Y-12

OAK RIDGE Y-12 PLANT

LOCKHEED MARTIN

EVALUATION OF CALENDAR YEAR 1996 GROUNDWATER AND SURFACE WATER QUALITY DATA FOR THE BEAR CREEK HYDROGEOLOGIC REGIME AT THE U.S. DEPARTMENT OF ENERGY Y-12 PLANT, OAK RIDGE, TENNESSEE

August 1997

Prepared by

AJA TECHNICAL SERVICES, INC.
Under Subcontract No. 70Y-KDS15V

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Water Compliance Department
Environmental Compliance Organization
Oak Ridge Y-12 Plant
Oak Ridge, Tennessee 37831

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List of Acronyms and Abbreviations

AGLLSF	Above Grade Low-Level Storage Facility
ASO	Analytical Services Organization
BCV	Bear Creek Valley
BCK	Bear Creek Kilometer
Bear Creek Regime	Bear Creek Hydrogeologic Regime
BG	Burial Grounds
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CY	Calendar Year
DNAPL	Dense, Non-Aqueous Phase Liquids
DOE	U.S. Department of Energy
DQO	Data Quality Objective
East Fork Regime	Upper East Fork Poplar Creek Hydrogeologic Regime
ft	feet
GWPP	Groundwater Protection Program
GWPS	Groundwater Protection Standard Constituent
HCDA	Hazardous Chemical Disposal Area
HWDU	Hazardous Waste Disposal Unit
ICP	Inductively Coupled Plasma Spectroscopy
ETTP	East Tennessee Technology Park
MCL	Maximum Contaminant Level
MDA	Minimum Detectable Activity
msl	mean sea level
µg/L	micrograms per liter
mg/L	milligrams per liter
NT	North Tributary (Bear Creek)
PCE	Tetrachloroethene
pCi/L	picoCuries per liter
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RPD	relative percent difference
SDWA	Safe Drinking Water Act
SS	South Side (Bear Creek)
SWMU	Solid Waste Management Unit
TCE	Trichloroethene
TDS	Total Dissolved Solids
TSD	treatment, storage, and disposal (unit)
TSS	Total Suspended Solids
UTL	upper tolerance limit
VOC	volatile organic compound

List of Acronyms and Abbreviations (cont'd)

WMA	Waste Management Area
1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethene
1,2-DCA	1,2-dichloroethane
1,2-DCE	1,2-dichloroethene
1,1,1-TCA	1,1,1-trichloroethane
⁹⁹ Tc	Technetium-99
²³⁴ U	Uranium-234
²³⁵ U	Uranium-235
²³⁸ U	Uranium-238

1.0 INTRODUCTION

This report presents an evaluation of the groundwater and surface water quality monitoring data obtained in the Bear Creek Hydrogeologic Regime (Bear Creek Regime) during calendar year (CY) 1996. The monitoring data were collected for the multiple programmatic purposes of the Y-12 Plant Groundwater Protection Program (GWPP) and have been reported in *Calendar Year 1996 Annual Groundwater Monitoring Report for the Bear Creek Hydrogeologic Regime at the Department of Energy Y-12 Plant, Oak Ridge, Tennessee* (Annual Monitoring Report; AJA Technical Services, Inc. 1997a). The Annual Monitoring Report presents only the results of the monitoring data evaluations required for waste management sites addressed under the Resource Conservation and Recovery Act (RCRA) post-closure permit for the Bear Creek Regime. The Annual Monitoring Report also serves as a consolidated reference for the groundwater and surface water monitoring data obtained throughout the Bear Creek Regime under the auspices of the Y-12 GWPP. This report provides an evaluation of the CY 1996 monitoring data with an emphasis on regime-wide groundwater and surface water quality and long-term concentration trends of regulated and non-regulated monitoring parameters.

2.0 BACKGROUND INFORMATION

The following sections contain background information regarding the waste management sites in the Bear Creek Regime and their current regulatory status, the hydrogeologic framework, the groundwater flow patterns, and the extent of groundwater and surface water contamination.

2.1 Waste Management Sites

The Bear Creek Regime encompasses a portion of Bear Creek Valley (BCV) used since the early 1950s for the treatment, storage, and disposal (TSD) of various hazardous and nonhazardous wastes associated with operation of the Y-12 Plant (Figure 1). With the exception of the Above Grade Low-Level Storage Facility (AGLLSF), all of these TSD facilities are closed and currently regulated under RCRA, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), or both (Table 1); the AGLLSF is an operating facility that is not regulated under either law.

All the closed TSD facilities in the Bear Creek Regime have been inactive since the late 1980s, and most have undergone some level of engineered closure (e.g., installation of multilayer or clay caps). Many of these sites are confirmed or suspected sources of contamination in the Bear Creek Regime. The contaminated media (groundwater, surface water, stream sediments in Bear Creek and its tributaries, and Bear Creek floodplain soils) were the primary focus of the CERCLA remedial investigation (RI) for the Bear Creek Watershed (Science Applications International Corporation 1997). The primary sources of contamination are the sites addressed in the RCRA post-closure permit for the Bear Creek Regime: the S-3 Site, the Oil Landfarm Waste Management Area (WMA), and the Bear Creek Burial Grounds WMA. Brief descriptions of these sites are provided below.

S-3 Site

The S-3 Site (formerly the S-3 Ponds) is a closed RCRA surface impoundment located near the headwaters of Bear Creek (Figure 2), just west of the groundwater and surface water flow divide between the Bear Creek Regime and the Upper East Fork Poplar Creek Hydrogeologic Regime (East

Fork Regime). The site consisted of four unlined ponds used between 1951 and 1984 for disposal of acidic, radioactive liquid wastes. Each 400 x 400-foot pond was about 17-feet (ft) deep and had a storage capacity of about 2.5 million gallons. When closed in 1988, the S-3 Site was covered with a low-permeability cap and an asphalt parking lot.

Oil Landfarm WMA

The Oil Landfarm WMA is north of Bear Creek about one mile west of the Y-12 Plant, and includes the Oil Landfarm hazardous waste disposal unit (HWDU); the Boneyard, Burnyard, and Hazardous Chemical Disposal Area (HCDA); and Sanitary Landfill I (Figure 2). Of these, only the Oil Landfarm HWDU is regulated under the RCRA post-closure permit for the Bear Creek Regime. The other sites are former RCRA solid waste management units (SWMUs) currently regulated under CERCLA (Table 1).

The Oil Landfarm HWDU was used between 1973 and 1982 for the biodegradation of about one million gallons of waste oil and machine coolants via landfarming. This process involved application of the wastes to nutrient-adjusted surficial soils during the dry months of the year (April to October). Closure of the site, which involved installation of the low-permeability cap, was completed in 1990.

The Boneyard was used for the disposal of magnesium chips and construction debris (e.g., concrete) in unlined shallow trenches. Filled trenches were covered with topsoil and seeded with grass. The Burnyard consisted of two unlined trenches, each about 300-ft long by 40-ft wide, in which various types of refuse (including pesticide containers, metal shavings, solvents, oils, and laboratory chemicals) were burned. Some of the burned residues may have been buried in the Boneyard. Constructed on top of the Burnyard in 1975, the HCDA served as a safe area for releasing compressed gas from cylinders with leaking or damaged valves, and for disposal of reactive or explosive laboratory chemicals. The chemicals were handled to induce the expected reaction or explosion, and remaining liquids were discharged into a small unlined surface impoundment. A low-permeability cap over the HCDA was installed during closure of the Oil Landfarm HWDU.

Sanitary Landfill I was used between 1968 and 1983 for disposal of combustible and decomposable solid wastes from the Y-12 Plant, some of which may have included toxic chemicals.

Disposal trenches at the landfill were excavated to depths of about 20-ft below ground surface (bgs) and backfilled to about 15-ft above grade. The landfill was graded and capped in 1983.

Bear Creek Burial Grounds WMA

The Bear Creek Burial Grounds WMA is about two miles west of the Y-12 Plant, and consists of several waste disposal areas designated Burial Grounds (BG)-A (North and South), -B, -C (East and West), -D, -E, and -J; the Walk-In Pits (North and South); the Uranium Vaults; and the Oil Retention Ponds (No.1 and No.2) (Figure 2). Of these, only BG-A (North and South), BG-C (West), and the Walk-In Pits are HWDUs addressed in the RCRA post-closure permit for the Bear Creek Regime; the remaining are former SWMUs currently regulated under CERCLA (Table 1). Each waste disposal area consisted of shallow (<25-ft bgs) trenches. These trenches received a diverse mixture of solid wastes (1955 to 1993) and liquid wastes (1959 to 1979) from the Y-12 Plant, all or most of which contained varying amounts of radioisotopic contamination. Oil Retention Ponds No. 1 and 2 were constructed to collect oils seeping from disposal trenches in BG-A South and BG-A North, respectively (Figure 2). Closure of the Bear Creek Burial Grounds WMA, with the exception of BG-B, BG-C, and the Walk-In Pits, was completed by 1990, and included construction of low-permeability caps over the disposal trenches, removal of contaminated sediments from the Oil Retention Ponds, and installation of a shallow leachate collection system and associated storage/treatment facilities. Closure of BG-C was certified in May 1993. The closure of BG-B and the Walk-In Pits was completed in February 1995 and involved installation of an engineered cap and concrete blast cover.

2.2 Topography and Bedrock Geology

The Bear Creek Regime is bound to the north by Pine Ridge and to the south by Chestnut Ridge, and encompasses the portion of BCV extending from a surface water and shallow groundwater divide at the west end of the Y-12 Plant to the western boundary of the Bear Creek watershed. Surface elevations range from 900 ft above mean sea level (msl) in the Bear Creek channel along the floor of BCV, to about 1,200 ft msl along the crests of Pine Ridge and Chestnut Ridge (Figure 3).

The geology of the Bear Creek Regime is characterized by alternating sequences of clastic and carbonate strata that form the distinctive topography of the Valley and Ridge Physiographic Province. On the Oak Ridge Reservation, shale and siltstone beds of the Rome Formation form Pine Ridge, limestone and shale formations of the Conasauga Group form BCV, and the primarily dolostone formations of the Knox Group form Chestnut Ridge (Figure 3). Strike and dip of bedding are generally N 55°E and 45°SE, respectively (as referenced to true north). Bedrock is overlain by up to 50-ft of several materials, including man-made fill, alluvium, colluvium, fine-grained residuum from the weathering of the bedrock, and saprolite (weathered bedrock). In some areas the saprolite retains primary textural features of the bedrock.

2.3 Hydrogeologic Framework

The following discussion is based on the conceptual hydrologic model for BCV presented in the CERCLA RI Report for the Bear Creek Watershed (Science Applications International Corporation 1997). This conceptual model incorporates: (1) the general hydrologic framework and associated nomenclature described in Solomon *et al.* (1992); (2) groundwater flow characteristics presented in Moore (1988 and 1989) and Moore and Toran (1992); (3) results of hydrologic studies and investigations in BCV, including Dreier *et al.* (1987), Goldstrand (1995), Shevenell (1994), and Turner *et al.* (1991); and (4) findings of sampling and analysis activities performed specifically for RI purposes. Key aspects of the conceptual model regarding the principal hydrogeologic units and respective flow characteristics, and the general hydrology of Bear Creek are summarized in the following discussion.

2.3.1 Groundwater System

Within the Bear Creek Regime, the Rome Formation, Conasauga Group, and Knox Group comprise two basic hydrogeologic units: the Aquifer, consisting of the Maynardville Limestone (upper Conasauga Group) and Copper Ridge Dolomite (lower Knox Group); and the Aquitard, consisting of the remaining Conasauga Group formations (Nolichucky Shale, Maryville Limestone, Rogersville Shale, Rutledge Limestone, and Pumpkin Valley Shale) and the Rome Formation (Figure 3). Components of the Aquifer underlie the axis of BCV (Maynardville Limestone) and the

steep flank and crest of Chestnut Ridge (Copper Ridge Dolomite). Formations comprising the Aquitard form the northern slope of BCV (Conasauga Group) and Pine Ridge (Rome Formation). The Aquitard, which underlies the primary contaminant source areas in the Bear Creek Regime, is hydraulically upgradient of the Aquifer, which functions as a hydrologic drain in BCV. Fractures provide the principal groundwater flowpaths in both units, and dissolution of carbonates in the Aquifer has enlarged fractures and produced solution cavities and conduits that greatly enhance its hydraulic conductivity relative to the Aquitard. Although negligible in both units, flow through the porous rock matrix plays an important role in contaminant migration because of matrix diffusion processes.

Groundwater flow in the Aquitard and the Aquifer is primarily parallel to bedding (along strike and dip), which in the Aquitard may or may not coincide with the direction of maximum hydraulic gradient inferred from water level isopleths. Flow tangent to bedding occurs primarily along permeable zones formed by cross-cutting fractures or fracture zones (and possibly small faults). The northern tributaries of Bear Creek are probably the surficial expression of these cross-cutting structures. Such structures provide preferred flowpaths that channel groundwater from the Aquitard to the Aquifer, or act as barriers to lateral flow, causing groundwater from deeper intervals to upwell and discharge to the shallower flow system in each hydrogeologic unit.

In the Aquitard, most groundwater flow occurs in a highly conductive interval near the bedrock/residuum interface (the water table interval). Flow occurs above the water table in response to precipitation when flowpaths in the residual soils become saturated and rapidly transmit water laterally (stormflow) down slope toward springs and seeps in drainage features, and vertically (recharge) to the water table interval. Recharge to the water table interval promotes strike-parallel groundwater flow toward discharge areas in nearby cross-cutting streams. Although flow is most active at depths less than 100-ft bgs, contaminants in groundwater more than 200-ft bgs in the Nolichucky Shale clearly indicate permeable flowpaths at depth. However, only a small percentage of total flow ultimately recharges the deeper bedrock. Overall, about 94% of the available groundwater in the Aquitard discharges to Bear Creek tributaries, about 5% flows along cross-cutting fractures into the Aquifer, and about 1% flows through strike-parallel pathways in the deeper subsurface (Science Applications International Corporation 1997).

Decreasing groundwater flux with depth in the Aquitard also is reflected by distinct changes in groundwater geochemistry. Most water table interval and shallow (i.e., <100-ft bgs) bedrock wells monitor calcium-magnesium-bicarbonate groundwater. A fairly abrupt change to sodium-bicarbonate groundwater occurs at a depth of about 100-ft bgs, and is interpreted to be a function of longer groundwater residence time related to reduced fracture aperture or increased fracture spacing (Solomon *et al.* 1992). Further reduced groundwater flux is indicated by the transition from sodium-bicarbonate groundwater to sodium-chloride groundwater that usually occurs at a depth of about 400-ft bgs. The transition to the sodium-chloride groundwater is accompanied by increased total dissolved solids (TDS).

Most groundwater flow in the Aquifer occurs at shallow depths (i.e., <100-ft bgs) in an extensively interconnected maze of solution conduits and cavities (karst network). Below the shallow karst network, fractures provide the primary flowpaths. Also, there are seven stratigraphic zones (numbered from bottom to top) in the Maynardville Limestone that are differentiated by distinct lithologic and hydrologic characteristics (Shevenell *et al.* 1995). The more permeable zones are at the bottom (Zone 2) and top (Zone 6) of the formation, but Zone 6 is the most permeable interval and probably transmits the bulk of the groundwater in the formation (Shevenell *et al.* 1995; Goldstrand 1995).

Flow in the shallow karst network in the Aquifer is relatively rapid and during rainfall occurs as “quickflow” discharge to Bear Creek. Active groundwater circulation occurs at greater depth than in the Aquitard, and groundwater from the deeper flow system discharges along major gaining (influent) reaches of Bear Creek. These discharge areas are probably related to large-scale structural (e.g., cross-strike faults) or stratigraphic discontinuities in the Maynardville Limestone. Overall, about 81% of the available groundwater in the Aquifer (Maynardville Limestone) discharges directly to Bear Creek, 16% flows into the creek from spring SS-5, and 3% follows strike-parallel flowpaths in the subsurface (Science Applications International Corporation, Inc. 1997).

Groundwater geochemistry is more homogeneous in the Aquifer than in the Aquitard; virtually every monitoring well in the Maynardville Limestone, regardless of depth, monitors calcium-magnesium-bicarbonate groundwater. Some shallow wells monitor sulfate-enriched groundwater, which probably reflects dissolution of locally disseminated sulfides, and several deep

wells monitor calcium-magnesium-sulfate groundwater with TDS that typically exceed 1,000 milligrams per liter (mg/L).

2.3.2 Surface Water System

Surface water in the Bear Creek Regime is drained by Bear Creek and its tributaries. From its headwaters near the west end of the Y-12 Plant, Bear Creek flows southwest for approximately 4.5 miles, where it turns northward to flow into East Fork Poplar Creek. Monitoring locations along the main channel are specified by the Bear Creek kilometer (BCK) value corresponding to the distance upstream from the confluence with East Fork Poplar Creek (e.g., BCK-09.40). Sections of the main channel upstream of BCK-11.97 are referenced as upper Bear Creek, middle Bear Creek lies between BCK-11.97 and BCK-09.40, and downstream of BCK-09.40 is referenced as lower Bear Creek. Tributaries are designated as north (e.g., NT), or south, along with a value representing the tributary number counted downstream from the headwaters (e.g., NT-1). Major springs along the south side (SS) of Bear Creek are numbered in ascending order from the headwaters (e.g., SS-1).

Approximately half of the annual precipitation in BCV exits via surface water flow in Bear Creek, and possibly higher proportions during winter and early spring (Science Applications International Corporation, Inc. 1997). Flow in the creek increases rapidly during rainfall, and afterward reflects the relative contributions of overland flow, stormflow, and groundwater discharge. Flow in the main channel and tributaries generally returns to pre-precipitation levels within one or two days. Major sections of upper and middle Bear Creek are seasonally dry, but flow is perennial in lower Bear Creek.

The main channel of Bear Creek functions as a major conduit of the shallow karst network within the Maynardville Limestone. Discharge from numerous springs located along the Maynardville Limestone/Copper Ridge Dolomite boundary on the north slope of Chestnut Ridge dominate the hydrology of the creek, especially during droughts when they provide most of the flow in the main channel. Additionally, the main channel contains alternating gaining and losing reaches. Each gaining reach generally correlates with an Aquifer discharge area. Losing reaches in the upper part of BCV, particularly south of Sanitary Landfill I, play an important role in transferring contaminants from Bear Creek to the Aquifer.

2.4 Groundwater Flow Patterns

Groundwater flow patterns in the Bear Creek Regime were evaluated based on depth-to-water measurements obtained from 148 monitoring wells during April 1-9, 1996 (the seasonally high water table) and 149 wells during October 1-7, 1996 (the seasonally low water table) (Table 2). Depth-to-water measurements recorded during the semiannual sampling events were not used because they were obtained from fewer wells over significantly longer time periods, and may have been influenced by sampling activities (i.e., purging/sampling adjacent wells).

Isopleths of seasonal groundwater surface elevations in the Bear Creek Regime (Figure 4) indicate southwesterly (strike-normal) flow in the Aquitard toward the Aquifer (Maynardville Limestone) and westerly (strike-parallel) flow in the Aquifer toward the west end of BCV. Seasonal water level fluctuations, which were typically less than 10-ft in most water table interval and bedrock interval monitoring wells (Table 2), influenced the magnitude of hydraulic gradients but did not significantly alter the overall groundwater flow patterns.

Based on the CY 1996 water level data for selected Aquitard and Aquifer monitoring wells, seasonal horizontal hydraulic gradients in the water table interval range from 0.027 to 0.102 across strike in the Aquitard, and from 0.001 to 0.014 along strike in the Aquifer. Steeper horizontal gradients in the water table interval occur during seasonally high water levels in the Aquitard, but in the Aquifer, steeper gradients typically occur during seasonally low water levels. In the shallow/intermediate bedrock intervals, seasonal horizontal hydraulic gradients range from 0.027 to 0.057 across strike in the Aquitard, and from 0.005 to 0.017 along strike in the Aquifer. Steeper horizontal gradients in the bedrock intervals usually occur during seasonally high water levels in both the Aquitard and the Aquifer.

Water level data for monitoring well clusters indicate a wide range of upward (0.001 to 0.227) and downward (0.001 to 0.602) vertical hydraulic gradients in the Aquitard and the Aquifer, with seasonal reversals of upward/downward flow directions evident in both hydrogeologic units. Upward gradients are most common and highest in the Aquitard, and downward gradients are highest in the Aquifer (Figure 4). Consistently concurrent temporal reversals of upward/downward flow directions are not indicated by the data for the existing network of monitoring well clusters.

2.5 Groundwater Contamination

The following discussion is based on the contaminant transport models for the primary source areas in the Bear Creek Regime (the S-3 Site, the Oil Landfarm WMA, and the Burial Grounds WMA) and the principal contaminant migration pathways (the Maynardville Limestone and Bear Creek) described in previous years Groundwater Quality Assessment Reports and the CERCLA RI Report for the Bear Creek Watershed (Science Applications International Corporation, 1997). These models incorporate the bulk of the geologic, hydrologic, and water quality databases maintained by the Y-12 Plant GWPP, and essentially represent the culmination of hydrogeologic characterization and contamination assessment efforts performed since the mid-1980's.

S-3 Site

Operation of the S-3 Site emplaced a large reservoir of contamination in the Aquitard (Nolichucky Shale) consisting of a heterogeneous mix of inorganic, organic, and radioactive constituents. The principal contaminants are nitrate, technetium-99 (^{99}Tc), uranium isotopes (^{234}U , ^{235}U , and ^{238}U), trace metals (e.g., cadmium), and volatile organic compounds (VOCs). A mixture of these contaminants extends south toward the upper reaches of Bear Creek along preferred migration pathways in the water table interval (including a buried tributary of the creek that passes underneath the S-3 Site), and west along deeper, strike- and dip-parallel pathways in bedrock. The relative distribution of the contaminants is strongly dependent on contaminant geochemistry and reactions with subsurface materials. Concentrations within the plume have probably reached maximum levels, and the center of mass in the Aquitard may be slowly moving west towards NT-2. A possible exception is uranium (and gross alpha activity), which seems to be increasing next to the S-3 Site. Westward, strike-parallel migration should continue until the plume encounters a cross-cutting structure that promotes upward discharge into the shallow flow system in the Aquitard, or cross-strike flow into the Aquifer (Maynardville Limestone).

As indicated by the distribution of nitrate, a highly mobile and chemically stable contaminant that delineates the maximum extent of transport and effectively traces the principal migration pathways, operation of the S-3 Ponds produced a contaminant plume in the Aquitard that extends downdip at least 400-ft bgs, and along strike at depth for over 3,000-ft to the west (Figure 5). Nitrate

(as N) concentrations (hereafter synonymous with “nitrate” concentrations) within the plume exceed 10,000 mg/L in the deep bedrock immediately below the former S-3 Ponds, 1,000 mg/L in the shallow groundwater near the site, and 10 mg/L near the plume boundaries.

Gross alpha activity and gross beta activity within the S-3 Site contaminant plume exceed 1,000 picoCuries per liter (pCi/L). Although a diverse population of radioisotopes may be present in the groundwater closest to the site, elevated gross alpha and gross beta activity in the groundwater (Figure 5) probably delineate migration of uranium isotopes and ^{99}Tc , respectively.

Other components of the S-3 Site contaminant plume are trace metals and VOCs. The distribution of trace metals is less extensive than that of nitrate and gross beta radioactivity, but the most mobile metals within the plume (e.g., barium) have been transported beyond the low pH (i.e., <5) groundwater nearest to the site. Acetone and tetrachloroethene (PCE) are the principal VOCs within the groundwater plume. Tetrachloroethene levels in wells adjacent to the site exceed 5,000 micrograms per liter ($\mu\text{g/L}$), suggesting the presence of dense nonaqueous phase liquids (DNAPLs), but rapidly decrease to less than 50 $\mu\text{g/L}$ downgradient of the site.

When closed, the S-3 Site contained several feet of sludge produced by in-situ denitrification of the remaining waste water. Sludges within the saturated zone may release ^{99}Tc and uranium isotopes to the shallow groundwater flow system in the Aquitard, which then may be transported westward through the water table interval toward discharge points in NT-1 (Science Applications International Corporation, 1997). Additionally, matrix diffusion and advective transport processes are slowly releasing contaminants (e.g., nitrate) from the deeper reservoir into the more active (shallow) Aquitard flow system.

Oil Landfarm WMA

The primary sources of groundwater contaminants in the Oil Landfarm WMA (listed in order of importance) are the Boneyard/Burnyard/HCDA, the Oil Landfarm HWDU, and Sanitary Landfill I. Each is a source of VOCs in the shallow groundwater, and the Boneyard/Burnyard is a major source of elemental uranium and alpha radioactivity.

Uranium isotopes are the principal groundwater contaminants at the Boneyard/Burnyard. Contamination delineated by soil sampling, and geophysical and radiological surveys indicate a

major source area located immediately northwest of the HCDA cap. Wastes in the Boneyard/Burnyard are probably within the saturated zone during seasonally high groundwater levels, and uranium isotopes may be leached and transported with the shallow groundwater that discharges into NT-3 or recharges directly into the Maynardville Limestone. Gross alpha and gross beta activity exceed 1,000 pCi/L in the shallow groundwater along NT-3 from the northwest corner of the site to the confluence of NT-3 and Bear Creek (Figure 5).

The Boneyard/Burnyard/HCDA also is the source of a dissolved VOC plume in the shallow groundwater. Primary components of the plume are trichloroethene (TCE), 1,2-dichloroethene (1,2-DCE), and PCE. Concentrations of these VOCs are less than one percent of solubility, indicating that DNAPLs are probably not present in the subsurface. The HCDA is most likely the principal source of these VOCs, as indicated by the lack of these constituents in surface water at NT-3, and their areal distribution relative to the radioactivity plume originating from elsewhere in the Boneyard/Burnyard (Figure 5).

Groundwater contaminants at the Oil Landfarm HWDU are principally VOCs, and two distinct plumes are evident: one to the northeast dominated by 1,1,1-trichloroethane (1,1,1-TCA), 1,1-dichloroethane (1,1-DCA), and 1,1-dichloroethene (1,1-DCE); and one to the south dominated by PCE, 1,2-DCE, and TCE. Concentrations of these compounds exceed 1,000 µg/L in the northeast plume, and 100 µg/L in the southern plume. Both plumes appear to be restricted to the shallow flow system. Maximum concentrations within the plumes do not indicate the presence of DNAPLs in the subsurface.

Sanitary Landfill I is a probable source of 1,1-DCA and 1,2-DCE in the shallow groundwater (Aquitard and Aquifer) downgradient to the south of the site (Figure 5). Maximum VOC concentrations are typically less than 50 µg/L. In the Aquifer (Maynardville Limestone), these constituents have intermingled with the VOC plume (primarily TCE and 1,2-DCE) originating from upgradient sources. Sanitary Landfill I also may be a source of elevated boron concentrations in the groundwater at several wells downgradient (west) of the site.

Bear Creek Burial Grounds WMA

Groundwater in the Aquitard underlying the Bear Creek Burial Grounds WMA is extensively contaminated with VOCs at both shallow (water table) and deep (bedrock) intervals (Figure 5). There are five primary source areas: BG-A (North and South), BG-C (East and West), and the Walk-In Pits. Dissolved VOC plumes in the shallow groundwater at several of these source areas are probably related to widespread occurrence of DNAPLs in the subsurface. Contamination in the deeper groundwater flow system reflects density-driven, downward migration of DNAPL.

The disposal trenches comprising BG-A (North and South) received almost two million gallons of waste oils and coolants, and DNAPLs have been encountered at 260-ft and 330-ft bgs in monitoring wells downdip of source trenches in BG-A South. Dissolved VOC plumes in the groundwater underlying both areas are dominated by PCE, TCE, and 1,2-DCE. Other common plume constituents are 1,1,1-TCA, 1,1-DCA, and 1,2-dichloroethane (1,2-DCA). Summed concentrations of these plume constituents exceed 100,000 µg/L. Groundwater in the water table interval transports the plume constituents along strike toward discharge areas in NT-7. Strike-parallel migration may also occur below the water table interval, as indicated by PCE data obtained from deeper bedrock wells at BG-A South.

Separate plumes of dissolved VOCs apparently occur in the shallow groundwater at BG-C East and BG-C West (Figure 5), both dominated by 1,2-DCE with lesser amounts of vinyl chloride. Concentrations within the plume are generally less than 500 µg/L. Groundwater containing these VOCs discharges to the NT-8 catchment on the northwest side of the Burial Grounds WMA. Data for both source areas do not clearly indicate the presence of DNAPLs in the subsurface.

Groundwater near the Walk-In Pits contains a distinct plume of dissolved VOCs dominated by PCE. Concentrations exceed 2,000 µg/L, which is about 1% of the maximum PCE solubility and possibly indicates DNAPLs in the subsurface. Contaminants in the shallow groundwater flow system may not discharge extensively to surface water (Science Applications International Corporation, Inc. 1997).

Although large quantities of uranium wastes were disposed in the Bear Creek Burial Grounds WMA, few monitoring wells in the area yield radioactive groundwater samples (Figure 5). However, RI data for soil samples and surface water samples collected from Bear Creek tributaries

NT-6, NT-7, and NT-8 indicate that BG-A South and BG-C East are probable sources of radioactivity. Maximum gross alpha and gross beta activities in the samples from these tributaries ranged from about 20 pCi/L to more than 100 pCi/L. The disparity with the groundwater sample data is probably an artifact of the monitoring well network; few of the wells are screened within the shallowest water table interval where radioactive contamination likely occurs (Science Applications International Corporation, Inc. 1997).

Boron is the primary trace metal contaminant in the groundwater at the Bear Creek Burial Grounds WMA. Elevated boron concentrations occur primarily in the shallow groundwater near BG-A South and BG-C (East and West), and probably resulted from disposal of borax waste waters from the Y-12 Plant. Boron is most likely present in the groundwater as borate $[B(OH)_3]$, which is chemically stable and relatively mobile, and is transported toward discharge points in Bear Creek tributaries NT-7 and NT-8.

Maynardville Limestone Exit Pathway

Primary groundwater contaminants in the Maynardville Limestone are nitrate, VOCs, radionuclides, and trace metals. These contaminants originate primarily from the S-3 Site (nitrate, trace metals, and radionuclides), the Boneyard/Burnyard/HCDA (radionuclides and VOCs), Sanitary Landfill I (VOCs), the Bear Creek Burial Grounds WMA (VOCs and radionuclides), and the Rust Spoil Area or a nearby unidentified VOC source area in the Bear Creek floodplain. Contaminants enter the Maynardville Limestone through a combination of several input pathways, including direct recharge, hydrologic communication with Bear Creek, and inflow of shallow groundwater from the Aquitard. Relative contributions from the source areas and the geochemical characteristics of the contaminants have generally produced two primary plumes of contamination in the groundwater: one containing nitrate and radioactivity, and another containing VOCs (trace metal contaminants are more sporadic and chiefly occur close to the primary source areas). Both plumes occur in the shallow karst network and the deeper fracture flowpaths, and are commingled downgradient of the Boneyard/Burnyard/HCDA.

The nitrate plume in the Aquifer essentially delineates the maximum extent of contaminant transport in the Bear Creek Regime and effectively traces the primary migration pathways in the

Maynardville Limestone (Figure 5). The plume is continuous in the deeper bedrock from south of the S-3 Site for about 10,000 ft along strike to the west, whereas attenuation (i.e., dilution) from more active recharge and groundwater flux has reduced the nitrate concentrations in the shallow karst network and produced a more discontinuous plume. Nitrate concentrations within the plume exceed 500 mg/L south of the S-3 Site, but rapidly decrease to less than 50 mg/L south of the Oil Landfarm WMA, and are typically highest in the intermediate depth (100 to 300-ft bgs), fracture-dominated groundwater flow system.

The distribution of VOCs in the Maynardville Limestone reflects the relative contributions of several source areas and commingling during downgradient transport along strike (Figure 5). Plume constituents in the upper part of BCV are TCE, PCE, and 1,2-DCE; probable source areas are Spoil Area I, the S-3 Site, and possibly another source area (the Fire Training Facility) located in the East Fork Regime. Additional inputs to the plume occur from the Rust Spoil Area or a nearby source in the Bear Creek floodplain (TCE), the Boneyard/Burnyard/HCDA (TCE and 1,2-DCE), Sanitary Landfill I (1,1,1-TCA and 1,1-DCA), and discharge from the Bear Creek tributary (NT-7) that traverses BG-A North and A South (1,2-DCE and 1,2-DCA). The highest concentrations (>300 µg/L) within the plume occur in the deeper groundwater to the south (down dip) of the Boneyard/Burnyard/HCDA. These high concentrations coincide with the downward vertical hydraulic gradients in the Maynardville Limestone in this area, and the major losing reach of Bear Creek south of Sanitary Landfill I.

Radioactivity in the groundwater in the Maynardville Limestone is primarily from uranium isotopes and ⁹⁹Tc. Gross beta activity in the the upper part of BCV generally delineates the extent of ⁹⁹Tc transport, and the distribution of gross beta activity generally mirrors that of nitrate, indicating both a common source area (the S-3 Site) and migration along common flowpaths (Figure 5). Increased gross alpha activity in the groundwater downstream of the NT-3 catchment reflects input of uranium isotopes from sources in the Boneyard/Burnyard/HCDA.

Most trace metal contamination in the Maynardville Limestone occurs in the shallow groundwater near the S-3 Site and the Boneyard/Burnyard/HCDA. Near the S-3 Site, the principal trace metal contaminants are barium, boron, cadmium, copper, lead, mercury, strontium, and uranium. Some of these metals (e.g., cadmium) were entrained in the highly acidic wastes disposed

at the site, and others (e.g., strontium) were dissolved from the underlying bedrock. Trace metal contamination is sporadic in the groundwater at the Boneyard/Burnyard/HCDA, and the principal contaminants are beryllium, manganese, mercury, nickel, and vanadium. Boron and uranium are the most widespread in the Aquifer downgradient of the S-3 Site and the Boneyard/Burnyard/HCDA.

2.6 Surface Water Contamination

Many of the principal components of the groundwater contamination plumes in the Bear Creek Regime, including nitrate, ^{99}Tc , uranium isotopes, several trace metals, and a few VOCs (PCE, TCE, and 1,2-DCE), occur in upper Bear Creek and several of its northern tributaries. However, the quality of surface water in Bear Creek improved dramatically after waste disposal at the S-3 Site ceased in 1983. Nitrate concentrations in upper Bear Creek at BCK-12.46, for example, exceeded 1,000 mg/L in 1983, but were less than 200 mg/L in 1994. Currently, input from several northern tributaries (primarily NT-1, NT-2, NT-3, and NT-8) during seasonally high flow conditions contribute the bulk of the contamination to the creek. During dry periods, contaminant flux into Bear Creek is generally lower, but because of less dilution in the creek channel, concentrations are typically higher and are probably controlled by contaminant levels in the groundwater discharged from springs SS-1, SS-4, and SS-5 (Science Applications International Corporation, 1997).

3.0 CY 1996 GROUNDWATER PROTECTION PROGRAM

This section provides an overview of CY 1996 groundwater and surface water monitoring activities performed in the Bear Creek Regime, and includes brief descriptions of the groundwater monitoring programs, the associated groundwater and surface water sampling locations and frequency, and the suite of field measurements/laboratory analytes for each sampling location.

3.1 Monitoring Programs

Groundwater and surface water monitoring was performed under the auspices of the Y-12 Plant GWPP for the purposes of: (1) RCRA post-closure corrective action monitoring, (2) U.S. Department of Energy (DOE) Order 5400.1 Surveillance Monitoring and DOE Order 5400.1 Exit Pathway/Perimeter Monitoring, (3) the best management practice of the Y-12 Plant GWPP, and (4) the CERCLA RI for the Bear Creek Watershed. The requirements for and objective of each monitoring program are described in the Annual Monitoring Report, and details regarding the sampling and analysis activities associated with each program are provided in the *Sampling and Analysis Plan for Groundwater and Surface Water Monitoring at the Y-12 Plant during Calendar Year 1996* (HSW Environmental Consultants, Inc. 1995a), as amended in addenda issued throughout the year by the Y-12 Plant GWPP Manager.

3.2 Sampling Locations and Frequency

Groundwater samples were collected semiannually from 53 of the monitoring wells in the Bear Creek Regime (28 Aquitard wells and 25 Aquifer wells) and three springs (SS-1, SS-4, and SS-5) that discharge to Bear Creek (Figure 6). Samples of surface water in Bear Creek were collected semiannually from eight locations, including NT-01 just upstream of its confluence with the main channel, and a total of seven stations along upper (BCK-11.97), middle (BCK-10.60 and BCK-09.40), and lower (BCK-07.55, BCK-04.55, BCK-03.87, and BCK-00.63) Bear Creek (Figure 6). Semiannual sampling was performed during the first quarter (January 16 - March 28, 1996) and third quarter (July 1 - September 6, 1996) of the year (Table 3).

Groundwater samples from 22 monitoring wells were obtained using dedicated, bladder pump sampling equipment (Well Wizards™); samples from the remaining 31 monitoring wells were

obtained using portable gas-piston pumps (Bennet Pumps™) and disposable bailers (Table 3). Surface water samples were collected using grab sample bottles. Sampling was performed by the Analytical Services Organization, Sampling and Environmental Support Department located at the East Tennessee Technology Park (ETTP [formerly the Oak Ridge K-25 Site]).

Filtered and unfiltered samples were collected from each monitoring well, spring, and surface water station (Table 4). Groundwater samples collected with Well Wizards™ and Bennet Pumps™ were filtered in the field using in-line 0.45 micron filters. Surface water samples and groundwater samples collected with bailers were filtered in the laboratory.

3.3 Field Measurements and Laboratory Analytes

Sampling personnel recorded field measurements of pH, temperature, specific conductance, dissolved oxygen, and oxidation-reduction potential for each groundwater and surface water sample (Table 4). The depth to water in each monitoring well also was recorded before groundwater purging and sampling.

Samples from each groundwater and surface water sampling location were analyzed for the following standard suite of inorganic, organic, radiological, and miscellaneous laboratory analytes: (1) principal cations and anions, (2) trace metals; the term used hereafter to differentiate metals which are typically minor constituents in groundwater (e.g., barium) from metals that are usually major ionic species (e.g., calcium), (3) VOCs, (4) gross alpha activity and gross beta activity, and (5) pH, specific conductance, turbidity, total suspended solids (TSS), and TDS. Unfiltered groundwater and surface water samples were analyzed for all of these analytes; filtered samples were analyzed only for the principal cations and trace metals (Table 4). Samples collected from wells used for RCRA post-closure corrective action monitoring and DOE Order 5400.1 monitoring purposes were also analyzed for several radioisotopes.

Most laboratory analyses of the groundwater and surface water samples were performed by the Analytical Services Organization (ASO) located at the ETTP. Selected radiochemical analyses were performed by the Y-12 Plant ASO and the Oak Ridge National Laboratory ASO. Laboratory analyses were performed in accordance with the methods and procedures referenced in Table 4.

4.0 GROUNDWATER QUALITY DATA EVALUATION

This section presents an evaluation of the groundwater quality data reported for the network of monitoring wells sampled during CY 1996. The evaluation is based on analytical results that meet the data quality objectives (DQOs) of the Y-12 Plant GWPP, and is focused on evidence for additional plume migration. Results of the evaluation are organized by groups of related analytes (principal ions, trace metals, VOCs, and radiological parameters), with analysis and interpretation of the data for Aquitard and Aquifer monitoring wells described separately for each group.

The DQOs for groundwater quality data obtained under the auspices of the Y-12 Plant GWPP are defined in the *Y-12 Plant Groundwater Protection Program - Groundwater Monitoring Program Data Management Plan* (Martin Marietta Energy Systems, Inc. 1993). The DQO criteria applicable to each major group of related analytes are summarized below.

DQO Criteria	Inorganic Analytes	Organic Analytes	Radiological Analytes	Miscellaneous Analytes
Duplicate Sample Data	●	●	●	●
Filtered/Unfiltered Sample	●	.	.	.
Ion Charge Balance	●	.	.	.
False Positive Results	.	●	.	.
Counting Errors	.	.	●	.

Results that do not meet the applicable DQO criteria were either replaced with a surrogate value such as the analytical detection limit (i.e., screened from evaluation) or were considered qualitative. A summary of the CY 1996 groundwater quality data qualified by the applicable DQO criteria is provided in Appendix C.

Evaluation of the CY 1996 groundwater quality data for evidence of additional contaminant plume migration in the Bear Creek Regime focused on the results for the following analytes:

- Nitrate
- Barium
- Strontium
- PCE
- Gross alpha
- Boron
- Uranium
- TCE
- Gross beta

These are primary components of the contaminant plumes and include constituents representing the relative range of contaminant mobility in groundwater. Evaluation of the CY 1996 results for these

contaminants focused on wells that show increasing long-term temporal trends. Increasing trends are indicated by nonparametric (Theil Slope) trend analysis of historical (CY 1990 - CY 1995) data for fifty-seven monitoring wells located downgradient of contaminant sources in the Bear Creek Regime (Paradigm Data Services, Inc. 1996). Twenty-one of these wells were sampled during CY 1996 (Table 5). Results for these wells show statistically significant (95% confidence level) increasing levels of nitrate (ten wells), barium (nine wells), strontium (six wells), boron (six wells), gross beta (five wells), TCE (five wells), and PCE (three wells) (Paradigm Data Services, Inc. 1996).

4.1 Principal Ions

Results for the principal anions (carbonate and bicarbonate alkalinity, chloride, fluoride, nitrate, and sulfate) and cations (calcium, magnesium, potassium, and sodium) reported for most of the monitoring wells sampled during CY 1996 generally reflect the respective geochemical characteristics of uncontaminated groundwater in the Aquitard and the Aquifer. Nitrate contamination from the S-3 Site caused the most significant deviations from the ion chemistry typical of the groundwater samples from each hydrogeologic unit.

4.1.1 Aquitard

Most of the Aquitard monitoring wells yield calcium-magnesium-bicarbonate groundwater, and samples from these monitoring wells typically exhibit low proportions (<10%) of chloride, potassium, sodium, and sulfate (Figure 7); carbonate alkalinity, fluoride, and nitrate concentrations below respective analytical reporting limits; TDS of 150 to 350 mg/L; and pH between 6.5 and 8.0. Several wells (e.g., GW-828) yield sodium-bicarbonate groundwater, which is usually encountered more than 100-ft bgs in the Aquitard, and samples from these wells are generally characterized by low proportions (<5%) of calcium, magnesium, and potassium (Figure 7); carbonate alkalinity above 5 mg/L; fluoride and nitrate levels below respective analytical reporting limits; TDS of 250 to 350 mg/L; and pH of about 9. Excluding nitrate contamination from the S-3 Site, results for some wells indicate locally elevated concentrations/proportions of chloride, sulfate, sodium, or potassium (e.g., sulfate in groundwater at well GW-040).

The conceptual model of the nitrate plume in the Aquitard, as defined by concentrations that exceed the 10 mg/L Maximum Contaminant Level (MCL) for drinking water, reflects the following

migration pattern from the S-3 Site: (1) vertical migration, driven by the higher density of the liquid wastes, downdip for at least 400-ft bgs; (2) lateral transport in the water table interval south and southwest toward Bear Creek, primarily via the buried drainage feature that extends beneath the S-3 Site; (3) westward, strike-parallel transport in the water table, shallow bedrock (i.e., <100-ft bgs) and deeper bedrock toward NT-1; (4) discharge from the water table interval into NT-1 and upward migration from the deeper bedrock to the shallow flow system; (5) westward, strike-parallel transport in the bedrock toward NT-2; (6) upward migration from the bedrock, and discharge from the water table interval into NT-2; and (7) westward, strike-parallel transport in the shallow bedrock toward NT-3 (Science Applications International Corporation 1997). The migration pattern indicated by the geometry of the nitrate plume is generally mirrored by the other groundwater contaminants originating from the S-3 Site.

As shown in the following summary, nitrate concentrations above 10 mg/L were reported for groundwater samples from one well (GW-276) to the south and three wells (GW-085, GW-537, and GW-829) to the west of the S-3 Site (Figure 8).

Well No.	Distance/Direction from S-3 Site	Monitored Interval Depth (ft bgs)	Nitrate (mg/L)	
			1st Qtr. 1996	3rd Qtr. 1996
GW-276	250-ft South	11.3 - 18.5	129	129*
GW-829	2,100-ft West	102.9 - 114.6	33.6	38.7
GW-537	2,500-ft West	4.8 - 23.3	780	730
GW-085	3,100-ft West	48.4 - 58.8	184	144
Note: * = Qualitative (ion charge balance error exceeds 10%); BOLD = increasing concentration trend				

These results are consistent with the nitrate migration pattern. Although the results for wells GW-085 and GW-537 show a slight concentration decrease, increasing long-term concentration trends are indicated by statistical analysis of the historical data for each well (Table 5).

Nitrate results for the groundwater samples collected from well GW-276 during CY 1996 are an order-of-magnitude lower than the nitrate levels evident during the mid- to late-1980's. Concentrations apparently decreased about 27% per year between January 1990 (454 mg/L) and March 1994 (147 mg/L), but only about 6% per year between March 1994 and March 1996 (129 mg/L). The overall decreasing trend reflects reduced contaminant flux after closing/capping the S-3 Site, and flushing of contaminated groundwater during seasonal and episodic

recharge/discharge cycles (Shevenell 1994). The apparently slower rate of decrease suggests that most highly contaminated groundwater in the more permeable flowpaths has been flushed from the shallow groundwater system, and that contaminant concentrations may be approaching relatively asymptotic levels generally controlled by relative rates of molecular diffusion from the bedrock matrix into the permeable fractures.

Nitrate concentrations in the groundwater at well GW-829, as indicated by results for both samples collected from the well during CY 1996, reflect the strike-parallel migration of the nitrate plume in the bedrock approximately 800-ft west of Bear Creek NT-1 (Figure 8). This well is paired with GW-828 (located about 100-ft north) and is completed in the Nolichucky Shale at a depth of about 115-ft bgs (well GW-828 is completed at 168-ft bgs). Both wells monitor sodium-bicarbonate groundwater (Figure 7), and the strongly upward hydraulic gradients in the area (well GW-828 was artesian in April 1995) suggest that the bedrock structure associated with NT-1 promotes upward migration of the nitrate from in the deep bedrock east of the tributary into the shallow bedrock west of the tributary.

Nitrate concentrations reported for both groundwater samples collected from well GW-537 exceed 700 mg/L, and nitrate dominates the principal ion chemistry of each sample (Figure 7). The high nitrate levels in the shallow groundwater at the well reflect westward (strike-parallel) migration of the nitrate plume toward Bear Creek NT-2 (Figure 8). Additionally, unusually high total and dissolved sodium concentrations in the shallow groundwater at the well, which consistently exceed 30 mg/L and are an order-of-magnitude higher than typical of shallow groundwater in the Aquitard, indicate upward migration of nitrate-contaminated, sodium-bicarbonate groundwater from the deeper (i.e., > 100-ft bgs) flow system.

An increasing concentration trend is indicated by statistical analysis of the nitrate data for well GW-537 (Table 5), although this upward trend is somewhat overshadowed by short-term temporal fluctuations (Figure 9). As noted in Section 2.5, westward migration of the center of mass of the nitrate plume at depth (i.e., >100-ft bgs) in the Aquitard may explain the increasing nitrate concentrations in the shallow groundwater near NT-2. Fate and transport modeling suggest that this upward trend will continue (assuming no remedial action) for the next 100 to 1,000 years (Science Applications International Corporation 1997). The short-term concentration fluctuations probably

reflect dilution via seasonal recharge of uncontaminated groundwater and seasonally variable groundwater flow/contaminant flux.

Nitrate also dominates the ion-chemistry of the groundwater samples collected from well GW-085 (Figure 7). Results for these samples are consistent with historical data showing nitrate concentrations above 100 mg/L in the shallow groundwater at the well. The high nitrate levels reflect migration of the nitrate plume in the shallow bedrock west of NT-2, and indicate that the leading edge of the plume lies west of the well toward NT-3 (Figure 8). Historical data for the well show that nitrate concentrations almost doubled from 115 to 312.6 mg/L between May 1991 and October 1993, dropped sharply to 115 mg/L in February 1994 and aside from an anomalously low result (17 mg/L) in June 1995, have remained above 140 mg/L (Figure 9). This short-term temporal variability also tends to overshadow the long-term concentration increase indicated by statistical analysis of the historical data for the well. Westward migration of the center of mass of the nitrate plume potentially explains the increasing nitrate concentrations in the groundwater at well GW-085 (Science Applications International Corporation 1997).

Although the concentrations are very low (<1 mg/L), the nitrate results for well GW-794 show a statistically significant (95% confidence level) increasing trend (Table 5) and possibly reflect low-level nitrate contamination. This monitoring well is located by the southeast corner of the AGLLSF about 100-ft north of Bear Creek, and is completed at a depth of 39.3-ft bgs in the upper Nolichucky Shale near the geologic contact with the Maynardville Limestone. Nitrate results obtained from the well since November 1992 show a steady concentration increase from the analytical reporting limit (0.2 mg/L) in May 1993 to 1 mg/L in July 1995, and a subsequent decrease to 0.42 mg/L in August 1996 (Figure 9). The nitrate plume in the shallow groundwater within the lower Maynardville Limestone and/or infiltration of nitrate-contaminated surface water in Bear Creek is the most likely source of the nitrate in the well.

Statistical analysis of the nitrate data for well GW-069 indicates an increasing concentration trend (Table 5), but this is probably an artifact of several spurious nitrate results. This well is located south of BG-A South and is completed at a depth of 99.2-ft bgs in the Nolichucky Shale more than 4,000 ft west of the nitrate plume in the Aquitard and at least 500-ft north (upgradient) of the nitrate plume in the Aquifer (Figure 8). Of the twenty-eight groundwater samples collected from the well since June 1990, only concentrations reported for those collected in October 1993 (0.26 mg/L), June

1995 (0.43 mg/L), and December 1995 (1.4 mg/L) exceed the analytical reporting limit. The significance of the increasing trend indicated by these three data points is questionable.

4.1.2 Aquifer

Aside from two deep (>500-ft bgs) monitoring wells (GW-710 and GW-711) that produce highly mineralized (TDS >1,000 mg/L) sulfate-dominated groundwater, calcium-magnesium-bicarbonate groundwater chemistry dominates the Aquifer wells sampled during CY 1996 (Figure 10). Groundwater samples from these wells typically exhibit carbonate alkalinity and fluoride below respective analytical reporting limits; low proportions (<10%) of chloride, potassium, sodium, and sulfate; TDS of 200 to 700 mg/L, and pH between 7.2 and 8.0. Distinctive proportions of magnesium characterize the groundwater from many of these monitoring wells, with proportions below 30% of total cations generally characteristic of shallow groundwater inflow from the Aquitard, and proportions above 30% indicative of groundwater inflow from the Copper Ridge Dolomite. Except for elevated chloride in samples from wells GW-056 (122-125 mg/L) and GW-715 (42.8 mg/L), nitrate from the S-3 Site was the principal source of variation from the typical ion chemistry of groundwater samples from the Aquifer monitoring wells.

The geometry of the nitrate plume in the Aquifer generally reflects the following migration pattern in the shallow karst network and deeper flow system: (1) inflow from the water table interval south of the S-3 Site, including influx via the buried drainage feature that extends beneath the site, and westward, strike-parallel transport toward Exit Pathway Picket C; (2) influx of contaminated groundwater and surface water from the NT-1 and NT-2 catchments, primarily into the basal portion (Zone 2) of the Maynardville Limestone; (3) westward, strike-parallel transport in the shallow karst network and vertical migration into the deeper bedrock along the losing reach of Bear Creek south of Sanitary Landfill I; and (4) westward, strike-parallel transport in the shallow karst network and deeper bedrock, with southward migration into successively higher stratigraphic zones in the Maynardville Limestone and ultimately into the Copper Ridge Dolomite (Science Applications International Corporation 1997). This migration pattern is mirrored by other similarly mobile contaminants in the Aquifer.

Nitrate was detected in the groundwater samples from twenty-one Aquifer wells, but as shown in the following summary, concentrations above 10 mg/L were reported only for samples

from Exit Pathway Picket C wells GW-724, GW-725, and GW-738; Exit Pathway Picket B wells GW-694, GW-703, GW-704, and GW-706; and Exit Pathway Picket A well GW-683.

Well No.	Exit Pathway Picket/ Distance from S-3 Site (ft west)	Monitored Interval Depth (ft bgs)	Maynardville Limestone Zone	Nitrate (mg/L)	
				1st Qtr.	3rd Qtr.
GW-724	C 3,000	289.6 - 301.6	Zone 2	38.8	35.1
GW-725		132.5 - 142.5	Zone 2	67.9	51.0*
GW-738		63.5 - 88.0	Zone 6	14.0	12.7
GW-694	B 7,000	50.6 - 62.6	Zone 6	13.2	3.57
GW-703		135.0 - 182.0	Zone 4	19.3	17.5
GW-704		246.0 - 256.0	Zone 4	17.5	16.5
GW-706		157.0 - 182.5	Zone 4	15.2	16.8
GW-683	A 10,000	133.9 - 196.8	Zone 6	14.5*	9.6

Note: * = Qualitative (ion charge balance error exceeds 10%); **BOLD** = Increasing concentration trend

Results for these wells illustrate three characteristics of the nitrate plume: (1) concentrations decrease rapidly from more than 500 mg/L directly south of the S-3 Site to less than 50 mg/L downgradient of Exit Pathway Picket C, (2) concentrations in the shallow flow system (e.g. GW-738) are lower than concentrations in the deeper bedrock (e.g., GW-725) because of greater dilution from uncontaminated recharge, and (3) concentrations in the shallow and deep groundwater fluctuate seasonally. Additionally, increasing concentration trends are indicated by statistical analysis of the historical nitrate data for Exit Pathway Picket B wells GW-695, GW-703, and GW-704; Exit Pathway Picket A well GW-685; and Exit Pathway Picket W wells GW-712 and GW-713 (Table 5). Of these, only wells GW-712 and GW-713 are located downgradient of the nitrate plume boundary (as defined by the 10 mg/L MCL) in the Aquifer (Figure 8).

Excluding suspected data outliers in June 1993 (GW-695 and GW-703), December 1993 (GW-704), and December 1994 (GW-703), nitrate concentrations reported for wells GW-695 and GW-704 show a fairly steady upward trend, but results for well GW-703 suggest a downward trend following a sharp increase between March (5.67 mg/L) and November (23.8 mg/L) 1992 (Figure 11). These wells are located downgradient of the losing reach of Bear Creek south of Sanitary Landfill I that appears to have a pivotal role in transferring contaminants into the deeper groundwater flow system in the Aquifer. Inflow of nitrate and other S-3 Site contaminants along this section of Bear Creek is primarily controlled by discharge from the catchments of NT-1 and NT-2. As noted previously, increasing concentrations of nitrate (and other comparably mobile S-3 Site contaminants)

in the groundwater at wells GW-085 and GW-537 suggest increased flux of contaminants into NT-1 and NT-2 catchments (and possibly the westward migration of the center of mass of the nitrate plume in the Aquitard). Inflow of increasingly contaminated groundwater discharged from the NT-1 and NT-2 catchments at shallow depths (< 100-ft bgs) into the Aquifer potentially explains the upward concentration trends indicated by the nitrate data for wells GW-695, GW-703, and GW-704. The lack of similarly increasing nitrate concentrations in groundwater at the Exit Pathway Picket C wells supports this interpretation; these wells are downgradient of NT-1 and NT-2 but upgradient of the losing reach of Bear Creek (Figure 8).

Although statistical analysis indicates an increasing concentration trend, nitrate results for Exit Pathway Picket A well GW-685 show significant temporal variability, particularly after semiannual sampling began in February 1994, and nitrate levels are frequently highest during seasonally low groundwater flow (Figure 11). This relationship probably reflects dilution from uncontaminated recharge during the wet season, but may also indicate seasonally variable inflow of nitrate-contaminated groundwater/surface from Bear Creek NT-1 and NT-2. Considering the nearly equal nitrate concentrations in June 1991 (2.0 mg/L) and July 1996 (2.67 mg/L), however, the increasing concentration trend may be an artifact of this seasonal variability.

Nitrate results reported for samples collected during CY 1996 from Exit Pathway Picket W wells GW-712 and GW-713 do not support the increasing concentration trends indicated by statistical analysis of the historical data for each well (Table 5). Nitrate levels in the groundwater samples collected from each well in July 1996 did not exceed the analytical reporting limit, and continue the decreasing trend evident since July 1995. These results were preceded by data showing both relatively steady (GW-712) and fairly erratic (GW-713) upward trends between April 1993 (when nitrate was first detected) and January 1995. In this area, however, the nitrate plume in the Maynardville Limestone occurs primarily in the uppermost hydrostratigraphic intervals (Zones 5 and 6), and these wells are completed in the basal part of the formation more than 300-ft bgs. Moreover, flowpaths in the deeper bedrock may be hydraulically connected to the shallow flow system, but rapid recharge to the deeper bedrock does not occur and the overall groundwater flux is substantially less (Science Applications International Corporation 1997). In light of these considerations, the increasing nitrate concentration trends indicated by historical data for wells GW-712 and GW-713 are probably sampling artifacts and do not reflect increased flux of nitrate at depth in the Aquifer.

4.2 Trace Metals

Evaluation of the CY 1996 groundwater quality data with respect to trace metals focused on the total (unfiltered sample) concentrations of barium, boron, strontium, and uranium that exceed the applicable upper tolerance limit (UTL) reported in: *Determination of Reference Concentrations for Inorganic Analytes in Groundwater at the Department of Energy Y-12 Plant, Oak Ridge, Tennessee* (HSW Environmental Consultants, Inc. et al. 1995). The UTLs were determined from statistical analysis of historical (CY 1986 - CY 1993) data for specific groups of wells (i.e., clusters) differentiated by similar geochemical characteristics. The barium, boron, strontium, and uranium UTLs applicable to wells sampled during CY 1996 are summarized below.

Trace Metal	UTL (mg/L)					
	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 6	Cluster 10
Barium	0.71	0.68	0.79	0.34	0.34	0.35
Boron	0.12	0.028	0.041	0.028	3.1	3.1
Strontium	4.4	0.079	0.92	0.079	0.92	0.92
Uranium	0.012	0.004	0.005	0.005	0.004	0.005

The UTL for each metal represents the maximum concentration expected in the groundwater monitored by the wells comprising each cluster, and results that exceed the UTL (i.e., elevated concentrations) were considered potential evidence of groundwater contamination. The well-cluster designation for each of the wells sampled during CY 1996 is provided in Appendix C.

4.2.1 Aquitard

Elevated concentrations of barium, boron, strontium, or uranium were reported for thirteen unfiltered groundwater samples from the following eight Aquitard monitoring wells located downgradient of contaminant source areas in the Bear Creek Regime (Figure 12).

Well No.	UTL Well Cluster	Total Concentration (mg/L)							
		Barium		Boron		Strontium		Uranium	
		1st Qtr.	3rd Qtr.	1st Qtr.	3rd Qtr.	1st Qtr.	3rd Qtr.	1st Qtr.	3rd Qtr.
GW-069	10	0.37	0.36	.	.	.	.	.	.
GW-276	3	.	.	0.048	.	.	.	1.9	1.2
GW-287	3	.	.	.	0.065	.	.	.	.
GW-537	3	2.7	2.3	.	.	3.1	2.7	.	.
GW-653	2	.	.	.	0.091	.	.	.	.
GW-794	3	.	.	0.062	0.071	.	.	.	.
GW-795	3	.	.	.	0.042	.	.	.	.
GW-829	10	0.56	0.84	.	.	1.2	1.5	.	.
Note: . = Less than applicable UTL; BOLD = wells/metals with increasing concentration trends.									

Total barium concentrations reported for well GW-069, located south of the Bear Creek Burial Grounds, are only slightly above the applicable UTL (0.35 mg/L) and probably reflect ambient levels in the groundwater. Results for the remaining wells indicate groundwater contamination from the S-3 Site (GW-276, GW-537, and GW-829) and the Bear Creek Burial Grounds WMA (GW-287 and GW-653), and possibly Sanitary Landfill I (GW-794 and GW-795). Additionally, increasing long-term concentration trends are indicated by statistical analysis of the historical barium and strontium results for well GW-537, and the historical boron results for wells GW-287, GW-653, and GW-795 (Table 5).

The plume of groundwater contamination in the Aquitard near the S-3 Site contains a heterogeneous mix of trace metals that were either entrained in the acidic wastewater (e.g., uranium) or dissolved from the saprolite and bedrock (e.g., barium). As illustrated by the following summary of barium, boron, strontium, and uranium results for well GW-276, trace metal concentrations in the shallow groundwater south of the site have generally decreased, but at different relative rates.

Trace Metal	Total Concentration (mg/L)							
	October 1988	January 1990	March 1994	August 1994	January 1995	July 1995	February 1996	July 1996
Barium	3.6	2.3	0.61	0.73	0.66	0.83	0.5	0.52
Boron	.	.	0.036	0.068	0.068	0.051	0.048	0.041
Strontium	.	.	0.31	0.35	0.36	0.35	0.35	0.32
Uranium	5.99	3.7	1.16	1.55	1.6	2.0	1.9	1.2
Note: . = Not analyzed; BOLD = result exceeds the applicable UTL (Well Cluster 3).								

Differential retardation probably explains the relative rates at which trace metal concentrations decreased following closure of the S-3 Ponds. For example, uranium concentrations have decreased

at a slower rate compared to barium levels because uranium is more readily adsorbed to mineral surfaces, and the elevated concentrations have been maintained by this subsurface reservoir of adsorbed uranium (Science Applications International Corporation 1997). Conversely, barium and other similarly mobile trace metals are more readily flushed from the shallow flow system and concentrations have decreased more rapidly.

The distribution of elevated barium and strontium concentrations (Figure 12) suggest the same migration pattern as that of nitrate. Elevated concentrations in the shallow groundwater at well GW-537 reflect strike-parallel transport from the S-3 Site and upward migration from the deeper bedrock east of NT-1 into the shallow bedrock west of the tributary. Statistical analysis of the historical barium and strontium data for the well indicates increasing long-term concentration trends (Table 5); fate and transport modeling also predict increasing concentrations of both metals (Science Applications International Corporation 1997). Increasing barium and strontium concentration trends (Figure 13) generally coincide with the increasing nitrate concentration trend and also may reflect the westward migration of the center of mass of the S-3 Site.

Elevated boron concentrations reported for the groundwater samples from wells GW-794 and GW-795 at the AGLLSF are consistent with respective historical data, but the AGLLSF is an unlikely source because boron wastes are not stored at the site. These wells produce groundwater from the upper Nolichucky Shale near the geologic contact with the Maynardville Limestone about 500-ft (GW-794) and 1,500-ft (GW-795) west of Sanitary Landfill I (Figure 12). Elevated boron concentrations have been reported for thirteen of the fifteen groundwater samples collected from well GW-794 since December 1992, including the samples collected in March (0.062 mg/L) and August (0.071 mg/L) 1996. Results for well GW-795 show somewhat lower concentrations (only four of the fifteen sample results exceed the UTL), but statistical analysis of these results indicates an increasing concentration trend (Table 5). Data for both wells potentially indicate downgradient (strike-parallel) transport of boron released from Sanitary Landfill I.

The Bear Creek Burial Grounds WMA received substantial volumes of borax (hydrated sodium borate) waste water from the Y-12 Plant, and elevated boron concentrations were reported for the groundwater samples collected in August 1996 from wells GW-287 (0.053 mg/L) and GW-653 (0.091 mg/L). Boron levels in the groundwater at well GW-653, which is completed in the Nolichucky Shale at a depth of 39.0-ft bgs, potentially indicate westward, strike-parallel transport

from BG-A South. Strike-parallel transport in the shallow groundwater flow system is supported by the characteristically low TDS (i.e., <100 mg/L) of the samples from the well; low TDS suggests short groundwater residence time within highly permeable flowpaths (Shevenell 1994). Elevated boron concentrations in the groundwater at well GW-287, which is about 400-ft directly north of well GW-653, may reflect similar shallow groundwater transport from source areas in the northern part of the Bear Creek Burial Grounds WMA. Results for both wells indicate migration toward NT-8 to the west of the site; similar migration patterns toward NT-6 and NT-7 are indicated by elevated boron concentrations in the groundwater at several wells sampled during CY 1995 (AJA Technical Services, Inc. 1996). Additionally, although the boron results for wells GW-287 and GW-653 show significant temporal variability (Figure 14), the increasing concentration trends indicated by statistical analysis of the historical data for each well (Table 5) potentially indicate increased flux toward NT-8.

4.2.2 Aquifer

As shown in the following summary, elevated total concentrations of boron, strontium, or uranium were reported for twenty-one unfiltered groundwater samples from thirteen Aquifer monitoring wells located downgradient of contaminant source areas in the Bear Creek Regime (Figure 12); the wells are listed in order from farthest upgradient to farthest downgradient.

Well No.	UTL Well Cluster	Total Boron (mg/L)		Total Strontium (mg/L)		Total Uranium (mg/L)	
		1st Qtr.	3rd Qtr.	1st Qtr.	3rd Qtr.	1st Qtr.	3rd Qtr.
GW-723	1	.	0.44	.	.	.	.
GW-725	1	.	0.21	.	.	.	.
GW-738	1	.	0.23	.	.	.	.
GW-740	4	.	0.65	.	.	.	.
GW-621	3	.	.	.	.	.	0.0062
GW-694	1	.	.	.	.	0.12	0.062
GW-706	1	.	.	.	.	0.12	0.13
GW-683	4	.	.	0.12	.	0.024	0.051
GW-684	1	.	.	.	.	0.022	0.041
GW-053	1	0.27	0.29	.	.	.	.
GW-710	1	0.33	0.29	8	7.9	.	.
GW-711	1	1.2	1.3	12	13	.	.
GW-714	3	0.082	0.047	.	.	.	.

Note: . = Less than applicable UTL; **BOLD** = well/metal with increasing concentration trends.

The elevated boron concentrations reported for Exit Pathway Picket C wells GW-723, GW-725, GW-738, and GW-740 are almost an order-of-magnitude higher than boron levels reported for previous samples from each well (none of the results reflect increasing concentration trends). Elevated boron and strontium concentrations reported for Exit Pathway Picket W wells GW-710 and GW-711 reflect ambient levels in the highly mineralized sulfate-dominated groundwater produced by each well. Results that indicate groundwater contamination probably reflect migration from the Boneyard/Burnyard (uranium), Sanitary Landfill I (boron), and the Bear Creek Burial Grounds WMA (boron).

The Burnyard/Boneyard is a principal source of uranium in the Aquifer. Uranium leached from the source(s) at this site recharges directly into the Maynardville Limestone or migrates along strike in the Aquitard toward NT-3, and enters the Aquifer along the major losing reach of the Bear Creek south of the Boneyard/Burnyard/HCDA and Sanitary Landfill I (Science Applications International Corporation 1997). This migration pattern is consistent with the elevated total uranium concentrations reported for Exit Pathway Picket B wells GW-621, GW-694, and GW-706. These wells are downgradient of the Burnyard/Boneyard, the confluence of NT-3 and Bear Creek, and the losing reach of the creek.

Elevated uranium concentrations in the groundwater at Exit Pathway Picket A wells GW-683 and GW-684 also may reflect downgradient, strike-parallel transport of uranium from the Boneyard/Burnyard/HCDA. However, the Bear Creek Burial Grounds WMA also received large volumes of uranium wastes, and data obtained during the RI for the Bear Creek Watershed show elevated uranium concentrations in surface water samples from NT-6 and NT-7, both of which discharge into Bear Creek upstream of Exit Pathway Picket A. Regardless of the source, the uranium results for wells GW-683 and GW-684 suggest a transport pattern similar to that of nitrate, with downgradient transport into successively higher hydrostratigraphic zones in the Maynardville Limestone and ultimately into the lower Copper Ridge Dolomite.

Elevated total boron concentrations reported for the groundwater samples from Aquifer well GW-053 probably reflect influx of boron-contaminated groundwater/surface water from sources in the Bear Creek Burial Grounds WMA (e.g., BG-A South). As noted in Section 4.2.1, boron results for Aquitard monitoring wells at the site indicate groundwater transport toward the Bear Creek tributaries (NT-6, NT-7, and NT-8) that traverse the site. Well GW-053 is located north of Bear

Creek, about 1,200-ft downstream of the confluence with NT-6 and about 200-ft upstream of the confluence with NT-7 (Figure 12). Infiltration of boron-contaminated surface water discharged into Bear Creek from these tributaries (and NT-8) may also explain the elevated boron concentration reported for the samples collected from Exit Pathway Picket W well GW-714.

Increasing long-term concentration trends are indicated by statistical analysis of the historical barium, boron, and strontium data for eight of the Aquifer monitoring wells that were sampled during CY 1996 (Table 5): GW-056 (strontium), GW-685 (strontium), GW-695 (barium), GW-703 (barium, boron, and strontium), GW-704 (barium, boron, and strontium), GW-711 (boron), and GW-724 (barium). Of these, only the boron concentrations reported for well GW-711 exceed the applicable UTL, but as noted previously, these results probably reflect ambient concentrations in the highly mineralized groundwater more than 500-ft bgs. Increasing concentration trends indicated by the data for the other wells potentially indicate increased flux from the S-3 Site contaminant plume (barium and strontium) and Sanitary Landfill I (boron).

Barium results for Exit Pathway Picket B monitoring wells GW-695, GW-703, and GW-704 show clearly increasing concentration trends (Figure 15). Results for shallow bedrock well GW-695 (62.6-ft bgs) show a steady increase from 0.012 to 0.033 mg/L between June 1991 and July 1996. Concentrations in the groundwater at deeper bedrock wells GW-703 (182-ft bgs) and GW-704 (256-ft bgs) increased 0.038 mg/L over this same time period, although results for both wells show considerably more short-term variability than the results for well GW-695. As noted in the discussion of increasing nitrate concentrations evident for these wells, the increasing barium levels potentially reflect inflow of increasingly contaminated groundwater from the NT-1 and NT-2 catchments in the Aquitard. The same rationale may also explain the increasing concentration trends indicated by the strontium results for well GW-703 and GW-704 (Figure 16).

Although most of the boron results for wells GW-703 and GW-704 are below the applicable UTL (0.12 mg/L), the results for well GW-703 show an overall increase of 0.055 mg/L between June 1991 (0.055 mg/L) and July 1996 (0.11 mg/L), and aside from an apparent data outlier in June 1993 (0.26 mg/L), the results for well GW-704 show a concurrent increase of 0.063 mg/L (0.013 to 0.076 mg/L) (Figure 17). These increasing concentration trends are probably not attributable to migration from the S-3 Site contaminant plume because: (1) the relatively low boron concentrations in the shallow groundwater at well GW-276, and the similarly low levels indicated by historical

boron data for the Exit Pathway Picket C wells tend to discount westward (strike-parallel) migration in the Aquifer from south of the S-3 Site, and (2) the lack of elevated or increasing boron concentrations in the groundwater at wells GW-085 and GW-537 discounts inflow of boron-contaminated groundwater and surface water discharged from NT-1 and NT-2. However, elevated boron concentrations reported for groundwater samples collected from several Aquifer wells during CY 1995 suggest that Sanitary Landfill I, which is a confirmed source of several VOCs, is a potential source of boron in the Aquifer (AJA Technical Services, Inc. 1996). Increasing boron concentration trends indicated by results for wells GW-703 and GW-704 may reflect increased flux of boron from the site.

Increasing strontium concentration trends are indicated by statistical analysis of the historical data for wells GW-056 and GW-685 (Table 5). These increasing trends, however, appear to be a result of anomalously low strontium results reported for samples collected from each well in CY 1991. For example, aside from the results reported for the groundwater samples collected from well GW-685 in September 1991 (0.094) and December 1991 (0.099), strontium concentrations vary between 0.1 and 0.13 mg/L, and were the same level (0.12 mg/L) in each sample collected from the well after September 1994.

4.3 Volatile Organic Compounds

Excluding false positive results, one or more of the following VOCs were detected (including estimated concentrations below the analytical reporting limit) in thirty-nine groundwater samples collected during CY 1996 from twenty-one monitoring wells: carbon tetrachloride, chloroform, PCE, TCE, 1,1-DCA, 1,1-DCE, 1,2-DCE, 1,1,1-TCA, and vinyl chloride (see Appendix C). The first occurrence of PCE was observed in a groundwater sample from Aquitard well GW-537 and 1,1,1-TCA in samples from Aquifer wells GW-056, GW-621, and GW-695. Although these results potentially show migration of groundwater with these specific compounds into new areas, detection of these constituents does not indicate a significant change in the summed VOC plume boundaries because other plume constituents have been detected in previous samples from each well. For example, PCE (1 µg/L) in the sample collected in March 1996 at GW-537 may represent the first arrival of PCE from the S-3 Site, but chloroform (also from the S-3 Site) has been detected at low levels (about 1 µg/L) since August 1992.

4.3.1 Aquitard

Few of the Aquitard monitoring wells that were sampled during CY 1996 monitor VOC-contaminated groundwater; VOCs were detected only in the groundwater samples from GW-069, GW-276, GW-537, GW-627, and GW-653 (Appendix C). Maximum summed concentrations exceed 10 µg/L only in groundwater samples collected from wells GW-276 (19 - 23 µg/L), GW-627 (60 - 71 µg/L), and GW-653 (15 - 40 µg/L). These results are consistent with respective historical data showing dissolved chloroethenes (primarily PCE, TCE, and 1,2-DCE) and/or lesser plume components (chloroform, 1,1-DCA, and vinyl chloride) in the shallow groundwater south (GW-276) and west (GW-537) of the S-3 Site, and in the shallow and deep groundwater south (GW-069) and west (GW-627 and GW-653) of BG-A South (Figure 18).

Historical data for wells located adjacent to the S-3 Site show dissolved PCE concentrations above 5,000 µg/L in the shallow groundwater and indicate the presence of DNAPL in the subsurface. However, the PCE results for samples collected in March (18 µg/L) and July (22 µg/L) 1996 from well GW-276, which is only 250-ft south of the S-3 Site, illustrate the substantial attenuation of VOCs that occurs in the subsurface. Both results exceed the 5 µg/L MCL for PCE, but are about 85% lower than the levels reported for samples collected from the well in the late-1980s. Substantially decreased PCE concentrations mirror the trends evident for nitrate and trace metals, and likewise result from closing/capping the S-3 Site and subsequent flushing of the highly contaminated groundwater from the shallow flow system.

Chloroform is a component of the S-3 Site contamination plume in the Aquitard and low levels (<5 µg/L) have been detected in several groundwater samples from well GW-537 (including 1 µg/L in both samples collected during CY 1996). The presence of chloroform in the groundwater at the well suggests strike-parallel transport in the shallow groundwater west of the S-3 Site, which also may explain the first-time detection of PCE (1 µg/L) in the sample collected in March 1996. In light of the very low concentrations, however, it is possible both chloroform and PCE have been present in the groundwater but were volatilized during sampling. Compared to the substantially higher concentrations of more mobile, non-volatile S-3 Site contaminants (e.g., nitrate) in the groundwater at the well, the trace levels of chloroform and PCE suggest significantly greater attenuation of VOCs along strike-parallel flowpaths in the Aquitard.

As noted in Section 2.5, very high VOC concentrations in the groundwater at the Bear Creek Burial Grounds WMA reflect widespread subsurface DNAPLs consisting of PCE and TCE. These compounds are the principal components of the dissolved VOC plume in the groundwater at the site and were detected in the samples collected during CY 1996 from wells GW-653 and GW-627 (Appendix C). The presence of these VOCs in the shallow groundwater at well GW-653 reflects westward, strike-parallel transport from BG-A South toward NT-8 (Figure 18). Results for this well also illustrate the proportionally higher concentrations of degradation products (e.g., 1,2-DCE) relative to the parent chemicals (PCE and TCE) that are characteristic of the VOC data for many water table interval and shallow bedrock wells near BG-A South. In contrast, the VOC data for well GW-627 show proportionally higher concentrations of parent compounds relative to degradation products. This well is completed at a depth of 270-ft bgs in the Nolichucky Shale about 150-ft west of BG-A South (Figure 18). The dissolved VOCs in the groundwater at the well probably originate from the DNAPL in the subsurface; DNAPL consisting of PCE and TCE was encountered 260 to 330-ft down dip of BG-A South and may have preferentially migrated through the middle Nolichucky Shale (Haase and King 1990; Drier and Davidson 1994).

The CY 1996 PCE and TCE results for well GW-627 are consistent with historical data showing steadily increasing concentration trends (Figure 19). Detection of TCE and PCE and the subsequent concentration increases generally coincide with discovery of DNAPLs down-dip of BG-A South during installation of monitoring wells in January 1990, and mobilization of the DNAPL may explain the increasing trend. Considering the depth of the well and the characteristically low permeability of the Aquitard at depth, however, the hydraulic gradient produced by purging and sampling may have induced VOC migration into the well. Regardless of whether migration has been induced, the presence of PCE and TCE indicates strike-parallel transport at depth in the Aquitard. Fate and transport modeling suggest it will take as long as 600 years for the PCE to migrate as far west as NT-8 (Science Applications International Corporation 1997).

Results for samples collected from well GW-069 are consistent with historical data showing low levels (<5 $\mu\text{g/L}$) of vinyl chloride in the groundwater at the well (see Appendix C). Vinyl chloride is a degradation product of TCE, and low levels in the groundwater at this well, combined with the upward vertical hydraulic gradients in the Nolichucky Shale, indicates upward migration from TCE DNAPL in the subsurface.

4.3.2 Aquifer

As noted in Section 2.5, the plume of dissolved VOCs in the Aquifer is dominated by TCE and reflects input from multiple sources (including the S-3 Site, Spoil Area I, the Rust Spoil Area, the Boneyard/Burnyard/HCDA, and the Bear Creek Burial Grounds WMA). Strike-parallel transport is observed following the same general pattern indicated by the geometry of the nitrate plume in the Aquifer. Results obtained during CY 1996 reflect both the TCE-dominated composition of the plume and strike-parallel transport from multiple source areas (Figure 18). Maximum summed VOC concentrations (Table 7) are highest for samples from Exit Pathway Picket C wells GW-724 (171 µg/L), GW-738 (55 µg/L), and GW-740 (79 µg/L), and Exit Pathway Picket B well GW-704 (114 µg/L). Additionally, increasing concentration trends are indicated by statistical analysis of historical data for Exit Pathway Picket C wells GW-724 (TCE), GW-725 (PCE), and GW-738 (PCE); Exit Pathway Picket B wells GW-695 (TCE) and GW-704 (TCE); and Exit Pathway Picket A well GW-683 (TCE) (Table 5).

Chloroform, PCE, TCE, and 1,2-DCE were detected in the groundwater samples from well GW-315, which is completed at a depth of 104-ft bgs on the northern flank of Chestnut Ridge south of Spoil Area I (Figure 18). Summed VOC concentrations for each sample were 13 and 24 µg/L, but the PCE concentrations (9 and 13 µg/L) dominate. These results are consistent with historical data for the well and reflect input of VOCs from Spoil Area I or possibly the Fire Training Facility, which is a confirmed source of chloroethenes (PCE and 1,2-DCE) in the East Fork Regime about 1,000-ft east of the well.

The low levels (5 - 8 µg/L) of TCE detected in the groundwater samples collected from well GW-311 during CY 1996 are consistent with historical results and reflect influx of TCE from the Rust Spoil Area (Figure 18). As noted in Section 2.5, low VOC concentrations are typical of groundwater in the shallow karst network and result from more rapid attenuation relative to the deeper, fracture-dominated flow system in the Maynardville Limestone.

The CY 1996 results for the groundwater samples from the Exit Pathway Picket C wells reflect strike-parallel transport of TCE from the Rust Spoil Area in the shallow karst network (GW-738) and deeper bedrock (GW-723, GW-724, GW-725, and GW-740), but trace concentrations (<5 µg/L) of PCE (GW-724), carbon tetrachloride (GW-724 and GW-740), chloroform (GW-738 and GW-740), and 1,1,1-TCA (GW-738 and GW-740) suggest another upgradient source, possibly

the S-3 Site and Spoil Area I (Table 7). The relatively high TCE concentrations (31 - 72 µg/L) compared to the relatively low nitrate concentrations (3.48 - 3.99 mg/L) in the groundwater at well GW-740 potentially indicate transport along different flowpaths in the shallow karst network.

Statistical analysis of historical data for the Exit Pathway Picket C wells indicates increasing concentrations of TCE in the groundwater at well GW-724 and PCE in the groundwater at wells GW-725 and GW-738 (Table 5). Trichloroethene has been detected in every sample collected from well GW-724 since May 1992, and excluding anomalously low results in September 1993 (3 µg/L) and August 1996 (40 µg/L), concentrations have increased from about 50 µg/L to more than 150 µg/L (Figure 20). This well is completed with a 12-ft open interval more than 300-ft bgs, and the increasing TCE levels potentially indicate increased flux along strike-parallel flowpaths at depth in the middle (Zone 4) of the Maynardville Limestone. In contrast, historical data show trace levels (3 µg/L or less) of PCE in six samples from well GW-725 and three samples from well GW-738 (Figure 20). Volatilization during sampling may explain the sporadic detection of PCE and the apparent concentration trend.

Results for Exit Pathway Picket B wells GW-621, GW-694, GW-695, GW-703, GW-704, and GW-706 are consistent with respective historical data for each well, and show primarily TCE and 1,2-DCE in the Aquifer downgradient of the Oil Landfarm WMA (Table 7). The highest TCE concentrations (70 - 97 µg/L) were reported for well GW-704, which is the deepest (256-ft bgs) well in Exit Pathway Picket B, and reflect either strike-parallel transport from the Rust Spoil Area, vertical migration along the loosing reach of Bear Creek south of Sanitary Landfill I, or both. Relatively low (<10 µg/L) concentrations of 1,1-DCE and 1,2-DCE in the groundwater at these wells may be from degradation of TCE, but trace levels (<5 µg/L) of carbon tetrachloride (GW-704) and 1,1,1-TCA (GW-695 and GW-704), suggest influx of VOCs from sources in the Burnyard/Boneyard/HCDA or Sanitary Landfill I (portions of both site directly overlie the Maynardville Limestone).

The significance of the increasing concentration trends indicated by statistical analysis of the TCE results for Exit Pathway Picket B wells GW-695 and GW-704 (Table 5) is questionable and may be artifacts of concentration variability. Trichloroethene has been detected in all but three of the seventeen groundwater samples collected from well GW-695, and concentrations have slightly increased from 3 µg/L in June 1991 to 5 µg/L in July 1996 (Figure 20). Considering the low TCE

concentrations and potential for volatilization during sampling, however, the significance of this apparent trend is questionable. Much higher TCE concentrations (>50 $\mu\text{g/L}$) have been reported each sample collected from well GW-704 since June 1991, but excluding results for March (120 $\mu\text{g/L}$) and December (55 $\mu\text{g/L}$) 1993, have ranged between 64 and 100 $\mu\text{g/L}$ (Figure 20).

Dissolved VOCs were detected in the groundwater samples from three Aquifer monitoring wells downgradient of Exit Pathway Picket B: well GW-053 (TCE, 1,2-DCE, 1,1-DCA, and vinyl chloride), and Exit Pathway Picket A wells GW-056 (1,1,1-TCA) and GW-685 (1,2-DCE). Summed VOC concentrations exceed 20 $\mu\text{g/L}$ in both samples from well GW-053, but only trace concentrations (1 $\mu\text{g/L}$) were detected in the samples collected from well GW-056 and GW-685 in March and December 1996, respectively (see Appendix C). Results for well GW-053 are consistent with historical data and indicate transport of VOCs from sources in the Bear Creek Burial Grounds WMA. Neither 1,1,1-TCA nor 1,2-DCE were detected in samples previously collected from wells GW-056 and GW-685, although trace levels of PCE have been reported for samples from well GW-685. The Bear Creek Burial Grounds WMA is the most likely source of the VOCs in the groundwater at these wells.

4.4 Radioactivity

Evaluation of groundwater quality with respect to radiological contamination was based on CY 1996 results for gross alpha and gross beta that exceed the associated minimum detectable activity (MDA) and counting error (the value which expresses the degree of analytical uncertainty) reported for each sample. Gross alpha and gross beta results that meet these DQO criteria were reported for a total of thirty-eight groundwater samples from twenty-five monitoring wells (Table 8). Samples from the Aquitard and Aquifer wells used for RCRA post-closure corrective action monitoring were analyzed for several radionuclides, and samples from selected Aquifer wells were analyzed for ^{99}Tc (Table 4). Radionuclide results that exceed the associated MDAs and counting errors were reported for samples collected from five monitoring wells located downgradient of contaminant source areas in the Bear Creek Regime: well GW-276 at the S-3 Site; Exit Pathway Picket B wells GW-694 and GW-706; and Exit Pathway Picket W wells GW-710, GW-711, GW-712, GW-713, GW-714, and GW-715 (see Appendix C).

4.4.1 Aquitard

Groundwater in the Aquitard with elevated gross alpha, as defined by activity above the MCL for drinking water (15 pCi/L), is primarily from uranium isotopes and mainly occurs near the S-3 Site and the Boneyard/Burnyard/HCDA (Figure 21). Elevated gross beta, as defined by results that exceed the Safe Drinking Water Act (SDWA) screening level of 50 pCi/L, also occurs in the groundwater at both sites (Figure 22), but is substantially higher nearest the S-3 Site. Gross beta in the groundwater near the S-3 Site is primarily from ^{99}Tc , but the activities derived from decay of uranium isotopes potentially account for gross beta in the groundwater near the Boneyard/Burnyard/HCDA (Science Applications International Corporation 1997). The CY 1996 gross alpha and gross beta results that reflect groundwater contamination are consistent with these findings; as shown in the following summary, elevated activities were reported only for groundwater samples from wells located to the south (GW-276) and west (GW-085, GW-537, and GW-828) of the S-3 Site.

Well Number	Gross Alpha $\pm$ Counting Error (pCi/L)		Gross Beta $\pm$ Counting Error (pCi/L)	
	1st Qtr.	3rd Qtr.	1st Qtr.	3rd Qtr.
GW-085	.	<	100 $\pm$ 16	95.6 $\pm$ 14
GW-276	410 $\pm$ 55	368 $\pm$ 51	810 $\pm$ 110	575 $\pm$ 75
GW-537	.	.	168 $\pm$ 24	401 $\pm$ 81
GW-828	18 $\pm$ 7.2	.	<	<
Note: "." = Less than MDA; < = Less than 15 pCi/L (gross alpha) or 50 pCi/L (gross beta); BOLD = increasing trend				

Considering the characteristic variability of the analytical results for gross alpha and gross beta, these results are generally consistent with historical data for each well. For example, gross alpha reported for each sample collected from well GW-537 during CY 1996 did not exceed the associated MDA, but results for several previous samples show alpha activity above 100 pCi/L. Variability inherent to the analytical method should be expected, but gross alpha results for samples collected using low-flow sampling protocols are substantially lower than results for samples collected using current GWPP sampling protocols and suggest that sampling bias is a possible source of the most extreme variations (AJA Technical Services, Inc. 1996).

Elevated gross alpha and gross beta in the shallow groundwater at well GW-276 reflects transport of uranium isotopes and ^{99}Tc from S-3 Site toward Bear Creek. Except for the ^{234}U and ^{238}U results for the sample collected from the well in July 1996 (see Appendix C), which are less than the associated MDAs and are probably analytical or data transcription errors, the CY 1996 gross alpha, gross beta, and radionuclide results are consistent with historical data for the well. Gross alpha and gross beta results show substantially decreased levels after closure of the S-3 Site, but gross beta has generally decreased more rapidly. Alpha activity levels are probably maintained by the uranium isotopes adsorbed to sludges remaining in the S-3 Ponds and mineral surfaces in the Aquitard that are slowly released, whereas more rapidly decreasing beta activity reflects greater flushing of ^{99}Tc from the shallow flow system (Science Applications International Corporation 1997).

The CY 1996 gross alpha and gross beta results for groundwater samples from wells GW-085 and GW-537 are generally consistent with respective historical data and clearly illustrate the differential retardation of radionuclides in the Aquitard. The low gross alpha in the groundwater at each well reflects substantial attenuation of uranium isotopes along strike-parallel flowpaths west (and east) of the S-3 Site: ^{234}U , ^{235}U , and ^{238}U activities reported for samples collected from each well in CY 1995 are either less than the associated MDAs or have proportionally high counting errors. In contrast, the high gross beta in the shallow groundwater at each well reflects lesser retardation of ^{99}Tc and substantially greater strike-parallel transport: ^{99}Tc activities above 100 and 1,000 pCi/L were reported for samples collected from wells GW-085 and GW-537, respectively, in CY 1995. Additionally, gross beta results for both wells show statistically significant increasing trends (Table 5) which generally mirror those indicated by the nitrate data for each well (Figure 23), and likewise suggest that the center of mass of the S-3 Site contaminant plume is moving west toward NT-2 (Science Applications International Corporation 1997).

4.4.2 Aquifer

As noted in Section 2.5, elevated gross alpha and gross beta in the Aquifer is from uranium isotopes and ^{99}Tc , respectively. Elevated gross alpha (i.e., >15 pCi/L) in the groundwater reflects transport of uranium isotopes from the S-3 Site, the Boneyard/Burnyard/HCDA (the primary source area), and the Bear Creek Burial Grounds WMA, primarily via (1) inflow from the buried tributary

of Bear Creek that extends beneath the S-3 Site, (2) direct recharge from the Boneyard/Burnyard/HCDA (and inflow from the NT-3 catchment), and (3) inflow from tributary catchments to the east (NT-6) and west (NT-7 and NT-8) of BG-A (North and South). Although gross beta below the SDWA screening level (50 pCi/L) is characteristic of samples from most Aquifer wells, gross beta is usually higher than gross alpha and is more frequently accompanied by elevated nitrate concentrations. These relationships reflect the greater attenuation of uranium isotopes relative to ^{99}Tc and essentially identical patterns of nitrate and ^{99}Tc transport from the S-3 Site. Gross alpha and gross beta results for Aquifer wells sampled during CY 1996 are generally consistent with these findings.

Gross alpha above the associated MDA and counting error was reported for at least one groundwater sample from eleven Aquifer wells (Table 8), including the following results that exceed 15 pCi/L: Exit Pathway Picket B wells GW-694 (43.6 ± 10 pCi/L), GW-704 (31.3 ± 7 pCi/L) and GW-706 (53.7 ± 12 pCi/L and 62.8 ± 11 pCi/L), and Exit-Pathway Picket A wells GW-683 (26.1 ± 6.2 pCi/L) and GW-684 (19.4 ± 5.3 pCi/L). Considering the characteristic variability of gross alpha and potential for sampling bias, these results are generally consistent with historical data for each well.

Attenuation of uranium isotopes (and other alpha-emitting radionuclides) along strike-parallel flowpaths in the Aquifer south of the S-3 Site is illustrated by low gross alpha in the groundwater at Exit Pathway Picket C wells (the highest activity was 5.11 ± 2.6 pCi/L at well GW-738), particularly in light of the elevated nitrate (>10 mg/L) in the groundwater at wells GW-724, GW-725, and GW-738 (Figure 21). Low gross alpha also probably reflects discharge of contaminated groundwater into Bear Creek, which gains flow upstream of Exit Pathway Picket C.

Elevated gross alpha activity in the groundwater at wells GW-704 and GW-706 reflect inflow of uranium isotopes along the losing reach of Bear Creek south of the Boneyard/Burnyard/HCDA and Sanitary Landfill I (Figure 21). Downgradient transport of the uranium isotopes may explain the elevated gross alpha activity in the groundwater at wells GW-683 and GW-684, but considering attenuation, influx of uranium from the Bear Creek Burial Grounds WMA seems more likely. In either case the elevated gross alpha activity suggests a transport pattern similar to that of nitrate, with downgradient transport southward into successively higher hydrostratigraphic zones in the Maynardville Limestone and ultimately into the lower Copper Ridge Dolomite.

Statistical analysis of historical data indicates increasing gross alpha in the groundwater at four Aquifer wells: GW-313 and GW-314 at Spoil Area I, GW-226 southwest of Sanitary Landfill I, and well GW-061 south of the Bear Creek Burial Grounds WMA. However, none of these wells were sampled during CY 1996 (Table 5). The strongest increase was noted for well GW-226, which is completed with an open interval from 45 to 55 ft bgs in the basal Maynardville Limestone. Gross alpha in the groundwater at the well reflects downgradient transport of uranium isotopes from the Burnyard/Boneyard/HCDA, and the historical results for this well show an increase from 12.19 ± 2.5 pCi/L in February 1990 to 33.86 ± 4 pCi/L in May 1991.

Gross beta above the associated MDA and counting error was reported for at least one groundwater sample from fifteen Aquifer wells: GW-315 at the Rust Spoil Area; Exit Pathway Picket C wells GW-723, GW-724, GW-725, GW-738, and GW-740; Exit Pathway Picket B wells GW-621, GW-694, GW-695, GW-702, GW-704, and GW-706; well GW-053 south of the Bear Creek Burial Grounds WMA; and Exit Pathway Picket A wells GW-683 and GW-684 (Figure 22). The highest activity (52.8 ± 10 pCi/L) was reported for the sample collected in July 1996 from Exit Pathway Picket B well GW-706 (Table 8).

Strike-parallel transport of ^{99}Tc in the Aquifer south of the S-3 Site is indicated by gross beta activity in the groundwater at wells GW-315, GW-723, GW-724, GW-725, GW-738, and GW-740 (Figure 23). Results for these wells generally mirror the respective nitrate data and show the comparable mobility of nitrate and ^{99}Tc . Similar nitrate and ^{99}Tc migration patterns also are supported by the ^{99}Tc activities reported for groundwater samples from Exit Pathway Picket B wells GW-694 (44.5 ± 6.5 pCi/L) and GW-706 (65.5 ± 8.5 pCi/L). Gross beta results for wells GW-683 (34 ± 7.4 pCi/L) and GW-684 (31.1 ± 6.5 pCi/L) likewise indicate downgradient transport into the lower Copper Ridge Dolomite (Figure 23).

Increasing temporal trends are indicated by statistical analysis of historical gross beta results for Exit Pathway Picket C wells GW-723 and GW-724, and Exit Pathway Picket B well GW-704 (Table 5 and Figure 24). Increasing gross beta in the groundwater at well GW-704 coincides with the increasing trends indicated by the nitrate, barium, and strontium results for the well and likewise suggests inflow of increasingly contaminated groundwater discharged from the NT-1 and NT-2 catchments.

5.0 SURFACE WATER QUALITY DATA EVALUATION

This section presents an evaluation of surface water quality in Bear Creek, as indicated by the CY 1996 data for samples from the main channel (BCK-00.63, BCK-03.87, BCK-04.55, BCK-07.75, BCK-09.40, BCK-10.60, and BCK-11.97), one major northern tributary (NT-1), and three springs that discharge to the creek (SS-1, SS-4, and SS-5) (Figure 6). The evaluation is based on the underlying assumptions and outcome of the respective data screening and evaluation procedures described in Section 4.0 for principal ions, trace metals, VOCs, and radiological parameters. Results for unfiltered samples that meet DQOs of the Y-12 Plant GWPP are provided in Appendix C.

For this discussion, the water quality of Bear Creek is divided into three sections: Upper Bear Creek, upstream of BCK-11.97, is near the S-3 Site; Middle Bear Creek, between BCK-11.97 and BCK-09.40, is below the Oil Landfarm and Burial Grounds WMAs; and Lower Bear Creek, downstream of BCK-09.40, is unaffected by other waste sites. The CY 1996 maximum results reported for the principal contaminants at each sampling location are presented below.

Sampling Point	Inorganics (mg/L)		Organics (µg/L)			Radioactivity (pCi/L)		
	Nitrate	Uranium	PCE	TCE	1,2-DCE	Alpha	Beta	⁹⁹ Tc
Upper Bear Creek								
NT-01	24.7	0.014	4	2	ND	11.7	173	313
SS-1	19.8	0.041	2	3	ND	16.3	32.8	67
BCK-11.97	42.8	0.13	ND	ND	ND	63.9	113	186
Middle Bear Creek								
BCK-10.60	13.2	0.12	ND	ND	ND	66.1	38.5	56
SS-4	14.2	0.12	ND	6	7	68.43	64.4	52
SS-5	8.6	0.086	ND	ND	ND	32.1	29.5	NA
BCK-09.40	9.29	0.096	ND	ND	14	46.7	33.4	37
Lower Bear Creek								
BCK-07.75	10.5	0.058	ND	ND	2	29.3	30.5	NA
BCK-04.55	2.77	0.039	ND	ND	ND	14.4	11.3	NA
BCK-03.87	2.52	0.029	ND	ND	ND	18.1	8.93	NA
BCK-00.63	1.13	0.031	ND	ND	ND	12.5	8.62	NA
Standard	10	UTL	5	5	-	15	50	
Note: Results for each sampling point may be from more than one sampling date. ND=not detected; NA=not analyzed; BOLD=exceeds water quality standard (MCL or UTL)								

In general, contaminant concentrations in Bear Creek decrease with distance from the S-3 Site. Localized segments of the creek show increases in concentration with distance from the S-3 Site that reflects input of contaminated groundwater from other waste sites or from the Aquifer into Bear Creek. Contaminant concentration trends at each sampling location show seasonal fluctuations, but generally decrease since closure of the waste sites. Furthermore, data from none of the surface water or spring sampling locations sampled in CY 1996 show statistically significant increasing trends for the contamination indicator constituents discussed in Section 4.0 (Paradigm Data Services 1996).

5.1 Upper Bear Creek

The surface water quality in the upper reaches of Bear Creek primarily reflects discharge of contaminated groundwater from the water table interval in the Aquitard and Aquifer downgradient of the S-3 Site. Discharge of contaminated groundwater from the Aquitard is demonstrated by CY 1996 results for samples collected from tributary NT-1; results for spring SS-1 show influx of contaminated groundwater from the Aquifer. The highest levels of PCE and gross beta activity were reported for samples from NT-01, suggesting preferred migration along strike from the S-3 Site in the Aquitard for these contaminants. Samples from BCK-11.97 (located about 1,500 ft downstream from NT-01 and SS-1) had higher nitrate, uranium, and gross alpha activity than the upstream sampling locations. This portion of Bear Creek is influent (Science Applications International Corporation 1997), so the higher contaminant levels at BCK-11.97 may reflect input of these contaminants with groundwater from the Aquifer.

Results for BCK-11.97 reflect the overall improvement of surface water quality in the upper reach of Bear Creek since closure of the S-3 Site. As indicated by the nitrate concentrations and gross alpha activity reported since 1990, contaminant levels in Upper Bear Creek fluctuate seasonally but generally decrease with time (Figure 25). Decreasing contaminant concentrations in the upper part of Bear Creek mirror the decreasing concentration trends evident in the shallow groundwater near the S-3 Site.

Concentrations are generally highest at BCK-11.97 during the seasonally dry periods of the year (summer and fall) when the bulk of the flow in the creek is from groundwater discharge

(Figure 25). These results suggest that contaminant concentrations in Bear Creek are generally controlled by varying degrees of seasonal dilution.

5.2 Middle Bear Creek

Surface water quality in Bear Creek downstream of BCK-11.97 reflects contaminant transport from the upper reaches of the creek, from the Burnyard/Boneyard (uranium, TCE, and 1,2-DCE), and from the Burial Grounds WMA (1,2-DCE). This portion of Bear Creek is effluent, and plays an important role in transferring contaminants from the creek to the Aquifer.

Concentrations of the “signature” constituents (nitrate and ^{99}Tc) of the plume that originates from the S-3 Site generally decrease steadily with distance from the site. Higher concentrations of other contaminants reported for downstream samples than for upstream samples reflect input from other sources. For example, maximum nitrate concentration and gross beta activity at BCK-10.60 are significantly lower (69% and 66%, respectively) than the maximum levels reported for BCK-11.97. However, the uranium concentration at BCK-10.60 is similar (8% lower) and gross alpha activity is slightly higher (3%) than at BCK-11.97. These results show input of uranium from the Boneyard/Boneyard, which lies between BCK-11.97 and BCK-10.60 (Figure 6). Furthermore, the 1,2-DCE concentration reported for BCK-09.45 probably reflect an influx of contaminated groundwater from Bear Creek tributaries (NT-7 and NT-8) that traverse the Burial Grounds WMA. As noted previously, both TCE and 1,2-DCE are primary components of the VOC plume in the shallow groundwater at BG-A South. Discharge from BC-A North into NT-7 also may contribute to gross alpha and gross beta activity in Bear Creek at BCK-09.40.

Springs SS-4 and SS-5, which contribute the bulk of the flow in the creek during seasonally low flow periods (Science Applications International Corporation 1997), are other sources of contamination in the creek downstream of BCK-11.97. Samples from SS-4 had lower nitrate concentration and ^{99}Tc activity than reported for spring SS-1, but had higher levels of uranium, TCE, 1,2-DCE, gross alpha, and gross beta. These higher levels reflect transfer of contaminants from Bear Creek into the Aquifer along the losing reach of the creek upgradient from SS-4, and migration along strike of VOCs from the Rust Spoil Area, which is between SS-4 and SS-1.

5.3 Lower Bear Creek

Surface water downstream of BCK-09.40 contains slightly elevated concentrations of several contaminants, but only uranium is consistently above applicable water quality standards. The slightly higher nitrate concentration at BCK-07.75 than reported for BCK-09.40 may reflect input of nitrate in groundwater from the Aquifer, as this section of Bear Creek is influent (Science Applications International Corporation 1997).

Results for BCK-00.63 reflect surface water quality as it exits the regime. Total uranium is the only constituent with results above water quality standards, and the associated gross alpha activity is below the 15 pCi/L MCL.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The groundwater and surface water quality data obtained during CY 1996 are generally consistent with historical results regarding the sources of contamination in the Bear Creek Regime, the types of contaminants from each source area, the pattern and extent of groundwater transport in the Aquitard and the Aquifer, and the downstream extent of surface water contamination in Bear Creek. This conclusion is based on evaluation of the data for the primary groundwater and surface water contaminants (nitrate, barium, boron, strontium, uranium, PCE, TCE, gross alpha, and gross beta), with particular focus on CY 1996 sampling locations (monitoring wells, springs, and surface water stations) for which increasing concentration trends are indicated by nonparametric (Theil Slope) statistical analysis of historical (CY 1990 - CY 1995) data.

Most of the Aquitard wells that were sampled during CY 1996 monitor uncontaminated calcium-magnesium-bicarbonate groundwater upgradient of the waste management sites in the Bear Creek Regime. Results that indicate groundwater contamination, summarized below, are consistent with historical data and indicate strike-parallel migration from the S-3 Site (GW-085, GW-276, GW-537, and GW-829), the Bear Creek Burial Grounds WMA (GW-287, GW-627, and GW-653), and possibly Sanitary Landfill I (GW-794 and GW-795).

Aquitard Well	Groundwater Contaminant Above Screening Level (○) and with Increasing Concentration Trend (●)								
	Nitrate	Barium	Boron	Strontium	Uranium	PCE	TCE	Gross Alpha	Gross Beta
GW-085	●	●	•	○	•	•	•	•	●
GW-276	○	○	○	○	○	○	•	○	○
GW-287	•	•	○	•	•	○	•	•	•
GW-537	●	●	•	●	•	●	•	•	●
GW-627	•	•	•	•	•	○	●	•	•
GW-653	•	•	○	•	•	•	○	•	•
GW-794	•	•	○	•	•	•	•	•	•
GW-795	•	•	●	•	•	•	•	•	•
GW-829	○	•	•	•	•	•	•	•	•
Screening Level	10 mg/L	UTL	UTL	UTL	UTL	5µg/L	5µg/L	15 pCi/L	50 pCi/L

Increasing nitrate, barium, strontium, and gross beta levels in the shallow groundwater at wells GW-085 and/or GW-537 potentially reflect the westward, strike-parallel migration of the center of

mass of the S-3 Site contaminant plume in the Aquitard. Mobilization of DNAPL encountered south (downdip) of BG-A South in January 1990 may explain the coincident detection and subsequent increase of dissolved TCE and PCE in the groundwater at well GW-627, although purging/sampling this deep bedrock well may induce migration into the well. Relationships between the elevated boron in the shallow groundwater at wells GW-794 and GW-795 are consistent with westward, strike-parallel transport from Sanitary Landfill I: concentrations are higher in the groundwater at well GW-794, which is closer to the landfill, and results for well GW-795 show an increasing concentration trend.

Each of the Aquifer wells sampled during CY 1996 monitor calcium-magnesium-bicarbonate groundwater downgradient of at least one contaminant source area in the Bear Creek Regime. Results reported for the Aquifer wells in the following summary (listed in general order from upgradient to downgradient) reflect transport of the specified contaminants from one or more of the source areas.

Aquifer Well	Groundwater Contaminant Above Screening Level (○) and with Increasing Concentration Trend (●)								
	Nitrate	Barium	Boron	Strontium	Uranium	PCE	TCE	Gross Alpha	Gross Beta
GW-315	○	.	.	.	.	○	○	.	○
GW-311	○	.	.	.	.	.	○	.	.
GW-723	○	.	.	.	.	.	○	.	●
GW-724	○	.	.	.	.	○	●	.	●
GW-725	○	.	.	.	.	.	●	.	○
GW-738	○	.	.	.	.	.	●	.	○
GW-740	.	.	.	.	.	.	○	.	.
GW-621	○	.	.	.	○	.	.	.	.
GW-694	○	.	.	.	○	.	○	○	○
GW-695	●	.	.	.	.	.	●	.	○
GW-703	●	●	.	●	.	.	●	.	○
GW-704	●	●	.	●	.	.	●	○	●
GW-706	○	.	.	.	○	.	○	○	○
GW-053	.	.	○	.	.	○	○	.	.
GW-683	○	.	.	.	○	.	●	○	○
GW-684	.	.	.	.	○	.	.	○	○
GW-685	○	.	.	.	.	.	.	.	.
GW-714	.	.	○	.	.	.	.	.	.
Screening Level	10 mg/L	UTL	UTL	UTL	UTL	5µg/L	5µg/L	15 pCi/L	50 pCi/L

Results for these Aquifer wells are generally consistent with respective historical data, and indicate influx/transport of contaminants from the S-3 Site (nitrate, gross beta, and VOCs); Spoil Area I (VOCs); the Rust Spoil Area (VOCs), including a nearby unidentified source in the Bear Creek floodplain; the Oil Landfarm WMA, including the Boneyard/Burnyard/HCDA (uranium, gross alpha, and VOCs) and Sanitary Landfill I (boron and VOCs); and the Bear Creek Burial Grounds WMA (boron, uranium, and VOCs).

Increasing levels of nitrate, barium, strontium and gross beta are indicated by statistical analysis of the historical data for Exit Pathway Picket B wells GW-695, GW-703, and GW-704. The upward concentration trends may be explained by influx of increasingly contaminated groundwater and surface water discharged into Bear Creek from NT-1 and NT-2 as a result of the westward migration of the S-3 Site contaminant plume in the Aquitard, and inflow into the Maynardville Limestone along the losing reach of the Bear Creek south of the Boneyard/Burnyard/HCDA and Sanitary Landfill I. However, considerable temporal variability tends to overshadow the upward concentration trends for these and other Aquifer wells, and upward trends for several wells appear to be caused by extreme values (high or low) that are probably sampling or analytical artifacts.

The CY 1996 results for samples from Bear Creek are consistent with historical data showing decreasing contaminant concentrations in the creek and springs that discharge into the creek. As shown in the following summary, most of the principal groundwater contaminants were detected above water quality screening levels in samples collected upstream of BCK-09.40.

Sampling Station	Surface Water Contaminant Above Screening Level					
	Nitrate	Uranium	PCE	TCE	Gross Alpha	Gross Beta
Upper Bear Creek	NT-01	○	○	○	○	○
	SS-1	○	○	○	○	○
	BCK-11.97	○	○	○	○	○
Middle Bear Creek	BCK-10.60	○	○	○	○	○
	SS-4	○	○	○	○	○
	SS-5	○	○	○	○	○
	BCK-09.40	○	○	○	○	○
Lower Bear Creek	BCK-07.75	○	○	○	○	○
	BCK-04.55	○	○	○	○	○
	BCK-03.87	○	○	○	○	○
	BCK-00.63	○	○	○	○	○
Screening Level	10 mg/L	UTL	0 µg/L	0 µg/L	15 pCi/L	50 pCi/L

The CY 1996 data for each sampling location also reflect seasonal concentration fluctuations; concentrations are typically highest during seasonally dry periods when groundwater discharge provides the bulk of the flow in the creek.

Groundwater and surface water sampling and analysis activities planned for the Bear Creek Regime during CY 1998 are specified in the *Sampling and Analysis Plan for Groundwater and Surface Water Monitoring at the Y-12 Plant during Calendar Year 1998* (AJA Technical Services, Inc. 1997b). Besides these planned monitoring activities, the following actions are recommended:

- Point-of-compliance wells (RCRA post-closure correction action monitoring) for the Oil Landfarm (GW-363) and the Bear Creek Burial Grounds/Walk-In Pits (GW-069) monitor groundwater that is relatively unaffected by the respective sites and should be replaced with wells that could provide data useful for long-term trending. The replacement wells should be GW-008 at the Oil Landfarm and GW-046 at the Bear Creek Burial Grounds/Walk-In Pits.
- Well GW-226 should be included in future monitoring programs to evaluate long-term contaminant (e.g., uranium and VOCs) concentration trends.

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APPENDIX A

FIGURES

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

LOCATION:

Y-12 PLANT
 OAK RIDGE, TN.

PREPARED BY:

**AJA TECHNICAL
 SERVICES, INC.**

DOC NUMBER:

97-D003

DWG ID.:

97-007

DATE:

5-10-97

FIGURE 1

**HYDROGEOLOGIC REGIMES
 AT 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: 97-D003
 DWG ID.: 96-035
 DATE: 5-20-97

WASTE MANAGEMENT SITES
 IN THE BEAR CREEK HYDROGEOLOGIC REGIME

SYSTEM GROUP	HYDRO UNIT	FORMATION	MAP SYMBOL	THICKNESS (ft)
CAMBRIAN	KNOX	COPPER RIDGE DOLOMITE	Ock	NOT DETERMINED
		MAYNARDVILLE LIMESTONE	Cmn	418-450
MIDDLE	ORR AQUITARDS	NOLICHUCKY SHALE	Cn	422-550
		MARYVILLE LIMESTONE	Cm	346-445
		ROGERSVILLE SHALE	Crg	90-120
		RUTLEDGE LIMESTONE	Crl	90-120
		PUMPKIN VALLEY SHALE	Cpv	260-320
LOWER		ROME	Cr	NOT DETERMINED

PREPARED FOR:
LOCKHEED MARTIN
ENERGY SYSTEMS, INC.

LOCATION: Y-12 PLANT
OAK RIDGE, TN.

PREPARED BY:
AJA TECHNICAL
SERVICES, INC.

DOC NUMBER: 97-D003
DWG ID.: 96-090
DATE: 5-20-97

FIGURE 3

TOPOGRAPHY AND BEDROCK GEOLOGY
IN THE BEAR CREEK HYDROGEOLOGIC REGIME

PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 4 SEASONAL GROUNDWATER ELEVATIONS IN THE BEAR CREEK HYDROGEOLOGIC REGIME
	DOC NUMBER:	97-D003	
	DWG ID.:	96-082	
	DATE:	5-20-97	
PREPARED BY: AJA TECHNICAL SERVICES, INC.

SOURCE: Modified from Science Applications International Corporation 1997.

0 2000
SCALE (FT)

NOTE: Plume reflects water table and bedrock intervals.

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

LOCATION: Y-12 PLANT
OAK RIDGE, TN.

FIGURE 5

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

DOC NUMBER: 97-D003
DWG ID.: 96-089
DATE: 5-20-97

GROUNDWATER CONTAMINATION
IN THE BEAR CREEK HYDROGEOLOGIC REGIME

EXPLANATION

- — MONITORING WELL
- ⊙ — RCRA POINT-OF-COMPLIANCE MONITORING WELL
- ▲ — RCRA BACKGROUND/UPGRADIENT MONITORING WELL
- ★ — RCRA PLUME DELINEATION MONITORING WELL
- ◇ — SPRING OR SURFACE WATER SAMPLING LOCATION

EXP-C — EXIT PATHWAY, MAYNARDVILLE LIMESTONE PICKET

--- SURFACE DRAINAGE FEATURE

NT-5 — NORTH TRIBUTARY

AQT — AQUITARD

--- APPROXIMATE NOLICHUCKY SHALE/MAYNARDVILLE LIMESTONE CONTACT AT GROUND SURFACE

AQF — AQUIFER

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

LOCATION: Y-12 PLANT
OAK RIDGE, TN.

FIGURE 6

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

DOC NUMBER:
DWG ID.: 96-083
DATE: 7-7-97

**CY 1996 GROUNDWATER
AND SURFACE WATER SAMPLING LOCATIONS**

EXPLANATION

— GROUNDWATER COMPOSITIONS CLUSTER IN THESE AREAS, 28 WELLS 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

□ — SPRING SAMPLING LOCATION

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

LOCATION: Y-12 PLANT
OAK RIDGE, TN.

FIGURE 7

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

DOC NUMBER: 97-D003
DWG ID.: 96-040
DATE: 5-20-97

GROUNDWATER GEOCHEMISTRY
IN THE AQUITARD

FIGURE 8

NITRATE IN GROUNDWATER
AND SURFACE WATER IN THE
BEAR CREEK HYDROGEOLOGIC REGIME, 1996

<ul style="list-style-type: none"> ■ - Water Table Monitoring Well ● - Bedrock Monitoring Well ▲ - Spring or Surface Water Sampling Station 	<ul style="list-style-type: none"> 19 — CY 1996 Maximum Nitrate (as N) Concentration (mg/L) ND — NOT DETECTED
EXP-A — Exit Pathway, Maynardville Limestone Picket	
— — Boundary of Site or Waste Management Area	
- - - - - Surface Drainage Feature	
AQT — Aquitard	
- - - - - Approximate Geologic Contact	
AQF — Aquifer	
	<p style="text-align: center;"><u>Approximate Plume Boundary</u></p> <div style="display: flex; align-items: center;"> <div style="width: 20px; height: 20px; border: 1px solid black; background: repeating-linear-gradient(45deg, transparent, transparent 2px, black 2px, black 4px); margin-right: 5px;"></div> <div> <p>— 10-100 mg/L</p> <p>— >100 mg/L</p> </div> </div>
	<ul style="list-style-type: none"> ① — Statistically Significant Increasing Trend ● — Not Sampled in CY 1996

FIGURE 8

Note: Nitrate MCL = 10 mg/L

PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 9 NITRATE CONCENTRATIONS IN GROUNDWATER AT AQUITARD MONITORING WELLS GW-085, GW-537, and GW-794
		DOC No.: 97-004	
		DWG ID.: BC PT296	
PREPARED BY: AJA TECHNICAL SERVICES, INC.	DATE: 8/3/97

EXPLANATION

— GROUNDWATER COMPOSITIONS CLUSTER IN THESE AREAS, 25 WELLS ARE PLOTTED ON THIS DIGRAM

■ — 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

□ — SURFACE WATER OR SPRING SAMPLING LOCATION

PREPARED FOR:

LOCKHEED MARTIN
ENERGY SYSTEMS, INC.

LOCATION:

Y-12 PLANT
OAK RIDGE, TN.

FIGURE 10

PREPARED BY:

AJA TECHNICAL
SERVICES, INC.

DOC NUMBER:

97-D003

DWG ID.:

96-039N

DATE:

5-10-97

GROUNDWATER GEOCHEMISTRY IN THE AQUIFER

Note: Nitrate MCL = 10 mg/L

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

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

LOCATION:

Y-12 PLANT
OAK RIDGE, TN.

DOC No.:

97-004

DWG ID.:

BC PT296

DATE:

8/3/97

FIGURE 11

**NITRATE CONCENTRATIONS IN GROUNDWATER AT
AQUIFER MONITORING WELLS GW-685,
GW-695, GW-703, AND GW-704**

EXPLANATION

AQT — AQUITARD
 --- APPROXIMATE NOLICHUCKY SHALE/MAYNARDVILLE LIMESTONE CONTACT
 AQF — AQUIFER
 EXP-C — EXIT PATHWAY, MAYNARDVILLE LIMESTONE PICKET

● — MONITORING WELL WITH INCREASING CONCENTRATION
 x — NOT SAMPLED IN 1996
 ○ — MONITORING WELL: CY 1996 CONCENTRATION ABOVE UTL
 ● — SURFACE WATER (BCK) OR SPRING (SS) SAMPLING LOCATION;
 CY 1996 CONCENTRATION ABOVE UTL
 L7 — CY 1996 MAXIMUM CONCENTRATION (mg/L)

PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 12
PREPARED BY: AJA TECHNICAL SERVICES, INC.	DOC NUMBER:	97-D003	ELEVATED BARIUM, BORON, STRONTIUM, AND URANIUM CONCENTRATIONS IN THE BEAR CREEK HYDROGEOLOGIC REGIME
	DWG ID.:		
	DATE:	5-27-97

Notes: Barium MCL = 2 mg/L and UTL = 0.79 mg/L
 Strontium UTL = 0.92 mg/L

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

LOCATION:

Y-12 PLANT
 OAK RIDGE, TN.

FIGURE 13

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

DOC No.:

97-004

DWG ID.:

BC PT296

DATE:

8/3/97

**BARIUM AND STRONTIUM CONCENTRATIONS
 IN GROUNDWATER AT AQUITARD
 MONITORING WELL GW-537**

Note: UTL = 0.041 mg/L

Note: UTL = 0.0028 mg/L

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

LOCATION:

Y-12 PLANT
OAK RIDGE, TN.

FIGURE 14

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

DOC No.:

97-004

DWG ID.:

BC PT296

DATE:

8/3/97

BORON CONCENTRATIONS IN
GROUNDWATER AT AQUITARD MONITORING
WELLS GW-287 AND GW-653

Note: UTL = 0.71 mg/L

PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 15 BARIUM CONCENTRATIONS IN GROUNDWATER AT AQUIFER MONITORING WELLS GW-695, GW-703, AND GW-704
	DOC No.:	97-004	
	DWG ID.:	BC PT296	
PREPARED BY: AJA TECHNICAL SERVICES, INC.	DATE:	8/3/97

Note: UTL = 4.4 mg/L

PREPARED BY: AJA TECHNICAL SERVICES, INC.	PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION: Y-12 PLANT OAK RIDGE, TN.	FIGURE 16
	DOC No.: 97-004		STRONTIUM CONCENTRATIONS IN GROUNDWATER AT AQUIFER MONITORING WELLS GW-703 AND GW-704
	DWG ID.: BC PT296		
	DATE: 8/3/97

Note: UTL = 0.12 mg/L

PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 17 BORON CONCENTRATIONS IN GROUNDWATER AT AQUIFER MONITORING WELLS GW-703 AND GW-704
		DOC No.: 97-004	
		DWG ID.: BC PT296	
		DATE: 8/3/97	
PREPARED BY: AJA TECHNICAL SERVICES, INC.

PREPARED FOR:
LOCKHEED MARTIN
ENERGY SYSTEMS, INC.

PREPARED BY:
AJA TECHNICAL
SERVICES, INC.

LOCATION:
Y-12 PLANT
OAK RIDGE, TN.

DOC NUMBER: 97-003

DWG ID: 96-041

DATE: 5-20-97

FIGURE 18

VOCS IN GROUNDWATER
AND SURFACE WATER IN THE
BEAR CREEK HYDROGEOLOGIC REGIME, 1996

Burial Grounds WMA: Well GW-627

Notes: PCE MCL = 5 ug/L
TCE MCL = 5 ug/L

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

LOCATION:

Y-12 PLANT
OAK RIDGE, TN.

FIGURE 19

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

DOC No.:

97-004

DWG ID.:

BC PT296

DATE:

8/3/97

PCE AND TCE CONCENTRATIONS IN
GROUNDWATER AT AQUITARD MONITORING
WELL GW-627

Notes: PCE MCL = 5 ug/L
TCE MCL = 5 ug/L

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

LOCATION:

Y-12 PLANT
OAK RIDGE, TN.

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

DOC No.:

97-004

DWG ID.:

BC PT296

DATE:

8/3/97

FIGURE 20

**CONCENTRATIONS OF SELECTED VOCs IN
GROUNDWATER AT AQUIFER MONITORING WELLS
GW-695, GW-704, GW-724,
GW-725, AND GW-738**

Note: SDWA Screening Level = 50 pCi/L

PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 23 GROSS BETA ACTIVITY IN GROUNDWATER AT AQUITARD MONITORING WELLS GW-085 AND GW-537
		DOC No.: 97-004	
		DWG ID.: BC PT296	
PREPARED BY: AJA TECHNICAL SERVICES, INC.	DATE: 8/3/97

Note: SDWA Screening Level = 50 pCi/L

PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 24 GROSS BETA ACTIVITY IN GROUNDWATER AT AQUIFER MONITORING WELLS GW-704, GW-723, AND GW-724
		DOC No.: 97-004	
		DWG ID.: BC PT296	
PREPARED BY: AJA TECHNICAL SERVICES, INC.	DATE:	8/3/97

Notes: Nitrate MCL = 10 mg/L
Gross Alpha MCL = 15 pCi/L

PREPARED FOR: <i>LOCKHEED MARTIN ENERGY SYSTEMS, INC.</i>		LOCATION: Y-12 PLANT OAK RIDGE, TN.	FIGURE 25 <
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APPENDIX B

TABLES

Table 1.
Waste Mangement Sites in the Bear Creek Hydrogeologic Regime and Associated Monitoring Programs

PROGRAM DRIVER		MONITORING PROGRAM						
RCRA Post-Closure Permit for the Bear Creek Regime		RCRA Post-Closure Corrective Action Monitoring						
DOE Order 5400.1		Exit Pathway/Perimeter Monitoring						
		Surveillance Monitoring						
Y-12 Plant GWPP Management Plan		Best Management Practice Monitoring						
Waste Management Site/ Regulated Unit	Regulatory Classification ¹	General Waste Inventory	Operational Status					
			Closed	Active				
Above Grade Low-Level Storage Facility	NR	Low level radioactive construction and demolition wastes.		●	●			
Boneyard/Burnyard/Hazardous Chemical Storage Area	CERCLA	Magnesium chips, construction debris, pesticide containers, metal shavings, solvents, oils, laboratory chemicals, acids, bases, organics, water-reactive compounds, and shock sensitive compounds.	●			●		
Burial Grounds A (North and South)	RCRA/ CERCLA	Waste oils, coolants, and spent solvents.	●			●		●
Burial Grounds C (West)	RCRA/ CERCLA	Waste oils, coolants, and spent solvents.	●			●		●
Burial Grounds B, D, E, and J	CERCLA	Solid wastes including salts, metals (beryllium and uranium) and metal oxides, metal saw fines, and asbestos.	●			●		
Oil Landfarm	RCRA/ CERCLA	Waste oils and coolants containing beryllium compounds, depleted uranium, polychlorinated biphenyls, and spent solvents.	●			●		●
Oil Retention Pond No. 1	CERCLA	Oil seepage from Burial Ground A South.	●			●		
Oil Retention Pond No. 2	CERCLA	Oil seepage from Burial Ground A North.	●			●		
Receptor Media	CERCLA	Contaminated groundwater, surface water, Bear Creek stream sediments, and Bear Creek floodplain soils.	Not Applicable				●	

Table 1 (cont'd)

PROGRAM DRIVER		MONITORING PROGRAM				
RCRA Post-Closure Permit for the Bear Creek Regime		RCRA Post-Closure Corrective Action Monitoring				
DOE Order 5400.1		Exit Pathway/Perimeter Monitoring				
		Surveillance Monitoring				
Y-12 Plant GWPP Management Plan		Best Management Practice Monitoring				
Waste Management Site/ Regulated Unit	Regulatory Classification ¹	General Waste Inventory	Operational Status			
			Closed	Active		
Rust Spoil Area	CERCLA	Nonradioactive construction debris.	●		●	
Sanitary Landfill I	CERCLA	Nonhazardous solid wastes.	●		●	
Spoil Area I	CERCLA	Nonradioactive construction debris.	●		●	
SY-200 Yard	CERCLA	Temporary storage of equipment, machinery, and miscellaneous items.	●		●	
S-3 Site	RCRA/ CERCLA	Liquid, radioactive, nitric acid wastes and denitrification	●		●	●
Walk-In Pits	RCRA/ CERCLA	Chemical wastes, shock-sensitive reagents, and uranium metal saw fines.	●		●	●

Notes:

- 1 From: *Oak Ridge Reservation Site Management Plan for the Environmental Restoration Program* (U.S. Department of Energy 1994).
- CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act
- RCRA - Resource Conservation and Recovery Act
- NR - Not regulated under RCRA or CERCLA.

Table 2.
Depth-to-Water Measurements and Water-Level Elevations in the Bear Creek
Hydrogeologic Regime, April 1996 and October 1996

Water-Level Elevation (ft above mean sea level)					October 2- 7, 1996				
					April 1 - 9, 1996				
					Seasonal Fluctuation (+/- ft)				
Depth-to-Water (ft below top of well casing)					October 2 -7, 1996				
					April 1 - 9, 1996				
Water Table Interval Monitoring Wells									
Well No. ¹	Location ²	Hydrogeologic Unit		Top of Casing Elevation ³					
		Aquifer	Aquitard						
GW-001	OLF		●	980.86	11.9	15.1	-3.2	968.96	965.76
GW-005	OLF		●	965.13	5.9	6.9	-1.0	961.76	960.76
GW-008	OLF		●	964.79	13.7	15.4	-1.7	953.11	951.41
GW-010	OLF		●	952.76	1.6	3.1	-1.5	951.16	949.66
GW-011	OLF		●	953.08	2.3	4.1	-1.8	950.78	948.98
GW-012	OLF		●	953.57	4.7	6.9	-2.2	950.86	948.66
GW-014	BG		●	933.76	4.8	6.4	-1.6	928.96	927.36
GW-016	BG		●	928.06	7.2	11.2	-4.0	920.86	916.86
GW-018	BG		●	924.49	5.0	9.2	-4.2	919.49	915.29
GW-041	BG		●	1007.55	13.2	23.6	-10.4	994.40	984.00
GW-043	OLF		●	1011.51	18.0	29.0	-11.0	995.96	984.96
GW-045	BG		●	909.79	5.6	NM ⁴	NA ⁵	904.19	NA
GW-047	BG		●	928.25	5.8	9.0	-3.2	922.45	919.25
GW-052	BG		●	906.04	6.6	14.4	-7.8	899.44	891.64
GW-053	BG	●		902.67	3.7	8.4	-4.7	898.97	894.27
GW-065	OLF		●	982.25	23.4	27.0	-3.6	958.85	955.25
GW-067	OLF		●	961.50	9.2	9.9	-0.7	952.30	951.60
GW-080	BG		●	980.31	17.9	24.6	-6.7	962.41	955.71
GW-084	OLF		●	996.60	11.7	14.9	-3.2	984.90	981.70
GW-086	OLF		●	982.76	11.5	14.0	-2.5	971.26	968.76
GW-087	OLF		●	960.50	6.9	10.4	-3.5	953.60	950.10
GW-089	BG		●	964.36	2.3	7.1	-4.8	962.06	957.26
GW-090	BG		●	961.88	4.2	6.9	-2.7	957.68	954.98
GW-091	BG		●	953.48	8.2	9.4	-1.2	945.28	944.08
GW-097	OLF		●	944.62	8.9	10.5	-1.6	935.72	934.12
GW-101	S3		●	1007.33	9.3	9.5	-0.2	998.00	997.80
GW-115	S3		●	1054.41	6.4	11.4	-5.0	1048.00	1043.00
GW-245	S3		●	1009.08	12.5	13.8	-1.3	996.60	995.30
GW-249	BG		●	991.15	29.1	37.1	-8.0	962.05	954.05
GW-257	BG		●	961.68	27.7	28.9	-1.2	933.98	932.78
GW-276	S3		●	1001.27	5.4	5.8	-0.4	995.90	995.50
GW-277	S3		●	1001.76	5.5	6.2	-0.7	996.30	995.60

Table 2 (cont'd)

Water-Level Elevation (ft above mean sea level)					October 2 - 7, 1996				
					April 1 - 9, 1996				
					Seasonal Fluctuation (+/- ft)				
Depth-to-Water (ft below top of well casing)					October 2 - 7, 1996				
					April 1 - 9, 1996				
Water Table Interval Monitoring Wells									
Well No. ¹	Location ²	Hydrogeologic Unit		Top of Casing Elevation ³					
		Aquifer	Aquitard						
GW-287	BG		●	926.87	8.5	9.3	-0.8	918.37	917.57
GW-289	BG		●	948.47	9.6	16.7	-7.1	938.87	931.77
GW-291	BG		●	948.36	7.6	11.6	-4.0	940.76	936.76
GW-307	RS	●		993.14	27.8	32.0	-4.2	965.34	961.14
GW-309	RS	●		988.17	20.3	21.6	-1.3	967.87	966.57
GW-310	RS	●		995.35	20.5	21.1	-0.6	974.85	974.25
GW-311	RS	●		999.35	30.5	38.6	-8.1	968.85	960.75
GW-323	SPI	●		1130.11	85.7	86.1	-0.4	1044.40	1044.00
GW-325	S3		●	1003.00	7.4	15.0	-7.6	995.60	988.00
GW-345	S3		●	999.46	16.5	19.1	-2.6	981.27	978.67
GW-347	S3		●	1001.56	13.7	17.8	-4.1	987.90	983.80
GW-370	BG		●	960.62	11.7	14.6	-2.9	948.92	946.02
GW-372	BG		●	983.53	14.0	24.9	-10.9	969.53	958.63
GW-531	LD		●	1004.61	13.6	17.2	-3.6	991.00	987.40
GW-537	OLF		●	976.24	5.5	6.9	-1.4	970.74	969.34
GW-613	S3		●	1013.37	9.3	14.7	-5.4	1004.10	998.70
GW-621	EXP-B	●		925.24	9.3	13.8	-4.5	915.94	911.44
GW-622	BG		●	924.16	6.6	10.8	-4.2	917.56	913.36
GW-624	BG		●	921.96	5.0	11.1	-6.1	916.96	910.86
GW-626	BG		●	942.61	21.5	25.9	-4.4	921.11	916.71
GW-630	LD		●	986.65	8.8	9.4	-0.6	977.85	977.25
GW-637	OLF		●	941.83	5.8	9.8	-4.0	936.03	932.03
GW-638	OLF		●	941.77	5.9	6.1	-0.2	935.87	935.67
GW-641	BG		●	946.66	14.7	19.3	-4.6	931.96	927.36
GW-642	BG		●	1014.67	17.3	21.3	-4.0	997.40	993.40
GW-644	OLF		●	959.75	6.5	9.4	-2.9	953.25	950.35
GW-648	RS		●	1029.17	62.7	68.8	-6.1	966.50	960.40
GW-651	BG		●	903.12	3.5	8.8	-5.3	899.62	894.32
GW-652	BG		●	900.83	7.7	10.7	-3.0	893.13	890.13
GW-653	BG		●	931.60	18.8	24.0	-5.2	912.80	907.60
GW-654	BG		●	940.79	6.2	7.7	-1.5	934.59	933.09
GW-715	EXP-W	●		874.72	24.6	28.6	-4.0	850.12	846.12
GW-795	AGLLSF		●	925.98	3.0	6.6	-3.6	922.98	919.38

Table 2 (cont'd)

Water-Level Elevation (ft above mean sea level)					October 2 - 7, 1996				
					April 1 - 9, 1996				
					Seasonal Fluctuation (+/- ft)				
Depth-to-Water (ft below top of well casing)					October 2 - 7, 1996				
					April 1 - 9, 1996				
Bedrock Interval Monitoring Wells									
Well No. ¹	Location ²	Hydrogeologic Unit		Top of Casing Elevation ³					
		Aquifer	Aquitard						
GW-044	OLF		●	1013.49	16.2	28.2	-12.0	997.30	985.30
GW-054	BG		●	893.33	8.8	10.8	-2.0	884.53	882.53
GW-055	BG		●	892.53	8.7	8.3	+0.4	883.83	884.23
GW-056	EXP-A	●		890.71	6.6	7.7	-1.1	884.11	883.01
GW-057	EXP-A	●		889.36	4.6	5.8	-1.2	884.76	883.56
GW-058	BG		●	912.96	19.3	22.5	-3.2	893.66	890.46
GW-059	BG		●	912.48	18.9	21.9	-3.0	893.58	890.58
GW-061	BG		●	904.44	11.0	15.6	-4.6	893.44	888.84
GW-062	OLF		●	962.16	22.9	31.5	-8.6	939.26	930.66
GW-064	OLF	●		981.56	22.4	26.0	-3.6	959.16	955.56
GW-066	OLF		●	961.72	7.4	9.2	-1.8	954.26	952.46
GW-069	BG	●		927.01	6.6	10.1	-3.5	920.41	916.91
GW-070	BG		●	926.39	5.8	8.3	-2.5	920.59	918.09
GW-071	BG		●	928.42	6.1	8.2	-2.1	922.32	920.22
GW-072	BG		●	929.91	9.1	11.4	-2.3	920.81	918.51
GW-075	OLF		●	964.31	3.8	5.6	-1.8	963.07	961.27
GW-076	OLF		●	966.01	4.1	5.3	-1.2	961.91	960.71
GW-077	BG		●	918.39	4.1	8.8	-4.7	914.29	909.59
GW-078	BG		●	917.33	3.0	7.7	-4.7	914.33	909.63
GW-079	BG		●	980.50	15.1	22.8	-7.7	965.40	957.70
GW-082	BG		●	962.49	19.4	21.2	-1.8	944.32	942.52
GW-083	BG		●	937.83	8.6	12.9	-4.3	929.23	924.93
GW-085	OLF		●	982.87	11.7	14.3	-2.6	971.17	968.57
GW-094	BG		●	913.12	5.4	8.8	-3.4	907.72	904.32
GW-095	BG		●	910.87	NM	5.8	NA	NA	905.07
GW-098	OLF		●	945.10	9.1	14.8	-5.7	936.00	930.30
GW-122	S3	●		1007.20	14.2	16.8	-2.6	993.00	990.40
GW-123	S3		●	1007.45	4.7	4.5	+0.2	1002.80	1003.00
GW-124	S3	●		1006.78	11.4	17.5	-6.1	995.40	989.30
GW-162	BG		●	1040.44	17.8	21.4	-3.6	1022.60	1019.00
GW-225	OLF	●		943.11	5.2	14.8	-9.6	937.91	928.31
GW-226	OLF	●		943.40	6.2	15.3	-9.1	937.20	928.10
GW-227	OLF	●		946.46	7.0	13.9	-6.9	939.46	932.56

Table 2 (cont'd)

Water-Level Elevation (ft above mean sea level)					October 2 - 7, 1996				
					April 1 - 9, 1996				
					Seasonal Fluctuation (+/- ft)				
Depth-to-Water (ft below top of well casing)					October 2 - 7, 1996				
					April 1 - 9, 1996				
Bedrock Interval Monitoring Wells									
Well No. ¹	Location ²	Hydrogeologic Unit		Top of Casing Elevation ³					
		Aquifer	Aquitard						
GW-228	OLF	●		946.47	6.4	14.6	-8.2	940.07	931.87
GW-229	OLF	●		949.00	15.6	25.0	-9.4	933.40	924.00
GW-248	BG		●	961.25	27.2	28.5	-1.3	934.05	932.75
GW-250	BG		●	991.25	30.1	35.7	-5.6	961.15	955.55
GW-286	BG		●	926.83	8.8	9.8	-1.0	918.03	917.03
GW-288	BG		●	948.36	9.2	16.3	-7.1	939.16	932.06
GW-290	BG		●	948.46	5.3	8.2	-2.9	943.16	940.26
GW-313	SPI	●		1052.52	65.7	71.6	-5.9	994.04	988.14
GW-315	SPI	●		1047.28	52.9	58.7	-5.8	994.40	988.60
GW-317	SPI	●		1062.98	68.5	75.3	-6.8	994.50	987.70
GW-324	S3		●	1003.83	5.8	15.7	-9.9	998.00	988.10
GW-346	S3		●	995.65	15.7	17.3	-1.6	982.07	980.47
GW-348	S3		●	1000.12	20.1	23.4	-3.3	980.00	976.70
GW-363	OLF		●	957.91	4.0	5.7	-1.7	953.91	952.21
GW-364	OLF		●	935.95	8.3	17.1	-8.8	927.65	918.85
GW-365	OLF		●	935.58	3.3	10.7	-7.4	932.28	924.88
GW-366	OLF		●	988.79	55.6	69.5	-13.9	933.19	919.29
GW-369	OLF		●	999.72	63.4	75.6	-12.2	936.32	924.12
GW-371	BG		●	960.22	15.9	17.3	-1.4	944.32	942.92
GW-373	BG		●	982.80	17.4	19.4	-2.0	965.40	963.40
GW-374	BG		●	926.94	NM	2.9	NA	NA	924.04
GW-375	BG		●	920.83	5.4	8.4	-3.0	915.43	912.43
GW-520	OLF		●	987.38	55.4	65.2	-9.8	931.98	922.18
GW-614	S3		●	1012.22	0.9	6.9	-6.0	1011.30	1005.30
GW-615	S3		●	1016.75	12.6	13.6	-1.0	1004.20	1003.20
GW-616	S3		●	1011.81	9.0	9.9	-0.9	1002.80	1001.90
GW-623	BG		●	925.21	3.1	5.2	-2.1	922.11	920.01
GW-627	BG		●	942.85	24.0	24.5	-0.5	918.85	918.35
GW-629	BG		●	927.16	4.8	5.7	-0.9	922.36	921.46
GW-640	BG		●	945.38	13.6	20.5	-6.9	931.78	924.88
GW-683	EXP-A	●		972.06	88.0	88.8	-0.8	884.06	883.26
GW-684	EXP-A	●		898.66	14.8	15.5	-0.7	883.86	883.16
GW-685	EXP-A	●		891.51	6.8	7.5	-0.7	884.71	884.01

Table 2 (cont'd)

Water-Level Elevation (ft above mean sea level)					October 2 - 7, 1996				
					April 1 - 9, 1996				
					Seasonal Fluctuation (+/- ft)				
Depth-to-Water (ft below top of well casing)					October 2 - 7, 1996				
					April 1 - 9, 1996				
Bedrock Interval Monitoring Wells									
Well No. ¹	Location ²	Hydrogeologic Unit		Top of Casing Elevation ³					
		Aquifer	Aquitard						
GW-694	EXP-B	●		941.38	21.5	28.9	-7.4	919.88	912.48
GW-695	EXP-B	●		939.37	22.9	28.8	-5.9	916.47	910.57
GW-703	EXP-B	●		954.69	36.4	43.9	-7.5	918.29	910.79
GW-704	EXP-B	●		944.73	26.0	33.8	-7.8	918.73	910.93
GW-706	EXP-B	●		928.67	8.9	16.2	-7.3	919.77	912.47
GW-710	EXP-W	●		911.26	64.4	68.1	-3.7	846.86	843.16
GW-711	EXP-W	●		905.20	62.7	66.4	-3.7	842.50	838.80
GW-712	EXP-W	●		877.09	30.8	35.0	-4.2	846.29	842.09
GW-713	EXP-W	●		880.63	33.9	37.7	-3.8	846.73	842.93
GW-714	EXP-W	●		875.08	25.9	30.2	-4.3	849.18	844.88
GW-736	EXP-C	●		960.12	6.4	10.6	-4.2	953.72	949.52
GW-737	EXP-C	●		959.91	6.2	10.6	-4.4	953.71	949.31
GW-740	EXP-C	●		1019.63	65.8	71.2	-5.4	953.80	948.40
GW-793	AGLLSF		●	968.18	6.9	8.9	-2.0	961.28	959.28

Notes:

- 1 Well locations shown on Figure 7 (water table interval wells); wells sampled during CY1996 denoted by **bold** typeface.
- 2
 - AGLLSF - Above Grade Low-Level Storage Facility
 - BG - Bear Creek Burial Grounds Waste Management Area
 - EXP-A - Exit Pathway (Maynardville Limestone) Picket A
 - EXP-B - Exit Pathway (Maynardville Limestone) Picket B
 - EXP-C - Exit Pathway (Maynardville Limestone) Picket C
 - EXP-W - Exit Pathway (Maynardville Limestone) Picket W
 - LD - Lysimeter Demonstration Site
 - OLF - Oil Landfarm Waste Management Area
 - RS - Rust Spoil Area
 - SPI - Spoil Area I
 - S3 - S-3 Site
- 3 Measuring point (top of well casing) elevation (ft above mean sea level)
- 4 Not measured.
- 5 Not applicable.

Table 3.
CY 1996 Sampling Dates for Monitoring Wells, Springs, and
Surface Water Stations in the Bear Creek Hydrogeologic Regime

Monitoring Program ¹		RCRA Post-Closure Corrective Action Monitoring							
		DOE Order 5400.1 Exit Pathway/Perimeter Monitoring							
		DOE Order 5400.1 Surveillance Monitoring							
		Best Management Practice Monitoring							
Sampling Point ²	Sampling Location ³	Sampling Equipment ⁴		Sampling Date ⁵					
		Dedicated	Portable	1st Quarter	3rd Quarter				
GW-040	BG	●		03/26/96	07/18/96				●
GW-042	BG	●		03/26/96	07/18/96				●
GW-043	OLF	●		02/01/96	07/08/96				●
GW-044	OLF	●		01/31/96	07/08/96				●
GW-053	BG		●	03/26/96	08/28/96		●		
GW-056	EXP-A	●		03/14/96	07/23/96			●	
GW-069	BG	●		02/25/96	07/23/96				●
GW-079	BG		●	02/25/96	07/24/96				●
GW-080	BG	●		02/24/96	07/24/96				●
GW-084	OLF	●		02/01/96	07/08/96				●
GW-085	OLF	●		03/25/96	08/20/96		●		
GW-095	BG		●	03/26/96	08/27/96		●		
GW-115	S3	●		01/31/96	07/02/96				●
GW-162	BG		●	02/26/96	07/24/96				●
GW-276	S3	●		02/29/96	07/08/96				●
GW-287	BG		●	03/26/96	08/27/96		●		
GW-311	RS	●		03/25/96	08/14/96		●		
GW-315	SPI	●		03/26/96	08/19/96		●		
GW-363	OLF		●	02/12/96	07/02/96				●
GW-372	BG	●		02/25/96	07/23/96				●
GW-373	BG		●	02/28/96	07/25/96				●
GW-521	LIV		●	01/16/96	07/02/96				●
GW-537	OLF	●		03/25/96	08/20/96		●		
GW-613	S3	●		01/31/96	07/01/96				●
GW-614	S3		●	02/12/96	07/01/96				●
GW-621	EXP-B	●		03/14/96	07/23/96			●	
GW-627	BG		●	03/28/96	09/06/96		●		
GW-642	BG	●		02/24/96	07/09/96				●
GW-653	BG		●	03/26/96	08/28/96		●		
GW-683	EXP-A		●	03/15/96	07/29/96			●	
GW-684	EXP-A		●	03/16/96	07/29/96			●	
GW-685	EXP-A		●	03/15/96	07/25/96			●	
GW-694	EXP-B		●	03/18/96	08/01/96			●	

Table 3 (cont'd)

Monitoring Program ¹		RCRA Post-Closure Corrective Action Monitoring								
		DOE Order 5400.1 Exit Pathway/Perimeter Monitoring								
		DOE Order 5400.1 Surveillance Monitoring								
		Best Managment Practice Monitoring								
Sampling Point ²	Sampling Location ³	Sampling Equipment ⁴		Sampling Date ⁵						
		Dedicated	Portable	1st Quarter	3rd Quarter					
GW-695	EXP-B	●		03/14/96	07/23/96			●		
GW-703	EXP-B		●	03/16/96	07/31/96			●		
GW-704	EXP-B		●	03/17/96	08/01/96			●		
GW-706	EXP-B		●	03/19/96	08/06/96			●		
GW-710	EXP-W		●	01/29/96	07/16/96			●	●	
GW-711	EXP-W		●	01/26/96	07/14/96			●	●	
GW-712	EXP-W		●	01/26/96	07/15/96			●	●	
GW-713	EXP-W		●	01/28/96	07/17/96			●	●	
GW-714	EXP-W		●	01/29/96	07/17/96			●	●	
GW-715	EXP-W		●	01/29/96	07/18/96			●	●	
GW-723	EXP-C		●	03/21/96	08/09/96			●		
GW-724	EXP-C		●	03/21/96	08/14/96			●		
GW-725	EXP-C		●	03/22/96	08/13/96			●		
GW-738	EXP-C		●	03/20/96	08/08/96			●		
GW-740	EXP-C		●	03/19/96	08/07/96			●		
GW-793	AGLLSF	●		03/27/96	08/27/96	●				
GW-794	AGLLSF	●		03/25/96	08/27/96	●				
GW-795	AGLLSF	●		03/25/96	08/27/96	●				
GW-828	OLF		●	03/26/96	08/21/96		●			
GW-829	OLF		●	03/27/96	08/22/96		●			
BCK-00.63	EXP-SW		●	NS	08/06/96			●		
BCK-03.87	EXP-SW		●	01/30/96	07/14/96			●		
BCK-04.55	EXP-SW		●	01/30/96	07/14/96			●		
BCK-07.75	EXP-SW		●	01/30/96	07/14/96			●		
BCK-09.40	EXP-SW		●	03/16/96	07/29/96			●		
BCK-10.60	EXP-SW		●	03/17/96	07/30/96			●		
BCK-11.97	EXP-SW		●	03/17/96	08/13/96			●		
NT-01	EXP-SW		●	03/18/96	08/13/96			●		
SS-1	EXP-SW		●	03/18/96	08/13/96			●		
SS-4	EXP-SW		●	03/16/96	07/30/96			●		
SS-5	EXP-SW		●	03/16/96	07/29/96			●		
TOTAL SAMPLING LOCATIONS				Monitoring Wells:		53	3	11	15	24
				Springs:		3	0	0	3	0
				Surface Water Stations:		8	0	0	8	0

Table 3 (cont'd)

Notes:

- 1 See Table 4 for a complete list of field measurements and laboratory analytes.
- 2 BCK - Bear Creek Kilometer
 GW - Groundwater Monitoring Well
 NT - Northern Tributary
 SS - Spring
- 3 AGLLSF - Above Grade Low-Level Storage Facility
 BG - Bear Creek Burial Grounds Waste Management Area
 EXP-A - Exit Pathway (Maynardville Limestone) Picket A
 EXP-B - Exit Pathway (Maynardville Limestone) Picket B
 EXP-C - Exit Pathway (Maynardville Limestone) Picket C
 EXP-W - Exit Pathway (Maynardville Limestone) Picket W
 EXP-SW - Exit Pathway (Bear Creek) Surface Water
 LIV - Industrial Landfill IV (Chestnut Ridge Regime)
 OLF - Oil Landfarm Waste Management Area
 RS - Rust Spoil Area
 SPI - Spoil Area I
 S3 - S-3 Site
- 4 Dedicated: Well Wizard™ (bladder pump that remains in the well)
 Portable: Bennet Pumps™ and disposable bailers (groundwater) and grab bottles
 (surface water and springs).
- 5 NS - Not Sampled

Table 4.
Laboratory Analytes and Field Measurements for CY 1996
Groundwater and Surface Water Samples

MONITORING PROGRAM	RCRA Post-Closure Corrective Action Monitoring ¹						
	DOE Order 5400.1 Monitoring ²						
	Best Management Practice Monitoring ³						
PRINCIPAL IONS	Analytical Method ⁴	GWPS Constituent ⁵	Sample Type ⁶				
			Filtered	Unfiltered			
Alkalinity - HCO ₃	SM-2320 B	.	.	●	●	●	●
Alkalinity - CO ₃	SM-2320 B	.	.	●	●	●	●
Calcium	EPA-6010	.	●	●	●	●	●
Chloride	EPA-300.0	.	.	●	●	●	●
Fluoride	EPA-340.2	.	.	●	●	●	●
Magnesium	EPA-6010	.	●	●	●	●	●
Nitrate (as N)	EPA-300.0	●	.	●	●	●	●
Potassium	EPA-6010	.	●	●	●	●	●
Sodium	EPA-6010	.	●	●	●	●	●
Sulfate	EPA-300.0	.	.	●	●	●	●
TRACE METALS	Analytical Method	GWPS Constituent	Sample Type				
			Filtered	Unfiltered			
Aluminum	EPA-6010	.	●	●	●	●	●
Antimony	EPA-6010	.	●	●	●	●	●
Arsenic	EPA-6010	.	●	●	●	●	●
Barium	EPA-6010	●	●	●	●	●	●
Beryllium	EPA-6010	.	●	●	●	●	●
Boron	EPA-6010	.	●	●	●	●	●
Cadmium	EPA-6010	●	●	●	●	●	●
Chromium	EPA-6010	●	●	●	●	●	●
Cobalt	EPA-6010	.	●	●	●	●	●
Copper	EPA-6010	.	●	●	●	●	●
Iron	EPA-6010	.	●	●	●	●	●
Lead ⁷	EPA-6010	.	●	●	●	●	●
	EPA-7421	●	●	●	●	●	●
	EPA-200.8	●	●	●	.	●	●
Lithium	EPA-6010	.	●	●	●	●	●
Manganese	EPA-6010	.	●	●	●	●	●
Mercury	EPA-7470	●	●	●	●	●	●
Molybdenum	EPA-6010	.	●	●	●	●	●
Nickel	EPA-6010	●	●	●	●	●	●
Selenium	EPA-6010	.	●	●	●	●	●
Silver	EPA-6010	.	●	●	●	●	●
Strontium	EPA-6010	.	●	●	●	●	●

Table 4 (cont'd)

MONITORING PROGRAM	RCRA Post-Closure Corrective Action Monitoring ¹						
	DOE Order 5400.1 Monitoring ²						
	Best Management Practice Monitoring ³						
TRACE METALS (cont'd)	Analytical Method ⁴	GWPS Constituent ⁵	Sample Type ⁶				
			Filtered	Unfiltered			
Thallium	EPA-200.8	.	●	●	●	●	●
Thorium	EPA-6010	.	●	●	●	●	●
Uranium	EPA-200.8	●	●	●	●	●	●
Vanadium	EPA-6010	.	●	●	●	●	●
Zinc	EPA-6010	.	●	●	●	●	●
VOLATILE ORGANIC COMPOUNDS	Analytical Method	GWPS Constituent	Sample Type				
			Filtered	Unfiltered			
Acetone	ACD-240040	●	.	●	●	●	●
Benzene	ACD-240040	●	.	●	●	●	●
Bromodichloromethane	ACD-240040	.	.	●	●	●	●
Bromoform	ACD-240040	●	.	●	●	●	●
Bromomethane	ACD-240040	.	.	●	●	●	●
2-Butanone	ACD-240040	●	.	●	●	●	●
Carbon Disulfide	ACD-240040	.	.	●	●	●	●
Carbon Tetrachloride	ACD-240040	●	.	●	●	●	●
Chlorobenzene	ACD-240040	.	.	●	●	●	●
Chlorodibromomethane	ACD-240040	.	.	●	●	●	●
Chloroethane	ACD-240040	.	.	●	●	●	●
Chloroform	ACD-240040	●	.	●	●	●	●
Chloromethane	ACD-240040	.	.	●	●	●	●
1,1-Dichloroethane	ACD-240040	.	.	●	●	●	●
1,2-Dichloroethane	ACD-240040	.	.	●	●	●	●
1,1-Dichloroethene	ACD-240040	●	.	●	●	●	●
1,2-Dichloroethene	ACD-240040	.	.	●	●	●	●
Trans-1,2-Dichloroethene	ACD-240040	●	.	●	●	●	●
1,2-Dichloropropane	ACD-240040	.	.	●	●	●	●
Cis-1,3-Dichloropropene	ACD-240040	.	.	●	●	●	●
Trans-1,3-Dichloropropene	ACD-240040	.	.	●	●	●	●
Ethylbenzene	ACD-240040	.	.	●	●	●	●
2-Hexanone	ACD-240040	.	.	●	●	●	●
4-Methyl-2-Pentanone	ACD-240040	●	.	●	●	●	●
Methylene Chloride	ACD-240040	●	.	●	●	●	●
Styrene	ACD-240040	.	.	●	●	●	●
1,1,2,2-Tetrachloroethane	ACD-240040	.	.	●	●	●	●
Tetrachloroethene	ACD-240040	●	.	●	●	●	●
Toluene	ACD-240040	●	.	●	●	●	●

Table 4 (cont'd)

MONITORING PROGRAM	RCRA Post-Closure Corrective Action Monitoring ¹						
	DOE Order 5400.1 Monitoring ²						
	Best Management Practice Monitoring ³						
VOLATILE ORGANIC COMPOUNDS (cont'd)	Analytical Method ⁴	GWPS Constituent ⁵	Sample Type ⁶				
			Filtered	Unfiltered			
1,1,1-Trichloroethane	ACD-240040	●	.	●	●	●	●
1,1,2-Trichloroethane	ACD-240040	.	.	●	●	●	
Trichloroethene	ACD-240040	●	.	●	●	●	
Vinyl Acetate	ACD-240040	.	.	●	●	●	
Vinyl Chloride	ACD-240040	.	.	●	●	●	
Xylenes	ACD-240040	.	.	●	●	●	
RADIOLOGICAL ANALYTES	Analytical Method	GWPS Constituent	Sample Type				
			Filtered	Unfiltered			
Gross Alpha Activity	Y/P65-7162	●	.	●	●	●	●
Gross Beta Activity	Y/P65-7162	●	.	●	●	●	●
Americium-241	Y/P65-7157	●	.	●	.	.	●
Iodine-129	EPA-901.1	●	.		.	.	●
Neptunium-237	Y/P65-7158	●	.	●	.	.	●
Plutonium-238	Y/P65-7159	●	.	●	.	.	●
Plutonium-239	Y/P65-7159	.	.	●	.	.	●
Radium (total)	EPA-903.0	●	.	●	.	.	●
Strontium-89/90	Y/P65-7196	●	.	●	.	●	●
Technetium-99	Y/P65-7154	●	.	●	.	●	●
Tritium	EPA-906.0	●	.	●	.	●	●
	Y/P65-7150	●	.	●	.	●	●
Uranium-234/-235/-238	Y/P65-7161	●	.	●	.	.	●
MISC. LABORATORY ANALYTES	Analytical Method	GWPS Constituent	Sample Type				
			Filtered	Unfiltered			
pH	EPA-150.1	.	.	●	●	●	●
Specific Conductance	EPA-129.1	.	.	●	●	●	●
Total Dissolved Solids	EPA-160.1	.	.	●	●	●	●
Total Suspended Solids	EPA-160.2	.	.	●	●	●	●
Turbidity	EPA-180.1	.	.	●	●	●	●
FIELD MEASUREMENTS	Analytical Method	GWPS Constituent ⁴	Sample Type ⁵				
			Filtered	Unfiltered			
Depth-to-Water	ESP 302-1	.	.	.	●	●	●
Water Temperature	ESP 307-1	.	.	●	●	●	●
pH	ESP 307-2	.	.	●	●	●	●
Specific Conductance	ESP 307-8	.	.	●	●	●	●
Dissolved Oxygen	ESP 307-5	.	.	●	●	●	●
REDOX	ESP 307-5	.	.	●	●	●	●

Table 4 (cont'd)

Notes:

- 1 Resource Conservation and Recovery Act (RCRA) post-closure corrective action monitoring per the requirements of the RCRA Post-Closure Permit for the Bear Creek Regime.
- 2 Surveillance monitoring and exit-pathway/perimeter monitoring per the requirements of U.S. Department of Energy (DOE) Order 5400.1.
- 3 Monitoring performed as a best management practice of the Y-12 Plant Groundwater Protection Program.
- 4 Analytical/field methods/procedures from:
 - *Test Methods for Evaluating Solid Waste Physical/Chemical Methods* (U.S. Environmental Protection Agency 1986)
 - *Methods for Chemical Analysis of Water and Wastes* (U.S. Environmental Protection Agency 1983)
 - *Environmental Surveillance Procedures Quality Control Program* (Martin Marietta Energy Systems, Inc. 1988)
 - K-25 Site Analytical Chemistry Department Procedures Manual
- 5 Groundwater protection standard (GWPS) constituent specified in the RCRA Post-Closure Permit for the Bear Creek Regime.
- 6 Groundwater samples for metals analysis were collected with dedicated sampling equipment or portable Bennet Pumps™ and were filtered in the field; all other samples were filtered in the laboratory as required by analytical procedures.
- 7 Lead concentrations in groundwater samples collected for RCRA monitoring during the first quarter and third quarter of 1996 were determined by Atomic Absorption Spectroscopy (EPA-7421), and Plasma Mass Spectroscopy (EPA-200.8), respectively. Lead results were obtained by the Inductively Coupled Plasma Spectroscopy (EPA-6010) for all samples; however, these results were evaluated only when no other data was available.

Table 5.
Sampling Locations in the Bear Creek Hydrogeologic Regime with Increasing
Concentrations of Groundwater Contamination Indicator Constituents¹

MONITORING WELL ²	WELLS SAMPLED DURING CY 1996										
	Hydrogeologic Unit ³		Inorganics ⁴					Organics ⁵		Radioanalytes ⁶	
	AQF	AQT	NO ₃	Ba	B	Sr	U	PCE	TCE	α	β
GW-047	.	●	●	.	.	.	.	.	.	.	.
GW-056	●	.	.	.	.	●	.	.	.	.	●
GW-057	●	.	.	●	.	.	.	.	.	.	.
GW-061	●	.	.	●	.	.	.	.	.	●	.
GW-069	.	●	●	.	.	.	.	.	.	.	●
GW-085	.	●	●	●	.	.	.	.	.	.	+
GW-086	.	●	●	.	.	.	●	.	.	.	.
GW-226	●	.	.	.	.	.	●	.	.	●	.
GW-227	●	.	●	.	.	.	.	.	.	.	.
GW-286	.	●	.	.	.	.	●	.	.	.	.
GW-287	.	●	.	●	+	●	.	.	.	.	●
GW-313	●	.	+	.	●	.	.	.	.	+	+
GW-314	●	.	●	●	.	●	●	.	.	●	.
GW-317	●	.	●	●	.	.	.	.	.	.	.
GW-347	●	.	+	.	+	.	.	.	.	.	.
GW-348	●	.	.	+	.	.	.	.	.	.	.
GW-364	●	.	●	.	.	.	+	.	.	.	.
GW-365	●	.	+	●	.	.	●	.	.	.	.
GW-526	.	●	●	+	.	+	.	.	.	.	.
GW-537	.	●	+	+	.	+	.	.	.	.	+
GW-601	●	.	.	+	+	.	.	.	.	.	.
GW-602	●	.	●	.	.	.	.	.	.	.	.
GW-616	.	●	+	.	.	.	.	.	.	.	.
GW-623	.	●	.	.	.	.	.	●	●	.	.
GW-626	.	●	.	+	.	.	.	●	●	.	.
GW-627	.	●	.	+	.	.	.	+	+	.	●
GW-629	.	●	.	.	.	.	.	●	●	.	.
GW-637	.	●	.	.	●	.	.	.	.	.	.
GW-638	.	●	.	.	.	.	●	.	.	.	.
GW-645	●	.	.	.	.	.	.	.	.	.	+
GW-647	●	.	.	.	●	.	.	.	.	.	.
GW-652	●	.	+	.	.	.	.	.	.	.	.
GW-653	.	●	.	.	●	.	.	.	.	.	●
GW-654	.	●	.	●	.	●	.	.	.	.	.
GW-683	●	.	.	.	.	.	.	.	●	.	●
GW-685	●	.	●	.	.	+	.	.	.	.	●

Table 5 (cont'd)

MONITORING WELL ²				WELLS SAMPLED DURING CY 1996								
Hydrogeologic Unit ³		Inorganics ⁴						Organics ⁵		Radioanalytes ⁶		
AQF	AQT	NO ₃	Ba	B	Sr	U	PCE	TCE	α	β		
GW-695	●	.	+	+	.	.	.	.	●	.	.	●
GW-703	●	.	●	+	●	●	.	.	.	.	.	●
GW-704	●	.	●	●	●	+	.	.	●	.	●	●
GW-711	●	.	.	.	●	.	.	.	.	.	.	●
GW-712	●	.	+	.	.	.	.	.	.	.	.	●
GW-713	●	.	●	.	.	.	.	.	.	.	.	●
GW-723	●	.	.	.	.	.	.	.	.	.	+	●
GW-724	●	.	.	+	.	.	.	.	●	.	●	●
GW-725	●	.	.	.	.	.	.	●	.	.	.	●
GW-738	●	.	.	.	.	.	.	●	.	.	.	●
GW-739	●	.	.	+	.	●	.	.	.	.	.	●
GW-794	.	●	+	.	.	.	.	.	.	.	.	●
GW-795	.	●	.	●	●	.	.	.	.	.	.	●
OVERALL WELL SUMMARY	TOTAL:		23	20	11	10	7	6	8	4	7	49
	AQF:		15	11	6	6	4	2	4	4	5	30
	AQT:		8	9	5	4	3	4	4	0	2	19
CY 1996 WELL SUMMARY	TOTAL:		10	9	6	6	0	3	5	0	5	21
	AQF:		6	4	3	4	0	2	4	0	3	13
	AQT:		4	5	3	2	0	1	1	0	2	8

Notes:

- 1 Increasing concentration trends indicated by nonparametric statistical analysis (Theil Slope) of CY 1990 - 1995 data (Paradigm Data Services, Inc. 1996).
 - . - No Trend Identified
 - - Standard level of significance (95 % confidence of positive relationship)
 - ⊕ - Highest level of significance (99 % confidence of positive relationship)
- 2 Monitoring wells located hydraulically downgradient (strike-parallel or dip-parallel) of all known sources of groundwater contamination in the Bear Creek Regime.
- 3
 - AQF - Aquifer (Maynardville Limestone and Knox Group)
 - AQT - Aquitard (Conasauga Group and Rome Formation)

Table 5 (cont'd)

Notes: (cont'd)

4	NO ₃	-	Nitrate (as N)
	Ba	-	Barium
	B	-	Boron
	Sr	-	Strontium (total)
	U	-	Uranium (total)
5	PCE	-	Tetrachloroethene
	TCE	-	Trichloroethene
6	α	-	Gross alpha
	β	-	Gross Beta

Table 6.
Elevated Trace Metal Concentrations in Groundwater and Surface Water, CY 1996

Metal ¹	Sampling Point ²	Location ³	UTL ⁴ (mg/L)	Concentration ⁵ (mg/L)	
				1st Qtr.	3rd Qtr.
Aquitard Wells					
Aluminum	GW-040	BG	2.4	6.5	3
	GW-080	BG	6.1	12	.
	GW-276	S3	2.4	11	13
	GW-828	OLF	2.4	4	.
	GW-829	OLF	2.4	.	2.7
Antimony	GW-079	BG	0.05	.	0.26
	GW-162	BG	0.05	.	0.38
Barium	GW-069	BG	0.35	0.37	0.36
	GW-537	OLF	0.79	2.7	2.3
	GW-829	OLF	0.79	0.56	0.84
Beryllium	GW-276	S3	0.00045	0.009	0.0094
	GW-828	OLF	0.00045	.	0.00071
Boron	GW-042	BG	0.0028	0.043	.
	GW-043	OLF	0.0028	0.045	0.052
	GW-115	S3	0.041	0.099	.
	GW-162	BG	0.041	0.056	0.07
	GW-276	S3	0.041	0.048	.
	GW-287	BG	0.041	.	0.065
	GW-372	BG	0.041	.	0.053
	GW-614	S3	0.041	0.075	.
	GW-653	BG	0.0028	.	0.091
	GW-794	AGLLSF	0.041	0.062	0.071
	GW-795	AGLLSF	0.041	.	0.042
Cadmium	GW-042	BG	0.002	0.0069	0.01
	GW-080	BG	0.002	0.0042	.
	GW-276	S3	0.002	0.045	0.047
Chromium	GW-287	BG	0.041	0.13	0.043
Cobalt	GW-276	S3	0.019	0.19	0.18
Copper	GW-080	BG	0.012	0.053	0.026
	GW-276	S3	0.012	.	0.03
Iron	GW-080	BG	8.7	20	.
Lead	GW-042	BG	0.0096	.	0.012
	GW-080	BG	0.0096	0.025	.
Manganese	GW-276	S3	1.7	8.6	8.8
Nickel	GW-276	S3	0.06	0.5	0.51
	GW-287	BG	0.06	0.084	.

Table 6 (cont'd)

Metal ¹	Sampling Point ²	Location ³	UTL ⁴ (mg/L)	Concentration ⁵ (mg/L)	
				1st Qtr.	3rd Qtr.
Aquitard Wells (cont'd)					
Selenium	GW-042	BG	0.05	.	0.13
	GW-373	BG	0.05	.	0.065
	GW-795	AGLLSF	0.05	.	0.069
Silver	GW-080	BG	0.006	0.015	0.0066
	GW-373	BG	0.006	.	0.011
	GW-829	OLF	0.006	.	0.0073
Strontium	GW-537	OLF	0.92	3.1	2.7
	GW-829	OLF	0.92	1.2	1.5
Uranium	GW-276	S3	0.005	1.9	1.2
Vanadium	GW-040	BG	0.005	0.0074	0.0068
	GW-080	BG	0.005	0.016	.
	GW-084	OLF	0.005	.	0.0051
	GW-276	S3	0.005	.	0.0059
	GW-373	BG	0.005	.	0.0057
Zinc	GW-079	BG	0.041	.	0.046
	GW-080	BG	0.043	0.074	.
	GW-276	S3	0.041	0.13	0.14
Aquifer Wells					
Aluminum	GW-715	EXP-W	2.4	3	.
	GW-738	EXP-C	2.4	4.6	.
Arsenic	GW-723	EXP-C	0.078	.	0.065
	GW-738	EXP-C	0.078	.	0.054
Beryllium	GW-712	EXP-W	0.00045	.	0.0083
	GW-738	EXP-C	0.00045	0.00061	.
Boron	GW-053	BG	0.12	0.27	0.29
	GW-683	EXP-A	0.028	.	0.069
	GW-710	EXP-W	0.12	0.33	0.29
	GW-711	EXP-W	0.12	1.2	1.3
	GW-714	EXP-W	0.041	0.082	0.047
	GW-723	EXP-C	0.12	.	0.44
	GW-725	EXP-C	0.12	.	0.21
	GW-738	EXP-C	0.12	.	0.23
	GW-740	EXP-C	0.028	.	0.65
Cadmium	GW-710	EXP-W	0.002	.	0.0066
	GW-712	EXP-W	0.002	.	0.0076
Copper	GW-694	EXP-W	0.012	.	0.069

Table 6 (cont'd)

Metal ¹	Sampling Point ²	Location ³	UTL ⁴ (mg/L)	Concentration ⁵ (mg/L)	
				1st Qtr.	3rd Qtr.
Aquifer Wells (cont'd)					
Iron	GW-710	EXP-W	8.7	25	21
	GW-711	EXP-W	8.7	9.9	9.4
	GW-714	EXP-W	8.7	.	9.1
	GW-723	EXP-C	8.7	.	10
Nickel	GW-056	EXP-A	0.06	0.12	0.61
	GW-621	EXP-B	0.02	0.033	0.025
	GW-715	EXP-W	0.06	0.12	.
Selenium	GW-706	EXP-B	0.05	0.058	.
	GW-723	EXP-C	0.05	.	0.06
	GW-724	EXP-C	0.05	.	0.078
Silver	GW-712	EXP-W	0.006	.	0.0083
	GW-725	EXP-C	0.006	.	0.0094
Strontium	GW-683	EXP-A	0.079	.	0.12
	GW-710	EXP-W	4.4	8	7.9
	GW-711	EXP-W	4.4	12	13
Uranium	GW-621	EXP-B	0.005	.	0.0062
	GW-683	EXP-A	0.005	0.024	0.051
	GW-684	EXP-A	0.012	0.022	0.041
	GW-694	EXP-B	0.012	0.12	0.062
	GW-706	EXP-B	0.012	0.12	0.13
Vanadium	GW-694	EXP-B	0.005	.	0.0059
	GW-712	EXP-W	0.005	.	0.0074
	GW-715	EXP-W	0.005	0.0054	.
	GW-738	EXP-C	0.005	0.0087	.
Zinc	GW-694	EXP-B	0.041	0.044	0.12
	GW-713	EXP-W	0.041	.	0.047
	GW-723	EXP-C	0.041	.	0.044
Surface Water					
Boron	BCK-09.40	EXP-SW	0.12	.	0.13
	BCK-07.75	EXP-SW	0.028	0.097	0.15
	BCK-04.55	EXP-SW	0.041	.	0.05
	BCK-03.87	EXP-SW	0.041	.	0.058
	BCK-00.63	EXP-SW	0.028	.	0.035
Cadmium	NT-01	EXP-SW	0.002	0.011	.
	BCK-11.97	EXP-SW	0.002	0.0034	.
Manganese	NT-01	EXP-SW	1.7	1.9	.
Selenium	NT-01	EXP-SW	0.05	0.066	0.15

Table 6 (cont'd)

Metal ¹	Sampling Point ²	Location ³	UTL ⁴ (mg/L)	Concentration ⁵ (mg/L)	
				1st Qtr.	3rd Qtr.
Surface Water (cont'd)					
Strontium	BCK-07.75	EXP-SW	0.079	0.083	0.13
	BCK-00.63	EXP-SW	0.079	0.11	.
Uranium	NT-01	EXP-SW	0.012	0.014	.
	BCK-11.97	EXP-SW	0.012	0.13	0.11
	BCK-10.60	EXP-SW	0.012	0.11	0.12
	BCK-09.40	EXP-SW	0.012	0.096	0.081
	BCK-07.75	EXP-SW	0.004	0.011	0.058
	BCK-04.55	EXP-SW	0.005	0.039	0.024
	BCK-03.87	EXP-SW	0.005	0.029	0.022
	BCK-00.63	EXP-SW	0.005	.	0.031
	SS-1	EXP-SW	0.012	0.028	0.041
	SS-4	EXP-SW	0.012	0.12	0.031
	SS-5	EXP-SW	0.012	0.031	0.086
Vanadium	SS-4	EXP-SW	0.005	.	0.0055

Notes:

- Results were obtained by Inductively Coupled Plasma spectroscopy, except for lead (third quarter) and uranium by Plasma Mass spectroscopy.
- Aquitard Wells shown in **bold** typeface are located hydraulically downgradient from waste management sites.

BCK - Bear Creek Kilometer
 GW - Groundwater Monitoring Well
 NT - Northern Tributary
 SS - Spring

- AGLLSF - Above Grade Low-Level Storage Facility
 BG - Bear Creek Burial Grounds Waste Management Area
 EXP-A - Exit Pathway (Maynardville Limestone) Picket A
 EXP-B - Exit Pathway (Maynardville Limestone) Picket B
 EXP-C - Exit Pathway (Maynardville Limestone) Picket C
 EXP-W - Exit Pathway (Maynardville Limestone) Picket W
 EXP-SW - Exit Pathway (Bear Creek) Surface Water
 OLF - Oil Landfarm Waste Management Area
 S3 - S-3 Site

Table 6 (cont'd)

Notes (cont'd):

- 4 UTL - Upper Tolerance Limit in milligrams per liter (mg/L) that represents a background concentration for clusters of wells grouped by geochemical characteristics. The cluster designation for each sampling location is provided in Appendix C.
- 5 Results shown in **bold** typeface exceed the applicable drinking water standard.

Table 7.
CY 1996 Maximum Summed VOC Concentrations for Aquifer Wells

MCL²	Sampling Point	CY 1996 Concentration¹ (µg/L)			
		GW-053	GW-056	GW-311	GW-315
	Location³	BG	EXP-A	RS	SPI
	Date Sampled	08/28/96	03/14/96	03/25/96	08/19/96
5	Carbon Tetrachloride	0	0	0	0
-	Chloroform	0	0	0	1
-	1,1-Dichloroethane	7	0	0	0
7	1,1-Dichloroethene	0	0	0	0
-	1,2-Dichloroethene	14	0	0	4
5	Tetrachloroethene	0	0	0	14
200	1,1,1-Trichloroethane	0	1	0	0
5	Trichloroethene	2	0	8	5
2	Vinyl Chloride	6	0	0	0
Summed Concentration		29	1	8	24

MCL²	Sampling Point	CY 1996 Concentration¹ (µg/L)			
		GW-621	GW-685	GW-694	GW-695
	Location³	EXP-B	EXP-A	EXP-B	EXP-B
	Date Sampled	03/14/96	07/25/96	03/18/96	03/14/96
5	Carbon Tetrachloride	1	0	0	0
-	Chloroform	0	0	0	0
-	1,1-Dichloroethane	0	0	0	0
7	1,1-Dichloroethene	0	0	0	0
-	1,2-Dichloroethene	0	1	7	4
5	Tetrachloroethene	0	0	0	0
200	1,1,1-Trichloroethane	1	0	0	1
5	Trichloroethene	0	0	8	5
2	Vinyl Chloride	0	0	0	0
Summed Concentration		2	1	15	10

Table 7 (cont'd)

MCL ²	Sampling Point Location ³ Date Sampled	CY 1996 Concentration ¹ (µg/L)			
		GW-703	GW-704	GW-706	GW-723
		EXP-B	EXP-B	EXP-B	EXP-C
		03/16/96	03/17/96	08/06/96	08/09/96
5	Carbon Tetrachloride	0	2	0	0
-	Chloroform	0	0	0	0
-	1,1-Dichloroethane	0	0	0	0
7	1,1-Dichloroethene	0	7	0	0
-	1,2-Dichloroethene	9	6	8	0
5	Tetrachloroethene	0	0	0	0
200	1,1,1-Trichloroethane	0	2	0	0
5	Trichloroethene	13	97	7	8
2	Vinyl Chloride	0	0	0	0
Summed Concentration		22	114	15	8

MCL ²	Sampling Point Location ³ Date Sampled	CY 1996 Concentration ¹ (µg/L)			
		GW-724	GW-725	GW-738	GW-740
		EXP-C	EXP-C	EXP-C	EXP-C
		03/21/96	03/22/96	03/20/96	03/19/96
5	Carbon Tetrachloride	3	0	0	2
-	Chloroform	0	0	1	1
-	1,1-Dichloroethane	0	0	0	0
7	1,1-Dichloroethene	0	0	0	0
-	1,2-Dichloroethene	4	0	3	3
5	Tetrachloroethene	4	0	0	0
200	1,1,1-Trichloroethane	0	0	1	1
5	Trichloroethene	160	17	50	72
2	Vinyl Chloride	0	0	0	0
Summed Concentration		171	17	55	79

Notes:

- Concentrations are reported in micrograms per liter (µg/L). Only results for the sample date with the highest summed concentration are presented. For analytes and analytical methods used in CY 1996 Bear Creek Regime monitoring, results less than 10 µg/L are below the analytical detection limit and are considered qualitative.
- MCL - Maximum Contaminant Level.

Table 7 (cont'd)

Notes: (cont'd)

- 3 BG - Bear Creek Burial Grounds Waste Management Area
- EXP-A - Exit Pathway (Maynardville Limestone) Picket A
- EXP-B - Exit Pathway (Maynardville Limestone) Picket B
- EXP-C - Exit Pathway (Maynardville Limestone) Picket C
- RS - Rust Spoil Area
- SPI - Spoil Area I

Table 8.
Gross Alpha and Gross Beta Activity in Groundwater
and Surface Water, CY 1996

Sampling Point	Gross Alpha Activity ¹ (pCi/L)		Gross Beta Activity ¹ (pCi/L)	
	1st Qtr.	3rd Qtr.	1st Qtr.	3rd Qtr.
Aquitard Wells				
GW-043	.	11 ± 5.9	.	.
GW-079	.	6.79 ± 3.3	.	.
GW-080	.	4.55 ± 3	.	11.9 ± 5.6
GW-085	.	5.02 ± 3	100 ± 16	95.6 ± 14
GW-276	410 ± 55	368 ± 51	810 ± 110	575 ± 75
GW-537	.	.	168 ± 24	401 ± 81
GW-627	.	.	.	14.7 ± 7
GW-828	18 ± 7.2	.	15.5 ± 5.7	7.92 ± 6
GW-829	.	6.62 ± 3.2	.	.
Aquifer Wells				
GW-053	.	.	9.11 ± 5	.
GW-056	.	3.66 ± 2.6	.	.
GW-315	.	.	24.4 ± 6.6	21.1 ± 5.7
GW-621	3.03 ± 2.3	.	11.9 ± 6.1	.
GW-683	7.95 ± 5.2	26.1 ± 6.2	.	34 ± 7.4
GW-684	14.8 ± 6.3	19.4 ± 5.3	14.6 ± 6.3	31.1 ± 6.5
GW-694	43.6 ± 10	.	41.7 ± 9.1	.
GW-695	9.09 ± 5.7	4.22 ± 2.6	17.5 ± 6.6	14.4 ± 4.9
GW-703	.	4.5 ± 2.9	33.4 ± 8.2	32.9 ± 6.9
GW-704	.	31.3 ± 7	.	16.9 ± 5.1
GW-706	53.7 ± 12	62.8 ± 11	52.8 ± 10	.
GW-723	.	.	.	8.65 ± 5.2
GW-724	.	2.83 ± 2.1	36.9 ± 8.4	29.5 ± 6.9
GW-725	.	.	34.3 ± 8.2	25.4 ± 6.8
GW-738	.	5.11 ± 2.6	33.2 ± 8	22.2 ± 5.9
GW-740	.	.	.	12.9 ± 6.3
Springs				
SS-1	16.3 ± 6.7	12.5 ± 4.2	32.4 ± 8	28.1 ± 7.6
SS-4	51 ± 11	68.4 ± 12	53.2 ± 10	64.4 ± 11
SS-5	12.9 ± 5.7	32.1 ± 7.1	16.6 ± 6.3	29.8 ± 6.4

Table 8 (cont'd)

Sampling Point	Gross Alpha Activity ¹ (pCi/L)		Gross Beta Activity ¹ (pCi/L)	
	1st Qtr.	3rd Qtr.	1st Qtr.	3rd Qtr.
Surface Water				
NT-01	11.7 ± 5.8	11.5 ± 4	173 ± 25	67.8 ± 11
BCK-11.97	63.9 ± 13	49.5 ± 9.2	113 ± 18	49.7 ± 9.4
BCK-10.60	61.5 ± 12	66.1 ± 11	38.5 ± 8.6	27.8 ± 6.4
BCK-09.40	46.7 ± 10	41.3 ± 8.2	33.4 ± 8.1	28.5 ± 7
BCK-07.75	29.3 ± 8.1	20.9 ± 7.4	30.5 ± 7.7	21.9 ± 6.6
BCK-04.55	.	5.81 ± 5.3	.	8.61 ± 5.2
BCK-03.87	18.1 ± 6.6	.	.	8.93 ± 5.3
BCK-00.63	.	12.5 ± 4.2	.	8.62 ± 5.5

Notes:

- 1 Activity, reported in picoCuries per liter (pCi/L), that exceeded the error associated with the result and the sample-specific minimum detectable activity (MDA).

. - Result less than the MDA or the associated error.

APPENDIX C

SCREENED DATA SUMMARY

CY 1996 GROUNDWATER AND SURFACE WATER SAMPLES

EXPLANATION

SAMPLING POINT:

- BCK - Bear Creek Kilometer
- GW - Monitoring Well
- NT - Northern Tributary
- SS - Spring (south side of Bear Creek)

LOCATION:

- AGLLSF - Above Grade Low-Level Storage Facility
- BG - Bear Creek Burial Grounds WMA
- EXP - Exit Pathway Monitoring Location:
 - Maynardville Limestone Picket (-A, -B, -C, -W)
 - Spring or Surface Water Sampling Location (-SW)
- OLF - Oil Landfarm WMA
- RS - Rust Spoil Area
- S3 - S-3 Site
- SPI - Spoil Area I

UNITS:

- ft - feet (water-level elevation is in feet above mean sea level)
- mg/L - milligrams per liter
- ug/L - micrograms per liter
- pCi/L - picoCuries per liter

DATA QUALIFIERS:

- .
- Not detected or not analyzed
- FLD DUP - Field Duplicate Sample differs by at least an order-of-magnitude.
- TOT < DIS - Total concentration (Unfiltered Sample) is at least an order-of-magnitude less than the dissolved concentration (Filtered Sample).
- FP - False positive VOC result, screened by data from the associated laboratory blank (FP1) or trip blank (FP2) sample.
- <MDA - Reported activity is less than the Minimum Detectable Activity.
- <CE - Reported activity is greater than the MDA, but less than the associated counting error.

EXPLANATION (cont'd)

NOTES:

Only unfiltered results that meet data quality objectives of the Y-12 Plant Groundwater Protection Program for the constituents detected at least once in CY 1996 are presented in this appendix. All of the analytical results for groundwater and surface water samples collected in 1996 are available in the Annual Groundwater Monitoring Report (AJA Technical Services, Inc. 1997).

Miscellaneous:

TSS - Total Suspended Solids

Major Ions:

The relative percent difference (RPD) between summed positive and negative charges (Charge Balance) is used to evaluate the accuracy of the data. Results for major ions are considered qualitative if the Charge Balance RPD is greater than 10 or less than -10.

Trace Metals:

The Cluster Designation reflects a group (numbered 1,2,3,4,6, or 10), based on similar geochemical characteristics, assigned to each sampling location (HSW Environmental Consultants, Inc 1995). Upper tolerance limits (UTLs) that represent trace metal background levels have been determined for each cluster (see Section 4.2).

All metals analyses were performed using the inductively coupled plasma (ICP) spectroscopy method unless otherwise noted.

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

Organics:

All results below 10 ug/L are below the analytical reporting limit, and are considered qualitative.

The maximum Summed VOCs value for each sampling location is used a plume delineation value (see Section 4.3).

APPENDIX C.1
Screened Data Summary, 1996

1

Sampling Point	BCK-00.63	BCK-03.87		BCK-04.55		BCK-07.75		BCK-09.40		BCK-10.60
Location	EXP-SW	EXP-SW		EXP-SW		EXP-SW		EXP-SW		EXP-SW
Date Sampled	08/06/96	01/30/96	07/14/96	01/30/96	07/14/96	01/30/96	07/14/96	03/16/96	07/29/96	03/17/96
MISCELLANEOUS	.	.	.	.	.	.	.	.	.	.
Water-Level Elevation	.	.	.	.	.	.	.	.	.	.
Water in Well (ft)	.	.	.	.	.	.	.	.	.	.
TSS (mg/L)	2	.	.	.	2.5	3	.	.	4	.
pH (Field)	6.9	6.7	7.8	7	6.6	7.3	7.6	7.9	7.6	8
MAJOR IONS (mg/L)	.	.	.	.	.	.	.	.	.	.
CHARGE BALANCE (RPD)	-0.2	-1.1	-2	0.6	-2.8	-0.6	-4.2	1.3	1.8	1.6
Calcium	45	29	46	30	45	40	59	57	61	57
Magnesium	13	7.8	15	8.5	15	9.7	16	11	9.8	9.5
Potassium	.	1.1	1.3	1.3	1.5	1.2	1.7	2.8	3	2.1
Sodium	4.2	3.3	3.6	3.5	3.7	4.7	6.9	8.7	8.7	10
Alkalinity-HCO3	137	86	158	92	162	108	179	131	143	115
Alkalinity-CO3	.	.	.	.	.	.	.	.	.	.
Chloride	5.7	5.21	6.56	5.54	6.52	7.39	13.3	14.6	14	15.8
Fluoride	0.15	.	.	.	0.13	0.16	0.16	0.27	0.3	0.35
Sulfate	16.8	9.53	8.06	9.98	7.62	15.7	14.3	19.9	19	23.9
Nitrate-N	1.13	1.39	2.52	1.57	2.77	4.11	10.5	9.29	7.98	13.2
METALS (mg/L)	.	.	.	.	.	.	.	.	.	.
CLUSTER DESIGNATION	4	3	3	3	3	2	2	1	1	1
Aluminum	0.16	0.24	0.1	0.11	0.15	0.21	0.12	0.15	0.48	0.28
Antimony	.	.	.	.	.	.	.	.	.	.
Arsenic	.	.	.	.	.	.	.	.	.	.
Barium	0.061	0.041	0.057	0.041	0.059	0.055	0.082	0.082	0.088	0.095
Beryllium	.	.	.	.	.	.	0.00033	.	.	.
Boron	0.035	0.027	0.058	0.026	0.05	0.097	0.15	0.085	0.13	0.046
Cadmium	.	.	.	.	.	.	.	.	.	.
Chromium	.	.	.	.	.	.	.	.	.	.
Cobalt	.	.	.	.	.	.	.	.	.	.
Copper	.	.	.	.	.	.	.	.	0.0085	.
Iron	0.22	0.26	0.086	0.18	0.17	0.2	0.16	0.13	0.65	0.24
Lead (AAS)	.	.	.	.	.	.	.	.	.	.
Lead (PMS)	0.0012	.	0.0035	.	0.0014	.	.	.	0.00089	.
Lithium	.	0.0079	0.0065	0.0072	0.0089	0.017	0.018	0.051	0.026	0.0076
Manganese	0.038	0.013	0.017	0.013	0.045	0.014	0.055	0.034	0.044	0.076
Molybdenum	.	.	.	.	.	.	.	.	.	.
Nickel	.	.	.	.	.	.	.	.	.	.
Selenium	.	.	.	.	.	.	.	.	.	.
Silver	.	.	.	.	.	.	.	.	.	.
Strontium	0.11	0.05	0.072	0.052	0.071	0.083	0.13	0.14	0.16	0.16
Thallium (PMS)	.	.	.	.	.	.	.	.	.	.
Uranium (PMS)	0.031	0.029	0.022	0.039	0.024	0.011	0.058	0.096	0.081	0.11
Vanadium	.	.	.	.	.	.	.	.	.	.
Zinc	0.003	0.0061	0.0028	0.0041	TOT<DIS	0.0075	0.0068	0.0097	0.0076	0.0067
ORGANICS (ug/L)	.	.	.	.	.	.	.	.	.	.
SUMMED VOCs	ND	ND	ND	ND	ND	2	ND	15	4	ND
Carbon tetrachloride	.	.	.	.	.	.	.	.	.	.
Chloroform	.	.	.	.	.	.	.	.	.	.
1,1-Dichloroethane	.	.	.	.	.	.	.	.	.	.
1,1-Dichloroethene	.	.	.	.	.	.	.	.	.	.
1,2-Dichloroethene	.	.	.	.	.	2	.	14	4	.
Tetrachloroethene	.	.	.	.	.	.	.	.	.	.
1,1,1-Trichloroethane	.	.	.	.	.	.	.	1	.	.
Trichloroethene	.	.	.	.	.	.	.	.	.	.
Vinyl chloride	.	.	.	.	.	.	.	.	.	.
RADIOACTIVITY (pCi/L)	.	.	.	.	.	.	.	.	.	.
Gross Alpha	12.5	18.1	<MDA	14.4	<MDA	29.3	20.9	46.7	41.3	61.5
Gross Beta	8.62	<MDA	8.93	11.3	<MDA	30.5	21.9	33.4	28.5	38.5

(CONTINUED)

APPENDIX C.1
Screened Data Summary, 1996

2

Sampling Point	BCK-10.60	BCK-11.97		GW-040		GW-042		GW-043		GW-044
Location	EXP-SW	EXP-SW		BG		BG		OLF		OLF
Date Sampled	07/30/96	03/17/96	08/13/96	03/26/96	07/18/96	03/26/96	07/18/96	02/01/96	07/08/96	01/31/96
MISCELLANEOUS	.	.	.	.	.	.	.	.	.	.
Water-Level Elevation	.	.	.	994.35	987.19	984.43	981.48	986.31	988.1	989.34
Water in Well (ft)	.	.	.	19.25	12.09	12.68	9.73	16.51	18.3	49.04
TSS (mg/L)	5	.	3.5	46	28	.	1	3.6	.	.
pH (Field)	7.5	8.2	7.4	6.4	6.8	6.1	5.5	6.8	6.1	7.3
MAJOR IONS (mg/L)	.	.	.	.	.	.	.	.	.	.
CHARGE BALANCE (RPD)	2.5	-0.9	4.7	5.8	-3.8	-1.4	-2.6	-0.3	6.2	1.3
Calcium	66	130	91	6.3	5.4	3.8	3.6	22	17	48
Magnesium	9.7	17	12	8.1	7.2	4.8	4.9	4.2	3	3.2
Potassium	3.3	4	2.4	5	2.9	1.6	0.61	0.66	0.98	1
Sodium	9.9	39	21	12	11	3.4	3.5	7.2	6.9	5.2
Alkalinity-HCO3	143	192	180	35	38	30	30	75	53	134
Alkalinity-CO3	.	.	.	.	.	.	.	.	.	.
Chloride	13.4	72.6	24.4	2.54	1.91	2.26	1.61	1.84	1.06	1.95
Fluoride	0.43	0.61	0.46	0.27	0.32	0.16	0.16	.	.	.
Sulfate	28.2	43.9	33.1	29.2	29.5	5.63	6.2	9.06	9.24	7.1
Nitrate-N	7.66	42.8	15.3	.	.	.	.	.	.	.
METALS (mg/L)	.	.	.	.	.	.	.	.	.	.
CLUSTER DESIGNATION	1	1	1	3	3	2	2	2	2	3
Aluminum	0.37	0.18	0.25	6.5	3	.	TOT<DIS	1.2	1.1	.
Antimony	.	.	.	.	.	.	.	.	.	.
Arsenic	.	.	.	.	.	.	.	.	.	.
Barium	0.1	0.19	0.12	0.12	0.08	0.14	0.15	0.025	0.019	0.25
Beryllium	.	.	.	0.0003	.	.	.	.	.	.
Boron	0.056	0.047	0.091	0.033	0.039	0.013	0.043	0.045	0.052	0.019
Cadmium	.	0.0034	.	.	.	0.0069	0.01	.	.	.
Chromium	.	.	.	.	.	.	.	.	.	.
Cobalt	.	.	.	0.0069	.	.	.	.	.	.
Copper	0.0059	.	0.0048	.	0.0092	.	0.0083	0.0041	0.0054	.
Iron	0.5	.	0.27	6.9	4	0.8	1.8	1.2	0.74	0.013
Lead (AAS)	.	.	.	0.0044	.	.	.	0.0059	.	.
Lead (PMS)	0.00082	.	0.00086	.	0.0044	.	0.012	.	0.0039	.
Lithium	0.016	.	.	0.035	0.033	0.022	0.02	0.009	0.0062	0.011
Manganese	0.048	0.54	0.21	1.1	1	0.29	0.31	0.02	0.017	0.0025
Molybdenum	.	.	.	.	.	.	.	.	.	.
Nickel	.	.	.	.	0.016	0.01	0.023	.	.	.
Selenium	.	.	.	.	.	.	0.13	.	.	.
Silver	.	.	.	.	.	.	.	.	.	.
Strontium	0.2	0.36	0.27	0.022	0.017	0.016	0.015	0.039	0.029	0.074
Thallium (PMS)	.	.	.	.	.	.	.	.	.	.
Uranium (PMS)	0.12	0.13	0.11	.	.	.	.	.	0.00056	.
Vanadium	.	.	.	0.0074	0.0068	.	.	.	.	.
Zinc	0.0068	0.0094	TOT<DIS	0.033	0.022	0.012	0.025	0.0094	0.011	0.0034
ORGANICS (ug/L)	.	.	.	.	.	.	.	.	.	.
SUMMED VOCs	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon tetrachloride	.	.	.	.	.	.	.	.	.	.
Chloroform	.	.	.	.	.	.	.	.	.	.
1,1-Dichloroethane	.	.	.	.	.	.	.	.	.	.
1,1-Dichloroethene	.	.	.	.	.	.	.	.	.	.
1,2-Dichloroethene	.	.	.	.	.	.	.	.	.	.
Tetrachloroethene	.	.	.	.	.	.	.	.	.	.
1,1,1-Trichloroethane	.	.	.	.	.	.	.	.	.	.
Trichloroethene	.	.	.	.	.	.	.	.	.	.
Vinyl chloride	.	.	.	.	.	.	.	.	.	.
RADIOACTIVITY (pCi/L)	.	.	.	.	.	.	.	.	.	.
Gross Alpha	66.1	63.9	49.5	<MDA	<MDA	<MDA	<MDA	<MDA	11	<MDA
Gross Beta	27.8	113	49.7	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA

(CONTINUED)

APPENDIX C.1
Screened Data Summary, 1996

3

Sampling Point	GW-044	GW-053		GW-056		GW-069		GW-079		GW-080
Location	OLF	BG		EXP-A		BG		BG		BG
Date Sampled	07/08/96	03/26/96	08/28/96	03/14/96	07/23/96	02/25/96	07/23/96	02/25/96	07/24/96	02/24/96
MISCELLANEOUS	.	.	.	.	.	.	.	.	.	.
Water-Level Elevation	991.95	897.56	893.88	885.16	882.57	919.19	917.58	962.58	959.14	959.21
Water in Well (ft)	51.65	30.03	26.35	53.71	51.12	94.14	92.53	50.34	46.9	11.88
TSS (mg/L)	.	17.5	4	3.5	21.5	.	.	.	10.5	764
pH (Field)	6.8	7.4	6.9	7.3	6.3	9.1	7.8	8.3	7.5	6.4
MAJOR IONS (mg/L)	.	.	.	.	.	.	.	.	.	.
CHARGE BALANCE (RPD)	-3.5	3.9	0	1.5	-2.8	-2.6	-6.6	-3.5	-3.8	-1.7
Calcium	45	130	120	98	90	12	11	37	36	4.8
Magnesium	3.2	15	15	19	17	5.3	5.1	3.6	4	7.9
Potassium	.	2.4	1.9	1.5	1.9	4.4	4.8	1.1	1.2	4.3
Sodium	5.4	7.9	8.3	71	59	66	61	4.3	4.5	9.9
Alkalinity-HCO3	135	316	321	266	267	139	139	110	114	37
Alkalinity-CO3	.	.	.	.	.	.	.	.	.	.
Chloride	1.04	25.6	27.3	122	125	38	50.8	1.65	.	1.76
Fluoride	.	.	.	0.11	0.12	.	0.11	.	0.13	0.14
Sulfate	7.45	23.3	22.6	30.6	30.6	2.7	2.48	7.18	8.01	13.3
Nitrate-N	.	.	.	.	0.31	.	.	.	.	.
METALS (mg/L)	.	.	.	.	.	.	.	.	.	.
CLUSTER DESIGNATION	3	1	1	1	1	10	10	3	3	2
Aluminum	0.035	0.088	0.1	0.099	0.32	0.021	.	0.023	1.3	12
Antimony	.	.	.	.	.	.	.	.	0.26	.
Arsenic	.	.	.	.	.	.	.	.	.	.
Barium	0.25	0.22	0.22	0.1	0.092	0.37	0.36	0.14	0.2	0.16
Beryllium	.	.	.	.	.	.	.	.	.	0.0004
Boron	0.034	0.27	0.29	0.056	0.042	0.13	0.11	0.012	0.0094	0.025
Cadmium	.	.	.	.	.	.	.	.	.	0.0042
Chromium	.	.	0.012	.	0.1	.	.	.	.	0.028
Cobalt	.	.	.	.	.	.	.	.	.	0.013
Copper	.	.	.	.	.	.	0.0066	.	0.0045	0.053
Iron	.	0.56	0.45	0.76	3.4	0.016	0.035	0.036	1.4	20
Lead (AAS)	.	.	.	.	.	.	.	.	.	0.025
Lead (PMS)	.	.	0.0026	.	0.0022	.	0.00061	.	0.0027	.
Lithium	0.0062	0.35	0.42	.	0.0059	0.042	0.039	0.0061	0.0088	0.026
Manganese	0.0042	0.087	0.089	0.3	0.098	0.0046	0.0089	0.047	0.06	0.14
Molybdenum	.	.	.	.	.	.	.	.	0.012	.
Nickel	.	0.02	0.025	0.12	0.61	.	.	.	.	0.031
Selenium	.	.	.	.	.	.	.	.	.	.
Silver	.	.	.	.	.	.	.	.	.	0.015
Strontium	0.073	0.43	0.41	0.16	0.15	0.86	0.76	0.13	0.12	0.03
Thallium (PMS)	.	.	0.00053	.	.	.	.	.	.	.
Uranium (PMS)	.	0.0015	0.002	0.0029	0.0026	.	.	.	.	.
Vanadium	.	.	.	.	.	.	.	.	.	0.016
Zinc	.	0.011	TOT<DIS	0.0077	0.011	0.005	0.002	0.0061	0.046	0.074
ORGANICS (ug/L)	.	.	.	.	.	.	.	.	.	.
SUMMED VOCs	ND	24	29	1	ND	ND	2	ND	ND	ND
Carbon tetrachloride	.	.	.	.	.	.	.	.	.	.
Chloroform	.	.	.	.	.	.	.	.	.	.
1,1-Dichloroethane	.	6	7	.	.	.	.	.	.	.
1,1-Dichloroethene	.	.	.	.	.	.	.	.	.	.
1,2-Dichloroethene	.	11	14	.	.	.	.	.	.	.
Tetrachloroethene	.	.	.	.	.	.	.	.	.	.
1,1,1-Trichloroethane	.	.	.	1	.	.	.	.	.	.
Trichloroethene	.	2	2	.	.	.	.	.	.	.
Vinyl chloride	.	5	6	.	.	.	2	.	.	.
RADIOACTIVITY (pCi/L)	.	.	.	.	.	.	.	.	.	.
Gross Alpha	<MDA	<MDA	<MDA	<MDA	3.66	<MDA	<MDA	<MDA	6.79	<MDA
Gross Beta	<MDA	9.11	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA

(CONTINUED)

APPENDIX C.1
Screened Data Summary, 1996

4

Sampling Point	GW-080	GW-084	GW-085	GW-095	GW-115	GW-162				
Location	BG	OLF	OLF	BG	S3	BG				
Date Sampled	07/24/96	02/01/96	07/08/96	03/25/96	08/20/96	03/26/96	08/27/96	01/31/96	07/02/96	02/26/96
MISCELLANEOUS	.	.	.	.	.	.	.	.	.	.
Water-Level Elevation	956.01	984.45	981.85	970.02	969.52	907.6	905.87	1047.67	1044.5	1022.3
Water in Well (ft)	8.68	17.88	15.28	49	48.5	155.62	153.89	48.77	45.6	109.2
TSS (mg/L)	54	14	18.5	5	12.5	.	.	.	1	.
pH (Field)	5.4	7.9	7.3	7	6.4	9.3	8.8	7.5	6.3	8.4
MAJOR IONS (mg/L)	.	.	.	.	.	.	.	.	.	.
CHARGE BALANCE (RPD)	4.5	0.5	-1.7	3.6	5.7	1.6	-1.4	2.6	-2.3	-6
Calcium	3.8	57	54	280	270	1.4	1.8	79	74	34
Magnesium	4.9	4.3	4.2	19	17	0.5	0.51	12	12	5.2
Potassium	3.3	0.96	1.5	2.8	2.1	2.2	2.3	1.5	1.6	3
Sodium	9.3	5.6	5.4	10	9.8	120	120	10	10	15
Alkalinity-HCO3	35	155	157	150	150	217	231	234	238	131
Alkalinity-CO3	.	.	.	.	.	30	32	.	.	.
Chloride	.	1.92	.	10.3	9.96	2.22	1.47	6.34	9.18	3.15
Fluoride	0.19	.	.	.	.	0.51	0.58	.	.	.
Sulfate	17.3	7.39	8.4	5.21	5.64	8.29	8.79	19	19.2	8.7
Nitrate-N	.	.	.	184	144	.	0.03	0.27	.	.
METALS (mg/L)	.	.	.	.	.	.	.	.	.	.
CLUSTER DESIGNATION	2	3	3	3	3	10	10	3	3	3
Aluminum	2.6	0.72	0.91	0.38	0.38	0.021	0.078	.	0.026	0.17
Antimony	.	.	.	.	.	.	.	.	.	.
Arsenic	.	.	.	.	.	.	.	.	.	.
Barium	0.054	0.18	0.17	0.74	0.69	0.025	0.026	0.23	0.22	0.29
Beryllium	.	.	.	.	.	.	.	.	.	.
Boron	0.025	0.0084	0.024	0.019	.	0.9	0.92	0.099	0.032	0.056
Cadmium	.	.	.	.	.	.	.	.	.	.
Chromium	.	.	.	.	.	.	.	.	.	.
Cobalt	0.005	.	.	.	.	.	.	.	.	.
Copper	0.026	.	0.0052	.	.	.	0.0089	.	.	.
Iron	3.8	0.9	1	0.32	0.18	0.013	0.12	0.19	0.42	0.86
Lead (AAS)	.	.	.	.	.	.	.	.	.	.
Lead (PMS)	0.007	.	0.0017	.	0.0018	.	0.00087	.	.	.
Lithium	0.013	0.0093	0.0087	0.02	0.014	0.067	0.07	0.017	0.015	0.042
Manganese	0.082	0.053	0.052	0.013	0.015	0.0013	0.0023	0.23	0.39	0.11
Molybdenum	.	.	.	.	.	.	.	.	.	.
Nickel	0.017	.	.	.	.	.	.	.	.	.
Selenium	.	.	.	.	.	.	.	.	.	.
Silver	0.0066	.	.	.	.	.	.	.	.	.
Strontium	0.017	0.079	0.076	0.64	0.57	0.1	0.097	0.13	0.12	0.86
Thallium (PMS)	.	.	.	.	.	.	.	.	.	.
Uranium (PMS)	.	.	.	.	.	.	.	.	.	.
Vanadium	.	.	0.0051	.	.	.	.	.	.	.
Zinc	0.028	0.0051	0.0072	0.0032	0.0034	0.0065	0.0098	0.0084	0.003	0.0024
ORGANICS (ug/L)	.	.	.	.	.	.	.	.	.	.
SUMMED VOCs	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon tetrachloride	.	.	.	.	.	.	.	.	.	.
Chloroform	.	.	.	.	.	.	.	.	.	.
1,1-Dichloroethane	.	.	.	.	.	.	.	.	.	.
1,1-Dichloroethene	.	.	.	.	.	.	.	.	.	.
1,2-Dichloroethene	.	.	.	.	.	.	.	.	.	.
Tetrachloroethene	.	.	.	.	.	.	.	.	.	.
1,1,1-Trichloroethane	.	.	.	.	.	.	.	.	.	.
Trichloroethene	.	.	.	.	.	.	.	.	.	.
Vinyl chloride	.	.	.	.	.	.	.	.	.	.
RADIOACTIVITY (pCi/L)	.	.	.	.	.	.	.	.	.	.
Gross Alpha	4.55	<MDA	<MDA	<MDA	5.02	<MDA	<MDA	<MDA	<MDA	<MDA
Gross Beta	11.9	<MDA	<MDA	100	95.6	<MDA	<MDA	<MDA	<MDA	<MDA

(CONTINUED)

APPENDIX C.1
Screened Data Summary, 1996

5

Sampling Point	GW-162	GW-276	GW-287	GW-311	GW-315	GW-363
Location	BG	S3	BG	RS	SPI	OLF
Date Sampled	07/24/96	02/29/96 07/08/96	03/26/96 08/27/96	03/25/96 08/14/96	03/26/96 08/19/96	02/12/96
MISCELLANEOUS	.	.	.	.	.	.
Water-Level Elevation	1019.8	995.51	994.5	917.98	917.42	965.92
Water in Well (ft)	106.7	15.21	14.2	5.88	5.32	9.79
TSS (mg/L)	12	.	11	.	12.5	.
pH (Field)	7.3	5.4	4	7.2	6.8	7.3
MAJOR IONS (mg/L)	.	.	.	.	.	.
CHARGE BALANCE (RPD)	-4.3	-6.4	-11	2.3	-4.9	-1.6
Calcium	32	150	130	44	45	79
Magnesium	5.3	27	26	7.2	5.7	5.9
Potassium	4.1	11	14	1.5	1.9	1.8
Sodium	15	84	85	3.8	4.5	2.7
Alkalinity-HCO3	127	.	.	127	136	220
Alkalinity-CO3	.	.	.	.	.	210
Chloride	3.21	187	192	3.27	2.79	2.48
Fluoride	0.11	4.6	4.87	0.12	0.18	1.88
Sulfate	9.77	30.4	40.1	6.21	6.1	3.16
Nitrate-N	.	129	129	.	0.03	0.34
METALS (mg/L)	.	.	.	.	.	.
CLUSTER DESIGNATION	3	3	3	3	3	3
Aluminum	0.11	11	13	2.4	1.9	0.022
Antimony	0.38	.	.	.	.	.
Arsenic	.	.	.	.	.	.
Barium	0.31	0.5	0.52	0.14	0.13	0.019
Beryllium	.	0.009	0.0094	.	.	0.017
Boron	0.07	0.048	0.041	0.021	0.065	.
Cadmium	.	0.045	0.047	.	.	0.058
Chromium	.	.	.	0.13	0.043	.
Cobalt	.	0.19	0.18	.	.	.
Copper	0.007	.	0.03	.	.	.
Iron	4.1	.	0.37	1.5	0.7	0.023
Lead (AAS)	.	.	.	.	.	.
Lead (PMS)	0.0039	.	0.0032	.	0.0019	.
Lithium	0.039	0.025	0.033	0.0092	.	0.0039
Manganese	0.14	8.6	8.8	0.034	0.018	.
Molybdenum	.	.	.	.	.	0.0029
Nickel	.	0.5	0.51	0.084	0.01	.
Selenium	.	.	.	.	.	.
Silver	.	.	.	.	.	.
Strontium	0.79	0.35	0.32	0.087	0.088	0.073
Thallium (PMS)	.	.	.	.	.	0.065
Uranium (PMS)	.	1.9	1.2	.	.	.
Vanadium	.	.	0.0059	.	.	0.0018
Zinc	0.0072	0.13	0.14	0.041	0.022	0.0082
ORGANICS (ug/L)	.	.	.	.	.	.
SUMMED VOCs	ND	19	23	ND	ND	8
Carbon tetrachloride	.	.	.	.	.	5
Chloroform	.	1	1	.	.	13
1,1-Dichloroethane	.	.	.	.	.	1
1,1-Dichloroethene	.	.	.	.	.	.
1,2-Dichloroethene	.	.	.	.	.	3
Tetrachloroethene	.	18	22	.	.	9
1,1,1-Trichloroethane	.	.	.	.	.	.
Trichloroethene	.	.	.	.	.	5
Vinyl chloride	.	.	.	.	.	.
RADIOACTIVITY (pCi/L)	.	.	.	.	.	.
Gross Alpha	<MDA	410	368	<MDA	<MDA	<MDA
Gross Beta	<MDA	810	575	<MDA	<MDA	<MDA

(CONTINUED)

APPENDIX C.1
Screened Data Summary, 1996

6

Sampling Point	GW-363	GW-372	GW-373	GW-537	GW-613	GW-614				
Location	OLF	BG	BG	OLF	S3	S3				
Date Sampled	07/02/96	02/25/96	07/23/96	02/28/96	07/25/96	03/25/96	08/20/96	01/31/96	07/01/96	02/12/96
MISCELLANEOUS	.	.	.	.	.	.	.	.	.	.
Water-Level Elevation	952.75	965.74	961.12	965.25	965.5	970.49	969.32	1002.12	999.25	1010.39
Water in Well (ft)	72.34	37.47	32.85	142.5	142.75	19.6	18.43	33.92	31.05	91.19
TSS (mg/L)	16.5	1.5	.	5	1.5	2	.	.	.	10
pH (Field)	8.5	7.9	7.2	9.5	8.8	6.8	6.6	7	5.7	8
MAJOR IONS (mg/L)	.	.	.	.	.	.	.	.	.	.
CHARGE BALANCE (RPD)	-5.3	2.7	-3	-4.4	-3.9	0.2	3	-0.7	-5	-3.2
Calcium	2.3	62	53	1.4	1.2	1200	1100	28	28	45
Magnesium	1	11	10	0.31	0.15	83	70	2.8	2.8	9.3
Potassium	2	1.8	1.8	1.1	2.7	5.1	4.4	.	0.67	1.6
Sodium	97	9	8.7	110	110	38	32	3.4	3.3	9.4
Alkalinity-HCO3	196	180	176	193	197	289	270	85	94	171
Alkalinity-CO3	38	.	.	36	30	.	.	.	.	.
Chloride	.	2.4	1.93	2.12	1.5	34.4	35.2	1.8	1.2	1.65
Fluoride	0.2	0.14	0.19	1.4	1.46	.	.	.	0.11	.
Sulfate	8.72	28	29.5	28.9	31.5	4.46	4.34	5.68	6.44	12.1
Nitrate-N	.	.	.	.	.	780	730	.	.	.
METALS (mg/L)	.	.	.	.	.	.	.	.	.	.
CLUSTER DESIGNATION	10	3	3	10	10	3	3	2	2	3
Aluminum	0.49	.	.	0.8	0.14	0.13	0.072	.	.	0.36
Antimony	.	.	.	.	.	.	.	.	.	.
Arsenic	.	.	.	.	.	.	.	.	.	.
Barium	0.066	0.066	0.065	0.05	0.046	2.7	2.3	0.056	0.056	0.14
Beryllium	.	.	.	.	.	.	.	.	.	.
Boron	0.29	0.033	0.053	0.17	0.2	.	0.019	0.019	0.006	0.075
Cadmium	.	.	.	.	.	.	.	.	.	.
Chromium	.	.	.	.	.	.	.	.	.	.
Cobalt	.	.	.	.	.	.	.	.	.	.
Copper	.	.	0.0051	.	0.0076	.	.	.	.	.
Iron	1.2	0.15	0.12	1.6	0.66	0.12	.	0.0065	.	0.71
Lead (AAS)	.	.	.	.	.	.	.	.	.	.
Lead (PMS)	.	.	.	.	0.005	.	.	.	0.0007	.
Lithium	0.037	0.015	0.012	0.033	0.035	0.042	0.039	0.006	0.0063	0.011
Manganese	0.0082	0.027	0.02	0.012	0.0074	0.006	0.0039	.	.	0.016
Molybdenum	.	.	.	.	.	.	.	.	.	.
Nickel	.	.	.	.	.	.	.	.	.	.
Selenium	.	.	.	.	0.065	.	.	.	.	.
Silver	.	.	.	.	0.011	.	.	.	.	.
Strontium	0.085	0.17	0.15	0.064	0.061	3.1	2.7	0.044	0.045	0.53
Thallium (PMS)	.	.	.	.	.	.	.	.	.	.
Uranium (PMS)	.	.	.	.	.	0.0012	0.0012	.	.	.
Vanadium	.	.	.	.	0.0057	.	.	.	.	.
Zinc	0.0054	0.0037	0.0027	0.005	0.0042	.	.	0.0071	.	0.0076
ORGANICS (ug/L)	.	.	.	.	.	.	.	.	.	.
SUMMED VOCs	ND	ND	ND	ND	ND	2	1	ND	ND	ND
Carbon tetrachloride	.	.	.	.	.	.	.	.	.	.
Chloroform	.	.	.	.	.	1	1	.	.	.
1,1-Dichloroethane	.	.	.	.	.	.	.	.	.	.
1,1-Dichloroethene	.	.	.	.	.	.	.	.	.	.
1,2-Dichloroethene	.	.	.	.	.	.	.	.	.	.
Tetrachloroethene	.	.	.	.	.	1	.	.	.	.
1,1,1-Trichloroethane	.	.	.	.	.	.	.	.	.	.
Trichloroethene	.	.	.	.	.	.	.	.	.	.
Vinyl chloride	.	.	.	.	.	.	.	.	.	.
RADIOACTIVITY (pCi/L)	.	.	.	.	.	.	.	.	.	.
Gross Alpha	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Gross Beta	<MDA	<MDA	<MDA	<MDA	<MDA	168	401	<MDA	<MDA	<MDA

(CONTINUED)

APPENDIX C.1
Screened Data Summary, 1996

7

Sampling Point	GW-614	GW-621	GW-627	GW-642	GW-653	GW-683				
Location	S3	EXP-B	BG	BG	BG	EXP-A				
Date Sampled	07/01/96	03/14/96	07/23/96	03/28/96	09/06/96	02/24/96	07/09/96	03/26/96	08/28/96	03/15/96
MISCELLANEOUS	.	.	.	.	.	.	.	.	.	.
Water-Level Elevation	1007.32	914.26	911.09	920.43	919.26	996.15	992.94	911.02	908.42	886.13
Water in Well (ft)	88.12	31.69	28.52	250.04	248.87	21.15	17.94	21.17	18.57	113.48
TSS (mg/L)	1.5	18	FLD DUP	.	.	1.5	.	16	67	.
pH (Field)	7.1	7.8	6.9	11	8.9	6.8	5.3	5.4	4.4	7.6
MAJOR IONS (mg/L)	.	.	.	.	.	.	.	.	.	.
CHARGE BALANCE (RPD)	-2.3	0.3	-2.4	1.6	0.9	-5.8	-3.7	-2.9	-0.8	-11.6
Calcium	47	56	60	1	1.1	8	7.6	2.2	2.4	40
Magnesium	9.9	11	11	0.23	0.22	8.5	8.5	1.3	1.5	14
Potassium	2	1.4	1.3	1.7	0.81	3.1	1.7	0.8	1.8	1.7
Sodium	9.7	2	3.7	310	310	7.7	7.5	2.6	4.6	3.8
Alkalinity-HCO3	174	169	175	503	511	65	65	13	14	141
Alkalinity-CO3	.	.	.	68	80	.	.	.	.	.
Chloride	.	3.89	7.98	29.9	20.7	2.13	1.4	1.8	0.88	6.65
Fluoride	.	.	.	5	5.32	0.35	0.47	.	.	0.12
Sulfate	12.3	3.84	8.42	30.9	31.6	9.74	11	2.32	2.68	9.23
Nitrate-N	.	4.45	5.47	.	.	.	.	.	.	14.5
METALS (mg/L)	.	.	.	.	.	.	.	.	.	.
CLUSTER DESIGNATION	3	3	3	10	10	2	2	2	2	4
Aluminum	0.056	1.4	0.71	0.039	0.063	0.035	.	0.52	1.5	.
Antimony	.	.	.	.	.	.	.	.	.	.
Arsenic	.	.	.	.	.	.	.	.	.	.
Barium	0.15	0.028	0.03	0.047	0.038	0.14	0.14	0.044	0.06	0.054
Beryllium	.	.	.	.	.	.	.	.	.	.
Boron	0.028	0.022	0.036	0.55	0.47	0.022	0.021	0.022	0.091	0.025
Cadmium	.	.	.	.	.	.	.	.	.	.
Chromium	.	0.032	0.03	.	.	.	.	.	.	.
Cobalt	.	.	.	.	.	.	.	.	.	.
Copper	.	.	.	.	.	.	.	.	.	.
Iron	0.05	1.4	1.2	0.095	0.59	5	3.6	0.46	0.98	0.0056
Lead (AAS)	.	.	.	.	.	.	.	.	.	.
Lead (PMS)	.	.	0.0018	.	0.0023	.	0.0018	.	0.0022	.
Lithium	0.011	.	.	0.087	0.09	0.038	0.039	.	.	.
Manganese	0.014	0.099	0.11	0.0043	0.013	1.4	1.3	0.022	0.041	.
Molybdenum	.	.	.	.	.	.	.	.	.	.
Nickel	.	0.033	0.025	.	.	.	.	.	.	.
Selenium	.	.	.	.	.	.	.	.	.	.
Silver	.	.	.	.	.	.	.	.	.	.
Strontium	0.56	0.064	0.073	0.082	0.077	0.025	0.024	0.02	0.024	0.057
Thallium (PMS)	.	.	.	.	.	.	.	.	.	.
Uranium (PMS)	.	0.0022	0.0062	.	.	.	.	.	.	0.024
Vanadium	.	.	.	.	.	.	.	.	.	.
Zinc	0.0056	0.0057	0.0076	0.017	0.011	0.0097	0.0051	0.013	0.017	0.0074
ORGANICS (ug/L)	.	.	.	.	.	.	.	.	.	.
SUMMED VOCs	ND	2	1	60	71	ND	ND	40	15	ND
Carbon tetrachloride	.	1	.	.	.	.	.	.	.	.
Chloroform	.	.	.	.	.	.	.	.	.	.
1,1-Dichloroethane	.	.	.	4	5	.	.	2	.	.
1,1-Dichloroethene	.	.	.	1	1	.	.	1	.	.
1,2-Dichloroethene	.	.	.	.	.	.	.	31	13	.
Tetrachloroethene	.	.	.	47	56	.	.	4	2	.
1,1,1-Trichloroethane	.	1	.	.	.	.	.	.	.	.
Trichloroethene	.	.	1	8	9	.	.	2	.	.
Vinyl chloride	.	.	.	.	.	.	.	.	.	.
RADIOACTIVITY (pCi/L)	.	.	.	.	.	.	.	.	.	.
Gross Alpha	<MDA	<MDA	3.03	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	7.95
Gross Beta	<MDA	<MDA	11.9	<MDA	14.7	<MDA	<MDA	<MDA	<MDA	<MDA

(CONTINUED)

APPENDIX C.1
Screened Data Summary, 1996

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Sampling Point	GW-683	GW-684		GW-685		GW-694		GW-695		GW-703
Location	EXP-A	EXP-A		EXP-A		EXP-B		EXP-B		EXP-B
Date Sampled	07/29/96	03/16/96	07/29/96	03/15/96	07/25/96	03/18/96	08/01/96	03/14/96	07/23/96	03/16/96
MISCELLANEOUS	.	.	.	.	.	.	.	.	.	.
Water-Level Elevation	884.38	883.44	883.26	884.02	883.36	917.03	918.63	914.82	910.99	916.84
Water in Well (ft)	111.73	116.31	116.13	133.04	132.38	182.95	184.55	40.2	36.37	147.04
TSS (mg/L)	1	22	8	2	7	.	.	43	19	.
pH (Field)	7.2	8.1	6.9	7.4	7	7.4	7.5	8.1	7.1	6.5
MAJOR IONS (mg/L)	.	.	.	.	.	.	.	.	.	.
CHARGE BALANCE (RPD)	-2.6	0.7	0.6	-3.2	-4.2	-6.4	-1.5	-4	-4.8	0.3
Calcium	65	42	58	82	79	79	58	37	43	66
Magnesium	17	14	16	25	23	16	14	19	21	30
Potassium	1.1	9.3	6.6	2.6	1.7	2.6	2.4	7.3	5.3	2.4
Sodium	7.5	5.3	7.3	27	24	13	8.7	31	21	10
Alkalinity-HCO3	186	150	177	274	260	205	155	199	193	211
Alkalinity-CO3	.	.	.	.	.	.	.	.	.	.
Chloride	14.3	11.3	19.7	57.7	59.2	23.7	15.3	8.95	10	18.6
Fluoride	0.18	0.16	0.2	.	0.11	0.4	0.33	0.12	0.12	0.17
Sulfate	15.6	9.91	14.2	20.8	21.4	25.7	16.1	9.81	11	22.7
Nitrate-N	9.6	3.68	9.02	1.9	2.67	13.2	3.57	8.64	8.99	19.3
METALS (mg/L)	.	.	.	.	.	.	.	.	.	.
CLUSTER DESIGNATION	4	1	1	1	1	1	1	1	1	1
Aluminum	0.033	0.61	0.43	0.45	0.38	0.054	0.74	1.2	0.27	0.033
Antimony	.	.	.	.	.	.	.	.	.	.
Arsenic	.	.	.	.	.	.	.	.	.	.
Barium	0.088	0.079	0.094	0.11	0.1	0.1	0.097	0.03	0.033	0.072
Beryllium	.	.	.	.	.	.	.	.	.	.
Boron	0.069	0.037	0.073	0.029	0.058	0.083	0.078	0.049	0.053	0.074
Cadmium	.	.	.	.	.	.	.	.	.	.
Chromium	.	.	.	.	.	.	.	0.014	0.019	.
Cobalt	.	.	.	.	.	.	.	.	.	.
Copper	0.0044	0.0041	0.0054	.	.	.	0.069	.	.	.
Iron	0.13	0.37	0.39	1.5	4.5	0.31	1.4	0.41	0.14	0.23
Lead (AAS)	.	.	.	.	.	.	.	.	.	.
Lead (PMS)	0.0016	.	0.0017	.	0.0028	.	0.0012	.	0.00098	.
Lithium	0.0055	0.018	0.017	0.0075	0.0072	0.017	0.015	0.013	0.013	0.015
Manganese	0.0026	0.0098	0.0093	0.14	0.12	0.076	0.11	0.002	0.0017	0.022
Molybdenum	.	.	.	.	.	.	.	.	.	.
Nickel	.	.	.	.	.	.	.	.	.	.
Selenium	.	.	.	.	.	.	.	.	.	.
Silver	.	.	.	.	.	.	.	.	.	.
Strontium	0.12	0.094	0.12	0.12	0.12	0.18	0.13	0.06	0.067	0.22
Thallium (PMS)	.	.	.	.	.	.	.	.	.	.
Uranium (PMS)	0.051	0.022	0.041	0.0037	0.0046	0.12	0.062	0.0027	0.0017	0.0035
Vanadium	.	.	.	.	.	.	0.0059	.	.	.
Zinc	0.022	0.02	0.023	0.022	0.032	0.044	0.12	0.0059	0.0079	0.0076
ORGANICS (ug/L)	.	.	.	.	.	.	.	.	.	.
SUMMED VOCs	ND	ND	ND	ND	1	15	3	10	8	22
Carbon tetrachloride	.	.	.	.	.	.	.	.	.	.
Chloroform	.	.	.	.	.	.	.	.	.	.
1,1-Dichloroethane	.	.	.	.	.	.	.	.	.	.
1,1-Dichloroethene	.	.	.	.	.	.	.	.	.	.
1,2-Dichloroethene	.	.	.	.	1	7	.	4	3	9
Tetrachloroethene	.	.	.	.	.	.	.	.	.	.
1,1,1-Trichloroethane	.	.	.	.	.	.	.	1	.	.
Trichloroethene	.	.	.	.	.	8	3	5	5	13
Vinyl chloride	.	.	.	.	.	.	.	.	.	.
RADIOACTIVITY (pCi/L)	.	.	.	.	.	.	.	.	.	.
Gross Alpha	26.1	14.8	19.4	<MDA	<MDA	43.6	<MDA	9.09	4.22	<MDA
Gross Beta	34	14.6	31.1	<MDA	<MDA	41.7	<MDA	17.5	14.4	33.4

(CONTINUED)

APPENDIX C.1
Screened Data Summary, 1996

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Sampling Point	GW-703	GW-704	GW-706	GW-710	GW-711	GW-712				
Location	EXP-B	EXP-B	EXP-B	EXP-W	EXP-W	EXP-W				
Date Sampled	07/31/96	03/17/96	08/01/96	03/19/96	08/06/96	01/29/96	07/16/96	01/26/96	07/14/96	01/26/96
MISCELLANEOUS	.	.	.	.	.	.	.	.	.	.
Water-Level Elevation	912.93	915.78	914.9	916.45	917.21	846.16	844.04	841.9	844.4	845.24
Water in Well (ft)	143.13	229.79	228.91	173.17	173.93	682.63	680.51	606.14	608.64	429.13
TSS (mg/L)	1	9.5	.	1.5	.	17.5	34	12	11.5	5
pH (Field)	7.5	7.8	7.2	7.8	6.3	6.6	5.9	7.7	7.2	7.5
MAJOR IONS (mg/L)	.	.	.	.	.	.	.	.	.	.
CHARGE BALANCE (RPD)	1.9	0.3	2.2	-0.1	1.5	1.5	-10.9	6.3	-13.9	3.3
Calcium	74	65	68	82	95	500	520	490	490	71
Magnesium	34	32	34	17	20	180	180	230	210	36
Potassium	1.6	2	1.5	3.2	3.3	10	10	21	24	1.5
Sodium	11	14	14	13	15	230	210	1100	1100	16
Alkalinity-HCO3	215	210	209	198	220	91	121	156	160	190
Alkalinity-CO3	.	.	.	.	.	.	.	.	.	.
Chloride	19.6	26.3	27.3	24.4	22.6	346	388	1720	2130	14.1
Fluoride	0.19	0.19	0.21	0.38	0.4	1.14	1.43	1.61	1.7	0.49
Sulfate	23.5	23.1	22.2	25.6	27.4	1900	2380	1740	2650	124
Nitrate-N	17.5	17.5	16.5	15.2	16.8	.	.	.	.	0.4
METALS (mg/L)	.	.	.	.	.	.	.	.	.	.
CLUSTER DESIGNATION	1	1	1	1	1	1	1	1	1	1
Aluminum	.	0.029	0.034	0.032	0.033	.	0.043	.	TOT<DIS	.
Antimony	.	.	.	.	.	.	.	.	.	.
Arsenic	.	.	.	.	.	.	.	.	.	.
Barium	0.08	0.094	0.1	0.1	0.13	0.0024	0.0051	0.0094	0.01	0.045
Beryllium	.	.	.	.	.	.	.	.	.	.
Boron	0.11	0.087	0.076	0.075	0.093	0.33	0.29	1.2	1.3	0.11
Cadmium	.	.	.	.	.	.	0.0066	.	.	.
Chromium	.	.	.	.	.	.	.	.	.	.
Cobalt	.	.	.	.	.	.	.	.	.	.
Copper	.	.	0.0048	.	0.0042	.	.	.	.	.
Iron	0.38	4.3	3.8	0.78	0.22	25	21	9.9	9.4	4.9
Lead (AAS)	.	.	.	.	.	.	.	.	.	.
Lead (PMS)	0.001	.	.	.	0.00068	.	0.0016	.	0.0012	.
Lithium	0.018	0.018	0.018	0.018	0.018	0.14	0.14	0.7	0.75	0.014
Manganese	0.025	0.026	0.022	0.023	0.015	0.63	0.43	0.056	0.059	0.028
Molybdenum	.	.	.	.	.	.	.	.	.	.
Nickel	.	0.012	.	.	.	.	.	.	.	.
Selenium	.	.	.	0.058	.	.	.	.	.	.
Silver	.	.	.	.	.	.	.	.	.	.
Strontium	0.24	0.42	0.44	0.2	0.26	8	7.9	12	13	1.2
Thallium (PMS)	.	.	.	.	.	.	.	.	.	.
Uranium (PMS)	0.0043	0.0012	0.0011	0.12	0.13	.	.	.	.	0.0006
Vanadium	.	.	.	.	.	.	.	.	.	.
Zinc	0.0037	0.01	0.01	0.0082	0.0034	.	0.0048	.	.	0.0035
ORGANICS (ug/L)	.	.	.	.	.	.	.	.	.	.
SUMMED VOCs	13	114	78	14	15	ND	ND	ND	ND	ND
Carbon tetrachloride	.	2	.	.	.	.	.	.	.	.
Chloroform	.	.	.	.	.	.	.	.	.	.
1,1-Dichloroethane	.	.	.	.	.	.	.	.	.	.
1,1-Dichloroethene	.	7	5	.	.	.	.	.	.	.
1,2-Dichloroethene	4	6	3	6	8	.	.	.	.	.
Tetrachloroethene	.	.	.	.	.	.	.	.	.	.
1,1,1-Trichloroethane	.	2	.	.	.	.	.	.	.	.
Trichloroethene	9	97	70	8	7	.	.	.	.	.
Vinyl chloride	.	.	.	.	.	.	.	.	.	.
RADIOACTIVITY (pCi/L)	.	.	.	.	.	.	.	.	.	.
Gross Alpha	4.5	<MDA	31.3	53.7	62.8	<MDA	<MDA	<MDA	<MDA	<MDA
Gross Beta	32.9	<MDA	16.9	52.8	<CE	<MDA	<MDA	<MDA	<MDA	<MDA

(CONTINUED)

APPENDIX C.1
Screened Data Summary, 1996

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Sampling Point	GW-712	GW-713	GW-714	GW-715	GW-723	GW-724				
Location	EXP-W	EXP-W	EXP-W	EXP-W	EXP-C	EXP-C				
Date Sampled	07/15/96	01/28/96	07/17/96	01/29/96	07/17/96	01/29/96	07/18/96	03/21/96	08/09/96	03/21/96
MISCELLANEOUS	.	.	.	.	.	.	.	.	.	.
Water-Level Elevation	842.47	848.65	843.48	852.71	845.63	853.41	846.17	953.39	951.75	951.77
Water in Well (ft)	426.36	286.02	280.85	125.41	118.33	25.24	18	378.59	376.95	276.75
TSS (mg/L)	.	5	.	1.5	11	27	5.5	8.5	21	.
pH (Field)	7.4	7.4	7.5	7	7.1	6.7	6.7	7	7.5	7.5
MAJOR IONS (mg/L)	.	.	.	.	.	.	.	.	.	.
CHARGE BALANCE (RPD)	-1.4	5.1	4.2	2.7	-3	0.3	13.8	1.8	-1.8	-4.9
Calcium	68	60	62	57	49	67	100	47	62	95
Magnesium	35	31	34	24	24	15	19	29	28	42
Potassium	1.9	2.8	2.4	1.2	2	3.3	3	2.3	3.2	1.8
Sodium	17	14	15	4.2	3.9	17	22	7.3	7.7	24
Alkalinity-HCO3	196	190	192	199	199	206	266	198	234	224
Alkalinity-CO3	.	.	.	.	.	.	.	.	.	.
Chloride	17.3	12.3	14.6	8.63	8.79	42.8	.	6.24	8.4	62.6
Fluoride	0.46	0.54	0.58	0.12	0.16	.	.	0.5	0.37	0.22
Sulfate	153	88.7	97.4	22.8	23.7	5.41	5.72	18.3	37.5	30
Nitrate-N	.	0.39	.	3.56	1.29	0.61	0.57	3.36	5.61	38.8
METALS (mg/L)	.	.	.	.	.	.	.	.	.	.
CLUSTER DESIGNATION	1	1	1	3	3	1	1	1	1	1
Aluminum	0.026	.	.	0.18	0.062	3	0.25	.	.	.
Antimony	.	.	.	.	.	.	.	.	.	.
Arsenic	.	.	.	.	.	.	.	.	0.065	.
Barium	0.051	0.051	0.053	0.069	0.058	0.093	0.091	0.054	0.063	0.17
Beryllium	0.0083	.	.	.	.	.	.	.	.	.
Boron	0.099	0.12	0.033	0.082	0.047	0.053	0.035	0.069	0.44	0.074
Cadmium	0.0076	.	.	.	.	.	.	.	.	.
Chromium	.	.	.	.	.	0.099	0.076	.	.	.
Cobalt	0.0071	.	.	.	.	.	.	.	.	.
Copper	0.0099	.	.	.	.	0.0055	0.0077	.	.	.
Iron	0.99	1	1	2.2	9.1	4.2	2.5	4.2	10	0.067
Lead (AAS)	.	.	.	.	.	0.0064	.	.	.	.
Lead (PMS)	0.00067	.	0.0013	.	.	.	0.0013	.	0.001	.
Lithium	0.021	0.013	0.01	0.0076	0.0087	0.0056	.	0.015	0.015	0.018
Manganese	0.031	0.013	0.013	0.028	0.099	0.59	0.062	0.1	0.053	0.0058
Molybdenum	.	.	.	.	.	.	.	.	.	.
Nickel	.	.	.	.	.	0.047	0.12	.	.	.
Selenium	.	.	.	.	.	.	0.05	.	0.06	.
Silver	0.0083	.	.	.	.	.	.	.	.	.
Strontium	1.2	1.6	1.7	0.2	0.16	0.085	0.13	1.3	1.1	1.2
Thallium (PMS)	.	.	.	.	.	.	.	.	.	.
Uranium (PMS)	.	.	.	0.0029	0.0015	0.00059	0.00072	0.0015	0.0027	.
Vanadium	0.0074	.	.	.	.	0.0054	.	.	.	.
Zinc	0.018	0.0088	0.047	0.0056	0.0086	0.022	0.0097	0.013	0.044	0.0037
ORGANICS (ug/L)	.	.	.	.	.	.	.	.	.	.
SUMMED VOCs	ND	ND	ND	ND	ND	ND	ND	5	8	171
Carbon tetrachloride	.	.	.	.	.	.	.	.	.	3
Chloroform	.	.	.	.	.	.	.	.	.	FP2
1,1-Dichloroethane	.	.	.	.	.	.	.	.	.	.
1,1-Dichloroethene	.	.	.	.	.	.	.	.	.	.
1,2-Dichloroethene	.	.	.	.	.	.	.	.	.	4
Tetrachloroethene	.	.	.	.	.	.	.	.	.	4
1,1,1-Trichloroethane	.	.	.	.	.	.	.	.	.	.
Trichloroethene	.	.	.	.	.	.	.	5	8	160
Vinyl chloride	.	.	.	.	.	.	.	.	.	.
RADIOACTIVITY (pCi/L)	.	.	.	.	.	.	.	.	.	.
Gross Alpha	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Gross Beta	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	8.65	36.9

(CONTINUED)

APPENDIX C.1
Screened Data Summary, 1996

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Sampling Point	GW-724	GW-725	GW-738	GW-740	GW-793	GW-794				
Location	EXP-C	EXP-C	EXP-C	EXP-C	AGLLSF	AGLLSF				
Date Sampled	08/14/96	03/22/96	08/13/96	03/20/96	08/08/96	03/19/96	08/07/96	03/27/96	08/26/96	03/25/96
MISCELLANEOUS	.	.	.	.	.	.	.	.	.	.
Water-Level Elevation	951.05	951.41	951.34	956.13	957.47	951.9	952.01	961.89	959.78	924.12
Water in Well (ft)	276.03	135.65	135.58	63.77	65.11	124.9	125.01	25.84	23.73	32.51
TSS (mg/L)	.	3	.	58	6	.	.	.	.	5
pH (Field)	7.3	7	6.4	7.2	6.9	7.4	5.6	7.7	6.8	7.6
MAJOR IONS (mg/L)	.	.	.	.	.	.	.	.	.	.
CHARGE BALANCE (RPD)	3.1	-4.5	16.2	-5.7	4.3	-0.1	4.6	5	-2.5	0.8
Calcium	100	180	240	110	100	59	67	59	49	94
Magnesium	43	36	48	24	22	29	33	5	4.3	9
Potassium	1.7	3	4.7	3	2.2	1.4	1.8	0.82	0.71	2.1
Sodium	25	23	31	6.3	6.3	2	3.2	3.9	3.6	3.3
Alkalinity-HCO3	217	301	293	311	299	253	259	153	154	232
Alkalinity-CO3	.	.	.	.	.	.	.	.	.	.
Chloride	61.2	65.8	58.5	32.1	12.1	6.7	6.55	1.55	0.78	8.27
Fluoride	0.25	.	0.26	.	.	0.18	0.2	.	0.11	.
Sulfate	26.1	36.6	41.6	30.2	29.8	13.5	12.9	5.25	4.87	22.3
Nitrate-N	35.1	67.9	51	14	12.7	3.99	3.48	.	.	0.45
METALS (mg/L)	.	.	.	.	.	.	.	.	.	.
CLUSTER DESIGNATION	1	1	1	1	1	4	4	3	3	3
Aluminum	0.04	.	0.077	4.6	1	.	0.029	0.02	0.023	0.58
Antimony	.	.	.	.	.	.	.	.	.	.
Arsenic	.	.	.	.	0.054	.	.	.	.	.
Barium	0.17	0.29	0.4	0.068	0.048	0.079	0.091	0.15	0.12	0.096
Beryllium	.	.	.	0.00061	.	.	.	.	.	.
Boron	FLD DUP	0.037	0.21	0.029	0.23	0.014	0.65	0.013	.	0.062
Cadmium	.	.	.	.	.	.	.	.	.	.
Chromium	.	.	.	.	.	.	.	.	.	.
Cobalt	.	.	.	.	.	.	.	.	.	.
Copper	.	.	0.0048	0.0059	.	.	.	.	.	.
Iron	0.23	1.4	0.58	5.9	1	0.22	0.21	0.031	0.07	0.74
Lead (AAS)	.	.	.	.	.	.	.	.	.	.
Lead (PMS)	0.0017	.	0.001	.	0.0037	.	.	.	.	.
Lithium	0.017	0.0059	0.012	0.0097	0.0066	0.012	0.016	0.0082	.	.
Manganese	0.026	0.27	0.33	0.15	0.026	0.0072	0.0083	0.018	0.043	0.024
Molybdenum	.	.	.	.	.	.	.	.	.	.
Nickel	.	.	.	.	.	.	.	.	.	.
Selenium	0.078	.	.	.	.	.	.	.	.	.
Silver	.	.	0.0094	.	.	.	.	.	.	.
Strontium	1.2	0.72	0.98	0.1	0.1	0.046	0.053	0.099	0.085	0.17
Thallium (PMS)	.	.	.	.	.	.	.	.	.	.
Uranium (PMS)	0.0005	0.0045	0.0045	0.0025	0.0025	.	.	.	.	.
Vanadium	.	.	.	0.0087	.	.	.	.	.	.
Zinc	0.0097	.	0.0041	0.035	0.015	0.0034	0.0038	0.0047	0.0022	0.0058
ORGANICS (ug/L)	.	.	.	.	.	.	.	.	.	.
SUMMED VOCs	42	17	12	55	43	79	33	ND	ND	ND
Carbon tetrachloride	.	.	.	.	.	2	.	.	.	.
Chloroform	.	.	.	1	1	1	.	.	.	.
1,1-Dichloroethane	.	.	.	.	.	.	.	.	.	.
1,1-Dichloroethene	.	.	.	.	.	.	.	.	.	.
1,2-Dichloroethene	1	.	.	3	2	3	2	.	.	.
Tetrachloroethene	1	.	.	.	.	.	.	.	.	.
1,1,1-Trichloroethane	.	.	.	1	.	1	.	.	.	.
Trichloroethene	40	17	12	50	40	72	31	.	.	.
Vinyl chloride	.	.	.	.	.	.	.	.	.	.
RADIOACTIVITY (pCi/L)	.	.	.	.	.	.	.	.	.	.
Gross Alpha	2.83	<MDA	<MDA	<MDA	5.11	<MDA	<MDA	<MDA	<MDA	<MDA
Gross Beta	29.5	34.3	25.4	33.2	22.2	<MDA	12.9	<MDA	<MDA	<MDA

(CONTINUED)

APPENDIX C.1
Screened Data Summary, 1996

12

Sampling Point	GW-794	GW-795	GW-828	GW-829	NT-01	SS-1				
Location	AGLLSF	AGLLSF	OLF	OLF	EXP-SW	EXP-SW				
Date Sampled	08/26/96	03/25/96	08/26/96	03/26/96	08/21/96	03/27/96	08/22/96	03/18/96	08/13/96	03/18/96
MISCELLANEOUS	.	.	.	.	.	.	.	.	.	.
Water-Level Elevation	916.86	922.38	919.45	982.92	980.4	974.04	972.78	.	.	.
Water in Well (ft)	25.25	19.56	16.63	171.84	169.32	106.72	105.46	.	.	.
TSS (mg/L)	2	.	.	2	.	18	698.5	7	.	.
pH (Field)	6	7.4	5	9.3	8.5	8.9	7.5	7.1	6.9	7.4
MAJOR IONS (mg/L)	.	.	.	.	.	.	.	.	.	.
CHARGE BALANCE (RPD)	-1.4	3.6	-2.9	1	-0.2	3.8	4.7	53.6	0.8	0.9
Calcium	88	81	87	6.3	2.1	20	37	110	68	180
Magnesium	8.2	3.3	3.6	1.9	0.53	7.9	10	16	11	17
Potassium	2.2	0.78	.	3.3	1.6	6.1	7.2	3.2	3.2	3.6
Sodium	3.6	1.9	2.4	190	170	110	120	15	8.7	17
Alkalinity-HCO3	231	181	218	268	272	163	172	86	105	341
Alkalinity-CO3	.	.	.	70	60	24	.	.	.	.
Chloride	9.48	4	4.29	10.6	11	2.89	3	10.5	6.06	49.9
Fluoride	.	.	.	1.6	1.7	0.41	0.42	0.6	0.34	0.16
Sulfate	23.3	20.3	22.2	25.6	23.6	16.1	16.3	18.5	17.9	66.1
Nitrate-N	0.42	.	.	3.25	0.73	33.6	38.7	.	24.7	19.8
METALS (mg/L)	.	.	.	.	.	.	.	.	.	.
CLUSTER DESIGNATION	3	3	3	10	10	10	10	1	1	1
Aluminum	0.37	.	.	4	0.35	0.26	2.7	0.6	0.67	0.078
Antimony	.	.	.	.	.	.	.	.	.	.
Arsenic	.	.	.	.	.	.	.	.	.	.
Barium	0.089	0.05	0.057	0.21	0.077	0.56	0.84	0.29	0.14	0.084
Beryllium	.	.	.	0.00071	.	.	0.00042	.	.	.
Boron	0.071	0.038	0.042	0.48	0.46	0.25	0.25	0.022	0.035	0.048
Cadmium	.	.	.	.	.	.	.	0.011	.	.
Chromium	.	.	.	.	.	.	.	.	.	.
Cobalt	.	.	.	.	.	.	0.0089	.	.	.
Copper	.	.	.	0.011	.	0.0083	.	.	0.0048	0.0063
Iron	0.38	.	.	2.7	0.11	0.24	3	0.16	0.8	0.016
Lead (AAS)	.	.	.	0.0043	.	.	.	.	.	.
Lead (PMS)	0.00086	.	.	.	0.0011	.	0.0045	.	0.00087	.
Lithium	.	.	.	0.062	0.057	0.058	0.067	0.005	.	.
Manganese	0.02	0.0015	0.028	0.068	0.0077	0.0084	0.12	1.9	0.46	0.0059
Molybdenum	.	.	.	.	.	.	.	.	.	.
Nickel	.	.	.	.	.	.	.	0.037	0.011	.
Selenium	.	.	0.069	.	.	.	.	0.066	0.15	.
Silver	.	.	.	.	.	.	0.0073	.	.	.
Strontium	0.16	0.13	0.14	0.29	0.12	1.2	1.5	0.34	0.24	0.46
Thallium (PMS)	.	.	0.00094	.	.	.	.	.	.	.
Uranium (PMS)	.	0.00072	0.002	0.0024	.	0.00052	0.0018	0.014	0.012	0.028
Vanadium	.	.	.	.	.	.	.	.	.	.
Zinc	0.0038	0.0078	.	0.02	0.013	0.012	0.019	0.021	0.014	0.018
ORGANICS (ug/L)	.	.	.	.	.	.	.	.	.	.
SUMMED VOCs	ND	ND	ND	ND	ND	ND	ND	6	1	3
Carbon tetrachloride	.	.	.	.	.	.	.	.	.	.
Chloroform	.	.	.	.	.	.	.	.	.	.
1,1-Dichloroethane	.	.	.	.	.	.	.	.	.	.
1,1-Dichloroethene	.	.	.	.	.	.	.	.	.	.
1,2-Dichloroethene	.	.	.	.	.	.	.	.	.	.
Tetrachloroethene	.	.	.	.	.	.	.	4	1	.
1,1,1-Trichloroethane	.	.	.	.	.	.	.	.	.	.
Trichloroethene	.	.	.	.	.	.	.	2	.	3
Vinyl chloride	.	.	.	.	.	.	.	.	.	.
RADIOACTIVITY (pCi/L)	.	.	.	.	.	.	.	.	.	.
Gross Alpha	<MDA	<MDA	<MDA	18	<MDA	<MDA	6.62	11.7	11.5	16.3
Gross Beta	<MDA	<MDA	<MDA	15.5	7.92	<MDA	<MDA	173	67.8	32.4

(CONTINUED)

APPENDIX C.1
Screened Data Summary, 1996

13

Sampling Point	SS-1	SS-4	SS-5
Location	EXP-SW	EXP-SW	EXP-SW
Date Sampled	08/13/96	03/16/96 07/30/96	03/16/96 07/29/96
MISCELLANEOUS	.	.	.
Water-Level Elevation	.	.	.
Water in Well (ft)	.	.	.
TSS (mg/L)	.	19	1
pH (Field)	7	6.9	7.3
MAJOR IONS (mg/L)	.	.	.
CHARGE BALANCE (RPD)	3.6	1.3	-0.9
Calcium	210	75	42
Magnesium	20	17	13
Potassium	4.4	1.9	1.4
Sodium	19	13	4.3
Alkalinity-HCO ₃	358	176	137
Alkalinity-CO ₃	.	.	.
Chloride	44.8	22.4	7.39
Fluoride	0.22	0.38	0.14
Sulfate	115	24	10.6
Nitrate-N	11.7	13.9	3.92
METALS (mg/L)	.	.	.
CLUSTER DESIGNATION	1	1	1
Aluminum	0.045	0.18	0.06
Antimony	.	.	.
Arsenic	.	.	.
Barium	0.1	0.12	0.052
Beryllium	.	.	.
Boron	0.11	0.068	0.079
Cadmium	.	.	.
Chromium	.	.	.
Cobalt	.	.	.
Copper	.	.	0.0047
Iron	0.012	0.32	1.2
Lead (AAS)	.	.	.
Lead (PMS)	.	.	0.00075
Lithium	0.0044	0.014	0.023
Manganese	0.076	0.19	0.62
Molybdenum	.	.	.
Nickel	.	.	.
Selenium	.	.	.
Silver	.	.	.
Strontium	0.6	0.18	0.25
Thallium (PMS)	.	.	.
Uranium (PMS)	0.041	0.12	0.031
Vanadium	.	.	0.0055
Zinc	0.0067	0.0076	0.0097
ORGANICS (ug/L)	.	.	.
SUMMED VOCs	3	13	9
Carbon tetrachloride	.	.	ND
Chloroform	.	.	ND
1,1-Dichloroethane	.	.	.
1,1-Dichloroethene	.	.	.
1,2-Dichloroethene	.	7	3
Tetrachloroethene	2	.	.
1,1,1-Trichloroethane	.	.	.
Trichloroethene	1	6	6
Vinyl chloride	.	.	.
RADIOACTIVITY (pCi/L)	.	.	.
Gross Alpha	12.5	51	68.4
Gross Beta	28.1	53.2	64.4

APPENDIX C.2
Screened Isotopic Data Summary, CY 1996

1

Sampling Point	BCK-09.40		BCK-10.60		BCK-11.97		GW-040		GW-042	
Location	EXP-SW		EXP-SW		EXP-SW		BG		BG	
Date Sampled	03/16/96	07/29/96	03/17/96	07/30/96	03/17/96	08/13/96	03/26/96	07/18/96	03/26/96	07/18/96
ACTIVITY (pCi/L)	.	.	.	.	.	.	.	.	.	.
Gross Alpha	46.7	41.3	61.5	66.1	63.9	49.5	<MDA	<MDA	<MDA	<MDA
Gross Beta	33.4	28.5	38.5	27.8	113	49.7	<MDA	<MDA	<MDA	<MDA
Americium 241	.	.	.	.	.	.	<MDA	<MDA	0.214	<MDA
Neptunium 237	.	.	.	.	.	.	<MDA	<MDA	<MDA	<MDA
Plutonium 238	.	.	.	.	.	.	<MDA	<MDA	<MDA	<MDA
Radium (total)	.	.	.	.	.	.	<MDA	<MDA	1.6	<MDA
Strontium 89/90	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Technetium 99	37	30.5	56	34.5	186	89.5	<MDA	<MDA	<MDA	<MDA
Tritium (X10)	<MDA	.	<MDA	.	<MDA	.	<MDA	<MDA	<MDA	<MDA
Uranium 234	.	.	.	.	.	.	<MDA	<MDA	<MDA	<MDA
Uranium 235	.	.	.	.	.	.	<MDA	<MDA	<MDA	<MDA
Uranium 238	.	.	.	.	.	.	< CE	<MDA	<MDA	<MDA

(CONTINUED)

Sampling Point	GW-043		GW-044		GW-069		GW-079		GW-080	
Location	OLF		OLF		BG		BG		BG	
Date Sampled	02/01/96	07/08/96	01/31/96	07/08/96	02/25/96	07/23/96	02/25/96	07/24/96	02/24/96	07/24/96
ACTIVITY (pCi/L)	.	.	.	.	.	.	.	.	.	.
Gross Alpha	<MDA	11	<MDA	<MDA	<MDA	<MDA	<MDA	6.79	<MDA	4.55
Gross Beta	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	11.9
Americium 241	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	0.461	<MDA
Neptunium 237	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	0.248	<MDA
Plutonium 238	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Radium (total)	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	3	<MDA
Strontium 89/90	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Technetium 99	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Tritium (X10)	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Uranium 234	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	0.17
Uranium 235	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Uranium 238	0.288	<MDA	< CE	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA

(CONTINUED)

Sampling Point	GW-084		GW-085		GW-115		GW-162		GW-276	
Location	OLF		OLF		S3		BG		S3	
Date Sampled	02/01/96	07/08/96	03/25/96	08/20/96	01/31/96	07/02/96	02/26/96	07/24/96	02/29/96	07/08/96
ACTIVITY (pCi/L)	.	.	.	.	.	.	.	.	.	.
Gross Alpha	<MDA	<MDA	<MDA	5.02	<MDA	<MDA	<MDA	<MDA	410	368
Gross Beta	<MDA	<MDA	100	95.6	<MDA	<MDA	<MDA	<MDA	810	575
Americium 241	<MDA	<MDA	.	.	<MDA	<MDA	<MDA	<MDA	0.2	<MDA
Neptunium 237	< CE	<MDA	.	.	<MDA	<MDA	<MDA	<MDA	25	19.8
Plutonium 238	1.54	<MDA	.	.	<MDA	<MDA	<MDA	< CE	<MDA	<MDA
Radium (total)	1.1	<MDA	.	.	<MDA	<MDA	<MDA	<MDA	1.3	3.5
Strontium 89/90	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	2.2	3.38
Technetium 99	<MDA	<MDA	257	219	<MDA	<MDA	<MDA	<MDA	950	1020
Tritium (X10)	<MDA	240	<MDA	.	<MDA	<MDA	<MDA	<MDA	.	<MDA
Uranium 234	< CE	<MDA	.	.	<MDA	<MDA	<MDA	< CE	170	<MDA
Uranium 235	<MDA	<MDA	.	.	<MDA	<MDA	<MDA	<MDA	8.6	<MDA
Uranium 238	<MDA	<MDA	.	.	<MDA	<MDA	<MDA	<MDA	410	<MDA

(CONTINUED)

APPENDIX C.2
Screened Isotopic Data Summary, CY 1996

2

Sampling Point	GW-363		GW-372		GW-373		GW-537		GW-613	
Location	OLF		BG		BG		OLF		S3	
Date Sampled	02/12/96	07/02/96	02/25/96	07/23/96	02/28/96	07/25/96	03/25/96	08/20/96	01/31/96	07/01/96
ACTIVITY (pCi/L)	.	.	.	.	.	.	.	.	.	.
Gross Alpha	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Gross Beta	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	168	401	<MDA	<MDA
Americium 241	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	.	.	<MDA	<MDA
Neptunium 237	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	.	.	<MDA	<MDA
Plutonium 238	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	.	.	<MDA	<MDA
Radium (total)	<MDA	1.7	<MDA	<MDA	<MDA	<MDA	.	.	<MDA	<MDA
Strontium 89/90	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Technetium 99	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	1200	1060	<MDA	<MDA
Tritium (X10)	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	230	.	<MDA	<MDA
Uranium 234	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	.	.	< CE	<MDA
Uranium 235	<MDA	<MDA	< CE	<MDA	<MDA	<MDA	.	.	<MDA	<MDA
Uranium 238	<MDA	<MDA	0.321	0.361	<MDA	<MDA	.	.	< CE	<MDA

(CONTINUED)

Sampling Point	GW-614		GW-642		GW-694		GW-706		GW-710	
Location	S3		BG		EXP-B		EXP-B		EXP-W	
Date Sampled	02/12/96	07/01/96	02/24/96	07/09/96	03/18/96	08/01/96	03/19/96	08/06/96	01/29/96	07/16/96
ACTIVITY (pCi/L)	.	.	.	.	.	.	.	.	.	.
Gross Alpha	<MDA	<MDA	<MDA	<MDA	43.6	<MDA	53.7	62.8	<MDA	<MDA
Gross Beta	<MDA	<MDA	<MDA	<MDA	41.7	<MDA	52.8	< CE	<MDA	<MDA
Americium 241	0.163	<MDA	<MDA	<MDA	.	.	.	.	<MDA	<MDA
Neptunium 237	<MDA	<MDA	<MDA	<MDA	.	.	.	.	<MDA	<MDA
Plutonium 238	<MDA	<MDA	<MDA	<MDA	.	.	.	.	<MDA	<MDA
Radium (total)	<MDA	1.3	<MDA	<MDA	.	.	.	.	2.1	3.5
Strontium 89/90	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Technetium 99	<MDA	<MDA	<MDA	<MDA	44.5	16	56	65.5	<MDA	<MDA
Tritium (X10)	<MDA	<MDA	<MDA	<MDA	<MDA	.	<MDA	.	<MDA	<MDA
Uranium 234	0.222	<MDA	<MDA	<MDA	.	.	.	.	0.0314	<MDA
Uranium 235	<MDA	<MDA	<MDA	<MDA	.	.	.	.	<MDA	<MDA
Uranium 238	<MDA	<MDA	<MDA	<MDA	.	.	.	.	< CE	<MDA

(CONTINUED)

Sampling Point	GW-711		GW-712		GW-713		GW-714		GW-715	
Location	EXP-W		EXP-W		EXP-W		EXP-W		EXP-W	
Date Sampled	01/26/96	07/14/96	01/26/96	07/15/96	01/28/96	07/17/96	01/29/96	07/17/96	01/29/96	07/18/96
ACTIVITY (pCi/L)	.	.	.	.	.	.	.	.	.	.
Gross Alpha	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Gross Beta	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Americium 241	1.34	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	0.488	<MDA
Neptunium 237	<MDA	<MDA	<MDA	<MDA	< CE	<MDA	<MDA	<MDA	<MDA	<MDA
Plutonium 238	<MDA	<MDA	<MDA	<MDA	<MDA	< CE	0.271	<MDA	1.24	<MDA
Radium (total)	5.4	4.1	<MDA	<MDA	1.3	<MDA	<MDA	<MDA	1.1	<MDA
Strontium 89/90	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Technetium 99	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Tritium (X10)	<MDA	<MDA	230	<MDA	<MDA	<MDA	<MDA	<MDA	270	<MDA
Uranium 234	<MDA	<MDA	<MDA	<MDA	0.85	0.375	1.42	0.345	0.423	0.274
Uranium 235	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Uranium 238	<MDA	<MDA	<MDA	0.491	<MDA	<MDA	0.726	0.692	<MDA	0.196

(CONTINUED)

APPENDIX C.2
Screened Isotopic Data Summary, CY 1996

3

Sampling Point	GW-829		NT-01		SS-1		SS-4	
Location	OLF		EXP-SW		EXP-SW		EXP-SW	
Date Sampled	03/27/96	08/22/96	03/18/96	08/13/96	03/18/96	08/13/96	03/16/96	07/30/96
ACTIVITY (pCi/L)	.	.	.	.	.	.	.	.
Gross Alpha	<MDA	6.62	11.7	11.5	16.3	12.5	51	68.4
Gross Beta	<MDA	<MDA	173	67.8	32.4	28.1	53.2	64.4
Americium 241	.	.	.	.	.	.	.	.
Neptunium 237	.	.	.	.	.	.	.	.
Plutonium 238	.	.	.	.	.	.	.	.
Radium (total)	.	.	.	.	.	.	.	.
Strontium 89/90	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Technetium 99	<MDA	<MDA	313	107	67	48	52	48
Tritium (X10)	<MDA	.	280	.	<MDA	.	<MDA	.
Uranium 234	.	.	.	.	.	.	.	.
Uranium 235	.	.	.	.	.	.	.	.
Uranium 238	.	.	.	.	.	.	.	.

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