-magnitude relative to maximum when saturation is 90%, and three orders-of-magnitude relative to maximum when saturation is 75%. Ketelle and Huff (1984) also noted that wide variations in soil permeability occur over short lateral distances. These findings are consistent with observations of permeability variation in residual soils found in other karst areas (Quinlan and Aley 1987).

3.2.3 Groundwater Zone

Groundwater below the vadose zone occurs within orthogonal sets of permeable, planar fractures that form water-producing zones within an essentially impermeable matrix; dissolution of carbonates has increased the permeability of these zones within the Knox Aquifer. 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). Because the frequency, aperture, and connectivity of permeable fractures decrease with depth, the bulk hydraulic conductivity of the groundwater zone is vertically gradational. Most of the groundwater flux 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, but active flow occurs at greater depth in the Knox Aquifer (Dreier *et al.* 1993).

Estimates of the hydraulic conductivity of water producing intervals within the Knox Group are provided by results of straddle packer tests performed in core holes near the Sediment Disposal Basin and Industrial Landfill IV (King and Haase 1988), and slug tests performed in wells at Industrial Landfill II, IV, and V and Construction/Demolitions Landfill VII. The packer tested intervals were generally less than 600 ft bgs in the Copper Ridge Dolomite, and calculated hydraulic conductivities ranged from 0.0002 (matrix intervals) to 3.1 ft/d (water-producing intervals). The slug tested intervals ranged from 36 to 195-ft bgs in the various Knox Group formations, and calculated hydraulic conductivities ranged from 0.003 to 28 ft/d (personal communication, S. Jones, August 1996). Dye-tracer tests, however, indicate higher flow rates comparable to those of typical karst terrains (Quinlan and Ewers 1985). Ketelle and Huff (1984), for example, determined flow rates of about 490 to 1,250 ft/d from a tracer test on Chestnut Ridge near ORNL. Results of a dye-tracer test at the Security Pits indicated flow rates of about 100 to 300 ft/d (Geraghty & Miller, Inc. 1990), although a second test using different tracers did not confirm these findings (Science Applications International Corporation 1993).

3.2.4 Aquiclude

The aquiclude is generally marked by the presence of saline water with total dissolved solids (TDS) concentrations of 40,000 to 300,000 milligrams per liter (mg/L) (Solomon *et al.* 1992). Information obtained southeast of the Chestnut Ridge Regime in Melton Valley suggests that sodium-, calcium-, and chloride-rich water chemically similar to brines associated with major sedimentary basins typically occurs at depths of about 600 to 700 ft bgs (Solomon *et al.* 1992).

3.3 Groundwater Flow Directions

Directions of groundwater flow in the Chestnut Ridge Regime were evaluated from April 1995 (the seasonally high water table) water level data for 86 monitoring wells, and October 1995 (the seasonally low water table) data for 84 wells; depth-to-water measurements and water-level elevations are presented in Appendix H of the Part 1 GWQR. These data show that the water table generally mirrors surface topography (Figure 6), with seasonal water level declines of 10 to 27 ft along the ridge crest (i.e., recharge areas), and 1 to 7 ft on the ridge flanks (i.e., discharge areas). Horizontal hydraulic gradients (0.01 to 0.05) are generally toward the east (i.e., parallel with geologic strike) along the axis of the ridge. Steeper horizontal gradients (0.04 to 0.07) are toward Upper East Fork Poplar Creek (normal to strike) on the northern ridge flank, and toward surface drainage features on the southern flank of the ridge. The overall pattern of groundwater flow is from the recharge areas on the ridge crest toward discharge areas that include the Maynardville Limestone in BCV, and springs and seeps in the crosscutting tributaries along the northern and southern flanks of Chestnut Ridge.

3.4 Groundwater Geochemistry

Calcium-magnesium bicarbonate groundwater occurs throughout the Knox Group formations that comprise the Knox Aquifer in the Chestnut Ridge Regime (Figure 7). Geochemical characteristics of the groundwater include equal or nearly equal molar concentrations of calcium and magnesium; pH of 7.5 to 8.0; very low (i.e., <1 mg/L) carbonate alkalinity and nitrate (as N) concentrations; low proportions (<5%) of chloride, sodium, sulfate, and potassium; and TDS above 150 mg/L. The geochemistry of the groundwater is fairly uniform throughout the Knox Aquifer,

although groundwater in some wells contains locally enriched chloride (e.g., GW-539) and sulfate (e.g., GW-339) concentrations, which potentially reflect the geochemical influence of locally disseminated sulfides (e.g., pyrite) or evaporites (e.g., gypsum). Additionally, groundwater within low permeability (matrix) intervals in the upper Knox Group (GW-143, GW-145, and GW-146) has greater proportions of sulfate and potassium, and higher trace metal concentrations (e.g., strontium) than typical of the groundwater from low yield intervals within the lower Knox Group formations (e.g., GW-177) (Figure 7). These geochemical differences potentially reflect corresponding differences between carbonate mineralogies in the upper and lower sections of the Knox Group, or the types of disseminated secondary minerals.

4.0 GROUNDWATER QUALITY MONITORING PROGRAMS

Groundwater monitoring during CY 1995 at the sites described in Section 2.0 was performed in general accordance with the *Sampling and Analysis Plan for Groundwater and Surface Water Monitoring at the Y-12 Plant during Calendar Year 1995* (Sampling and Analysis Plan) (HSW Environmental Consultants, Inc. 1994a). Deviations from and additions to the Sampling and Analysis Plan were documented in addenda issued by the Y-12 Plant GWPP Manager throughout the year. The following sections provide an overview of these sampling and analysis activities, including information regarding the sampling locations, frequency, and procedures, analytical parameters, and a discussion of the results of quality assurance/quality control (QA/QC) sampling.

4.1 Sampling Locations

Groundwater samples were collected from a total 73 monitoring wells and two springs. Some wells satisfy multiple programmatic drivers. The total number of sampling stations by program were as follows (Table 2):

- ten wells for RCRA interim status assessment monitoring,
- 15 wells for RCRA interim status detection monitoring,
- four wells for RCRA post-closure detection monitoring,
- six wells for post-closure CERCLA ROD monitoring,
- 24 wells and one spring for SWDF detection monitoring,
- 18 wells for best-management practice monitoring, and
- six wells and one spring for one-time special sampling purposes.

Locations of the monitoring wells and springs are shown on Figure 8. Selected construction information for the monitoring wells is summarized on Table 3; detailed well construction data are provided in Appendix C of the Part 1 GWQR.

4.2 Sampling Frequency

Groundwater samples were collected during each quarter of CY 1995. First through fourth quarter sampling events were performed January 4 - March 24, April 4 - May 16, July 10 - August

14, and October 6 - November 20, respectively. The number of monitoring wells and springs included in each sampling event varied depending on the quarterly or semiannual sampling requirements of the governing monitoring programs. For planned monitoring purposes, groundwater samples were collected from 33 wells in the first quarter, 65 wells and one spring during the second quarter, 33 wells during the third quarter, and 68 wells and one spring during the fourth quarter (Table 2).

Implementation of the various groundwater monitoring programs resulted in changes to the planned sampling frequency of some wells. Wells GW-539, GW-709, and GW-757 at Industrial Landfill II were included in three quarterly sampling events because of a shift from a first quarter/third quarter to a second quarter/fourth quarter semiannual sampling schedule. Quarterly sampling of wells GW-158, GW-241, GW-303, and GW-304 for RCRA interim status detection monitoring at the Sediment Disposal Basin was discontinued after the RCRA post closure permit was issued for the site in September 1995. Wells designated in the permit for semiannual RCRA post-closure detection monitoring at the site (GW-156, GW-159, GW-731, and GW-732) were sampled in October 1995 in accordance with the permit-specified protocol requiring sampling over a four consecutive day period (Table 2).

Six wells and one spring were included in specialized, one-time sampling events performed in January, March, and August 1995 (Table 2). Groundwater in well GW-321 at the Ash Disposal Basin was sampled at the request of the Y-12 Plant ER Program on January 10, 1995. Groundwater discharging at spring SCR2.2SP was sampled on March 15, 1995 in conjunction with the TDEC DOE Oversight Division. To confirm elevated total strontium and/or total uranium concentrations in groundwater at Kerr Hollow Quarry, groundwater samples for isotopic analyses were collected in March 1995 from wells GW-142, GW-144, GW-145, and GW-146. Similarly, well GW-732 at the Sediment Disposal Basin was redeveloped and resampled on August 14, 1995 to confirm the elevated uranium concentrations and gross alpha/gross beta activities reported for samples collected during the first and second quarters of the year.

4.3 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 HSEA Organization assisted with sample collection at springs SCR2.2SP and CBS-1. Sampling was performed in accordance with the most recent version of the technical procedure for groundwater sampling (SESD-TP-8204) and surface water sampling approved by the Y-12 Plant GWPP Manager.

Filtered and unfiltered samples were collected from each location; filtering was performed in the field with an in-line 0.45 micron filter. To reduce the potential for cross-contamination, samples were generally collected in sequence from the least contaminated wells to the most contaminated wells 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 is present, samples were collected from the farthest upgradient wells first.

4.4 Laboratory Analysis

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

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

Unfiltered groundwater samples were analyzed for the entire standard suite of constituents and parameters; filtered samples were analyzed only for the principal cations and trace metals. Unfiltered or filtered samples collected from some wells also were analyzed for other compounds or parameters required by TDEC regulations or specified in site operating permits. For example, the groundwater samples collected from wells at Construction/Demolition Landfill VII (and the associated QA/QC samples) were analyzed for additional organic compounds and other required parameters specified by the TDEC solid waste management regulations. Samples collected for special purposes were analyzed for targeted parameters.

Most of the laboratory analyses were performed by the K-25 Analytical Services Organization (ASO). Selected radiochemical analyses were performed by the ORNL ASO. Analytical results for all groundwater samples are presented in Appendix E of the Part 1 GWQR.

4.5 Quality Assurance/Quality Control Sampling

Seventy laboratory blanks, 122 trip blanks, four field blanks, and 33 equipment rinsate samples were analyzed for the target compound list VOCs. Selected equipment rinsate samples also were analyzed for trace metals, gross alpha and gross beta activity, and radionuclides. Duplicate groundwater samples were analyzed for the constituents and parameters specified for the wells from which they were collected. The analytical results for the duplicate samples are presented in Appendix F of the Part 1 GWQR; results for the other QA/QC samples are summarized in Appendix L of the Part 1 GWQR.

One or more of ten target compound list VOCs were detected in 15 (21%) of the laboratory blanks, 90 (74%) of the trip blanks, three (75%) of the field blanks, and 16 (48%) of the equipment rinsate samples analyzed during CY 1995 (Table 4). These compounds included: (1) five common laboratory reagents (acetone, 2-butanone, 2-hexanone, methylene chloride, and toluene), (2) three compounds, chloroform, 1,1,1-trichloroethane (1,1,1-TCA), and 1,2-dichloroethane (1,2-DCA), that are present in the groundwater in the Chestnut Ridge Regime (VOC plume constituents), and (3) two compounds (ethylbenzene and xylenes) that are neither common laboratory reagents nor known or suspected VOC plume constituents in the regime.

Common laboratory reagents were detected in 15 (21%) of the laboratory blanks, 13 (10%) of the trip blanks, and five (16%) of the equipment rinsate samples. As in previous years, acetone, 2-butanone, and methylene chloride were detected most frequently (Table 4). However, as summarized below, the very low percentages of laboratory blanks and trip blanks with methylene chloride contrast with respective historical results.

Calendar Year	Percent of Samples with Methylene Chloride			
	Laboratory Blanks	Trip Blanks	Field Blanks	Equipment Rinsates
1992	33	30	.	24
1993	43	36	.	35
1994	29	20	11	10
1995	3	6	0	12

This may be partially related to the declining number of groundwater samples and associated laboratory blanks and trip blanks analyzed each year; about 40% more laboratory blanks were analyzed in CY 1993 (115 samples) than in CY 1995 (70 samples), and about 35% more trip blanks were analyzed in CY 1993 (185 samples) than in CY 1995 (122 samples). Nevertheless, the overall reduction in the percentage of QA/QC samples containing methylene chloride (and other laboratory reagents) illustrates improved performance of the K-25 ASO with regard to laboratory contamination of QA/QC samples.

Two VOC plume constituents were detected in the QA/QC samples: 1,1,1-TCA in 86 (70%) of the trip blanks, three (75%) of the field blanks, and 13 (48%) of the equipment rinsate samples, and chloroform in one equipment rinsate sample (Table 4). As summarized below, 1,1,1-TCA was detected in samples analyzed each quarter of CY 1995, including all but four of the trip blanks and two of the equipment rinsate samples that contained any VOCs, and was the only compound detected in the field blank samples.

Type of QA/QC Sample	Number of Samples				
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Total
<u>Laboratory Blanks</u>	15	24	10	21	70
with VOCs	3	6	1	5	15
with 1,1,1-TCA	0	0	0	0	0
<u>Trip Blanks</u>	23	42	19	38	122
with VOCs:	19	24	13	34	90
with 1,1,1-TCA:	19	22	13	31	86
<u>Equipment Rinsates</u>	6	10	5	10	33
with VOCs:	3	2	3	7	15
with 1,1,1-TCA:	3	2	3	3	13
<u>Field Blanks</u>	1	1	1	1	4
with VOCs:	1	1	0	1	3
with 1,1,1-TCA:	1	1	0	1	3

The lack of 1,1,1-TCA in the laboratory blanks discounts the analytical environment as a source of the contamination in the other QA/QC samples. Relationships between 1,1,1-TCA results for the groundwater samples and associated trip blanks, field blanks, and equipment rinsates do not indicate cross contamination during sample handling and transportation, or improper equipment decontamination. Contamination of the deionized water source used by the K-25 ASO to prepare the blanks has been determined to be the cause of the widespread detection of 1,1,1-TCA in these QA/QC samples. Similar source water contamination with chloroform and 1,2-dichloropropane occurred during CYs 1991 and 1992, and was determined by the K-25 ASO to have resulted from: (1) an insufficient replacement frequency for the ionization columns, (2) improper flushing of the deionized water system, and (3) problems with system handling and maintenance (Buckley 1992). A routine sampling program of the water source used to prepare blanks has been implemented by the ASO to monitor the quality of deionized water.

Ethylbenzene and xylenes were detected in one laboratory blank, and in the two trip blanks and two equipment rinsate samples associated with this blank (Table 4). Both compounds also were detected in the groundwater samples associated with these QA/QC samples. These QA/QC and groundwater samples were analyzed by the K-25 ASO during October 8-9, 1995. None of the waste

sites in the Chestnut Ridge Regime are sources of these compounds, and all these results were considered analytical artifacts.

Thirty-four laboratory blanks, 61 trip blanks, and 12 equipment rinsates associated with selected wells used for SWDF detection monitoring were analyzed for the additional organic compounds specified by SWDF regulations and operating permits; analytical results for these samples are summarized in Appendix L of the Part 1 GWQR. Ethanol was the only compound detected in any of the QA/QC samples, including all of the laboratory blanks, trip blanks, and equipment rinsates analyzed during the first quarter, and about half of each type of QA/QC sample analyzed in the second quarter of CY 1995. Ethanol also was detected in the associated groundwater samples collected each quarter, but all these results were screened as false positives (see Appendix C). The widespread detection of ethanol clearly indicates laboratory contamination, which was subsequently corrected. Ethanol was not detected in any of the QA/QC samples or groundwater samples analyzed after the second quarter of the year.

5.0 DATA ANALYSIS AND INTERPRETATION

Analysis of the CY 1995 groundwater monitoring data for the Chestnut Ridge Regime was based on the interpretive assumptions associated with the data screening and evaluation processes described in Appendix C. The following sections present the analysis and interpretation of the data for principal ions, trace metals, VOCs, and radiological parameters.

5.1 Principal Ions

Concentrations of the principal ions reported for the bulk of the CY 1995 groundwater samples were consistent with the overall geochemical characteristics described in Section 3.4. However, data for several wells are conspicuous with regard to extremely high sodium and chloride levels, and atypical nitrate (as N) concentrations (hereafter synonymous with "nitrate concentrations"). Also, the data for some sampling locations show unusually low TDS or geochemical indicators of localized grout contamination.

Sodium (>20 mg/L) and chloride (>5 mg/L) concentrations in groundwater samples from wells GW-186, GW-187, and GW-188 are substantially higher than in samples from well GW-184 (2 mg/L). The elevated concentrations in the groundwater near these wells, particularly GW-186 and GW-187, have probably resulted from years of seasonal recharge containing dissolved salts (e.g., NaCl) routinely used to de-ice Bethel Valley Road. Dissolved sodium and chloride both tend to remain in solution and are readily transported in groundwater, but horizontal hydraulic gradients near Rogers Quarry are very low (e.g., 0.0001 to 0.0018 between wells GW-184 and GW-186). Thus, purging these wells before sampling probably induces much greater movement in the groundwater than occurs under normal hydraulic gradients. Moreover, considering the depth of the monitored interval for GW-187 (139 - 160 ft bgs), the extreme sodium (140 mg/L) and chloride (110 mg/L) concentrations characteristic of the groundwater samples from the well may indicate a failure in the annular grout that allows direct hydraulic communication with the shallow flow system.

Nitrate concentrations are typically below 1 mg/L in groundwater throughout the Chestnut Ridge Regime. Groundwater samples from several wells, however, have higher nitrate

concentrations, although as indicated by the following summary, none collected after CY 1990 have exceeded the 10 mg/L maximum contaminant level (MCL) adopted by TDEC.

Monitoring Well	Annual Average Nitrate (as N) (mg/L)					
	1990	1991	1992	1993	1994	1995
GW-144	0.57	0.76	0.99	1.20	1.70	2.10
GW-147	0.43	0.60	0.42	0.71	1.20	1.30
GW-184	15.90	6.20	5.50	4.20	7.50	5.60
GW-203	0.88	1.00	1.20	1.20	1.20	1.30
GW-231	<0.20	<0.20	0.46	0.73	0.86	1.10
GW-294	3.00	2.60	2.70	2.80	3.10	2.70
GW-302	1.10	1.00	1.10	1.00	1.10	1.20
GW-609	0.95	0.93	0.94	1.00	1.10	1.20
GW-611	3.20	2.80	2.70	2.90	3.60	3.30

The nitrate data obtained since CY 1990 also show: (1) increased concentrations in the groundwater downgradient (GW-144) and upgradient (GW-147 and GW-231) of Kerr Hollow Quarry, (2) fairly stable or slightly increased concentrations in groundwater along the axis (GW-203, GW-294, GW-302, and GW-609) and northern flank (GW-611) of Chestnut Ridge, and (3) decreased concentrations in groundwater upgradient of Rogers Quarry (GW-184). Nitrate is highly mobile in groundwater, and, as illustrated by data for wells GW-144 and GW-147, concentrations generally correlate with high and low groundwater flow conditions (Figure 9). The correlation with flow conditions suggests nitrate is leached from the surficial soils and residuum by recharging groundwater (note the elevated nitrate concentrations in low TDS groundwater samples from wells GW-144 and GW-203).

The TDS of groundwater samples from wells and springs in the Chestnut Ridge Regime typically exceed 150 mg/L (the 25th percentile of the TDS data). Some of the monitoring wells, however, occasionally yield groundwater samples with lower TDS, including wells GW-144 (104 mg/L), GW-147 (144 mg/L), GW-177 (120 mg/L), GW-217 (108 mg/L), GW-305 (88 mg/L), GW-514 (142 mg/L), GW-522 (88 mg/L), and GW-796 (78 mg/L). The low TDS of these samples suggests groundwater with short residence time, which implies active groundwater recharge and discharge flowpaths, possibly "quickflow" conduits described in Shevenell (1994a). The monitored

interval in well GW-144, for example, intercepts a fracture at 170 ft bgs that yields 20 gallons per minute (Jones *et al.* 1994). Additionally, the low TDS of these samples may be a function of groundwater inflow at the time of sample collection. Hydrograph recession curves for several wells in the Knox Aquifer are characterized by three distinct line segments: a steeply sloped segment representing the dominant effects of drainage from conduits, an intermediately sloped segment representing drainage from well connected and partially karstified fractures, and a third more gently sloped line segment representing drainage from the porous (matrix) aquifer intervals (Shevenell 1994b). Samples collected when inflow from conduits is dominant would be expected to have lower TDS than samples collected when inflow is primarily from matrix intervals.

Localized grout contamination is indicated by the atypical pH (>8.5), carbonate alkalinity (>1 mg/L), and potassium:sodium ratios ($>1:1$) for groundwater samples from wells GW-731 and GW-732 at the Sediment Disposal Basin, and well GW-796 at Industrial Landfill V. This is clearly illustrated by the results for the series of groundwater detection monitoring samples collected October 23-26, 1995 from well GW-732. The sample collected the first day was obtained immediately after purging the stagnant water in the well, and the chemistry of the sample was typical of groundwater in the Knox Group. Samples collected on the following three successive days were obtained within 24 hours of each other without repurging the well, and each had the above characteristics of grout contamination as well as successively increasing ion charge balance errors (see Section 2.4 in Appendix C).

5.2 Trace Metals

Based on the data screening and evaluation criteria described in Appendix C, median total concentrations of fourteen trace metals determined from CY 1995 data for the unfiltered groundwater samples from 29 monitoring wells and one spring exceeded either the MCL adopted by the TDEC, or an upper tolerance limit (UTL) assumed to be representative of uncontaminated groundwater at the Y-12 Plant (Table 5). Review and analysis of the body of data for each sampling location, however, suggests that many of the CY 1995 results were affected by one or more extraneous factors, including preservation (acidification) of turbid (unfiltered) samples, laboratory contamination, analytical interferences, corrosion of stainless steel well casing and

screen, and well construction artifacts/deficiencies. Results most likely representative of concentrations in the groundwater are described in the following sections.

Industrial Landfill IV

Total boron concentrations are higher in the groundwater downgradient to the east (along strike) of Industrial Landfill IV, as indicated by the median concentrations for wells GW-217 (0.18 mg/L) and GW-522 (0.047 mg/L), than in the groundwater upgradient (west) of the site, as indicated by the median concentration (0.013 mg/L) for well GW-521. The boron results for well GW-217 continue the overall increasing trend evident since a conspicuous concentration "spike" (0.69 mg/L) in January 1992 (Figure 10), a trend which corresponds with a sodium concentration increase from 2 mg/L to more than 6 mg/L. As noted in the preceding section, the low TDS characteristic of the samples from wells GW-217 and GW-522 indicate that both intercept hydraulically active groundwater flowpaths. The elevated boron (and sodium) concentrations potentially reflect downgradient transport of inorganic wastes from Industrial Landfill IV, possibly borax (i.e., hydrated sodium borate) cleaning fluids if these materials were placed into the landfill. Currently, the GWPP is monitoring trends and examining disposal records in conjunction with the Y-12 Waste Management Organization to determine if these constituents are a concern.

Kerr Hollow Quarry

Median total boron, strontium, and uranium concentrations in groundwater at several wells downgradient of Kerr Hollow Quarry exceed the applicable UTLs (Table 5). However, the following characteristics of the data for these metals suggest that the elevated concentrations are not a result of past disposal of wastes in the quarry.

- As illustrated by trace metal data for wells GW-143 (boron), GW-145 (uranium), and GW-146 (strontium), increasing concentration trends are not evident in the groundwater downgradient of the site (Figure 11).
- Similar total (and dissolved) metal concentrations occur in the groundwater up and downgradient of the site. Total uranium concentrations, for example, are of similar

magnitude in the groundwater samples from upgradient well GW-147 and downgradient well GW-144 (Figure 11).

- The highest concentrations occur in the more mineralized (TDS >300 mg/L) groundwater from low-yield (matrix) zones intercepted by wells GW-143, GW-145, and GW-146. For instance, strontium concentrations in sulfate-enriched groundwater samples collected from well GW-146, which purges dry and recovers very slowly, are two orders-of-magnitude higher than in the low TDS groundwater samples from well GW-144, which intercepts a productive water-bearing fracture (Figure 11).
- Strontium (^{89}Sr and ^{90}Sr) and uranium isotope activities reported from the groundwater samples collected from wells GW-142, GW-144, GW-145, and GW-146 were below the respective minimum detectable activity (MDA) or were otherwise characterized by large associated counting errors (see Section 5.4).

The high strontium concentrations characteristic of the low-yield wells at Kerr Hollow Quarry, particularly GW-146, probably reflect hydrochemical processes related to the types of secondary minerals within the upper Knox Group. Long term dissolution of celestite (SrSO_4), for example, may explain the high strontium (and sulfate) concentrations characteristic of the samples from these wells. Alternatively, the strontium concentrations may reflect the mineralogy of fine grained, thick to massive limestone beds in the Mascot Dolomite; strontium ranges from 100 to 900 parts per million (ppm) in limestone (Brownlow 1979).

5.3 Volatile Organic Compounds

Based on the data screening and evaluation criteria described in Appendix C, results obtained during CY 1995 are generally consistent with previous monitoring data showing dissolved VOCs (primarily chloroethanes and chloroethenes) in groundwater at the Security Pits, Industrial Landfills IV and V, and Kerr Hollow Quarry.

Chestnut Ridge Security Pits

Volatile organic compounds in groundwater at the Security Pits occur in a narrow dissolved plume extending parallel with geologic strike for at least 2,600 ft downgradient to the east, and perpendicular to geologic strike for at least 500 ft downgradient to the north and south (Figure 12). The primary components of the plume are 1,1,1-TCA, 1,1-dichloroethane (1,1-DCA), and

1,1-dichloroethene (1,1-DCE) in the western trench area, and tetrachloroethene (PCE) and 1,2-DCE in the eastern trench area (Figure 13). Concentrations within the plume exceed 500 micrograms per liter ($\mu\text{g/L}$), as indicated by summed average VOC concentrations determined from July 1992 data for well GW-322 (532 $\mu\text{g/L}$), and maximum concentrations of 1,1-DCE, PCE, and 1,1,1-TCA exceed respective MCLs adopted by the TDEC. Distribution of the plume constituents relative to the respective source areas, and elongation of the plume along the axis of Chestnut Ridge despite steeper hydraulic gradients toward the ridge flanks, suggest primarily strike-parallel horizontal transport (west to east) in the groundwater. The maximum depth of vertical transport has not been determined, but is at least 150 ft bgs (GW-177) in the western trench area, 250 ft bgs (GW-612) near the middle of the site, and 270 ft bgs (GW-609) downgradient of the eastern trench area (Figure 14).

The eight monitoring wells at the Security Pits sampled during CY 1995 are outside (GW-610, GW-742, and GW-743) or just within (GW-175, GW-177, GW-608, GW-609, and GW-611) the boundaries of the dissolved VOC plume (Figure 12). Samples from the latter five wells contained low levels (i.e., $<20 \mu\text{g/L}$) of one or more plume constituents; only the PCE concentrations for wells GW-175 (15 - 19 $\mu\text{g/L}$) and GW-609 (13 - 19 $\mu\text{g/L}$) exceeded the MCL adopted by the TDEC (Table 6). As discussed in Section 2.5 of Appendix C, a total of eleven results for 1,1,1-TCA that were consistent with historical data for wells GW-175, GW-177, GW-608, and GW-611 were screened as false positives. However, the loss of data quality was not critical and summed average VOC concentrations for all eight wells are generally consistent with the respective historical results shown below.

Monitoring Well	Summed Average VOC Concentration ($\mu\text{g/L}$)					
	1990	1991	1992	1993	1994	1995
GW-175	38	31	30	17	25	22
GW-177	19	26	26	33	28	26
GW-608	15	15	5	4	4	2
GW-609	78	68	36	28	55	29
GW-610	1	<1	0	0	<1	0
GW-611	16	9	14	11	12	8
GW-742	NS	NS	0	0	0	0
GW-743	NS	NS	0	0	0	0

NS=Not sampled

These data also illustrate the overall decreasing concentration trends evident since the disposal trenches were closed and capped in 1988 and 1989; the 1,1,1-TCA and 1,1-DCA results for well GW-177 suggest a decrease to asymptotic levels in the groundwater near the western (upgradient) disposal trenches (Figure 15).

Besides the decreased VOC concentrations evident since closure of the Security Pits, the data for some wells show distinctive fluctuations with seasonal groundwater flow conditions. For example, VOC concentrations and water levels in well GW-177 show an inverse correlation (i.e., concentrations are lowest when water levels are highest) indicative of greater dilution during seasonally high flow conditions (Figure 15). Conversely, VOC results for well GW-609 show a generally positive correlation with water levels (i.e., concentrations are highest when water levels are highest) reflecting greater transport during seasonally high flow conditions (Figure 15). In either case, the seasonal fluctuations coupled with the decreased concentrations after closure of the Security Pits suggest that the active source of the VOCs is within the residuum and bedrock underlying the disposal trenches, possibly as residual dense non-aqueous phase liquids (DNAPL). Steady dissolution of the DNAPL (as well as associated matrix diffusion processes) may explain the dilution-related concentration fluctuations, and flushing by seasonal recharge and discharge may explain the transport-related concentration fluctuations.

Ash Disposal Basin and Industrial Landfill V

Data obtained since the early 1990s show low concentrations (1 to 2 $\mu\text{g/L}$) of 1,1,1-TCA in the groundwater at two wells downgradient of the western disposal trenches at the Security Pits (Figure 12): well GW-796 at Industrial Landfill V (about 400 ft south of the disposal trenches), and well GW-514 at the Ash Disposal Basin (about 900 ft south of the disposal trenches). Similar 1,1,1-TCA concentrations (1 $\mu\text{g/L}$) were detected in samples collected from well GW-796 in April and October 1995. However, both results were screened as false positives because of 1,1,1-TCA contamination in the associated trip blanks. No VOCs were detected in the two samples collected during CY 1995 from well GW-514, although low concentrations (1 to 2 $\mu\text{g/L}$) of 1,1,1-TCA were detected in all three samples collected during CY 1994. The repeated detection of 1,1,1-TCA in the groundwater samples from both wells potentially reflects southward migration from the Security

Pits, possibly along “quickflow” conduits oriented perpendicular to geologic strike (Shevenell 1994a; HSW Environmental Consultants, Inc. 1995). Moreover, the apparently sporadic detection of 1,1,1-TCA may result from occasional volatilization during sampling, and not the absence of the compound in the groundwater at each well.

Industrial Landfill IV

Groundwater at well GW-305, located on the east (downgradient) side of Industrial Landfill IV about 4,500 ft west (upgradient) of the Security Pits, also contains low levels of 1,1,1-TCA (Figure 12). Samples of the groundwater in the well have been collected since early 1988, and 1,1,1-TCA was first detected ($0.6 \mu\text{g/L}$) in the sample collected in January 1992. As indicated by the $6 \mu\text{g/L}$ result for the sample collected in July 1995, the concentrations have subsequently increased by an order-of-magnitude but remain well below the MCL of $200 \mu\text{g/L}$ (Figure 16).

The source of the 1,1,1-TCA in the groundwater at well GW-305 is uncertain. Potential cross contamination of the well during sampling was indicated by data obtained during CY 1992 (HSW Environmental Consultants, Inc. 1993), but was not supported by subsequent data (HSW Environmental Consultants, Inc. 1994b) and nevertheless does not explain the increasing concentration trend. Transport along strike from the western disposal trenches at the Security Pits seems unlikely because the water-table elevation near Industrial Landfill IV is more than 20 ft higher than at the Security Pits during both seasonally high and low groundwater flow conditions (Figure 6). Groundwater transport downgradient from Industrial Landfill IV is possible, assuming the waste stream has included chlorinated organic solvents, although 1,1,1-TCA has not been detected in any of the groundwater samples collected from the other downgradient wells at the site (GW-141, GW-217, and GW-522). However, the detection of 1,1,1-TCA in January 1992 and the subsequent increasing concentration trend coincides with data for well GW-217 showing a boron concentration spike in January 1992 and a subsequent increasing concentration trend. Additionally, the characteristically low TDS of the groundwater samples from well GW-305 suggest that it intercepts active groundwater flowpaths in the lower Knox Group (Copper Ridge Dolomite). As with boron, trending of this compound will continue as part of SWDF detection monitoring, and disposal

inventories for Industrial Landfill IV are being reviewed to determine if the site is a possible source of VOCs in the groundwater:

Kerr Hollow Quarry

Data obtained during CY 1995 are generally consistent with historical results showing low levels ($<5 \mu\text{g/L}$) of carbon tetrachloride, chloroform, and PCE in the groundwater downgradient to the south (GW-144) and southeast (GW-142) of Kerr Hollow Quarry (Figure 12). All three compounds have been detected in the groundwater at well GW-144, particularly carbon tetrachloride, which was detected in 12 of the 20 samples collected from the well since March 1991, including those obtained in January ($3 \mu\text{g/L}$), April ($3 \mu\text{g/L}$), and November 1995 ($2 \mu\text{g/L}$). Either chloroform (a degradation product of carbon tetrachloride) or PCE was detected in seven of the 20 groundwater samples collected from well GW-142 since March 1991, including PCE ($1 \mu\text{g/L}$) in the sample collected in November 1995. As noted previously, however, the sporadic detection of low VOC concentrations potentially reflects volatilization during sampling, and not the absence of the compounds in the groundwater. In either case, results for these wells indicate migration of VOCs both down-dip (GW-144) and along strike (GW-142) of Kerr Hollow Quarry.

5.4 Radioactivity

Gross alpha activity reported for 22 groundwater samples from twelve monitoring wells exceeded the 4.7 picoCuries per liter (pCi/L) MDA (Table 7). Annual average gross alpha activity for three of these wells exceeded the 15 pCi/L MCL: GW-160 ($23.1 \pm 4.4 \text{ pCi/L}$) at the Chestnut Ridge Borrow Area Waste Pile, GW-562 ($50.1 \pm 0.89 \text{ pCi/L}$) at Construction Demolition Landfill VII, and well GW-732 at the Sediment Disposal Basin ($43.9 \pm 9.6 \text{ pCi/L}$).

Annual average gross alpha activities for wells GW-160 and GW-732 were skewed by results reported for highly turbid groundwater samples. The unfiltered sample collected from well GW-160 in November 1995 had TSS of $5,365 \text{ mg/L}$ and gross alpha activity 39.4 ± 7.4 . In contrast, TSS were below 250 mg/L in all of the previous unfiltered samples from the well (including the sample collected in April 1995), and gross alpha activities for these samples were less than or only slightly above the MDA. Similarly, the elevated gross alpha activities reported for samples collected from

well GW-732 in January (34.1 ± 6 pCi/L) and April 1995 (91 ± 28 pCi/L) had respective TSS of 820 and 1,152 mg/L, whereas the unfiltered samples collected later in the year had low TSS (32 to 41 mg/L) and gross alpha activities below or just above the MDA.

Gross beta activity reported for 27 groundwater samples from nine monitoring wells exceeded the 11 pCi/L MDA (Table 7), but the annual average gross beta activity for each well was below the 50 pCi/L Safe Drinking Water Act screening level (see Section 3.2 in Appendix C). As with gross alpha activity, the highest gross beta activities were reported for turbid, unfiltered groundwater samples collected from well GW-732 (59.8 ± 31 pCi/L) in April, and from well GW-160 (34.2 ± 5.4 pCi/L) in November 1995.

No identifiable patterns or trends are evident among the radionuclide results that exceeded the respective MDAs, which were characterized by counting errors that typically exceeded 50% of the reported radionuclide activity (Table 8). None of the results indicate the presence of radionuclides in the groundwater in the Chestnut Ridge Regime.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Groundwater quality monitoring data obtained during CY 1995 from wells and springs in the Chestnut Ridge Regime are generally consistent with historical data. Evaluation and interpretation of the data indicate the following:

- Natural hydrochemical processes may locally enrich chloride and sulfate in the calcium-magnesium-bicarbonate groundwater in the Knox Aquifer, but the extreme concentrations (i.e., >100 mg/L) of chloride and sodium ions typical of the samples from well GW-187 at Rogers Quarry probably reflect groundwater contamination related to deicing of Bethel Valley Road.
- The low TDS (i.e., <150 mg/L) characteristic of the groundwater samples from several monitoring wells (e.g., GW-217) suggest short groundwater residence time and hydraulically active recharge/discharge flowpaths.
- Positive correlations between water levels and atypically high (i.e., >1 mg/L) nitrate concentrations in several wells (e.g., GW-144) probably reflect recharge of groundwater containing nitrate leached from the residuum and surficial soils overlying the Knox Group.
- Localized grout contamination in the groundwater at several wells in the regime, notably GW-732 at the Sediment Disposal Basin, is shown by atypical pH (>8.5), carbonate alkalinity (>1 mg/L), and potassium to sodium ratios (>1:1).
- Increasing total boron and sodium concentrations evident in the groundwater at well GW-217 since January 1992 potentially indicate downgradient transport of inorganic wastes (possibly borax cleaning fluids) from Industrial Landfill IV.
- The elevated total boron, strontium, and uranium levels characteristic of the unfiltered groundwater samples from several wells at Kerr Hollow Quarry probably do not reflect contamination because: (1) no increasing concentration trends are evident, (2) similar concentrations occur in groundwater up and downgradient of the quarry, (3) concentrations are typically highest in the samples from wells (e.g., GW-146) that yield more mineralized groundwater samples (TDS >300 mg/L) from low-permeability (matrix) aquifer zones, and (5) results of radiological analyses indicate neither strontium nor uranium isotopes in the groundwater.
- The performance of the K-25 ASO showed continued improvement with respect to detection of common laboratory reagents (e.g., methylene chloride) in the QA/QC samples and the associated groundwater samples. However, problems with operation and/or maintenance of

the deionized water supply system led to 1,1,1-TCA contamination of the deionized water used for trip blanks and field blanks, and to decontaminate groundwater sampling equipment.

- The known horizontal and vertical extent of dissolved VOCs in groundwater at the Security Pits remains unchanged from that observed over the past several years. Decreasing VOC concentrations in the groundwater at the site and correlations with seasonal water levels in some wells indicate that the disposal trenches at the site are no longer active sources of VOCs. A continued source may now be residual DNAPL in the residuum and bedrock underlying the disposal trenches.
- Although 1,1,1-TCA was not detected in the groundwater samples collected during CY 1995 from well GW-512, and the 1,1,1-TCA results for well GW-796 were screened as false positives, the low (estimated) concentrations repeatedly detected in previous samples from each well potentially indicate downgradient transport from the western disposal trenches at the Security Pits. Additionally, less-than-detection limit results for the samples from these wells possibly reflect volatilization during sampling and not the absence of 1,1,1-TCA in the groundwater.
- The CY 1995 data for well GW-305 reflect increasing concentrations of 1,1,1-TCA in the groundwater downgradient (east) of Industrial Landfill IV. Also, the detection of 1,1,1-TCA in the groundwater sample collected from the well in January 1992 and the subsequent concentration increase corresponds with increasing boron and sodium concentrations in the groundwater at well GW-217. The only confirmed sources of 1,1,1-TCA in the regime, the western disposal trenches at the Security Pits, lie more than 4,000 ft east and 20 ft hydraulically downgradient of Industrial Landfill IV. In light of these considerations, the 1,1,1-TCA data for well GW-305 potentially indicates migration of chlorinated organic wastes from the landfill.
- Low (estimated) concentrations of carbon tetrachloride, chloroform, or PCE sporadically detected in samples from wells GW-142 and GW-144 probably reflect downgradient transport of chlorinated organic wastes from Kerr Hollow Quarry. However, as indicated by the CY 1995 data, concentrations of these compounds are below applicable MCLs and show no increasing trends; sporadic detection of the VOCs may reflect volatilization during sampling.
- Gross alpha activity and gross beta activity reported for all but a few of the groundwater samples collected during CY 1995 were less than the respective MDAs. Activities that exceeded the MDAs were below the 15 pCi/L MCL for gross alpha activity, and the 50 pCi/L Safe Drinking Water Act screening level for gross beta activity. Moreover, these results were associated with highly turbid (i.e., nonrepresentative) groundwater samples. Additionally, results of isotopic strontium and uranium analyses do not suggest the presence of these radionuclides in the groundwater.

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

- Consecutive daily groundwater samples from wells GW-731 and GW-732 at the Sediment Disposal Basin collected for the purposes of post-closure detection monitoring should be collected only after purging the volumes of water necessary to ensure inflow of fresh groundwater as determined by stabilized field parameters.
- Pressure transducers should be used in wells GW-217 and GW-305 to obtain continuous water-level hydrographs needed to evaluate the relationship between groundwater flow conditions and respective total boron and 1,1,1-TCA concentrations.
- Analysis for VOCs in the groundwater samples from wells at Rogers Quarry, the East Chestnut Ridge Waste Pile, and the Chestnut Ridge Borrow Area Waste Pile should be discontinued; aside from common laboratory reagents, no VOCs have been detected in samples collected from the wells over the past several years.
- Low-flow purging and sampling techniques may be needed to avoid volatilization of VOCs potentially present at low concentrations in the groundwater at wells GW-142, GW-144, GW-514, and GW-796.
- Annual sampling of spring stations located along the southern flank of Chestnut Ridge to augment exit-pathway surveillance monitoring. These stations will include spring SCR2.2SP and potentially other stations of interest.

7.0 REFERENCES

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APPENDIX A

FIGURES

PREPARED FOR:
**LOCKHEED MARTIN
 ENERGY SYSTEMS, INC.**

LOCATION:

Y-12 PLANT
 OAK RIDGE, TN.

FIGURE 1

PREPARED BY:

**AJA TECHNICAL
 SERVICES, INC.**

DOC NUMBER:

96-D001

DWG ID.:

96-020

DATE:

3-19-96

REGIONAL LOCATION OF THE Y-12 PLANT

PREPARED FOR:
**LOCKHEED MARTIN
ENERGY SYSTEMS, INC.**

LOCATION:

Y-12 PLANT
OAK RIDGE, TN.

FIGURE 2

PREPARED BY:

**AJA TECHNICAL
SERVICES, INC.**

DOC NUMBER:

96-D001

DWG ID.:

96-021

DATE:

3-19-96

HYDROGEOLOGIC REGIMES
AT THE Y-12 PLANT

0 2000
SCALE (ft)

EXPLANATION

- 1200 TOPOGRAPHIC CONTOUR
- SURFACE DRAINAGE FEATURE
- 9 SPRING

PREPARED FOR:
LOCKHEED MARTIN
ENERGY SYSTEMS, INC.

LOCATION:

Y-12 PLANT
OAK RIDGE, TN.

PREPARED BY:

AJA TECHNICAL
SERVICES, INC.

DOC NUMBER:

96-D001

DWG ID.:

96-022

DATE:

3-19-96

FIGURE 3

WASTE-MANAGEMENT SITES AND CERCLA
OPERABLE UNITS IN THE CHESTNUT RIDGE
HYDROGEOLOGIC REGIME

PREPARED FOR:
**LOCKHEED MARTIN
 ENERGY SYSTEMS, INC.**

PREPARED BY:
**AIA TECHNICAL
 SERVICES, INC.**

LOCATION:
**Y-12 PLANT
 OAK RIDGE, TN.**

DOC NUMBER:
96-D001

DWG ID. #:
96-023

DATE:
3-19-96

**TOPOGRAPHY AND BEDROCK GEOLOGY
 IN THE CHESTNUT RIDGE HYDROGEOLOGIC REGIME**

SOURCE: King and Haase, 1987

ORR AQUITARDS KNOX AQUIFER

SYSTEM	GROUP (Formation)	HYDRO UNIT	MAP SYMBOL	THICKNESS (FT)
ORDOVICIAN	CHICKAMAUGA (Undifferentiated)	ORR AQUITARDS	Och	1500 TO 2000
	MISSING SECTION (Subaerial Erosion)			
	KNOX (Undifferentiated)	KNOX AQUIFER	Ock	2500 TO 3000
CAMBRIAN	CONASAUGA (Maynardville Limestone)		Cmn	418 TO 450

FIGURE 4

HYDROSTRATIGRAPHIC UNITS PROPOSED BY SOLOMON *et al.* (1992)

PREPARED FOR:
**LOCKHEED MARTIN
ENERGY SYSTEMS, INC.**

LOCATION: Y-12 PLANT
OAK RIDGE, TN.

FIGURE 5

PREPARED BY:
**AJA TECHNICAL
SERVICES, INC.**

DOC NUMBER: 96-D001
DWG ID.: 96-030
DATE: 3-26-95

SCHEMATIC PROFILE OF
HYDROSTRATIGRAPHIC UNITS IN THE
CHESTNUT RIDGE HYDROGEOLOGIC REGIME

GROUNDWATER
ELEVATIONS
APRIL 3-7, 1995

GROUNDWATER
ELEVATIONS
OCTOBER 16-23, 1995

Modified from CY 1995 GWQR Part 1

EXPLANATION

- Water Table Monitoring Well
 - Bedrock Monitoring Well
 - Approximate Water-Level Isopleth (ft msl)
 - Surface Drainage Feature
 - Spring
- SCALE (ft)
0 1000

PREPARED FOR:
LOCKHEED MARTIN
ENERGY SYSTEMS, INC.

LOCATION: Y-12 PLANT
OAK RIDGE, TN.

PREPARED BY:
AJA TECHNICAL
SERVICES, INC.

DOC NUMBER: 96-D001
DWG ID.: 96-029
DATE: 3-26-96

FIGURE 6

GROUNDWATER ELEVATIONS IN THE
CHESTNUT RIDGE HYDROGEOLOGIC REGIME

EXPLANATION

— GROUNDWATER COMPOSITIONS CLUSTER IN THESE AREAS.
73 WELLS AND 2 SPRINGS ARE PLOTTED ON THIS DIAGRAM

■ — 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

◇ — BEDROCK MONITORING WELL

□ — SPRING SAMPLING LOCATION

— Knox Group

— Chickamauga Group

PREPARED FOR:
**LOCKHEED MARTIN
ENERGY SYSTEMS, INC.**

LOCATION: Y-12 PLANT
OAK RIDGE, TN.

FIGURE 7

PREPARED BY:
**AJA TECHNICAL
SERVICES, INC.**

DOC NUMBER: 96-D001
DWG ID.: 96-017
DATE: 3-19-96

GROUNDWATER GEOCHEMISTRY
IN THE CHESTNUT RIDGE
HYDROGEOLOGIC REGIME

PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.		LOCATION: Y-12 PLANT OAK RIDGE, TN.	
PREPARED BY: AJA TECHNICAL SERVICES, INC.		DOC NUMBER: 96-D001	FIGURE 8
		DWG ID.: 96-031	
DATE: 3-26-96		CY 1995 GROUNDWATER SAMPLING LOCATIONS

GW-144

GW-147

PREPARED FOR:
LOCKHEED MARTIN
ENERGY SYSTEMS, INC.

LOCATION:

Y-12 PLANT
OAK RIDGE, TN.

FIGURE 9

PREPARED BY:

AJA TECHNICAL
SERVICES, INC.

DOC NUMBER:

96-D001

DWG ID.:

HG9

DATE:

4-28-96

NITRATE CONCENTRATIONS
IN GROUNDWATER AT WELLS
GW-144 AND GW-147

GW-217

GW-522

PREPARED FOR:
LOCKHEED MARTIN
ENERGY SYSTEMS, INC.

LOCATION:

Y-12 PLANT
OAK RIDGE, TN.

FIGURE 10

PREPARED BY:

AJA TECHNICAL
SERVICES, INC.

DOC NUMBER:

96-D001

DWG ID.:

HG10

DATE:

4-28-96

TOTAL BORON CONCENTRATIONS
IN GROUNDWATER AT WELLS
GW-217 AND GW-522

Downgradient

Uranium

Strontium

PREPARED FOR:
**LOCKHEED MARTIN
ENERGY SYSTEMS, INC.**

PREPARED BY:
**AJA TECHNICAL
SERVICES, INC.**

LOCATION: Y-12 PLANT
OAK RIDGE, TN.

DOC NUMBER: 96-D001
DWG ID.: HG11
DATE: 4-28-96

FIGURE 11

BORON, STRONTIUM, AND URANIUM
CONCENTRATIONS IN GROUNDWATER
AT KERR HOLLOW QUARRY

PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.		LOCATION: Y-12 PLANT OAK RIDGE, TN.	
PREPARED BY: ATA TECHNICAL SERVICES, INC.		DOC NUMBER: 96-D001	
		DWG ID.: 96-016	
		DATE: 3-19-96	

HORIZONTAL EXTENT OF VOCs
 IN GROUNDWATER IN THE CHESTNUT RIDGE
 HYDROGEOLOGIC REGIME

- EXPLANATION**
---	Surface Drainage Feature	ND	Not Detected		ND
■	Water Table Monitoring Well	4.3	Plume Delineation Value (ug/L)		0-100 ug/L
●	Bedrock Monitoring Well				>100 ug/L
▲	Spring Sampling Location				
*	Historic Data, Well Not Sampled in CY 1995				
- VOC Concentration outside Plume Boundaries (ug/L)
- 100 — Line of Equal Concentration

FIGURE 12

EXPLANATION

TCA — Annual Average 1,1,1-Trichloroethane Concentration (ug/L)	⊙ — PCE > 50% of TOT
PCE — Annual Average Tetrachloroethene Concentration (ug/L)	⊕ — TCA > 50% of TOT
TOT — Plume Delineation Value (ug/L)	(30) — TCA Concentration From CY 1994, False Positive In CY 1995
ND — Not Detected	● — Bedrock Monitoring Well
	× — Well not Sampled in CY 1995

PREPARED FOR:

LOCKHEED MARTIN
ENERGY SYSTEMS, INC.

LOCATION:

Y-12 PLANT
OAK RIDGE, TN.

FIGURE 13

PREPARED BY:

AJA TECHNICAL
SERVICES, INC.

DOC NUMBER:

96-DD001

DWG ID.:

96-018

DATE:

3-19-96

DISTRIBUTION OF VOCs IN GROUNDWATER
AT THE CHESTNUT RIDGE SECURITY PITS

GW-177 Chloroethanes

GW-609 Chloroethenes

PREPARED FOR:
**LOCKHEED MARTIN
 ENERGY SYSTEMS, INC.**

LOCATION:

Y-12 PLANT
 OAK RIDGE, TN.

PREPARED BY:

**AJA TECHNICAL
 SERVICES, INC.**

DOC NUMBER:

96-D001

DWG ID.:

HG15

DATE:

4-28-96

FIGURE 15

CONCENTRATIONS OF SELECTED VOCs
 IN GROUNDWATER AT WELLS
 GW-177 AND GW-609

GW-305

Industrial Landfill IV

PREPARED FOR:
LOCKHEED MARTIN
ENERGY SYSTEMS, INC.

LOCATION:

Y-12 PLANT
OAK RIDGE, TN.

FIGURE 16

PREPARED BY:

AJA TECHNICAL
SERVICES, INC.

DOC NUMBER:

96-D001

DWG ID.:

HG16

DATE:

4-28-96

CONCENTRATIONS OF 1,1,1-TCA
IN GROUNDWATER AT WELL GW-305

APPENDIX B

TABLES

**Table 1. Waste-Management Sites and CERCLA Operable Units
in the Chestnut Ridge Hydrogeologic Regime**

Site	Regulatory Classification	
	Historical ¹	Current ²
Chestnut Ridge Sediment Disposal Basin	TSD Unit	Study Area/TSD Unit
East Chestnut Ridge Waste Pile	TSD Unit	Study Area/TSD Unit
Kerr Hollow Quarry	TSD Unit	Study Area/TSD Unit
Chestnut Ridge Security Pits	TSD Unit	CR OU 01/TSD Unit
Ash Disposal Basin	SWMU	CR OU 02
United Nuclear Corporation Site	SWMU	CR OU 03
Rogers Quarry	SWMU	CR OU 04
Industrial Landfill II	SWDF	SWDF
Industrial Landfill IV	SWDF	SWDF
Industrial Landfill V	N/A	SWDF
Construction/Demolition Landfill VI	N/A	SWDF
Construction/Demolition Landfill VII	N/A	SWDF
Chestnut Ridge Borrow Area Waste Pile	NR	Study Area

Notes:

1 Regulatory classification before the 1992 Federal Facility Agreement.

TSD Unit - RCRA-regulated land-based Treatment, Storage, or Disposal Facility.
 SWMU - RCRA-regulated Solid Waste Management Unit
 SWDF - Solid Waste Disposal Facility (non-hazardous waste)
 N/A - Not applicable (new facility)
 NR - Not regulated

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

CR OU 01 - Chestnut Ridge Operable Unit 01 (Source Control and Groundwater OU)
 CR OU 02 - Chestnut Ridge Operable Unit 02 (Source Control and Groundwater OU)
 CR OU 03 - Chestnut Ridge Operable Unit 03 (Source Control and Groundwater OU)
 CR OU 04 - Chestnut Ridge Operable Unit 04 (Source Control and Groundwater OU)

Table 2. Monitoring Programs Implemented During CY 1995

Sampling Point ¹	Location ²	Date Sampled			
		1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
RCRA Interim Status Assessment Monitoring					
GW-175	CRSP	02/14/95	05/15/95	08/01/95	11/17/95
GW-177	CRSP	02/13/95	05/11/95	08/01/95	11/16/95
GW-181	CRSP	01/24/95	05/02/95	07/28/95	11/05/95
GW-511	CRSP	01/24/95	05/03/95	07/29/95	11/07/95
GW-608	CRSP	02/02/95	05/11/95	07/31/95	11/16/95
GW-609	CRSP	02/15/95	05/16/95	08/01/95	11/20/95
GW-610	CRSP	01/31/95	05/07/95	07/31/95	11/13/95
GW-611	CRSP	02/14/95	05/15/95	08/01/95	11/17/95
GW-742	CRSP	01/27/95	05/07/95	07/30/95	11/09/95
GW-743	CRSP	01/31/95	05/07/95	07/31/95	11/13/95
RCRA Interim Status Detection Monitoring					
GW-142	KHQ	01/10/95	04/20/95	07/14/95	11/05/95
GW-143	KHQ	01/17/95	04/24/95	07/16/95	11/09/95
GW-144	KHQ	01/18/95	04/25/95	07/16/95	11/14/95
GW-145	KHQ	01/18/95	04/26/95	07/17/95	11/15/95
GW-146	KHQ	01/17/95	04/24/95	07/17/95	11/08/95
GW-147	KHQ	01/15/95	04/21/95	07/14/95	11/06/95
GW-156	CRSDB	01/18/95	04/07/95	07/13/95	PDM
GW-158	CRSDB	01/20/95	04/13/95	07/18/95	.
GW-159 ^a	CRSDB	01/15/95	04/06/95	07/12/95	PDM
GW-231	KHQ	01/15/95	04/21/95	07/15/95	11/06/95
GW-241	CRSDB	01/20/95	04/09/95	07/16/95	.
GW-303	CRSDB	01/19/95	04/09/95	07/16/95	.
GW-304	CRSDB	01/15/95	04/06/95	07/12/95	.
GW-731	CRSDB	01/17/95	04/07/95	07/13/95	PDM
GW-732	CRSDB	01/18/95	04/07/95	07/13/95	PDM
RCRA Post-Closure Detection Monitoring					
GW-156 ^a	CRSDB	.	.	.	10/23/95
		.	.	.	10/24/95
		.	.	.	10/25/95
		.	.	.	10/26/95
GW-159 ^a	CRSDB	.	.	.	10/23/95
		.	.	.	10/24/95
		.	.	.	10/25/95

Table 2 (cont'd)

Sampling Point ¹	Location ²	Date Sampled			
		1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
RCRA Post-Closure Detection Monitoring (cont'd)					
GW-159 ^a	CRSDB	.	.	.	10/26/95
GW-731	CRSDB	.	.	.	10/23/95
		.	.	.	10/24/95
		.	.	.	10/25/95
		.	.	.	10/26/95
GW-732	CRSDB	.	.	.	10/23/95
		.	.	.	10/24/95
		.	.	.	10/25/95
		.	.	.	10/26/95
CERCLA Record of Decision Monitoring					
1090	UNCS	.	04/20/95	.	10/09/95
GW-203	UNCS	.	04/18/95	.	10/07/95
GW-205	UNCS	.	04/18/95	.	10/07/95
GW-221	UNCS	.	04/19/95	.	10/08/95
GW-302	UNCS	.	04/19/95	.	10/08/95
GW-339	UNCS	.	04/19/95	.	10/08/95
SWDF Detection and Background Monitoring					
CBS-1 ^b	CDLVII	.	04/17/95	.	10/11/95
GW-141	LIV	01/09/95	.	07/10/95	.
GW-217	LIV	01/04/95	.	07/10/95	.
GW-305	LIV	01/10/95	.	07/12/95	.
GW-521 ^a	LIV	01/09/95	.	07/11/95	.
GW-522	LIV	01/10/95	.	07/12/95	.
GW-539 ^a	LII	01/04/95	.	07/10/95	10/06/95
GW-540	CDLVI	.	04/04/95	.	10/11/95
GW-541 ^a	CDLVI	.	04/05/95	.	10/12/95
GW-542	CDLVI	.	04/06/95	.	10/16/95
GW-543	CDLVI	.	04/06/95	.	10/17/95
GW-544	CDLVI	.	04/06/95	.	10/17/95
GW-546	CDLVI	.	04/05/95	.	10/11/95
GW-557	LV	.	04/06/95	.	10/07/95
GW-560	CDLVII	.	04/05/95	.	10/06/95
GW-562	CDLVII	.	04/05/95	.	10/06/95
GW-564	CDLVII	.	04/06/95	.	10/07/95
GW-709	LII	01/09/95	.	07/10/95	10/06/95

Table 2 (cont'd)

Sampling Point ¹	Location ²	Date Sampled			
		1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
SWDF Detection and Background Monitoring (cont'd)					
GW-757	LII	01/09/95	.	07/11/95	10/06/95
GW-796 ^a	LV	.	04/12/95	.	10/08/95
GW-797 ^a	LV	.	04/11/95	.	10/08/95
GW-798 ^a	CDLVII	.	04/11/95	.	10/08/95
GW-799	CDLVII	.	04/06/95	.	10/07/95
GW-801	LV	.	04/13/95	.	10/09/95
GW-827	CDLVI	.	04/05/95	.	10/16/95
Best-Management Practice Monitoring					
GW-160	CRBAWP	.	04/26/95	.	11/02/95
GW-161	CRBAWP	.	04/20/95	.	10/31/95
GW-184	RQ	.	05/01/95	.	10/31/95
GW-186	RQ	.	05/03/95	.	11/03/95
GW-187	RQ	.	05/02/95	.	11/02/95
GW-188	RQ	.	05/01/95	.	10/31/95
GW-292	ECRWP	.	04/24/95	.	11/06/95
GW-293	ECRWP	.	04/23/95	.	11/06/95
GW-294	ECRWP	.	04/22/95	.	11/05/95
GW-296	ECRWP	.	04/22/95	.	11/05/95
GW-298	CRBAWP	.	05/02/95	.	11/04/95
GW-299	CRBAWP	.	05/01/95	.	11/03/95
GW-300 ^a	CRBAWP	.	04/27/95	.	11/03/95
GW-301	CRBAWP	.	04/27/95	.	11/03/95
GW-321	ADB	.	04/25/95	.	10/26/95
GW-512	ADB	.	04/26/95	.	10/31/95
GW-513	ADB	.	04/25/95	.	10/31/95
GW-514	ADB	.	04/27/95	.	11/02/95
Special Sampling					
SCR2.2SP ^b	EXP	03/15/95	.	.	.
GW-142	KHQ	03/20/95	.	.	.
GW-144	KHQ	03/22/95	.	.	.
GW-145	KHQ	03/24/95	.	.	.
GW-146	KHQ	03/23/95	.	.	.
GW-321	ADB	01/10/95	.	.	.
GW-732	CRSDB	.	.	08/14/95	.

Table 2 (cont'd)

Notes:

1 Some monitoring locations were sampled to meet requirements of more than one programmatic driver during CY 1995. For example, well GW-156 was sampled for both RCRA interim status and post-closure detection monitoring programs.

2 ADB - Ash Disposal Basin
 CDLVI - Construction/Demolition Landfill VI
 CDLVII - Construction/Demolition Landfill VII
 CRBWAP - Chestnut Ridge Borrow Area Waste Pile
 CRSDB - Chestnut Ridge Sediment Disposal Basin
 CRSP - Chestnut Ridge Security Pits
 ECRWP - East Chestnut Ridge Waste Pile
 KHQ - Kerr Hollow Quarry
 LII - Industrial Landfill II
 LIV - Industrial Landfill IV
 LV - Industrial Landfill V
 RQ - Rogers Quarry
 UNCS - United Nuclear Corporation Site

a Designated upgradient monitoring well.

b Spring

PDM - Monitoring Program changed to Post-closure detection

Table 3. Construction Information¹ for Monitoring Wells Sampled During CY 1995

Well	Location ²	Cluster Designation ³	Aquifer ⁴		Monitored Interval Depths ⁵	
			Interval	Form.		
1090	UNCS	4	WT	OCk	unknown	- 96.7
GW-141	LIV	4	BDR	OCk	141.0	- 156.0
GW-142 ^a	KHQ	4	BDR	OCk	248.5	- 295.0
GW-143 ^a	KHQ	1	BDR	OCk	205.0	- 253.0
GW-144	KHQ	4	BDR	Och/OCk	148.0	- 195.0
GW-145	KHQ	1	WT	OCk	86.0	- 110.0
GW-146 ^a	KHQ	1	BDR	OCk	190.0	- 220.0
GW-147	KHQ	4	BDR	OCk	52.0	- 69.0
GW-156	CRSDB	4	BDR	OCk	146.0	- 157.0
GW-158 ^a	CRSDB	4	BDR	OCk	356.0	- 441.0
GW-159	CRSDB	4	BDR	OCk	146.0	- 157.0
GW-160 ^a	CRBAWP	4	WT	OCk	205.0	- 235.0
GW-161 ^a	CRBAWP	4	BDR	OCk	350.0	- 400.0
GW-175	CRSP	4	BDR	OCk	148.3	- 166.7
GW-177	CRSP	4	BDR	OCk	132.0	- 145.0
GW-181 ^a	CRSP	4	BDR	OCk	155.0	- 168.0
GW-184	RQ	3	BDR	Och	101.5	- 130.0
GW-186	RQ	1	BDR	Och	142.0	- 171.0
GW-187	RQ	1	BDR	Och	139.0	- 162.0
GW-188	RQ	1	BDR	Och	49.0	- 68.0
GW-203	UNCS	4	BDR	OCk	144.0	- 156.0
GW-205	UNCS	4	BDR	OCk	154.0	- 164.0
GW-217	LIV	4	BDR	OCk	165.2	- 180.0
GW-221	UNCS	4	BDR	OCk	147.0	- 158.0
GW-231	KHQ	4	BDR	OCk	22.8	- 35.0
GW-241	CRSDB	4	WT	OCk	78.0	- 103.0
GW-292	ECRWP	4	BDR	OCk	172.1	- 186.0

Table 3 (cont'd)

Well	Location ²	Cluster Designation ³	Aquifer ⁴		Monitored Interval Depths ⁵	
			Interval	Form.		
GW-293 ^a	ECRWP	4	BDR	OCk	197.0	- 214.0
GW-294	ECRWP	4	BDR	OCk	113.0	- 128.0
GW-296	ECRWP	4	BDR	OCk	134.4	- 147.0
GW-298	CRBAWP	4	BDR	OCk	171.1	- 190.0
GW-299	CRBAWP	4	BDR	OCk	153.0	- 168.0
GW-300	CRBAWP	4	BDR	OCk	132.0	- 147.0
GW-301	CRBAWP	4	BDR	OCk	148.5	- 163.5
GW-302	UNCS	4	BDR	OCk	121.5	- 134.8
GW-303 ^a	CRSDB	1	BDR	OCk	300.0	- 321.0
GW-304	CRSDB	3	BDR	OCk	148.5	- 167.0
GW-305	LIV	4	BDR	OCk	165.3	- 179.6
GW-321	ADB	4	BDR	OCk	84.0	- 98.6
GW-339	UNCS	4	BDR	OCk	101.0	- 114.0
GW-511	CRSP	4	BDR	OCk	140.0	- 153.7
GW-512	ADB	4	WT	OCk	48.0	- 61.0
GW-513	ADB	4	BDR	OCk	111.0	- 125.3
GW-514 ^a	ADB	4	BDR	OCk	174.0	- 195.0
GW-521	LIV	4	BDR	OCk	123.2	- 136.0
GW-522	LIV	4	BDR	OCk	183.0	- 195.3
GW-539	LII	4	BDR	OCk	136.4	- 156.0
GW-540	CDLVI	4	BDR	OCk	158.5	- 171.5
GW-541	CDLVI	4	BDR	OCk	86.7	- 104.5
GW-542	CDLVI	4	WT	OCk	59.0	- 76.5
GW-543	CDLVI	4	BDR	OCk	76.2	- 93.6
GW-544	CDLVI	4	BDR	OCk	91.0	- 109.3
GW-546	CDLVI	4	WT	OCk	66.2	- 84.4
GW-557	LV	4	WT	OCk	112.9	- 138.0

Table 3 (cont'd)

Well	Location ²	Cluster Designation ³	Aquifer ⁴		Monitored Interval Depths ⁵		
			Interval	Form.			
GW-560	CDLVII	4	WT	OCk	45.2	-	69.0
GW-562	CDLVII	4	WT	OCk	36.0	-	60.0
GW-564	CDLVII	4	WT	OCk	52.0	-	81.0
GW-608 ^a	CRSP	4	BDR	OCk	148.0	-	220.0
GW-609	CRSP	4	BDR	OCk	256.4	-	269.0
GW-610	CRSP	4	BDR	OCk	105.1	-	117.4
GW-611	CRSP	4	BDR	OCk	101.5	-	121.6
GW-709	LII	4	BDR	OCk	68.7	-	80.6
GW-731	CRSDB	4	BDR	OCk	164.0	-	178.7
GW-732	CRSDB	4	BDR	OCk	178.3	-	190.0
GW-742 ^a	CRSP	4	BDR	OCk	350.0	-	420.0
GW-743	CRSP	4	BDR	OCk	150.1	-	161.1
GW-757	LII	3	BDR	OCk	134.0	-	166.7
GW-796	LV	4	BDR	OCk	122.9	-	136.5
GW-797	LV	4	BDR	OCk	118.0	-	134.1
GW-798	CDLVII	4	BDR	OCk	122.0	-	135.4
GW-799	CDLVII	4	BDR	OCk	78.7	-	92.0
GW-801	LV	4	BDR	OCk	175.8	-	188.9
GW-827	CDLVI	4	BDR	OCk	122.1	-	134.8

Table 3 (cont'd)

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).

- 2

ADB CDLVI CDLVII CRBAWP CRSDB CRSP ECRWP KHQ LII LIV LV RQ UNCS	- - - - - - - - - - - - -	Ash Disposal Basin Construction/Demolition Landfill VI Construction/Demolition Landfill VII Chestnut Ridge Borrow Area Waste Pile Chestnut Ridge Sediment Disposal Basin Chestnut Ridge Security Pits East Chestnut Ridge Waste Pile Kerr Hollow Quarry Industrial Landfill II Industrial Landfill IV Industrial Landfill V Rogers Quarry United Nuclear Corporation Site
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- 3 Cluster designation for trace metal data evaluation purposes (see Table 8).
Springs CBS-1 and SCR2.2SP were assigned to clusters 4 and 1, respectively.

- 4

Interval:	
WT	- Water Table Interval
BDR	- Bedrock Interval
Form.:	
Och	- Chickamauga Group (ORR Aquitard)
OCK	- Knox Group (Knox Aquifer)

- 5 Depth in feet from the ground surface.

- a Open borehole well construction.

Table 4. VOCs Detected in CY 1995 QA/QC Samples

Compound	Number of QA/QC Samples Containing Specified Compound (by Sample Type)				
	Laboratory Blanks	Trip Blanks	Field Blanks	Equipment Rinsates	Total
Laboratory Reagents					
Acetone	7	13	.	5	25
2-Butanone	9	12	.	2	23
Methylene Chloride	2	7	.	4	13
Toluene	2	5	.	2	9
VOC Plume Constituents					
1,1,1-Trichloroethane	.	86	3	13	102
Chloroform	.	.	.	1	1
Miscellaneous Compounds					
Ethylbenzene	1	2	.	2	5
Xylenes	1	2	.	2	5
2-Hexanone	.	1	.	.	1
Data Summary					
Total Samples ¹ :	70	122	4	33	229
Samples with VOCs ² :	15	90	3	16	124
Percent of Total Samples with VOCs:	21%	74%	75%	48%	54%

Notes:

- 1 Only samples analyzed for the target compound list of organic compounds were reviewed.
- 2 Some contaminated samples contain more than one compound.

**Table 5. CY 1995 Median Trace Metal Concentrations
that Exceed UTLs or MCLs**

Metal¹	Sampling Point	Location²	Cluster³	UTL/ MCL (mg/L)	CY 1995 Median⁴ (mg/L)	Number of Results⁵
Aluminum						
	GW-160	CRBAWP	4	2.4	44.5	2
	GW-546	CDLVI	4	2.4	3.65	2
Beryllium						
	GW-160	CRBAWP	NA	0.004	0.0142	2
Boron						
	1090	UNCS	4	0.028	0.059	2
	GW-142	KHQ	4	0.028	0.048	4
	GW-143	KHQ	1	0.12	0.905	4
	GW-144	KHQ	4	0.028	0.030	4
	GW-145	KHQ	1	0.12	0.280	5
	GW-146	KHQ	1	0.12	0.485	4
	GW-147	KHQ	4	0.028	0.045	4
	GW-186	RQ	1	0.12	0.140	2
	GW-187	RQ	1	0.12	0.555	2
	GW-188	RQ	1	0.12	0.130	2
	GW-217	LIV	4	0.028	0.180	2
	GW-296	ECRWP	4	0.028	0.039	2
	GW-302	UNCS	4	0.028	0.030	2
	GW-321	ADB	4	0.028	0.062	3
	GW-522	LIV	4	0.028	0.047	2
	GW-797	LV	4	0.028	0.030	2
Chromium (AAS)						
	GW-302	UNCS	NA	0.1	0.285	2
Copper						
	GW-160	CRBAWP	4	0.012	0.148	2
Iron						
	GW-160	CRBAWP	4	4.6	117.5	2
Manganese						
	GW-160	CRBAWP	4	0.13	2.435	2
	GW-546	CDLVI	4	0.13	0.175	2
Molybdenum						
	GW-541	CDLVI	4	0.018	0.028	2

Table 5 (cont'd)

Metal ¹	Sampling Point	Location ²	Cluster ³	UTL/ MCL (mg/L)	CY 1995 Median ⁴ (mg/L)	Number of Results ⁵
Nickel						
	GW-302	UNCS	NA	0.1	0.265	2
	GW-539	LII	NA	0.1	0.15	3
Selenium						
	GW-827	CDLVI	NA	0.05	0.058	2
Strontium						
	CBS-1	CDLVII	4	0.079	0.084	2
	GW-142	KHQ	4	0.079	0.515	4
	GW-144	KHQ	4	0.079	0.089	4
	GW-145	KHQ	1	4.4	7.700	4
	GW-146	KHQ	1	4.4	7.100	4
	GW-147	KHQ	4	0.079	0.680	4
	GW-732	CRSDB	4	0.079	0.240	4
Uranium (PMS)						
	GW-142	KHQ	4	0.005	0.00975	4
Vanadium						
	GW-160	CRBAWP	4	0.005	0.268	2
	GW-546	CDLVI	4	0.005	0.0091	2
Zinc						
	GW-160	CRBAWP	4	0.041	0.85	2
	GW-177	CRSP	4	0.041	0.062	2

Notes:

- 1 Results obtained by ICP spectroscopy unless otherwise noted.
 AAS - Atomic Absorption Spectrometry
 PMS - Plasma Mass Spectrometry
- 2
 CRSDB - Chestnut Ridge Sediment Disposal Basin
 CDLVI - Construction/Demolition Landfill VI
 CDLVII - Construction/Demolition Landfill VII
 CRBAWP - Chestnut Ridge Borrow Area Waste Pile
 CRSP - Chestnut Ridge Security Pits

Notes (cont'd):

Table 5 (cont'd)

ECRWP	-	East Chestnut Ridge Waste Pile
KHQ	-	Kerr Hollow Quarry
LIV	-	Industrial Landfill IV
RQ	-	Rogers Quarry
UNCS	-	United Nuclear Corporation Site

- 3 Cluster designation for trace metal data evaluation purposes (see Appendix C).
N/A - Not applicable for metal concentrations compared to MCLs.
- 4 Concentrations in milligrams per liter.
- 5 The number of results used to determine median values.

**Table 6. Annual Average VOC Concentrations
in CY 1995 Groundwater Samples**

Sampling Point Location ¹	MCL ²	VOC Concentrations ³ (µg/L)				
		GW-142 KHQ	GW-144 KHQ	GW-145 KHQ	GW-175 CRSP	GW-177 CRSP
Qualitative Results ⁴						
Carbon tetrachloride	5	0	2.0	0	0	0.5
Chloroform	-	0	0.3	0	0	0
1,1-Dichloroethane	-	0	0	0	0	0
1,1-Dichloroethene	7	0	0	0	0.3	2.3
Tetrachloroethene	5	0.3	0.3	0.5	0	0
1,1,1-Trichloroethane	200	0	0	0	1.0	0
Trichloroethene	5	0	0	0	0.3	0
Summed Average		1	3	1	2	3
Quantitative Results ⁵						
1,1-Dichloroethane	-	0	0	0	0	12.3
1,2-Dichloroethene	-	0	0	0	0	0
Tetrachloroethene	5	0	0	0	17.5	0
1,1,1-Trichloroethane	200	0	0	0	0	9.3
Summed Average		0	0	0	18	22
Plume Delineation Value ⁶		1	3	1	20	25

Table 6. (cont'd.)

Sampling Point Location ¹	MCL ²	VOC Concentrations ³ (µg/L)			
		GW-305 LIV	GW-608 CRSP	GW-609 CRSP	GW-611 CRSP
Qualitative Results ⁴					
Carbon tetrachloride	5	0	0	0	0.3
Chloroform	-	0	0	0	0
1,1-Dichloroethane	-	0	0	0	1.0
1,1-Dichloroethene	7	0	0	0	1.3
Tetrachloroethene	5	0	1.5	0	0
1,1,1-Trichloroethane	200	3.0	0	0	0
Trichloroethene	5	0	0	1.3	0
Summed Average		3	2	1	3
Quantitative Results ⁵					
1,1-Dichloroethane	-	0	0	0	0
1,2-Dichloroethene	-	0	0	12.0	0
Tetrachloroethene	5	0	0	15.3	0
1,1,1-Trichloroethane	200	0	0	0	3.0
Summed Average		0	0	27	3
Plume Delineation Value ⁶		3	2	28	6

Notes:

- 1 CRSP - Chestnut Ridge Security Pits
KHQ - Kerr Hollow Quarry
LIV - Industrial Landfill IV
- 2 MCL - Maximum Contaminant Level
- 3 All results in Micrograms per Liter (µg/L)
0 - False Positive, anomalous, or not detected
- 4 Average concentration determined solely from estimated concentrations reported below the analytical detection limit.
- 5 Average concentration determined from concentrations reported above the analytical detection limit.
- 6 Value used for plume delineation purposes. Sampling points not shown on the table have a value of "not detected".

Table 7. CY 1995 Gross Alpha and Gross Beta Activities that Exceed MDAs

Sampling Point	Location ¹	Date Sampled	Activity ² (pCi/L)					
			Gross Alpha (MDA = 4.7)			Gross Beta (MDA = 11)		
GW-142	KHQ	01/10/95	6.08	±	2.5	.		
		04/20/95	6.34	±	2.4	.		
		07/14/95	6.62	±	1.9	.		
GW-143	KHQ	01/17/95	.			18.2	±	3.7
		04/24/95	.			15.7	±	3.5
		07/16/95	.			13.7	±	2.6
		11/09/95	.			14.2	±	3.5
GW-145	KHQ	01/18/95	14.1	±	3.5	16.7	±	3.6
		04/26/95	9.93	±	3	14.7	±	3.5
		07/17/95	9.71	±	2.3	16.3	±	2.8
		11/15/95	13	±	3.2	21.1	±	3.8
GW-146	KHQ	01/17/95	.			14	±	3.3
		04/24/95	.			16.1	±	3.6
		07/17/95	.			15.9	±	2.8
		11/08/95	.			16.8	±	3.8
GW-159	CRSDB	04/06/95	5.71	±	2.5	.		
		10/26/95	.			13.1	±	3.6
GW-160	CRBAWP	04/26/95	6.73	±	4.8	12.9	±	6.6
		11/02/95	39.4	±	7.4	34.2	±	5.4
GW-177	CRSP	05/11/95	4.72	±	2.4	.		
GW-511	CRSP	05/03/95	6.81	±	2.6	.		
GW-544	CDLVI	10/17/95	6.22	±	4	.		
GW-546	CDLVI	04/05/95	4.96	±	3.2	11.1	±	3.6
GW-562	CDLVII	10/06/95	50.1	±	0.89	.		
GW-731	CRSDB	01/17/95	.			19.8	±	3.9
		07/13/95	.			14.6	±	2.8
		10/24/95	.			11.4	±	3.3
		10/25/95	.			12.5	±	3.3
GW-732	CRSDB	01/18/95	34.1	±	6	27.4	±	4.6
		04/07/95	91	±	28	59.8	±	31
		07/13/95	6.48	±	1.8	11.7	±	2.6

Table 7 (cont'd)

Sampling Point	Location ¹	Date Sampled	Activity ² (pCi/L)		
			Gross Alpha (MDA = 4.7)		Gross Beta (MDA = 11)
GW-732 (cont'd)	CRSDB	10/26/95	.		17.5 ± 3.9
		10/24/95	.		28.4 ± 4.8
		10/25/95	.		25.1 ± 4.4
GW-742	CRSP	01/27/95	6.42	± 2.8	.
		05/07/95	6.34	± 2.6	.
		11/09/95	5.01	± 2.4	.
GW-743	CRSP	11/13/95	.		13.4 ± 3.6
GW-757	LII	07/11/95	6.39	± 2.2	.

Notes:

- 1
 - CDLVI - Construction/Demolition Landfill VI
 - CDLVII - Construction/Demolition Landfill VII
 - CRBAWP - Chestnut Ridge Borrow Area Waste Pile
 - CRSDB - Chestnut Ridge Sediment Disposal Basin
 - CRSP - Chestnut Ridge Security Pits
 - KHQ - Kerr Hollow Quarry
 - LII - Industrial Landfill II
- 2 Activity reported in picoCuries per liter (pCi/L).
 - .
 - results below the MDA (Minimum Detectable Activity)

Table 8. CY 1995 Radioisotope Activities That Exceed MDAs

Isotope ¹	MDA ²	Sampling Point	Location ³	Date Sampled	Activity (pCi/L)		
Cesium-137	3.9	GW-203	UNCS	04/18/95	5.3	±	5
		GW-542	CDLVI	10/16/95	16.5	±	10
Protactinium	700	GW-540	CDLVI	04/04/95	1,200	±	910
		GW-541	CDLVI	10/12/95	1,490	±	1,300
		GW-542	CDLVI	10/16/95	1,560	±	1,400
		GW-544	CDLVI	10/17/95	2,280	±	1,500
		GW-557	LV	10/07/95	1,090	±	1,000
		GW-797	LV	04/11/95	1,100	±	840
Radium	1.5	GW-221	UNCS	10/08/95	2.67	±	1.67
		GW-339	UNCS	10/08/95	1.92	±	1.22
Strontium	33	GW-143	KHQ	07/16/95	39.8	±	14
Uranium-235	14	GW-144	KHQ	03/22/95	96.6	±	91

Notes:

- 1 Protactinium and uranium-235 were "tentatively identified isotopes", as indicated by an "I" qualifier associated with these results (see GWQR Part 1, Appendix E).
Radium activity was converted from bequerels to picoCuries.
- 2 Minimum Detectable Activity in picoCuries per liter
- 3

CDLVI	-	Construction/Demolition Landfill VI
LV	-	Industrial Landfill V
KHQ	-	Kerr Hollow Quarry
UNCS	-	United Nuclear Corporation Site

APPENDIX C

DATA SCREENING AND EVALUATION CRITERIA

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List of Acronyms and Abbreviations

AAS	Atomic Absorption Spectroscopy
BQR	blank qualification result
CY	calendar year
DQOs	data quality objectives
GWPP	Groundwater Protection Program
GWQR	Groundwater Quality Report
ICP	Inductively Coupled Plasma (spectroscopy)
MCL	maximum contaminant level
MDA	minimum detectable activity
$\mu\text{g/L}$	micrograms per liter
mg/L	milligrams per liter
mrem/yr	millirem per year
pCi/L	picoCuries per liter
RPD	relative percent difference
TDS	total dissolved solids
UTL	upper tolerance limit
VOC	volatile organic compound
1,1,1-TCA	1,1,1-trichloroethane

C.1 INTRODUCTION

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

C.2 DATA SCREENING

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

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

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

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

C.2.1 Less-than-Reporting-Limit Results

Less-than-reporting-limit results (i.e., censored data) for principal ions and volatile organic compounds (VOCs) were replaced with zero for the purposes of calculating ion charge balance errors (Section C.2.4), identifying false positive results for VOCs (Section C.2.6), and determining representative concentrations for each sampling point (Section C.3.1). To identify order-of-magnitude differences between results for original/duplicate samples (Section C.2.2) and filtered/unfiltered samples (Section C.2.3), censored data were replaced with zero (VOCs), or analytical reporting limits (principal ions and trace metals). Similarly, the median concentration of each trace metal (Section C.3.1) was calculated using half the analytical reporting limit as the surrogate value for censored data.

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

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

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

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

C.2.2 Original/Duplicate Sample Results

As noted in Section 4.3 of the report, duplicate groundwater samples were collected from 26 monitoring wells. Data for the original/duplicate samples from each well were compared to identify order-of-magnitude differences between corresponding analytical results. Such differences occurred between original/duplicate results, in milligrams per liter (mg/L), for the samples listed in the following summary.

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

Well Number	Date Sampled	Analyte	Original Sample (mg/L)	Duplicate Sample (mg/L)
GW-159	04/06/95	Iron	0.005	0.17
GW-221	10/08/95	Zinc	0.0057	0.13
GW-522	07/12/95	Alkalinity (carbonate)	<1	12
GW-732	10/25/95	Total Suspended Solids	32	701

These results were replaced with missing values.

C.2.3 Filtered/Unfiltered Sample Results

Filtered and unfiltered groundwater and surface water samples were analyzed for the principal cations (calcium, magnesium, potassium, and sodium) and trace metals. If the dissolved (filtered) cation or trace metal concentration exceeded the corresponding total (unfiltered) concentration by an order-of-magnitude or more, both results were replaced with missing values. As shown below in Table C-4, such differences occurred between the filtered/unfiltered results reported for three monitoring wells.

Table C-4. Screened Results for Filtered/Unfiltered Groundwater Samples.

Sampling Location	Date Sampled	Analyte	Unfiltered Sample (mg/L)	Filtered Sample (mg/L)
GW-145	07/17/95	Uranium	<0.0005	0.012
GW-146	11/08/95	Zinc	0.01	0.41
GW-175	11/17/95	Copper	<0.004	0.045
GW-175	11/17/95	Zinc	0.008	0.092
GW-205	10/07/95	Aluminum	<0.004	0.074
GW-731	10/26/95	Zinc	0.014	0.22

C.2.4 Ion Charge Balance

The calculated ion charge balance was used to screen the principal ion data. Charge balances were estimated by computing the relative percent difference (RPD) between summed milliequivalent concentrations (i.e., molecular weight of the ion divided by the net ionic charge) of the dissolved cations (which exclude digested cations), and the total anions, respectively. If the summed milliequivalent concentrations of the cations and anions differed by 10% or more, all the principal ion data were replaced with missing values. As summarized below in Table C-5, ion charge balance RPDs greater than 10% were calculated from the principal ion data for four groundwater samples collected from two monitoring wells; principal ion results for these samples were replaced with missing values.

Table C-5. Groundwater Samples with Unacceptable Charge Balance Errors.

Well Number	Date Sampled	Charge Balance RPD
GW-205	04/18/95	-11%
GW-732	10/24/95	-57%
GW-732	10/25/95	-39%
GW-732	10/26/95	-13%

An unusually high nitrate (as N) concentration (6.3 mg/L) caused the slight charge balance error for the sample from well GW-205; all other samples collected from the well since CY 1990 had acceptable charge balance errors and nitrate (as N) concentrations below 0.5 mg/L. Charge balance errors for the samples from well GW-732 reflect probable localized grout contamination. As summarized in the following table, the pH of the groundwater samples collected after the well was initially purged and sampled on October 23, 1995 increased substantially, which totally reversed the bicarbonate/carbonate chemistry typical of the previous samples from the well, and was accompanied by substantially increased potassium concentrations.

Date Sampled	Bicarbonate Alkalinity (mg/L)	Carbonate Alkalinity (mg/L)	pH	Potassium (mg/L)
01/18/95	162	1	8.1	8
04/07/95	157	<1	8.3	8.2
07/13/95	29	76	10	11
08/14/95	156	<1	8.2	0.9
10/23/95	149	<1	8.1	1.7
10/24/95	<1	146	11.5	32
10/25/95	<1	148	11.2	23
10/26/95	<1	120	10.2	18

The chemical composition of these samples is characteristic of grout contamination. These samples were not considered representative, and all the inorganic analytical results (including trace metal data) were considered unusable and replaced with missing values.

C.2.5 Analytical Methods

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

C.2.6 False Positive Results

Laboratory blank and trip blank data associated with each groundwater and surface water sample were used to identify false positive VOC results (i.e., sampling and/or analytical artifacts). False positive VOC results were defined as concentrations reported for the groundwater or surface water samples that were less than the blank qualification result (BQR) for each compound. For each VOC detected in a groundwater or surface water sample, the highest concentration in either associated blank sample multiplied by a factor of five or ten served as the BQR. A factor of five was

used for all VOCs except acetone, methylene chloride, toluene, and 2-butanone; BQRs for these common laboratory reagents were calculated using a factor of ten (U.S. Environmental Protection Agency 1988). Zero served as the surrogate value for false positive VOC results.

As summarized below on Table C.6, false positive results were identified for eight of the 17 VOCs detected in the groundwater samples collected during CY 1995; results for these groundwater samples are presented in Appendix M of the Part 1 Groundwater Quality Report.

Table C-6. Summary of False Positive Results for VOCs.

Compound	Number of False Positive Results:	
	Identified from Laboratory BQRs	Identified from Trip BQRs
Laboratory Reagents		
2-butanone	10	2
Methylene chloride	6	2
Acetone	2	5
Toluene	2	2
Plume Constituents		
1,1,1-trichloroethane	0	14
Miscellaneous Compounds		
Ethylbenzene	1	4
Xylenes	0	5
Ethanol	16	4
Total False Positive Results	37	38

These compounds included four common laboratory reagents, one of the VOCs known to be present in groundwater in the regime (plume constituents), and three compounds that are neither common laboratory reagents nor plume constituents (miscellaneous compounds). False positive results for each compound except 1,1,1-trichloroethane (1,1,1-TCA) were identified in groundwater samples collected during each of the past four years. The false positive results for these compounds also are historically consistent in that most (75%) were estimated concentrations that were less than the 10 micrograms per liter ($\mu\text{g/L}$) analytical reporting limit for each compound (the maximum false positive result was 15 $\mu\text{g/L}$ for acetone).

The false positive results for 1,1,1-TCA are in distinct contrast with historical data. They were identified in the data for seven wells (GW-175, GW-177, GW-305, GW-608, GW-609, GW-611, and GW-796) with a history of yielding groundwater samples with relatively low ($< 25 \mu\text{g/L}$)

1,1,1-TCA concentrations, none of which were identified in previous GWQRs as false positive results. The CY 1995 results for this compound were identified as false positives as a direct consequence of the 1,1,1-TCA contamination of the trip blank samples associated with the groundwater samples from each of these wells. As discussed in report text Section 4.5, this compound was detected in 74% of the trip blanks analyzed during CY 1995, which is strongly suspected to reflect 1,1,1-TCA contamination at the source of the deionized water used to prepare the trip blanks, and not cross contamination during sample collection, transportation, and laboratory analysis.

C.2.7 Counting Errors

The degree of analytical uncertainty associated with each gross alpha, gross beta, and radionuclide result is expressed by the corresponding counting error (defined as twice the sample standard deviation). Groundwater samples with gross alpha, gross beta, and/or radionuclide activities that exceeded the respective MDAs, but were less than the associated counting errors, are listed below; these results were replaced with missing values.

Table C-7. Screened Results for Radioanalytes.

Radioanalyte	Well Number	Date Sampled	Activity $\pm$ Counting Error (pCi/L)
Gross Alpha	GW-709	10/06/95	5.75 $\pm$ 16
	GW-757	10/06/95	7.17 $\pm$ 16
Gross Beta	CBS-1	10/11/95	11 $\pm$ 33
	GW-709	10/06/95	11.3 $\pm$ 28
Cesium 137	CBS-1	04/17/95	4.61 $\pm$ 15
	GW-542	04/06/95	6.01 $\pm$ 15
	GW-560	04/05/95	7.82 $\pm$ 15
	GW-564	04/06/95	13.6 $\pm$ 14
	GW-796	04/12/95	6.81 $\pm$ 15
	GW-798	04/11/95	9.22 $\pm$ 15
Protactinium	CBS-1	04/17/95	1670 $\pm$ 2200
	GW-539	10/06/95	750 $\pm$ 1100
	GW-543	04/06/95	814 $\pm$ 940
	GW-543	10/17/95	1250 $\pm$ 1600
	GW-546	10/11/95	777 $\pm$ 1500
	GW-796	10/08/95	938 $\pm$ 1100
	GW-801	10/09/95	950 $\pm$ 1000
	GW-827	10/16/95	911 $\pm$ 1300
Uranium 235	GW-521	01/9/95	18.2 $\pm$ 91

C.3 DATA EVALUATION

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

C.3.1 Representative Concentration/Activity Values

Representative concentration/activity values for each sampling point were: (1) results for individual samples, or (2) calculated from as many as four results depending on the number of samples collected and the outcome of the data screening process. Results for individual samples were the assumed representative values for the springs SCR2.2SP, which was sampled only once during CY 1995. Singular results also were the assumed representative values if data screening replaced all other results for the analyte with missing values. Also, field data (e.g., depth-to-water) and other selected parameters (e.g., turbidity) were evaluated individually regardless of the number of available results.

For sampling locations with multiple CY 1995 results, representative concentration/activity values for inorganics (principal ions and trace metals), VOCs, and radioanalytes (gross alpha, gross beta, and radionuclides) were calculated as specified below, using the designated surrogate values for censored and screened data.

Table C-8. Methods used to Calculate Representative Concentration/Activity Values.

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

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

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

where $E_1, E_2, \dots$ are the individual errors reported for each sample, and n is the number of samples (Evans 1955). Where applicable, dose equivalents were calculated using representative values for radionuclides, and corresponding dose factors issued by the U.S. Environmental Protection Agency (Federal Register, Vol. 56 No. 138, July 18, 1991). Individual dose equivalents for the radionuclides were summed to determine the cumulative dose for each applicable monitoring well, spring/seep, and surface water sampling point.

C.3.2 Water Quality Standards

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

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

Table C-9. Summary of UTL Well Cluster Characteristics.

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

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

Table C-10. UTLs used as Water Quality Standards.

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

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

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

Table C-11. MCLs used as Water Quality Standards.

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

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

C.3.3 Data Corroboration

Representative VOC and trace metal concentrations that exceeded water quality standards were corroborated through review of historical data for each applicable sampling point. Historical corroboration focused on VOC results and elevated trace metal concentrations because of the characteristic variability of the data for these analytes. Principal ion data are typically less variable (and the ion charge balance criteria effectively screens spurious data) and problems with DQOs render the bulk of the historical radioanalyte data unsuitable for corroboration purposes.

Frequency-based criteria were used to identify anomalous VOC and trace metal results in the CY 1995 data: the detection frequency for VOCs (determined from the screened data for samples collected since CY 1991), and the frequency of elevated total metal concentrations (determined from

screened data for samples collected since CY 1990). Anomalous results were defined as VOC or elevated total metal concentrations detected in 25% or less of the samples from each monitoring well, spring, or surface water sampling point. Depending on the location of the sampling point relative to known or suspected sources of contamination in the Chestnut Ridge Regime, anomalous results were either replaced with zero (VOCs) or missing values (trace metals), or accepted as qualitative data.

As shown in the following summary, the CY 1995 data included a total of 14 anomalous results reported for two laboratory reagents and five compounds that are known components (e.g., carbon tetrachloride), or are associated degradation products (e.g., chloroform), of dissolved VOC plumes in groundwater in the Chestnut Ridge Regime.

Table C-12. Anomalous Results for VOCs.

Compound	Sampling Point	Date Sampled	Anomalous Result (µg/L)
Laboratory Reagents			
Acetone	GW-175	02/14/95	10
2-butanone	GW-231	11/06/95	10
Acetone	GW-511	05/03/95	2
Acetone	GW-743	11/13/95	8
2-butanone	GW-757	10/06/95	9
Acetone	GW-797	04/11/95	21
Plume Constituents			
Tetrachloroethene (PCE)	GW-142	11/05/95	1
Chloroform	GW-144	04/25/95	1
PCE	GW-144	01/18/95	1
PCE	GW-145	07/17/95	2
Trichloroethene (TCE)	GW-175	02/14/95	1
1,1-dichloroethene	GW-175	02/14/95	1
Carbon tetrachloride	GW-177	11/16/95	2
Carbon tetrachloride	GW-611	11/17/95	1

Anomalous results for acetone and 2-butanone were replaced with zero as a surrogate value; results for both common laboratory blank contaminants were considered probable analytical artifacts.

Anomalous results for the known plume constituents were considered qualitative. These results were reported for samples collected from: (1) wells at the Chestnut Ridge Security Pits (GW-175, GW-177, and GW-611) known to monitor groundwater contaminated with several VOCs including carbon tetrachloride, TCE, and 1,1-dichloroethene, and (2) wells located at Kerr Hollow

Quarry (GW-142, GW-144, and GW-145) with a history of sporadically yielding groundwater samples containing low concentrations of carbon tetrachloride, chloroform (a degradation product of carbon tetrachloride), or PCE. Results for these wells were not replaced with surrogate values because of the possibility that the apparently sporadic detection of VOCs in samples from these wells is a sampling artifact; the compounds may be present at low concentrations in the groundwater, but are occasionally volatilized during sample collection.

Sporadically elevated concentrations (i.e., anomalous results) are characteristic of the trace metal data for most wells at the Y-12 Plant, and few of these erratically fluctuating results display any clear spacial patterns or temporal relationships (although required monitoring protocols and sampling procedures may not generate data needed to recognize and characterize such relationships). Data obtained during CY 1995 reflects similar variability, and as summarized below in Table C-13, a total of 18 anomalous results for nine trace metals reported for 12 samples collected from 11 monitoring wells.

Table C-13. Anomalous Trace Metal Results

Well No. Date Sampled	GW-160 11/02/95	GW-221 04/18/95	GW-241 01/20/95	GW-293 04/16/95	GW-339 04/23/95	GW-339 10/08/95
Antimony	.	.	.	.	.	.
Arsenic	0.027	.	.	.	.	.
Boron	.	0.053	0.032	0.045	0.041	.
Cobalt	0.054	.	.	.	.	.
Chromium	0.31	.	.	.	.	.
Lead	0.55	.	.	.	.	.
Molybdenum	0.048	.	.	.	.	.
Nickel	0.25	.	.	.	.	0.43
Selenium	.	.	.	.	.	.

Table C-13. (cont'd.)

Well No. Date Sampled	GW-512 10/31/95	GW-557 10/06/95	GW-560 10/06/95	GW-796 10/07/95	GW-798 10/08/95	GW-799 10/08/95
Antimony	.	.	.	.	0.11	.
Arsenic	.	.	.	0.079	0.084	.
Boron	0.093	.	.	.	.	0.075
Cobalt	.	.	.	.	.	.
Chromium	.	.	.	.	.	.
Lead	.	.	.	.	.	.
Molybdenum	.	.	.	.	.	.
Nickel	.	.	.	.	.	.
Selenium	.	0.12	0.08	.	.	.

Elevated metal concentrations reported for these samples are not corroborated by the historical data for these wells. Accordingly, representative concentration values (i.e., median concentrations) for each of these trace metals were recalculated using a missing value as the surrogate for the anomalous results.

C.4 REFERENCES

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