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# FINAL REMEDIAL INVESTIGATION REPORT FOR SITE 12 ROCKET CENTER WV

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**Final**

# Remedial Investigation Report for Site 12

## Allegany Ballistics Laboratory Rocket Center, West Virginia

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# Acronyms and Abbreviations

| | |
|---|---|
| ABL | Allegany Ballistics Laboratory |
| ADAF | default age-dependent adjustment factors |
| AMPC | Alliant Missile Products Company |
| AOC | Area of Concern |
| AOC N | Area of Concern N |
| AST | above ground storage tank |
| ATK | ATK Tactical Systems Company LLC |
| atm-m3/M | atmosphere meter cubed per mole |
| ATSDR | Agency for Toxic Substances and Disease Registry |
| C.L.E.A.N. | Comprehensive Long-Term Environmental Action Navy |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| COC | chain-of-custody |
| COPC | constituent of potential concern |
| CPS | counts per second |
| CSF | cancer slope factors |
| CSM | conceptual site model |
| CT | central tendency |
| CTE | central tendency exposure |
| CTO | contract task order |
| DCA | Dichloroethane |
| DCE | Dichloroethene |
| DQO | data quality objectives |
| DoD | Department of Defense |
| DPT | Direct-Push Technology |
| EE/CA | Engineering Evaluation/Cost Analysis |
| EPC | exposure point concentrations |
| ERA | Ecological Risk Assessment |
| $f_{oc}$ | fraction of organic carbon |
| ft/day | foot per day |
| $ft^2$/day | square feet per day |
| ft/ft | foot per foot |
| ft/yr | foot per year |
| gal/day/ft | gallons per day per foot |
| GIS | Graphical Information System |
| GOCO | government-owned, contractor operated |
| gpm | gallons per minute |
| $K_d$ | distribution coefficient of geologic material for an individual constituent |

| | |
|---|---|
| $K_{oc}$ | compound's partition coefficient |
| $K_h$ | Henry's Law Constant |
| HEAST | Health Effects Assessment Summary Tables |
| HHRA | Human Health Risk Assessment |
| HI | hazard index |
| HQ | hazard quotient |
| IEUBK | Integrated Exposure Uptake Biokinetic |
| IRIS | integrated risk information system |
| IRP | Installation Restoration Program |
| LLC | Limited Liability Corporation |
| LNAPL | Light Non-aqueous Phase Liquid |
| LOAEL | lowest observed adverse effect level |
| MC | methylene chloride |
| MCL | maximum contaminant level |
| mg/kg | milligrams per kilogram |
| µg/l | microgram per liter |
| Mid-LANT | Mid-Atlantic Division |
| ml/g | milliliter/gram |
| NAPL | Non-aqueous Phase Liquid |
| NAVFACENGCOM | Naval Facilities Engineering Command |
| NCEA | National Center for Environmental Assessment |
| NOAEL | no observed adverse effect level |
| ORP | oxidation reduction potential |
| OVM | Organic Vapor Monitor |
| $p_b$ | bulk density |
| ppb | parts per billion |
| ppm | parts per million |
| PVC | Polyvinyl Chloride |
| QA/QC | quality assurance/quality control |
| QAPP | Quality Assurance Project Plan |
| R | retardation coefficient |
| RAGS | Risk Assessment Guidance for Superfund |
| RBC | Risk-based concentration |
| RCRA | Resource Conservation and Recovery Act |
| RDA | Recommended Daily Allowance |
| RFA | Resource Conservation and Recovery Act Facility Assessment |
| RfD | reference dose |
| RI | Remedial Investigation |
| RME | reasonable maximum exposure |
| SERA | Screening Ecological Risk Assessment |
| SMDP | Scientific Management Decision Point |
| SSL | Soil Screening Level |

| | |
|---|---|
| SVOC | Semivolatile Organic Compound |
| SWMU | Solid Waste Management Unit |
| TAL | Target Analyte List |
| TAT | turn-around time |
| TCA | Trichloroethane |
| TCE | Trichloroethene |
| TCL | Target Compound List |
| TCLP | Toxicity Characteristics Leaching Procedure |
| UCL | Upper Confidence Interval |
| UF | uncertainty factor |
| EPA | U. S. Environmental Protection Agency |
| VC | Vinyl Chloride |
| VOC | Volatile Organic Compound |
| WVDEP | West Virginia Department of Environmental Protection |

SECTION 1

# Introduction

This Remedial Investigation (RI) report is submitted on behalf of the Naval Facilities (NAVFAC) Engineering Command (ENGCOM), Mid-Atlantic Division (MIDLANT) under Navy CLEAN III (Contract No. N62470-02-D-3052), Contract Task Order (CTO) 71 to document the RI conducted at Site 12, at the Allegany Ballistics Laboratory (ABL) at Rocket Center, West Virginia. Except as noted in this report, the RI field activities were conducted in accordance with the *Final Work Plan Addendum for Remedial Investigation of Site 12, Allegany Ballistics Laboratory, Rocket Center, West Virginia*, (CH2M HILL, June 2007).

## 1.1 Objectives and Approach

The objective of the Site 12 RI is to sufficiently characterize the nature and extent of contamination such that associated human health and ecological risks can be appropriately assessed. This information, in turn, will be used to make appropriate remedial decisions for the site.

This report summarizes the history of environmental actions at Site 12 and presents an interpretation and evaluation of the data collected during the Site 12 RI (and previous investigations) and documents the nature and extent of contamination (i.e., contaminant types, concentrations, and distribution), contaminant migration pathways, and transport mechanisms for soil and groundwater at the site. This report also documents the potential human health and environmental risks associated with current site conditions.

## 1.2 Report Organization

Section 2 of this report provides a brief description and history of Site 12, including a summary of previous investigation and interim action activities. Section 3 provides a summary of the methodology for Site 12 investigation activities. Section 4 discusses the physical characteristics of the site (e.g., geology, hydrogeology, and ecology). The nature and extent of contamination is presented in Section 5. Section 6 discusses the fate and transport of constituents detected at Site 12. Baseline human health and ecological risk assessments are presented in Sections 7 and 8, respectively. Section 9 summarizes the findings and conclusions of the RI. Section 10 provides a list of reference material cited in this report. Tables and figures are presented at the end of their respective sections throughout the document.

SECTION 2

# Site Background

Site 12 has been the subject of multiple environmental investigations and interim remedial actions since approximately 1993, when nine Solid Waste Management Units (SWMUs) were identified in the vicinity of the area that is now defined as Site 12 (A.T. Kearney, 1993). The following section briefly describes the physical location and operations at the ABL facility, provides a brief description of the area surrounding Site 12, and provides a historical activity summary that highlights the results of each investigation and describes the interim remedial actions conducted to date.

## 2.1 Facility Description

ABL is a government-owned (Navy), contractor-operated [ATK Tactical Systems Company LLC[1] (ATK)], research, development, testing, and production facility for solid propellants and motors used for ammunition, rockets, and armaments. The facility is located in Mineral County, West Virginia, along its border with Maryland. Several towns are located near the facility, including Pinto (unincorporated), Maryland, located just north of the North Branch Potomac River; Short Gap, West Virginia, approximately 2 miles to the southeast; and Cumberland, Maryland, which lies approximately 10 miles to the northwest. The land surrounding the ABL facility is primarily rural agricultural, and forest. The North Branch Potomac River flows along the northern and western boundaries of the facility and Knobly Mountain bounds the facility to the south and east (Figure 2-1).

ABL comprises about 350 buildings that are located mainly on the northern portion of the 1,634 acres of land that lie within the facility boundaries. Operations at the facility are divided into two distinct operating plants, Plant 1 and Plant 2 (Figure 2-1). Plant 1 is a government-owned, contractor-operated (GOCO) facility that occupies an area of about 1,577 acres, which includes a large undeveloped area located northwest of Knobly Mountain. Plant 1 is owned by the Navy and is leased, through a Facilities Use Contract, to ATK by the Naval Sea Systems Command (NAVSEA). Plant 2 is owned and operated by ATK and it occupies the remaining 57 acres of the facility.

## 2.2 Site Description

The investigation and interim remedial activities performed for Site 12 have focused on the area that surrounds Building 167, which is located on the western portion of Plant 1 (Figure 2-2). Most of the area that surrounds Building 167 is flat and paved for parking and road use. The area located immediately southwest of Building 167 is a grass field that contains several aboveground steam lines and utilities. Several monitoring wells for Site 11, which borders Site 12 to the southwest, are also located within the grassy field.

[1] The ABL facility was previously operated by Hercules Aerospace Company (Hercules). The facility was constructed in 1942 by the Kelly Springfield Engineering Company as a loading plant for 0.50-caliber machine gun ammunition for the U.S. Army.

A drainage ditch runs along the southeast side of the site, between the Building 167 parking area and Building 378. The ditch is a part of the facility wide Plant 1 Drainage Ditch System which was investigated as SWMU 27A. As outlined in Section 2.3.6, this portion of the ditch is considered closed to further investigation and requires no further action under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as it poses no unacceptable risk to human health and the environment (CH2M HILL, 2002a).

Building 167 serves as the chamber prep building that is utilized mainly for the preparation of rocket casings. Casing preparation activities in the building include hydro-testing, grit blasting, degreasing, painting, and coating for propellant bonding. In the 1960s and 1970s, both trichloroethene (TCE) and methylene chloride (MC) were used as degreasing solvents in the building operations. The building housed two, 500 to 1,000 gallon above ground tanks (ASTs) and a solvent recovery unit which were used for the storage and handling of solvent that contained MC. Historic features of the building also included an unlined waste water sump and an alodine treatment tank. Both the sump and alodine treatment tanks are described in greater detail below.

## 2.3 Site History

Much of the Site 12 investigation was conducted under SWMU/Area of Concern (AOC) investigations and/or remedial actions that were initiated prior the designation of the area as Site 12. The work summary presented in Sections 2.3.1 through 2.3.5 and Section 2.3.7 focuses on soil, sediment, and source areas identified during the SWMU/AOC investigations. These sections illustrate that contamination or potential contamination associated with these media have been evaluated and, as applicable, remediated. Section 2.3.6 presents a more comprehensive discussion of the Phase III groundwater investigation activities, which served as a primary catalyst for the designation of the area as a Site. Investigation activities conducted specifically for the Site 12 RI are outlined in Section 3 of this report.

### 2.3.1 SWMU History and Status

Nine SWMUs were originally identified during a Phase II Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) in the vicinity of what is now known as Site 12 (Figure 2-2) (A.T. Kearney, 1993). The characteristics of these SWMUs, as presented in the Phase II RFA, are summarized below.

#### 2.3.1.1 SWMU 12—Former Alodine Treatment Tank

SWMU 12 is the former location of a 1,000-gallon, aboveground, alodine treatment tank that was located south of Building 167. SWMU 12 began operation in 1978, ceased operation in 1982, and was closed in 1987. Records indicate that 4,200 gallons of alodine process wastewater were treated in the unit on a monthly basis. At SWMU 12, alodine waste was chemically treated through the addition of acid, sodium bisulfate and lime with the main goal of chromium reduction and precipitation. Alodine waste that was stored within the tank comprised up to 40 percent chromic acid, and may have contained up to 2 percent hexavalent chromium. In 1991, alodine operations resumed using a different treatment process and a new alodine tank, known as SWMU 52 (described below).

#### 2.3.1.2 SWMU 14—Alodine Waste Storage Area I

SWMU 14 is a concrete area inside of Building 167 that was used to store drummed alodine waste and alodine contaminated rags. The waste stored at the unit was generated by the alodine treatment process at SWMU 52. The unit began operation in 1991 and is no longer in use. The unit was contained within a fully enclosed building structure and there was no observed evidence of release.

#### 2.3.1.3 SWMU 24S—Building 167 Satellite Accumulation Area I

SWMU 24S was used for the temporary storage of drummed waste materials that were generated by chamber preparation operations performed in Building 167. The unit began operation in 1978 and was still in operation during the Phase II RFA. SWMU 24S consisted of a four-drum capacity, spill containment pallet, located on the south side of Building 167. Waste materials that were stored in the area included MC still bottoms, spent degreasing solvents, paint-related waste, bond liner and D008 chromium. The drums were stored on a containment unit and no evidence of release was observed during the Phase II RCRA Facility Assessment. This SWMU, including the containment pallet, is no longer in use, nor is it present at the Site.

#### 2.3.1.4 SWMU 24T—Building 167 Satellite Accumulation Area II

SWMU 24T was identified as a 20 by 10 foot area on the concrete floor inside the south end of Building 167. The unit began operation in 1978 and was used for the storage of residual dust from grit blasting operations, which was contained in 25-gallon drums. It is no longer in use. The unit was contained within an enclosed building and no releases are known to have occurred.

#### 2.3.1.5 SWMU 25B—Building 167 Solvent Recovery Still

SWMU 25B was a solvent recovery still that began operation in 1978 inside of Building 167 and was used to manage MC still bottoms. No evidence of release from this unit was observed during the Phase II RCRA Facility Assessment. This SWMU received no further action status in February 2002, and is no longer present at Site 12.

#### 2.3.1.6 SWMU 29F—Building 167 Dust Collectors and Baghouses

SWMU 29F was identified as the dust collector in Building 167. Typical wastes that were managed include sawdust, metal residues and fly ash. No evidence of release from this unit is known to have occurred. This SWMU is no longer present at Site 12.

#### 2.3.1.7 SWMU 30—Building 167 Paint and Spray Booth Filters

SWMU 30 was identified as the paint and spray booth filters in Building 167. The booth in the building was equipped with particulate filters for the operations conducted in the Building. No evidence of release from this unit is known to have occurred. It is still present at Site 12, but is used for storage purposes and was no longer in use as a paint spray booth at the time this investigation was complete. Instead it is used as a storage area.

#### 2.3.1.8 SWMU 37N—Building 167 Wastewater Sump

SWMU 37N was an unlined waste water sump that was located approximately 60 feet southeast of the southeast corner of Building 167. It was enclosed within a wooden cover.

Historical information indicated that the sump received water from a grated trench located between SWMUs 12 and 24S. Therefore, the unit was considered to have potentially received alodine waste or by-products from alodine treatment operations. The Phase II RFA indicated that the sump discharge point was unknown. The sump was the subject of further investigation and was removed during activities conducted in 2000 and 2001, as described in Section 2.3.5.

#### 2.3.1.9 SWMU 52—Current Alodine Treatment Tank (no longer in use)

SWMU 52 began operation in 1991 as a replacement for the former Alodine treatment tank (SWMU 12). Both SWMU 12 and SWMU 52 were located outside, on the same concrete pad, south of Building 167. The most recent aboveground alodine treatment tank was open on the top and had a plastic containment structure (6 feet in diameter and 2 feet deep) below it. The unit was located on a concrete pad with exposed ground surrounding it. In 1995, the tank was removed. At SWMU 52, alodine waste was treated by heat to reduce the volume of waste material. After treatment, the concentrated waste material was removed and temporarily stored in drums at SWMU 14. The unit was contained within a plastic containment structure and no evidence of release to soil or groundwater was observed during the RFA. SWMU 52 ceased operations sometime prior to 1995 when the tank was removed.

### 2.3.2 SWMU/AOC Assessment

The ABL Partnering Team, comprised of representatives from the Navy, EPA, and West Virginia Department of Environmental Protection (WVDEP), determined that no further action was required for SWMU 12, SWMU 14, SWMU 24S, SWMU 24T, SWMU 25B, SWMU 29F, and SWMU 30 (Baker, 1997) (CH2M HILL, 2002a). They further determined that possible releases from SWMUs 12, 14, 24S, 24T and 25B would be evaluated as part of the investigation of SWMU 52 (CH2M HILL, 1995). SWMU 37N was also recommended for further investigation. Therefore, both SWMU 37N and SWMU 52 were included in subsequent investigations.

### 2.3.3 Phase I SWMU/AOC Investigation

Samples were collected from the locations of SWMU 37N and SWMU 52, during the Phase I SWMU/AOC Investigation (CH2M HILL, 1996a). One surface and one subsurface soil sample were collected from SWMU 37N and five surface and five subsurface soil samples were collected from SWMU 52. Additionally, two groundwater samples were collected from SWMU 52 (Figure 2-3).

Sample locations and analytical results for these two SWMUs were presented in the Phase I Report, Phase II SWMU/AOC Investigation Project Plans and again in the Site 12 Soil Engineering and Cost Evaluation Analysis (EE/CA) (CH2M HILL, 1996a; CH2M HILL, 2000; CH2M HILL, 2004a). Results from the Phase I sampling effort indicated that further investigation of SWMUs 37N and 52 was warranted.

### 2.3.4 Phase II SWMU/AOC Investigation

During the Phase II SWMU/AOC Investigation, SWMUs 37N and 52 were investigated as AOC N (CH2M HILL, 2000). AOC N is later designated as IRP Site 12, as described in Section 2.3.6. The objectives of the Phase II investigation for AOC N were to adequately

define the nature and extent of inorganic and organic constituents in surface soil and alluvial groundwater in the vicinity of SWMUs 37N and 52 (CH2M HILL, 2005a).

The investigation included the installation of monitoring wells GGW14, GGW15 and GGW16 and the collection of five surface soil samples near the location of each SWMU within AOC N (Figure 2-3). Constituents detected during the Phase I and Phase II investigations were screened against regulatory criteria and it was determined that a number of constituents detected in surface soil, subsurface soil, and groundwater posed an unacceptable risk for human health and the environment (CH2M HILL, 2005a). Consequently, AOC N was recommended for further investigation. The full set of raw analytical data is provided in Appendix C.

### 2.3.5 Sump Removal

As part of a SWMU Removal Action, the concrete and metal sump identified as SWMU 37N was excavated and removed in November 2000 (CH2M HILL, 2005d). Soil water, and sediment samples were collected during the removal action. Sediment and water samples were obtained from within the sump. Analytical results from the sediment and water samples verified that material inside the sump was not a hazardous waste. Confirmatory soil samples collected from the excavation indicated that a potential non-cancer soil exposure risk was still present and it was determined that the remaining soil contamination would be addressed through subsequent investigation activities at AOC N.

### 2.3.6 Phase III Investigation

The objectives of the Phase III SWMU/AOC Investigation at AOC N were to define the nature and extent of volatile organic compounds (VOCs) and inorganic constituents in alluvial groundwater and to define the nature and extent of inorganic constituents (including hexavalent chromium) in soil south and east of SWMU 37N and SWMU 52 (Figure 2-4) (CH2M HILL, 2002b). During the Phase III investigation, the proposed scope of work for AOC N was expanded after the initial field work was complete, mainly due to the magnitude and extent of constituents detected in groundwater. The expanded scope of work also included the collection of additional soil samples.

Soil analytical results for the Phase III investigation at AOC N were presented in a technical memorandum addressed to the ABL Partnering Team and in the Site 12 Soil EE/CA (CH2M HILL, 2003b; CH2M HILL, 2004a). The soil analytical results from the Phase III investigation defined the limits of soil contamination associated with SWMUs 37N and 52. These results were compared to risk criteria in the soil EE/CA, which provided the rationale for a non-time-critical removal action, as discussed in Section 2.3.7.

In addition to the activities referenced above, sediment samples were collected from the drainage ditch that runs along the southeastern side of Site 12 (Figure 2-4). The samples, 27A-3 and 27A-4, were considered a part of the sampling effort for SWMU 27A—Drainage Ditch System (CH2M HILL, 2002b). Analytical data for the sediment samples are presented in the Phase III/IV investigation report and the results were subjected to human health risk screening, as presented in the SWMU/AOC Closeout Documentation (CH2M HILL, 2005c; CH2M HILL, 2002a). Results from the risk-screening indicated that sediment located within SWMU 27A poses no unacceptable risk to human health and the environment (CH2M HILL,

2002a). Consequently, no further action was necessary for select portions of SWMU 27A, which included the ditch at Site 12.

The Phase III SWMU/AOC investigation of AOC N groundwater was designed to define the nature and extent of VOCs and inorganic constituents in alluvial groundwater (CH2M HILL, 2002b). The Phase III groundwater investigation included the installation and sampling of 33 temporary monitoring wells and the collection of five additional groundwater samples (grab samples) for analysis of Target Compound List (TCL) VOCs (Figure 2-4). In addition, four groundwater samples were collected to evaluate the site for perchlorate and if present for a potential remedial pilot study.

Results from the investigation delineated the extent of two TCE contaminant plumes and one MC contaminant plume in the alluvial aquifer. The location of one TCE plume is centered around Building 167. The second, smaller TCE plume, is centered beneath the location of the former SWMU 37N waste water sump (Figure 2-6). It is notable that the smaller plume contained higher concentrations of TCE. The results also identified the limits of a MC plume that coincides with the small TCE plume located beneath the former SWMU 37N waste water sump (Figure 2-7). Alluvial groundwater was determined to flow generally to the north-northwest (Figure 2-8), in the direction of the North Branch Potomac River.

Follow-on work to the Phase III Investigation at AOC N included the collection of groundwater samples from three direct-push technology (DPT) boreholes that were installed through the floor of Building 167 (Figure 2-9) to determine if there was a source inside or beneath the building. The borings were placed near a floor drain in the building and beneath the former locations of a solvent tank and degreaser. Because of the generally turbid nature of DPT samples, analytical results from this investigation were used to provide a qualitative understanding of groundwater contamination beneath the building. The analytical results of samples obtained from within the building suggest there are no additional source areas within or beneath the building.

As a result of the groundwater VOC detections, the proposed scope of work for Phase III at AOC N was expanded to include the installation and sampling of four alluvial (GGW14, GGW17A, GGW18A, and GGW19) and five dual-depth bedrock (GGW15S/D, GGW16S/D, GGW17S/D, GGW18S/D, and GGW19S/D) monitoring wells (CH2M HILL, 2003a). However, the completed scope of work for this investigation included the installation of six alluvial wells (11GW14, 12MW06, 12MW08, 12MW10, 12MW15, and 12MW16) and five bedrock boreholes (12MW04S/D, 12MW05S/D, 12MW07S/D, and 12MW11S/D) (CH2M HILL, 2003c). The actual well designations were changed from the proposed designations due to the advancement of AOC N into the IRP as Site 12, as well as including additional wells to further characterize the site.

Groundwater results from the Phase III investigation were presented to the ABL Partnering Team in 2003 (CH2M HILL, 2003b). Per the recommendations of the Phase III investigation memorandum, AOC N was designated as IRP Site 12 and the RI was subsequently initiated (CH2M HILL, 2003c). The temporary monitoring wells at Site 12 were abandoned during follow-up work to the Phase III investigation in 2003. It should be noted that on Figures 2-6, 2-7, and 2-8, sample locations AOCN-39, AOCN-45 and AOCN-46 are shown as being within Building 385; in actuality, they were obtained outside of the building, prior to the

building being expanded over these areas. All of the subsequent RI activities involved the installation and sampling of permanent monitoring wells, as discussed in Section 3.

### 2.3.7 Site 12 Soil Removal Action

Soil analytical results from the Phase I, II, and III SWMU/AOC investigations at Site 12 indicated that the primary human health and ecological risks were associated with impacted shallow soils (<2 feet), near the locations of SWMU 37N and SWMU 52 (CH2M HILL, 2004;, CH2M HILL, 2004b). After a review of remedial alternatives in the soil EE/CA, it was determined that a soil excavation would be the preferred alternative, because it would provide for greater long-term reliability, greater land use flexibility, and would likely serve as a final remedial action for soil.

The soil removal action at Site 12 was completed in 2005. This removal action included the removal of approximately 237 tons of soil from the site, collecting confirmatory soil samples, and performing site restoration activities (CH2M HILL, 2005b). The soil excavation extended to a depth of approximately 2 feet and encompassed the entire area of defined soil impacts, including the former location of SWMUs 37N and 52 (Figure 2-5). The cleanup goals, as well as excavation wall and floor confirmatory soil sample results, are provided in Tables 2-1, 2-2, and 2-3, respectively.

Average concentrations of VOCs, SVOCs, and the metals cadmium and chromium were all detected at concentrations below cleanup goals. The mean (average) concentrations of the confirmatory results were compared to the cleanup goals, as specified in the Site 12 Action Memorandum (U.S. Navy, 2004). Although benzo(a)pyrene, chromium and cadmium were shown to exceed their cleanup criteria in select samples, the Remedial Action Objectives (RAOs) for these constituents were met. Mercury was detected in three side wall samples at concentrations ranging from 5.8 to 67.2 mg/kg. The cleanup goal for mercury was 0.31 mg/kg. The elevated mercury appeared to be present in a localized area near the former alodine treatment tank. Mercury was identified as a COC based upon potential exposure to ecological receptors. The detected concentrations are not expected to pose an unacceptable risk to human receptors and there is a limited pathway present to ecological receptors. Based upon these factors, in May 2005, the ABL Partnering Team determined that no additional removal action was required for soil (CH2M HILL, 2005b).

**TABLE 2-1**
Site 12 Soil Cleanup Goals
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| COC | Cleanup Goal | Source |
|---|---|---|
| Chromium[1] | 230 mg/kg | Residential RBC |
| Benzo(a)anthracene[1] | 870 μg/kg | Residential RBC |
| Benzo(a)pyrene[1] | 87 μg/kg | Residential RBC |
| Benzo(b)fluoranthene[1] | 870 μg/kg | Residential RBC |
| Cadmium[2] | 20 mg/kg | Ecological Screening |
| | | Value (Oak Ridge Lab) |
| Mercury[2] | 0.31 mg/kg | Background UTL |
| 1,2-dichlorobenzene[2] | 100 mg/kg | Ecological Screening |
| | | Value (BTAG) |

Note: Mean concentrations of the confirmatory sample results for each COC were compared to the cleanup goals.

[1] Human health COC – Confirmatory samples were collected from excavation side walls and floor and analyzed for this constituent.

[2] Ecological COC – Confirmatory samples were collected from excavation side walls and analyzed for this constituent.

**TABLE 2-2**
Detected Constituents in Confirmatory Side Wall Soil Samples
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| **Sample ID** | AS12-SS04-0-0.5 | AS12-SS04P-0-0.5 | AS12-SS05-0-0.5 | AS12-SS06-0-0.5 | AS12-SS07-0-0.5 | AS12-SS08-0-0.5 |
|---|---|---|---|---|---|---|
| **Sample Date** | 11/11/04 | 11/11/04 | 11/11/04 | 11/12/04 | 11/12/04 | 11/12/04 |
| **Chemical Name** | | | | | | |
| | | | | | | |
| **Volatile Organic Compounds (µg/kg)** | | | | | | |
| 1,1,2-Trichloro-1,2,2- trifluoroethane | 10 U | 11 U | 11 U | 12 U | 12 UJ | 10 U |
| 1,2-Dichlorobenzene | 10 U | 11 U | 11 U | 4 J | 12 UJ | 10 U |
| 4-Methyl-2-pentanone | 10 U | 11 U | 11 U | 2 J | 12 UJ | 10 U |
| Carbon disulfide | 10 U | 11 U | 11 U | 12 U | 12 UJ | 10 U |
| Cyclohexane | 10 U | 3 J | 11 U | 12 U | 12 UJ | 10 U |
| m- and p-Xylenes | 10 U | 11 U | 1 J | 2 J | 12 UJ | 10 U |
| Tetrachloroethene | 10 U | 11 U | 11 U | 12 U | 12 UJ | 10 U |
| Trichloroethene | 10 U | 11 U | 11 U | 2 J | 12 UJ | 10 U |
| Trichlorofluoromethane | 10 U | 3 J | 11 U | 12 U | 14 J | 7 J |
| Xylene, total | 10 U | 11 U | 1 J | 2 J | 12 UJ | 10 U |
| | | | | | | |
| **Semivolatile Organic Compounds (µg/kg)** | | | | | | |
| Anthracene | 360 U | 380 U | 370 U | 410 U | 430 U | 410 U |
| Benzo(a)anthracene | 360 U | 380 U | 370 U | 410 U | 430 U | 410 U |
| Benzo(a)pyrene | 360 U | 380 U | 370 U | 410 U | 430 U | 410 U |
| Benzo(b)fluoranthene | 360 U | 380 U | 370 U | 410 U | 430 U | 410 U |
| Benzo(g,h,i)perylene | 360 U | 380 U | 370 U | 410 U | 430 U | 410 U |
| Benzo(k)fluoranthene | 360 U | 380 U | 370 U | 410 U | 430 U | 410 U |
| bis(2-Ethylhexyl)phthalate | 500 | 900 | 2,700 | 420 | 430 U | 180 J |
| Butylbenzylphthalate | 920 | 1,900 | 630 | 410 U | 430 U | 410 U |
| Chrysene | 360 U | 380 U | 370 U | 410 U | 430 U | 410 U |
| Di-n-butylphthalate | 320 J | 480 | 150 J | 410 U | 430 U | 410 U |
| Fluoranthene | 110 J | 110 J | 370 U | 410 U | 430 U | 410 U |
| Isophorone | 110 J | 180 J | 370 U | 410 U | 430 U | 410 U |
| Phenanthrene | 120 J | 140 J | 370 U | 410 U | 430 U | 410 U |
| Pyrene | 93 J | 380 U | 370 U | 410 U | 430 U | 410 U |
| | | | | | | |
| **Total Metals (mg/kg)** | | | | | | |
| Aluminum | 6,300 | 5,570 | 8,060 | 9,840 | 12,300 | 8,510 |
| Antimony | 0.58 B | 0.64 B | 0.27 B | 0.12 B | 0.15 B | 0.13 B |
| Arsenic | 3.7 L | 4.2 L | 5.8 L | 5.8 L | 6.5 L | 5 L |
| Barium | 49.9 | 53.6 | 113 | 128 | 108 | 78.9 |
| Beryllium | 0.49 J | 0.52 J | 0.88 J | 1.1 | 0.98 J | 0.69 J |
| Cadmium | 18.1 | 20 | 6.5 | 0.8 J | 0.53 J | 5.8 |
| Calcium | 5,600 | 2,430 | 2,620 | 10,200 | 11,700 | 37,700 |
| Chromium | 241 K | 131 K | 47.4 K | 23.1 K | 60.6 K | 183 K |
| Cobalt | 5.9 J | 7 J | 10.7 | 16.5 | 11.3 | 11.5 |
| Copper | 21.7 | 23.6 | 24.8 | 21.7 | 21.2 | 24.6 |
| Iron | 14,600 | 16,800 | 24,900 | 27,500 | 33,000 | 25,900 |
| Lead | 42.7 | 32.4 | 47.5 | 21.9 | 15.9 | 183 |
| Magnesium | 1,310 | 973 | 1,180 | 1,980 | 2,260 | 4,200 |
| Manganese | 318 | 479 | 650 | 610 | 686 | 707 |
| Mercury | 5.9 | 4.4 | 0.08 J | 0.15 | 0.06 J | 0.08 J |
| Nickel | 16.1 | 22.4 | 19.4 | 25.6 | 22.9 | 21.8 |
| Potassium | 975 | 802 | 1,250 | 1,410 | 1,810 | 1,320 |
| Selenium | 0.4 J | 0.55 J | 8.9 | 0.73 J | 0.16 J | 0.54 J |
| Silver | 0.21 B | 0.18 B | 0.12 B | 0.06 B | 0.04 B | 0.16 B |
| Thallium | 0.61 U | 0.64 U | 0.85 J | 1.1 J | 0.82 U | 0.88 J |
| Vanadium | 14.1 | 14.2 | 19.4 | 20.2 | 20.1 | 14.1 |
| Zinc | 189 L | 174 L | 145 L | 81.7 L | 50.9 L | 267 L |
| | | | | | | |
| **Wet Chemistry (%)** | | | | | | |
| % SOLIDS | 90 | 88 | 89 | 81 | 77 | 80 |

Notes:
NA - Not analyzed
U- Not Detected
B- Blank Contamination
J- Estimated
K- Biased High
L- Biased Low
Shading represents detect

U- Not Detected
B- Blank Contamination
J- Estimated
K- Biased High
L- Biased Low

**TABLE 2-2**
Detected Constituents in Confirmatory Side Wall Soil Samp
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| **Sample ID** | AS12-SS09-0-0.5 | AS12-SS10-0-0.5 | AS12-SS11-0-0.5 | AS12-SS12-0-0.5 | AS12-SS13-0-0.5 | AS12-SS14-0-0.5 | AS12-SS15-0-0.5 |
|---|---|---|---|---|---|---|---|
| **Sample Date** | 11/12/04 | 11/12/04 | 11/12/04 | 11/12/04 | 11/12/04 | 11/12/04 | 11/12/04 |
| **Chemical Name** | | | | | | | |
| | | | | | | | |
| **Volatile Organic Compounds (µg/kg)** | | | | | | | |
| 1,1,2-Trichloro-1,2,2- trifluoroethane | 12 U | 10 U | 2 J | 14 U | 10 UJ | 13 U | 13 U |
| 1,2-Dichlorobenzene | 12 U | 10 U | 19 U | 14 U | 10 UJ | 13 U | 13 UJ |
| 4-Methyl-2-pentanone | 12 U | 10 U | 19 U | 14 U | 10 UJ | 13 U | 13 UJ |
| Carbon disulfide | 12 U | 10 U | 19 U | 14 U | 2 J | 13 U | 13 U |
| Cyclohexane | 12 U | 10 U | 19 U | 3 J | 10 UJ | 2 J | 13 U |
| m- and p-Xylenes | 12 U | 10 U | 19 U | 14 U | 10 UJ | 13 U | 13 UJ |
| Tetrachloroethene | 12 U | 10 U | 19 U | 11 J | 10 UJ | 13 U | 13 U |
| Trichloroethene | 12 U | 2 J | 19 U | 2 J | 10 UJ | 13 U | 13 U |
| Trichlorofluoromethane | 4 J | 3 J | 12 J | 4 J | 2 J | 3 J | 10 J |
| Xylene, total | 12 U | 10 U | 19 U | 14 U | 10 UJ | 13 U | 13 UJ |
| | | | | | | | |
| **Semivolatile Organic Compounds (µg/kg)** | | | | | | | |
| Anthracene | 450 U | 380 U | 430 U | 450 U | 400 U | 420 U | 420 U |
| Benzo(a)anthracene | 450 U | 380 U | 170 J | 450 U | 400 U | 120 J | 420 U |
| Benzo(a)pyrene | 450 U | 380 U | 160 J | 450 U | 400 U | 420 U | 420 U |
| Benzo(b)fluoranthene | 450 U | 380 U | 170 J | 450 U | 400 U | 420 U | 420 U |
| Benzo(g,h,i)perylene | 450 U | 380 U | 110 J | 450 U | 400 U | 420 U | 420 U |
| Benzo(k)fluoranthene | 450 U | 380 U | 150 J | 450 U | 400 U | 420 U | 420 U |
| bis(2-Ethylhexyl)phthalate | 450 U | 380 U | 780 | 2,500 | 400 U | 1,600 | 420 U |
| Butylbenzylphthalate | 450 U | 380 U | 430 U | 450 U | 400 U | 420 U | 420 U |
| Chrysene | 450 U | 380 U | 200 J | 450 U | 400 U | 110 J | 420 U |
| Di-n-butylphthalate | 450 U | 380 U | 430 U | 540 | 400 U | 120 J | 420 U |
| Fluoranthene | 450 U | 150 J | 330 J | 450 U | 140 J | 230 J | 420 U |
| Isophorone | 450 U | 380 U | 430 U | 450 U | 400 U | 420 U | 420 U |
| Phenanthrene | 450 U | 100 J | 210 J | 450 U | 400 U | 200 J | 420 U |
| Pyrene | 450 U | 120 J | 320 J | 450 U | 130 J | 230 J | 420 U |
| | | | | | | | |
| **Total Metals (mg/kg)** | | | | | | | |
| Aluminum | 11,800 | 6,650 | 8,780 | 10,800 | 7,250 | 9,480 | 11,000 |
| Antimony | 0.1 B | 0.35 B | 0.36 B | 1.3 L | 0.16 L | 0.51 B | 0.23 B |
| Arsenic | 5.8 L | 5.7 L | 5.4 L | 10.2 L | 5.6 L | 6.7 L | 6.4 L |
| Barium | 80.8 | 81.3 | 76.7 | 117 | 92.9 | 85.9 | 127 |
| Beryllium | 0.88 J | 0.85 J | 0.86 J | 1 J | 0.86 J | 1 | 1.3 |
| Cadmium | 0.32 J | 0.39 J | 24.6 | 49.9 | 2.9 | 0.6 J | 0.36 J |
| Calcium | 37,000 | 1,610 | 2,870 | 4,130 | 1,840 | 7,000 | 3,530 |
| Chromium | 17.3 K | 16.1 K | 191 K | 206 K | 132 K | 33.2 K | 16.9 K |
| Cobalt | 12.9 | 10.6 | 11 | 12.3 | 12.1 | 12.5 | 14.1 |
| Copper | 21.8 | 18.6 | 41.7 | 76.7 | 19.6 | 38.9 | 18.6 |
| Iron | 29,500 | 24,700 | 25,300 | 72,600 | 24,000 | 36,600 | 30,600 |
| Lead | 15.2 | 23.6 | 48.3 | 56.5 | 25 | 20.5 | 18.4 |
| Magnesium | 4,040 | 922 | 1,260 | 1,820 | 1,080 | 1,570 | 1,650 |
| Manganese | 523 | 485 | 530 | 1,000 | 724 | 798 | 1,080 |
| Mercury | 0.06 J | 0.07 J | 0.15 | 0.09 J | 0.07 J | 0.09 J | 0.12 J |
| Nickel | 23.3 | 16.9 | 21.7 | 49.1 | 16.6 | 30.1 | 25.1 |
| Potassium | 1,900 | 778 J | 1,290 | 1,880 | 1,070 | 1,480 | 1,340 |
| Selenium | 0.34 J | 0.44 J | 0.54 J | 0.4 J | 0.37 J | 0.49 J | 0.49 J |
| Silver | 0.04 B | 0.12 B | 0.14 B | 0.14 B | 0.36 B | 0.11 B | 0.06 B |
| Thallium | 0.98 U | 1.3 J | 0.92 U | 1.75 U | 0.73 U | 1.4 J | 0.75 U |
| Vanadium | 15.7 | 16.4 | 20.9 | 29.3 | 17.4 | 23.4 | 22.8 |
| Zinc | 46.1 L | 73.4 L | 236 L | 423 L | 102 L | 78 L | 71 L |
| | | | | | | | |
| **Wet Chemistry (%)** | | | | | | | |
| % SOLIDS | 73 | 86 | 76 | 74 | 81 | 78 | 78 |

Notes:
NA - Not analyzed
U- Not Detected
B- Blank Contamination
J- Estimated
K- Biased High
L- Biased Low
Shading represents detect

U- Not Detected
B- Blank Contamination
J- Estimated
K- Biased High
L- Biased Low

**TABLE 2-2**
Detected Constituents in Confirmatory Side Wall Soil Samples
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| **Sample ID** | AS12-SS19-0-0.5 | AS12-SS19P-0-0.5 | AS12-SS20-0-0.5 | AS12-SS21-0-0.5 |
|---|---|---|---|---|
| **Sample Date** | 1/20/05 | 1/20/05 | 1/20/05 | 1/20/05 |
| **Chemical Name** | | | | |
| | | | | |
| **Volatile Organic Compounds (µg/kg)** | | | | |
| Trichlorofluoromethane | 12 U | 13 U | 3 J | 8 J |
| | | | | |
| **Semivolatile Organic Compounds (µg/kg)** | | | | |
| Benzo(a)anthracene | 420 U | 360 J | 440 U | 440 U |
| Benzo(a)pyrene | 110 | 90 | 51 | 22 J |
| Benzo(b)fluoranthene | 420 U | 460 | 440 U | 440 U |
| Benzo(k)fluoranthene | 420 U | 280 J | 440 U | 440 U |
| Chrysene | 420 U | 440 | 440 U | 440 U |
| Fluoranthene | 420 U | 950 | 440 U | 440 U |
| Phenanthrene | 420 U | 980 | 440 U | 440 U |
| Pyrene | 420 U | 950 | 440 U | 440 U |
| | | | | |
| **Total Metals (mg/kg)** | | | | |
| Aluminum | 15,800 | 7,250 | 8,150 | 8,560 |
| Arsenic | 7.7 | 7.8 | 7.9 | 7.8 |
| Barium | 86.7 | 84.5 | 104 | 110 |
| Beryllium | 0.76 J | 0.89 J | 1 | 1.1 |
| Cadmium | 1.2 | 1.2 | 0.44 J | 0.39 J |
| Calcium | 39,700 | 3,080 | 3,360 | 3,520 |
| Chromium | 40.5 | 48.1 | 15.7 | 15.8 |
| Cobalt | 11.4 | 12.6 | 12.9 | 13.6 |
| Copper | 27 | 30.6 | 19.2 | 19.1 |
| Iron | 29,000 | 29,400 | 28,300 | 29,200 |
| Lead | 73.2 | 69.3 | 34.3 | 22.1 |
| Magnesium | 4,770 | 1,870 | 1,520 | 1,580 |
| Manganese | 647 | 607 | 782 | 897 |
| Mercury | 67.2 K | 62.7 K | 0.45 K | 0.37 K |
| Nickel | 23.2 | 25.4 | 24.5 | 25.5 |
| Potassium | 1,360 | 1,270 | 1,320 | 1,450 |
| Selenium | 1.3 | 1.1 | 0.76 J | 0.76 U |
| Thallium | 0.73 U | 1.2 J | 0.77 U | 0.83 U |
| Vanadium | 21.9 | 22.9 | 24.8 | 25.3 |
| Zinc | 197 | 196 | 108 | 101 |
| | | | | |
| **Wet Chemistry (%)** | | | | |
| % SOLIDS | 79 | 80 | 74 | 76 |

Notes:
NA - Not analyzed
U- Not Detected
B- Blank Contamination
J- Estimated
K- Biased High
L- Biased Low
Shading represents detect

U- Not Detected
J- Estimated
K- Biased High

**TABLE 2-2**
Detected Constituents in Confirmatory Side Wall Soil Samples
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| **Sample Date** | AS12-SS22-0-0.5<br>4/15/05 | | AS12-SS23-0-0.5<br>4/15/05 | | AS12-SS23P-0-0.5<br>4/15/05 | |
|---|---|---|---|---|---|---|
| **Chemical Name** | | | | | | |
| | | | | | | |
| **Volatile Organic Compounds (µg/kg)** | | | | | | |
| 1,2-Dichloroethylene | 12 U | NA | 10 U | NA | 11 U | NA |
| cis-1,2-Dichloroethene | 12 U | NA | 10 U | NA | 11 U | NA |
| Methylene Chloride | 16 B | NA | 18 B | NA | 13 B | NA |
| Trichlorofluoromethane | 12 U | NA | 10 U | NA | 11 U | NA |
| | | | | | | |
| **Semivolatile Organic Compounds (µg/kg)** | | | | | | |
| Benzo(a)pyrene | 30 | NA | 77 | NA | 87 | NA |
| Benzo(b)fluoranthene | 400 U | NA | 250 J | NA | 380 U | NA |
| bis(2-Ethylhexyl)phthalate | 400 U | NA | 420 | NA | 380 U | NA |
| Butylbenzylphthalate | 400 U | NA | 460 | NA | 380 U | NA |
| Fluoranthene | 400 U | NA | 350 J | NA | 380 U | NA |
| Phenanthrene | 400 U | NA | 240 J | NA | 380 U | NA |
| Pyrene | 400 U | NA | 370 J | NA | 380 U | NA |
| | | | | | | |
| **Total Metals (mg/kg)** | | | | | | |
| Aluminum | 8,470 | NA | 7,470 | NA | 7,990 | NA |
| Antimony | 0.73 L | NA | 0.6 UL | NA | 0.63 UL | NA |
| Arsenic | 6.7 | NA | 7.5 | NA | 8.1 | NA |
| Barium | 90.8 J | NA | 97 J | NA | 97.5 J | NA |
| Beryllium | 0.76 J | NA | 0.76 J | NA | 0.78 J | NA |
| Cadmium | 0.72 J | NA | 0.9 | NA | 0.56 J | NA |
| Calcium | 30,400 | NA | 5,020 | NA | 7,470 | NA |
| Chromium | 27.7 | NA | 37.8 | NA | 32.7 | NA |
| Cobalt | 10.6 | NA | 12.4 | NA | 12.4 | NA |
| Copper | 33.7 | NA | 32.4 | NA | 33.6 | NA |
| Iron | 26,000 | NA | 27,300 | NA | 28,400 | NA |
| Lead | 23.4 | NA | 68.5 | NA | 57.2 | NA |
| Magnesium | 2,810 | NA | 1,620 | NA | 2,880 | NA |
| Manganese | 487 | NA | 707 | NA | 711 | NA |
| Mercury | 0.13 K | NA | 0.14 K | NA | 0.14 K | NA |
| Nickel | 21.6 | NA | 23.8 | NA | 23.5 | NA |
| Potassium | 1,660 | NA | 1,570 | NA | 1,420 | NA |
| Silver | 0.14 U | NA | 2.8 | NA | 2 | NA |
| Sodium | 60.1 B | NA | 31 B | NA | 43 B | NA |
| Thallium | 0.8 U | NA | 0.72 U | NA | 0.76 U | NA |
| Vanadium | 21.3 | NA | 20.8 | NA | 21.2 | NA |
| Zinc | 180 L | NA | 185 L | NA | 177 L | NA |
| | | | | | | |
| **Wet Chemistry (%)** | | | | | | |
| % SOLIDS | 82 | 82 | 88 | 88 | 88 | 88 |

Notes:
NA - Not analyzed
U- Not Detected
B- Blank Contamination
J- Estimated
K- Biased High
L- Biased Low
Shading represents detect

**TABLE 2-2**
Detected Constituents in Confirmatory Side Wall Soil Sample
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| | AS12-SS24-0-0.5 | | AS12-SS25-0-0.5 | | AS12-SS26-0-0.5 | |
|---|---|---|---|---|---|---|
| **Sample Date** | 4/15/05 | | 4/15/05 | | 4/15/05 | |
| **Chemical Name** | | | | | | |
| | | | | | | |
| **Volatile Organic Compounds (µg/kg)** | | | | | | |
| 1,2-Dichloroethylene | 16 U | NA | 5 L | NA | 12 U | NA |
| cis-1,2-Dichloroethene | 16 U | NA | 5 L | NA | 12 U | NA |
| Methylene Chloride | 45 B | NA | 17 B | NA | 67 B | NA |
| Trichlorofluoromethane | 4 J | NA | 12 R | NA | 5 J | NA |
| | | | | | | |
| **Semivolatile Organic Compounds (µg/kg)** | | | | | | |
| Benzo(a)pyrene | 37 | NA | 36 | NA | 6.3 J | NA |
| Benzo(b)fluoranthene | 420 U | NA | 400 U | NA | 400 U | NA |
| bis(2-Ethylhexyl)phthalate | 420 U | NA | 400 U | NA | 400 U | NA |
| Butylbenzylphthalate | 420 U | NA | 400 U | NA | 400 U | NA |
| Fluoranthene | 420 U | NA | 400 U | NA | 400 U | NA |
| Phenanthrene | 420 U | NA | 400 U | NA | 400 U | NA |
| Pyrene | 420 U | NA | 400 U | NA | 400 U | NA |
| | | | | | | |
| **Total Metals (mg/kg)** | | | | | | |
| Aluminum | 9,980 | NA | 11,300 | NA | 10,300 | NA |
| Antimony | 1.1 L | NA | 0.67 UL | NA | 0.6 UL | NA |
| Arsenic | 7.5 | NA | 9.5 | NA | 7.9 | NA |
| Barium | 89.9 J | NA | 91.1 J | NA | 81.6 J | NA |
| Beryllium | 0.73 J | NA | 0.82 J | NA | 0.77 J | NA |
| Cadmium | 2 | NA | 0.08 U | NA | 0.07 U | NA |
| Calcium | 15,000 | NA | 12,200 | NA | 8,040 | NA |
| Chromium | 50.6 | NA | 15.8 | NA | 13.9 | NA |
| Cobalt | 13.6 | NA | 14.6 | NA | 15.3 | NA |
| Copper | 54.5 | NA | 21.9 | NA | 22 | NA |
| Iron | 31,800 | NA | 33,900 | NA | 30,500 | NA |
| Lead | 65.1 | NA | 14.4 | NA | 15.2 | NA |
| Magnesium | 2,700 | NA | 2,610 | NA | 2,120 | NA |
| Manganese | 635 | NA | 688 | NA | 628 | NA |
| Mercury | 0.08 K | NA | 0.24 K | NA | 5.8 K | NA |
| Nickel | 26.3 | NA | 25.5 | NA | 23.9 | NA |
| Potassium | 1,760 | NA | 1,840 | NA | 1,550 | NA |
| Silver | 0.66 J | NA | 0.14 U | NA | 0.13 U | NA |
| Sodium | 59.9 B | NA | 69.3 B | NA | 58.8 B | NA |
| Thallium | 0.81 U | NA | 0.81 U | NA | 0.72 U | NA |
| Vanadium | 20 | NA | 18.6 | NA | 17.8 | NA |
| Zinc | 341 L | NA | 57 L | NA | 67.8 L | NA |
| | | | | | | |
| **Wet Chemistry (%)** | | | | | | |
| % SOLIDS | 78 | 78 | 82 | 82 | 82 | 82 |

Notes:
NA - Not analyzed
U- Not Detected
B- Blank Contamination
J- Estimated
K- Biased High
L- Biased Low
Shading represents detect

**TABLE 2-3**
Detected Constituents in Confirmatory Floor Soil Samples
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| **Sample ID**<br>**Sample Date** | AS12-SB16-2-2.5<br>11/12/04 | AS12-SB17-2-2.5<br>11/12/04 | AS12-SB17P-2-2.5<br>11/12/04 | AS12-SB18-2-2.5<br>11/12/04 |
|---|---|---|---|---|
| **Chemical Name** | | | | |
| | | | | |
| **Volatile Organic Compounds (µg/kg)** | | | | |
| 1,1,2-Trichloro-1,2,2- trifluoroethane | NA | NA | NA | NA |
| 1,2-Dichlorobenzene | NA | NA | NA | NA |
| 4-Methyl-2-pentanone | NA | NA | NA | NA |
| Carbon disulfide | NA | NA | NA | NA |
| Cyclohexzne | NA | NA | NA | NA |
| m- and p-Xylenes | NA | NA | NA | NA |
| Tetrachloroethene | NA | NA | NA | NA |
| Trichloroethene | NA | NA | NA | NA |
| Trichlorofluoromethane | NA | NA | NA | NA |
| Xylene, total | NA | NA | NA | NA |
| | | | | |
| **Semivolatile Organic Compounds (µg/kg)** | | | | |
| Anthracene | 380 U | 440 U | 100 J | 450 U |
| Benzo(a)anthracene | 380 U | 440 U | 190 J | 450 U |
| Benzo(a)pyrene | 380 U | 440 U | 130 J | 450 U |
| Benzo(b)fluoranthene | 380 U | 440 U | 140 J | 450 U |
| Benzo(g,h,i)perylene | 380 U | 440 U | 390 U | 450 U |
| Benzo(k)fluoranthene | 380 U | 440 U | 100 J | 450 U |
| bis(2-Ethylhexyl)phthalate | 380 U | 440 U | 390 U | 450 U |
| Butylbenzylphthalate | 380 U | 440 U | 390 U | 450 U |
| Chrysene | 380 U | 440 U | 190 J | 450 U |
| Di-n-butylphthalate | 380 U | 440 U | 390 U | 250 J |
| Fluoranthene | 380 U | 440 U | 480 | 450 U |
| Isophorone | 380 U | 440 U | 390 U | 450 U |
| Phenanthrene | 380 U | 440 U | 430 | 450 U |
| Pyrene | 380 U | 440 U | 300 J | 450 U |
| | | | | |
| **Total Metals (mg/kg)** | | | | |
| Aluminum | 6,820 | 10,900 | 8,470 | 9,780 |
| Antimony | 0.15 B | 0.26 B | 0.11 B | 0.22 B |
| Arsenic | 4.7 L | 6 L | 4.4 L | 7.5 L |
| Barium | 51.3 | 97.4 | 66.4 | 157 |
| Beryllium | 0.5 J | 1.2 | 0.83 J | 1.1 |
| Cadmium | 0.35 J | 1.4 | 0.96 | 2.1 |
| Calcium | 127,000 | 4,820 | 3,250 | 2,630 |
| Chromium | 64.5 K | 36.2 K | 31.7 K | 36 K |
| Cobalt | 9.9 | 13 | 10.2 | 11.3 |
| Copper | 18.6 | 19.6 | 13.5 | 21.5 |
| Iron | 24,500 | 30,400 | 24,700 | 32,200 |
| Lead | 14.6 | 19.6 | 15.2 | 23.9 |
| Magnesium | 3,130 | 1,580 | 1,220 | 1,500 |
| Manganese | 401 | 751 | 518 | 272 |
| Mercury | 0.05 J | 0.11 | 0.09 J | 0.1 J |
| Nickel | 19.3 | 22.6 | 17 | 22.2 |
| Potassium | 1,550 | 1,470 | 1,040 | 1,080 |
| Selenium | 0.76 J | 0.62 J | 0.27 J | 0.63 J |
| Silver | 0.03 B | 0.07 B | 0.04 B | 0.07 B |
| Thallium | 0.74 U | 0.7 U | 0.72 U | 0.63 U |
| Vanadium | 9.2 | 22.7 | 17 | 21.9 |
| Zinc | 26.2 L | 81.5 L | 63.2 L | 120 L |
| | | | | |
| **Wet Chemistry (%)** | | | | |
| % SOLIDS | 86 | 76 | 84 | 74 |

Notes:
NA - Not analyzed
U- Not Detected
B- Blank Contamination
J- Estimated
K- Biased High
L- Biased Low
Shading represents detect

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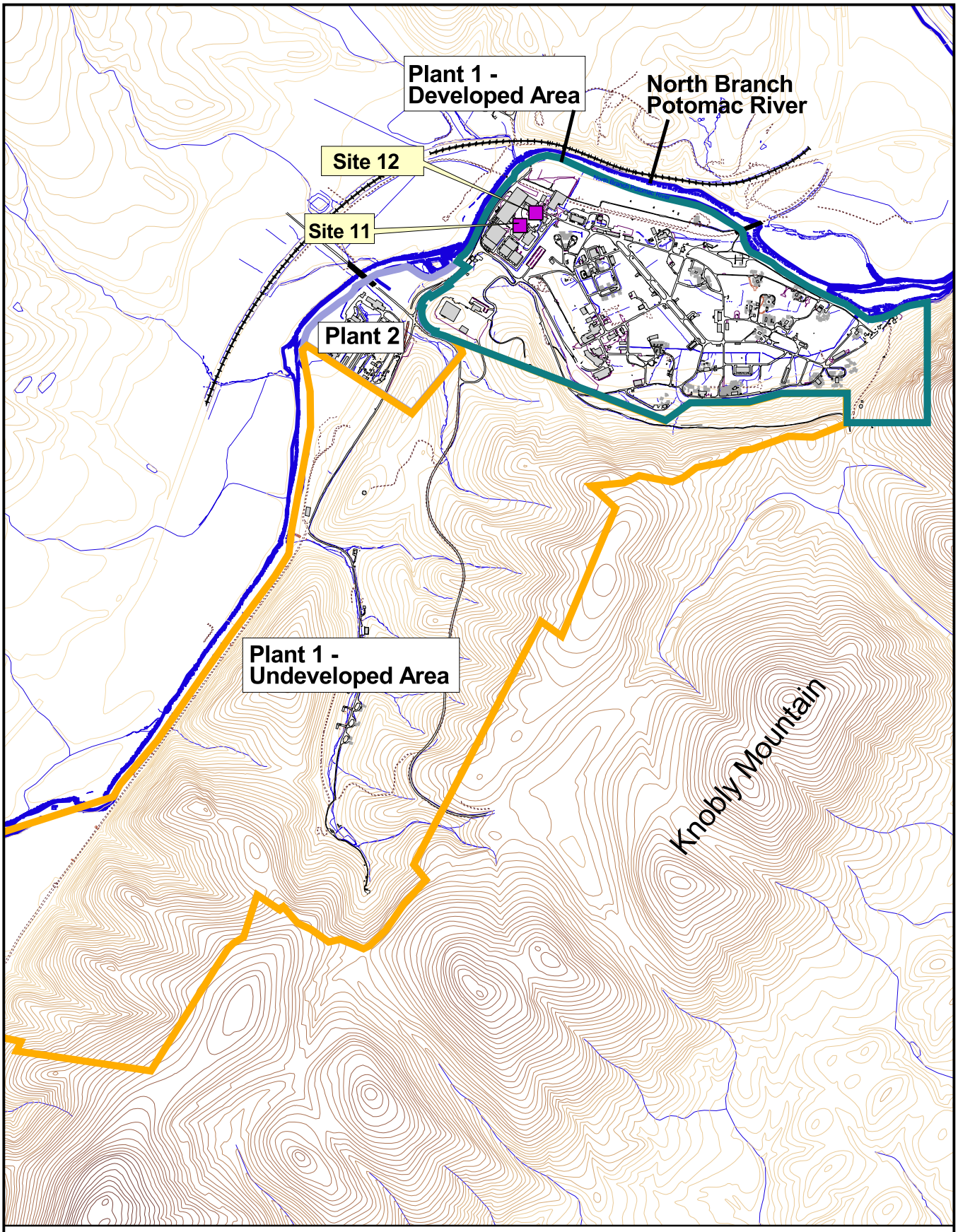


**LEGEND**

- Site Location
- Buildings
- Contours
- Paved Roads
- Dirt Roads
- Bridges

N

1000 0 1000 Feet

Figure 2-1
Facility Map
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

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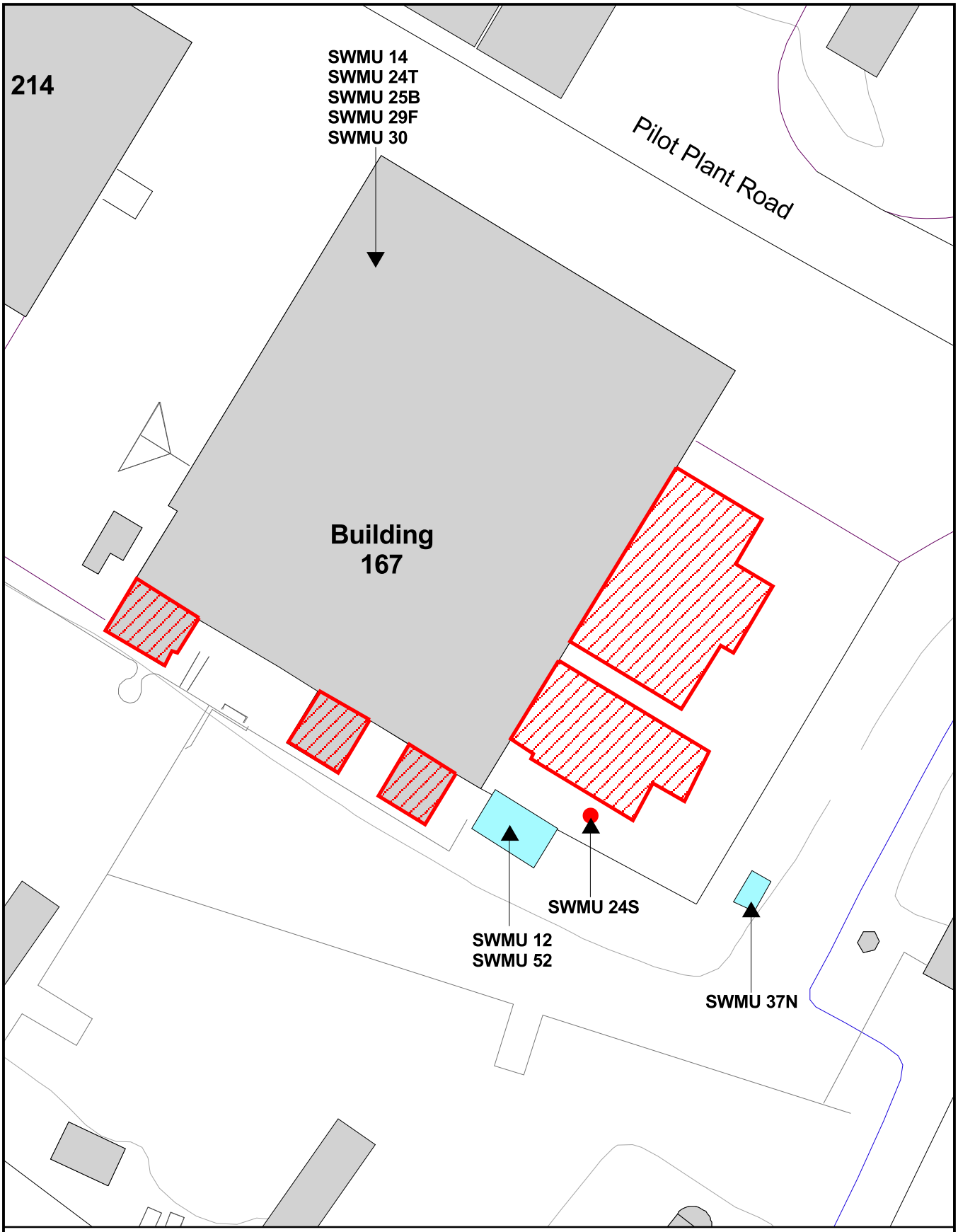


**LEGEND**

- Former Building 167 Configuration
- Buildings
- SWMU Boundary
- Streams and Drainage Ditches
- Steam Line
- SWMU Location

N

0 15 30 45 Feet

Figure 2-2
Site Map and Former SWMU Locations
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

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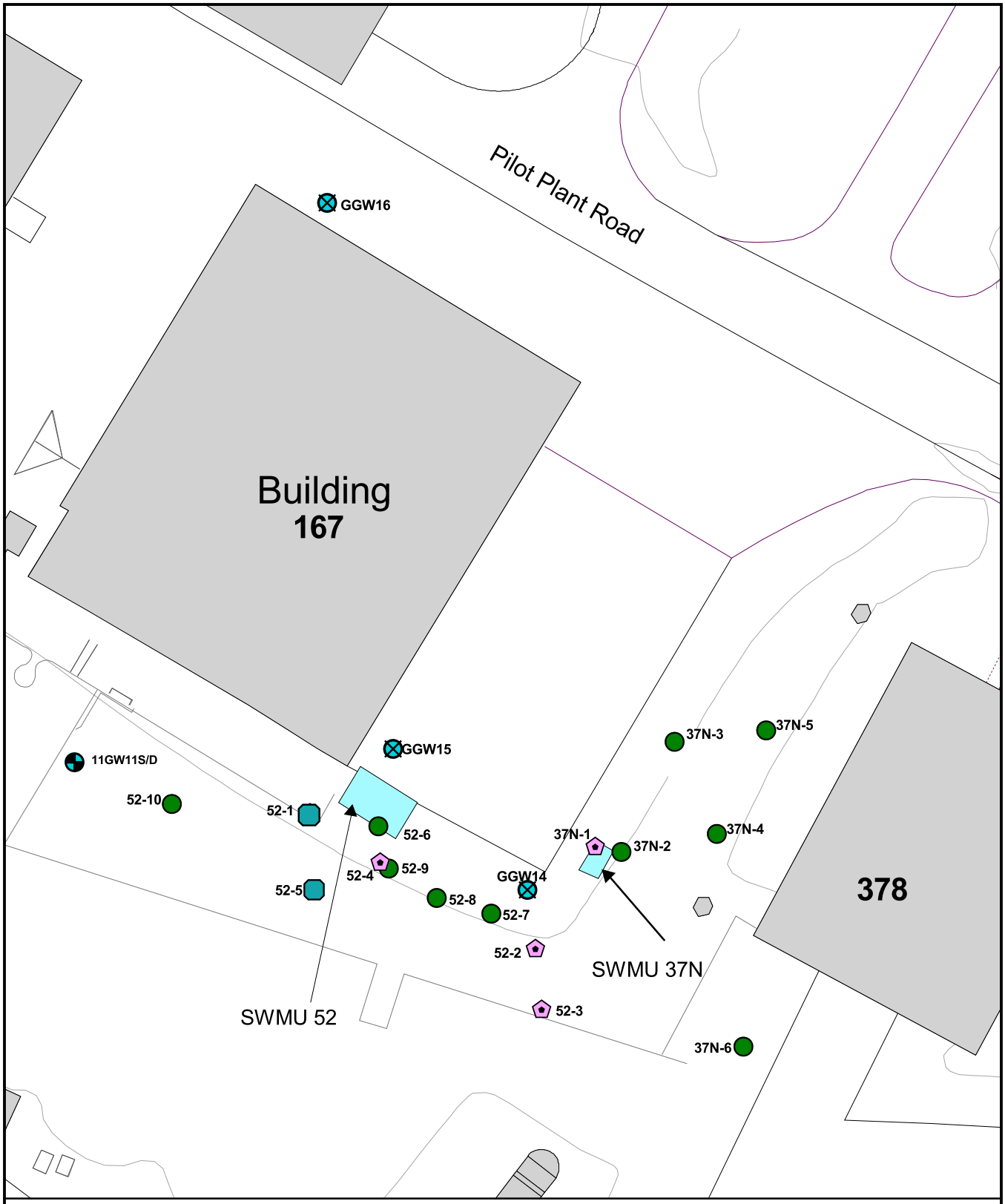


**LEGEND**

- Phase II SWMU/AOC Investigation Soil Sample Location
- Bedrock Monitoring Well
- Phase I SWMU/AOC Investigation Multi-Media Groundwater Sample Location
- Phase II SWMU/AOC Investigation Monitoring Well - Alluvial Groundwater Sample Location
- Phase I SWMU/AOC Investigation Soil Sample Location
- Streams and Drainage Ditches
- Steam Line
- SWMU Boundary

N

0 20 40 60 Feet

Figure 2-3
Phase I and Phase II Sampling Locations
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

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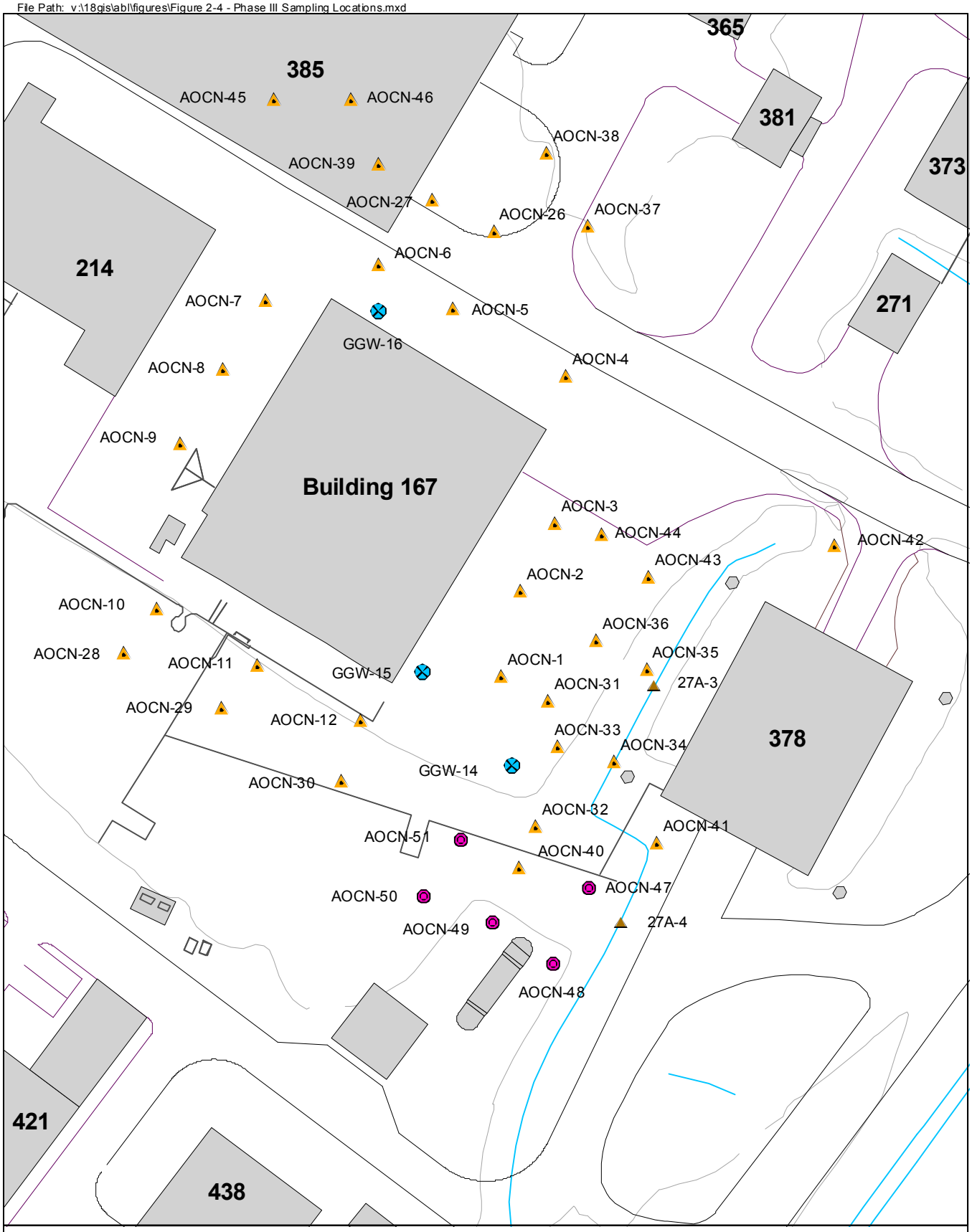


**Legend**

- Alluvial Monitoring Well
- Temporary Monitoring Well
- Grab Groundwater Sample Location
- Sediment Sample Location
- Buildings
- Stream Lines

N

0 25 50 Feet

Figure 2-4
Phase III Sampling Locations
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

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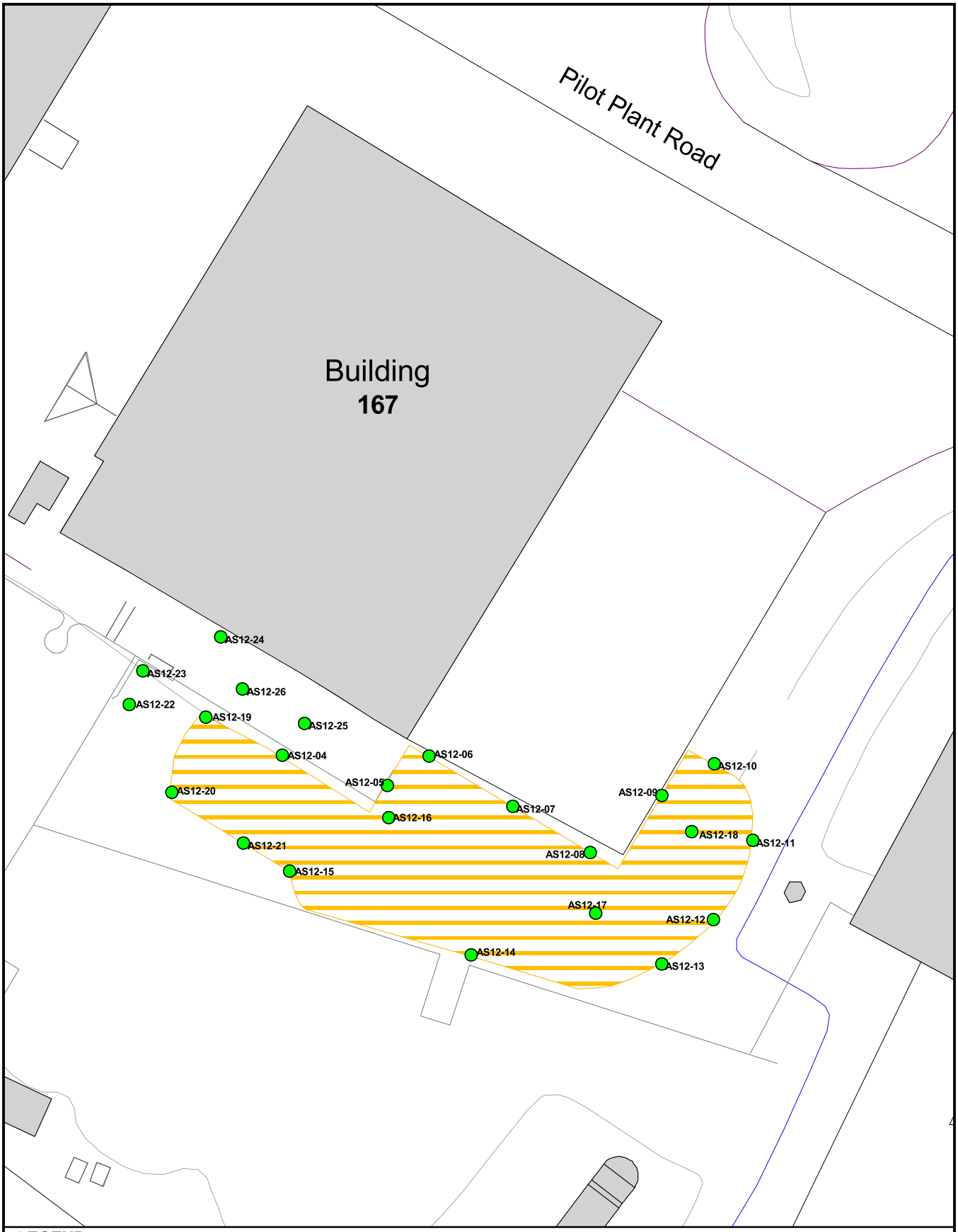


**LEGEND**

- Confirmatory Soil Sample Location
- Soil Excavation Limit
- Buildings
- Streams and Drainage Ditches
- Steam Lines

N

0 15 30 45 Feet

Figure 2-5
Extent of Soil Removal Action and Confirmatory Sample Locations
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

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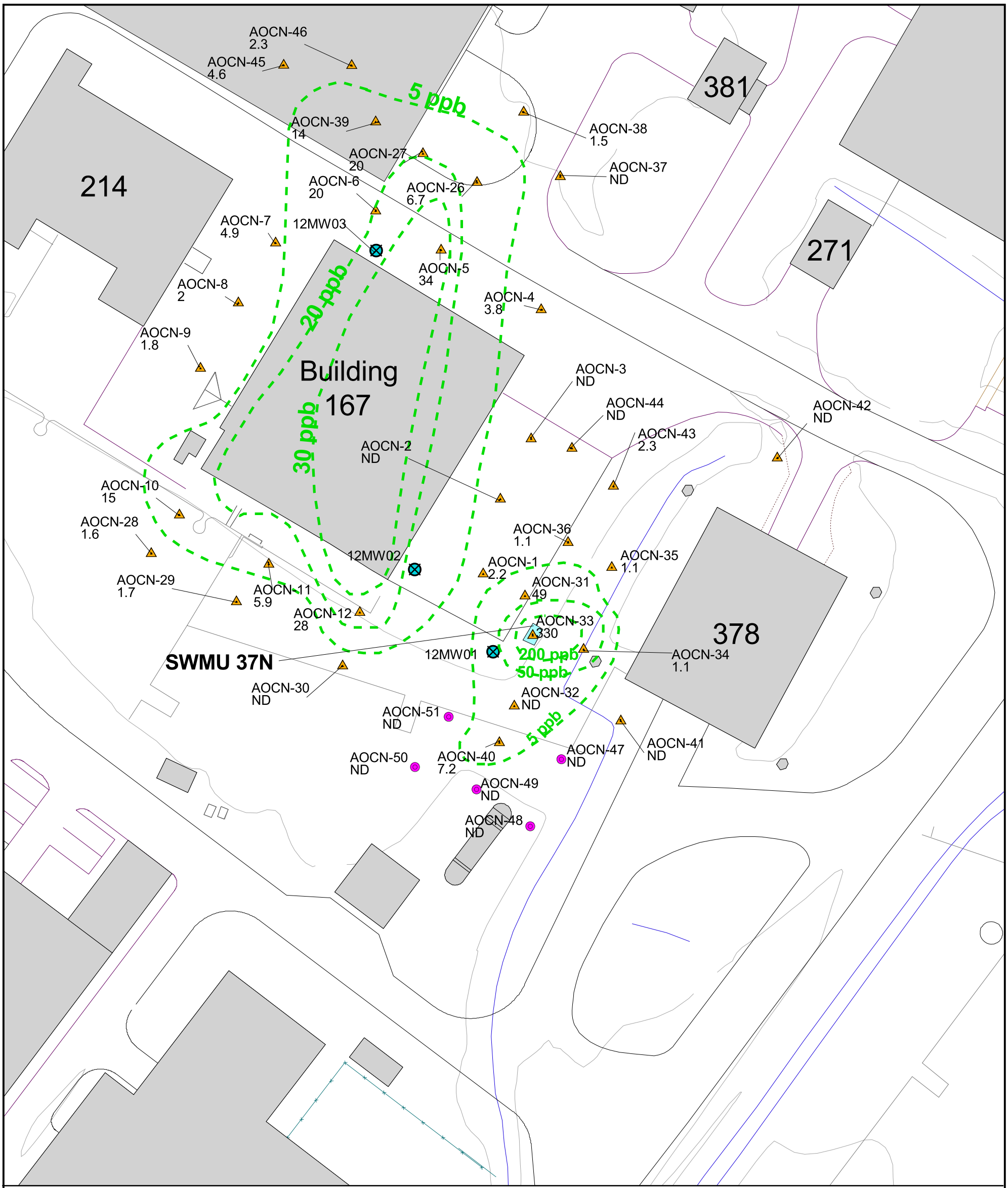


**LEGEND**

- Alluvial Monitoring Wells
- Temporary Monitoring Wells
- Grab Groundwater Samples
- Buildings
- SWMU Boundary
- TCE Plume
- Streams and Drainage Ditches
- Steam Lines

TCE Concentrations in ppb
ND = No TCE Detected

N

0 20 40 60 80 Feet

Figure 2-6
Extent of TCE Detections in Phase III Groundwater Samples
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

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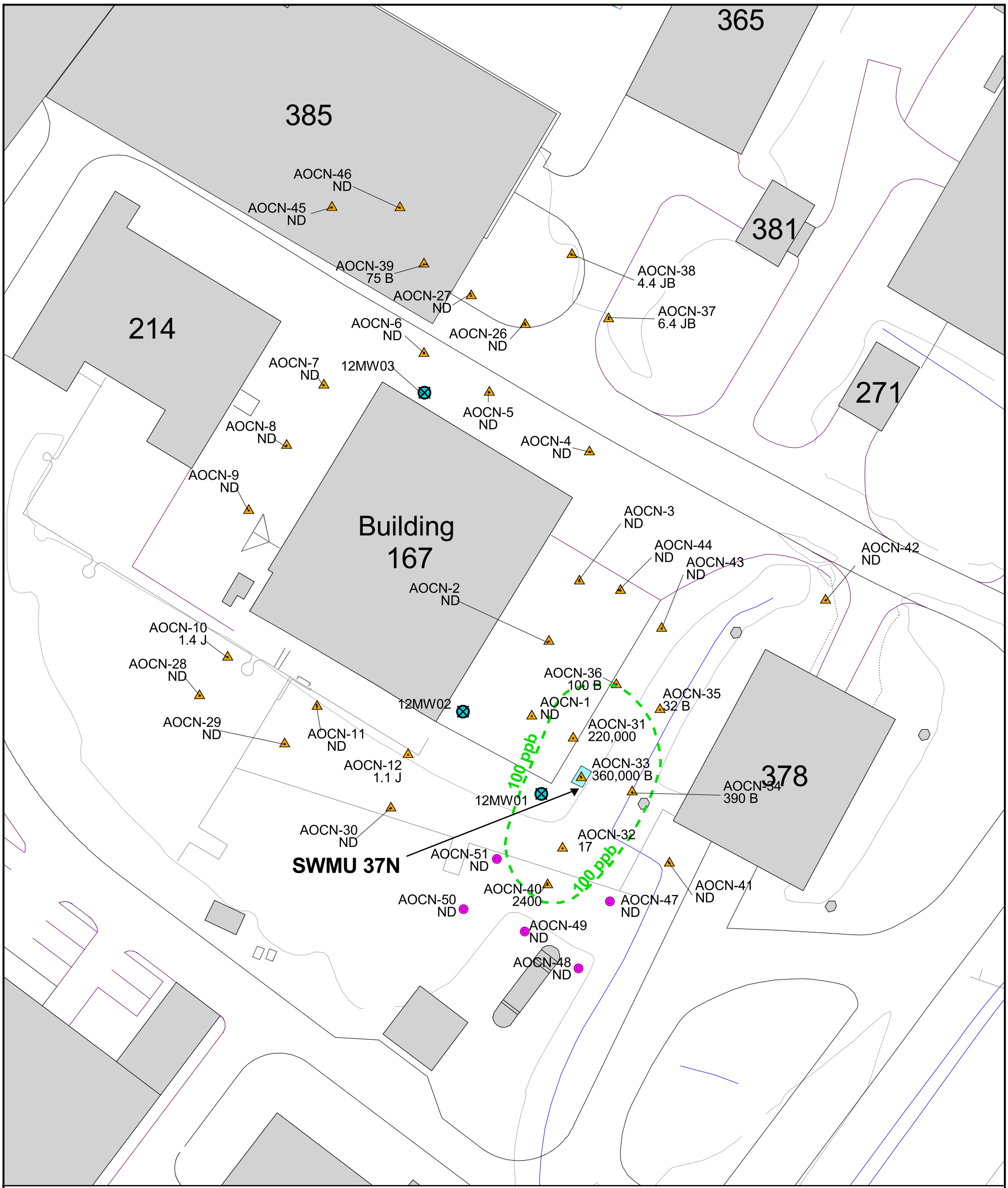


**LEGEND**

- Alluvial Monitoring Wells
- Temporary Monitoring Wells
- Grab Groundwater Samples
- Buildings
- SWMU Boundary
- Streams and Drainage Ditches
- Methylene Chloride Plume
- Steam Lines

390 = MC Concentrations in ppb
ND = No TCE Detected
J = Estimated Concentration
B = Blank Contamination

N

0 20 40 60 80 Feet

Figure 2-7
Extent of MC Detections in Phase III Groundwater Samples
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

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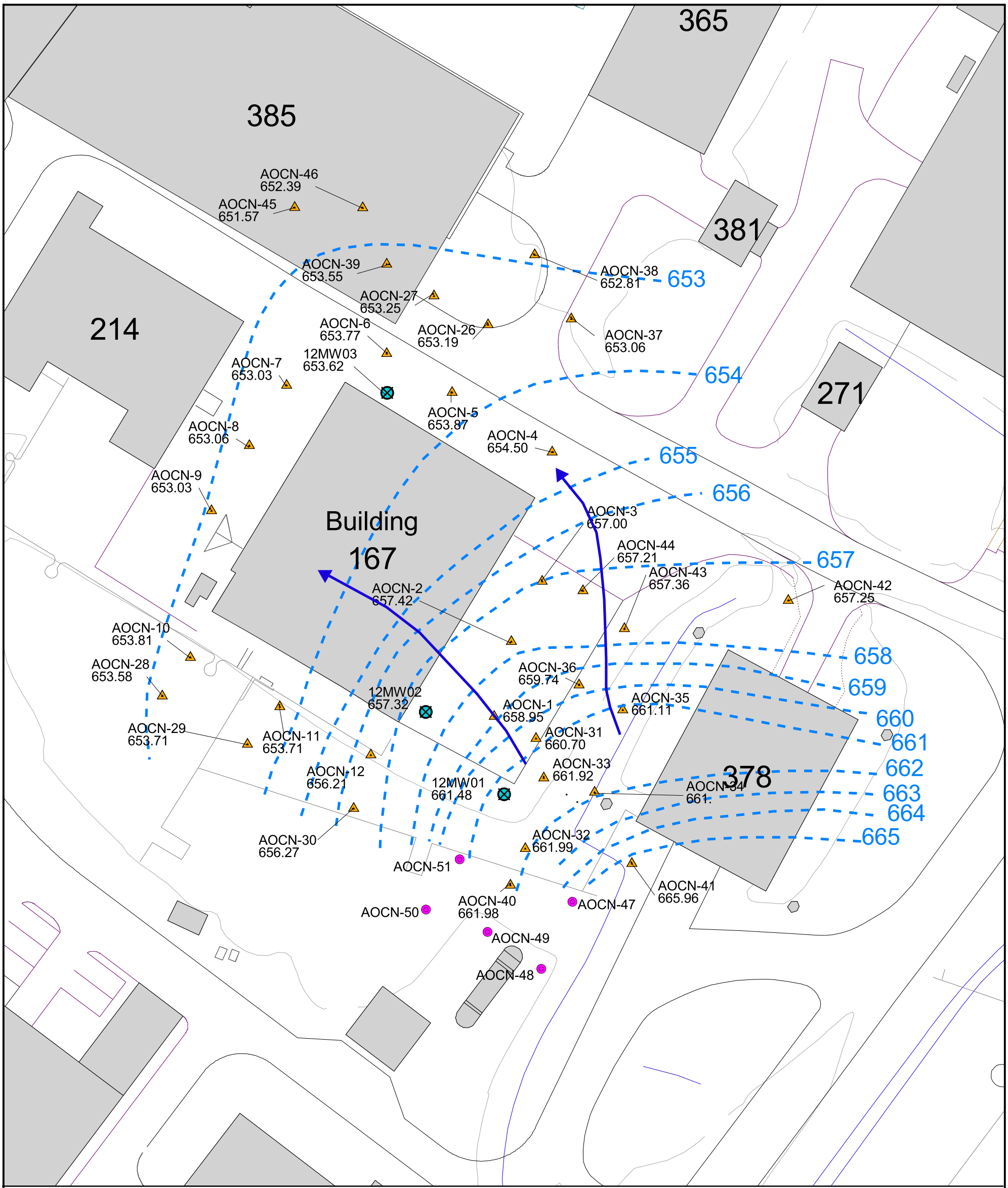


**LEGEND**

- Alluvial Monitoring Wells
- Temporary Monitoring Wells
- Grab Groundwater Samples
- Buildings
- Steam Lines
- Streams and Drainage Ditches
- Groundwater Contours
- Direction of Alluvial Groundwater Flow

657.2 = Alluvial Groundwater Elevations measured on June 28, 2002 (feet above mean sea level)

N

0 20 40 60 80 Feet

Figure 2-8
Phase III Alluvial Groundwater Elevation Contours
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

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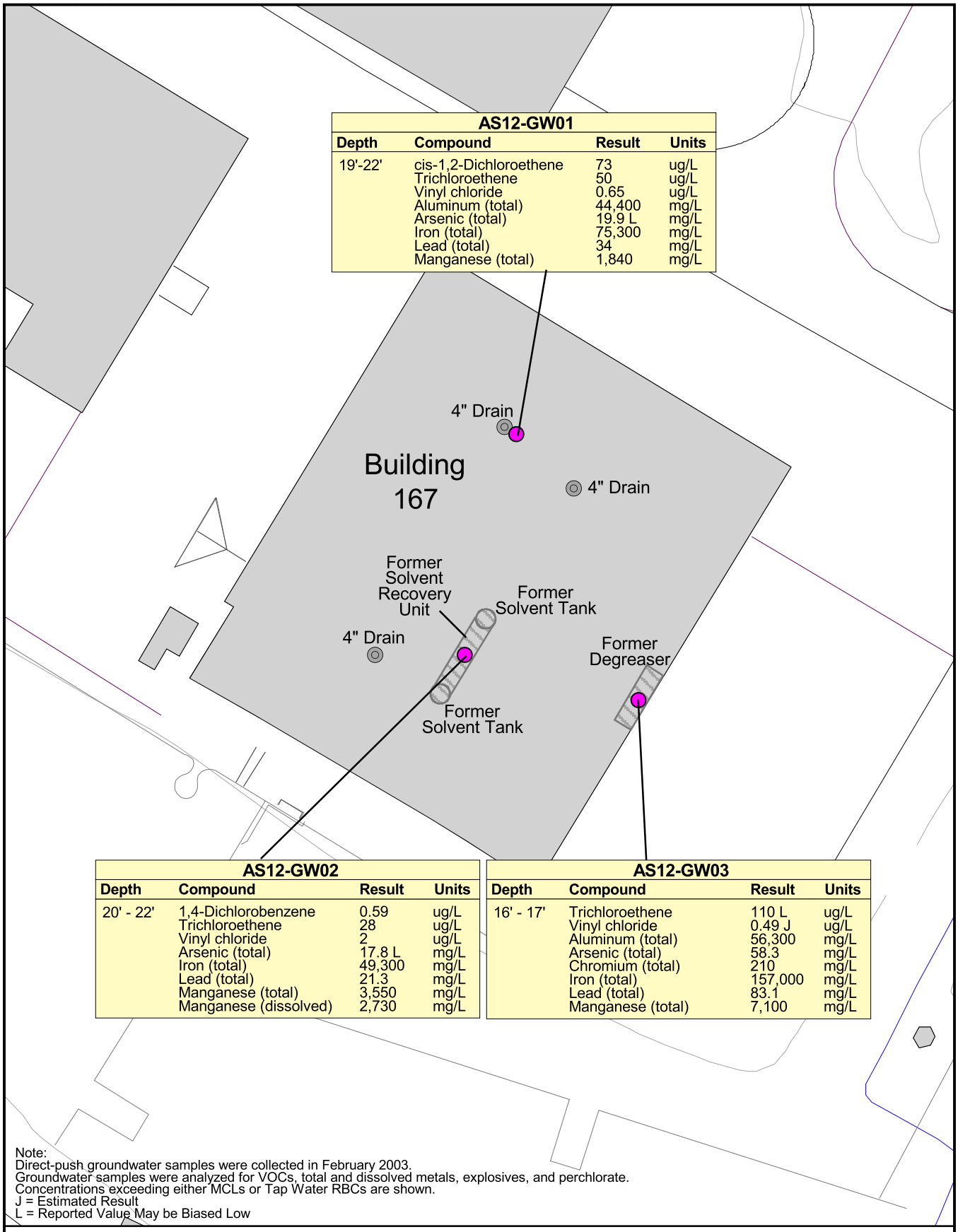


**AS12-GW01**

| Depth | Compound | Result | Units |
|---|---|---|---|
| 19'-22' | cis-1,2-Dichloroethene | 73 | ug/L |
| | Trichloroethene | 50 | ug/L |
| | Vinyl chloride | 0.65 | ug/L |
| | Aluminum (total) | 44,400 | mg/L |
| | Arsenic (total) | 19.9 L | mg/L |
| | Iron (total) | 75,300 | mg/L |
| | Lead (total) | 34 | mg/L |
| | Manganese (total) | 1,840 | mg/L |

**AS12-GW02**

| Depth | Compound | Result | Units |
|---|---|---|---|
| 20' - 22' | 1,4-Dichlorobenzene | 0.59 | ug/L |
| | Trichloroethene | 28 | ug/L |
| | Vinyl chloride | 2 | ug/L |
| | Arsenic (total) | 17.8 L | mg/L |
| | Iron (total) | 49,300 | mg/L |
| | Lead (total) | 21.3 | mg/L |
| | Manganese (total) | 3,550 | mg/L |
| | Manganese (dissolved) | 2,730 | mg/L |

**AS12-GW03**

| Depth | Compound | Result | Units |
|---|---|---|---|
| 16' - 17' | Trichloroethene | 110 L | ug/L |
| | Vinyl chloride | 0.49 J | ug/L |
| | Aluminum (total) | 56,300 | mg/L |
| | Arsenic (total) | 58.3 | mg/L |
| | Chromium (total) | 210 | mg/L |
| | Iron (total) | 157,000 | mg/L |
| | Lead (total) | 83.1 | mg/L |
| | Manganese (total) | 7,100 | mg/L |

Note:
Direct-push groundwater samples were collected in February 2003.
Groundwater samples were analyzed for VOCs, total and dissolved metals, explosives, and perchlorate.
Concentrations exceeding either MCLs or Tap Water RBCs are shown.
J = Estimated Result
L = Reported Value May be Biased Low

**LEGEND**

- Direct-Push Soil and Groundwater Sampling Locations
- Buildings
- Steam Lines
- Streams and Drainage Ditches

N

0 15 30 45 Feet

Figure 2-9
Building 167 Sample Locations and Results
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

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SECTION 3

# Remedial Investigation Methodology

Groundwater sampling results from the Phase III SWMU/AOC Investigation were presented to the ABL Partnering Team in 2003 (CH2M HILL, 2003b). VOC contamination was discovered in the groundwater of what was then referred to as AOC N. Based upon the Phase III SWMU/AOC Investigation results, AOC N was designated by the Partnering Team as IRP Site 12 and the RI was subsequently initiated (CH2M HILL, 2003c).

As stated in Section 2, the focus of the Site 12 RI is on groundwater. The investigation activities conducted to date have included monitoring well installation and development, aquifer testing, a dye trace study, synoptic water level measurements, and groundwater sampling. The following section provides a general summary of the methodology for these investigation activities. For specific details on the objectives and technical approach for each separate investigation event, the reader is referred to the investigation work plans and/or reports that outline the Site 12 RI activities (CH2M HILL, 2000; CH2M HILL, 2003a; CH2M HILL, 2005e; CH2M HILL, 2006).

## 3.1 Monitoring Well Installation

The monitoring well network at Site 12 consists of 31 individual wells, which are screened across the alluvial saturated interval or across shallow or deep bedrock fractures. These wells are located in the area that surrounds Building 167 (Table 3-1; Figure 3-1). For purposes of this RI, the Site 12 monitoring well network has also been supplemented through the inclusion of one alluvial monitoring well (11GW14) and one bedrock monitoring well pair (11GW11S/D) that were installed as part of Site 11, but are located in close proximity to Building 167 (Figure 3-1).

Consistent well installation and construction techniques have been utilized throughout the investigation and in general, the monitoring well network has been constructed as specified in the associated work plans (CH2M HILL, 2000; CH2M HILL, 2003a; CH2M HILL, 2006). The following subsections summarize the installation, construction, and development methods for the alluvial and bedrock wells at Site 12. Soil boring and well construction diagrams for most of the Site 12 monitoring wells are provided in Appendix A. Soil boring logs that are not included in Appendix A indicate that a field log was not prepared for that specific location (e.g. 12MW23S, 12MW20S/D, 12MW21S/D, and 12MW22S/D). Boring logs were not completed for these locations due to the fact that the boreholes were drilled with air rotary techniques and cuttings could not be observed because they were discharged directly into a waste container in compliance with the Health and Safety Plan.

### 3.1.1 Alluvial Wells

Data from 14 alluvial monitoring wells at Site 12 (including 11GW14) are utilized in this RI report (Table 3-1). Alluvial wells 12MW01, 12MW02, and 12MW03 were originally installed as wells GGW14, GGW15, and GGW16, respectively, during the Phase II SWMU/AOC Investigation (CH2M HILL, 2000; CH2M HILL, 2005a), but were renamed when Site 12 was

designated. Wells 12MW06, 12MW08, 12MW10, 12MW15, and 12MW16 were installed as part of the Site 12 RI activities that were conducted in conjunction with the Phase III SWMU/AOC investigation (CH2M HILL, 2003a). Wells 12MW12 and 12MW14 were originally scoped in the Phase III Investigation Work Plan, but were installed during later investigation work. No VOCs exceedances were detected in 12MW10 during the April 2003 Phase III SWMU/AOC investigation, groundwater sampling effort. For this reason, 12MW12 was not installed at the location originally proposed, downgradient of 12MW10. It was instead installed north and downgradient of Building 167, to horizontally delineate the extent of VOCs detected immediately north of Building 167 (i.e., in 12MW03) Well 12MW14 was installed north of Building 167 to further delineate the horizontal extent of VOCs that had been detected in 12MW03. Wells 12MW18 and 12MW19 were installed in August 2003 as replacement wells for 12MW03 and 12MW06, which were damaged by construction activities and subsequently abandoned. Finally, alluvial well 12MW23 was installed during investigation work in December 2006 (CH2M HILL, 2006).

The alluvial monitoring wells at Site 12 were constructed in boreholes that extend to the top of bedrock. The boreholes were advanced using casing advancement and air rotary drilling techniques. The casing advancement technique utilized a temporary outer steel casing to prevent collapse of the unconsolidated alluvium. Air rotary techniques were necessary to drill through the cobbles and gravel that are typically encountered in the alluvium directly above the bedrock surface. The casing advancement technique did not allow for the collection of soil samples and most descriptions of soil lithology are based on observations of drill cuttings. However, split-spoon samples were collected in shallow unconsolidated material during installation of 12MW01, 12MW02, and 12MW03.

The alluvial monitoring wells are constructed of 2-inch, Schedule 40 polyvinyl chloride (PVC) screen and riser pipe. Screen intervals comprise 0.001-inch slotted PVC sections that span the lower 10 feet of the alluvium. The alluvial monitoring wells range in depth from 12 to 32 feet below grade (Table 3-1). Additional construction details (e.g. sand pack interval, seal type, completion method, etc.) are specified on well construction diagrams provided in Appendix A.

### 3.1.2 Bedrock Wells

The Site 12 bedrock wells (including the Site 11 well 11GW11S/D) are screened across either a shallow (“S”) or deep (“D”) fracture zone (Table 3-1). There are 20 individual bedrock wells and at nine locations, the shallow and deep bedrock wells (“S/D” locations) are nested well pairs (Figure 3-1). Bedrock wells 12MW04S, 12MW05S/D, 12MW07S/D, 12MW09S/D, and 12MW11S/D were installed as part of the Site 12 RI activities that were conducted in conjunction with the Phase III SWMU/AOC investigation (CH2M HILL, 2003a). Wells 12MW13S and 12MW17S/D were originally scoped in the Phase III Investigation Work Plan, but were installed during later investigation work. No VOCs were detected in 12MW11S/D during the April 2003 Phase III SWMU/AOC investigation, groundwater sampling effort. For this reason, 12MW13S was not installed at the location originally proposed, downgradient of 12MW11S/D. It was instead installed north and downgradient of Building 167, to horizontally delineate the extent of VOCs detected immediately north of Building 167 (i.e., in 12MW05S/D). Well 12MW17, was proposed by the Partnering Team during the March 2003 Partnering Meeting to also serve a similar purpose as 12MW13, but is located between

12MW05S/D and 12MW13S. Finally, wells 12MW20S/D, 12MW21S/D and 12MW22S/D were installed during investigation work in December 2006 (CH2M HILL, 2006).

Bedrock borehole installation was accomplished at Site 12 using casing advancement and air hammer drilling techniques. Casing advancement drilling was used to install surface isolation casing to a depth of at least 5 feet into competent bedrock to prevent collapse of the unconsolidated alluvium. After setting the surface casing, a 6-inch diameter air hammer was utilized to advance the borehole into bedrock. This drilling technique did not allow for the collection of samples and lithologic descriptions are based on observations of drill cuttings.

Depths of the shallow and deep bedrock wells range from 36 to 140 feet and there is some depth range overlap between the shallow and deep screen intervals (Table 3-1). The bedrock monitoring wells are constructed of 2-inch, Schedule 40 PVC well screens and riser pipe. Screen intervals are typically 10 feet in length and comprise 0.01-inch slotted PVC. Screen interval depths were typically identified through the use of geophysical techniques, as described in Section 3.3. Additional construction details (e.g. sand pack interval, seal type, completion method, etc.) are specified on well construction diagrams provided in Appendix A.

## 3.2 Well Development

The Site 12 monitoring wells were developed by alternately surging the saturated screen interval and extracting groundwater from the well using a submersible pump. Development continued until the extracted groundwater was relatively free from turbidity and/or the water quality parameters stabilized within specified limits, per the associated Work Plan (CH2M HILL, 2000; CH2M HILL, 2003a; CH2M HILL, 2006).

## 3.3 Downhole Geophysics

The primary purpose of the downhole geophysical measurements was to identify the depth and magnitude of fracture zones within the bedrock and assess their water-bearing/producing capability. The measurements were obtained from open bedrock boreholes and were ultimately used to select screen intervals for the shallow and deep bedrock monitoring wells. The geophysical techniques included caliper, fluid conductivity, temperature, heat pulse, and impeller flow logging measurements. Impeller flow logging measurements were collected under both static and pumping conditions. Geophysical results for bedrock monitoring wells 12MW04S/D, 12MW05S/D, 12MW07S/D, 12MW09S/D, 12MW11S/D, 12MW13S/D, and 12MW17S/D are compiled in Appendix B. Geophysical techniques were also utilized to select screen intervals for wells 12MW20S/D, 12MW21S/D and 12MW22S/D, but the results were utilized immediately in the field and geophysical logs were not compiled.

## 3.4 Packer Testing

The geophysical results were also used to select packer sampling intervals for up to three identified fracture zones in seven bedrock boreholes at Site 12 (Table 3-2). The objective of

the packer sampling was to delineate the vertical distribution and variation of groundwater contaminants and to assess the degree of interconnection of bedrock fracture zones.

The sampling event was attempted in January 2004. The packer sampling was conducted by installing and inflating the two ends of a straddle packer device above and below the identified fracture interval. The packer device was designed to seal the fracture zone from the borehole above and below the packed interval; pressure transducers installed below, within, and above the packer assembly were used to monitor water levels and assess the effectiveness of the seal. Upon observing an adequate seal, the packer interval was purged of 2 volumes of water using a submersible pump. At the completion of purging, groundwater samples were collected under low-flow conditions and shipped to the laboratory for analysis of low-concentration VOCs.

Due to technical complications, the packer sampling method yielded limited success and only four of the fifteen proposed samples were collected (Table 3-2). Specifically, the packer assembly was unable to maintain an adequate seal or be placed at the proposed depth intervals. These complications were likely due to the presence of vertical bedding planes and/or fractures in the bedrock that significantly hindered the seating and sealing ability of the packer device on the borehole walls. Due to the limited results obtained from this method, the packer test results were not used extensively to aid in the determination of bedrock well screen intervals. Rather, the data from geophysical techniques, previously described in Section 3.3, were used to select screen intervals. Analytical samples obtained during the packer testing are included as Appendix F.

## 3.5 Aquifer Yield Testing

A 2-hour yield test was conducted in 2004 which was designed to assess the properties of the bedrock aquifer and the productivity of a proposed injection point for a dye tracing test (CH2M HILL, 2005e). Prior to the test, a submersible pump was placed in the open bedrock borehole at location 12M09S/D. During the first hour of the test, groundwater was pumped from the well at incrementally increasing rates, to determine the sustainable yield (Table 3-3). The sustainable yield of the borehole was determined to be greater than the maximum pump rate of 32 gallons per minute (gpm). During the second hour of the test, the borehole was pumped at 32 gpm. At various time intervals during the entire test, manual water level measurements were obtained in alluvial wells 12MW02 and 12MW08 and in open borehole 12MW04S/D (Figure 3-2).

Groundwater samples were collected from the open borehole at 12MW09S/D during the yield test. Specifically, samples were collected at five minutes after the start of pumping and immediately before pump shut-off. The groundwater samples were analyzed for VOCs by the on-site (ATK) laboratory. There was a 3-fold increase in the methylene chloride concentrations during the yield test. Other VOCs are summarized in a technical memorandum that includes the dye testing results discussed below (CH2M HILL, 2005e). The aquifer yield test results are discussed in greater detail in Section 4.3.3.

## 3.6 Dye Testing

A dye test was conducted at Site 12 to assess the potential interconnection of bedrock fracture zones, the potential interconnection between the alluvial and bedrock aquifers, and the potential interconnection of the bedrock fractures and North Branch Potomac River (CH2M HILL, 2005e). The dye test was completed in 2004 and involved preliminary background monitoring, dye injection, and post-injection monitoring at select monitoring well and surface water sample locations (Figure 3-3).

Prior to dye injection, background samples were collected during two separate events to determine if there were existing concentrations of dye (man-made and/or naturally-occurring) within the investigation area. Dye concentrations were analyzed through the installation of adsorbent carbon packets in monitoring wells at Site 12 and in two extraction wells and one bedrock monitoring well at Site 1. The Site 1 wells are located northeast of Site 12, and along strike of the bedding and the primary bedrock fracture orientation at ABL (Figure 3-3). Carbon packets in bedrock wells were installed at the depth of identified fractures. In addition, carbon packets were placed at three near-shore sample locations in the North Branch Potomac River.

At the beginning of the dye test, 15 pounds of fluorescein dye was injected into the open borehole at location 12MW09S/D, which is the suspected source area for groundwater contamination in the bedrock at Site 12. The dye was injected at the depth of an identified fracture interval at 85 feet below grade. Following injection, 1,500 gallons of potable water were added to the borehole to flush the dye into the fracture(s). The same select group of monitoring wells and near shore sample locations were equipped with carbon packets to monitor the post-injection dye concentrations at 7, 21, and 35 days after injection. The results of the dye test are summarized in Table 3-4 and discussed in greater detail in Section 4.3.4.

## 3.7 Synoptic Water Level Monitoring

Synoptic water levels were collected at various times during the Site 12 RI. However, more recent (2007) measurements represent the most comprehensive data set, because the present monitoring well network was not completed until December 2006. Three rounds of water levels, one on March 16, 2007, another on June 11, 2007, and a final round on November 12, 2007 represent the measurement rounds that occurred after the current monitoring well network was complete. The March 16, 2007 round is analyzed extensively in this RI because all monitoring wells were measured on this date. The November 12, 2007 round is used to represent regional conditions because all wells at Sites 11 and 12 were measured on this date. Only a select set of monitoring wells, which comprised only the proposed sampling locations, were measured on June 11, 2007 per the June 2007, Site 12 Work Plan Addendum (CH2M HILL, 2007a).

Prior to obtaining water level readings, the caps on the monitoring wells at Site 12 were opened and the water levels were allowed to equilibrate with atmospheric pressure for approximately 30 minutes. Water level measurements were then collected using an electronic water level indicator. The measurements were obtained relative to a surveyed measuring point located on top of the well casing and the measurements were recorded to the nearest 0.01 foot. Groundwater elevations were then calculated by subtracting the depth

to water from the surveyed top of casing elevation. The potentiometric surfaces, measured in alluvial and bedrock groundwater monitoring wells, are discussed in greater detail in Section 4.3.1.

## 3.8 Groundwater Sampling

This RI utilizes groundwater analytical data collected during five sampling events, which took place in July 2003, September 2003, May/June 2005, December 2006, and June 2007. The number of wells sampled during each event depended on the objective of the event and the extent of the monitoring well network at the time of the event. The most comprehensive, site-wide data set is represented by the June 2007 sampling event, when 20 wells at Site 12 were sampled. Parameters analyzed during the monitoring events have typically included all, or a subset of, the following analytes: VOCs, Semi-Volatile Organic Compounds (SVOCs), Explosives, Total and Dissolved Metals, and wet chemistry parameters (e.g. alkalinity, nitrate, nitrite, total organic carbon (TOC), etc.). Additional field measurements and laboratory sample analyses were performed during the last round of sampling (i.e., June 2007) to evaluate the potential for monitored natural attenuation (MNA), including field measurements of oxidation reduction potential, dissolved oxygen, temperature, conductivity, pH, alkalinity, ferrous iron test kits and sulfide test kits. Samples were also laboratory analyzed for MNA parameters (i.e., chloride, nitrate/nitrite/sulfate, total organic carbon and methane/ethane/ethane).

Groundwater samples were collected under low-flow purge and sample conditions in accordance with the applicable Work Plan (CH2M HILL, 2000; CH2M HILL, 2003a; CH2M HILL, 2006). During purging, water quality parameters, comprising pH, conductivity, dissolved oxygen, turbidity, and oxidation-reduction potential (ORP), were measured with a water quality meter that was mounted in a flow-through cell. These parameters were continuously monitored and recorded every 3 to 5 minutes, until the parameters stabilized within specified limits.

Once the water quality parameters stabilized, the samples were collected in laboratory supplied containers that were pre-preserved in accordance with the method of analysis. Dissolved metals samples were field filtered through a disposable, 0.45 micron filter, as the groundwater was placed into the sampling container. Samples were then preserved on ice and transported to the laboratory under industry standard chain-of-custody (COC) protocols and procedures. The parameters and their frequency for analysis are summarized in Table 3-5.

## 3.9 Field QA/QC Procedures

Quality assurance/quality control (QA/QC) procedures were followed during the RI to ensure the appropriate custody and integrity of environmental samples. QA/QC samples, comprising equipment rinsate blanks, trip blanks, matrix spike /matrix spike duplicates, and field duplicates, were collected in accordance with the applicable Work Plan CH2M HILL, 2000; CH2M HILL, 2003a; CH2M HILL, 2006).

## 3.10 Surveying

Monitoring wells at Site 12 were surveyed after installation by a licensed surveyor. The horizontal datum for Site 12 is West Virginia State Plane, North Zone, North American Datum 1983 [NAD 83(91)] and the vertical datum is National Geodetic Vertical Datum 1929 (NGVD 29).

## 3.11 Laboratory Procedure/Data Validation

Groundwater samples were analyzed by GPL Laboratories of Fredrick, Maryland. Samples were analyzed in accordance with EPA CLP protocols and with the Navy Installation Restoration Laboratory Quality Assurance Guide; Interim Guidance Document (NFESC, 1996). Specifically, the groundwater samples were analyzed for the following constituents by the listed methods:

- VOCs were analyzed using methods OLC-V, OLM-V, OLC03-V, and SW8260B.
- SVOCs were analyzed using methods OLC03-SV, OLM04-SV, and OLM.
- Total and Dissolved metals were analyzed using methods 7196A, ILM03, ILM04, and ILM05.
- Explosives were analyzed using 6850, E314.0, SW8830, and SW8832.
- MNA parameters were analyzed using methods 300.0a (Nitrate/Nitrite/Sulfate), 9060 (TOC), 325.1/325.3a (Chloride) and RSK 175/147 (methane/ethane/ethane)

An independent contractor validated all laboratory analytical results. DataQual Environmental Services, LLC of Saint Louis, Missouri, validated the December 2006 and June 2007 data. The data were fully validated using the Region III Modifications to the National Functional Guidelines for organic and inorganic data (EPA, 1994). Once final electronic deliverables were received and validated, the data were electronically transferred to CH2M HILL's environmental data management system.

**TABLE 3-1**

Monitoring Well Construction Information, Survey Data, and Groundwater Elevations from Select Events

*Site 12 Remedial Investigation Report*

*Allegany Ballistics Laboratory*

*Rocket Center, West Virginia*

| Water-Bearing Zone | Well ID | Installation Date | Status | Northing | Easting | Ground Elevation | TOC Elevation1 | Depth of Screen Interval | Groundwater Depth 3/16/2007 | Groundwater Elevation 03/16/2007 | Groundwater Depth 11/12/2007 | Groundwater Elevation 11/12/2007 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alluvial | 11GW14 | Mar-03 | Active | 388498.2 | 2154766.7 | 668.70 | 671.12 | 5-15 | 14.53 | 656.59 | 17.03 | 654.09 |
| | 12MW01 | Mar-99 | Active | 388457.6 | 2154893.4 | 670.25 | 669.85 | 10-20 | 5.62 | 664.23 | 8.07 | 661.78 |
| | 12MW02 | Apr-99 | Active | 388491.6 | 2154861.1 | 671.02 | 670.57 | 12-22 | 10.01 | 660.56 | 14.05 | 656.52 |
| | 12MW03 | Mar-99 | Abandoned | 388622.7 | 2154845.1 | 670.91 | 670.56 | -- | -- | -- | -- | -- |
| | 12MW06 | Mar-03 | Abandoned | 388599.5 | 2154789.9 | 671.13 | 673.97 | -- | -- | -- | -- | -- |
| | 12MW08 | Mar-03 | Active | 388462.5 | 2154909.4 | 669.68 | 671.64 | 11-21 | 7.46 | 664.18 | 9.94 | 661.7 |
| | 12MW10 | Mar-03 | Active | 388543.0 | 2154968.3 | 669.84 | 672.63 | 22-32 | 10.08 | 662.55 | 13.87 | 658.76 |
| | 12MW12 | Aug-03 | Active | 388671.3 | 2154765.8 | 671.79 | 671.59 | 15-25 | 15.14 | 656.45 | 20.05 | 651.54 |
| | 12MW14 | Aug-03 | Active | 388630.4 | 2154898.8 | 670.77 | 670.57 | 15-25 | 12.23 | 658.34 | 17.34 | 653.23 |
| | 12MW15 | Mar-03 | Active | 388431.7 | 2154955.3 | 667.25 | 669.59 | 2-12 | 2.58 | 667.01 | 4.21 | 665.38 |
| | 12MW16 | Mar-03 | Active | 388425.3 | 2154831.9 | 668.48 | 671.26 | 7.7-17.7 | 11.76 | 659.5 | 15.97 | 655.29 |
| | 12MW18 | Aug-03 | Active | 388620.1 | 2154849.2 | 671.13 | 670.81 | 15-25 | 14.10 | 656.71 | 18.95 | 651.86 |
| | 12MW19 | Aug-03 | Active | 388594.3 | 2154786.6 | 671.18 | 670.93 | 15-25 | 14.41 | 656.52 | 19.25 | 651.68 |
| | 12MW23 | Nov-06 | Active | 388592.0 | 2155000.4 | 667.19 | 666.48 | 22-32 | 6.74 | 659.74 | 10.68 | 655.8 |
| Shallow Bedrock | 12MW04S | Apr-03 | Active | 388489.0 | 2154879.7 | 670.86 | 670.15 | 50-60 | 9.39 | 660.76 | 13.5 | 656.65 |
| | 12MW05S | Apr-03 | Active | 388626.9 | 2154839.7 | 670.77 | 670.22 | 66-76 | 13.57 | 656.65 | 18.52 | 651.7 |
| | 12MW07S | Apr-03 | Active | 388607.0 | 2154794.9 | 671.12 | 670.39 | 50-60 | 13.80 | 656.59 | 18.82 | 651.57 |
| | 12MW09S | Mar-03 | Active | 388471.0 | 2154914.8 | 669.76 | 671.39 | 60-70 | 1.88 | 669.51 | 6.35 | 665.04 |
| | 12MW11S | Mar-03 | Active | 388544.0 | 2154978.9 | 669.51 | 671.69 | 42-52 | 5.95 | 665.74 | 10.32 | 661.37 |
| | 12MW13S | Aug-03 | Active | 388676.6 | 2154756.4 | 671.78 | 670.92 | 36-46 | 15.19 | 655.73 | 19.48 | 651.44 |
| | 12MW17S | Aug-03 | Active | 388638.4 | 2154804.0 | 671.20 | 670.62 | 26-36 | 14.21 | 656.41 | 19.13 | 651.49 |
| | 12MW20S | Nov-06 | Active | 388520.6 | 2154894.9 | 668.60 | 668.32 | 60-70 | 9.86 | 658.46 | 13.92 | 654.4 |
| | 12MW21S | Nov-06 | Active | 388511.1 | 2154934.4 | 667.99 | 669.97 | 58-68 | 3.15 | 666.82 | 7.41 | 662.56 |
| | 12MW22S | Nov-06 | Active | 388416.4 | 2154896.9 | 666.06 | 668.63 | 57-67 | 1.81 | 666.82 | 5.41 | 663.22 |
| | 11GW11S | Sep-98 | Active | 388488.3 | 2154784.4 | 668.64 | 669.89 | 35-50 | 13.23 | 656.66 | 18.17 | 651.72 |
| Deep Bedrock | 12MW05D | Apr-03 | Active | 388626.9 | 2154839.7 | 670.77 | 670.16 | 81-85 | 13.49 | 656.67 | 18.43 | 651.73 |
| | 12MW07D | Apr-03 | Active | 388607.0 | 2154794.9 | 671.12 | 670.33 | 66-76 | 13.97 | 656.36 | 18.75 | 651.58 |
| | 12MW09D | Mar-03 | Active | 388471.0 | 2154914.8 | 669.76 | 671.26 | 80-90 | 0.36 | 670.9 | 4.63 | 666.63 |
| | 12MW11D | Mar-03 | Active | 388544.0 | 2154978.9 | 669.51 | 671.66 | 63-83 | 1.55 | 670.11 | 5.75 | 665.91 |
| | 12MW17D | Aug-03 | Active | 388638.4 | 2154804.0 | 671.20 | 670.54 | 65-85 | 14.01 | 656.53 | 18.17 | 652.37 |
| | 12MW20D | Nov-06 | Active | 388520.5 | 2154895.0 | 668.60 | 668.15 | 76-86 | 9.85 | 658.3 | 13.95 | 654.2 |
| | 12MW21D | Nov-06 | Active | 388511.4 | 2154934.2 | 667.99 | 670.16 | 74-84 | 3.02 | 667.14 | 6.93 | 663.23 |
| | 12MW22D | Nov-06 | Active | 388416.2 | 2154896.7 | 666.06 | 668.67 | 73-83 | 0.20 | 668.47 | 4.21 | 664.46 |
| | 11GW11D | Sep-98 | Active | 388488.3 | 2154784.4 | 668.64 | 669.75 | 130-140 | 11.89 | 657.86 | 17.01 | 652.74 |

**Notes:**

Horizontal Datum = West Virginia State Plane, North Zone, NAD83(91), US feet

Vertical Datum = NGVD 29, US feet

1 = Top of Casing Elevation (feet)

**TABLE 3-2**
Packer Sampling Intervals
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Sampling Order | Well | Depth1 | Depth 2 | Depth 3 |
|---|---|---|---|---|
| 1 | 12MW13SD | **36' -46'** | | |
| 2 | 12MW17SD | **26' -36'** | 62' -72' | 78' -88' |
| 3 | 12MW11SD | **42' -52'** | **60' -70'** | 78' -88' |
| 4 | 12MW07SD | 50' -60' | 66' -76' | -- |
| 5 | 12MW05SD | 66' -76' | 80' -90' | -- |
| 6 | 12MW04SD | 50' -60' | 66' -76' | -- |
| 7 | 12MW09SD | 60' -70' | 80' -90' | -- |

**Bold** intervals were sampled during the week of January 19, 2004; non-bold intervals were not sampled because the packer assembly was unable to maintain an adequate seal

**TABLE 3-3**
Aquifer Test Data
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Elapsed Time (minutes) | Pump Rate (gpm) | Observation Well ID | | | |
|---|---|---|---|---|---|
| | | 12MW02 | 12MW04S/D | 12MW09S/D | 12MW08 |
| | | Drawdown (feet) | | | |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | 10 | - | - | 5.4 | - |
| 26 | 20 | - | - | 13.3 | - |
| 45 | 25 | 0.18 | 1.28 | 15.15 | 9.29 |
| 60 | 32 | 0.27 | 1.26 | 17.95 | Dry |
| 75 | 32 | 0.26 | 1.29 | 15.95 | 9.71 |
| 90 | 32 | 0.33 | 1.32 | 16.73 | 9.86 |
| 105 | 32 | 0.33 | 1.37 | 17.29 | 9.79 |
| 120 | 32 | 0.36 | 1.39 | 17.06 | 9.9 |

**TABLE 3-4**
Dye Test Results
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Dye Monitoring Locations | Depth | Pre-Injection Sample Results (ppb) | | Post-Injection Sample Results (ppb) | | | Post-Injection Sample Results (concentration per day of exposure) (ppb) | | |
|---|---|---|---|---|---|---|---|---|---|
| **Site 11/12** | | 10/19/2004 | 11/3/2004 | 11/11/2004 | 11/24/2004 | 12/9/2004 | 11/11/2004 | 11/24/2004 | 12/9/2004 |
| 11GW11D-135 | 135 | X | X | 2.4 | ND | 0.512 | 0.34 | ND | 0.03 |
| 11GW11S-40 | 40 | X | X | 2.32 | 0.728 | 0.547 | 0.33 | 0.06 | 0.04 |
| 12MW02-17 | 17 | X | X | 21.3 | 4.91 | 22 | 3.04 | 0.38 | 1.47 |
| 12MW04S/D-50 | 50 | X | X | 7.3 | 18.5 | 6.02 | 1.04 | 1.42 | 0.40 |
| 12MW04S/D-80 | 80 | X | X | 5.66 | 4.55 | 6.9 | 0.81 | 0.35 | 0.46 |
| 12MW05S/D-41 | 41 | ND | ND | 6.79 | 1.15 | 3.63 | 0.97 | 0.09 | 0.24 |
| 12MW05S/D-80 | 80 | ND | ND | 15 | 1.65 | 2.34 | 2.14 | 0.13 | 0.16 |
| 12MW07S/D-60 | 60 | X | X | 3.19 | ND | 0.937 | 0.46 | ND | 0.06 |
| 12MW07S/D-75 | 75 | X | X | 1.7 | ND | 0.784 | 0.24 | ND | 0.05 |
| 12MW08-17 | 17 | ND | ND | 105 | 532 | 192 | 15.00 | 40.92 | 12.80 |
| 12MW10-27 | 27 | X | X | 17.9 | 1,410 | 3,900 | 2.56 | 108.46 | 260.00 |
| 12MW11S/D-50 | 50 | X | X | ND | ND | 0.594 | ND | ND | 0.04 |
| 12MW11S/D-80 | 80 | X | X | ND | ND | 1.07 | ND | ND | 0.07 |
| 12MW13S/D-41 | 41 | X | X | ND | ND | ND | ND | ND | ND |
| 12MW17S/D-32 | 32 | X | X | 5.34 | 0.965 | 1.13 | 0.76 | 0.07 | 0.08 |
| 12MW17S/D-80 | 80 | X | X | 4.17 | 0.663 | 1.01 | 0.60 | 0.05 | 0.07 |
| 12MW18S/D-20 | 20 | X | X | ND | 1.33 | 2.2 | ND | 0.10 | 0.15 |
| 12MW19-20 | 20 | ND | ND | ND | ND | ND | ND | ND | ND |
| **Site 1** | | 10/19/2004 | 11/3/2004 | 11/11/2004 | 11/24/2004 | 12/9/2004 | 11/11/2004 | 11/24/2004 | 12/9/2004 |
| 1GW40-59 | 59 | ND | ND | 2.36 | ND | 0.907 | 0.34 | ND | 0.06 |
| 1EW23-0 | -- | X | X | ND | ND | ND | ND | ND | ND |
| 1EW28-0 | -- | X | X | ND | ND | ND | ND | ND | ND |
| **North Branch Potomac River** | | 10/19/2004 | 11/3/2004 | 11/11/2004 | 11/24/2004 | 12/9/2004 | 11/11/2004 | 11/24/2004 | 12/9/2004 |
| River Sample 1 | -- | 0.639 | ND | 1.07 | 2.32 | ND | 0.15 | 0.18 | ND |
| River Sample 2 | -- | 0.607 | ND | 1.21 | 1.84 | 1.27 | 0.17 | 0.14 | 0.08 |
| River Sample 3 | -- | 0.71 | ND | 1.06 | 7.87 | 1.08 | 0.15 | 0.61 | 0.07 |

**Notes:**
ND = Non-Detect
x = Not Sampled
1.84 = A fluorescence peak is present that does not meet all criteria for a positive dye result.

**TABLE 3-5**
Monitoring Well Sampling Dates and Parameters
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

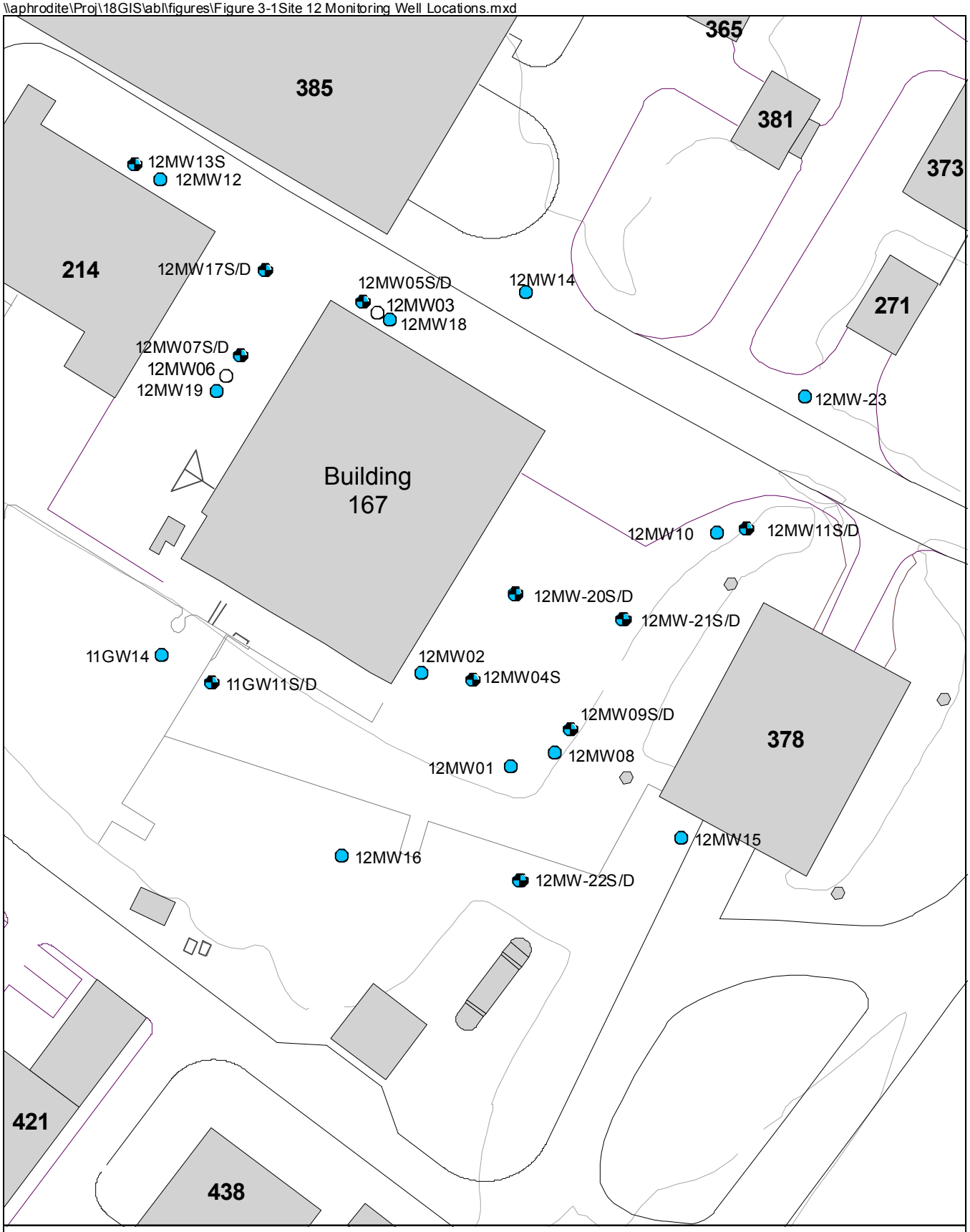
| | Well ID | Sampling Date | VOC | SVOC | Explosives | Total Metals | Dissolved Metals |
|---|---|---|---|---|---|---|---|
| Alluvial | 12MW01 | 09/11/03 | X | X | X | X | X |
| | | 06/01/05 | X | X | X | X | X |
| | | 12/07/06 | X | | | | |
| | 12MW02 | 09/11/03 | X | X | X | X | X |
| | | 06/01/05 | X | X | X | X | X |
| | | 12/07/06 | X | | | | |
| | 12MW03 | | | | | | |
| | 12MW06 | 07/10/03 | X | | | | |
| | 12MW08 | 07/09/03 | X | | | | |
| | | 09/15/03 | X | X | X | X | X |
| | | 06/02/05 | X | X | X | X | X |
| | | 12/07/06 | X | | | | |
| | | 06/11/07 | X | X | X | X | X |
| | 12MW10 | 07/09/03 | X | | | | |
| | | 09/12/03 | X | X | X | X | X |
| | | 05/28/05 | X | X | X | X | X |
| | | 12/07/06 | X | | | | |
| | | 06/12/07 | X | X | X | X | X |
| | 12MW12 | 09/11/03 | X | X | X | X | X |
| | | 05/24/05 | X | X | X | X | X |
| | 12MW14 | 09/11/03 | X | X | X | X | X |
| | | 05/26/05 | X | X | X | X | X |
| | 12MW15 | 07/10/03 | X | | | | |
| | | 09/15/03 | X | X | X | X | X |
| | | 05/28/05 | X | X | X | X | X |
| | | 12/07/06 | X | | | | |
| | 12MW16 | 07/10/03 | X | | | | |
| | | 09/12/03 | X | X | X | X | X |
| | | 06/01/05 | X | X | X | X | X |
| | | 12/06/06 | X | | | | |
| | | 06/13/07 | X | X | X | X | X |
| | 12MW18 | 09/11/03 | X | X | X | X | X |
| | | 05/26/05 | X | X | X | X | X |
| | | 06/12/07 | X | X | X | X | X |
| | 12MW19 | 09/12/03 | X | X | X | X | X |
| | | 05/25/05 | X | X | X | X | X |
| | | 06/12/07 | X | X | X | X | X |
| | 12MW23 | 12/06/06 | X | | | | |
| | | 06/12/07 | X | X | X | X | X |

**TABLE 3-5**
Monitoring Well Sampling Dates and Parameters
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| | Well ID | Sampling Date | VOC | SVOC | Explosives | Total Metals | Dissolved Metals |
|---|---|---|---|---|---|---|---|
| Shallow Bedrock | 12MW04S | 06/01/05 | X | X | X | X | X |
| | | 12/07/06 | X | | | | |
| | 12MW05S | 05/26/05 | X | X | X | X | X |
| | | 06/13/07 | X | X | X | X | X |
| | 12MW07S | 05/25/05 | X | X | X | X | X |
| | | 06/12/07 | X | X | X | X | X |
| | 12MW09S | 06/02/05 | X | X | X | X | X |
| | | 12/07/06 | X | | | | |
| | | 06/11/07 | X | X | X | X | X |
| | 12MW11S | 06/02/05 | X | X | X | X | X |
| | | 12/07/06 | X | | | | |
| | | 06/13/07 | X | X | X | X | X |
| | 12MW13S | 05/23/05 | X | X | X | X | X |
| | 12MW17S | 05/24/05 | X | X | X | X | X |
| | | 06/12/07 | X | X | X | X | X |
| | 12MW20S | 12/06/06 | X | | | | |
| | 12MW21S | 12/06/06 | X | | | | |
| | | 06/11/07 | X | X | X | X | X |
| | 12MW22S | 12/06/06 | X | | | | |
| | | 06/13/07 | X | X | X | X | X |
| Deep Bedrock | 12MW05D | 05/26/05 | X | X | X | X | X |
| | | 06/13/07 | X | X | X | X | X |
| | 12MW07D | 05/25/05 | X | X | X | X | X |
| | | 06/12/07 | X | X | X | X | X |
| | 12MW09D | 06/02/05 | X | X | X | X | X |
| | | 12/07/06 | X | | | | |
| | | 06/11/07 | X | X | X | X | X |
| | 12MW11D | 05/27/05 | X | X | X | X | X |
| | | 12/07/06 | X | | | | |
| | | 06/12/07 | X | X | X | X | X |
| | 12MW17D | 05/24/05 | X | X | X | X | X |
| | | 06/12/07 | X | X | X | X | X |
| | 12MW20D | 12/07/06 | X | | | | |
| | 12MW21D | 12/06/06 | X | | | | |
| | | 06/11/07 | X | X | X | X | X |
| | 12MW22D | 12/06/06 | X | | | | |
| | | 06/13/07 | X | X | X | X | X |

**Notes:**
X - Indicates sample was collected and analyzed for indicated parameter on that sampling date

\\aphrodite\Proj\18GIS\abl\figures\Figure 3-1Site 12 Monitoring Well Locations.mxd




**Legend**

- Alluvial Monitoring Well
- Bedrock Well
- Abandoned Well
- Steam Lines
- Buildings

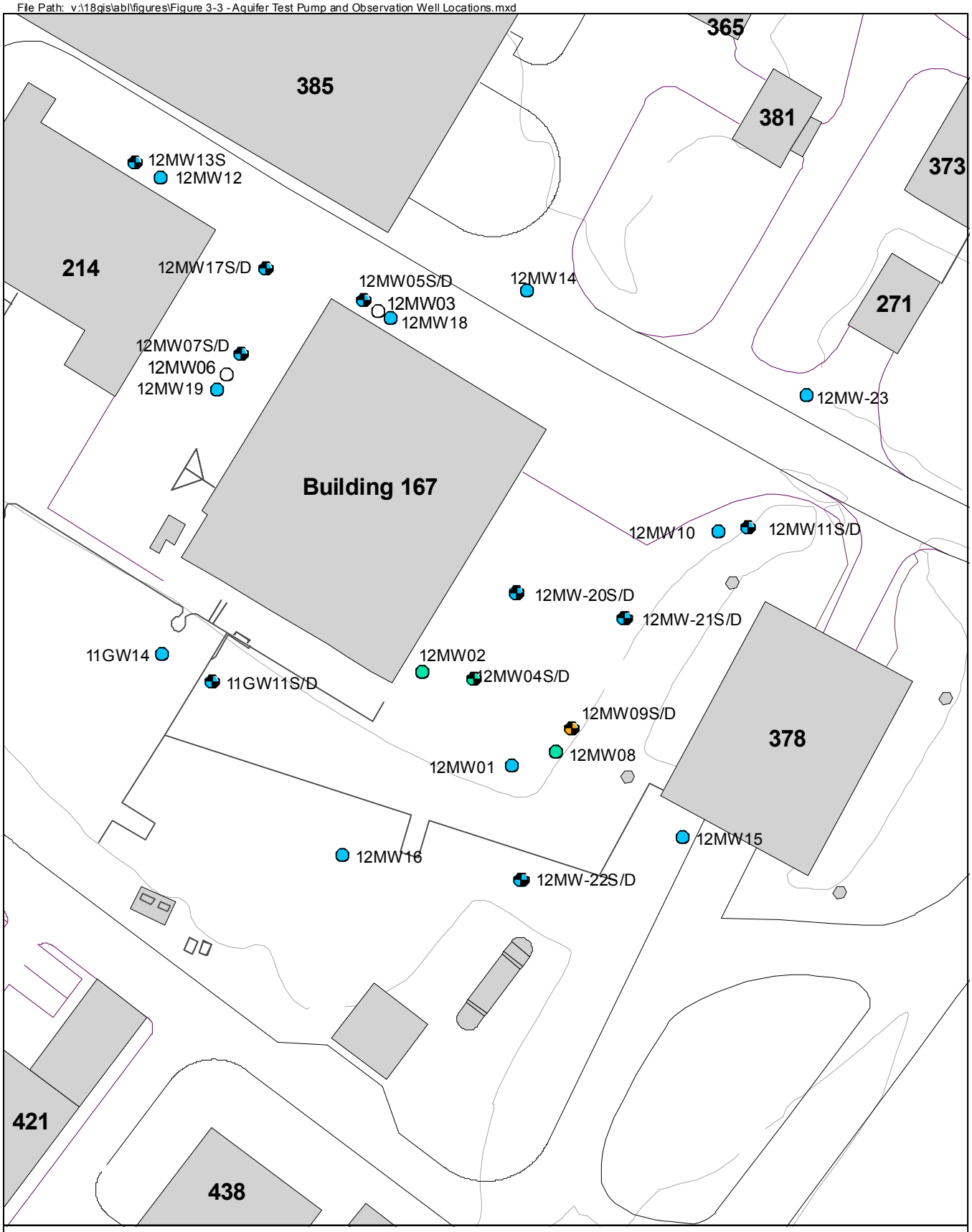
N

0 25 50 100 Feet

Figure 3-1
Site 12 Monitoring Well Locations
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

CH2MHILL

File Path: v:\18gis\abl\figures\Figure 3-3 - Aquifer Test Pump and Observation Well Locations.mxd




**Legend**

- Aquifer Test Observation Well
- Aquifer Test Observation Well
- Alluvial Monitoring Well
- Aquifer Test Pumping Well
- Bedrock Well
- Abandoned Well
- Buildings
- Steam Lines

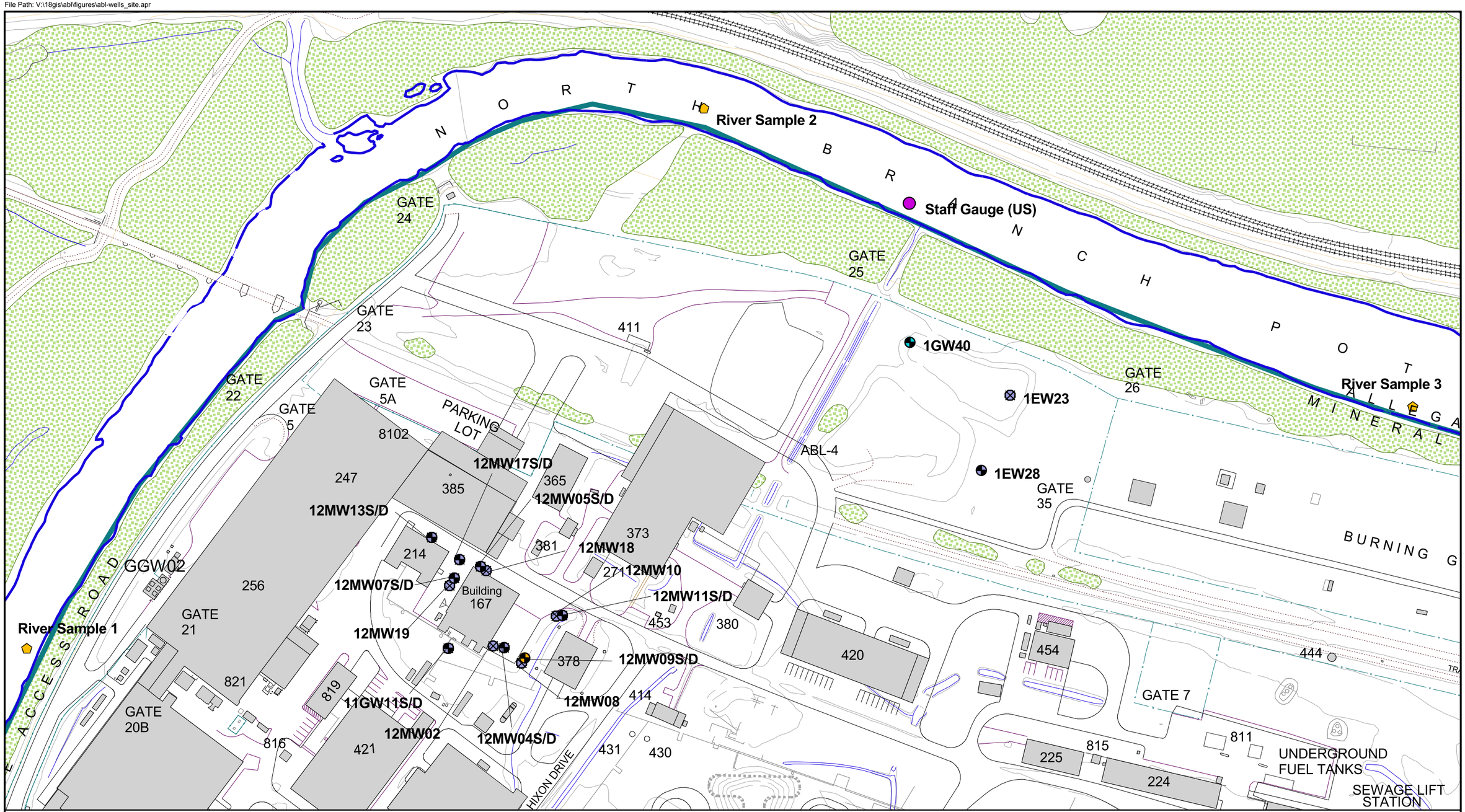
N

0 25 50 Feet

Figure 3-2
Aquifer Test Pump and Observation Well Locations
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

CH2MHILL

File Path: V:\18gis\abl\figures\abl-wells_site.apr




**LEGEND**

**Samples: Groundwater**

- Dye Monitoring Locations - Alluvial Aquifer
- Dye Monitoring Locations - Bedrock Aquifer
- Dye Monitoring Locations - Hybrid Well
- Dye Injection Location
- Staff Gauge
- Dye Monitoring Location - North Branch Potomac River
- Buildings

N

0 80 160 240 320 Feet

Figure 3-3
Dye Study Injection and Monitoring Locations
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

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SECTION 4

# Physical Characterization

The geologic structure in the layered sedimentary rocks that underlie the facility exhibit some control on groundwater flow patterns and the observed distribution of contaminants at Site 12. These regional characteristics are summarized below in order to link the regional geology to site-specific subsurface conditions. Sections 4.2 and 4.3 provide a summary of physical site characterization data. This data is then interpreted with respect to the regional characteristics and hydrogeologic conditions. Hydrogeologic and 3-D conceptual site models (CSM) have been created for Site 12, as discussed in Section 4.3.5

## 4.1 Regional Geology and Hydrogeology

ABL is located on the floodplain of the North Branch Potomac River and is flanked by Knobly Mountain to the south and east. The facility is immediately underlain by sediments that are characterized as overbank (floodplain) and channel deposits related to fluvial sedimentation within the North Branch Potomac River basin. These sediments appear to be consistently stratified across the facility and generally comprise an upper silt and clay layer underlain by coarser deposits of sand and gravel (CH2M HILL, 1996b).

Silurian and Devonian age limestone and shale immediately underlie the sand and gravel deposits (CH2M HILL, 1996b). Limestone appears to be the dominant lithology beneath the western third of the facility, where Site 12 is located, and the remaining portion of the facility is underlain primarily by shale. The western third of the facility also lies on the upright to overturned limb of the Willis Mountain Anticline. The near vertical bedding planes of the limb are oriented sub-parallel to the northeast trend of the anticlinal fold axis (CH2M HILL, 1996b). The dominant fracture set in the bedrock trends N26°E and a set of subordinate fractures trend N39°W. Down-hole camera work in bedrock wells on the facility suggest that the fractures dip steeply at angles of 70 to 90° (CH2M HILL, 1996b).

The saturated portion of the alluvial sediments forms the alluvial aquifer, which is an extensive hydrogeologic unit beneath the facility. On a facility-wide basis, groundwater in the alluvial aquifer flows north and west toward the North Branch Potomac River (CH2M HILL, 1996b). Slug tests conducted in alluvial wells suggest that there are local variations in the hydraulic conductivity of the aquifer, which is primarily caused by heterogeneity within the alluvial deposits. The hydraulic conductivity tends to be higher where gravels are encountered near the base of the alluvium than in locations where a gravel layer is thin or absent. Likely due to this heterogeneity, conductivity estimates in the aquifer range from 0.04 to 15 feet/day.

The bedrock aquifer forms the second major hydrogeologic unit beneath the facility. Groundwater flow in the bedrock aquifer is likely confined to fractures and limestone solution cavities, but the regional groundwater flow pattern and direction are generally similar to the alluvial aquifer (CH2M HILL, 1996b). Transmissivity in the bedrock aquifer was estimated at 2,000 to 6,300 gallons per day per foot, but may be variable depending on

the size, frequency, and orientation of the fracture sets. Hydrogeologic data also suggest an interconnection between the alluvial and bedrock aquifers. The vertical hydraulic gradient appears to vary locally, but is predominately in the downward direction on a regional scale.

## 4.2 Site 12 Geology

The geology beneath Site 12 comprises unconsolidated deposits that directly overlie bedrock. The characteristics and stratigraphy of the unconsolidated deposits at Site 12 are similar to the alluvial deposits that are encountered across the facility. The site-specific characteristics of the alluvial sediments and bedrock are discussed in Sections 4.2.1 and 4.2.2, respectively.

### 4.2.1 Alluvial Deposits

The upper portion of the alluvial deposits at Site 12 comprises a unit of clay. The clay is generally described in the field as a yellowish brown to brown, lean clay, sandy clay or silty clay. Shallow (<10 feet) portions of the clay are soft to stiff, medium plastic, and may contain trace amounts of gravel and sand. The percentage of sand and gravel tends to increase with depth and the clay unit grades into the underlying sand and gravel deposits. The basal contact of the clay is not well defined due to its gradational nature, but the contact appears to exist within the depth range of 10 to 15 feet below grade.

A unit of sand and gravel directly underlies the clay at Site 12. The sand and gravel unit is yellowish brown to brown and is heterogeneous. Typical field classifications of the unit include well-graded gravel, poorly-graded gravel, gravelly sand, clayey gravel, and well-graded sand with clay and gravel. Fine to coarse sand and fine to coarse gravel are encountered in the unit and occasional cobbles are noted on boring logs. A coarsening downward sequence with cobbles or large gravel was present at the base of alluvial aquifer. The sand and gravel unit is directly underlain by bedrock across the site and appears to extend to a maximum depth of about 30 feet below grade near well location 12MW20S/D.

### 4.2.2 Bedrock

At Site 12, bedrock is encountered at depths ranging from 12 to 30 feet below grade and the bedrock surface slopes generally northward and toward the central portion of the site (Figure 4-1). Field observations of air rotary cuttings suggest that dark gray to black limestone underlies much of Site 12. Calcite veins are common in the limestone and the general frequency of the veins appears to increase toward the northwestern portion of the site. In the northwestern portion of the site, the bedrock encountered at boreholes 12MW13S and 12MW17S/D was identified as black shale, although the log for 12MW13S states that the rock may possibly be classified as fissile (or fractured) limestone.

Near vertical bedding planes and subhorizontal fractures of limited extent were observed during downhole camera work performed at the adjacent Site 11 (CH2M HILL, 2005f). The magnitude and frequency of the fracture sets at Site 12 was assessed through the use of geophysical logs and field observations. These data suggest that highly fractured and/or friable bedrock exists beneath the central and northwestern portions of the site and that the remaining area of the site is underlain by relatively competent bedrock. These assertions are based on the fact that larger deflections were observed in caliper logs for boreholes

12MW07S, 12MW13S, 12MW17S, and 12MW22S. Deflections recorded in these logs were generally greater that one inch and are interpreted as the location of significant fracture zones. Minimal caliper deflections (<0.5 inches) were observed in boreholes 12MW04S, 12MW05S, 12MW09S, 12MW11S, 12MW20S and 12MW22S. These logs are interpreted to represent relatively intact bedrock.

The interpretation of the caliper data is supported by field observations of notable fractures in boreholes 12MW13S, 12MW17S/D, and 12MW22S/D and observations of friable bedrock to depth at location 12MW20S/D. In addition, the fractures at 12MW13S and 12MW17S/D produced large volumes of water that tended to overwhelm the available pumps and tank storage capacity. Flow rates observed in these boreholes were on the order of 60 to 80 gpm. In contrast, minimal fractures with lower water production rates were noted in boreholes 12MW04S/D, 12MW05S/D, 12MW07S/D, and 12MW11S/D and competent bedrock was noted during installation of 12MW09S/D and 12MW21S/D.

The conductivity and temperature logs also support the data presented above. Fluctuations in these parameters with depth were generally observed in boreholes located on the southeast portions of the site, whereas these parameters were generally stable in wells located on the northwest portion of the site. The constant temperature and conductivity profiles observed in wells on the northwest portion of the site may have resulted from the influx of water from one or two major water bearing fractures. In this case, these parameters would stabilize if the water were derived from a single source. Fluctuations in these parameters observed in the remaining wells may indicate the influx of bedrock groundwater from a less interconnected, and more likely isolated, smaller sets of fractures.

The available geophysical data for Site 12 includes impeller flow logs, heat pulse logs and gamma logs. The heat pulse and impeller logs indicate the direction of groundwater flow in the borehole. Heat pulse logs are able to detect relatively low flow rates and the impeller logs are recorded under static and pumping conditions. Both flow logging techniques indicate that groundwater generally flows in the upward direction across the site at relatively constant rates. Gamma logs were recorded in 12MW20S/D, 12MW21S/D and 12MW22S/D and are used to assess lithologic change with depth in the borehole. The low gamma counts (<60 counts per second [cps]) are consistent with the identification of limestone at these locations and the relatively constant gamma values indicate that no significant changes in lithology are present.

## 4.3 Site 12 Hydrogeology

Similar to the facility-wide hydrogeologic regime at ABL, the alluvium and bedrock that underlie Site 12 form two hydrogeologic units, which are discussed below as the alluvial aquifer and the bedrock aquifer, respectively. As described in Section 3 and summarized below, the Site 12 monitoring wells are screened at the base of the alluvial aquifer or are screened across shallow or deep bedrock fracture zones. The design of the monitoring well network has allowed aquifer specific characteristics to be determined through the tasks conducted during the RI. These tasks have included synoptic water level measurements, aquifer testing, a dye study, and groundwater sampling. The results from each of these tasks are summarized below.

### 4.3.1 Potentiometric Surfaces

A relatively consistent pattern of potentiometric surfaces in the alluvial and bedrock aquifers has been identified during the RI tasks at Site 12. The round of synoptic groundwater measurements collected on March 16, 2007 is considered to be the most representative data set, because this round included measurements from all available monitoring wells. The discussion presented below was primarily derived from analysis of the March 2007 groundwater elevation measurements. However, information from other synoptic water-level measurement events supports the findings from the March 2007 event.

#### 4.3.1.1 Alluvial Aquifer

During the March 2007 event, groundwater elevations in the alluvial wells ranged from a maximum of 667.01 feet above mean sea level (feet MSL) (12MW15) to a minimum of 656.45 feet MSL (12MW12) (Table 3-1). Near-flowing artesian conditions were observed in 12MW15, where groundwater was measured at 0.24 feet below grade. Contours of the groundwater elevation data show that the alluvial water table decreases in elevation to the north and northwest from the high point at 12MW15 (Figure 4-2). The groundwater elevation appears to decrease at a relatively consistent gradient of 0.05 foot/foot toward the northwest portion of the site, where the gradient flattens in the vicinity of wells 12MW12, 12MW18, and 12MW19. The November 2007 alluvial groundwater elevation data show a regional picture of alluvial groundwater elevation contours; these contours are consistent with the March 2007 data (Figure 4-3).

#### 4.3.1.2 Bedrock Aquifer

In March 2007, groundwater elevations in the shallow bedrock wells ranged from a maximum of 669.51 feet MSL (12MW09S) to a minimum of 656.41 feet MSL (12MW17S) (Table 3-1). Flowing artesian conditions were observed in 12MW22S. Contours of the shallow bedrock data show that the groundwater elevations decrease in a northwesterly direction from a high point located in the southeast portion of the site at 12MW09S (Figure 4-4). The groundwater gradient is steep (0.2 foot/foot) from 12MW09S to 12MW20S and shallows (0.01 foot/foot) from 12MW20S to 12MW17S. The November 2007 data is consistent with the March 2007 groundwater elevation contours and shows how the contours extend to the south (Figure 4-5).

The March 2007 groundwater elevations in the deep bedrock wells ranged from a maximum of 670.11 feet MSL (12MW11D) to a minimum of 656.36 feet MSL (12MW07D) (Table 3-1). Flowing artesian conditions were observed in wells 12MW09D, 12MW11D, and 12MW22D. The measured groundwater in 12MW22D was approximately 2.4 feet above ground surface. Contours of the deep bedrock data show that groundwater elevations decrease to the northwest from a high point located at the southeast portion of the site (Figure 4-6). Similar to the shallow bedrock elevation data the groundwater gradient is steep (0.23 foot/foot) from approximately 12MW09D to 12MW20D and the gradient shallows (0.01 foot/foot) from 12MW20D to approximately 12MW17D. Again, the regional data collected in November 2007 are consistent with the March 2007 groundwater elevation contours and show how the contours extend to the south (Figure 4-7).

The pattern of the contoured groundwater elevation data in the shallow and deep bedrock fractures is generally very similar. Both maps show decreasing elevation to the northwest

and steep gradients on the southeast portion of the site that shallow to the northwest of well location 12MW20S/D. In all but two locations, 12MW07S/D and 12MW20S/D, the groundwater elevation measured in the deep wells is higher than the elevation measured in the shallow wells. At five well locations, the elevation difference is less than 0.32 foot. For all but one of the remaining wells (12MW11D difference = 4.37 feet), the elevation difference range is less than 1.65 feet. The magnitude of elevation difference shows no spatial correlations and the differences are likely due to local variations in fracture density. The bedrock groundwater elevation data demonstrate that groundwater flow conditions are similar throughout the aquifer in both shallow and deep fracture zones. Therefore, to simplify the comparison presented below, the contours of the deep bedrock wells are used to represent overall conditions in the bedrock aquifer.

#### 4.3.1.3 Comparison of Potentiometric Surfaces

The potentiometric surface maps show that groundwater elevations in the alluvial aquifer and bedrock aquifer generally decrease toward the northwest portion of the site (Figure 4-8). However, the contours are not interpreted to represent northwest directed groundwater flow in both aquifers. Because groundwater in the alluvial aquifer is flowing through unconfined, unconsolidated deposits, the groundwater elevation contours do represent north and northwest directed flow through this aquifer. This interpretation is consistent with the facility-wide alluvial groundwater flow pattern and is consistent with historic determinations of alluvial groundwater flow at Site 12 (CH2M HILL, 1996b; CH2M HILL, 2003b; CH2M HILL, 2003c). In contrast, groundwater flow in the bedrock aquifer is likely controlled primarily by the orientation and density of fractures in the bedrock. Because a variable fracture density exists at Site 12, the potentiometric surface contours may not represent that primary direction or magnitude of groundwater flow in this aquifer. The potentiometric surface contours suggest bedrock groundwater flows to the northwest (parallel to subordinate fractures that trend N39°W). It is more likely however that the migration pathway for bedrock groundwater is northeast to the North Branch Potomac River, through the prominent fracture zones located beneath the northwest portion of the site. These fractures trend N26°E, as previously discussed in Section 4.1.

The potentiometric surface map also shows the largest difference in hydraulic head between the alluvial and bedrock aquifers (upward) occurs near the southeast corner of the site (Figure 4-8), with declining magnitude of difference toward the northwest. This pattern suggests a potential upward discharge of bedrock groundwater to the alluvial aquifer in this portion of the site. This interpretation is supported by the upward flow observed in bedrock boreholes, as indicated by heat pulse and impeller flow data, and by the fact that artesian conditions are observed in bedrock wells located along the southeast boundary of the site. Furthermore, the dye test results show that bedrock groundwater flows from 12MW09S/D to the alluvium.

Northwest of well 12MW20S/D, the flow patterns in both aquifers appear to change relative to conditions observed in the southeast portion of the site. The alluvial groundwater "mound" dissipates rapidly to the northwest of this well location and the bedrock groundwater gradient declines. In addition, the groundwater elevations in the alluvial and bedrock wells located northwest of 12MW20S/D are nearly equal or indicate a downward component of flow. The change in flow conditions in the vicinity of 12MW20S/D suggests

that upward flow from bedrock to the alluvial aquifer is a local phenomenon and that a change in fracture orientation or density may occur in the vicinity of this well location.

Table 4-1 summarizes wells where a comparison can be made of the vertical gradient because bedrock and/or alluvial wells are clustered together in one area. Refer to Figure 3-1 for monitoring well locations. Overall, an upward flow from bedrock to the alluvial aquifer is noticeable in wells located farther to the east/southeast and a downward flow from the alluvial aquifer to bedrock in wells located farther to the west.

### 4.3.2 Correlation of Water Levels to Gage Height in the Potomac River

Water levels at Site 12 were compared with stream gage heights to see if the groundwater levels correlate with fluctuation of water levels in North Branch Potomac River. Flow in the river is regulated by a dam located 29 miles upstream at Jennings Randolph Lake. The dam controlled flow yields a cyclic pattern of river heights that is dependant on the timing of water release at the dam (Figure 4-9).

In the comparison, water levels from the March 2007 event were compared with the river elevation based on data from the U.S. Geological Survey gauging station located at Pinto, Maryland. The gauging station is located approximately 600 feet north of the northern boundary of Site 12. The gage data indicate that there was an increase in river elevation just prior to the monitoring round (Figure 4-9). The maximum gage height on March 16 was 5.55 feet, which converts to an elevation of 653.78 feet MSL using a vertical datum of NGV29. The difference between groundwater elevations and the maximum river elevation on March 16, 2007 was plotted. As shown in Figures 4-10 and 4-11, these plots yield patterns that are similar to the potentiometric maps. In the southeast portion of the site the groundwater was up to 15.5 feet higher than the river elevation. To the northwest, the groundwater elevations are approximately 3 to 4 feet above the river elevation.

Facility-wide groundwater maps show that a difference of 2 to 5 feet between groundwater level and the river is a reasonable estimate of the local groundwater gradient (CH2M HILL, 1996b). Therefore, groundwater elevations from monitoring wells on the northwest portion of the site most likely reflect the facility-wide groundwater gradient. Groundwater elevations in the southeast portion of the site appear to be unrelated to local river levels. The amount of head difference suggests that little hydraulic connection exists between bedrock fractures on the southeast portion of the site and local segments of the river.

### 4.3.3 Aquifer Yield Test Results

The yield test was primarily designed to assess the hydraulic connection between the alluvial and bedrock aquifers and on a limited scale the interconnection of water bearing fractures within the bedrock aquifer. Results from the test show that drawdown was observed in all observation wells (Table 3-3). From 90 minutes after start-up until the end of the test, during the time the test was conducted at a constant rate, the difference in the drawdown measurements in the observation wells was less than 0.07 foot and in the pumping well the difference was 0.33 foot.

Results from the aquifer test suggest that there is hydraulic connection between the alluvium and bedrock aquifers at Site 12 (CH2M HILL, 2005e). In addition, the results also suggest that there is some degree of hydraulic connection within the bedrock aquifer as

well. However, because the pump was set in an open borehole and the yield test was performed prior to the construction of the associated Site 12 bedrock wells, the interconnection between the shallow and deep fracture zones cannot be assessed. Despite the fact that the test was conducted on a limited scale, it was conducted in a key area of the site near the alluvial groundwater mound and does lend support to the Site 12 hydrogeologic CSM, as discussed in Section 4.3.5.

### 4.3.4 Dye Test Results

The dye test results provide additional information on the hydraulic interconnection of the aquifers beneath Site 12. However, unlike the aquifer test, the dye test results provide a better assessment of groundwater and contaminant migration pathways because the test was conducted under conditions that are essentially static (i.e., un-influenced by pumping). Results from the test show that dye was not detected in groundwater during the pre-injection sampling events and that dye was detected in nearly all of the monitoring wells during the post-injection monitoring events (Table 3-4).

As described in Section 3.6, dye was injected at the suspected source area into the bedrock borehole of well 12MW09S/D. The dye test results reveal that dye concentrations in alluvial wells 12MW08 and 12MW10 were orders of magnitude greater than concentrations in the bedrock wells (Figure 4-12). In addition, the dye concentration in these alluvial wells was sustained throughout the study and actually increased in 12MW10. Dye concentrations of roughly the same order of magnitude as the bedrock wells were detected in alluvial wells 12MW18 and 12MW02 and no dye was detected at 12MW19. The results also indicate that dispersion of the dye into the alluvial aquifer occurred rapidly, as dye was detected 7 days after injection.

The dye also dispersed into the bedrock aquifer and the maximum detections were present at 7 days after injection in most of the bedrock wells, with the exception of 12MW11S/D, 12MW13S/D, and 12MW18S/D. The concentration of dye in many of the bedrock wells reached a maximum approximately 14 days after injection and was nearly the same or less than the initial concentration at 21 days after injection. Dye concentrations were roughly the same order of magnitude in the shallow and deep monitoring points, within the same borehole, and the dye was detected within the same time frame for both depths (i.e., dye was detected only at 21 days after injection at both monitoring depths in 12MW11S/D). Dye was also detected in one bedrock monitoring well at Site 1 (1EW35), which is located approximately along strike of the principal bedrock fracture orientation. The well completion diagram and groundwater analytical results and from well 1EW35 (later renamed as 1GW40) can be found in Appendix A and Appendix C, respectively.

The interconnection between Site 12 and Site 1 has been examined to determine if groundwater contaminants have the potential to migrate from Site 12 to Site 1. TCE was detected in well 1GW40 in August 2000, at a concentration of 14 µg/L. At Site 12 TCE concentrations drop below detection limits prior to reaching the site boundaries. Other Site 12 contaminants (i.e., methylene chloride) have not been detected in 1GW40. Therefore, it is not believed that contamination at Site 12 is migrating to Site 1 via fracture flow or other mechanisms.

Dye appears to have also been detected at monitoring points located in the North Branch Potomac River. However, a fluorescence peak that does not meet all criteria for a positive

dye detection was observed during analysis of the first pre-injection samples collected from these locations. The same peak was not observed during the second pre-injection monitoring event, but it was observed again during all post-injection monitoring events. Dye concentration are roughly the same magnitude as concentrations detected in bedrock groundwater, but it is difficult to accurately determine if the dye concentrations detected in the river resulted from dye injection activities at Site 12. The fact that the fluorescence peak was observed in the pre-injection sample and all post-injection samples at River Sample Location 1 (RS1) suggests that the observed peak is not a product of dye in the sample, since RS1 is located due west and not likely hydraulically downgradient of Site 12 (Figure 3-3).

The dye test results suggest interconnection between the alluvial and bedrock aquifers at Site 12. The elevated concentrations of dye detected in alluvial wells 12MW08 and 12MW10 suggest that upward flow from the bedrock aquifer into the alluvial aquifer may be the primary direction of groundwater movement in the vicinity of the injection point (12MW09S/D). The fact that the dye concentrations in these two alluvial wells increased throughout the study period suggests that the dye was transported by groundwater flow and was not forced into the aquifer by the injection mechanism. This upward mode of flow is likely only applicable to dissolved constituents, to buoyant, or neutrally buoyant substances like fluorescein dye and may not apply to substances with a specific gravity greater than one.

Dye test results also show hydraulic connection within the bedrock aquifer, although this component of flow may not be as significant as upward flow to the alluvial aquifer. Dye concentrations were generally much lower in the bedrock wells, as compared to concentrations in the alluvial aquifer. Lower dye concentrations in the bedrock could suggest limited flow in the bedrock, but it could also indicate substantial flow and dilution in the bedrock. Dye concentrations of roughly the same magnitude were detected in both the shallow and deep bedrock fracture zones suggesting approximately equal dispersion throughout both zones. Although the dye was injected at a depth of 85 feet in 12MW09S/D, it was subsequently mixed with 1,500 gallons of potable water and its migration was likely not restricted to specific fractures, as the dye injection was performed while 12MW09S/D was still an open boring.

A comparison of the spatial distribution of dye detections with potentiometric surface maps provides additional information for defining groundwater flow patterns at the site. The spatial distribution of dye detections in the alluvial aquifer coincides with and can generally be explained by the direction of alluvial groundwater flow (Figure 4-2). In contrast, the spatial distribution and timing of dye detections is not readily explained by the potentiometric surfaces in the shallow and deep fracture zones, which serves to support the interpretation that the potentiometric surface defined for the bedrock aquifer may not accurately indicate direction of groundwater flow in the aquifer (Figure 4-4). The detection of dye in the bedrock well at Site 1 is significant because it suggests a northeasterly component of groundwater flow, whereas a northwest-directed flow gradient is suggested by the bedrock potentiometric surface maps. Therefore, the characterization of the bedrock aquifer at Site 12 evaluated groundwater along the fracture orientations as well as hydraulically downgradient.

## 4.3.5 Conceptual Site Model

### 4.3.5.1 Hydrogeologic Conceptual Site Model

A comprehensive summary and interpretation of the results presented above is provided by the development of a hydrogeologic CSM for Site 12 (Figures 4-13 and 4-14). The geologic contacts, alluvial lithology, and alluvial water table depicted in the hydrogeologic CSM are based on observations and measurements collected at Site 12. The bedrock lithology, bedding orientations, and location and orientation of fracture zones are mainly interpretative, but are drawn to represent conditions observed elsewhere on the facility. The hydrogeologic CSM is used to predict pathways of groundwater migration and will be used to evaluate the nature and extent of site contaminants. The hydrogeologic CSM is also useful for evaluating potential ecological and human health exposure pathways for contaminants detected in site groundwater.

The bedrock at Site 12 is interpreted to correlate with the Tonoloway Limestone and Wills Creek Formation that crop out across the North Branch Potomac River, to the north of the facility. Both units are oriented nearly vertical to overturned with an average dip of 87° to the southeast. Locally, the Tonoloway Limestone appears in outcrop as 30 to 45 foot thick massive limestone that is interbedded with thinly bedded calcareous shale. The Wills Creek Formation appears in outcrop as a massive 30-foot thick unit composed primarily of limestone with minor amounts of thin interbedded calcareous shale. The shale members in both the Tonoloway and Wills Creek show deformation caused by folding. Joint spacing's and lengths in the massive beds of both units average 3 feet to 6 feet. The majority of joints are subhorizontal. One large sub-horizontal normal fault cutting through both units was observed in the outcrop at Pinto. At the adjacent Site 11, the sub-horizontal fractures appear to be localized in extent as they are not consistently observed in boreholes (CH2M HILL, 2005f). The downhole camera work performed for Site 11 suggests that a greater frequency of fractures and possible faults are present on the western portion of the site, relative to the east portion of the site. In support of the Site 11 RI, a fracture trace analysis was performed at ABL, in which a primary set of fractures was identified that were oriented parallel to bedding in bedrock at N27°E.

The upward movement of bedrock groundwater creates the alluvial groundwater flow patterns that are observed at Site 12. Upward movement of bedrock groundwater is suggested by potentiometric surface maps, borehole flow logs, dye study results, and the presence of artesian conditions along the southeast boundary of the site (Figure 4-11). In addition, hydraulic connection between the alluvial aquifer and the bedrock aquifer is suggested by results from the aquifer test and dye study. The potentiometric surface maps developed for the alluvial aquifer indicate that the upward movement of groundwater in the southeast portion of the site creates a localized "mound" in the alluvial water table (Figure 4-11). The alluvial groundwater subsequently appears to flow outward from the mound in a north to northwest direction. The "mound" dissipates toward the margins of the site and groundwater flow then likely becomes equal to the regional flow gradient. The ultimate discharge point for alluvial groundwater at ABL is the North Branch Potomac River (CH2M HILL, 1996b).

The upward movement of bedrock groundwater at Site 12 is likely caused by a structural and/or unidentified lithologic change in the bedrock beneath the site. Geophysical logs and

field observations suggest that prominent fracture sets are located beneath the northwest portion of the site and the remaining site area is underlain by relatively competent bedrock with a low fracture density. As indicated by potentiometric surface maps developed for the shallow and deep aquifers, the change in bedrock structure appears to occur somewhere to the northwest of monitoring well 12MW20S/D.

The potentiometric head in the bedrock aquifer is likely controlled by groundwater recharge in the mountainous area to the south of the facility. As the groundwater flows from the recharge areas through the bedrock beneath Site 12, it encounters competent bedrock with low fracture density. The hydraulic pressure driving the groundwater movement then forces the groundwater through the available open channels. At Site 12 the primary migration path for the groundwater appears to be up and into the alluvial aquifer (Figure 4-14).

A secondary migration pathway for bedrock groundwater is through the prominent fracture zones located beneath the northwest portion of the site. During drilling activities, it was noted that this area of the bedrock produces a significant amount of flow, on the order of 140 to 180 gpm. The relatively low groundwater elevations observed in this area suggest that these fractures are interconnected with the fractures that control the regional movement of groundwater beneath the facility, northeast towards the North Branch Potomac River. This also correlates to the dye study results, as discussed in Section 4.3.4. These fractures may be responsible for most of offsite migration of groundwater from Site 12.

The hydrogeologic CSM for Site 12 is summarized in Figure 4-14. As shown in this figure, there is an upwelling of groundwater flowing from the mountains to the south, along the fractures, that discharge to the bedrock and cause recharge to and mounding in the alluvium along the eastern boundary of Site 12 (near the source area). This mounded groundwater affects flow in the alluvial aquifer, causing it to migrate toward the west. This alluvial groundwater, as well as groundwater that remains within the bedrock, is captured by the fractures in the northwestern portion of the site and subsequently transported to the northeast, eventually discharging to the North Branch Potomac River.

#### 4.3.5.2 3D Conceptual Site Model

A comprehensive site summary and interpretation of the results presented above is provided in a three-dimensional CSM for Site 12 (Figure 4-15). The 3D visual representation describes the site geology and hydrology, contaminant sources, release mechanisms, exposure pathways and routes, and receptors in the Site 12 RI.

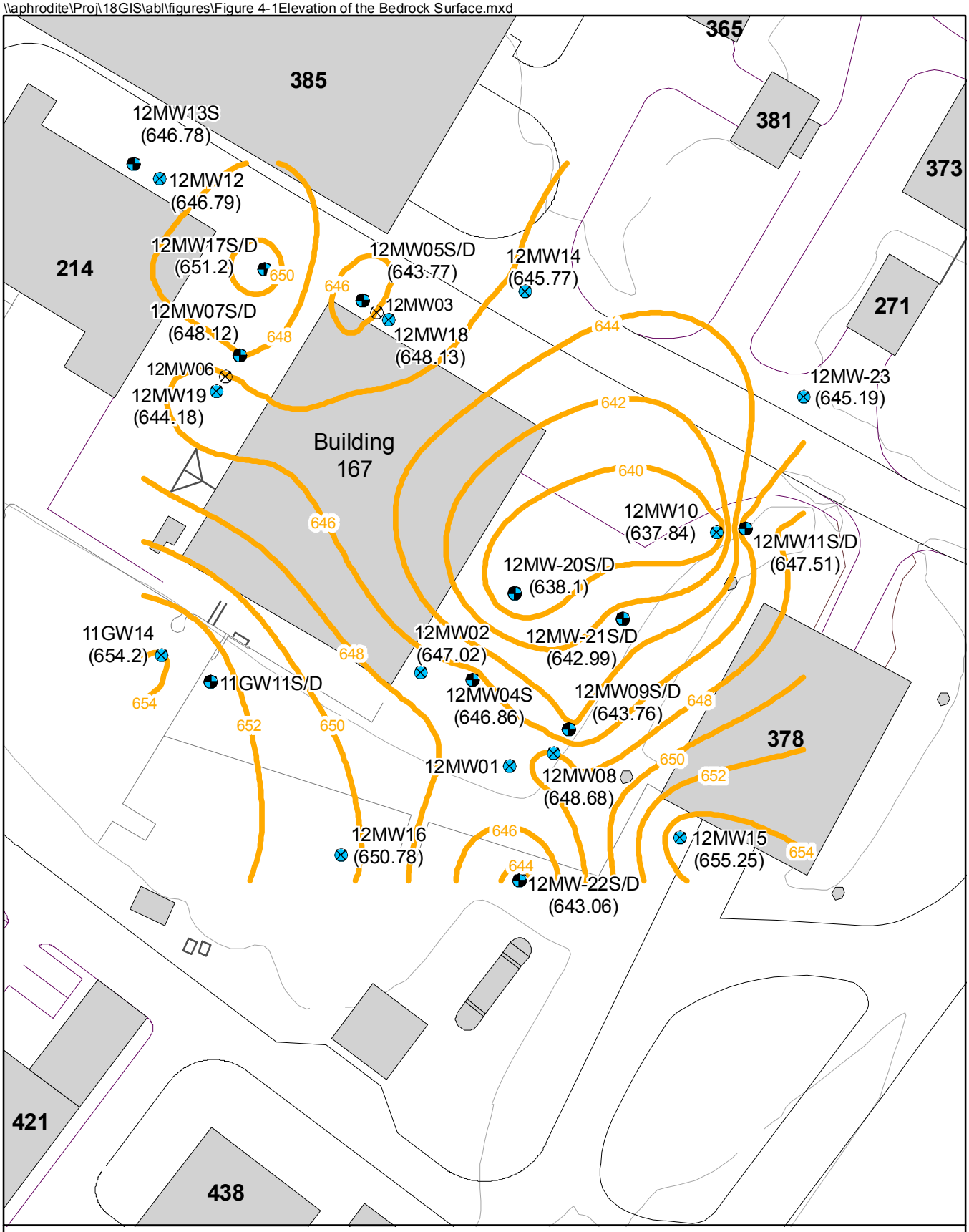
**TABLE 4-1**
Comparison of Potentiometric Gradient in Clustered Groundwater Monitoring Wells
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Well ID | Groundwater Elevation 11/12/2007 | Potentiometric Gradient | Notes |
|---|---|---|---|
| 12MW02 | 661.78 | ↓ | Gradient is from alluvial to shallow bedrock, no deep bedrock well was installed in this well cluster |
| 12MW04S | 656.65 | | |
| 12MW18 | 651.86 | ↓ | Gradient is from alluvial to bedrock, while deep bedrock has a (+) gradient compared to shallow bedrock in this well cluster |
| 12MW05S | 651.7 | | |
| 12MW05D | 651.73 | ↑ | |
| 12MW19 | 651.68 | ↓ | Gradient is from alluvial to bedrock, while deep bedrock has a slightly (+) gradient compared to shallow bedrock in this well cluster |
| 12MW07S | 651.57 | | |
| 12MW07D | 651.58 | ↑ | |
| 12MW12 | 651.54 | ↓ | Gradient is from alluvial to shallow bedrock, no deep bedrock well was installed in this well cluster |
| 12MW13S | 651.44 | | |
| 11GW14 | 654.09 | ↓ | Gradient is from alluvial to bedrock, while deep bedrock has a (+) gradient compared to shallow bedrock in this well cluster |
| 11GW11S | 651.72 | | |
| 11GW11D | 652.74 | ↑ | |
| 12MW08 | 661.7 | ↑ | Gradient is from deep bedrock to shallow bedrock, to alluvial |
| 12MW09S | 665.04 | | |
| 12MW09D | 666.63 | | |
| 12MW10 | 658.76 | ↑ | Gradient is from deep bedrock to shallow bedrock, to alluvial |
| 12MW11S | 661.37 | | |
| 12MW11D | 665.91 | | |
| 12MW17S | 651.49 | ↑ | Gradient is from deep bedrock to shallow bedrock, no alluvial well was installed in this cluster of wells |
| 12MW17D | 652.37 | | |
| 12MW20S | 654.4 | ↑ | Gradient is from shallow bedrock to deep bedrock, no alluvial well was installed in this cluster of wells |
| 12MW20D | 654.2 | | |
| 12MW21S | 662.56 | ↑ | Gradient is from deep bedrock to shallow bedrock, no alluvial well was installed in this cluster of wells |
| 12MW21D | 663.23 | | |
| 12MW22S | 663.22 | ↑ | Gradient is from deep bedrock to shallow bedrock, no alluvial well was installed in this cluster of wells |
| 12MW22D | 664.46 | | |

**Notes:**

Only wells grouped in clusters of shallow and deep bedrock wells or alluvial wells were included in this table for a comparison of vertical gradient throughout the Site
Vertical Datum = NGVD 29, US feet

\\aphrodite\Proj\18GIS\abl\figures\Figure 4-1Elevation of the Bedrock Surface.mxd




**Legend**

- Alluvial Monitoring Well
- Bedrock Well
- Abandoned Well
- Bedrock Surface Elevations
- Steam Lines
- Buildings
- (643.06) Bedrock Elevations

N

0 25 50 Feet

Figure 4-1
Elevation of the Bedrock Surface
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

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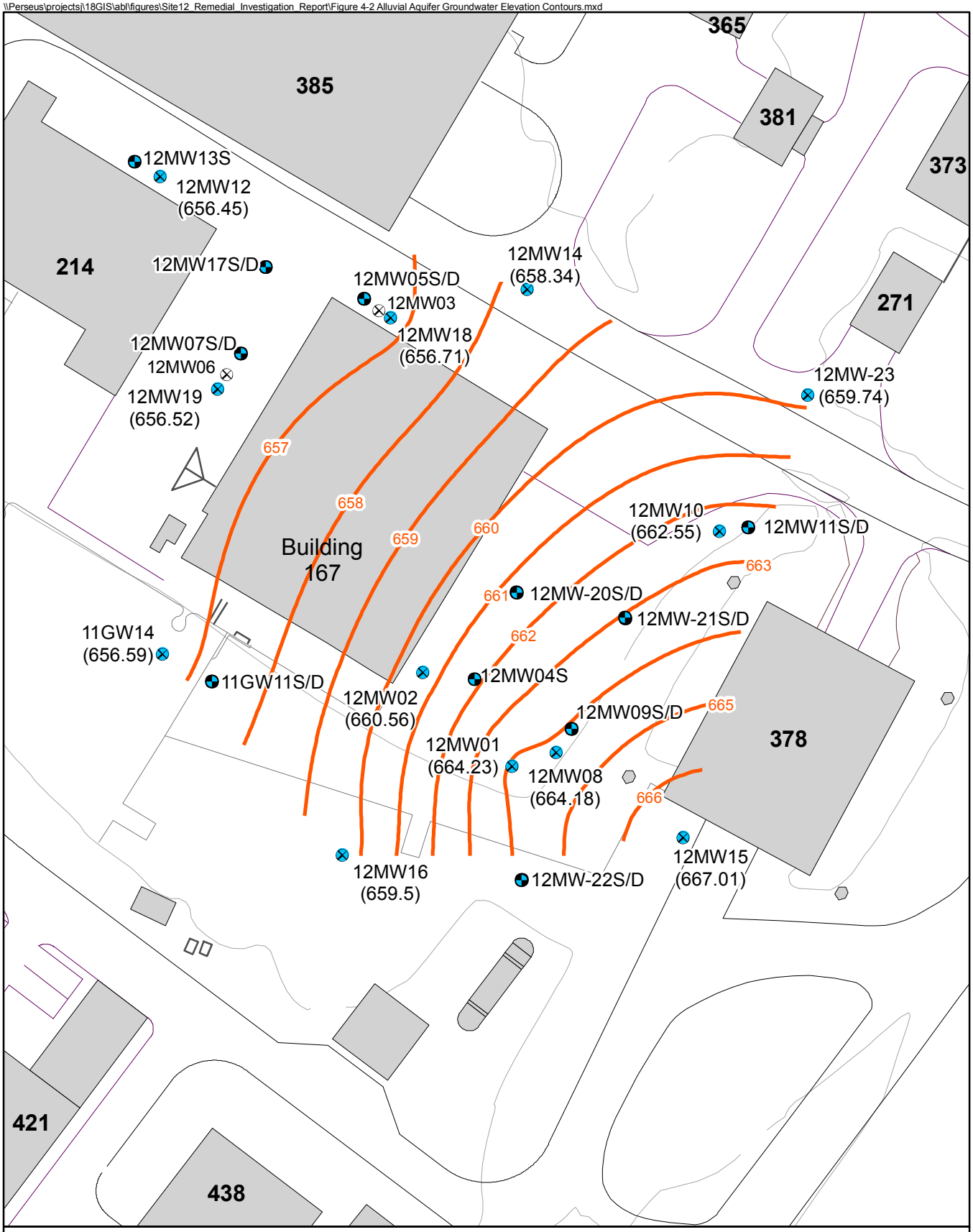
\\Perseus\projects\18GIS\abl\figures\Site12_Remedial_Investigation_Report\Figure 4-2 Alluvial Aquifer Groundwater Elevation Contours.mxd




**Legend**

- Alluvial Monitoring Well
- Bedrock Well
- Abandoned Well
- Groundwater Elevation Contours
- Steam Lines
- Buildings
- (643.06) Groundwater Elevations

N

0 25 50 Feet

Figure 4-2
Alluvial Groundwater Elevation Contours,
March 2007
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

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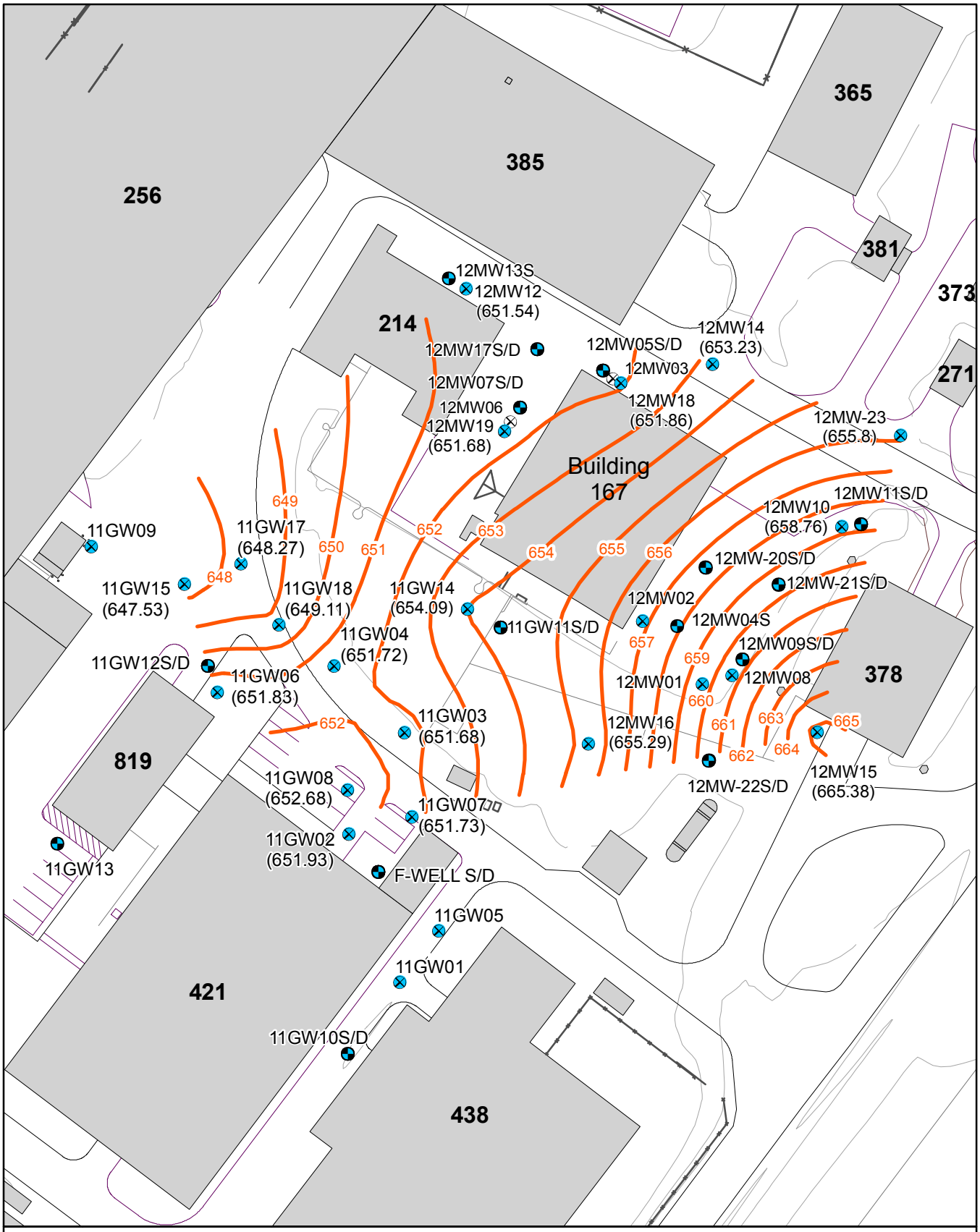
\\Perseus\projects\18GIS\abl\figures\Site12_Remedial_Investigation_Report\Figure 4-3 - Alluvail Groundwater Elevation Contours.mxd




**Legend**

- Alluvial Monitoring Well
- Bedrock Well
- Abandoned Well
- Alluvial GWE Contours
- Steam Lines
- Buildings
- (655.68) Groundwater Elevations

N

0 25 50 100 Feet

Figure 4-3
Alluvial Groundwater Elevation Contours, November 2007
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

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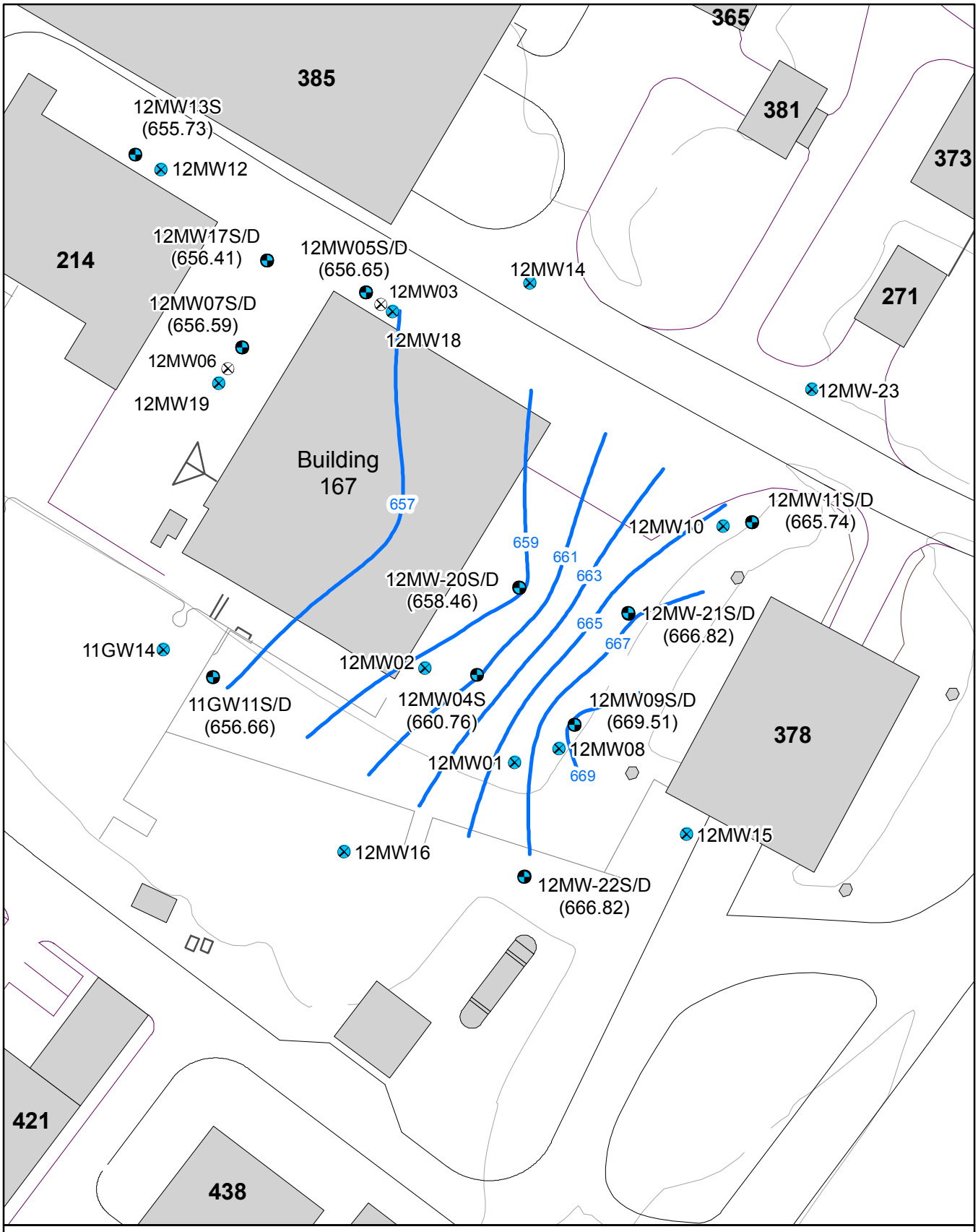
\\Perseus\projects\18GIS\abl\figures\Site12_Remedial_Investigation_Report\Figure 4-4 Shallow Bedrock Groundwater Elevation Contours




**Legend**

- Alluvial Monitoring Well
- Bedrock Well
- Abandoned Well
- Groundwater Elevation Contours
- Steam Lines
- Buildings
- (643.06) Groundwater Elevations

N

0 25 50 Feet

Figure 4-4
Shallow Bedrock Groundwater Elevation Contours, March 2007
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

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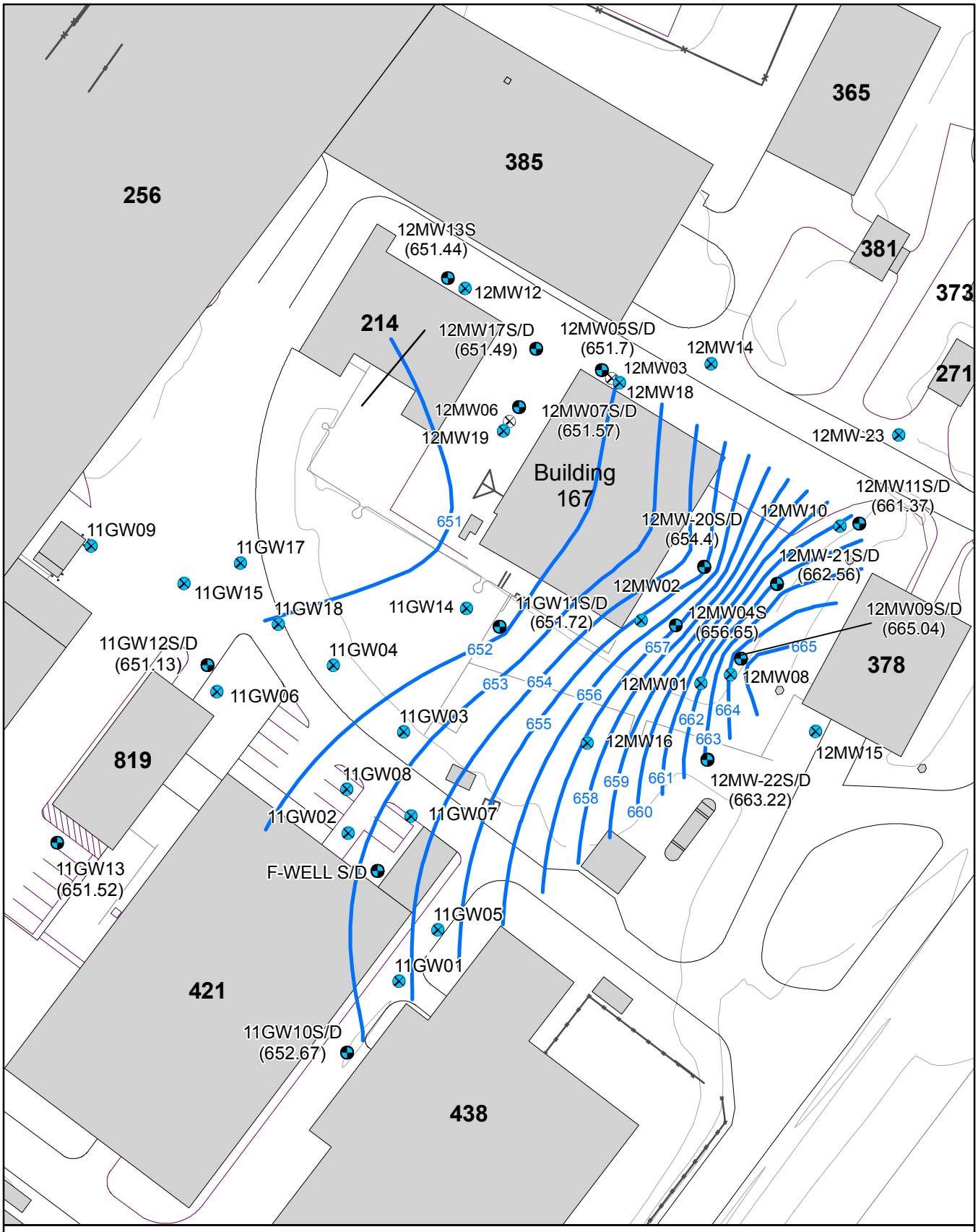
\\Perseus\projects\18GIS\abl\figures\Site12_Remedial_Investigation_Report\Figure 4-5 Shallow Bedrock Groundwater Elevation Contours.mxd




**Legend**

- Alluvial Monitoring Well
- Bedrock Well
- Abandoned Well
- Shallow Bedrock GWE Contours
- Steam Lines
- Buildings
- (655.68) Groundwater Elevations

N

0 25 50 100 Feet

Figure 4-5
Shallow Bedrock Groundwater Elevation Contours, November 2007
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

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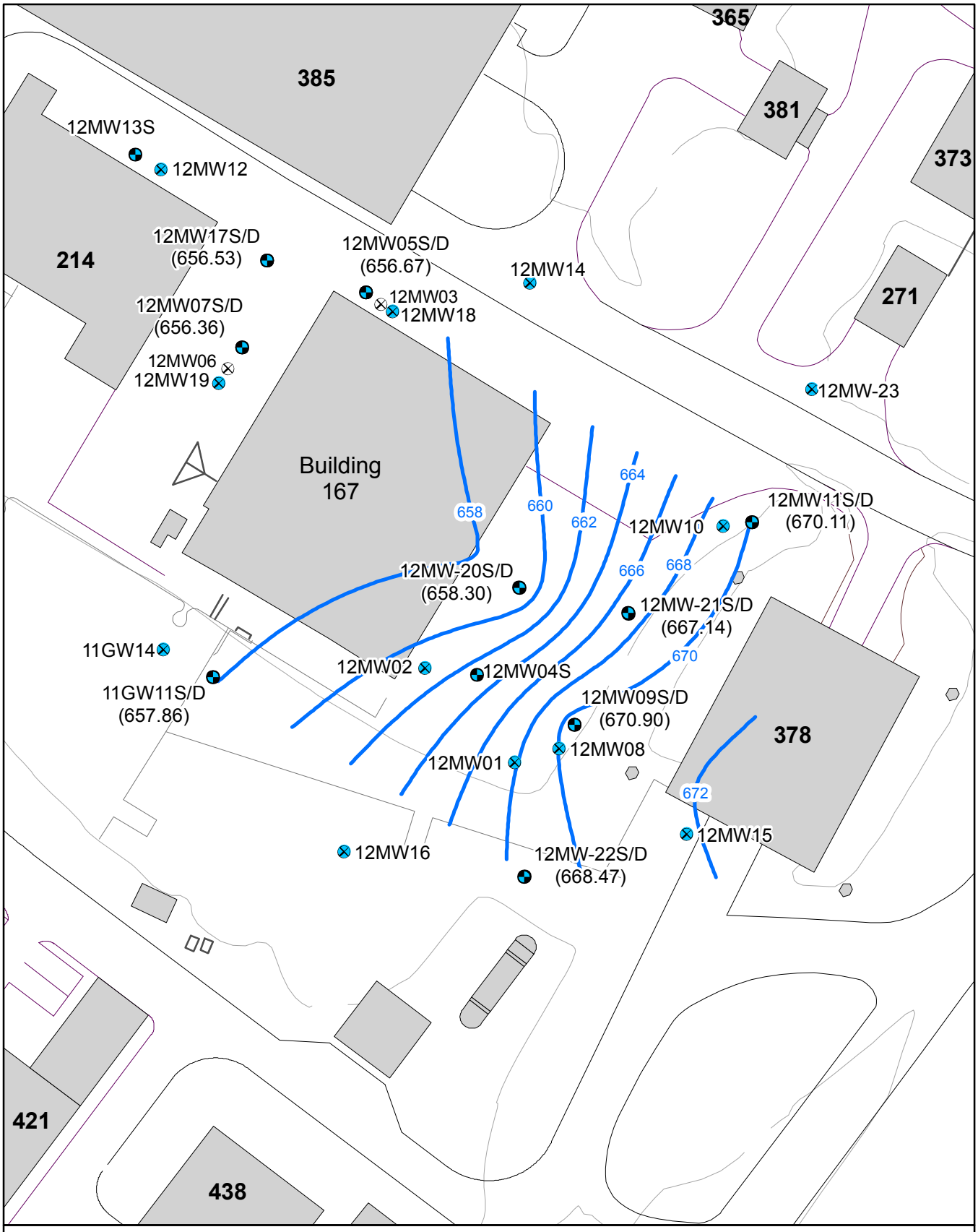
\\Perseus\projects\18GIS\abl\figures\Site12_Remedial_Investigation_Report\Figure 4-6 Deep Bedrock Groundwater Elevation Contours.mxd




**Legend**

- Alluvial Monitoring Well
- Bedrock Well
- Abandoned Well
- Groundwater Elevation Contours
- Steam Lines
- Buildings
- (643.06) Groundwater Elevations

N

0 25 50 Feet

Figure 4-6
Deep Bedrock Groundwater Elevation Contours, March 2007
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

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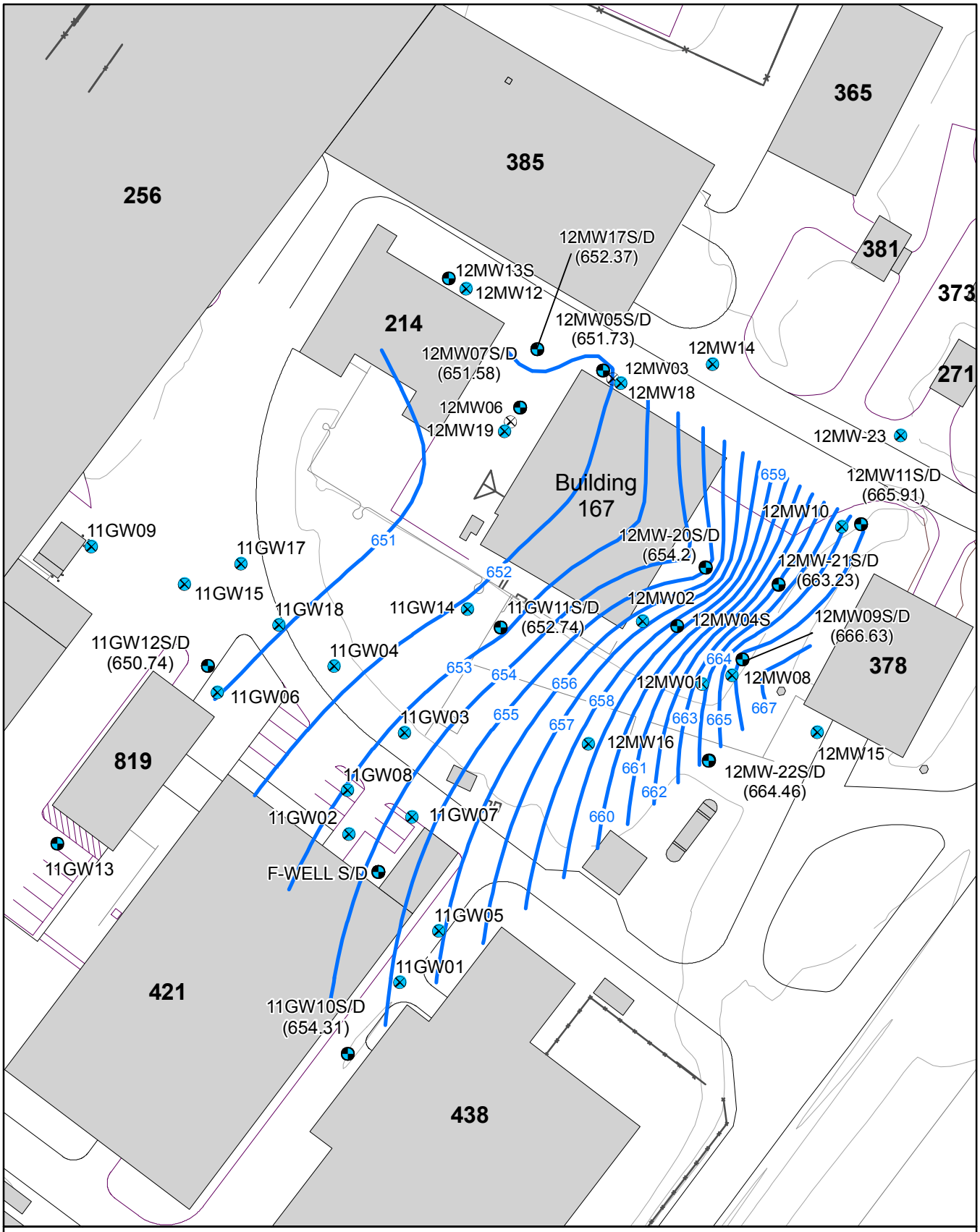
\\Perseus\projects\18GIS\abl\figures\Site12_Remedial_Investigation_Report\Figure 4-7 - Deep Bedrock Groundwater Elevation Contours.mxd




**Legend**

- Alluvial Monitoring Well
- Bedrock Well
- Abandoned Well
- Deep Bedrock GWE Contours
- Steam Lines
- Buildings
- (655.68) Groundwater Elevations

N

0 25 50 100 Feet

Figure 4-7
Deep Bedrock Groundwater Elevation Contours, November 2007
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

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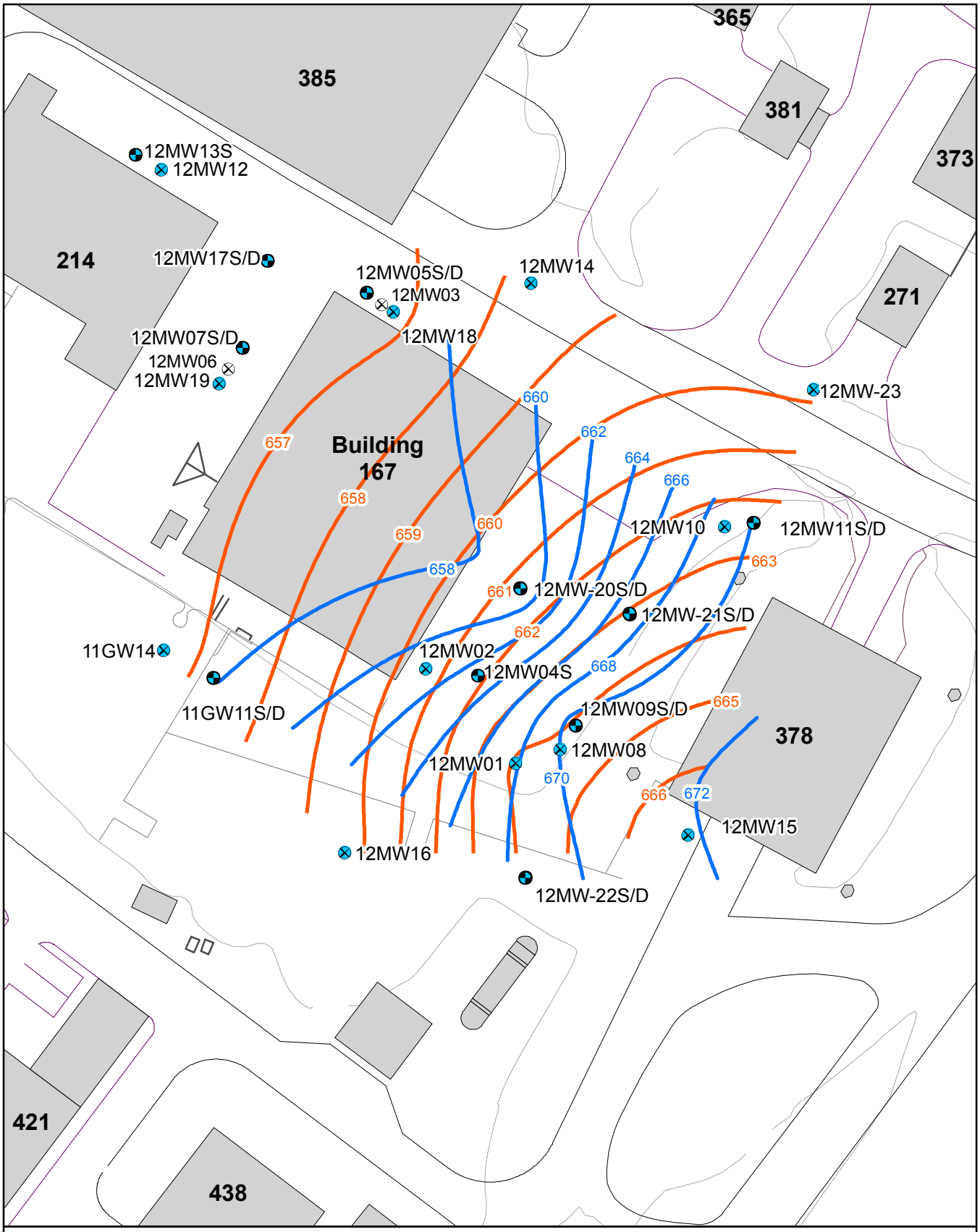
\\Perseus\projects\18GIS\abl\figures\Site12_Remedial_Investigation_Report\Figure 4-8 Comparison of Groundwater Elevation Contours in the Alluvial and Bedrock Aquifers.mxd




**Legend**

- Alluvial Monitoring Well
- Bedrock Well
- Abandoned Well
- Bedrock Contours
- Alluvial Contours
- Steam Lines
- Buildings

N

0 25 50 Feet

Figure 4-8
Comparison of Groundwater Elevation Contours in the Alluvial and Bedrock Aquifers
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

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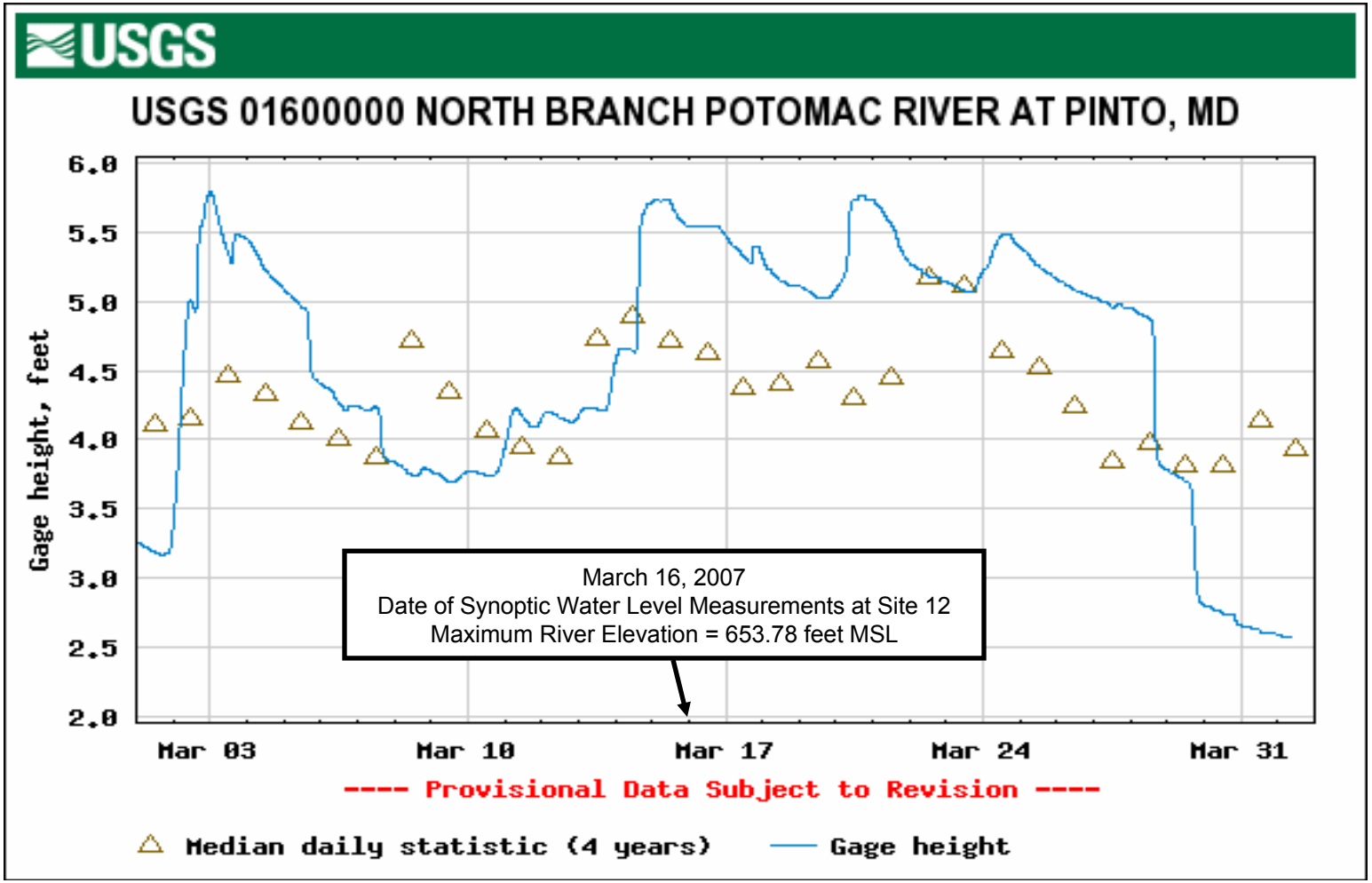
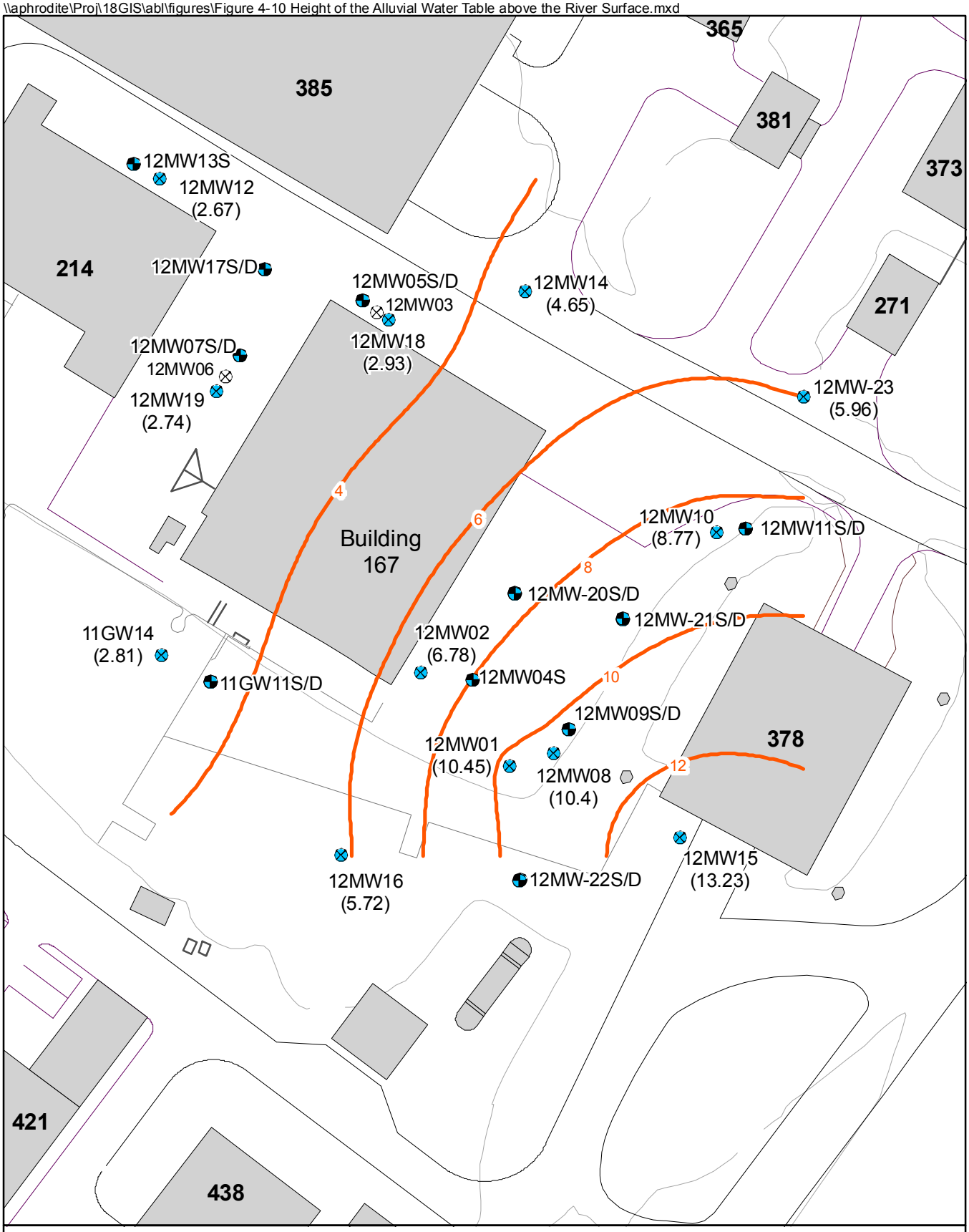



**Figure 4-9**
**USGS Stream Gage Data for the North Branch Potomac River**
**Site 12 Remedial Investigation Report**
**Allegany Ballistics Laboratory**
**Rocket Center, West Virginia**

\\aphrodite\Proj\18GIS\abl\figures\Figure 4-10 Height of the Alluvial Water Table above the River Surface.mxd




**Legend**

- Alluvial Monitoring Well
- Bedrock Well
- Abandoned Well
- Alluvial Water Table Contours
- Steam Lines
- Buildings
- (64.06) Alluvial Water Table Height Above River

N

0 25 50 Feet

Figure 4-10
Height of the Alluvial Water Table above the River Surface
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

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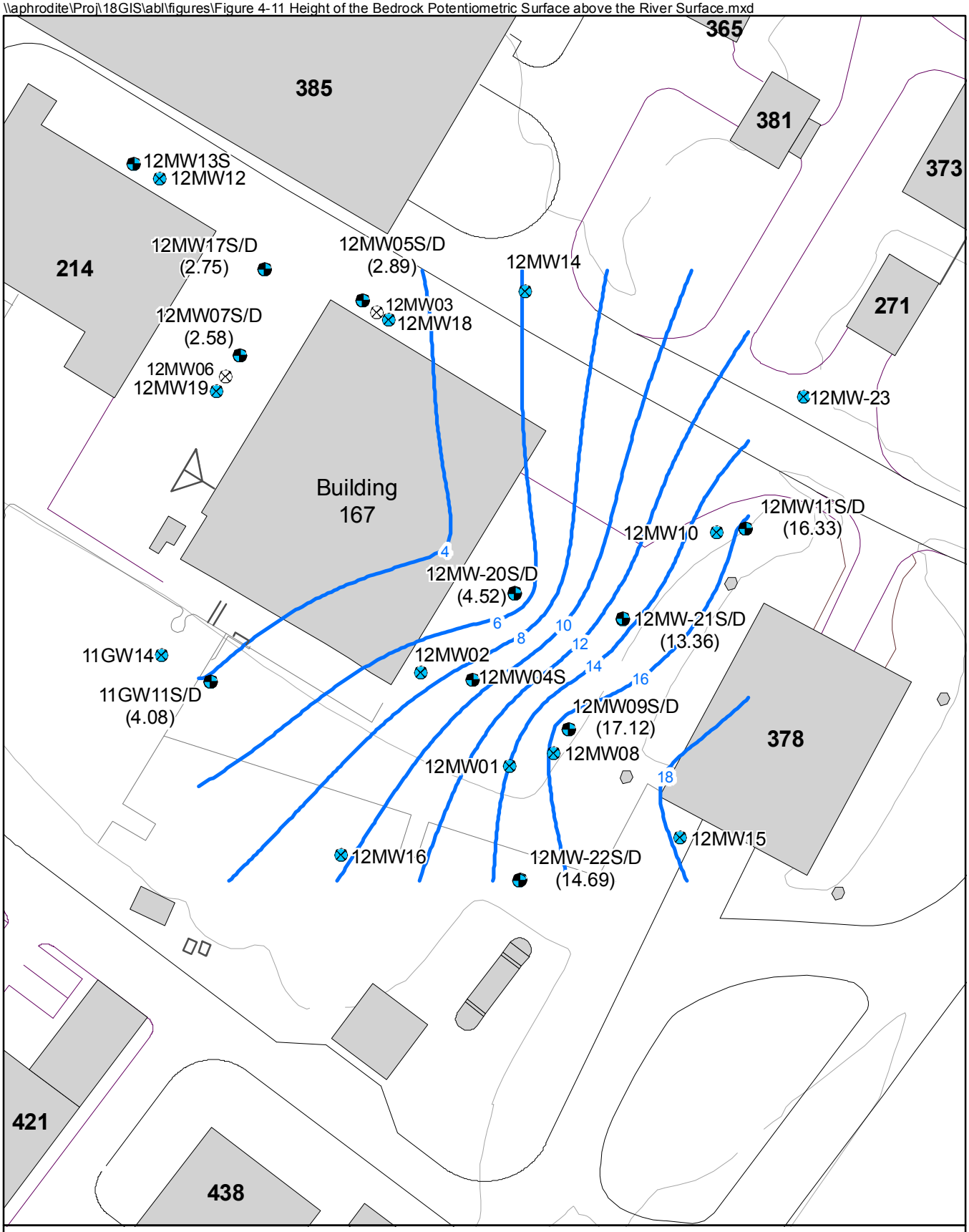
\\aphrodite\Proj\18GIS\abl\figures\Figure 4-11 Height of the Bedrock Potentiometric Surface above the River Surface.mxd




**Legend**

- Alluvial Monitoring Well
- Bedrock Well
- Abandoned Well
- Bedrock Potentiomeric Surface Contours
- Steam Lines
- Buildings
- (64.06) Bedrock Potentiometric Surface Above River Surface

N

0 25 50 Feet

Figure 4-11
Height of the Bedrock Potentiometric Surface above the River Surface
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

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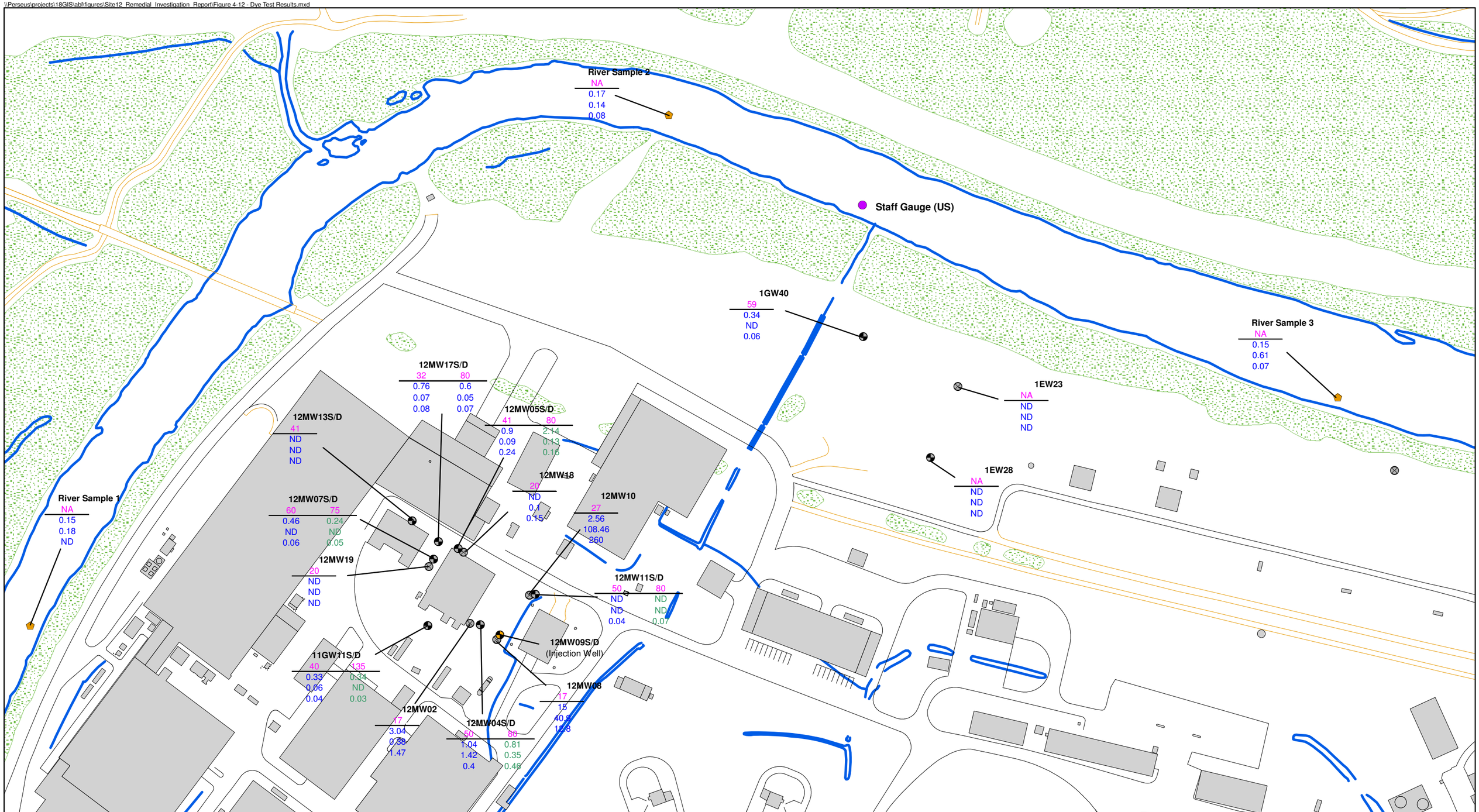
\\Perseus\projects\18GIS\abl\figures\Site12_Remedial_Investigation_Report\Figure 4-12 - Dye Test Results.mxd




**Legend**

- Dye Monitoring Locations - Alluvial Aquifer
- Dye Monitoring Locations - Bedrock Aquifer
- Dye Injection Location
- Staff Gauge
- Dye Monitoring Location - North Branch Potomac River
- Building

NA - Not Applicable

Example:

| Station ID-- | 11GW11S/D | |
|---|---|---|
| Depth Ft-- | 40 | 135 |
| Day 7 -- | 0.33 | 0.34 |
| Day 21-- | 0.06 | ND |
| Day 35-- | 0.04 | 0.03 |
| | Shallow | Deep |

N

0 80 160 320 Feet

Figure 4-12
Dye Test Results
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

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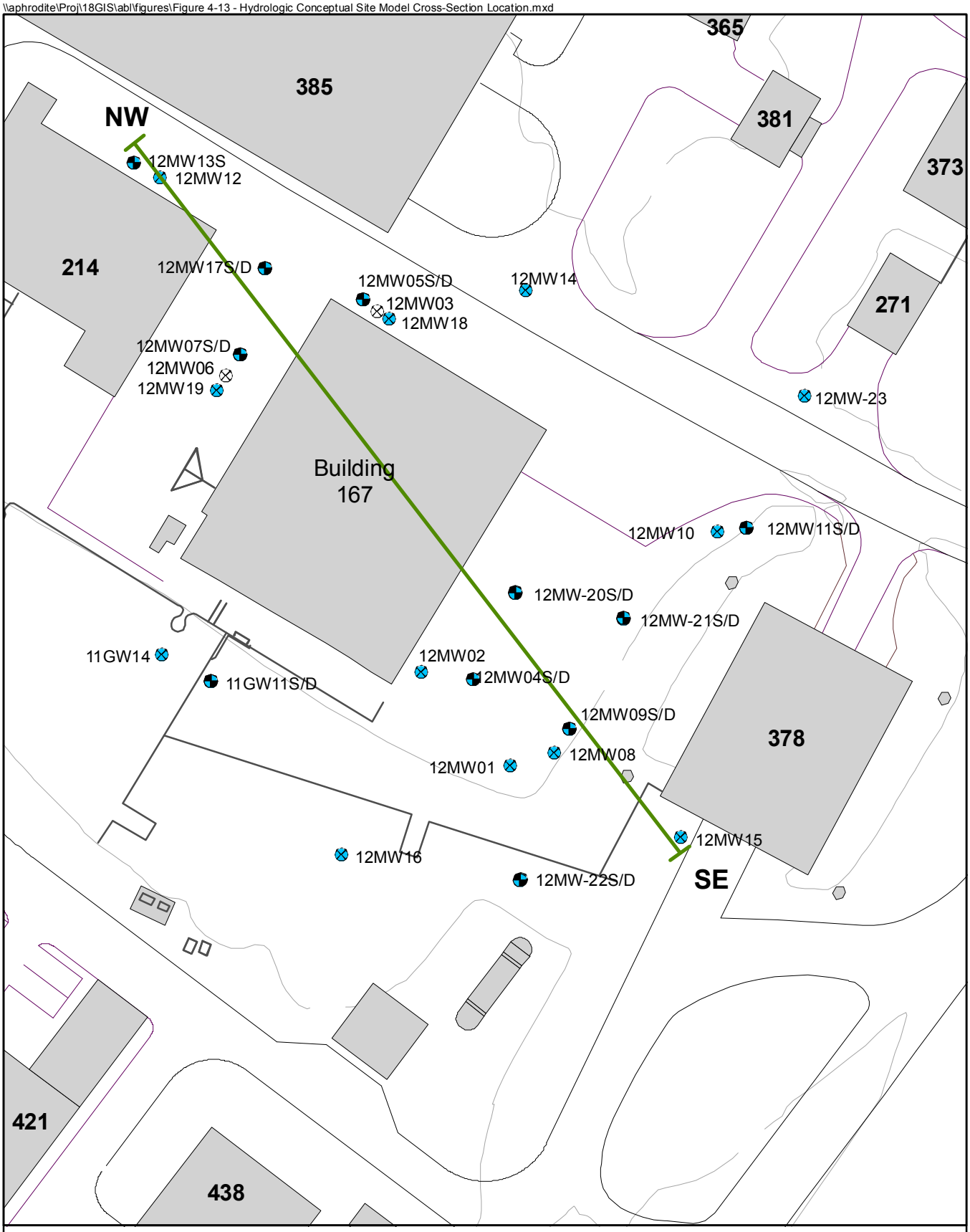
\\aphrodite\Proj\18GIS\abl\figures\Figure 4-13 - Hydrologic Conceptual Site Model Cross-Section Location.mxd




**Legend**

- Alluvial Monitoring Well
- Bedrock Well
- Abandoned Well
- Cross Section Location
- Steam Lines
- Buildings

N

0 25 50 Feet

Figure 4-13
Hydrologic Conceptual Site Model Cross-Section Location
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

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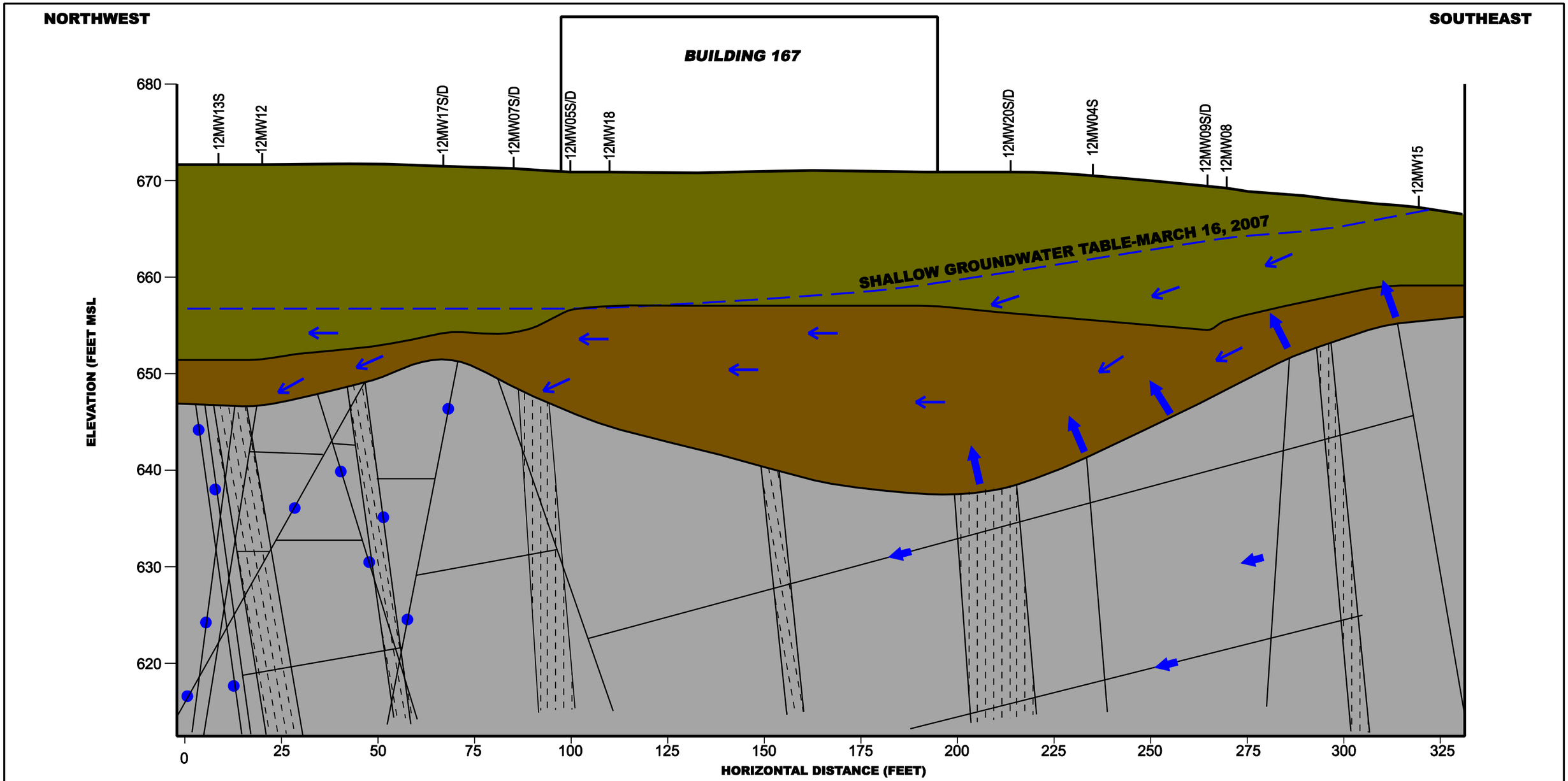
f01_315948.dgn




**Alluvium**

- Clay
- Sand and Gravel

**Bedrock**

- Calcareous Shale
- Limestone

**Legend**

- Alluvial Groundwater Flow
- Primary Bedrock Flow
- 12MW12 Alluvial Well
- 12MW05S/D Bedrock Well
- Secondary Bedrock Flow
- Primary Bedrock Flow Perpendicular to Line of Section
- Fracture Planes
- * Bedrock lithology shown to represent lithology observed in outcrop and do not represent actual conditions beneath Site 12.

Figure 4-14
**Hydrogeologic Conceptual Site Model**
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

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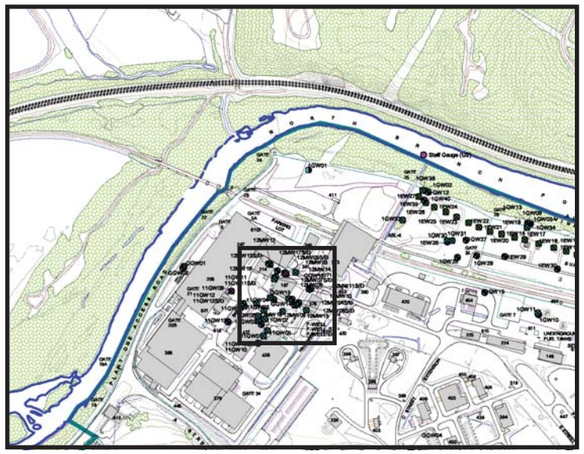

Key Plan

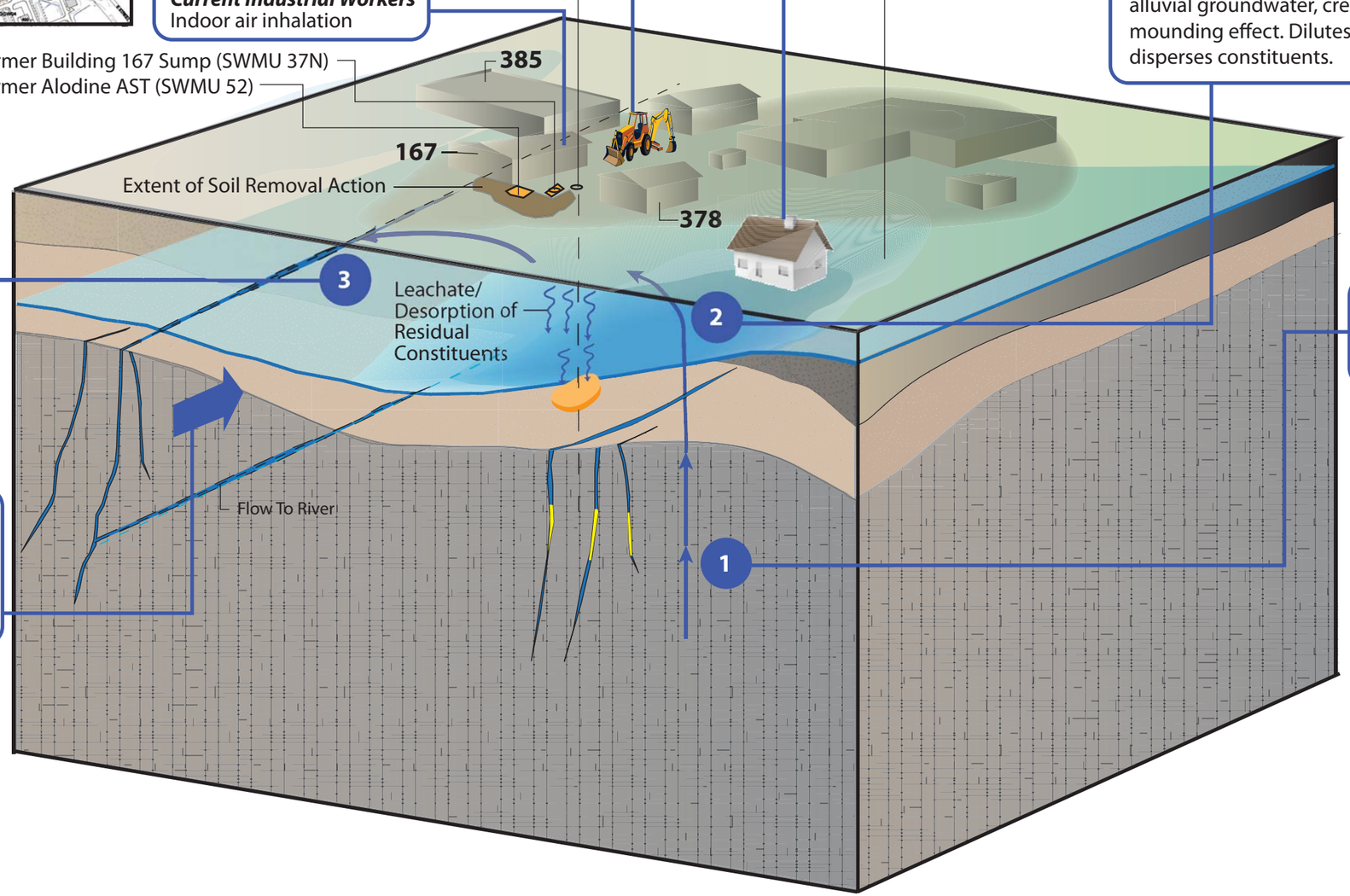


Figure 4-15
3D Conceptual Site Model
Site 12 Remedial Investigation
Allegany Ballistics Laboratory
Rocket Center, West Virginia

SECTION 5

# Nature and Extent of Contamination

The following section presents a discussion of the nature and extent of constituents detected in groundwater beneath Site 12. The primary goal of this section is to discuss the detected constituents, as well as to identify the spatial and temporal trends in the analytical data. The primary drivers behind environmental actions at the site have been detections of TCE and MC in groundwater, which are discussed below and compared to historic levels in Section 5.3. Concentrations of constituents identified in the human health risk assessment (Section 7), as risk drivers, as well as those exceeding regulatory human health screening criteria, are emphasized in this Section.

A facility wide background study has not been performed on inorganic constituents in groundwater. Rather the site data have been compared to data from one or two site-specific background wells (per aquifer). This approach is consistent with past remedial investigation approaches at ABL. Inorganic constituents were compared to upgradient alluvial well 12MW15 and bedrock well 11GW10. This comparison was made to assist in assessing if the inorganic detections are the result of a release or other geochemical affect from past activities at Site 12 or are they attributable to background conditions of the facility.

## 5.1 Alluvial Groundwater Analytical Results

Analytical results for groundwater samples collected from the alluvial monitoring wells at Site 12 are discussed below. The detected constituents in the alluvial groundwater samples are presented on Table 5-1. Constituents detected at concentrations exceeding the National Primary Drinking Water Regulations maximum contaminant levels (MCLs) and/or the EPA Region III RBC for tap water are presented in Table 5-2, depicted on Figure 5-1 and Figure 5-2, and discussed further in Section 7. Figure 5-1 and Figure 5-2 depict exceedances from the most recent analytical data available (i.e. if a well was not sampled during the last sampling event, the previous data was included in the figures). The full set of raw analytical data is provided in Appendix C.

### 5.1.1 VOCs

Thirty-three VOCs were detected in alluvial groundwater samples collected from Site 12 (Table 5-1). The maximum number of VOCs have historically been detected in samples collected from monitoring wells 12MW01 (18 compounds) and 12MW08 (21 compounds) and the maximum number of compounds in these wells were typically detected in samples collected prior to 2005. Additionally, the maximum concentrations of 17 VOCs were detected in samples from monitoring wells 12MW01 and 12MW08. These wells are located at or near the suspected source area for VOC contamination in groundwater (SWMU 37N), as shown in Figure 3-1. Samples collected from locations 12MW12, 12MW19 and 12MW23 have typically contained a low number (< 3) of individual compounds and no VOCs have been detected in samples collected from 12MW15.

The most frequently detected VOCs at Site 12 are TCE, 1,1-dichloroethane (1,1-DCA), and cis-1,2-dichloroethene (cis-1,2-DCE). TCE detections range from 24 µg/L in 2003 (12MW18) to 0.41J µg/L in 2005 (12MW19). TCE is persistent throughout the time period of investigation at most locations where it has been detected. In contrast, the detected concentrations of many other VOCs are generally lower and appear to fluctuate or were detected sporadically during the investigation.

The extent of the TCE groundwater plume, as determined by monitoring well results, is generally similar to the plume extent that was defined during the Phase III Investigation (Figure 5-1). The results presented on Figure 5-1 represent the most recent sampling event at each well location where TCE was detected at concentrations exceeding the MCL value and/or the EPA Region III RBC for tap water. Of the five alluvial wells sample results depicted on Figure 5-1 as exceeding the RBC for tap water (0.026 µg/L), only one of these exceeds the MCL of 5 µg/L, which was obtained from 12MW18 at a concentration of 8.8 µg/L in June 2007. TCE has only been detected at concentrations exceeding the MCL in one other well (16 µg/L), 12MW01, in the sample obtained in September 2003. TCE was not detected in subsequent samples obtained from 12MW01. Additionally, TCE was not identified as a risk driver for human health, as discussed in Section 7.

The only VOC identified as a risk driver to human health in alluvial groundwater is 1,2-dibromo-3-chloropropane, as further elaborated in Section 7. It was only detected once, in one of the alluvial groundwater samples of all the alluvial samples (i.e., 26 samples) obtained from Site 12 and was not detected in bedrock groundwater samples, as discussed in Section 5.2. It was reported at an estimated concentration of 3.8 J µg/L, below the detection limit (10 µg/L). The one detection was qualified with a J, indicating the concentration is estimated. The single detection was in 12MW10 when it was sampled in December 2006. It was not detected during the previous or following sampling events of this well in May 2005 or June 2007, both of which have lower detection limits (0.5 µg/L) for this constituent. Furthermore, this constituent was not detected during any of the previous sampling events leading up the RI. Therefore, it is unlikely this compound is present in Site 12 groundwater, and the detection is considered an anomaly.

Other VOCs that have been detected at concentrations exceeding MCL values are MC and vinyl chloride (VC). MC has been detected in two alluvial wells, 12MW01 and 12MW08, at concentrations exceeding the MCL of 5 µg/L. MC was only detected once in well 12MW01 in the sample obtained in September 2003, at an estimated concentration of 2,900 µg/L. Likewise, MC was only detected once in the sample obtained from 12MW08, in September 2003, at an estimated concentration of 36 µg/L. MC was not detected in either of these wells during subsequent sampling events that were performed following the source removal actions that were discussed in Section 2.

VC has been detected in wells 12MW01, 12MW02, and 12MW08 at concentrations exceeding the MCL value of 2 µg/L. The highest concentration of VC that has been detected in Site 12 alluvial wells was 8.8 µg/L, detected in the sample obtained from 12MW01 in September 2003. During the most recent VOC sampling events, VC was not detected in Site 12 alluvial wells.

### 5.1.2 SVOCs

Five SVOCs were detected in alluvial groundwater samples collected from Site 12 (Table 5-1). These SVOCs include 4-methylphenol, di-n-butylphthalate, naphthalene,

phenol, and bis (2-Ethylhexyl) phthalate. With the exception of one sporadic detection of bis-(2-ethylhexyl) phthalate at 12MW15 (1.1J µg/L), all of the SVOCs were detected in samples collected from well 12MW08 during the September 2003 and June 2005 sampling events. No SVOCs were detected in alluvial well samples obtained during the most recent June 2007 sampling event. No SVOCs have been detected in alluvial groundwater samples at concentrations exceeding MCLs or RBCs (Table 5-2), nor were they considered risk drivers based on the human health risk assessment.

### 5.1.3 Explosives

Two explosive compounds, nitrobenzene and perchlorate, were detected in a limited number of alluvial groundwater samples collected at Site 12 (Table 5-1). Perchlorate was only detected at 12MW08 (13 µg/L) in the sample obtained in September 2003, and was not detected in subsequent samples obtained from this well. Perchlorate was detected in samples obtained in June 2007 from wells 12MW19 (0.3 µg/L), and 12MW23 (0.2 µg/L). Perchlorate was not detected in the previous sample obtained from 12MW19 and was only analyzed during the most recent sampling event (June 2007) in 12MW23, so temporal trends cannot be assessed. Perchlorate was not detected above its RBC nor identified as a risk driver in the human health risk assessment.

Nitrobenzene was detected in one sample at well location 12MW15, at an estimated concentration of 0.04 µg/L, below its RBC. It was not detected in previous samples obtained from this well and was not analyzed for this parameter in subsequent sampling events. Nitrobenzene was not identified as a risk driver in the human health risk assessment.

### 5.1.4 Inorganic Constituents

Twenty inorganic constituents were detected in unfiltered samples collected from Site 12 (Table 5-1). A number of these constituents (e.g. calcium, iron, magnesium, potassium, and sodium) are natural nutrients that are commonly present in groundwater samples. Therefore, these constituents are not discussed extensively in this section of this report.

This section focuses on the inorganic constituents on the constituents of potential concern (COPCs), which are comprised of arsenic, iron, thallium (dissolved), and manganese. Determination of COPCs is discussed in detail in Section 7. Hexavalent chromium is also discussed because this constituent was known to be present in wastes stored at Site 12. The results for these four constituents are summarized below.

Site 12 is predominately paved or covered with buildings, reducing infiltration and minimizing the amount of recharge of oxygen-rich water from reaching the aquifer, allowing the reducing conditions to persist. Field parameters obtained in June 2005 and 2007 from the Site 12 wells in the proximity of the alluvial VOC plumes (i.e., 12MW01, 12MW02, 12MW08, 12MW10, 12MW12, 12MW15, 12MW18, and 12MW19) have an average oxidation reduction potential (ORP) of negative (-) 22 millivolts (mV). The ORP values are indicative of aquifer reducing condition. The presence of VOCs and other organic constituents in the alluvial groundwater may also contribute to the reducing condition. The reducing condition affect the oxidation states of the metals, allowing previously immobile metals naturally present in the soil matrix to solubilize into groundwater.

#### 5.1.4.1 Arsenic

The extent of arsenic is also generally similar to results of the Phase III Investigation. Arsenic was detected in samples collected from monitoring wells 12MW01, 12MW02, 12MW08, 12MW14, 12MW15, 12MW19, and 12MW23, at concentrations ranging from 3.7 µg/L (12MW23) to 16.3 µg/L in the upgradient well (12MW15). At locations where arsenic has been analyzed during multiple sampling events, this constituent was only consistently detected in samples from wells 12MW02 and 12MW08. Arsenic has generally been detected at concentrations of less than 10 µg/L, the MCL value, with the exception of three samples from 12MW08 (11.1 µg/L to 12 µg/L) and one sample from the upgradient well 12MW15 (16.3 µg/L).

Exceedances of MCL or RBC values during a well's most recent sampling event are depicted on Figure 5-2. The highest concentration of total arsenic detected during the most recent sampling event for alluvial well 12MW15 was 16.3 µg/L. Alluvial well 12MW08 had the second highest total arsenic concentration detected (11.1 µg/L). Both of these sample results exceed the MCL value and the EPA Region III RBC of 0.045 µg/L. Additionally, it should be noted that alluvial well 12MW15 is the alluvial well that was selected for qualitative background comparisons due to it's upgradient location to Site 12 SWMU's, and lack of VOC detections historically. 12MW14 is the remaining alluvial well with an exceedance depicted on Figure 5-2, is below the MCL value but not the EPA Region III RBC value.

Past Site 12 activities, discussed in Section 2, do not include processes known to potentially release arsenic. Therefore, the presence of arsenic in the alluvial groundwater is not attributed to past activities at Site 12. Because the highest arsenic concentrations were detected in the upgradient well at Site 12, they are most likely attributable to natural background conditions.

#### 5.1.4.2 Hexavalent Chromium

Hexavalent chromium was detected in samples from well locations 12MW02, 12MW08, 12MW10, 12MW16, and 12MW19 at concentrations ranging from 16 µg/L (12MW19) to 68 µg/L (12MW16). Note that all detections for this constituent occurred in the sampling event that was conducted in May/June 2005. Total hexavalent chromium was not detected in these five well locations, or any other alluvial samples, during previous or subsequent sampling events. The hexavalent chromium detections in the May/June 2005 alluvial groundwater samples were detected during an event in which there were chromium detections in the associated blank. Previous site activities (alodine treatment tanks) are potential sources of hexavalent chromium, as summarized in Section 2. However, hexavalent chromium was not detected at concentrations exceeding its MCLs or EPA Region 3 RBC values, in any of the alluvial aquifer samples. Additionally, hexavalant chromium was not identified as a risk driver in the human health risk assessment, as discussed in Section 7.

#### 5.1.4.3 Iron

Elevated concentrations of iron (greater than the EPA Region III risk based screening criteria (RBC) for tap water of 26,000 µg/L) were detected in samples collected from well locations 12MW01 (30,100 µg/L), 12MW08 (48,900 µg/L), and 12MW14 (27,600 µg/L). However, iron concentrations at these well locations did not consistently exceed 26,000 µg/L during each

sampling event. In fact, one sample each from 12MW01 and 12MW08 which contained elevated iron levels were also associated with elevated turbidity levels (>245 NTU), as recorded during sample collection. This suggests that the elevated turbidity resulted in data that is biased higher in unfiltered iron concentrations than in sample results for dissolved iron. Iron was detected at concentrations ranging from 2,110 to 13,900 µg/L in background alluvial well 12MW15. No historic Site 12 activities are associated with potential iron releases. Iron concentrations detected at Site 12 are therefore attributed to natural background conditions.

#### 5.1.4.4 Manganese

Elevated concentrations of manganese (greater than the tap water RBC of 730 µg/L) were detected in samples collected from monitoring wells 12MW01 (up to 4,800 µg/L), 12MW02 (up to 5,140 µg/L), 12MW08 (up to 1,730 µg/L), 12MW10 (up to 786 µg/L), 12MW16 (up to 892 µg/L), and 12MW18 (up to 1,250 µg/L). Across the site, manganese concentrations range from 19.1 (12MW12) µg/L to 5,140 µg/L. Wells 12MW01, 12MW02 and 12MW08, which all have detected concentrations greater than 1,500 µg/L, are located in the immediate vicinity of the previous known source areas of VOCs. Manganese concentrations are generally consistent across multiple sampling events at specific well locations. The background alluvial well sample results have had concentrations of up to 81.4 µg/L. No historic Site 12 activities are associated with potential manganese releases. Concentrations of manganese detected at Site 12 are attributed to the localized reducing conditions in Site 12 groundwater, as discussed above.

### 5.1.5 Dissolved Inorganic Constituents

Nineteen dissolved inorganic constituents were detected in filtered groundwater samples collected from Site 12 (Table 5-1). In addition to the COPCs discussed for total inorganics, dissolved thallium is also discussed due to one screening exceedance, as presented in Section 7. With the exception of thallium, which was not detected in samples analyzed for total metals, these COPCs were generally detected at lower concentrations and less frequently when compared to unfiltered sample results. The highest detections of dissolved metals in groundwater are typically co-located with the highest detections of organics. The data for these five dissolved constituents is summarized below.

#### 5.1.5.1 Dissolved Arsenic

Dissolved arsenic was detected in only six alluvial groundwater samples obtained from Site 12. The concentration of dissolved arsenic at these locations ranged from 2.5K µg/L (12MW16) to 8.9 µg/L (12MW08). It was detected in 12MW02, 12MW08, and 12MW16, and all detected concentrations were either qualified with a J (indicating the concentration was estimated) or K (indicating the concentration is biased high). This constituent was present during all sampling events at location 12MW08 and two of three sampling events at 12MW02. Dissolved arsenic was only detected during one sampling event at 12MW16, at a concentration of 2.5 K µg/L. Dissolved arsenic was not detected in background well 12MW15. Past Site 12 activities, do not include processes known to potentially release arsenic. Therefore, concentrations of arsenic detected at Site 12 are attributed to the localized reducing conditions in Site 12 groundwater, as discussed above.

#### 5.1.5.2 Dissolved Hexavalent Chromium

Dissolved hexavalent chromium was only detected in one sample from well location 12MW08. The concentration of hexavalent chromium at 12MW08 (11 µg/L) only slightly exceeds the detection limit for this constituent (10 µg/L) (Table 5-1).

#### 5.1.5.3 Dissolved Iron

Dissolved iron is a relatively common constituent that was detected in 16 of 26 groundwater samples collected from the site. Elevated dissolved iron levels (>26,000 µg/L) were present in one sample from 12MW01 and in two of three samples from 12MW08. As stated above, the sample from 12MW01 and one of the samples from 12MW08 were associated with high groundwater turbidity levels as recorded during sample collection. Dissolved iron was detected at relatively lower levels (17,400 µg/L) in the sample from 12MW08 that was collected during the most recent sampling event. Additionally, iron was generally detected at lower concentrations in filtered samples. Up to 606 µg/L has been detected in filtered samples obtained from background well 12MW15. Past Site 12 activities, do not include processes known to potentially release iron to the alluvial aquifer. Iron concentrations detected at Site 12 are therefore attributed to the localized reducing conditions, as discussed above.

#### 5.1.5.4 Dissolved Manganese

Dissolved manganese was detected at elevated levels (>730 µg/L) in samples collected from well locations 12MW01, 12MW02, 12MW08, and 12MW16. The elevated concentrations of this constituent were generally consistent at these locations during all sampling events. Dissolved manganese was detected in background well 12MW15 at concentrations ranging from 431 to 606 µg/L. Wells 12MW01, 12MW02 and 12MW08, are located in the immediate vicinity of the previous known VOC source areas. Well 12MW16 is located just upgradient of SWMU 52. Concentrations of dissolved manganese detected at Site 12 are attributed to the localized reducing conditions in Site 12 groundwater, as discussed above.

#### 5.1.5.5 Dissolved Thallium

Dissolved thallium has only been detected during the most recent event (June 2007) in one sample (out of 26) collected from 12MW08. The concentration of this constituent was 6.2K µg/L, and the validation flag indicates that the reported value is biased high. Thallium was not detected in background well 12MW15. Thallium has not historically been detected in unfiltered Site 12 alluvial groundwater samples. No activities historically performed at Site 12 are known to have included the use of thallium. Therefore, it is unlikely this compound is present in Site 12 groundwater, but was rather more likely to be an anomaly.

## 5.2 Bedrock Groundwater Analytical Results

Analytical results for groundwater samples collected from the bedrock monitoring wells at Site 12 are discussed below. Results from the shallow and deep monitoring wells are discussed concurrently so that analytical trends can be discussed with regard to each constituent group. The detected constituents are presented on Table 5-3. Constituents detected at concentrations exceeding MCLs and/or the EPA Region III RBC for tap water are presented in Table 5-4, depicted on Figures 5-1 and 5-2, and discussed further in Section 7. The full set of analytical data is provided in Appendix C.

### 5.2.1 VOCs

Twenty-one VOCs were detected in bedrock groundwater samples collected from Site 12 (Table 5-2). With the exception of four constituents (2-Butanone, 2-Hexanone, Acetone, and Carbon Disulfide), the maximum concentration of the remaining VOCs were detected in samples obtained from shallow bedrock monitoring wells. The majority of the VOCs were detected in samples collected from wells 12MW09S (14 compounds) and 12MW21S (7 compounds). The maximum number of VOCs detected in the deep bedrock monitoring wells (4 compounds) was present in one sample from well location 12MW21D. The sample from well 12MW20S, located about 50 feet downgradient of SWMU 37N, was the only sample where VOCs were not detected.

TCE was the most common constituent detected in bedrock groundwater samples, followed by MC. The concentration of TCE ranged from 0.33J µg/L (12MW21S) to 8.9 µg/L (12MW07S) and this constituent was detected in samples from each well location, except 12MW09D, 12MW11S/D, 12MW13S, 12MW20S, and 12MW21S/D. TCE concentrations were relatively consistent throughout all sampling events and the concentrations tend to decrease through time. The results presented on Figure 5-3 represent the most recent sampling event at each well location where TCE was detected at concentrations exceeding its MCL and/or the EPA Region III RBC for tap water. During this most recent event, none of the eight bedrock monitoring well TCE concentrations were detected at values exceeding the MCL. These results show elevated concentrations of TCE in the vicinity of Building 167 and the former location of SWMU 37N. The extent of the TCE groundwater plume, as determined by the most recent monitoring well results (Figure 5-3), is generally similar to the plume extent that was defined during the Phase III Investigation. The results also show that the TCE contamination is somewhat vertically stratified, decreasing concentration with depth. Specific TCE concentrations tend to be lowest in the deep bedrock samples and the average TCE concentration in the deep monitoring wells is lower than the alluvial and shallow bedrock monitoring wells. TCE was not detected in the Site 12 alluvial or bedrock wells located farthest downgradient and northwest Building 167.

The extent of the MC groundwater plume in the bedrock aquifer is also generally similar to results of the Phase III Investigation. MC was detected in wells 12MW09S, 12MW20D, 12MW21S/D and 12MW22S/D up to a maximum concentration of 4,400 µg/L (12MW09S). In contrast to TCE, concentrations of MC tend to fluctuate throughout the RI investigation. The maximum MC concentrations have been sporadically detected in 12MW09S, which is located near former SWMU 37N. For example, in 12MW09S the concentration of MC fluctuated from 4,400 µg/L to below detection limits (10 U µg/L), then up to 540 µg/L during the most recent sampling event. Note that the elevated concentrations of MC in 12MW09S corresponded to times when low water production was observed during the sampling event and the well was pumped dry prior to sampling. Elevated levels of MC have also been historically detected in wells 12MW21S/D and 12MW22S/D, which are also located near SWMU 37N. The MC plume does not appear to be vertically stratified, but the average concentration of MC is highest in samples obtained from shallow bedrock monitoring wells, which may be skewed by the relatively high concentration of MC detected in 12MW09S. During the most recent sampling event, only one bedrock well (12MW09S) sample contained MC at concentrations exceeding both the MCL (5 µg/L) and

the EPA Region III RBC for MC in tap water (4.1 µg/L). Additionally, MC was not detected in samples obtained from Site 12 wells located downgradient of SWMU 37N.

The only other VOC detected in bedrock groundwater samples exceeding MCL or EPA Region III RBC values was tetrachloroethene (PCE). PCE was only detected in one bedrock monitoring well (12MW09S), once, at a concentration (1.4 µg/L) exceeding EPA Region III RBC value of 0.1 µg/L but below its MCL. Additionally, PCE was only detected in 12MW09S once and was not detected during two subsequent sampling events at this well.

Methane, 1,1 Dichloroethane, and cis-1,2-DCE were also relatively common VOC constituents detected in bedrock groundwater sample. The remaining VOC compounds were detected in less than 5 bedrock groundwater samples. In general, the concentrations of these remaining compounds tended to be low (i.e. slightly exceeding the detection limit) and the compounds tended not to be consistently detected during each sampling event.

### 5.2.2 SVOCs

Three SVOC compounds, Caprolatcam, Di-n-butylphthalate, and bis(2-Ethylhexyl)phthalate, were detected in bedrock groundwater samples (Table 5-2). The detected concentrations of these compounds were generally low (< 3.2 µg/L), with the exception of a detection of 21 µg/L of bis(2-Ethylhexyl)phthalate, in a sample from well location 12MW09D. This exceeds the MCL (6 µg/L) and EPA Region III RBC (4.8 µg/L) values. The SVOC detections were not consistent through each sampling event at specific well locations. Bis(2-Ethylhexyl)phthalate was only detected in a subsequent sample obtained from 12MW09S at a concentration of 2.2 B, possibly due to blank contamination. This most recent detection is below both the MCL and EPA Region III RBC values. Additionally, bis(2-Ethylhexyl)phthalate was not considered to be at concentrations that would pose an unacceptable risk to human health, as discussed in Section 7.

### 5.2.3 Explosives

Perchlorate was detected in one sample from shallow bedrock monitoring well 12MW17S (Table 5-3). The concentration of this constituent was relatively low (0.4 µg/L) and it was only detected in one of the two samples collected from 12MW17S. This concentration is below the EPA Region III RBC value of 26 µg/L, and no MCL exists for this constituent (Table 5-4).

### 5.2.4 Inorganic Constituents

Twenty-two inorganic constituents were detected in unfiltered bedrock groundwater samples collected at Site 12 (Table 5-3). Note that hexavalent chromium was not detected. The discussion of detected inorganic constituents is focused on COPCs comprised of arsenic, chromium, manganese, and thallium. Note there were also slightly elevated concentrations of lead (18.5K µg/L at 12MW09D) present in these samples. However, because the lead detections were isolated, the concentrations barely exceed screening criteria, and it was not considered a risk driver in the human health risk assessment, this constituent is not further discussed. Inorganic constituents detected at concentrations exceeding MCL or EPA Region III RBC values, during the most recent sampling of a particular well, are depicted on Figure 5-4 and summarized in Table 5-4. The discussion

below also includes a brief summary of the major elements concentrations detected in the bedrock groundwater samples.

As discussed in Section 5.1.4, the highest detections of metals in groundwater are typically co-located with the highest detections of organics. Field sampling parameters obtained from Site 12 wells in June of 2005 and 2007, in the proximity of the bedrock VOC plume (i.e., 12MW04S, 12MW21S, 12MW21D,12MW09S, 12MW09D, 12MW09D, 12MW22S, and 12MW22D) have an average ORP of (–) 107, which are indicative of reducing conditions (EPA, 1998). Once the concentration of VOCs decrease, it is expected that the conditions in the aquifer will be less reducing and that the metals will remain in the soil/rock matrix.

#### 5.2.4.1 Major Element Concentrations

A discussion of major element concentrations in the bedrock groundwater samples is included to illustrate trends in these analytical data. For purposes of discussion, the major elements discussed in this section include aluminum, barium, calcium, iron, magnesium, manganese, potassium and sodium because these elements have been detected in approximately 90 percent to 100 percent of the samples. The concentrations of these elements are very similar in samples obtained from the shallow and deep bedrock wells, although the average concentration of sodium is higher in samples obtained from the shallow bedrock wells.

The concentrations of these elements appear to remain relatively stable throughout the monitoring period at specific well locations. However, these concentrations are not the same magnitude at all locations across the site. In general, concentrations of these elements in samples obtained from the eastern portion of the site, specifically, locations 12MW04S, 12MW09S/D, 12MW20S/D, and 12MW21S/D are as much as three times greater than concentrations of these elements in other bedrock monitoring wells. It is hypothesized that this variation in major element metal concentrations is indicative of a different source of bedrock groundwater for the two portions of the site, each with its unique geochemical signature.

#### 5.2.4.2 Arsenic

Arsenic was detected in bedrock wells 12MW05D, 12MW07D, 12MW09S/D, 12MW11S, 12MW21S/D, and 12MW22S/D (Table 5-3). The concentration range and average concentration of arsenic is roughly the same for samples collected from the shallow and deep monitoring wells. With one exception, 12MW09D, arsenic was only detected during one sampling event that occurred in June 2007. All of the June 2007 results are "K" flagged, meaning that the results are biased high. Arsenic has been detected during more than one event in samples collected from well 12MW09D. With the exception of the June 2007 result from 12MW09D (10.6K µg/L), all of the detected arsenic concentrations exceed the EPA Region II RBC value (0.045 µg/L), but are less than the MCL value of 10 µg/L. Other than the arsenic concentrations detected in samples obtained from 12MW09D, 12MW07D was the only other well where arsenic was detected in sampling events other than June 2007. Arsenic was detected in the sample obtained from 12MW07D during the May 2005 sampling event, at an estimated concentration of 5.5J µg/L. It was not detected in samples obtained from this well in previous or subsequent sampling events. The background bedrock monitoring well, 11GW10, has had unfiltered sample detections of arsenic (4.9 µg/L), which are comparable to Site 12 arsenic detection. Additionally, the average unfiltered bedrock well sample

concentration of arsenic is 12.9 µg/L. No past activities were performed at Site 12 that are known to have potentially released arsenic to the bedrock aquifer. Arsenic concentrations detected at in bedrock groundwater monitoring wells at Site 12 are therefore attributed to natural background conditions.

#### 5.2.4.3 Manganese

Manganese was detected in all Site 12 bedrock wells (Table 5-3) at concentrations ranging from and estimated concentration of 7 µg/L (12MW17S) to 738 µg/L (12MW09S). Only one unfiltered bedrock well sample (12MW09S) collected during the June 2005 sampling event contained manganese at concentrations exceeding the EPA Region III RBC value of 730 µg/L. During subsequent sampling events that took place in June 2007, it was detected in this well at a concentration of 719 µg/L, which is less then the EPA Region III RBC value. No historic Site 12 activities are associated with potential manganese releases. Manganese was detected in background bedrock monitoring wells 11GW10S and 11GW10D at concentrations of up to and estimated concentration of 13 J µg/L and 21.3 µg/L, respectively. Bedrock well 12MW09S has historically had high VOC concentrations. The presence of organics in the bedrock groundwater at this location has likely created reducing conditions in the subsurface and mobilized manganese into the groundwater.

#### 5.2.4.4 Chromium

Chromium was detected in bedrock wells 12MW05S/D, 12MW07D, 12MW09S/D, 12MW11S/D, 12MW17S/D, 12MW21D, and 12MW22S/D. The average concentration of chromium tended to be higher in samples collected from shallow bedrock wells versus samples collected from deep bedrock wells. The majority of the chromium concentrations are less than 37.2 µg/L (12MW11S), but elevated chromium levels (> 110 µg/L) were present in one sample (out of 26), which was obtained from 12MW09S (250 µg/L). Note that the elevated chromium level in 12MW09S was detected during the June 2007 event. A much lower chromium concentration (12.8 µg/L) was detected in the sample obtained in the June 2005 sampling event at this well location. The elevated chromium detected during the June 2007 sampling event, was the only unfiltered bedrock groundwater sample with concentrations exceeding MCL (100 µg/L) and EPA Region III RBC values (110 µg/L). Dissolved chromium was not detected in the sample collected in June 2007. The turbidity level during June 2007 sampling event at well 12MW09S measured 348 NTU. Due to the difference in unfiltered and filtered chromium values, the elevated chromium level is likely a result of high turbidity in the sample. Chromium was detected at a concentration of 23 µg/L in the background bedrock well 11GW10. Based upon the background well sample concentration, most of the chromium detections are attributed to natural background conditions. However, the single elevated detection of chromium in past releases at the bedrock aquifer at 12MW09S may be associated with past releases at the site.

#### 5.2.4.5 Thallium

Thallium was detected during one sampling event at three bedrock well locations; 12MW04S (5.8J µg/L), 12MW07D (6.2J µg/L), and 12MW17D (6.2K µg/L) (Table 5-3). Thallium was not detected in subsequent sampling events of 12MW07D. Thallium was only detected during the most recent sampling event in the samples obtained from 12MW17D. Thallium was detected at concentrations that exceed the MCL (2 µg/L and EPA Region II

RBC (2.6 µg/L) values (Table 5-4). Thallium was not detected in background well 11MW10. However, it was not detected in any of the filtered samples obtained from these three wells either. It was detected in one filtered bedrock sample, as discussed in the following section. Based upon the Site 12 history, it is unlikely that site activities resulted in a release of thallium to the bedrock aquifer. Therefore, it is unlikely this compound is present in Site 12 groundwater, and the detection is considered an anomaly.

### 5.2.5 Dissolved Inorganic Constituents

Nineteen dissolved inorganic constituents were detected in the shallow and deep bedrock monitoring wells at Site 12 (Table 5-3). The dissolved major elements are not discussed separately in this section, but the same data trends are observed in these constituents as were observed in the major elements as discussed in Section 5.2.4.1. Arsenic and thallium are the only constituents detected in filtered samples at concentrations exceeding MCL or EPA Region III RBC Values (Table 5-4).

#### 5.2.5.1 Dissolved Arsenic

Dissolved arsenic has been detected in bedrock wells 12MW05S, 12MW07S, 12MW09S/D, and 12MW21S/D (Table 5-2). However, dissolved arsenic has only been consistently detected at location 12MW09D. Well 12MW09D is located at the former SWMU 37N area. The presence of organics in the bedrock groundwater at this location has likely created reducing conditions in the subsurface and mobilized metals into the groundwater, resulting in increased dissolved arsenic concentrations. Dissolved arsenic has been detected in background well 11GW11S at concentrations up to 4.2 µg/L. This constituent has been detected at relatively low levels in samples obtained from 12MW09S (3 µg/L to 7.3J µg/L). While the consistent detections of dissolved arsenic in well 12MW09S could be attributed to the reducing conditions present at this well, its presence is more likely attributed to natural background conditions.

#### 5.2.5.2 Dissolved Thallium

Dissolved thallium was detected in one sample collected from 12MW21S during the June 2007 sampling round. The concentration of dissolved thallium in this sample (5.8 K µg/L) exceeds the MCL (2 µg/L) and EPA Region III RBC (2.6 µg/L) values. This sample is flagged "K" indicating that it is likely biased higher than the actual concentration. Well 12MW21S is located directly downgradient of the former SWMU 37N area. The presence of organics in the bedrock groundwater at this location has likely created reducing conditions in the subsurface and mobilized metals into the groundwater. However, thallium has not historically been used at Site 12, was not detected at elevated concentrations in other Site 12 wells, and the one elevated detection was "K" flagged. Therefore, it is unlikely this compound is present in Site 12 groundwater, and the detection is considered an anomaly.

## 5.3 Nature and Extent of Contamination Summary

The RI data support the conclusion that former SWMU 37N was a primary source of groundwater contamination at Site 12. Specifically, this conclusion is supported by the fact that the largest number and highest concentration of VOC detections were collected from monitoring wells located near the former SWMU. The nature of the constituents detected in

these wells is generally consistent with the historic use of SWMU 37N, as a sump that received wastewater from operations in Building 167. These building operations included the distillation and storage of solvents that contained TCE and MC. SWMU 37N also likely received waste water from alodining operations as evidenced by hexavalent chromium and elevated chromium detections in wells located near the former SWMU. As stated in Section 2, SWMU 37N was removed in November 2000.

It is not definitively known if SWMU 37N was the only source area for Site 12 groundwater contamination. The Phase III Groundwater Investigation results suggest that the floor drains inside of Building 167 may have served as a source for an alluvial TCE plume centered beneath the building. However, the RI results do not suggest the presence of two distinct plumes. The most recent groundwater data indicate hat TCE at low concentrations near or below its MCL downgradient of Building 167. This TCE may represent the remnants of a plume sourced beneath Building 167 or sourced at SWMU 37N.

A major difference between the Phase III Investigation results and the RI results is the magnitude of the TCE and MC concentrations. The concentrations of TCE and MC are much lower in samples collected in support of the RI, especially the more recent results. While some of the decrease in constituent concentrations may be attributed to differences in sampling methodology, the analytical results from the RI show a decreasing trend over the course of the investigation. Concentrations of MC and TCE in both bedrock and alluvial wells are depicted graphically as trend lines in Appendix E. While specific bedrock and alluvial wells may be depicted with a slight increase in MC or TCE concentrations between sampling events, the average and linear average concentrations of both constituents are graphically depicted as decreasing in the alluvial and bedrock aquifers.

The analytical data presented in this section support the CSMs presented in Section 4. The hydrogeologic CSM for Site 12 suggests that alluvial groundwater can move rather rapidly beneath the site and that the alluvial groundwater is recharged by relatively clean bedrock groundwater. Upwelling of clean bedrock groundwater flowing from the mountains to the south may recharge the alluvium and bedrock aquifers along the eastern (source area) side of Site 12. This would cause contaminated groundwater to flow to the west. This groundwater would then be captured by the highly transmissive bedrock fractures in the northwestern portion of the site and subsequently transported to the northeast, eventually discharging to the North Branch Potomac River.

**TABLE 5-1**
Analytical Results-Alluvial Samples
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| **Station ID** | 12MW01 | | | | 12MW02 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AOCN-GGW14-1 | AS12-12MW01-R02 | AS12-12MW01-0605 | AS12-12MW01-1206 | AOCN-GGW15-1 | AOCN-GGW15-1/DUP | AS12-12MW02-R02 | AS12-12MW02-R02/DUP | AS12-12MW02-0605 | AS12-12MW02-1206 | AS12-12MW02P-1206 |
| **Sample Date** | 07/06/00 | 09/11/03 | 06/01/05 | 12/07/06 | 07/06/00 | 07/06/00 | 09/11/03 | 09/11/03 | 06/01/05 | 12/07/06 | 12/07/06 |
| **Chemical Name** | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Volatile Organic Compounds (UG_L)** | | | | | | | | | | | |
| 1,1,1-Trichloroethane | 1 U | 11 J | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| 1,1,2,2-Tetrachloroethane | 1 U | 0.5 UJ | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| 1,1,2-Trichloroethane | 1 U | 0.5 UJ | 0.5 U | 10 UL | 5.6 U | NA | 0.77 | 0.81 | 0.5 U | 10 UL | 10 UL |
| 1,1-Dichloroethane | 15 | 42 J | 13 | 3.8 L | 15 | NA | 6.7 | 6.7 | 9 | 10 UL | 4.8 L |
| 1,1-Dichloroethene | 1 U | 4.2 J | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| 1,2,4-Trichlorobenzene | NA | 0.5 UJ | 0.5 U | 10 UL | NA | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| 1,2-Dibromo-3-chloropropane | NA | 130 R | 0.5 U | 10 UL | NA | NA | 2.5 R | 2.5 R | 0.5 U | 10 UL | 10 UL |
| 1,2-Dichlorobenzene | NA | 0.64 J | 0.5 U | 1.6 L | NA | NA | 50 | 52 | 82 | 10 UJ | 87 J |
| 1,2-Dichloroethene (total) | 0.8 J | NA | NA | NA | 120 | NA | NA | NA | NA | NA | NA |
| 1,2-Dichloropropane | 1 U | 0.5 UJ | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| 1,3-Dichlorobenzene | NA | 0.5 UJ | 0.5 U | 10 UL | NA | NA | 0.76 | 0.5 U | 0.5 U | 10 UL | 10 UL |
| 1,4-Dichlorobenzene | NA | 0.5 UJ | 0.5 U | 10 UL | NA | NA | 0.5 U | 0.83 | 2.1 | 10 UL | 1.8 L |
| 2-Hexanone | 5 U | 5 UJ | 5 U | 10 UL | 28 U | NA | 5 U | 5 U | 5 U | 10 UL | 10 UL |
| 4-Methyl-2-pentanone | 1 U | 5.1 J | 5 U | 10 UL | 5.6 U | NA | 5 U | 5 U | 5 U | 10 UL | 10 UL |
| Acetone | 5 R | 5.5 B | 5 U | 10 UL | 28 R | NA | 2.2 B | 28 R | 5 U | 10 UL | 10 UL |
| Benzene | 0.23 J | 0.5 UJ | 0.5 U | 10 UL | 1.3 J | NA | 0.63 | 0.65 | 1.8 | 10 UL | 1.4 L |
| Bromodichloromethane | 1 U | 0.5 UJ | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Carbon disulfide | 0.16 J | 0.5 UJ | 0.88 | 10 UL | 5.6 U | NA | 0.3 B | 0.59 B | 0.5 U | 10 UL | 10 UL |
| Chlorobenzene | 0.48 J | 0.5 UJ | 0.5 U | 2.4 L | 43 | NA | 49 | 49 | 99 R | 4 J | 94 J |
| Chloroethane | 1 U | 0.5 UJ | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Chloroform | 1 U | 0.5 UJ | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Cyclohexane | NA | 40 J | 9.6 | 1.3 L | NA | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Ethylbenzene | 1 U | 5.3 J | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Isopropylbenzene | NA | 0.33 J | 0.5 U | 10 UL | NA | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Methane | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Methylcyclohexane | NA | 0.5 UJ | 0.5 U | 10 UL | NA | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Methylene chloride | 6.7 B | 2,900 J | 2.9 B | 10 UL | 6.3 B | NA | 0.82 B | 0.7 B | 4 B | 10 UL | 10 UL |
| Tetrachloroethene | 1 U | 2 J | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 1.9 L | 10 UL |
| Toluene | 1 U | 13 J | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Trichloroethene | 0.1 J | 16 J | 0.5 U | 10 UL | 4.7 J | NA | 3.4 | 3.2 | 1.9 | 1.7 L | 10 UL |
| Vinyl chloride | 3.4 | 8.6 J | 3.1 | 10 UL | 15 | NA | 4.3 | 4.4 | 7.6 | 10 UL | 10 UL |
| Xylene, total | 1 U | 8.7 J | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| cis-1,2-Dichloroethene | NA | 25 J | 1.2 J | 10 UL | NA | NA | 51 | 52 | 22 | 2.4 J | 16 J |
| trans-1,2-Dichloroethene | NA | 27 J | 1.3 J | 10 UL | NA | NA | 1.5 | 1.5 | 1.4 J | 10 UL | 10 UL |
| | | | | | | | | | | | |
| **Semi-volatile Organic Compounds (UG_L)** | | | | | | | | | | | |
| 4-Methylphenol | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Di-n-butylphthalate | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Naphthalene | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Phenol | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| bis(2-Ethylhexyl)phthalate | 5 U | 5.8 U | 10 U | NA | 5 U | 1 B | 5.3 U | 5.3 U | 11 U | NA | NA |
| | | | | | | | | | | | |
| **Explosives (UG_L)** | | | | | | | | | | | |
| Nitrobenzene | 5 U | NA | 0.26 U | NA | 5 U | 5 UJ | NA | NA | 0.26 U | NA | NA |
| Perchlorate | NA | 2 U | 5 U | NA | NA | NA | 2 U | 2 U | 5 U | NA | NA |

**TABLE 5-1**
Analytical Results-Alluvial Samples
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| **Station ID** | 12MW01 | | | | 12MW02 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AOCN-GGW14-1 | AS12-12MW01-R02 | AS12-12MW01-0605 | AS12-12MW01-1206 | AOCN-GGW15-1 | AOCN-GGW15-1/DUP | AS12-12MW02-R02 | AS12-12MW02-R02/DUP | AS12-12MW02-0605 | AS12-12MW02-1206 | AS12-12MW02P-1206 |
| **Sample Date** | 07/06/00 | 09/11/03 | 06/01/05 | 12/07/06 | 07/06/00 | 07/06/00 | 09/11/03 | 09/11/03 | 06/01/05 | 12/07/06 | 12/07/06 |
| **Chemical Name** | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Total Metals (UG_L)** | | | | | | | | | | | |
| Aluminum | 2,080 J | 2,970 | 1,200 | NA | 304 B | NA | 2,710 K | 747 | 7,090 | NA | NA |
| Arsenic | 12.1 | 8.3 J | 3.6 U | NA | 6.1 J | NA | 5.2 J | 5 U | 9.4 J | NA | NA |
| Barium | 316 | 288 J | 166 J | NA | 90.8 B | NA | 72.5 J | 68.7 J | 113 J | NA | NA |
| Beryllium | 0.69 B | 0.25 B | 0.1 J | NA | 0.2 U | NA | 0.08 U | 0.08 U | 0.32 J | NA | NA |
| Cadmium | 0.44 J | 0.89 B | 0.4 U | NA | 0.4 U | NA | 0.4 U | 0.4 U | 0.4 U | NA | NA |
| Calcium | 206,000 | 228,000 | 145,000 | NA | 216,000 | NA | 145,000 | 139,000 | 165,000 | NA | NA |
| Chromium | 7.1 B | 8.7 J | 11.3 | NA | 2.7 B | NA | 5.9 J | 3.7 B | 9.6 B | NA | NA |
| Chromium (hexavalent) | 20 L | 10 U | 10 U | NA | 50 L | 40 L | 10 U | 10 U | 65 | NA | NA |
| Cobalt | 8.3 B | 4.7 J | 2.8 J | NA | 13.9 J | NA | 11.5 J | 9 J | 14 J | NA | NA |
| Copper | 2.2 B | 7 B | 3.6 B | NA | 1.9 U | NA | 5.7 B | 5.3 B | 7.9 B | NA | NA |
| Iron | 40,900 J | 30,100 | 21,300 | NA | 9,450 J | NA | 7,810 | 4,400 | 20,400 | NA | NA |
| Lead | 11.3 | 3.9 B | 2.6 J | NA | 1.8 J | NA | 3.9 B | 1.9 B | 6.2 | NA | NA |
| Magnesium | 41,200 | 46,400 | 33,100 | NA | 52,800 | NA | 35,500 | 32,600 | 41,400 | NA | NA |
| Manganese | 5,760 J | 4,800 | 3,280 | NA | 6,290 J | NA | 3,800 | 3,860 | 5,140 | NA | NA |
| Nickel | 168 | 150 | 89.7 | NA | 120 | NA | 77.3 | 70.2 | 84.9 | NA | NA |
| Potassium | 1,590 J | 3,420 J | 1,510 J | NA | 1,620 J | NA | 2,370 J | 1,750 J | 3,740 J | NA | NA |
| Selenium | 4.3 UL | 3.4 J | 2.6 U | NA | 4.3 UL | NA | 3.7 J | 3.2 UL | 2.6 U | NA | NA |
| Sodium | 75,400 | 91,600 | 57,900 | NA | 54,300 | NA | 40,700 | 40,500 | 46,100 | NA | NA |
| Vanadium | 6.4 J | 5.6 J | 2.6 J | NA | 1.4 U | NA | 5.2 J | 0.7 U | 12.3 J | NA | NA |
| Zinc | 41.6 | 20 B | 10.3 B | NA | 11.2 B | NA | 15.1 J | 11.6 B | 21.9 | NA | NA |
| | | | | | | | | | | | |
| **Dissolved Metals (UG_L)** | | | | | | | | | | | |
| Aluminum | NA | 641 | 67.4 J | NA | NA | NA | 15.1 U | 15.1 U | 40.3 U | NA | NA |
| Arsenic | NA | 5 U | 3.6 U | NA | NA | NA | 7.3 J | 5 U | 3.9 J | NA | NA |
| Barium | NA | 279 J | 161 J | NA | NA | NA | 54.8 J | 56.8 J | 68 J | NA | NA |
| Beryllium | NA | 0.096 B | 0.1 U | NA | NA | NA | 0.08 U | 0.08 U | 0.1 U | NA | NA |
| Calcium | NA | 237,000 | 148,000 | NA | NA | NA | 151,000 | 144,000 | 169,000 | NA | NA |
| Chromium | NA | 2.9 B | 2.7 J | NA | NA | NA | 0.89 B | 0.7 U | 0.6 U | NA | NA |
| Chromium (hexavalent) | NA | 10 U | 10 U | NA | NA | NA | 10 U | 10 U | 10 U | NA | NA |
| Cobalt | NA | 2.7 B | 1.7 J | NA | NA | NA | 13.4 J | 10.9 J | 12.7 J | NA | NA |
| Iron | NA | 26,200 | 19,300 | NA | NA | NA | 3,170 | 3,140 | 7,550 | NA | NA |
| Lead | NA | 1.9 U | 1.8 U | NA | NA | NA | 1.9 U | 1.9 U | 1.8 U | NA | NA |
| Magnesium | NA | 48,000 | 33,900 | NA | NA | NA | 37,600 | 35,400 | 41,600 | NA | NA |
| Manganese | NA | 4,880 | 3,180 | NA | NA | NA | 4,130 | 4,000 | 5,060 | NA | NA |
| Nickel | NA | 143 | 85.2 | NA | NA | NA | 91.8 | 83.5 | 87 | NA | NA |
| Potassium | NA | 3,180 J | 1,320 J | NA | NA | NA | 1,550 J | 1,480 J | 1,280 J | NA | NA |
| Selenium | NA | 3.2 UL | 2.6 U | NA | NA | NA | 3.8 J | 3.2 UL | 2.6 U | NA | NA |
| Sodium | NA | 90,700 | 57,800 | NA | NA | NA | 43,500 | 43,200 | 47,900 | NA | NA |
| Thallium | NA | 5.8 U | 4.6 U | NA | NA | NA | 5.8 U | 5.8 U | 4.6 U | NA | NA |
| Vanadium | NA | 1.6 B | 1.1 U | NA | NA | NA | 0.9 B | 0.7 U | 1.1 U | NA | NA |
| Zinc | NA | 6.6 B | 3.2 B | NA | NA | NA | 8.1 B | 7.5 B | 7.5 B | NA | NA |
| | | | | | | | | | | | |
| **Wet Chemistry (MG_L)** | | | | | | | | | | | |
| Alkalinity | NA | NA | NA | 230 | NA | NA | NA | NA | NA | 200 | 210 |
| Chloride | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Hardness | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Nitrate | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Nitrogen | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Sulfate | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Total organic carbon (TOC) | NA | NA | NA | 1.4 B | NA | NA | NA | NA | NA | 2.2 B | 2.2 B |

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Shading represents detect

**TABLE 5-1**
Analytical Results-Alluvial Samples
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| **Station ID** | 12MW06 | | | 12MW08 | | | | | | 12MW10 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AOCN-GGW16-1 | AOCN-GGW16-2 | AS12-12MW06-R01 | AS12-12MW08-R01 | AS12-12MW08-R02 | AS12-12MW08-R02/DUP | AS12-12MW08-0605 | AS12-12MW08-1206 | AS12-12MW08-0607 | AS12-12MW10-R01 | AS12-12MW10-R02 | AS12-12MW10-0505 | AS12-12MW10-1206 |
| **Sample Date** | 07/06/00 | 07/17/02 | 07/10/03 | 07/09/03 | 09/15/03 | 09/15/03 | 06/02/05 | 12/07/06 | 06/11/07 | 07/09/03 | 09/12/03 | 05/27/05 | 12/07/06 |
| **Chemical Name** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **Volatile Organic Compounds (UG_L)** | | | | | | | | | | | | | |
| 1,1,1-Trichloroethane | 1.2 | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U |
| 1,1,2,2-Tetrachloroethane | 1.2 U | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 3.2 J |
| 1,1,2-Trichloroethane | 1.2 U | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 3.4 J |
| 1,1-Dichloroethane | 2.8 | NA | 1 U | 15 | 15 | 14 | 12 | 6.2 J | 2.4 | 1.5 | 1.4 | 1.1 | 10 U |
| 1,1-Dichloroethene | 0.25 J | NA | 1 U | 0.46 J | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U |
| 1,2,4-Trichlorobenzene | NA | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 1.3 J |
| 1,2-Dibromo-3-chloropropane | NA | NA | 1 U | 1 U | 13 R | 13 R | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 R | 0.5 U | 3.8 J |
| 1,2-Dichlorobenzene | NA | NA | 1 U | 0.76 J | 1.2 | 1.2 | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U |
| 1,2-Dichloroethene (total) | 20 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1,2-Dichloropropane | 1.2 U | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U |
| 1,3-Dichlorobenzene | NA | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U |
| 1,4-Dichlorobenzene | NA | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U |
| 2-Hexanone | 6.2 U | NA | 5 U | 5 U | 5 U | 5 U | 5 U | 10 U | 5 U | 5 U | 5 U | 5 U | 10 U |
| 4-Methyl-2-pentanone | 1.2 U | NA | 5 U | 5 U | 3.4 J | 4.2 J | 5 U | 10 U | 5 U | 5 U | 5 U | 5 U | 10 U |
| Acetone | 6.2 R | NA | 5 U | 3.4 B | 4 B | 4 B | 5 U | 10 U | 3.8 J | 1.8 B | 2.7 B | 5 UJ | 10 U |
| Benzene | 0.14 J | NA | 1 U | 0.43 J | 0.44 J | 0.39 J | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 1.8 J |
| Bromodichloromethane | 1.2 U | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U |
| Carbon disulfide | 1.2 U | NA | 1.1 | 0.57 J | 2.3 B | 1.9 B | 0.87 | 10 U | 0.5 U | 0.7 J | 1.7 B | 0.5 U | 10 U |
| Chlorobenzene | 5.9 | NA | 1 U | 1 U | 0.86 | 0.83 | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U |
| Chloroethane | 1.2 U | NA | 1 U | 8.4 | 2.8 | 3 | 1.8 | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U |
| Chloroform | 1.2 U | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U |
| Cyclohexane | NA | NA | 1 U | 300 | 370 J | 370 | 81 | 18 | 4.8 | 1 U | 0.96 B | 0.5 U | 10 U |
| Ethylbenzene | 1.2 U | NA | 1 U | 53 | 42 | 43 | 0.45 J | 1.4 J | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U |
| Isopropylbenzene | NA | NA | 1 U | 3.9 | 4.2 | 3.8 | 2 | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U |
| Methane | NA | NA | NA | NA | NA | NA | NA | NA | 2,400 | NA | NA | NA | NA |
| Methylcyclohexane | NA | NA | 1 U | 3.4 | 3.3 | 3.1 | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U |
| Methylene chloride | 9.2 B | NA | 0.67 B | 2 B | 31 J | 36 J | 11 B | 10 U | 0.62 B | 1.2 B | 1.2 B | 0.5 U | 10 U |
| Tetrachloroethene | 0.76 J | NA | 0.82 J | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 1.4 J |
| Toluene | 1.2 U | NA | 1 U | 2.4 | 20 | 19 | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U |
| Trichloroethene | 28 | NA | 1.8 | 2 | 0.73 | 0.76 | 0.5 U | 10 U | 0.62 | 0.87 J | 0.78 | 0.5 U | 2.6 J |
| Vinyl chloride | 1.3 | NA | 1 U | 6 | 2.5 | 2.4 | 0.55 | 10 U | 0.5 U | 1.4 | 0.53 | 0.66 | 10 U |
| Xylene, total | 1.2 U | NA | 1 U | 1 U | 11 | 11 | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U |
| cis-1,2-Dichloroethene | NA | NA | 0.98 J | 4 | 3.1 | 3.2 | 0.4 J | 10 U | 0.5 U | 1.3 | 1.1 | 1.3 | 3 J |
| trans-1,2-Dichloroethene | NA | NA | 1 U | 7.4 | 5.1 | 5 | 0.79 | 10 U | 0.92 | 1.2 | 0.99 | 0.73 | 2.1 J |
| | | | | | | | | | | | | | |
| **Semi-volatile Organic Compounds (UG_L)** | | | | | | | | | | | | | |
| 4-Methylphenol | 5 U | NA | NA | NA | 2.5 J | 2.9 J | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA |
| Di-n-butylphthalate | 5 U | NA | NA | NA | 8.4 | 10 | 1.5 J | NA | 11 U | NA | 5.3 U | 11 U | NA |
| Naphthalene | 5 U | NA | NA | NA | 1.1 J | 1.3 J | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA |
| Phenol | 5 U | NA | NA | NA | 8.5 | 10 | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA |
| bis(2-Ethylhexyl)phthalate | 5 U | NA | NA | NA | 5.3 U | 1.1 J | 2.5 J | NA | 2.5 B | NA | 5.3 U | 11 U | NA |
| | | | | | | | | | | | | | |
| **Explosives (UG_L)** | | | | | | | | | | | | | |
| Nitrobenzene | 5 U | NA | NA | NA | NA | NA | 0.26 U | NA | NA | NA | 0.26 U | 0.26 U | NA |
| Perchlorate | NA | 4 U | NA | NA | 13 | 13 | 2 U | NA | 0.0612 U | NA | 3 U | 5 U | NA |

**TABLE 5-1**
Analytical Results-Alluvial Samples
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| **Station ID** | 12MW06 | | | 12MW08 | | | | | | 12MW10 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AOCN-GGW16-1 | AOCN-GGW16-2 | AS12-12MW06-R01 | AS12-12MW08-R01 | AS12-12MW08-R02 | AS12-12MW08-R02/DUP | AS12-12MW08-0605 | AS12-12MW08-1206 | AS12-12MW08-0607 | AS12-12MW10-R01 | AS12-12MW10-R02 | AS12-12MW10-0505 | AS12-12MW10-1206 |
| **Sample Date** | 07/06/00 | 07/17/02 | 07/10/03 | 07/09/03 | 09/15/03 | 09/15/03 | 06/02/05 | 12/07/06 | 06/11/07 | 07/09/03 | 09/12/03 | 05/27/05 | 12/07/06 |
| **Chemical Name** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **Total Metals (UG_L)** | | | | | | | | | | | | | |
| Aluminum | 5,650 J | NA | NA | NA | 3,140 K | 3,310 K | 1,270 | NA | 960 J | NA | 3,830 | 6,570 | NA |
| Arsenic | 6.5 J | NA | NA | NA | 12 K | 7.3 J | 12 | NA | 11.1 K | NA | 5 U | 3.6 U | NA |
| Barium | 141 J | NA | NA | NA | 179 J | 182 J | 130 J | NA | 173 J | NA | 30.9 J | 44.8 J | NA |
| Beryllium | 0.8 B | NA | NA | NA | 0.12 B | 0.08 U | 0.11 J | NA | 5 U | NA | 0.24 B | 0.32 J | NA |
| Cadmium | 0.4 U | NA | NA | NA | 0.4 U | 0.4 U | 0.4 U | NA | 5 U | NA | 0.57 B | 0.57 J | NA |
| Calcium | 224,000 | NA | NA | NA | 102,000 | 102,000 | 88,800 | NA | 320,000 | NA | 223,000 | 234,000 | NA |
| Chromium | 34.4 | NA | NA | NA | 7.7 J | 7.8 J | 4 J | NA | 3.9 B | NA | 4.9 J | 8.2 B | NA |
| Chromium (hexavalent) | 50 L | NA | NA | NA | 10 U | 10 U | 24 | NA | 10 U | NA | 10 U | 64 | NA |
| Cobalt | 13.7 J | NA | NA | NA | 18.2 J | 18.5 J | 8.6 J | NA | 3.8 J | NA | 3.1 B | 4.2 J | NA |
| Copper | 23.8 B | NA | NA | NA | 3.8 B | 4.2 B | 3.3 B | NA | 4.6 B | NA | 6.1 B | 8.3 B | NA |
| Iron | 13,900 J | NA | NA | NA | 48,500 | 48,900 | 36,400 | NA | 20,500 | NA | 4,870 | 7,660 | NA |
| Lead | 13.1 | NA | NA | NA | 4.4 B | 4 B | 1.8 U | NA | 10 U | NA | 4.4 B | 5.1 | NA |
| Magnesium | 33,400 | NA | NA | NA | 17,600 | 17,600 | 18,000 | NA | 89,700 | NA | 71,300 | 72,800 | NA |
| Manganese | 1,200 J | NA | NA | NA | 1,730 | 1,730 | 1,340 | NA | 1,520 | NA | 479 | 786 | NA |
| Nickel | 70 L | NA | NA | NA | 324 | 324 | 337 | NA | 116 | NA | 8.6 B | 10.9 B | NA |
| Potassium | 3,210 J | NA | NA | NA | 1,740 J | 1,840 J | 955 J | NA | 3,300 J | NA | 4,300 J | 4,830 J | NA |
| Selenium | 4.3 UL | NA | NA | NA | 3.2 UL | 3.2 UL | 4.2 B | NA | 35 U | NA | 4.8 B | 2.6 U | NA |
| Sodium | 18,500 | NA | NA | NA | 108,000 | 107,000 | 73,700 | NA | 33,100 | NA | 7,730 | 4,680 J | NA |
| Vanadium | 9 J | NA | NA | NA | 8.1 J | 7.7 J | 3.6 J | NA | 2.2 J | NA | 6.1 J | 11.7 B | NA |
| Zinc | 36.8 L | NA | NA | NA | 19.8 J | 20.4 K | 13.8 B | NA | 14.3 B | NA | 30.9 B | 50.5 | NA |
| | | | | | | | | | | | | | |
| **Dissolved Metals (UG_L)** | | | | | | | | | | | | | |
| Aluminum | NA | NA | NA | NA | 1,050 K | 1,200 K | 40.3 U | NA | 200 UJ | NA | 1,630 J | 40.3 U | NA |
| Arsenic | NA | NA | NA | NA | 8.9 J | 8.7 J | 8.5 J | NA | 7.9 K | NA | 5 U | 3.6 U | NA |
| Barium | NA | NA | NA | NA | 176 J | 186 J | 121 J | NA | 164 J | NA | 22.8 J | 21 J | NA |
| Beryllium | NA | NA | NA | NA | 0.08 U | 0.08 U | 0.1 U | NA | 5 U | NA | 0.18 B | 0.1 U | NA |
| Calcium | NA | NA | NA | NA | 106,000 | 112,000 | 87,600 | NA | 321,000 | NA | 223,000 | 234,000 | NA |
| Chromium | NA | NA | NA | NA | 4 B | 4.8 J | 0.6 U | NA | 2.1 B | NA | 2.2 B | 0.6 U | NA |
| Chromium (hexavalent) | NA | NA | NA | NA | 10 U | 10 U | 11 | NA | NA | NA | 10 U | 10 U | NA |
| Cobalt | NA | NA | NA | NA | 15.8 J | 14.7 J | 7.3 J | NA | 3.1 J | NA | 2.2 B | 1.1 B | NA |
| Iron | NA | NA | NA | NA | 47,400 | 50,300 | 32,600 | NA | 17,400 | NA | 2,220 | 28.7 B | NA |
| Lead | NA | NA | NA | NA | 1.9 U | 3.9 B | 1.8 U | NA | 10 U | NA | 2 B | 1.8 U | NA |
| Magnesium | NA | NA | NA | NA | 18,000 | 19,100 | 17,500 | NA | 90,300 | NA | 71,400 | 72,400 | NA |
| Manganese | NA | NA | NA | NA | 1,800 | 1,920 | 1,360 | NA | 1,440 | NA | 470 | 513 | NA |
| Nickel | NA | NA | NA | NA | 314 | 291 | 318 | NA | 101 | NA | 5.9 J | 4.5 J | NA |
| Potassium | NA | NA | NA | NA | 1,280 J | 1,280 J | 690 J | NA | 3,280 J | NA | 3,620 J | 2,740 J | NA |
| Selenium | NA | NA | NA | NA | 3.2 UL | 3.2 UL | 2.6 U | NA | 35 U | NA | 3.2 U | 2.6 U | NA |
| Sodium | NA | NA | NA | NA | 106,000 | 100,000 | 71,200 | NA | 31,000 | NA | 7,570 K | 4,460 J | NA |
| Thallium | NA | NA | NA | NA | 5.8 U | 5.8 U | 4.6 U | NA | 6.2 K | NA | 5.8 U | 4.6 U | NA |
| Vanadium | NA | NA | NA | NA | 4.1 J | 4.2 J | 1.1 J | NA | 50 U | NA | 2.4 B | 1.1 U | NA |
| Zinc | NA | NA | NA | NA | 9.7 B | 12 B | 7 B | NA | 8.1 B | NA | 17.8 B | 3.4 B | NA |
| | | | | | | | | | | | | | |
| **Wet Chemistry (MG_L)** | | | | | | | | | | | | | |
| Alkalinity | NA | NA | NA | NA | NA | NA | NA | 220 | NA | NA | NA | NA | 240 |
| Chloride | NA | NA | NA | NA | NA | NA | NA | NA | 53 | NA | NA | NA | NA |
| Hardness | NA | NA | NA | NA | NA | NA | NA | NA | 1,400 | NA | NA | NA | NA |
| Nitrate | NA | NA | NA | NA | NA | NA | NA | NA | 0.1 U | NA | NA | NA | NA |
| Nitrogen | NA | NA | NA | NA | NA | NA | NA | NA | 0.16 | NA | NA | NA | NA |
| Sulfate | NA | NA | NA | NA | NA | NA | NA | NA | 1,000 | NA | NA | NA | NA |
| Total organic carbon (TOC) | NA | NA | NA | NA | NA | NA | NA | 6.1 B | 2.9 | NA | NA | NA | 1 U |

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probabl
Shading represents detect

**TABLE 5-1**
Analytical Results-Alluvial Samples
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| **Station ID** | | 12MW12 | | 12MW14 | | 12MW15 | | | | 12MW16 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW10-0607 | AS12-12MW12-R02 | AS12-12MW12-0505 | AS12-12MW14-R02 | AS12-12MW14-0505 | AS12-12MW15-R01 | AS12-12MW15-R02 | AS12-12MW15-0505 | AS12-12MW15-1206 | AS12-12MW16-R01 | AS12-12MW16-R02 | AS12-12MW16-0605 | AS12-12MW16-1206 |
| **Sample Date** | 06/12/07 | 09/11/03 | 05/24/05 | 09/11/03 | 05/26/05 | 07/10/03 | 09/15/03 | 05/27/05 | 12/07/06 | 07/10/03 | 09/12/03 | 06/01/05 | 12/06/06 |
| **Chemical Name** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **Volatile Organic Compounds (UG_L)** | | | | | | | | | | | | | |
| 1,1,1-Trichloroethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL |
| 1,1,2,2-Tetrachloroethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL |
| 1,1,2-Trichloroethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 UJ | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL |
| 1,1-Dichloroethane | 0.64 | 0.5 U | 0.5 U | 2.4 | 1.8 | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.32 J | 1.1 | 10 UL |
| 1,1-Dichloroethene | 0.5 U | 0.5 U | 0.5 U | 0.36 J | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL |
| 1,2,4-Trichlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL |
| 1,2-Dibromo-3-chloropropane | 0.5 U | 0.5 R | 0.5 U | 0.5 R | 0.5 U | 1 U | 0.5 R | 0.5 U | 10 UL | 1 U | 0.5 R | 0.5 U | 10 R |
| 1,2-Dichlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.39 J | 2.4 | 10 UL |
| 1,2-Dichloroethene (total) | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1,2-Dichloropropane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.96 | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL |
| 1,3-Dichlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL |
| 1,4-Dichlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL |
| 2-Hexanone | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 10 UL | 5 U | 5 U | 5 U | 10 UL |
| 4-Methyl-2-pentanone | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 10 UL | 5 U | 5 U | 5 U | 10 UL |
| Acetone | 5 U | 2.1 B | 5 U | 5 R | 5 U | 1.5 B | 5 R | 5 UJ | 10 UL | 4.5 B | 5 R | 5 U | 10 UL |
| Benzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL |
| Bromodichloromethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.61 | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL |
| Carbon disulfide | 0.5 U | 0.58 B | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.31 B | 0.5 U | 10 UL | 0.77 J | 1.3 B | 0.5 U | 10 UL |
| Chlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 3.5 | 10 UL |
| Chloroethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL |
| Chloroform | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 2.2 | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL |
| Cyclohexane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL |
| Ethylbenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL |
| Isopropylbenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL |
| Methane | 30 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Methylcyclohexane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1.3 | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL |
| Methylene chloride | 0.5 U | 0.8 B | 3.2 B | 0.79 B | 4.4 | 0.57 B | 0.5 UJ | 0.5 U | 10 UL | 0.69 B | 1.3 B | 3.4 B | 10 UL |
| Tetrachloroethene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL |
| Toluene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL |
| Trichloroethene | 0.5 U | 0.46 J | 0.5 U | 2.4 | 1.4 | 1 U | 0.5 U | 0.5 U | 10 UL | 0.89 J | 1.5 | 2.9 | 2.4 L |
| Vinyl chloride | 0.5 UJ | 0.5 U | 0.5 U | 0.4 J | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.48 J | 10 UL |
| Xylene, total | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL |
| cis-1,2-Dichloroethene | 0.66 | 0.5 U | 0.5 U | 2.5 | 1.6 | 1 U | 0.5 UJ | 0.5 U | 10 UL | 1 U | 0.5 U | 1.7 | 10 UL |
| trans-1,2-Dichloroethene | 0.44 J | 0.5 U | 0.5 U | 1.4 | 0.5 U | 1 U | 0.5 UJ | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL |
| | | | | | | | | | | | | | |
| **Semi-volatile Organic Compounds (UG_L)** | | | | | | | | | | | | | |
| 4-Methylphenol | 10 U | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA |
| Di-n-butylphthalate | 10 U | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA |
| Naphthalene | 10 U | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA |
| Phenol | 10 U | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA |
| bis(2-Ethylhexyl)phthalate | 10 U | 5 U | 1.4 B | 5.3 U | 5.3 B | NA | 5.3 U | 1.1 J | NA | NA | 5.3 U | 10 U | NA |
| | | | | | | | | | | | | | |
| **Explosives (UG_L)** | | | | | | | | | | | | | |
| Nitrobenzene | NA | 0.26 U | 0.26 U | 0.26 U | 0.26 U | NA | 0.26 U | 0.044 J | NA | NA | 0.26 U | 0.26 U | NA |
| Perchlorate | 0.0612 U | 2 U | 2 U | 4 U | 2 U | NA | 3 U | 5 U | NA | NA | 2 U | 5 U | NA |

**TABLE 5-1**
Analytical Results-Alluvial Samples
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| **Station ID** | | 12MW12 | | 12MW14 | | 12MW15 | | | | 12MW16 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW10-0607 | AS12-12MW12-R02 | AS12-12MW12-0505 | AS12-12MW14-R02 | AS12-12MW14-0505 | AS12-12MW15-R01 | AS12-12MW15-R02 | AS12-12MW15-0505 | AS12-12MW15-1206 | AS12-12MW16-R01 | AS12-12MW16-R02 | AS12-12MW16-0605 | AS12-12MW16-1206 |
| **Sample Date** | 06/12/07 | 09/11/03 | 05/24/05 | 09/11/03 | 05/26/05 | 07/10/03 | 09/15/03 | 05/27/05 | 12/07/06 | 07/10/03 | 09/12/03 | 06/01/05 | 12/06/06 |
| **Chemical Name** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **Total Metals (UG_L)** | | | | | | | | | | | | | |
| Aluminum | 1,450 | 662 | 229 B | 1,940 | 17,200 | NA | 1,010 | 69.8 J | NA | NA | 6,430 | 2,790 | NA |
| Arsenic | 10 U | 5 U | 3.6 U | 5 U | 7.8 J | NA | 5 U | 16.3 | NA | NA | 5 U | 3.6 U | NA |
| Barium | 25.8 J | 65.2 J | 57.3 J | 81.7 J | 165 J | NA | 19.1 J | 14 J | NA | NA | 59.2 J | 41.9 J | NA |
| Beryllium | 0.32 J | 0.08 U | 0.1 U | 0.1 B | 0.85 J | NA | 0.15 B | 0.28 J | NA | NA | 0.32 B | 0.11 J | NA |
| Cadmium | 5 U | 0.4 U | 0.4 U | 0.48 B | 0.62 J | NA | 0.4 U | 0.4 U | NA | NA | 0.4 U | 0.4 U | NA |
| Calcium | 218,000 | 147,000 | 137,000 | 201,000 | 205,000 | NA | 280,000 | 283,000 | NA | NA | 199,000 | 206,000 | NA |
| Chromium | 2.7 B | 1.4 B | 10.7 | 14.8 | 37.2 | NA | 16.1 | 1.2 B | NA | NA | 13.3 | 6.5 B | NA |
| Chromium (hexavalent) | 10 U | 10 U | 10 U | 10 U | 10 U | NA | 10 U | 10 U | NA | NA | 10 U | 68 | NA |
| Cobalt | 2.5 B | 0.7 U | 0.7 U | 2.3 B | 8.6 J | NA | 1.1 B | 0.7 U | NA | NA | 4.6 J | 4.1 J | NA |
| Copper | 2.4 B | 3.8 B | 2 B | 9.8 B | 19.3 J | NA | 4.8 B | 1.9 B | NA | NA | 8.2 B | 3.8 B | NA |
| Iron | 1,800 | 827 | 405 | 2,450 | 27,600 | NA | 2,110 | 13,900 | NA | NA | 5,920 | 2,470 | NA |
| Lead | 2.4 J | 1.9 U | 1.8 U | 1.9 B | 14.6 | NA | 1.9 U | 1.8 U | NA | NA | 3.7 B | 2.2 J | NA |
| Magnesium | 69,100 | 35,900 | 30,600 | 49,100 | 56,700 | NA | 78,200 | 79,800 | NA | NA | 54,600 | 54,900 | NA |
| Manganese | 582 | 19.1 | 20.6 | 242 | 655 | NA | 81.4 | 20.5 | NA | NA | 742 | 892 | NA |
| Nickel | 5.2 B | 1.9 B | 9.4 J | 23.3 J | 38.1 J | NA | 11.2 J | 1.2 U | NA | NA | 16.2 J | 11.3 J | NA |
| Potassium | 3,070 J | 2,380 J | 2,040 J | 2,220 J | 6,380 | NA | 3,790 J | 3,160 J | NA | NA | 4,080 J | 2,830 J | NA |
| Selenium | 35 U | 3.2 UL | 2.6 U | 3.2 UL | 3 J | NA | 3.2 UL | 2.6 U | NA | NA | 3.2 UL | 2.6 U | NA |
| Sodium | 4,320 J | 34,700 | 36,300 | 33,400 | 27,800 | NA | 5,230 K | 4,180 J | NA | NA | 21,500 | 23,100 | NA |
| Vanadium | 2.4 J | 0.86 B | 1.1 U | 2.6 B | 29.6 J | NA | 1.2 B | 1.1 U | NA | NA | 9.7 J | 4.4 J | NA |
| Zinc | 24.8 B | 7.8 B | 7 J | 20.4 B | 42.6 | NA | 14.4 B | 9 B | NA | NA | 24.1 B | 11.4 B | NA |
| | | | | | | | | | | | | | |
| **Dissolved Metals (UG_L)** | | | | | | | | | | | | | |
| Aluminum | 200 U | 675 | 40.3 U | 766 | 40.3 U | NA | 85.9 B | 40.3 U | NA | NA | 4,210 J | 40.3 U | NA |
| Arsenic | 10 U | 5 U | 3.6 U | 5 U | 3.6 U | NA | 5 U | 3.6 U | NA | NA | 5 U | 3.6 U | NA |
| Barium | 20.4 J | 64.4 J | 55.2 J | 71.6 J | 77.4 J | NA | 14.3 J | 12 J | NA | NA | 68.1 J | 27.6 J | NA |
| Beryllium | 5 U | 0.08 U | 0.1 U | 0.08 U | 0.1 U | NA | 0.08 U | 0.1 U | NA | NA | 0.24 B | 0.1 U | NA |
| Calcium | 223,000 | 141,000 | 133,000 | 198,000 | 202,000 | NA | 278,000 | 280,000 | NA | NA | 178,000 | 231,000 | NA |
| Chromium | 10 U | 1.1 B | 3.1 J | 3.3 B | 0.6 U | NA | 1.8 B | 0.6 U | NA | NA | 19.6 | 0.6 U | NA |
| Chromium (hexavalent) | NA | 10 U | 10 U | 10 U | 10 U | NA | 10 U | 10 U | NA | NA | 10 U | 10 U | NA |
| Cobalt | 1.7 B | 0.7 U | 0.7 U | 1.4 B | 1.5 J | NA | 0.99 B | 0.7 U | NA | NA | 4.3 J | 3.4 J | NA |
| Iron | 24.2 J | 914 | 16.3 U | 1,280 | 16.3 U | NA | 606 | 431 | NA | NA | 4,590 | 16.3 U | NA |
| Lead | 10 U | 1.9 U | 1.8 U | 1.9 U | 1.8 U | NA | 1.9 U | 1.8 U | NA | NA | 3.1 B | 1.8 U | NA |
| Magnesium | 71,300 | 34,400 | 29,700 | 48,900 | 51,100 | NA | 77,700 | 78,900 | NA | NA | 47,000 | 62,700 | NA |
| Manganese | 455 | 21.7 | 8.9 J | 261 | 2.6 J | NA | 42.4 | 19.3 | NA | NA | 647 | 1,050 | NA |
| Nickel | 4.1 J | 2.2 J | 7.4 J | 16.9 J | 10.9 J | NA | 2.5 J | 1.2 U | NA | NA | 22.9 J | 10.5 J | NA |
| Potassium | 2,700 J | 2,330 J | 1,950 J | 1,910 J | 1,370 J | NA | 3,580 J | 3,080 J | NA | NA | 3,420 J | 2,270 J | NA |
| Selenium | 35 U | 3.2 UL | 2.6 U | 3.2 UL | 2.6 U | NA | 3.2 UL | 2.6 U | NA | NA | 3.2 U | 2.6 U | NA |
| Sodium | 4,230 J | 33,800 | 35,500 | 31,600 | 27,900 | NA | 4,820 J | 3,780 J | NA | NA | 19,600 | 23,200 | NA |
| Thallium | 25 U | 5.8 U | 5.4 B | 5.8 U | 4.6 U | NA | 5.8 U | 4.6 U | NA | NA | 5.8 U | 4.6 U | NA |
| Vanadium | 50 U | 0.7 U | 1.1 U | 0.7 U | 1.1 U | NA | 0.7 U | 1.1 U | NA | NA | 7 J | 1.1 U | NA |
| Zinc | 12.6 B | 7.5 B | 6.9 J | 13.9 B | 4.5 B | NA | 9.5 B | 3.3 J | NA | NA | 21 B | 4.6 B | NA |
| | | | | | | | | | | | | | |
| **Wet Chemistry (MG_L)** | | | | | | | | | | | | | |
| Alkalinity | NA | NA | NA | NA | NA | NA | NA | NA | 1 U | NA | NA | NA | 240 |
| Chloride | 42 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Hardness | 870 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Nitrate | 0.1 U | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Nitrogen | 0.1 U | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Sulfate | 610 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Total organic carbon (TOC) | 1.3 | NA | NA | NA | NA | NA | NA | NA | 1 U | NA | NA | NA | 1.1 |

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably
Shading represents detect

**TABLE 5-1**
Analytical Results-Alluvial Samples
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| **Station ID** | | 12MW18 | | | | 12MW19 | | | 12MW23 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW16-0607 | AS12-12MW18-R02 | AS12-12MW18-0505 | AS12-12MW18-0607 | AS12-12MW18P-0607 | AS12-12MW19-R02 | AS12-12MW19-0505 | AS12-12MW19-0607 | AS12-12MW23-1206 | AS12-12MW23-0607 | AS12-12MW23P-0607 |
| **Sample Date** | 06/13/07 | 09/11/03 | 05/26/05 | 06/12/07 | 06/12/07 | 09/12/03 | 05/25/05 | 06/12/07 | 12/06/06 | 06/12/07 | 06/12/07 |
| **Chemical Name** | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Volatile Organic Compounds (UG_L)** | | | | | | | | | | | |
| 1,1,1-Trichloroethane | 0.5 U | 0.31 J | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,1,2,2-Tetrachloroethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,1,2-Trichloroethane | 0.5 U | 0.79 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,1-Dichloroethane | 0.5 U | 1.7 | 1.3 | 0.83 | 0.83 | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,1-Dichloroethene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,2,4-Trichlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,2-Dibromo-3-chloropropane | 0.5 U | 0.5 R | 0.5 U | 0.5 U | 0.5 U | 0.5 R | 0.5 U | 0.5 U | 10 R | 0.5 U | 0.5 U |
| 1,2-Dichlorobenzene | 0.58 | 5.6 | 0.5 U | 2.4 | 2.5 | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,2-Dichloroethene (total) | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1,2-Dichloropropane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,3-Dichlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,4-Dichlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 2-Hexanone | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 10 UL | 2 J | 5 U |
| 4-Methyl-2-pentanone | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 10 UL | 5 U | 5 U |
| Acetone | 5 U | 1.8 B | 5 U | 5 U | 3.6 J | 5 R | 5 U | 5 U | 38 L | 5 U | 5 U |
| Benzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Bromodichloromethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Carbon disulfide | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Chlorobenzene | 0.5 U | 3.8 | 0.5 U | 2.6 | 2.7 | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Chloroethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Chloroform | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Cyclohexane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Ethylbenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Isopropylbenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Methane | 5.3 | NA | NA | 3.3 U | 9.2 | NA | NA | 3.3 U | NA | 3.3 U | 6.4 |
| Methylcyclohexane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Methylene chloride | 0.72 B | 0.78 B | 0.5 U | 0.5 U | 0.46 B | 1.4 B | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Tetrachloroethene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.87 | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Toluene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Trichloroethene | 0.88 | 24 | 9.4 | 8.8 | 8.6 | 0.78 | 0.41 J | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Vinyl chloride | 0.5 U | 0.59 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Xylene, total | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| cis-1,2-Dichloroethene | 0.5 U | 12 | 7.5 | 11 | 11 | 0.33 J | 0.5 UJ | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| trans-1,2-Dichloroethene | 0.5 U | 0.71 | 0.5 U | 0.42 J | 0.51 | 0.5 U | 0.5 UJ | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| | | | | | | | | | | | |
| **Semi-volatile Organic Compounds (UG_L)** | | | | | | | | | | | |
| 4-Methylphenol | 11 U | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Di-n-butylphthalate | 11 U | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Naphthalene | 11 U | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Phenol | 11 U | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| bis(2-Ethylhexyl)phthalate | 3.1 B | 5.1 U | 1.3 B | 11 U | 2.8 B | 5.3 U | 1.5 B | 10 U | NA | 7.8 B | 2.6 B |
| | | | | | | | | | | | |
| **Explosives (UG_L)** | | | | | | | | | | | |
| Nitrobenzene | NA | 0.26 U | 0.26 U | NA | NA | 0.26 U | 0.26 U | NA | NA | NA | NA |
| Perchlorate | 0.0612 U | 4 U | 2 U | 0.0612 U | 0.0612 U | 2 U | 2 U | 0.329 | NA | 0.19 J | 0.216 |

**TABLE 5-1**
Analytical Results-Alluvial Samples
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| **Station ID** | | 12MW18 | | | | 12MW19 | | | 12MW23 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW16-0607 | AS12-12MW18-R02 | AS12-12MW18-0505 | AS12-12MW18-0607 | AS12-12MW18P-0607 | AS12-12MW19-R02 | AS12-12MW19-0505 | AS12-12MW19-0607 | AS12-12MW23-1206 | AS12-12MW23-0607 | AS12-12MW23P-0607 |
| **Sample Date** | 06/13/07 | 09/11/03 | 05/26/05 | 06/12/07 | 06/12/07 | 09/12/03 | 05/25/05 | 06/12/07 | 12/06/06 | 06/12/07 | 06/12/07 |
| **Chemical Name** | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Total Metals (UG_L)** | | | | | | | | | | | |
| Aluminum | 129 J | 3,720 | 2,590 | 2,580 | 2,590 | 316 | 989 | 759 | NA | 8,360 | 7,720 |
| Arsenic | 10 U | 5 U | 3.6 U | 10 U | 10 U | 5 U | 5.7 J | 10 U | NA | 3.7 J | 3 J |
| Barium | 23.8 J | 98.4 J | 71.8 J | 77.8 J | 77.1 J | 50.3 J | 54.1 J | 64.6 J | NA | 84.8 J | 79.1 J |
| Beryllium | 5 U | 0.25 B | 0.16 J | 0.57 J | 5 U | 0.08 U | 0.1 U | 5 U | NA | 0.51 J | 0.46 J |
| Cadmium | 5 U | 0.4 U | 0.4 U | 5 U | 5 U | 0.4 U | 0.4 U | 5 U | NA | 5 U | 5 U |
| Calcium | 230,000 | 156,000 | 153,000 | 178,000 | 184,000 | 170,000 | 173,000 | 171,000 | NA | 180,000 | 178,000 |
| Chromium | 2.4 J | 8.8 J | 6.3 J | 4.4 B | 3.9 B | 3.4 B | 5.6 B | 4.1 B | NA | 13.7 K | 14.1 K |
| Chromium (hexavalent) | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 16 | 10 U | NA | 10 U | 10 U |
| Cobalt | 2.4 B | 6.2 J | 5.2 J | 8.1 J | 8.5 J | 0.7 U | 0.7 U | 1.1 B | NA | 5.7 J | 4.9 J |
| Copper | 3.6 B | 9.1 B | 7.1 B | 5.6 B | 7.2 B | 2.8 B | 0.8 U | 2.7 B | NA | 11.6 J | 11.6 J |
| Iron | 85.8 B | 6,610 | 3,480 | 3,560 | 3,340 | 499 | 1,330 | 1,140 | NA | 12,800 | 11,500 |
| Lead | 10 U | 4.6 B | 1.8 U | 2.7 J | 10 U | 1.9 U | 1.8 U | 10 U | NA | 6.8 J | 5.7 J |
| Magnesium | 61,000 | 29,100 | 28,500 | 34,800 | 36,400 | 45,300 | 46,100 | 48,600 | NA | 51,400 | 50,900 |
| Manganese | 854 | 788 | 1,230 | 1,080 | 1,250 | 19.5 B | 32.7 | 91 | NA | 357 | 335 |
| Nickel | 3.7 J | 30.3 J | 19.8 J | 17.7 J | 17.8 J | 2.5 B | 4.9 B | 3.7 B | NA | 19.3 J | 18.6 J |
| Potassium | 2,220 J | 3,040 J | 2,150 J | 2,170 J | 2,200 J | 2,520 J | 2,570 J | 2,560 J | NA | 3,890 J | 3,800 J |
| Selenium | 35 U | 3.2 UL | 2.6 U | 35 U | 35 U | 4.2 B | 2.6 U | 35 U | NA | 35 U | 35 U |
| Sodium | 21,200 | 41,500 | 32,900 | 34,900 | 34,900 | 39,700 | 32,200 | 40,800 | NA | 19,800 | 19,700 |
| Vanadium | 0.54 J | 6.3 J | 4.7 J | 3.7 J | 4.2 J | 0.7 U | 1.6 J | 1 J | NA | 13.9 J | 13.1 J |
| Zinc | 27.6 B | 21 B | 10.2 B | 23.7 B | 25.1 B | 10.6 B | 9.1 B | 15.9 B | NA | 45.3 B | 39.8 B |
| | | | | | | | | | | | |
| **Dissolved Metals (UG_L)** | | | | | | | | | | | |
| Aluminum | 200 U | 282 | 40.3 U | 200 U | 200 U | 229 B | 40.3 U | 200 U | NA | 200 U | 200 U |
| Arsenic | 2.5 K | 5 U | 3.6 U | 10 U | 10 U | 5 U | 3.6 U | 10 U | NA | 10 U | 10 U |
| Barium | 23.4 J | 73.4 J | 57.3 J | 64 J | 64.9 J | 49.2 J | 49 J | 55.6 J | NA | 38.5 J | 38.8 J |
| Beryllium | 5 U | 0.08 U | 0.1 U | 0.24 J | 5 U | 0.08 U | 0.1 U | 0.21 J | NA | 5 U | 5 U |
| Calcium | 226,000 | 156,000 | 147,000 | 181,000 | 189,000 | 168,000 | 176,000 | 166,000 | NA | 170,000 | 174,000 |
| Chromium | 0.9 J | 0.7 U | 1.1 J | 10 U | 10 U | 1.6 B | 2.1 J | 0.98 K | NA | 1.1 K | 10 U |
| Chromium (hexavalent) | NA | 10 U | 10 U | NA | NA | 10 U | 10 U | NA | NA | NA | NA |
| Cobalt | 2.1 B | 4 J | 1.4 J | 3 B | 3.6 B | 0.7 U | 0.7 U | 50 U | NA | 1.1 B | 0.86 B |
| Iron | 100 U | 517 | 16.3 U | 100 U | 100 U | 381 | 16.3 U | 100 U | NA | 100 U | 100 U |
| Lead | 10 U | 1.9 U | 1.8 U | 10 U | 10 U | 1.9 U | 1.8 U | 2.4 J | NA | 10 U | 10 U |
| Magnesium | 59,700 | 28,400 | 27,000 | 34,900 | 36,700 | 44,900 | 46,500 | 47,300 | NA | 45,800 | 47,100 |
| Manganese | 806 | 707 | 49.7 | 474 | 504 | 13.4 B | 1.8 J | 5.1 J | NA | 7.6 J | 8 J |
| Nickel | 3.7 J | 23.3 J | 14.2 J | 13.6 J | 14.3 J | 2 J | 4.1 J | 2.4 J | NA | 4 J | 4.6 J |
| Potassium | 2,200 J | 1,720 J | 1,240 J | 1,310 J | 1,340 J | 2,420 J | 2,340 J | 2,350 J | NA | 1,770 J | 1,780 J |
| Selenium | 35 U | 3.2 UL | 2.6 U | 35 U | 35 U | 6.5 B | 3.5 B | 35 U | NA | 35 U | 35 U |
| Sodium | 21,800 | 39,500 | 31,900 | 34,900 | 35,600 | 38,700 | 32,000 | 40,500 | NA | 19,500 | 19,800 |
| Thallium | 25 U | 5.8 U | 4.6 U | 25 U | 25 U | 5.8 U | 4.6 U | 25 U | NA | 25 U | 25 U |
| Vanadium | 0.59 J | 0.7 U | 1.1 U | 50 U | 50 U | 0.7 U | 1.1 U | 50 U | NA | 50 U | 50 U |
| Zinc | 18.8 B | 7.3 B | 5.2 B | 13.7 B | 25 B | 4.6 B | 4.9 B | 47.8 B | NA | 11.6 B | 14.9 B |
| | | | | | | | | | | | |
| **Wet Chemistry (MG_L)** | | | | | | | | | | | |
| Alkalinity | NA | NA | NA | NA | NA | NA | NA | NA | 270 | NA | NA |
| Chloride | 29 | NA | NA | 89 | 71 | NA | NA | 87 | NA | 36 | 42 |
| Hardness | 1,800 | NA | NA | 620 | 620 | NA | NA | 620 | NA | 690 | 630 |
| Nitrate | 1.2 | NA | NA | 0.18 | 0.18 | NA | NA | 0.84 | NA | 0.31 | 0.32 |
| Nitrogen | 0.1 U | NA | NA | 0.1 U | 0.1 U | NA | NA | 0.1 U | NA | 0.1 U | 0.1 U |
| Sulfate | 660 | NA | NA | 330 | 340 | NA | NA | 340 | NA | 440 | 440 |
| Total organic carbon (TOC) | 1 U | NA | NA | 1.9 | 2.3 | NA | NA | 1.1 | 1 U | 1 U | 1 U |

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably
Shading represents detect

TABLE 5-2
Analytical Results for Alluvial Groundwater Samples (Exceedances)
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

| Station ID | MCL-Groundwater | RBC-Tap Water | 12MW01 | | | | 12MW02 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | AOCN-GGW14-1 | AS12-12MW01-R02 | AS12-12MW01-0605 | AS12-12MW01-1206 | AOCN-GGW15-1 | AOCN-GGW15-1/DUP | AS12-12MW02-R02 | AS12-12MW02-R02/DUP | AS12-12MW02-0605 | AS12-12MW02-1206 | AS12-12MW02P-1206 |
| Sample Date | | | 07/06/00 | 09/11/03 | 06/01/05 | 12/07/06 | 07/06/00 | 07/06/00 | 09/11/03 | 09/11/03 | 06/01/05 | 12/07/06 | 12/07/06 |
| **Chemical Name** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **Volatile Organic Compounds (UG_L)** | | | | | | | | | | | | | |
| 1,1,1-Trichloroethane | 200 | 9,100 | 1 U | 11 J | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| 1,1,2,2-Tetrachloroethane | -- | 0.053 | 1 U | 0.5 UJ | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| 1,1,2-Trichloroethane | 5 | 0.19 | 1 U | 0.5 UJ | 0.5 U | 10 UL | 5.6 U | NA | 0.77 | 0.81 | 0.5 U | 10 UL | 10 UL |
| 1,1-Dichloroethane | -- | 900 | 15 | 42 J | 13 | 3.8 L | 15 | NA | 6.7 | 6.7 | 9 | 10 UL | 4.8 L |
| 1,1-Dichloroethene | 7 | 350 | 1 U | 4.2 J | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| 1,2,4-Trichlorobenzene | 70 | 61 | NA | 0.5 UJ | 0.5 U | 10 UL | NA | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| 1,2-Dibromo-3-chloropropane | 0.2 | 2.00E-04 | NA | 130 R | 0.5 U | 10 UL | NA | NA | 2.5 R | 2.5 R | 0.5 U | 10 UL | 10 UL |
| 1,2-Dichlorobenzene | 600 | 270 | NA | 0.64 J | 0.5 U | 1.6 L | NA | NA | 50 | 52 | 82 | 10 UJ | 87 J |
| 1,2-Dichloroethene (total) | 70 | 55 | 0.8 J | NA | NA | NA | 120 | NA | NA | NA | NA | NA | NA |
| 1,2-Dichloropropane | 5 | 0.26 | 1 U | 0.5 UJ | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| 1,3-Dichlorobenzene | -- | 18 | NA | 0.5 UJ | 0.5 U | 10 UL | NA | NA | 0.76 | 0.5 U | 0.5 U | 10 UL | 10 UL |
| 1,4-Dichlorobenzene | 75 | 0.28 | NA | 0.5 UJ | 0.5 U | 10 UL | NA | NA | 0.5 U | 0.83 | 2.1 | 10 UL | 1.8 L |
| 2-Hexanone | -- | 6,300 | 5 U | 5 UJ | 5 U | 10 UL | 28 U | NA | 5 U | 5 U | 5 U | 10 UL | 10 UL |
| 4-Methyl-2-pentanone | -- | 6,300 | 1 U | 5.1 J | 5 U | 10 UL | 5.6 U | NA | 5 U | 5 U | 5 U | 10 UL | 10 UL |
| Acetone | -- | 5,500 | 5 R | 5.5 B | 5 U | 10 UL | 28 R | NA | 2.2 B | 28 R | 5 U | 10 UL | 10 UL |
| Benzene | 5 | 0.34 | 0.23 J | 0.5 UJ | 0.5 U | 10 UL | 1.3 J | NA | 0.63 | 0.65 | 1.8 | 10 UL | 1.4 L |
| Bromodichloromethane | 80 | 0.17 | 1 U | 0.5 UJ | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Carbon disulfide | -- | 1,000 | 0.16 J | 0.5 UJ | 0.88 | 10 UL | 5.6 U | NA | 0.3 B | 0.59 B | 0.5 U | 10 UL | 10 UL |
| Chlorobenzene | 100 | 90 | 0.48 J | 0.5 UJ | 0.5 U | 2.4 L | 43 | NA | 49 | 49 | 99 R | 4 J | 94 J |
| Chloroethane | -- | 3.6 | 1 U | 0.5 UJ | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Chloroform | 80 | 0.15 | 1 U | 0.5 UJ | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Cyclohexane | -- | 12,000 | NA | 40 J | 9.6 | 1.3 L | NA | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Ethylbenzene | 700 | 1,300 | 1 U | 5.3 J | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Isopropylbenzene | -- | 660 | NA | 0.33 J | 0.5 U | 10 UL | NA | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Methane | -- | -- | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Methylcyclohexane | -- | 6,300 | NA | 0.5 UJ | 0.5 U | 10 UL | NA | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Methylene chloride | 5 | 4.1 | 6.7 B | 2,900 J | 2.9 B | 10 UL | 6.3 B | NA | 0.82 B | 0.7 B | 4 B | 10 UL | 10 UL |
| Tetrachloroethene | 5 | 0.1 | 1 U | 2 J | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 1.9 L | 10 UL |
| Toluene | 1,000 | 2,300 | 1 U | 13 J | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Trichloroethene | 5 | 0.026 | 0.1 J | 16 J | 0.5 U | 10 UL | 4.7 J | NA | 3.4 | 3.2 | 1.9 | 1.7 L | 10 UL |
| Vinyl chloride | 2 | 0.015 | 3.4 | 8.6 J | 3.1 | 10 UL | 15 | NA | 4.3 | 4.4 | 7.6 | 10 UL | 10 UL |
| Xylene, total | 10,000 | 210 | 1 U | 8.7 J | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| cis-1,2-Dichloroethene | 70 | 61 | NA | 25 J | 1.2 J | 10 UL | NA | NA | 51 | 52 | 22 | 2.4 J | 16 J |
| trans-1,2-Dichloroethene | 100 | 110 | NA | 27 J | 1.3 J | 10 UL | NA | NA | 1.5 | 1.5 | 1.4 J | 10 UL | 10 UL |
| | | | | | | | | | | | | | |
| **Semi-volatile Organic Compounds (UG_L)** | | | | | | | | | | | | | |
| 4-Methylphenol | -- | 180 | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Di-n-butylphthalate | -- | 3,700 | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Naphthalene | -- | 6.5 | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Phenol | -- | 11,000 | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| bis(2-Ethylhexyl)phthalate | 6 | 4.8 | 5 U | 5.8 U | 10 U | NA | 5 U | 1 B | 5.3 U | 5.3 U | 11 U | NA | NA |
| | | | | | | | | | | | | | |
| **Explosives (UG_L)** | | | | | | | | | | | | | |
| Nitrobenzene | -- | 3.5 | 5 U | NA | 0.26 U | NA | 5 U | 5 UJ | NA | NA | 0.26 U | NA | NA |
| Perchlorate | -- | 26 | NA | 2 U | 5 U | NA | NA | NA | 2 U | 2 U | 5 U | NA | NA |
| | | | | | | | | | | | | | |
| **Total Metals (UG_L)** | | | | | | | | | | | | | |
| Aluminum | -- | 37,000 | 2,080 J | 2,970 | 1,200 | NA | 304 B | NA | 2,710 K | 747 | 7,090 | NA | NA |
| Arsenic | 10 | 0.045 | 12.1 | 8.3 J | 3.6 U | NA | 6.1 J | NA | 5.2 J | 5 U | 9.4 J | NA | NA |
| Barium | 2,000 | 7,300 | 316 | 288 J | 166 J | NA | 90.8 B | NA | 72.5 J | 68.7 J | 113 J | NA | NA |
| Beryllium | 4 | 73 | 0.69 B | 0.25 B | 0.1 J | NA | 0.2 U | NA | 0.08 U | 0.08 U | 0.32 J | NA | NA |
| Cadmium | 5 | 18 | 0.44 J | 0.89 B | 0.4 U | NA | 0.4 U | NA | 0.4 U | 0.4 U | 0.4 U | NA | NA |
| Calcium | -- | -- | 206,000 | 228,000 | 145,000 | NA | 216,000 | NA | 145,000 | 139,000 | 165,000 | NA | NA |
| Chromium | 100 | 110 | 7.1 B | 8.7 J | 11.3 | NA | 2.7 B | NA | 5.9 J | 3.7 B | 9.6 B | NA | NA |
| Chromium (hexavalent) | -- | 110 | 20 L | 10 U | 10 U | NA | 50 L | 40 L | 10 U | 10 U | 65 | NA | NA |
| Cobalt | -- | 730 | 8.3 B | 4.7 J | 2.8 J | NA | 13.9 J | NA | 11.5 J | 9 J | 14 J | NA | NA |
| Copper | 1,300 | 1,500 | 2.2 B | 7 B | 3.6 B | NA | 1.9 U | NA | 5.7 B | 5.3 B | 7.9 B | NA | NA |

TABLE 5-2
Analytical Results for Alluvial Groundwater Samples (Exceedances)
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

| Station ID | MCL-Groundwater | RBC-Tap Water | 12MW01 | | | | 12MW02 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | AOCN-GGW14-1 | AS12-12MW01-R02 | AS12-12MW01-0605 | AS12-12MW01-1206 | AOCN-GGW15-1 | AOCN-GGW15-1/DUP | AS12-12MW02-R02 | AS12-12MW02-R02/DUP | AS12-12MW02-0605 | AS12-12MW02-1206 | AS12-12MW02P-1206 |
| Sample Date | | | 07/06/00 | 09/11/03 | 06/01/05 | 12/07/06 | 07/06/00 | 07/06/00 | 09/11/03 | 09/11/03 | 06/01/05 | 12/07/06 | 12/07/06 |
| **Chemical Name** | | | | | | | | | | | | | |
| Iron | -- | 26,000 | 40,900 J | 30,100 | 21,300 | NA | 9,450 J | NA | 7,810 | 4,400 | 20,400 | NA | NA |
| Lead | 15 | 15 | 11.3 | 3.9 B | 2.6 J | NA | 1.8 J | NA | 3.9 B | 1.9 B | 6.2 | NA | NA |
| Magnesium | -- | -- | 41,200 | 46,400 | 33,100 | NA | 52,800 | NA | 35,500 | 32,600 | 41,400 | NA | NA |
| Manganese | -- | 730 | 5,760 J | 4,800 | 3,280 | NA | 6,290 J | NA | 3,800 | 3,860 | 5,140 | NA | NA |
| Nickel | -- | 730 | 168 | 150 | 89.7 | NA | 120 | NA | 77.3 | 70.2 | 84.9 | NA | NA |
| Potassium | -- | -- | 1,590 J | 3,420 J | 1,510 J | NA | 1,620 J | NA | 2,370 J | 1,750 J | 3,740 J | NA | NA |
| Selenium | 50 | 180 | 4.3 UL | 3.4 J | 2.6 U | NA | 4.3 UL | NA | 3.7 J | 3.2 UL | 2.6 U | NA | NA |
| Sodium | -- | -- | 75,400 | 91,600 | 57,900 | NA | 54,300 | NA | 40,700 | 40,500 | 46,100 | NA | NA |
| Vanadium | -- | 37 | 6.4 J | 5.6 J | 2.6 J | NA | 1.4 U | NA | 5.2 J | 0.7 U | 12.3 J | NA | NA |
| Zinc | -- | 11,000 | 41.6 | 20 B | 10.3 B | NA | 11.2 B | NA | 15.1 J | 11.6 B | 21.9 | NA | NA |
| | | | | | | | | | | | | | |
| **Dissolved Metals (UG_L)** | | | | | | | | | | | | | |
| Aluminum | -- | 37,000 | NA | 641 | 67.4 J | NA | NA | NA | 15.1 U | 15.1 U | 40.3 U | NA | NA |
| Arsenic | 10 | 0.045 | NA | 5 U | 3.6 U | NA | NA | NA | 7.3 J | 5 U | 3.9 J | NA | NA |
| Barium | 2,000 | 7,300 | NA | 279 J | 161 J | NA | NA | NA | 54.8 J | 56.8 J | 68 J | NA | NA |
| Beryllium | 4 | 73 | NA | 0.096 B | 0.1 U | NA | NA | NA | 0.08 U | 0.08 U | 0.1 U | NA | NA |
| Calcium | -- | -- | NA | 237,000 | 148,000 | NA | NA | NA | 151,000 | 144,000 | 169,000 | NA | NA |
| Chromium | 100 | 110 | NA | 2.9 B | 2.7 J | NA | NA | NA | 0.89 B | 0.7 U | 0.6 U | NA | NA |
| Chromium (hexavalent) | -- | 110 | NA | 10 U | 10 U | NA | NA | NA | 10 U | 10 U | 10 U | NA | NA |
| Cobalt | -- | 730 | NA | 2.7 B | 1.7 J | NA | NA | NA | 13.4 J | 10.9 J | 12.7 J | NA | NA |
| Iron | -- | 26,000 | NA | 26,200 | 19,300 | NA | NA | NA | 3,170 | 3,140 | 7,550 | NA | NA |
| Lead | 15 | 15 | NA | 1.9 U | 1.8 U | NA | NA | NA | 1.9 U | 1.9 U | 1.8 U | NA | NA |
| Magnesium | -- | -- | NA | 48,000 | 33,900 | NA | NA | NA | 37,600 | 35,400 | 41,600 | NA | NA |
| Manganese | -- | 730 | NA | 4,880 | 3,180 | NA | NA | NA | 4,130 | 4,000 | 5,060 | NA | NA |
| Nickel | -- | 730 | NA | 143 | 85.2 | NA | NA | NA | 91.8 | 83.5 | 87 | NA | NA |
| Potassium | -- | -- | NA | 3,180 J | 1,320 J | NA | NA | NA | 1,550 J | 1,480 J | 1,280 J | NA | NA |
| Selenium | 50 | 180 | NA | 3.2 UL | 2.6 U | NA | NA | NA | 3.8 J | 3.2 UL | 2.6 U | NA | NA |
| Sodium | -- | -- | NA | 90,700 | 57,800 | NA | NA | NA | 43,500 | 43,200 | 47,900 | NA | NA |
| Thallium | 2 | 2.6 | NA | 5.8 U | 4.6 U | NA | NA | NA | 5.8 U | 5.8 U | 4.6 U | NA | NA |
| Vanadium | -- | 37 | NA | 1.6 B | 1.1 U | NA | NA | NA | 0.9 B | 0.7 U | 1.1 U | NA | NA |
| Zinc | -- | 11,000 | NA | 6.6 B | 3.2 B | NA | NA | NA | 8.1 B | 7.5 B | 7.5 B | NA | NA |
| | | | | | | | | | | | | | |
| **Wet Chemistry (MG_L)** | | | | | | | | | | | | | |
| Alkalinity | -- | -- | NA | NA | NA | 230 | NA | NA | NA | NA | NA | 200 | 210 |
| Chloride | -- | -- | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Hardness | -- | -- | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Nitrate | 10 | 10 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Nitrogen | -- | -- | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Sulfate | -- | -- | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Total organic carbon (TOC) | -- | -- | NA | NA | NA | 1.4 B | NA | NA | NA | NA | NA | 2.2 B | 2.2 B |

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Exceeds one or more criteria

TABLE 5-2
Analytical Results for Alluvial Groundwater Samples (Exceedances)
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

| Station ID | MCL-Groundwater | RBC-Tap Water | 12MW06 | | | 12MW08 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | AOCN-GGW16-1 | AOCN-GGW16-2 | AS12-12MW06-R01 | AS12-12MW08-R01 | AS12-12MW08-R02 | AS12-12MW08-R02/DUP | AS12-12MW08-0605 | AS12-12MW08-1206 | AS12-12MW08-0607 | AS12-12MW10-R01 | AS12-12MW10-R02 |
| Sample Date | | | 07/06/00 | 07/17/02 | 07/10/03 | 07/09/03 | 09/15/03 | 09/15/03 | 06/02/05 | 12/07/06 | 06/11/07 | 07/09/03 | 09/12/03 |
| **Chemical Name** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **Volatile Organic Compounds (UG_L)** | | | | | | | | | | | | | |
| 1,1,1-Trichloroethane | 200 | 9,100 | 1.2 | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U |
| 1,1,2,2-Tetrachloroethane | -- | 0.053 | 1.2 U | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U |
| 1,1,2-Trichloroethane | 5 | 0.19 | 1.2 U | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U |
| 1,1-Dichloroethane | -- | 900 | 2.8 | NA | 1 U | 15 | 15 | 14 | 12 | 6.2 J | 2.4 | 1.5 | 1.4 |
| 1,1-Dichloroethene | 7 | 350 | 0.25 J | NA | 1 U | 0.46 J | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U |
| 1,2,4-Trichlorobenzene | 70 | 61 | NA | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U |
| 1,2-Dibromo-3-chloropropane | 0.2 | 2.00E-04 | NA | NA | 1 U | 1 U | 13 R | 13 R | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 R |
| 1,2-Dichlorobenzene | 600 | 270 | NA | NA | 1 U | 0.76 J | 1.2 | 1.2 | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U |
| 1,2-Dichloroethene (total) | 70 | 55 | 20 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1,2-Dichloropropane | 5 | 0.26 | 1.2 U | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U |
| 1,3-Dichlorobenzene | -- | 18 | NA | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U |
| 1,4-Dichlorobenzene | 75 | 0.28 | NA | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U |
| 2-Hexanone | -- | 6,300 | 6.2 U | NA | 5 U | 5 U | 5 U | 5 U | 5 U | 10 U | 5 U | 5 U | 5 U |
| 4-Methyl-2-pentanone | -- | 6,300 | 1.2 U | NA | 5 U | 5 U | 3.4 J | 4.2 J | 5 U | 10 U | 5 U | 5 U | 5 U |
| Acetone | -- | 5,500 | 6.2 R | NA | 5 U | 3.4 B | 4 B | 4 B | 5 U | 10 U | 3.8 J | 1.8 B | 2.7 B |
| Benzene | 5 | 0.34 | 0.14 J | NA | 1 U | 0.43 J | 0.44 J | 0.39 J | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U |
| Bromodichloromethane | 80 | 0.17 | 1.2 U | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U |
| Carbon disulfide | -- | 1,000 | 1.2 U | NA | 1.1 | 0.57 J | 2.3 B | 1.9 B | 0.87 | 10 U | 0.5 U | 0.7 J | 1.7 B |
| Chlorobenzene | 100 | 90 | 5.9 | NA | 1 U | 1 U | 0.86 | 0.83 | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U |
| Chloroethane | -- | 3.6 | 1.2 U | NA | 1 U | 8.4 | 2.8 | 3 | 1.8 | 10 U | 0.5 U | 1 U | 0.5 U |
| Chloroform | 80 | 0.15 | 1.2 U | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U |
| Cyclohexane | -- | 12,000 | NA | NA | 1 U | 300 | 370 J | 370 | 81 | 18 | 4.8 | 1 U | 0.96 B |
| Ethylbenzene | 700 | 1,300 | 1.2 U | NA | 1 U | 53 | 42 | 43 | 0.45 J | 1.4 J | 0.5 U | 1 U | 0.5 U |
| Isopropylbenzene | -- | 660 | NA | NA | 1 U | 3.9 | 4.2 | 3.8 | 2 | 10 U | 0.5 U | 1 U | 0.5 U |
| Methane | -- | -- | NA | NA | NA | NA | NA | NA | NA | NA | 2,400 | NA | NA |
| Methylcyclohexane | -- | 6,300 | NA | NA | 1 U | 3.4 | 3.3 | 3.1 | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U |
| Methylene chloride | 5 | 4.1 | 9.2 B | NA | 0.67 B | 2 B | 31 J | 36 J | 11 B | 10 U | 0.62 B | 1.2 B | 1.2 B |
| Tetrachloroethene | 5 | 0.1 | 0.76 J | NA | 0.82 J | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U |
| Toluene | 1,000 | 2,300 | 1.2 U | NA | 1 U | 2.4 | 20 | 19 | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U |
| Trichloroethene | 5 | 0.026 | 28 | NA | 1.8 | 2 | 0.73 | 0.76 | 0.5 U | 10 U | 0.62 | 0.87 J | 0.78 |
| Vinyl chloride | 2 | 0.015 | 1.3 | NA | 1 U | 6 | 2.5 | 2.4 | 0.55 | 10 U | 0.5 U | 1.4 | 0.53 |
| Xylene, total | 10,000 | 210 | 1.2 U | NA | 1 U | 1 U | 11 | 11 | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U |
| cis-1,2-Dichloroethene | 70 | 61 | NA | NA | 0.98 J | 4 | 3.1 | 3.2 | 0.4 J | 10 U | 0.5 U | 1.3 | 1.1 |
| trans-1,2-Dichloroethene | 100 | 110 | NA | NA | 1 U | 7.4 | 5.1 | 5 | 0.79 | 10 U | 0.92 | 1.2 | 0.99 |
| | | | | | | | | | | | | | |
| **Semi-volatile Organic Compounds (UG_L)** | | | | | | | | | | | | | |
| 4-Methylphenol | -- | 180 | 5 U | NA | NA | NA | 2.5 J | 2.9 J | 11 U | NA | 11 U | NA | 5.3 U |
| Di-n-butylphthalate | -- | 3,700 | 5 U | NA | NA | NA | 8.4 | 10 | 1.5 J | NA | 11 U | NA | 5.3 U |
| Naphthalene | -- | 6.5 | 5 U | NA | NA | NA | 1.1 J | 1.3 J | 11 U | NA | 11 U | NA | 5.3 U |
| Phenol | -- | 11,000 | 5 U | NA | NA | NA | 8.5 | 10 | 11 U | NA | 11 U | NA | 5.3 U |
| bis(2-Ethylhexyl)phthalate | 6 | 4.8 | 5 U | NA | NA | NA | 5.3 U | 1.1 J | 2.5 J | NA | 2.5 B | NA | 5.3 U |
| | | | | | | | | | | | | | |
| **Explosives (UG_L)** | | | | | | | | | | | | | |
| Nitrobenzene | -- | 3.5 | 5 U | NA | NA | NA | NA | NA | 0.26 U | NA | NA | NA | 0.26 U |
| Perchlorate | -- | 26 | NA | 4 U | NA | NA | 13 | 13 | 2 U | NA | 0.0612 U | NA | 3 U |
| | | | | | | | | | | | | | |
| **Total Metals (UG_L)** | | | | | | | | | | | | | |
| Aluminum | -- | 37,000 | 5,650 J | NA | NA | NA | 3,140 K | 3,310 K | 1,270 | NA | 960 J | NA | 3,830 |
| Arsenic | 10 | 0.045 | 6.5 J | NA | NA | NA | 12 K | 7.3 J | 12 | NA | 11.1 K | NA | 5 U |
| Barium | 2,000 | 7,300 | 141 J | NA | NA | NA | 179 J | 182 J | 130 J | NA | 173 J | NA | 30.9 J |
| Beryllium | 4 | 73 | 0.8 B | NA | NA | NA | 0.12 B | 0.08 U | 0.11 J | NA | 5 U | NA | 0.24 B |
| Cadmium | 5 | 18 | 0.4 U | NA | NA | NA | 0.4 U | 0.4 U | 0.4 U | NA | 5 U | NA | 0.57 B |
| Calcium | -- | -- | 224,000 | NA | NA | NA | 102,000 | 102,000 | 88,800 | NA | 320,000 | NA | 223,000 |
| Chromium | 100 | 110 | 34.4 | NA | NA | NA | 7.7 J | 7.8 J | 4 J | NA | 3.9 B | NA | 4.9 J |
| Chromium (hexavalent) | -- | 110 | 50 L | NA | NA | NA | 10 U | 10 U | 24 | NA | 10 U | NA | 10 U |
| Cobalt | -- | 730 | 13.7 J | NA | NA | NA | 18.2 J | 18.5 J | 8.6 J | NA | 3.8 J | NA | 3.1 B |
| Copper | 1,300 | 1,500 | 23.8 B | NA | NA | NA | 3.8 B | 4.2 B | 3.3 B | NA | 4.6 B | NA | 6.1 B |

TABLE 5-2
Analytical Results for Alluvial Groundwater Samples (Exceedances)
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

| Station ID | MCL-Groundwater | RBC-Tap Water | 12MW06 | | | 12MW08 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | AOCN-GGW16-1 | AOCN-GGW16-2 | AS12-12MW06-R01 | AS12-12MW08-R01 | AS12-12MW08-R02 | AS12-12MW08-R02/DUP | AS12-12MW08-0605 | AS12-12MW08-1206 | AS12-12MW08-0607 | AS12-12MW10-R01 | AS12-12MW10-R02 |
| Sample Date | | | 07/06/00 | 07/17/02 | 07/10/03 | 07/09/03 | 09/15/03 | 09/15/03 | 06/02/05 | 12/07/06 | 06/11/07 | 07/09/03 | 09/12/03 |
| **Chemical Name** | | | | | | | | | | | | | |
| Iron | -- | 26,000 | 13,900 J | NA | NA | NA | 48,500 | 48,900 | 36,400 | NA | 20,500 | NA | 4,870 |
| Lead | 15 | 15 | 13.1 | NA | NA | NA | 4.4 B | 4 B | 1.8 U | NA | 10 U | NA | 4.4 B |
| Magnesium | -- | -- | 33,400 | NA | NA | NA | 17,600 | 17,600 | 18,000 | NA | 89,700 | NA | 71,300 |
| Manganese | -- | 730 | 1,200 J | NA | NA | NA | 1,730 | 1,730 | 1,340 | NA | 1,520 | NA | 479 |
| Nickel | -- | 730 | 70 L | NA | NA | NA | 324 | 324 | 337 | NA | 116 | NA | 8.6 B |
| Potassium | -- | -- | 3,210 J | NA | NA | NA | 1,740 J | 1,840 J | 955 J | NA | 3,300 J | NA | 4,300 J |
| Selenium | 50 | 180 | 4.3 UL | NA | NA | NA | 3.2 UL | 3.2 UL | 4.2 B | NA | 35 U | NA | 4.8 B |
| Sodium | -- | -- | 18,500 | NA | NA | NA | 108,000 | 107,000 | 73,700 | NA | 33,100 | NA | 7,730 |
| Vanadium | -- | 37 | 9 J | NA | NA | NA | 8.1 J | 7.7 J | 3.6 J | NA | 2.2 J | NA | 6.1 J |
| Zinc | -- | 11,000 | 36.8 L | NA | NA | NA | 19.8 J | 20.4 K | 13.8 B | NA | 14.3 B | NA | 30.9 B |
| | | | | | | | | | | | | | |
| **Dissolved Metals (UG_L)** | | | | | | | | | | | | | |
| Aluminum | -- | 37,000 | NA | NA | NA | NA | 1,050 K | 1,200 K | 40.3 U | NA | 200 UJ | NA | 1,630 J |
| Arsenic | 10 | 0.045 | NA | NA | NA | NA | 8.9 J | 8.7 J | 8.5 J | NA | 7.9 K | NA | 5 U |
| Barium | 2,000 | 7,300 | NA | NA | NA | NA | 176 J | 186 J | 121 J | NA | 164 J | NA | 22.8 J |
| Beryllium | 4 | 73 | NA | NA | NA | NA | 0.08 U | 0.08 U | 0.1 U | NA | 5 U | NA | 0.18 B |
| Calcium | -- | -- | NA | NA | NA | NA | 106,000 | 112,000 | 87,600 | NA | 321,000 | NA | 223,000 |
| Chromium | 100 | 110 | NA | NA | NA | NA | 4 B | 4.8 J | 0.6 U | NA | 2.1 B | NA | 2.2 B |
| Chromium (hexavalent) | -- | 110 | NA | NA | NA | NA | 10 U | 10 U | 11 | NA | NA | NA | 10 U |
| Cobalt | -- | 730 | NA | NA | NA | NA | 15.8 J | 14.7 J | 7.3 J | NA | 3.1 J | NA | 2.2 B |
| Iron | -- | 26,000 | NA | NA | NA | NA | 47,400 | 50,300 | 32,600 | NA | 17,400 | NA | 2,220 |
| Lead | 15 | 15 | NA | NA | NA | NA | 1.9 U | 3.9 B | 1.8 U | NA | 10 U | NA | 2 B |
| Magnesium | -- | -- | NA | NA | NA | NA | 18,000 | 19,100 | 17,500 | NA | 90,300 | NA | 71,400 |
| Manganese | -- | 730 | NA | NA | NA | NA | 1,800 | 1,920 | 1,360 | NA | 1,440 | NA | 470 |
| Nickel | -- | 730 | NA | NA | NA | NA | 314 | 291 | 318 | NA | 101 | NA | 5.9 J |
| Potassium | -- | -- | NA | NA | NA | NA | 1,280 J | 1,280 J | 690 J | NA | 3,280 J | NA | 3,620 J |
| Selenium | 50 | 180 | NA | NA | NA | NA | 3.2 UL | 3.2 UL | 2.6 U | NA | 35 U | NA | 3.2 U |
| Sodium | -- | -- | NA | NA | NA | NA | 106,000 | 100,000 | 71,200 | NA | 31,000 | NA | 7,570 K |
| Thallium | 2 | 2.6 | NA | NA | NA | NA | 5.8 U | 5.8 U | 4.6 U | NA | 6.2 K | NA | 5.8 U |
| Vanadium | -- | 37 | NA | NA | NA | NA | 4.1 J | 4.2 J | 1.1 J | NA | 50 U | NA | 2.4 B |
| Zinc | -- | 11,000 | NA | NA | NA | NA | 9.7 B | 12 B | 7 B | NA | 8.1 B | NA | 17.8 B |
| | | | | | | | | | | | | | |
| **Wet Chemistry (MG_L)** | | | | | | | | | | | | | |
| Alkalinity | -- | -- | NA | NA | NA | NA | NA | NA | NA | 220 | NA | NA | NA |
| Chloride | -- | -- | NA | NA | NA | NA | NA | NA | NA | NA | 53 | NA | NA |
| Hardness | -- | -- | NA | NA | NA | NA | NA | NA | NA | NA | 1,400 | NA | NA |
| Nitrate | 10 | 10 | NA | NA | NA | NA | NA | NA | NA | NA | 0.1 U | NA | NA |
| Nitrogen | -- | -- | NA | NA | NA | NA | NA | NA | NA | NA | 0.16 | NA | NA |
| Sulfate | -- | -- | NA | NA | NA | NA | NA | NA | NA | NA | 1,000 | NA | NA |
| Total organic carbon (TOC) | -- | -- | NA | NA | NA | NA | NA | NA | NA | 6.1 B | 2.9 | NA | NA |

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Exceeds one or more criteria

TABLE 5-2
Analytical Results for Alluvial Groundwater Samples (Exceedances)
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

| Station ID | MCL-Groundwater | RBC-Tap Water | 12MW10 | | | 12MW12 | | 12MW14 | | 12MW15 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | AS12-12MW10-0505 | AS12-12MW10-1206 | AS12-12MW10-0607 | AS12-12MW12-R02 | AS12-12MW12-0505 | AS12-12MW14-R02 | AS12-12MW14-0505 | AS12-12MW15-R01 | AS12-12MW15-R02 | AS12-12MW15-0505 | AS12-12MW15-1206 |
| Sample Date | | | 05/27/05 | 12/07/06 | 06/12/07 | 09/11/03 | 05/24/05 | 09/11/03 | 05/26/05 | 07/10/03 | 09/15/03 | 05/27/05 | 12/07/06 |
| **Chemical Name** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **Volatile Organic Compounds (UG_L)** | | | | | | | | | | | | | |
| 1,1,1-Trichloroethane | 200 | 9,100 | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL |
| 1,1,2,2-Tetrachloroethane | -- | 0.053 | 0.5 U | 3.2 J | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL |
| 1,1,2-Trichloroethane | 5 | 0.19 | 0.5 U | 3.4 J | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 UJ | 0.5 U | 10 UL |
| 1,1-Dichloroethane | -- | 900 | 1.1 | 10 U | 0.64 | 0.5 U | 0.5 U | 2.4 | 1.8 | 1 U | 0.5 U | 0.5 U | 10 UL |
| 1,1-Dichloroethene | 7 | 350 | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.36 J | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL |
| 1,2,4-Trichlorobenzene | 70 | 61 | 0.5 U | 1.3 J | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL |
| 1,2-Dibromo-3-chloropropane | 0.2 | 2.00E-04 | 0.5 U | 3.8 J | 0.5 U | 0.5 R | 0.5 U | 0.5 R | 0.5 U | 1 U | 0.5 R | 0.5 U | 10 UL |
| 1,2-Dichlorobenzene | 600 | 270 | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL |
| 1,2-Dichloroethene (total) | 70 | 55 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1,2-Dichloropropane | 5 | 0.26 | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.96 | 1 U | 0.5 U | 0.5 U | 10 UL |
| 1,3-Dichlorobenzene | -- | 18 | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL |
| 1,4-Dichlorobenzene | 75 | 0.28 | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL |
| 2-Hexanone | -- | 6,300 | 5 U | 10 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 10 UL |
| 4-Methyl-2-pentanone | -- | 6,300 | 5 U | 10 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 10 UL |
| Acetone | -- | 5,500 | 5 UJ | 10 U | 5 U | 2.1 B | 5 U | 5 R | 5 U | 1.5 B | 5 R | 5 UJ | 10 UL |
| Benzene | 5 | 0.34 | 0.5 U | 1.8 J | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL |
| Bromodichloromethane | 80 | 0.17 | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.61 | 1 U | 0.5 U | 0.5 U | 10 UL |
| Carbon disulfide | -- | 1,000 | 0.5 U | 10 U | 0.5 U | 0.58 B | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.31 B | 0.5 U | 10 UL |
| Chlorobenzene | 100 | 90 | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL |
| Chloroethane | -- | 3.6 | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL |
| Chloroform | 80 | 0.15 | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 2.2 | 1 U | 0.5 U | 0.5 U | 10 UL |
| Cyclohexane | -- | 12,000 | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL |
| Ethylbenzene | 700 | 1,300 | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL |
| Isopropylbenzene | -- | 660 | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL |
| Methane | -- | -- | NA | NA | 30 | NA | NA | NA | NA | NA | NA | NA | NA |
| Methylcyclohexane | -- | 6,300 | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1.3 | 1 U | 0.5 U | 0.5 U | 10 UL |
| Methylene chloride | 5 | 4.1 | 0.5 U | 10 U | 0.5 U | 0.8 B | 3.2 B | 0.79 B | 4.4 | 0.57 B | 0.5 UJ | 0.5 U | 10 UL |
| Tetrachloroethene | 5 | 0.1 | 0.5 U | 1.4 J | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL |
| Toluene | 1,000 | 2,300 | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL |
| Trichloroethene | 5 | 0.026 | 0.5 U | 2.6 J | 0.5 U | 0.46 J | 0.5 U | 2.4 | 1.4 | 1 U | 0.5 U | 0.5 U | 10 UL |
| Vinyl chloride | 2 | 0.015 | 0.66 | 10 U | 0.5 UJ | 0.5 U | 0.5 U | 0.4 J | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL |
| Xylene, total | 10,000 | 210 | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL |
| cis-1,2-Dichloroethene | 70 | 61 | 1.3 | 3 J | 0.66 | 0.5 U | 0.5 U | 2.5 | 1.6 | 1 U | 0.5 UJ | 0.5 U | 10 UL |
| trans-1,2-Dichloroethene | 100 | 110 | 0.73 | 2.1 J | 0.44 J | 0.5 U | 0.5 U | 1.4 | 0.5 U | 1 U | 0.5 UJ | 0.5 U | 10 UL |
| | | | | | | | | | | | | | |
| **Semi-volatile Organic Compounds (UG_L)** | | | | | | | | | | | | | |
| 4-Methylphenol | -- | 180 | 11 U | NA | 10 U | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA |
| Di-n-butylphthalate | -- | 3,700 | 11 U | NA | 10 U | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA |
| Naphthalene | -- | 6.5 | 11 U | NA | 10 U | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA |
| Phenol | -- | 11,000 | 11 U | NA | 10 U | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA |
| bis(2-Ethylhexyl)phthalate | 6 | 4.8 | 11 U | NA | 10 U | 5 U | 1.4 B | 5.3 U | 5.3 B | NA | 5.3 U | 1.1 J | NA |
| | | | | | | | | | | | | | |
| **Explosives (UG_L)** | | | | | | | | | | | | | |
| Nitrobenzene | -- | 3.5 | 0.26 U | NA | NA | 0.26 U | 0.26 U | 0.26 U | 0.26 U | NA | 0.26 U | 0.044 J | NA |
| Perchlorate | -- | 26 | 5 U | NA | 0.0612 U | 2 U | 2 U | 4 U | 2 U | NA | 3 U | 5 U | NA |
| | | | | | | | | | | | | | |
| **Total Metals (UG_L)** | | | | | | | | | | | | | |
| Aluminum | -- | 37,000 | 6,570 | NA | 1,450 | 662 | 229 B | 1,940 | 17,200 | NA | 1,010 | 69.8 J | NA |
| Arsenic | 10 | 0.045 | 3.6 U | NA | 10 U | 5 U | 3.6 U | 5 U | 7.8 J | NA | 5 U | 16.3 | NA |
| Barium | 2,000 | 7,300 | 44.8 J | NA | 25.8 J | 65.2 J | 57.3 J | 81.7 J | 165 J | NA | 19.1 J | 14 J | NA |
| Beryllium | 4 | 73 | 0.32 J | NA | 0.32 J | 0.08 U | 0.1 U | 0.1 B | 0.85 J | NA | 0.15 B | 0.28 J | NA |
| Cadmium | 5 | 18 | 0.57 J | NA | 5 U | 0.4 U | 0.4 U | 0.48 B | 0.62 J | NA | 0.4 U | 0.4 U | NA |
| Calcium | -- | -- | 234,000 | NA | 218,000 | 147,000 | 137,000 | 201,000 | 205,000 | NA | 280,000 | 283,000 | NA |
| Chromium | 100 | 110 | 8.2 B | NA | 2.7 B | 1.4 B | 10.7 | 14.8 | 37.2 | NA | 16.1 | 1.2 B | NA |
| Chromium (hexavalent) | -- | 110 | 64 | NA | 10 U | 10 U | 10 U | 10 U | 10 U | NA | 10 U | 10 U | NA |
| Cobalt | -- | 730 | 4.2 J | NA | 2.5 B | 0.7 U | 0.7 U | 2.3 B | 8.6 J | NA | 1.1 B | 0.7 U | NA |
| Copper | 1,300 | 1,500 | 8.3 B | NA | 2.4 B | 3.8 B | 2 B | 9.8 B | 19.3 J | NA | 4.8 B | 1.9 B | NA |

TABLE 5-2
Analytical Results for Alluvial Groundwater Samples (Exceedances)
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

| Station ID | MCL-Groundwater | RBC-Tap Water | 12MW10 | | | 12MW12 | | 12MW14 | | 12MW15 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | AS12-12MW10-0505 | AS12-12MW10-1206 | AS12-12MW10-0607 | AS12-12MW12-R02 | AS12-12MW12-0505 | AS12-12MW14-R02 | AS12-12MW14-0505 | AS12-12MW15-R01 | AS12-12MW15-R02 | AS12-12MW15-0505 | AS12-12MW15-1206 |
| Sample Date | | | 05/27/05 | 12/07/06 | 06/12/07 | 09/11/03 | 05/24/05 | 09/11/03 | 05/26/05 | 07/10/03 | 09/15/03 | 05/27/05 | 12/07/06 |
| **Chemical Name** | | | | | | | | | | | | | |
| Iron | -- | 26,000 | 7,660 | NA | 1,800 | 827 | 405 | 2,450 | 27,600 | NA | 2,110 | 13,900 | NA |
| Lead | 15 | 15 | 5.1 | NA | 2.4 J | 1.9 U | 1.8 U | 1.9 B | 14.6 | NA | 1.9 U | 1.8 U | NA |
| Magnesium | -- | -- | 72,800 | NA | 69,100 | 35,900 | 30,600 | 49,100 | 56,700 | NA | 78,200 | 79,800 | NA |
| Manganese | -- | 730 | 786 | NA | 582 | 19.1 | 20.6 | 242 | 655 | NA | 81.4 | 20.5 | NA |
| Nickel | -- | 730 | 10.9 B | NA | 5.2 B | 1.9 B | 9.4 J | 23.3 J | 38.1 J | NA | 11.2 J | 1.2 U | NA |
| Potassium | -- | -- | 4,830 J | NA | 3,070 J | 2,380 J | 2,040 J | 2,220 J | 6,380 | NA | 3,790 J | 3,160 J | NA |
| Selenium | 50 | 180 | 2.6 U | NA | 35 U | 3.2 UL | 2.6 U | 3.2 UL | 3 J | NA | 3.2 UL | 2.6 U | NA |
| Sodium | -- | -- | 4,680 J | NA | 4,320 J | 34,700 | 36,300 | 33,400 | 27,800 | NA | 5,230 K | 4,180 J | NA |
| Vanadium | -- | 37 | 11.7 B | NA | 2.4 J | 0.86 B | 1.1 U | 2.6 B | 29.6 J | NA | 1.2 B | 1.1 U | NA |
| Zinc | -- | 11,000 | 50.5 | NA | 24.8 B | 7.8 B | 7 J | 20.4 B | 42.6 | NA | 14.4 B | 9 B | NA |
| | | | | | | | | | | | | | |
| **Dissolved Metals (UG_L)** | | | | | | | | | | | | | |
| Aluminum | -- | 37,000 | 40.3 U | NA | 200 U | 675 | 40.3 U | 766 | 40.3 U | NA | 85.9 B | 40.3 U | NA |
| Arsenic | 10 | 0.045 | 3.6 U | NA | 10 U | 5 U | 3.6 U | 5 U | 3.6 U | NA | 5 U | 3.6 U | NA |
| Barium | 2,000 | 7,300 | 21 J | NA | 20.4 J | 64.4 J | 55.2 J | 71.6 J | 77.4 J | NA | 14.3 J | 12 J | NA |
| Beryllium | 4 | 73 | 0.1 U | NA | 5 U | 0.08 U | 0.1 U | 0.08 U | 0.1 U | NA | 0.08 U | 0.1 U | NA |
| Calcium | -- | -- | 234,000 | NA | 223,000 | 141,000 | 133,000 | 198,000 | 202,000 | NA | 278,000 | 280,000 | NA |
| Chromium | 100 | 110 | 0.6 U | NA | 10 U | 1.1 B | 3.1 J | 3.3 B | 0.6 U | NA | 1.8 B | 0.6 U | NA |
| Chromium (hexavalent) | -- | 110 | 10 U | NA | NA | 10 U | 10 U | 10 U | 10 U | NA | 10 U | 10 U | NA |
| Cobalt | -- | 730 | 1.1 B | NA | 1.7 B | 0.7 U | 0.7 U | 1.4 B | 1.5 J | NA | 0.99 B | 0.7 U | NA |
| Iron | -- | 26,000 | 28.7 B | NA | 24.2 J | 914 | 16.3 U | 1,280 | 16.3 U | NA | 606 | 431 | NA |
| Lead | 15 | 15 | 1.8 U | NA | 10 U | 1.9 U | 1.8 U | 1.9 U | 1.8 U | NA | 1.9 U | 1.8 U | NA |
| Magnesium | -- | -- | 72,400 | NA | 71,300 | 34,400 | 29,700 | 48,900 | 51,100 | NA | 77,700 | 78,900 | NA |
| Manganese | -- | 730 | 513 | NA | 455 | 21.7 | 8.9 J | 261 | 2.6 J | NA | 42.4 | 19.3 | NA |
| Nickel | -- | 730 | 4.5 J | NA | 4.1 J | 2.2 J | 7.4 J | 16.9 J | 10.9 J | NA | 2.5 J | 1.2 U | NA |
| Potassium | -- | -- | 2,740 J | NA | 2,700 J | 2,330 J | 1,950 J | 1,910 J | 1,370 J | NA | 3,580 J | 3,080 J | NA |
| Selenium | 50 | 180 | 2.6 U | NA | 35 U | 3.2 UL | 2.6 U | 3.2 UL | 2.6 U | NA | 3.2 UL | 2.6 U | NA |
| Sodium | -- | -- | 4,460 J | NA | 4,230 J | 33,800 | 35,500 | 31,600 | 27,900 | NA | 4,820 J | 3,780 J | NA |
| Thallium | 2 | 2.6 | 4.6 U | NA | 25 U | 5.8 U | 5.4 B | 5.8 U | 4.6 U | NA | 5.8 U | 4.6 U | NA |
| Vanadium | -- | 37 | 1.1 U | NA | 50 U | 0.7 U | 1.1 U | 0.7 U | 1.1 U | NA | 0.7 U | 1.1 U | NA |
| Zinc | -- | 11,000 | 3.4 B | NA | 12.6 B | 7.5 B | 6.9 J | 13.9 B | 4.5 B | NA | 9.5 B | 3.3 J | NA |
| | | | | | | | | | | | | | |
| **Wet Chemistry (MG_L)** | | | | | | | | | | | | | |
| Alkalinity | -- | -- | NA | 240 | NA | NA | NA | NA | NA | NA | NA | NA | 1 U |
| Chloride | -- | -- | NA | NA | 42 | NA | NA | NA | NA | NA | NA | NA | NA |
| Hardness | -- | -- | NA | NA | 870 | NA | NA | NA | NA | NA | NA | NA | NA |
| Nitrate | 10 | 10 | NA | NA | 0.1 U | NA | NA | NA | NA | NA | NA | NA | NA |
| Nitrogen | -- | -- | NA | NA | 0.1 U | NA | NA | NA | NA | NA | NA | NA | NA |
| Sulfate | -- | -- | NA | NA | 610 | NA | NA | NA | NA | NA | NA | NA | NA |
| Total organic carbon (TOC) | -- | -- | NA | 1 U | 1.3 | NA | NA | NA | NA | NA | NA | NA | 1 U |

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Exceeds one or more criteria

TABLE 5-2
Analytical Results for Alluvial Groundwater Samples (Exceedances)
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

| Station ID | MCL-Groundwater | RBC-Tap Water | 12MW16 | | | | | 12MW18 | | | | 12MW19 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | AS12-12MW16-R01 | AS12-12MW16-R02 | AS12-12MW16-0605 | AS12-12MW16-1206 | AS12-12MW16-0607 | AS12-12MW18-R02 | AS12-12MW18-0505 | AS12-12MW18-0607 | AS12-12MW18P-0607 | AS12-12MW19-R02 | AS12-12MW19-0505 |
| Sample Date | | | 07/10/03 | 09/12/03 | 06/01/05 | 12/06/06 | 06/13/07 | 09/11/03 | 05/26/05 | 06/12/07 | 06/12/07 | 09/12/03 | 05/25/05 |
| **Chemical Name** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **Volatile Organic Compounds (UG_L)** | | | | | | | | | | | | | |
| 1,1,1-Trichloroethane | 200 | 9,100 | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.31 J | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,1,2,2-Tetrachloroethane | -- | 0.053 | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,1,2-Trichloroethane | 5 | 0.19 | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.79 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,1-Dichloroethane | -- | 900 | 1 U | 0.32 J | 1.1 | 10 UL | 0.5 U | 1.7 | 1.3 | 0.83 | 0.83 | 0.5 U | 0.5 U |
| 1,1-Dichloroethene | 7 | 350 | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,2,4-Trichlorobenzene | 70 | 61 | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,2-Dibromo-3-chloropropane | 0.2 | 2.00E-04 | 1 U | 0.5 R | 0.5 U | 10 R | 0.5 U | 0.5 R | 0.5 U | 0.5 U | 0.5 U | 0.5 R | 0.5 U |
| 1,2-Dichlorobenzene | 600 | 270 | 1 U | 0.39 J | 2.4 | 10 UL | 0.58 | 5.6 | 0.5 U | 2.4 | 2.5 | 0.5 U | 0.5 U |
| 1,2-Dichloroethene (total) | 70 | 55 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1,2-Dichloropropane | 5 | 0.26 | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,3-Dichlorobenzene | -- | 18 | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,4-Dichlorobenzene | 75 | 0.28 | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 2-Hexanone | -- | 6,300 | 5 U | 5 U | 5 U | 10 UL | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 4-Methyl-2-pentanone | -- | 6,300 | 5 U | 5 U | 5 U | 10 UL | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Acetone | -- | 5,500 | 4.5 B | 5 R | 5 U | 10 UL | 5 U | 1.8 B | 5 U | 5 U | 3.6 J | 5 R | 5 U |
| Benzene | 5 | 0.34 | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Bromodichloromethane | 80 | 0.17 | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Carbon disulfide | -- | 1,000 | 0.77 J | 1.3 B | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Chlorobenzene | 100 | 90 | 1 U | 0.5 U | 3.5 | 10 UL | 0.5 U | 3.8 | 0.5 U | 2.6 | 2.7 | 0.5 U | 0.5 U |
| Chloroethane | -- | 3.6 | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Chloroform | 80 | 0.15 | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Cyclohexane | -- | 12,000 | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Ethylbenzene | 700 | 1,300 | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Isopropylbenzene | -- | 660 | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Methane | -- | -- | NA | NA | NA | NA | 5.3 | NA | NA | 3.3 U | 9.2 | NA | NA |
| Methylcyclohexane | -- | 6,300 | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Methylene chloride | 5 | 4.1 | 0.69 B | 1.3 B | 3.4 B | 10 UL | 0.72 B | 0.78 B | 0.5 U | 0.5 U | 0.46 B | 1.4 B | 0.5 U |
| Tetrachloroethene | 5 | 0.1 | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.87 | 0.5 U |
| Toluene | 1,000 | 2,300 | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Trichloroethene | 5 | 0.026 | 0.89 J | 1.5 | 2.9 | 2.4 L | 0.88 | 24 | 9.4 | 8.8 | 8.6 | 0.78 | 0.41 J |
| Vinyl chloride | 2 | 0.015 | 1 U | 0.5 U | 0.48 J | 10 UL | 0.5 U | 0.59 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Xylene, total | 10,000 | 210 | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| cis-1,2-Dichloroethene | 70 | 61 | 1 U | 0.5 U | 1.7 | 10 UL | 0.5 U | 12 | 7.5 | 11 | 11 | 0.33 J | 0.5 UJ |
| trans-1,2-Dichloroethene | 100 | 110 | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.71 | 0.5 U | 0.42 J | 0.51 | 0.5 U | 0.5 UJ |
| | | | | | | | | | | | | | |
| **Semi-volatile Organic Compounds (UG_L)** | | | | | | | | | | | | | |
| 4-Methylphenol | -- | 180 | NA | 5.3 U | 10 U | NA | 11 U | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U |
| Di-n-butylphthalate | -- | 3,700 | NA | 5.3 U | 10 U | NA | 11 U | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U |
| Naphthalene | -- | 6.5 | NA | 5.3 U | 10 U | NA | 11 U | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U |
| Phenol | -- | 11,000 | NA | 5.3 U | 10 U | NA | 11 U | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U |
| bis(2-Ethylhexyl)phthalate | 6 | 4.8 | NA | 5.3 U | 10 U | NA | 3.1 B | 5.1 U | 1.3 B | 11 U | 2.8 B | 5.3 U | 1.5 B |
| | | | | | | | | | | | | | |
| **Explosives (UG_L)** | | | | | | | | | | | | | |
| Nitrobenzene | -- | 3.5 | NA | 0.26 U | 0.26 U | NA | NA | 0.26 U | 0.26 U | NA | NA | 0.26 U | 0.26 U |
| Perchlorate | -- | 26 | NA | 2 U | 5 U | NA | 0.0612 U | 4 U | 2 U | 0.0612 U | 0.0612 U | 2 U | 2 U |
| | | | | | | | | | | | | | |
| **Total Metals (UG_L)** | | | | | | | | | | | | | |
| Aluminum | -- | 37,000 | NA | 6,430 | 2,790 | NA | 129 J | 3,720 | 2,590 | 2,580 | 2,590 | 316 | 989 |
| Arsenic | 10 | 0.045 | NA | 5 U | 3.6 U | NA | 10 U | 5 U | 3.6 U | 10 U | 10 U | 5 U | 5.7 J |
| Barium | 2,000 | 7,300 | NA | 59.2 J | 41.9 J | NA | 23.8 J | 98.4 J | 71.8 J | 77.8 J | 77.1 J | 50.3 J | 54.1 J |
| Beryllium | 4 | 73 | NA | 0.32 B | 0.11 J | NA | 5 U | 0.25 B | 0.16 J | 0.57 J | 5 U | 0.08 U | 0.1 U |
| Cadmium | 5 | 18 | NA | 0.4 U | 0.4 U | NA | 5 U | 0.4 U | 0.4 U | 5 U | 5 U | 0.4 U | 0.4 U |
| Calcium | -- | -- | NA | 199,000 | 206,000 | NA | 230,000 | 156,000 | 153,000 | 178,000 | 184,000 | 170,000 | 173,000 |
| Chromium | 100 | 110 | NA | 13.3 | 6.5 B | NA | 2.4 J | 8.8 J | 6.3 J | 4.4 B | 3.9 B | 3.4 B | 5.6 B |
| Chromium (hexavalent) | -- | 110 | NA | 10 U | 68 | NA | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 16 |
| Cobalt | -- | 730 | NA | 4.6 J | 4.1 J | NA | 2.4 B | 6.2 J | 5.2 J | 8.1 J | 8.5 J | 0.7 U | 0.7 U |
| Copper | 1,300 | 1,500 | NA | 8.2 B | 3.8 B | NA | 3.6 B | 9.1 B | 7.1 B | 5.6 B | 7.2 B | 2.8 B | 0.8 U |

TABLE 5-2
Analytical Results for Alluvial Groundwater Samples (Exceedances)
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

| Station ID | MCL-Groundwater | RBC-Tap Water | 12MW16 | | | | | 12MW18 | | | | 12MW19 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | AS12-12MW16-R01 | AS12-12MW16-R02 | AS12-12MW16-0605 | AS12-12MW16-1206 | AS12-12MW16-0607 | AS12-12MW18-R02 | AS12-12MW18-0505 | AS12-12MW18-0607 | AS12-12MW18P-0607 | AS12-12MW19-R02 | AS12-12MW19-0505 |
| Sample Date | | | 07/10/03 | 09/12/03 | 06/01/05 | 12/06/06 | 06/13/07 | 09/11/03 | 05/26/05 | 06/12/07 | 06/12/07 | 09/12/03 | 05/25/05 |
| **Chemical Name** | | | | | | | | | | | | | |
| Iron | -- | 26,000 | NA | 5,920 | 2,470 | NA | 85.8 B | 6,610 | 3,480 | 3,560 | 3,340 | 499 | 1,330 |
| Lead | 15 | 15 | NA | 3.7 B | 2.2 J | NA | 10 U | 4.6 B | 1.8 U | 2.7 J | 10 U | 1.9 U | 1.8 U |
| Magnesium | -- | -- | NA | 54,600 | 54,900 | NA | 61,000 | 29,100 | 28,500 | 34,800 | 36,400 | 45,300 | 46,100 |
| Manganese | -- | 730 | NA | 742 | 892 | NA | 854 | 788 | 1,230 | 1,080 | 1,250 | 19.5 B | 32.7 |
| Nickel | -- | 730 | NA | 16.2 J | 11.3 J | NA | 3.7 J | 30.3 J | 19.8 J | 17.7 J | 17.8 J | 2.5 B | 4.9 B |
| Potassium | -- | -- | NA | 4,080 J | 2,830 J | NA | 2,220 J | 3,040 J | 2,150 J | 2,170 J | 2,200 J | 2,520 J | 2,570 J |
| Selenium | 50 | 180 | NA | 3.2 UL | 2.6 U | NA | 35 U | 3.2 UL | 2.6 U | 35 U | 35 U | 4.2 B | 2.6 U |
| Sodium | -- | -- | NA | 21,500 | 23,100 | NA | 21,200 | 41,500 | 32,900 | 34,900 | 34,900 | 39,700 | 32,200 |
| Vanadium | -- | 37 | NA | 9.7 J | 4.4 J | NA | 0.54 J | 6.3 J | 4.7 J | 3.7 J | 4.2 J | 0.7 U | 1.6 J |
| Zinc | -- | 11,000 | NA | 24.1 B | 11.4 B | NA | 27.6 B | 21 B | 10.2 B | 23.7 B | 25.1 B | 10.6 B | 9.1 B |
| | | | | | | | | | | | | | |
| **Dissolved Metals (UG_L)** | | | | | | | | | | | | | |
| Aluminum | -- | 37,000 | NA | 4,210 J | 40.3 U | NA | 200 U | 282 | 40.3 U | 200 U | 200 U | 229 B | 40.3 U |
| Arsenic | 10 | 0.045 | NA | 5 U | 3.6 U | NA | 2.5 K | 5 U | 3.6 U | 10 U | 10 U | 5 U | 3.6 U |
| Barium | 2,000 | 7,300 | NA | 68.1 J | 27.6 J | NA | 23.4 J | 73.4 J | 57.3 J | 64 J | 64.9 J | 49.2 J | 49 J |
| Beryllium | 4 | 73 | NA | 0.24 B | 0.1 U | NA | 5 U | 0.08 U | 0.1 U | 0.24 J | 5 U | 0.08 U | 0.1 U |
| Calcium | -- | -- | NA | 178,000 | 231,000 | NA | 226,000 | 156,000 | 147,000 | 181,000 | 189,000 | 168,000 | 176,000 |
| Chromium | 100 | 110 | NA | 19.6 | 0.6 U | NA | 0.9 J | 0.7 U | 1.1 J | 10 U | 10 U | 1.6 B | 2.1 J |
| Chromium (hexavalent) | -- | 110 | NA | 10 U | 10 U | NA | NA | 10 U | 10 U | NA | NA | 10 U | 10 U |
| Cobalt | -- | 730 | NA | 4.3 J | 3.4 J | NA | 2.1 B | 4 J | 1.4 J | 3 B | 3.6 B | 0.7 U | 0.7 U |
| Iron | -- | 26,000 | NA | 4,590 | 16.3 U | NA | 100 U | 517 | 16.3 U | 100 U | 100 U | 381 | 16.3 U |
| Lead | 15 | 15 | NA | 3.1 B | 1.8 U | NA | 10 U | 1.9 U | 1.8 U | 10 U | 10 U | 1.9 U | 1.8 U |
| Magnesium | -- | -- | NA | 47,000 | 62,700 | NA | 59,700 | 28,400 | 27,000 | 34,900 | 36,700 | 44,900 | 46,500 |
| Manganese | -- | 730 | NA | 647 | 1,050 | NA | 806 | 707 | 49.7 | 474 | 504 | 13.4 B | 1.8 J |
| Nickel | -- | 730 | NA | 22.9 J | 10.5 J | NA | 3.7 J | 23.3 J | 14.2 J | 13.6 J | 14.3 J | 2 J | 4.1 J |
| Potassium | -- | -- | NA | 3,420 J | 2,270 J | NA | 2,200 J | 1,720 J | 1,240 J | 1,310 J | 1,340 J | 2,420 J | 2,340 J |
| Selenium | 50 | 180 | NA | 3.2 U | 2.6 U | NA | 35 U | 3.2 UL | 2.6 U | 35 U | 35 U | 6.5 B | 3.5 B |
| Sodium | -- | -- | NA | 19,600 | 23,200 | NA | 21,800 | 39,500 | 31,900 | 34,900 | 35,600 | 38,700 | 32,000 |
| Thallium | 2 | 2.6 | NA | 5.8 U | 4.6 U | NA | 25 U | 5.8 U | 4.6 U | 25 U | 25 U | 5.8 U | 4.6 U |
| Vanadium | -- | 37 | NA | 7 J | 1.1 U | NA | 0.59 J | 0.7 U | 1.1 U | 50 U | 50 U | 0.7 U | 1.1 U |
| Zinc | -- | 11,000 | NA | 21 B | 4.6 B | NA | 18.8 B | 7.3 B | 5.2 B | 13.7 B | 25 B | 4.6 B | 4.9 B |
| | | | | | | | | | | | | | |
| **Wet Chemistry (MG_L)** | | | | | | | | | | | | | |
| Alkalinity | -- | -- | NA | NA | NA | 240 | NA | NA | NA | NA | NA | NA | NA |
| Chloride | -- | -- | NA | NA | NA | NA | 29 | NA | NA | 89 | 71 | NA | NA |
| Hardness | -- | -- | NA | NA | NA | NA | 1,800 | NA | NA | 620 | 620 | NA | NA |
| Nitrate | 10 | 10 | NA | NA | NA | NA | 1.2 | NA | NA | 0.18 | 0.18 | NA | NA |
| Nitrogen | -- | -- | NA | NA | NA | NA | 0.1 U | NA | NA | 0.1 U | 0.1 U | NA | NA |
| Sulfate | -- | -- | NA | NA | NA | NA | 660 | NA | NA | 330 | 340 | NA | NA |
| Total organic carbon (TOC) | -- | -- | NA | NA | NA | 1.1 | 1 U | NA | NA | 1.9 | 2.3 | NA | NA |

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Exceeds one or more criteria

TABLE 5-2
Analytical Results for Alluvial Groundwater Samples (Exceedances)
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

| Station ID | MCL-Groundwater | RBC-Tap Water | | 12MW23 | | |
|---|---|---|---|---|---|---|
| Sample ID | | | AS12-12MW19-0607 | AS12-12MW23-1206 | AS12-12MW23-0607 | AS12-12MW23P-0607 |
| Sample Date | | | 06/12/07 | 12/06/06 | 06/12/07 | 06/12/07 |
| **Chemical Name** | | | | | | |
| | | | | | | |
| **Volatile Organic Compounds (UG_L)** | | | | | | |
| 1,1,1-Trichloroethane | 200 | 9,100 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,1,2,2-Tetrachloroethane | -- | 0.053 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,1,2-Trichloroethane | 5 | 0.19 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,1-Dichloroethane | -- | 900 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,1-Dichloroethene | 7 | 350 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,2,4-Trichlorobenzene | 70 | 61 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,2-Dibromo-3-chloropropane | 0.2 | 2.00E-04 | 0.5 U | 10 R | 0.5 U | 0.5 U |
| 1,2-Dichlorobenzene | 600 | 270 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,2-Dichloroethene (total) | 70 | 55 | NA | NA | NA | NA |
| 1,2-Dichloropropane | 5 | 0.26 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,3-Dichlorobenzene | -- | 18 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,4-Dichlorobenzene | 75 | 0.28 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 2-Hexanone | -- | 6,300 | 5 U | 10 UL | 2 J | 5 U |
| 4-Methyl-2-pentanone | -- | 6,300 | 5 U | 10 UL | 5 U | 5 U |
| Acetone | -- | 5,500 | 5 U | 38 L | 5 U | 5 U |
| Benzene | 5 | 0.34 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Bromodichloromethane | 80 | 0.17 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Carbon disulfide | -- | 1,000 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Chlorobenzene | 100 | 90 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Chloroethane | -- | 3.6 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Chloroform | 80 | 0.15 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Cyclohexane | -- | 12,000 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Ethylbenzene | 700 | 1,300 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Isopropylbenzene | -- | 660 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Methane | -- | -- | 3.3 U | NA | 3.3 U | 6.4 |
| Methylcyclohexane | -- | 6,300 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Methylene chloride | 5 | 4.1 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Tetrachloroethene | 5 | 0.1 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Toluene | 1,000 | 2,300 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Trichloroethene | 5 | 0.026 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Vinyl chloride | 2 | 0.015 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Xylene, total | 10,000 | 210 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| cis-1,2-Dichloroethene | 70 | 61 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| trans-1,2-Dichloroethene | 100 | 110 | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| | | | | | | |
| **Semi-volatile Organic Compounds (UG_L)** | | | | | | |
| 4-Methylphenol | -- | 180 | 10 U | NA | 11 U | 12 U |
| Di-n-butylphthalate | -- | 3,700 | 10 U | NA | 11 U | 12 U |
| Naphthalene | -- | 6.5 | 10 U | NA | 11 U | 12 U |
| Phenol | -- | 11,000 | 10 U | NA | 11 U | 12 U |
| bis(2-Ethylhexyl)phthalate | 6 | 4.8 | 10 U | NA | 7.8 B | 2.6 B |
| | | | | | | |
| **Explosives (UG_L)** | | | | | | |
| Nitrobenzene | -- | 3.5 | NA | NA | NA | NA |
| Perchlorate | -- | 26 | 0.329 | NA | 0.19 J | 0.216 |
| | | | | | | |
| **Total Metals (UG_L)** | | | | | | |
| Aluminum | -- | 37,000 | 759 | NA | 8,360 | 7,720 |
| Arsenic | 10 | 0.045 | 10 U | NA | 3.7 J | 3 J |
| Barium | 2,000 | 7,300 | 64.6 J | NA | 84.8 J | 79.1 J |
| Beryllium | 4 | 73 | 5 U | NA | 0.51 J | 0.46 J |
| Cadmium | 5 | 18 | 5 U | NA | 5 U | 5 U |
| Calcium | -- | -- | 171,000 | NA | 180,000 | 178,000 |
| Chromium | 100 | 110 | 4.1 B | NA | 13.7 K | 14.1 K |
| Chromium (hexavalent) | -- | 110 | 10 U | NA | 10 U | 10 U |
| Cobalt | -- | 730 | 1.1 B | NA | 5.7 J | 4.9 J |
| Copper | 1,300 | 1,500 | 2.7 B | NA | 11.6 J | 11.6 J |

TABLE 5-2
Analytical Results for Alluvial Groundwater Samples (Exceedances)
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | **MCL-Groundwater** | **RBC-Tap Water** | | 12MW23 | | |
|---|---|---|---|---|---|---|
| **Sample ID** | | | AS12-12MW19-0607 | AS12-12MW23-1206 | AS12-12MW23-0607 | AS12-12MW23P-0607 |
| **Sample Date** | | | 06/12/07 | 12/06/06 | 06/12/07 | 06/12/07 |
| **Chemical Name** | | | | | | |
| Iron | -- | 26,000 | 1,140 | NA | 12,800 | 11,500 |
| Lead | 15 | 15 | 10 U | NA | 6.8 J | 5.7 J |
| Magnesium | -- | -- | 48,600 | NA | 51,400 | 50,900 |
| Manganese | -- | 730 | 91 | NA | 357 | 335 |
| Nickel | -- | 730 | 3.7 B | NA | 19.3 J | 18.6 J |
| Potassium | -- | -- | 2,560 J | NA | 3,890 J | 3,800 J |
| Selenium | 50 | 180 | 35 U | NA | 35 U | 35 U |
| Sodium | -- | -- | 40,800 | NA | 19,800 | 19,700 |
| Vanadium | -- | 37 | 1 J | NA | 13.9 J | 13.1 J |
| Zinc | -- | 11,000 | 15.9 B | NA | 45.3 B | 39.8 B |
| | | | | | | |
| **Dissolved Metals (UG_L)** | | | | | | |
| Aluminum | -- | 37,000 | 200 U | NA | 200 U | 200 U |
| Arsenic | 10 | 0.045 | 10 U | NA | 10 U | 10 U |
| Barium | 2,000 | 7,300 | 55.6 J | NA | 38.5 J | 38.8 J |
| Beryllium | 4 | 73 | 0.21 J | NA | 5 U | 5 U |
| Calcium | -- | -- | 166,000 | NA | 170,000 | 174,000 |
| Chromium | 100 | 110 | 0.98 K | NA | 1.1 K | 10 U |
| Chromium (hexavalent) | -- | 110 | NA | NA | NA | NA |
| Cobalt | -- | 730 | 50 U | NA | 1.1 B | 0.86 B |
| Iron | -- | 26,000 | 100 U | NA | 100 U | 100 U |
| Lead | 15 | 15 | 2.4 J | NA | 10 U | 10 U |
| Magnesium | -- | -- | 47,300 | NA | 45,800 | 47,100 |
| Manganese | -- | 730 | 5.1 J | NA | 7.6 J | 8 J |
| Nickel | -- | 730 | 2.4 J | NA | 4 J | 4.6 J |
| Potassium | -- | -- | 2,350 J | NA | 1,770 J | 1,780 J |
| Selenium | 50 | 180 | 35 U | NA | 35 U | 35 U |
| Sodium | -- | -- | 40,500 | NA | 19,500 | 19,800 |
| Thallium | 2 | 2.6 | 25 U | NA | 25 U | 25 U |
| Vanadium | -- | 37 | 50 U | NA | 50 U | 50 U |
| Zinc | -- | 11,000 | 47.8 B | NA | 11.6 B | 14.9 B |
| | | | | | | |
| **Wet Chemistry (MG_L)** | | | | | | |
| Alkalinity | -- | -- | NA | 270 | NA | NA |
| Chloride | -- | -- | 87 | NA | 36 | 42 |
| Hardness | -- | -- | 620 | NA | 690 | 630 |
| Nitrate | 10 | 10 | 0.84 | NA | 0.31 | 0.32 |
| Nitrogen | -- | -- | 0.1 U | NA | 0.1 U | 0.1 U |
| Sulfate | -- | -- | 340 | NA | 440 | 440 |
| Total organic carbon (TOC) | -- | -- | 1.1 | 1 U | 1 U | 1 U |

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Exceeds one or more criteria

**TABLE 5-3**
Analytical Results for Bedrock Groundwater Samples (Detected Constituents)
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| **Station ID** | 12MW04S | | 12MW05S | | | 12MW05D | | 12MW07S | | 12MW07D | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW04S-0605 | AS12-12MW04S-1206 | AS12-12MW05S-0505 | AS12-12MW05SP-0505 | AS12-12MW05S-0607 | AS12-12MW05D-0505 | AS12-12MW05D-0607 | AS12-12MW07S-0505 | AS12-12MW07S-0607 | AS12-12MW07D-0505 | AS12-12MW07DP-0505 | AS12-12MW07D-0607 | AS12-12MW07DP-0607 |
| **Sample Date** | 06/01/05 | 12/07/06 | 05/26/05 | 05/26/05 | 06/13/07 | 05/26/05 | 06/13/07 | 05/25/05 | 06/12/07 | 05/25/05 | 05/25/05 | 06/12/07 | 06/12/07 |
| **Chemical Name** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **Volatile Organic Compounds (UG_L)** | | | | | | | | | | | | | |
| 1,1,1-Trichloroethane | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,1,2,2-Tetrachloroethane | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,1,2-Trichloroethane | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,1-Dichloroethane | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,1-Dichloroethene | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,2,4-Trichlorobenzene | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,2-Dibromo-3-chloropropane | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,2-Dichlorobenzene | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,2-Dichloropropane | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,3-Dichlorobenzene | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,4-Dichlorobenzene | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 2-Butanone | 5 U | 10 UL | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 2-Hexanone | 5 U | 10 UL | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 4-Methyl-2-pentanone | 5 U | 10 UL | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Acetone | 5 U | 10 UL | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Benzene | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Bromochloromethane | 0.5 U | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Bromodichloromethane | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Carbon disulfide | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.61 | 0.5 U | 0.5 U |
| Chlorobenzene | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Chloroethane | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Chloroform | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Chloromethane | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Cyclohexane | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Ethane | NA | NA | NA | NA | 6.2 U | NA | 6.2 U | NA | 6.2 U | NA | NA | 6.2 U | 6.2 U |
| Ethylbenzene | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Isopropylbenzene | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Methane | NA | NA | NA | NA | 3.3 U | NA | 3.3 U | NA | 3.3 U | NA | NA | 3.3 U | 3.3 U |
| Methylcyclohexane | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Methylene chloride | 4 B | 10 UL | 0.5 U | 0.5 U | 0.53 B | 0.5 U | 0.46 B | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Tetrachloroethene | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Toluene | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Trichloroethene | 1.4 | 2.1 L | 2.2 | 2.1 | 0.87 | 1 | 0.6 | 8.9 | 3.8 | 2.2 | 2.2 | 1.6 | 1.6 |
| Vinyl chloride | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Xylene, total | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| cis-1,2-Dichloroethene | 0.5 UJ | 10 UL | 0.5 UJ | 0.5 U | 0.5 U | 0.5 UJ | 0.5 U | 1.9 | 0.5 U | 0.5 U | 0.5 UJ | 0.5 U | 0.5 U |
| trans-1,2-Dichloroethene | 0.5 UJ | 10 UL | 0.5 UJ | 0.5 U | 0.5 U | 0.5 UJ | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 UJ | 0.5 U | 0.5 U |

**Notes:**
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
E - Exceeds calibration range
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Shading represents detect

**TABLE 5-3**
Analytical Results for Bedrock Groundwater Samples (Detected Constituents)
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| **Station ID** | 12MW04S | | 12MW05S | | | 12MW05D | | 12MW07S | | 12MW07D | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW04S-0605 | AS12-12MW04S-1206 | AS12-12MW05S-0505 | AS12-12MW05SP-0505 | AS12-12MW05S-0607 | AS12-12MW05D-0505 | AS12-12MW05D-0607 | AS12-12MW07S-0505 | AS12-12MW07S-0607 | AS12-12MW07D-0505 | AS12-12MW07DP-0505 | AS12-12MW07D-0607 | AS12-12MW07DP-0607 |
| **Sample Date** | 06/01/05 | 12/07/06 | 05/26/05 | 05/26/05 | 06/13/07 | 05/26/05 | 06/13/07 | 05/25/05 | 06/12/07 | 05/25/05 | 05/25/05 | 06/12/07 | 06/12/07 |
| **Chemical Name** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **Semi-volatile Organic Compounds (UG_L)** | | | | | | | | | | | | | |
| 4-Methylphenol | 10 U | NA | 10 U | 11 U | 11 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Caprolactam | 10 U | NA | 10 U | 1.9 J | 11 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Di-n-butylphthalate | 10 U | NA | 10 U | 1.8 J | 11 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Naphthalene | 10 U | NA | 10 U | 11 U | 11 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Phenol | 10 U | NA | 10 U | 11 U | 11 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| bis(2-Ethylhexyl)phthalate | 10 U | NA | 10 U | 2 B | 7.8 B | 1.8 B | 2.9 B | 1.6 B | 10 U | 10 U | 1.1 B | 2 B | 10 U |
| | | | | | | | | | | | | | |
| **Explosives (UG_L)** | | | | | | | | | | | | | |
| Nitrobenzene | 0.26 U | NA | 0.26 U | 0.26 U | NA | 0.26 U | NA | 0.26 U | NA | 0.26 U | 0.26 U | NA | NA |
| Perchlorate | 5 U | NA | 2 U | 2 U | 0.0612 U | 2 U | 0.0612 U | 2 U | 0.0612 U | 2 U | 2 U | 0.0612 U | 0.0612 U |
| | | | | | | | | | | | | | |
| **Total Metals (UG_L)** | | | | | | | | | | | | | |
| Aluminum | 178 B | NA | 277 | 142 J | 215 | 111 J | 90.8 J | 284 | 176 J | 302 | 396 | 235 | 213 |
| Antimony | 2.8 U | NA | 2.8 U | 2.8 U | 60 U | 2.8 U | 60 U | 3.3 J | 60 U | 2.8 U | 2.8 U | 60 U | 60 U |
| Arsenic | 3.6 U | NA | 3.6 U | 3.6 U | 10 U | 3.6 U | 2.6 K | 3.6 U | 10 U | 3.6 U | 5.5 J | 10 U | 10 U |
| Barium | 10.9 J | NA | 37 J | 36.6 J | 40.7 J | 33.8 J | 39 J | 35 J | 40.2 J | 37 J | 37.1 J | 41.2 J | 41.7 J |
| Beryllium | 0.1 U | NA | 0.1 U | 0.1 U | 5 U | 0.1 U | 5 U | 0.1 U | 5 U | 0.1 U | 0.1 U | 5 U | 5 U |
| Cadmium | 0.4 U | NA | 0.4 U | 0.4 U | 5 U | 0.4 U | 5 U | 0.4 U | 5 U | 0.4 U | 0.4 U | 5 U | 5 U |
| Calcium | 397,000 | NA | 110,000 | 111,000 | 109,000 | 111,000 | 111,000 | 123,000 | 109,000 | 109,000 | 108,000 | 108,000 | 111,000 |
| Chromium | 0.74 B | NA | 1.6 B | 1.3 B | 1.9 J | 1.1 B | 2.8 J | 2 B | 1.6 B | 3.2 J | 4.1 J | 2.2 B | 1.8 B |
| Chromium (hexavalent) | 10 U | NA | 10 U | 10 U | NA | 10 U | NA | 10 U | NA | 10 U | 10 U | NA | NA |
| Cobalt | 0.7 U | NA | 0.7 U | 0.7 U | 50 U | 0.7 U | 50 U | 0.7 U | 50 U | 0.7 U | 0.7 U | 0.61 B | 50 U |
| Copper | 1.5 B | NA | 2.6 B | 2.1 B | 3.3 B | 2.7 B | 2.5 B | 0.8 U | 1.8 B | 0.8 U | 0.8 U | 2.5 B | 3.3 B |
| Iron | 1,090 | NA | 506 | 377 | 474 | 622 | 557 | 573 | 549 | 254 | 339 | 280 | 220 |
| Lead | 1.8 U | NA | 1.8 U | 1.8 U | 2.7 K | 1.8 U | 10 U | 1.8 U | 10 U | 1.8 U | 1.8 U | 2.3 J | 10 U |
| Magnesium | 140,000 | NA | 44,200 | 44,300 | 44,600 | 44,300 | 44,800 | 43,800 | 43,900 | 44,000 | 43,500 | 43,800 | 45,100 |
| Manganese | 27.7 | NA | 18 | 14.8 J | 7.7 J | 62.8 | 13.7 J | 88.4 | 7.8 J | 25 | 26.5 | 8.2 J | 4.4 B |
| Mercury | 0.1 U | NA | 0.1 U | 0.1 U | 0.2 U | 0.1 U | 0.2 U | 0.1 U | 0.2 UL | 0.1 U | 0.1 U | 0.2 UL | 0.2 U |
| Nickel | 1.2 U | NA | 1.2 U | 1.2 U | 1.3 J | 1.7 J | 40 U | 3.7 B | 1.3 B | 1.9 J | 2.4 J | 2.4 B | 40 U |
| Potassium | 5,630 | NA | 2,030 J | 2,010 J | 2,070 J | 2,130 J | 2,060 J | 2,960 J | 2,080 J | 2,600 J | 2,640 J | 2,130 J | 2,140 J |
| Selenium | 2.6 U | NA | 4 J | 2.6 U | 35 U | 2.6 U | 35 U | 2.6 U | 35 U | 2.6 U | 3.5 B | 35 U | 35 U |
| Sodium | 6,470 | NA | 8,230 | 8,290 | 7,880 | 7,610 | 9,520 | 9,880 | 9,030 | 7,250 | 7,130 | 9,240 | 9,440 |
| Thallium | 5.8 J | NA | 4.6 U | 4.6 U | 25 U | 4.6 U | 25 U | 4.6 U | 25 U | 6.2 J | 5.7 J | 25 U | 25 U |
| Vanadium | 1.1 U | NA | 1.1 U | 1.1 U | 50 U | 1.1 U | 50 U | 1.1 U | 50 U | 1.1 U | 1.2 J | 50 U | 0.64 J |
| Zinc | 6.9 B | NA | 5.9 B | 4.8 B | 18 B | 12.3 B | 37.5 B | 10.6 B | 16.9 B | 6 B | 6.2 B | 22.6 B | 10.1 B |

**Notes:**
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
E - Exceeds calibration range
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Shading represents detect

**TABLE 5-3**
Analytical Results for Bedrock Groundwater Samples (Detected Constituents)
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| **Station ID** | 12MW04S | | 12MW05S | | | 12MW05D | | 12MW07S | | 12MW07D | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW04S-0605 | AS12-12MW04S-1206 | AS12-12MW05S-0505 | AS12-12MW05SP-0505 | AS12-12MW05S-0607 | AS12-12MW05D-0505 | AS12-12MW05D-0607 | AS12-12MW07S-0505 | AS12-12MW07S-0607 | AS12-12MW07D-0505 | AS12-12MW07DP-0505 | AS12-12MW07D-0607 | AS12-12MW07DP-0607 |
| **Sample Date** | 06/01/05 | 12/07/06 | 05/26/05 | 05/26/05 | 06/13/07 | 05/26/05 | 06/13/07 | 05/25/05 | 06/12/07 | 05/25/05 | 05/25/05 | 06/12/07 | 06/12/07 |
| **Chemical Name** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **Dissolved Metals (UG_L)** | | | | | | | | | | | | | |
| Aluminum | 40.3 U | NA | 40.3 U | 40.3 U | 200 U | 40.3 U | 200 U | 40.3 U | 200 U | 40.3 U | 40.3 U | 200 U | 200 U |
| Antimony | 2.8 U | NA | 2.8 U | 2.8 U | 60 U | 2.8 U | 60 U | 3.4 J | 60 U | 4 J | 2.8 U | 60 U | 60 U |
| Arsenic | 3.6 U | NA | 3.6 U | 3.6 U | 3 K | 3.6 U | 10 U | 7.3 J | 10 U | 3.6 U | 3.6 U | 10 U | 10 U |
| Barium | 9.6 J | NA | 34.1 J | 34 J | 37.9 J | 32.2 J | 38 J | 33.4 J | 39.2 J | 36.5 J | 36.1 J | 39.6 J | 40.1 J |
| Beryllium | 0.1 U | NA | 0.1 U | 0.1 U | 5 U | 0.1 U | 5 U | 0.1 U | 5 U | 0.1 U | 0.1 U | 5 U | 5 U |
| Calcium | 392,000 | NA | 110,000 | 110,000 | 109,000 | 109,000 | 109,000 | 122,000 | 109,000 | 108,000 | 107,000 | 106,000 | 109,000 |
| Chromium | 0.6 U | NA | 0.6 U | 0.6 U | 0.99 J | 0.6 U | 0.84 J | 0.6 U | 10 U | 3 J | 1.9 J | 1 K | 0.9 J |
| Chromium (hexavalent) | 10 U | NA | 10 U | 10 U | NA | 10 U | NA | 10 U | NA | 10 U | 10 U | NA | NA |
| Cobalt | 0.7 U | NA | 0.7 U | 0.7 U | 50 U | 0.7 U | 50 U | 0.7 U | 50 U | 0.7 U | 0.7 U | 50 U | 50 U |
| Iron | 968 | NA | 56.4 J | 54.1 J | 100 U | 508 | 430 | 241 | 100 U | 16.3 U | 16.3 U | 100 U | 100 U |
| Lead | 1.8 U | NA | 1.8 U | 1.8 U | 10 U | 1.8 U | 10 U | 1.8 U | 10 U | 1.8 U | 1.8 U | 10 U | 10 U |
| Magnesium | 139,000 | NA | 44,100 | 44,100 | 44,500 | 43,400 | 44,400 | 43,400 | 43,900 | 44,000 | 43,600 | 43,300 | 44,100 |
| Manganese | 24.1 | NA | 8.5 J | 8.8 J | 2.3 J | 62.3 | 10.4 J | 88.7 | 4.2 J | 24.7 | 23.1 | 1.9 B | 2 B |
| Mercury | 0.1 U | NA | 0.1 U | 0.1 U | 0.2 U | 0.1 U | 0.2 U | 0.1 U | 0.2 UL | 0.1 U | 0.1 U | 0.2 UL | 0.2 U |
| Nickel | 1.6 J | NA | 1.4 J | 1.2 U | 40 U | 1.2 U | 1.4 J | 2.7 J | 1.5 J | 1.9 J | 1.5 J | 1.5 J | 1.6 J |
| Potassium | 5,590 | NA | 1,930 J | 1,970 J | 1,950 J | 1,980 J | 2,010 J | 2,890 J | 2,080 J | 2,610 J | 2,510 J | 2,050 J | 2,020 J |
| Selenium | 2.6 U | NA | 2.9 J | 2.6 U | 35 U | 2.6 U | 35 U | 5.6 B | 35 U | 2.6 U | 2.6 U | 35 U | 35 U |
| Sodium | 6,290 | NA | 8,040 | 8,030 | 7,680 | 7,510 | 9,430 | 9,860 | 9,220 | 7,290 | 6,950 | 9,120 | 9,060 |
| Thallium | 7.3 B | NA | 4.6 U | 4.6 U | 25 U | 4.6 U | 25 U | 4.6 U | 25 U | 4.6 U | 4.6 U | 25 U | 25 U |
| Vanadium | 1.1 U | NA | 1.1 U | 1.1 U | 50 U | 1.1 U | 50 U | 1.1 U | 50 U | 1.1 U | 1.1 U | 50 U | 50 U |
| Zinc | 6.1 B | NA | 3.1 B | 4.6 B | 15.5 B | 4.8 B | 32.6 B | 3.4 B | 16.2 B | 3.6 B | 2.9 B | 16 B | 7.7 B |
| | | | | | | | | | | | | | |
| **Wet Chemistry (MG_L)** | | | | | | | | | | | | | |
| Alkalinity | NA | 220 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Chloride | NA | NA | NA | NA | 31 | NA | 28 | NA | 28 | NA | NA | 31 | 31 |
| Hardness | NA | NA | NA | NA | 740 | NA | 520 | NA | 460 | NA | NA | 440 | 480 |
| Nitrate | NA | NA | NA | NA | 0.14 | NA | 0.15 | NA | 0.16 | NA | NA | 0.2 | 0.2 |
| Nitrogen | NA | NA | NA | NA | 0.1 U | NA | 0.1 U | NA | 0.1 U | NA | NA | 0.1 U | 0.1 U |
| Sulfate | NA | NA | NA | NA | 180 | NA | 190 | NA | 200 | NA | NA | 180 | 190 |
| Total organic carbon (TOC) | NA | 1 U | NA | NA | 1 U | NA | 1 U | NA | 1 U | NA | NA | 1 U | 1 U |

**Notes:**
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
E - Exceeds calibration range
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Shading represents detect

**TABLE 5-3**
Analytical Results for Bedrock Groundwater Samples (Detected Constituents)
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| **Station ID** | 12MW09S | | | 12MW09D | | | | 12MW11S | | | 12MW11D | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW09S-0605 | AS12-12MW09S-1206 | AS12-12MW09S-0607 | AS12-12MW09D-0605 | AS12-12MW09DP-0605 | AS12-12MW09D-1206 | AS12-12MW09D-0607 | AS12-12MW11S-0605 | AS12-12MW11S-1206 | AS12-12MW11S-0607 | AS12-12MW11D-0505 | AS12-12MW11D-1206 | AS12-12MW11D-0607 |
| **Sample Date** | 06/02/05 | 12/07/06 | 06/11/07 | 06/02/05 | 06/02/05 | 12/07/06 | 06/11/07 | 06/02/05 | 12/07/06 | 06/13/07 | 05/27/05 | 12/07/06 | 06/12/07 |
| **Chemical Name** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **Volatile Organic Compounds (UG_L)** | | | | | | | | | | | | | |
| 1,1,1-Trichloroethane | 2 | 10 U | 1.3 | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,1,2,2-Tetrachloroethane | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,1,2-Trichloroethane | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,1-Dichloroethane | 8 | 10 U | 9 | 0.45 J | 0.42 J | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,1-Dichloroethene | 0.43 J | 10 U | 0.61 | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,2,4-Trichlorobenzene | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,2-Dibromo-3-chloropropane | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,2-Dichlorobenzene | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,2-Dichloropropane | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,3-Dichlorobenzene | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,4-Dichlorobenzene | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 2-Butanone | 5 U | 10 U | 5 U | 5 U | 5 U | 10 U | 5 U | 5 U | 10 U | 5 U | 5 U | 10 U | 5 U |
| 2-Hexanone | 5 U | 10 U | 2.5 J | 5 U | 5 U | 10 U | 3.3 J | 5 U | 10 U | 5 U | 5 U | 10 U | 2.2 J |
| 4-Methyl-2-pentanone | 5 U | 10 U | 5 U | 5 U | 5 U | 10 U | 5 U | 5 U | 10 U | 5 U | 5 U | 10 U | 5 U |
| Acetone | 5 U | 10 U | 7 | 5 U | 5 U | 10 U | 4.2 J | 5 U | 10 U | 5 U | 5 UJ | 10 U | 5 U |
| Benzene | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Bromochloromethane | 1.1 | NA | 0.5 U | 0.5 U | 0.5 U | NA | 0.5 U | 0.5 U | NA | 0.5 U | 0.5 U | NA | 0.5 U |
| Bromodichloromethane | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Carbon disulfide | 1 | 10 U | 0.5 U | 0.49 J | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Chlorobenzene | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Chloroethane | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Chloroform | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Chloromethane | 1.4 | 10 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Cyclohexane | 2.7 | 1.5 J | 2.8 | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Ethane | NA | NA | 31 U | NA | NA | NA | 6.2 U | NA | NA | 6.2 U | NA | NA | 6.2 U |
| Ethylbenzene | 0.5 U | 10 U | 0.42 J | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Isopropylbenzene | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Methane | NA | NA | 70 | NA | NA | NA | 9.8 | NA | NA | 5.3 | NA | NA | 3.3 U |
| Methylcyclohexane | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Methylene chloride | 4,400 | 10 U | 540 J | 95 B | 98 B | 10 U | 0.59 B | 0.82 | 10 U | 0.43 B | 0.5 U | 10 U | 0.5 U |
| Tetrachloroethene | 1.4 | 10 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Toluene | 3.1 | 10 U | 0.45 J | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Trichloroethene | 4.3 | 1.5 J | 1.8 | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Vinyl chloride | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Xylene, total | 0.5 U | 10 U | 0.62 | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| cis-1,2-Dichloroethene | 2 J | 4.7 J | 11 | 0.5 U | 0.5 UJ | 10 U | 0.5 U | 0.5 UJ | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| trans-1,2-Dichloroethene | 2.2 J | 2.7 J | 3.1 | 0.5 U | 0.5 UJ | 10 U | 0.5 U | 0.5 UJ | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |

**Notes:**
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
E - Exceeds calibration range
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Shading represents detect

**TABLE 5-3**
Analytical Results for Bedrock Groundwater Samples (Detected Constituents)
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| **Station ID** | 12MW09S | | | 12MW09D | | | | 12MW11S | | | 12MW11D | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW09S-0605 | AS12-12MW09S-1206 | AS12-12MW09S-0607 | AS12-12MW09D-0605 | AS12-12MW09DP-0605 | AS12-12MW09D-1206 | AS12-12MW09D-0607 | AS12-12MW11S-0605 | AS12-12MW11S-1206 | AS12-12MW11S-0607 | AS12-12MW11D-0505 | AS12-12MW11D-1206 | AS12-12MW11D-0607 |
| **Sample Date** | 06/02/05 | 12/07/06 | 06/11/07 | 06/02/05 | 06/02/05 | 12/07/06 | 06/11/07 | 06/02/05 | 12/07/06 | 06/13/07 | 05/27/05 | 12/07/06 | 06/12/07 |
| **Chemical Name** | | | | | | | | | | | | | |
| **Semi-volatile Organic Compounds (UG_L)** | | | | | | | | | | | | | |
| 4-Methylphenol | 10 U | NA | 11 U | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Caprolactam | 10 U | NA | 11 U | 10 U | 1.2 J | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Di-n-butylphthalate | 10 U | NA | 1.4 J | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Naphthalene | 10 U | NA | 11 U | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Phenol | 10 U | NA | 11 U | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| bis(2-Ethylhexyl)phthalate | 3.2 J | NA | 2.4 B | 1.3 J | 21 | NA | 2.2 B | 10 U | NA | 7.4 B | 1.2 J | NA | 2.8 B |
| **Explosives (UG_L)** | | | | | | | | | | | | | |
| Nitrobenzene | 0.26 U | NA | NA | 0.26 U | 0.26 U | NA | NA | 0.26 U | NA | NA | 0.26 U | NA | NA |
| Perchlorate | 5 U | NA | 0.0612 U | 5 U | 5 U | NA | 0.0612 U | 2 U | NA | 0.0612 U | 2 U | NA | 0.0612 U |
| **Total Metals (UG_L)** | | | | | | | | | | | | | |
| Aluminum | 1,480 | NA | 10,900 J | 3,120 | 2,800 | NA | 17,100 J | 1,570 | NA | 1,910 | 145 J | NA | 589 |
| Antimony | 2.8 U | NA | 60 U | 2.8 U | 2.8 U | NA | 60 U | 2.8 U | NA | 60 U | 2.8 U | NA | 60 U |
| Arsenic | 3.6 U | NA | 9.3 K | 6 J | 5 J | NA | 10.6 K | 3.6 U | NA | 6.9 K | 3.6 U | NA | 10 U |
| Barium | 57.9 J | NA | 102 J | 41.2 J | 39.7 J | NA | 62.5 J | 56.8 J | NA | 78.1 J | 25.7 J | NA | 29.6 J |
| Beryllium | 0.1 U | NA | 0.47 J | 0.18 J | 0.17 J | NA | 0.83 J | 0.12 J | NA | 5 U | 0.1 U | NA | 0.27 J |
| Cadmium | 0.4 U | NA | 0.93 B | 0.4 U | 0.4 U | NA | 1 B | 0.4 U | NA | 5 U | 0.41 J | NA | 5 U |
| Calcium | 213,000 | NA | 270,000 | 341,000 | 346,000 | NA | 382,000 | 105,000 | NA | 114,000 | 147,000 | NA | 139,000 |
| Chromium | 12.8 | NA | 250 | 16.8 | 9 J | NA | 28.7 | 4.2 J | NA | 37.2 | 6.2 B | NA | 8.3 K |
| Chromium (hexavalent) | 10 U | NA | NA | 10 U | 10 U | NA | NA | 10 U | NA | NA | 10 U | NA | NA |
| Cobalt | 3.2 J | NA | 11.8 J | 4.1 J | 1.9 J | NA | 13.4 J | 0.7 U | NA | 1.3 B | 0.7 U | NA | 0.87 B |
| Copper | 9.6 J | NA | 31.9 | 5.6 B | 4.9 B | NA | 25.2 | 5.5 B | NA | 6.8 B | 3.1 B | NA | 2.5 B |
| Iron | 5,390 | NA | 19,600 | 5,600 | 4,450 | NA | 19,500 | 2,240 | NA | 4,590 | 326 | NA | 809 |
| Lead | 1.8 U | NA | 14.1 K | 3.5 | 2.2 J | NA | 18.5 K | 2.6 J | NA | 2.8 K | 1.8 J | NA | 10 U |
| Magnesium | 69,700 | NA | 96,500 | 116,000 | 118,000 | NA | 129,000 | 65,900 | NA | 48,400 | 58,800 | NA | 57,200 |
| Manganese | 738 | NA | 719 | 537 | 436 | NA | 629 | 77 | NA | 102 | 11.9 B | NA | 16.3 |
| Mercury | 0.1 U | NA | 0.029 J | 0.1 U | 0.1 U | NA | 0.2 U | 0.1 U | NA | 0.023 J | 0.1 U | NA | 0.2 UL |
| Nickel | 22.8 J | NA | 163 | 13.5 J | 7.5 J | NA | 26.6 J | 2.9 J | NA | 24.8 J | 4.2 B | NA | 7.2 B |
| Potassium | 6,470 | NA | 7,350 | 5,080 | 5,000 | NA | 8,560 | 17,600 | NA | 6,170 | 3,300 J | NA | 3,130 J |
| Selenium | 2.9 J | NA | 35 U | 2.6 U | 2.6 U | NA | 35 U | 2.6 U | NA | 35 U | 2.6 U | NA | 35 U |
| Sodium | 13,000 | NA | 16,900 | 5,340 | 5,150 | NA | 4,620 J | 20,000 | NA | 71,800 | 2,460 J | NA | 2,350 J |
| Thallium | 4.6 U | NA | 25 U | 4.6 U | 4.6 U | NA | 25 U | 4.6 U | NA | 25 U | 4.6 U | NA | 25 U |
| Vanadium | 2.7 J | NA | 19.2 J | 5.6 J | 4.2 J | NA | 28.4 J | 2.6 J | NA | 3.6 J | 1.1 U | NA | 0.82 J |
| Zinc | 27.2 | NA | 86.2 B | 18.4 B | 15.8 B | NA | 99.9 B | 9.8 B | NA | 38.3 B | 9.4 B | NA | 164 B |

**Notes:**
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
E - Exceeds calibration range
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Shading represents detect

**TABLE 5-3**
Analytical Results for Bedrock Groundwater Samples (Detected Constituents)
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| **Station ID** | 12MW09S | | | 12MW09D | | | | 12MW11S | | | 12MW11D | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW09S-0605 | AS12-12MW09S-1206 | AS12-12MW09S-0607 | AS12-12MW09D-0605 | AS12-12MW09DP-0605 | AS12-12MW09D-1206 | AS12-12MW09D-0607 | AS12-12MW11S-0605 | AS12-12MW11S-1206 | AS12-12MW11S-0607 | AS12-12MW11D-0505 | AS12-12MW11D-1206 | AS12-12MW11D-0607 |
| **Sample Date** | 06/02/05 | 12/07/06 | 06/11/07 | 06/02/05 | 06/02/05 | 12/07/06 | 06/11/07 | 06/02/05 | 12/07/06 | 06/13/07 | 05/27/05 | 12/07/06 | 06/12/07 |
| **Chemical Name** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **Dissolved Metals (UG_L)** | | | | | | | | | | | | | |
| Aluminum | 40.3 U | NA | 200 UJ | 40.3 U | 40.3 U | NA | 627 J | 40.3 U | NA | 74.7 J | 40.3 U | NA | 200 U |
| Antimony | 2.8 U | NA | 60 U | 2.8 U | 2.8 U | NA | 60 U | 2.8 U | NA | 60 U | 2.8 U | NA | 60 U |
| Arsenic | 3.6 U | NA | 10 U | 3.6 U | 3.6 U | NA | 10 U | 3.6 U | NA | 10 U | 3.6 U | NA | 10 U |
| Barium | 49.5 J | NA | 56.8 J | 25.7 J | 25.9 J | NA | 15.5 J | 42 J | NA | 36.4 J | 24.7 J | NA | 26.5 J |
| Beryllium | 0.1 U | NA | 5 U | 0.1 U | 0.1 U | NA | 5 U | 0.1 U | NA | 5 U | 0.1 U | NA | 0.36 J |
| Calcium | 202,000 | NA | 257,000 | 335,000 | 338,000 | NA | 380,000 | 102,000 | NA | 95,000 | 144,000 | NA | 133,000 |
| Chromium | 0.6 U | NA | 0.85 B | 0.6 U | 0.6 U | NA | 1.4 B | 0.6 U | NA | 10 U | 0.66 J | NA | 1.5 K |
| Chromium (hexavalent) | 10 U | NA | NA | 10 U | 10 U | NA | NA | 10 U | NA | NA | 10 U | NA | NA |
| Cobalt | 1.6 J | NA | 1.7 J | 0.73 J | 0.7 U | NA | 50 U | 0.7 U | NA | 50 U | 0.7 U | NA | 0.72 B |
| Iron | 2,330 | NA | 3,460 | 1,220 | 1,240 | NA | 573 | 16.3 U | NA | 65 B | 79.2 B | NA | 266 |
| Lead | 1.8 U | NA | 10 U | 1.8 U | 1.8 U | NA | 10 U | 1.8 U | NA | 10 U | 1.8 U | NA | 10 U |
| Magnesium | 66,700 | NA | 90,400 | 113,000 | 115,000 | NA | 127,000 | 64,200 | NA | 45,000 | 58,000 | NA | 54,400 |
| Manganese | 621 | NA | 98.9 | 66.9 | 68.1 | NA | 30.6 | 46 | NA | 23.9 | 8.9 J | NA | 9.1 J |
| Mercury | 0.1 U | NA | 0.2 U | 0.1 U | 0.11 J | NA | 0.058 J | 0.1 U | NA | 0.2 U | 0.1 U | NA | 0.2 UL |
| Nickel | 13.4 J | NA | 39.5 J | 1.8 J | 1.7 J | NA | 1.2 B | 1.2 U | NA | 2.7 J | 1.2 U | NA | 2 J |
| Potassium | 5,680 | NA | 4,750 J | 4,050 J | 4,080 J | NA | 4,010 J | 15,200 | NA | 7,500 | 3,270 J | NA | 2,890 J |
| Selenium | 2.6 U | NA | 35 U | 2.6 U | 2.6 U | NA | 35 U | 2.6 U | NA | 35 U | 2.6 U | NA | 35 U |
| Sodium | 11,100 | NA | 13,900 | 5,290 | 5,060 | NA | 4,510 J | 13,000 | NA | 33,200 | 2,530 J | NA | 2,370 J |
| Thallium | 4.6 U | NA | 25 U | 4.6 U | 4.6 U | NA | 25 U | 4.6 U | NA | 25 U | 4.6 U | NA | 25 U |
| Vanadium | 1.1 U | NA | 50 U | 1.1 U | 1.1 U | NA | 50 U | 1.1 U | NA | 50 U | 1.1 U | NA | 50 U |
| Zinc | 12.5 B | NA | 16.2 B | 4.6 B | 4.8 B | NA | 9.8 B | 3.7 B | NA | 41.4 B | 5.4 J | NA | 16 B |
| | | | | | | | | | | | | | |
| **Wet Chemistry (MG_L)** | | | | | | | | | | | | | |
| Alkalinity | NA | 240 | NA | NA | NA | 230 | NA | NA | 220 | NA | NA | 260 | NA |
| Chloride | NA | NA | 64 | NA | NA | NA | 6.3 | NA | NA | 3.7 | NA | NA | 4.2 |
| Hardness | NA | NA | 1,300 | NA | NA | NA | 1,700 | NA | NA | 580 | NA | NA | 600 |
| Nitrate | NA | NA | 0.1 U | NA | NA | NA | 0.1 U | NA | NA | 0.1 U | NA | NA | 0.1 U |
| Nitrogen | NA | NA | 0.1 U | NA | NA | NA | 0.1 U | NA | NA | 0.1 U | NA | NA | 0.1 U |
| Sulfate | NA | NA | 780 | NA | NA | NA | 1,300 | NA | NA | 340 | NA | NA | 370 |
| Total organic carbon (TOC) | NA | 4.1 B | 2.5 | NA | NA | 1 U | 1 U | NA | 1.5 B | 2.6 | NA | 1 B | 1 U |

**Notes:**
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
E - Exceeds calibration range
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Shading represents detect

**TABLE 5-3**
Analytical Results for Bedrock Groundwater Samples (Detected Constituents)
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| **Station ID** | 12MW13S | 12MW17S | | 12MW17D | | 12MW20S | 12MW20D | 12MW21S | | | 12MW21D | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW13S-0505 | AS12-12MW17S-0505 | AS12-12MW17S-0607 | AS12-12MW17D-0505 | AS12-12MW17D-0607 | AS12-12MW20S-1206 | AS12-12MW20D-1206 | AS12-12MW21S-1206 | AS12-12MW21SP-1206 | AS12-12MW21S-0607 | AS12-12MW21D-1206 | AS12-12MW21D-0607 |
| **Sample Date** | 05/23/05 | 05/24/05 | 06/12/07 | 05/24/05 | 06/12/07 | 12/06/06 | 12/07/06 | 12/06/06 | 12/06/06 | 06/11/07 | 12/06/06 | 06/11/07 |
| **Chemical Name** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Volatile Organic Compounds (UG_L)** | | | | | | | | | | | | |
| 1,1,1-Trichloroethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 U | 10 UL | 10 UL | 0.5 U | 10 U | 0.5 U |
| 1,1,2,2-Tetrachloroethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 U | 10 UL | 10 UL | 0.5 U | 10 U | 0.5 U |
| 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | 3.6 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 U | 10 UL | 10 UL | 0.5 U | 10 U | 0.5 U |
| 1,1,2-Trichloroethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 U | 10 UL | 10 UL | 0.5 U | 10 U | 0.5 U |
| 1,1-Dichloroethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 U | 10 UL | 2.7 L | 0.91 | 10 U | 0.92 |
| 1,1-Dichloroethene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 U | 10 UL | 10 UL | 0.5 U | 10 U | 0.5 U |
| 1,2,4-Trichlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 U | 10 UL | 10 UL | 0.5 U | 10 U | 0.5 U |
| 1,2-Dibromo-3-chloropropane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 R | 10 U | 10 R | 10 R | 0.5 U | 10 U | 0.5 U |
| 1,2-Dichlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 U | 10 UL | 10 UL | 0.5 U | 10 U | 0.5 U |
| 1,2-Dichloropropane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 U | 10 UL | 10 UL | 0.5 U | 10 U | 0.5 U |
| 1,3-Dichlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 U | 10 UL | 10 UL | 0.5 U | 10 U | 0.5 U |
| 1,4-Dichlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 U | 10 UL | 10 UL | 0.5 U | 10 U | 0.5 U |
| 2-Butanone | 5 U | 5 U | 5 U | 5 U | 5 U | 10 UL | 7.9 J | 10 UL | 10 UL | 5 U | 10 UJ | 5 U |
| 2-Hexanone | 5 U | 5 U | 5 U | 5 U | 5 U | 10 UL | 10 U | 10 UL | 10 UL | 2.5 J | 10 UJ | 5 U |
| 4-Methyl-2-pentanone | 5 U | 5 U | 5 U | 5 U | 5 U | 10 UL | 10 U | 10 UL | 10 UL | 5 U | 10 UJ | 5 U |
| Acetone | 5 U | 5 U | 5 U | 5 U | 2.2 J | 10 UL | 10 U | 10 UL | 10 UL | 5 U | 10 U | 6.7 |
| Benzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 U | 10 UL | 10 UL | 0.5 U | 10 U | 0.5 U |
| Bromochloromethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | NA | NA | NA | NA | 0.5 U | NA | 0.5 U |
| Bromodichloromethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 U | 10 UL | 10 UL | 0.5 U | 10 U | 0.5 U |
| Carbon disulfide | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 | 10 UL | 10 UL | 0.5 U | 3.2 J | 0.5 U |
| Chlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 U | 10 UL | 10 UL | 0.5 U | 10 U | 0.5 U |
| Chloroethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 U | 10 UL | 10 UL | 0.5 U | 10 U | 0.5 U |
| Chloroform | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 U | 10 UL | 10 UL | 0.5 U | 10 U | 0.5 U |
| Chloromethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 U | 10 UL | 10 UL | 0.5 U | 10 U | 0.5 U |
| Cyclohexane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 U | 1.4 L | 1.2 L | 0.52 | 10 U | 0.5 U |
| Ethane | NA | NA | 6.2 U | NA | 6.2 U | NA | NA | NA | NA | 6 J | NA | 31 U |
| Ethylbenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 U | 10 UL | 10 UL | 0.5 U | 10 U | 0.5 U |
| Isopropylbenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 U | 10 UL | 10 UL | 0.5 U | 10 U | 0.5 U |
| Methane | NA | NA | 3.3 U | NA | 3.3 U | NA | NA | NA | NA | 70 E | NA | 43 |
| Methylcyclohexane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 U | 10 UL | 10 UL | 0.5 U | 10 U | 0.5 U |
| Methylene chloride | 2.3 B | 3.4 B | 0.5 U | 3.8 B | 0.49 B | 10 UL | 3 J | 29 L | 170 L | 0.5 U | 300 | 0.86 B |
| Tetrachloroethene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 U | 10 UL | 10 UL | 0.5 U | 10 U | 0.5 U |
| Toluene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 U | 1.7 L | 1.3 L | 0.5 U | 2.1 J | 0.5 U |
| Trichloroethene | 0.5 U | 0.56 | 0.5 U | 0.81 | 0.5 U | 10 UL | 1.8 J | 3 L | 2.9 L | 0.33 J | 10 U | 0.5 U |
| Vinyl chloride | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 U | 10 UL | 10 UL | 0.5 U | 10 U | 0.5 U |
| Xylene, total | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 U | 10 UL | 10 UL | 0.5 U | 10 U | 0.5 U |
| cis-1,2-Dichloroethene | 0.5 U | 0.5 UJ | 0.5 U | 0.5 UJ | 0.5 U | 10 UL | 10 U | 10 UL | 10 UL | 1.2 | 10 U | 1.2 |
| trans-1,2-Dichloroethene | 0.5 U | 0.5 UJ | 0.5 U | 0.5 UJ | 0.5 U | 10 UL | 10 U | 10 UL | 10 UL | 0.5 U | 10 U | 0.5 U |

**Notes:**
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
E - Exceeds calibration range
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Shading represents detect

**TABLE 5-3**
Analytical Results for Bedrock Groundwater Samples (Detected Constituents)
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| **Station ID** | 12MW13S | 12MW17S | | 12MW17D | | 12MW20S | 12MW20D | 12MW21S | | | 12MW21D | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW13S-0505 | AS12-12MW17S-0505 | AS12-12MW17S-0607 | AS12-12MW17D-0505 | AS12-12MW17D-0607 | AS12-12MW20S-1206 | AS12-12MW20D-1206 | AS12-12MW21S-1206 | AS12-12MW21SP-1206 | AS12-12MW21S-0607 | AS12-12MW21D-1206 | AS12-12MW21D-0607 |
| **Sample Date** | 05/23/05 | 05/24/05 | 06/12/07 | 05/24/05 | 06/12/07 | 12/06/06 | 12/07/06 | 12/06/06 | 12/06/06 | 06/11/07 | 12/06/06 | 06/11/07 |
| **Chemical Name** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Semi-volatile Organic Compounds (UG_L)** | | | | | | | | | | | | |
| 4-Methylphenol | 10 U | 10 U | 10 U | 11 U | 10 U | NA | NA | NA | NA | 11 U | NA | 11 U |
| Caprolactam | 10 U | 10 U | 10 U | 11 U | 10 U | NA | NA | NA | NA | 11 U | NA | 11 U |
| Di-n-butylphthalate | 1.5 B | 10 U | 10 U | 11 U | 10 U | NA | NA | NA | NA | 11 U | NA | 11 U |
| Naphthalene | 10 U | 10 U | 10 U | 11 U | 10 U | NA | NA | NA | NA | 11 U | NA | 11 U |
| Phenol | 10 U | 10 U | 10 U | 11 U | 10 U | NA | NA | NA | NA | 11 U | NA | 11 U |
| bis(2-Ethylhexyl)phthalate | 3.2 B | 16 B | 1.6 B | 11 U | 10 U | NA | NA | NA | NA | 2.8 B | NA | 2.6 B |
| | | | | | | | | | | | | |
| **Explosives (UG_L)** | | | | | | | | | | | | |
| Nitrobenzene | 0.26 U | 0.26 U | NA | 0.26 U | NA | NA | NA | NA | NA | NA | NA | NA |
| Perchlorate | 2 U | 2 U | 0.402 | 2 U | 0.0612 U | NA | NA | NA | NA | 0.0612 U | NA | 0.0612 U |
| | | | | | | | | | | | | |
| **Total Metals (UG_L)** | | | | | | | | | | | | |
| Aluminum | 40.3 U | 365 | 667 | 488 | 1,430 | NA | NA | NA | NA | 200 UL | NA | 119 J |
| Antimony | 2.8 U | 2.8 U | 60 U | 2.8 U | 60 U | NA | NA | NA | NA | 60 U | NA | 60 U |
| Arsenic | 3.6 U | 3.6 U | 10 U | 3.6 U | 10 U | NA | NA | NA | NA | 4 K | NA | 3.9 K |
| Barium | 53.6 J | 67.3 J | 86.2 J | 34.5 J | 49 J | NA | NA | NA | NA | 23.1 J | NA | 26 J |
| Beryllium | 0.1 U | 0.1 U | 5 U | 0.1 U | 5 U | NA | NA | NA | NA | 5 U | NA | 5 U |
| Cadmium | 0.4 U | 0.4 U | 5 U | 0.4 U | 5 U | NA | NA | NA | NA | 5 U | NA | 5 U |
| Calcium | 130,000 | 161,000 | 160,000 | 115,000 | 113,000 | NA | NA | NA | NA | 356,000 | NA | 318,000 |
| Chromium | 0.6 U | 1.3 J | 6.3 B | 2.3 J | 3.8 B | NA | NA | NA | NA | 1.7 B | NA | 34 |
| Chromium (hexavalent) | 10 U | 10 U | NA | 10 U | NA | NA | NA | NA | NA | NA | NA | NA |
| Cobalt | 0.7 U | 0.7 U | 0.7 B | 0.7 U | 0.85 B | NA | NA | NA | NA | 50 U | NA | 3.9 J |
| Copper | 4.1 B | 1.2 B | 2.3 B | 0.8 U | 4.8 B | NA | NA | NA | NA | 4.4 B | NA | 6.6 B |
| Iron | 61.3 B | 538 | 1,270 | 1,650 | 2,850 | NA | NA | NA | NA | 2,400 | NA | 3,540 |
| Lead | 1.8 U | 1.8 U | 10 U | 1.8 U | 10 U | NA | NA | NA | NA | 10 U | NA | 10 U |
| Magnesium | 30,600 | 41,000 | 43,100 | 43,600 | 46,200 | NA | NA | NA | NA | 123,000 | NA | 112,000 |
| Manganese | 31.9 | 7 J | 19.7 | 105 | 10.4 J | NA | NA | NA | NA | 22.1 | NA | 92.1 |
| Mercury | 0.1 U | 0.1 U | 0.2 UL | 0.1 U | 0.2 U | NA | NA | NA | NA | 0.2 U | NA | 0.2 U |
| Nickel | 1.2 U | 2 B | 4.2 B | 2.4 B | 2.5 B | NA | NA | NA | NA | 4.3 B | NA | 29.8 J |
| Potassium | 1,900 J | 2,250 J | 2,320 J | 2,290 J | 2,380 J | NA | NA | NA | NA | 3,980 J | NA | 4,090 J |
| Selenium | 2.6 U | 2.6 U | 35 U | 2.6 U | 35 U | NA | NA | NA | NA | 35 U | NA | 35 U |
| Sodium | 32,700 | 33,100 | 41,900 | 9,480 | 9,190 | NA | NA | NA | NA | 5,800 | NA | 13,300 |
| Thallium | 4.6 U | 4.6 U | 25 U | 4.6 U | 6.2 K | NA | NA | NA | NA | 25 U | NA | 25 U |
| Vanadium | 1.1 U | 1.1 U | 50 U | 1.1 U | 2.7 J | NA | NA | NA | NA | 50 U | NA | 0.67 J |
| Zinc | 8 J | 0.6 U | 13.1 B | 8.2 J | 14.2 B | NA | NA | NA | NA | 10.8 B | NA | 15.3 B |

**Notes:**
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
E - Exceeds calibration range
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Shading represents detect

**TABLE 5-3**
Analytical Results for Bedrock Groundwater Samples (Detected Constituents)
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| **Station ID** | 12MW13S | 12MW17S | | 12MW17D | | 12MW20S | 12MW20D | 12MW21S | | | 12MW21D | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW13S-0505 | AS12-12MW17S-0505 | AS12-12MW17S-0607 | AS12-12MW17D-0505 | AS12-12MW17D-0607 | AS12-12MW20S-1206 | AS12-12MW20D-1206 | AS12-12MW21S-1206 | AS12-12MW21SP-1206 | AS12-12MW21S-0607 | AS12-12MW21D-1206 | AS12-12MW21D-0607 |
| **Sample Date** | 05/23/05 | 05/24/05 | 06/12/07 | 05/24/05 | 06/12/07 | 12/06/06 | 12/07/06 | 12/06/06 | 12/06/06 | 06/11/07 | 12/06/06 | 06/11/07 |
| **Chemical Name** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Dissolved Metals (UG_L)** | | | | | | | | | | | | |
| Aluminum | 40.3 U | 40.3 U | 200 U | 40.3 U | 200 U | NA | NA | NA | NA | 1,100 J | NA | 200 UJ |
| Antimony | 2.8 U | 2.8 U | 60 U | 2.8 U | 60 U | NA | NA | NA | NA | 60 U | NA | 60 U |
| Arsenic | 3.6 U | 3.6 U | 10 U | 3.7 J | 10 U | NA | NA | NA | NA | 4.1 K | NA | 5.3 K |
| Barium | 53.3 J | 59.8 J | 54.2 J | 31.1 J | 40.8 J | NA | NA | NA | NA | 25.6 J | NA | 23.2 J |
| Beryllium | 0.1 U | 0.1 U | 5 U | 0.1 U | 5 U | NA | NA | NA | NA | 5 U | NA | 5 U |
| Calcium | 129,000 | 164,000 | 131,000 | 114,000 | 109,000 | NA | NA | NA | NA | 333,000 | NA | 338,000 |
| Chromium | 0.6 U | 1 J | 2.1 K | 0.6 U | 0.9 J | NA | NA | NA | NA | 1.8 B | NA | 2.6 B |
| Chromium (hexavalent) | 10 U | 10 U | NA | 10 U | NA | NA | NA | NA | NA | NA | NA | NA |
| Cobalt | 0.7 U | 0.7 U | 50 U | 0.7 U | 50 U | NA | NA | NA | NA | 50 U | NA | 1.4 J |
| Iron | 16.3 U | 16.3 U | 100 U | 720 | 100 U | NA | NA | NA | NA | 2,220 | NA | 2,010 |
| Lead | 1.8 U | 1.8 U | 10 U | 1.8 U | 10 U | NA | NA | NA | NA | 2.3 K | NA | 10 U |
| Magnesium | 30,300 | 41,900 | 35,500 | 43,100 | 44,300 | NA | NA | NA | NA | 116,000 | NA | 118,000 |
| Manganese | 29.9 | 2.3 J | 1 B | 102 | 2.7 B | NA | NA | NA | NA | 38.9 | NA | 48.5 |
| Mercury | 0.1 U | 0.1 U | 0.2 UL | 0.1 U | 0.2 U | NA | NA | NA | NA | 0.2 U | NA | 0.2 U |
| Nickel | 1.3 J | 3 J | 2.9 J | 1.8 J | 40 U | NA | NA | NA | NA | 4.1 B | NA | 17.4 J |
| Potassium | 1,880 J | 2,210 J | 1,820 J | 2,160 J | 2,000 J | NA | NA | NA | NA | 3,830 J | NA | 4,000 J |
| Selenium | 2.6 U | 4.1 J | 35 U | 3.5 J | 35 U | NA | NA | NA | NA | 35 U | NA | 35 U |
| Sodium | 32,500 | 33,600 | 34,100 | 9,210 | 8,780 | NA | NA | NA | NA | 6,540 | NA | 9,120 |
| Thallium | 4.6 U | 4.6 U | 25 U | 10.2 B | 25 U | NA | NA | NA | NA | 5.8 K | NA | 25 U |
| Vanadium | 1.1 U | 1.1 U | 50 U | 1.1 U | 50 U | NA | NA | NA | NA | 50 U | NA | 50 U |
| Zinc | 3.2 J | 0.6 U | 13.1 B | 4.6 J | 21.3 B | NA | NA | NA | NA | 23.2 B | NA | 12 B |
| | | | | | | | | | | | | |
| **Wet Chemistry (MG_L)** | | | | | | | | | | | | |
| Alkalinity | NA | NA | NA | NA | NA | 220 | 230 | 230 | 220 | NA | 240 | NA |
| Chloride | NA | NA | 94 | NA | 28 | NA | NA | NA | NA | 9.4 | NA | 10 |
| Hardness | NA | NA | 600 | NA | 480 | NA | NA | NA | NA | 1,500 | NA | 1,400 |
| Nitrate | NA | NA | 1 | NA | 0.1 | NA | NA | NA | NA | 0.1 U | NA | 0.1 U |
| Nitrogen | NA | NA | 0.1 U | NA | 0.1 U | NA | NA | NA | NA | 0.1 U | NA | 0.1 U |
| Sulfate | NA | NA | 250 | NA | 200 | NA | NA | NA | NA | 1,200 | NA | 1,000 |
| Total organic carbon (TOC) | NA | NA | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 2.7 | 1 |

**Notes:**
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B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
E - Exceeds calibration range
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
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**TABLE 5-3**
Analytical Results for Bedrock Groundwater Samples (Detected Constituents)
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| **Station ID** | 12MW22S | | 12MW22D | |
|---|---|---|---|---|
| **Sample ID** | AS12-12MW22S-1206 | AS12-12MW22S-0607 | AS12-12MW22D-1206 | AS12-12MW22D-0607 |
| **Sample Date** | 12/06/06 | 06/13/07 | 12/06/06 | 06/13/07 |
| **Chemical Name** | | | | |
| | | | | |
| **Volatile Organic Compounds (UG_L)** | | | | |
| 1,1,1-Trichloroethane | 10 U | 0.5 U | 10 UL | 0.5 U |
| 1,1,2,2-Tetrachloroethane | 10 U | 0.5 U | 10 UL | 0.5 U |
| 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | 10 U | 0.5 U | 10 UL | 0.5 U |
| 1,1,2-Trichloroethane | 10 U | 0.5 U | 10 UL | 0.5 U |
| 1,1-Dichloroethane | 10 U | 0.5 U | 10 UL | 0.5 U |
| 1,1-Dichloroethene | 10 U | 0.5 U | 10 UL | 0.5 U |
| 1,2,4-Trichlorobenzene | 10 U | 0.5 U | 10 UL | 0.5 U |
| 1,2-Dibromo-3-chloropropane | 10 U | 0.5 U | 10 R | 0.5 U |
| 1,2-Dichlorobenzene | 10 U | 0.5 U | 10 UL | 0.5 U |
| 1,2-Dichloropropane | 10 U | 0.5 U | 10 UL | 0.5 U |
| 1,3-Dichlorobenzene | 10 U | 0.5 U | 10 UL | 0.5 U |
| 1,4-Dichlorobenzene | 10 U | 0.5 U | 10 UL | 0.5 U |
| 2-Butanone | 10 UJ | 5 U | 10 UL | 5 U |
| 2-Hexanone | 10 UJ | 5 U | 10 UL | 5 U |
| 4-Methyl-2-pentanone | 10 UJ | 5 U | 10 UL | 5 U |
| Acetone | 10 U | 5 U | 16 L | 5 U |
| Benzene | 10 U | 0.5 U | 10 UL | 0.5 U |
| Bromochloromethane | NA | 0.5 U | NA | 0.5 U |
| Bromodichloromethane | 10 U | 0.5 U | 10 UL | 0.5 U |
| Carbon disulfide | 10 U | 0.5 U | 10 UL | 0.5 U |
| Chlorobenzene | 10 U | 0.5 U | 10 UL | 0.5 U |
| Chloroethane | 10 U | 0.5 U | 10 UL | 0.5 U |
| Chloroform | 10 U | 0.5 U | 10 UL | 0.5 U |
| Chloromethane | 10 U | 0.5 U | 10 UL | 0.5 U |
| Cyclohexane | 10 U | 0.5 U | 10 UL | 0.5 U |
| Ethane | NA | 120 U | NA | 12 U |
| Ethylbenzene | 10 U | 0.5 U | 10 UL | 0.5 U |
| Isopropylbenzene | 10 U | 0.5 U | 10 UL | 0.5 U |
| Methane | NA | 700 E | NA | 69 E |
| Methylcyclohexane | 10 U | 0.5 U | 10 UL | 0.5 U |
| Methylene chloride | 13 | 0.62 B | 10 L | 0.58 B |
| Tetrachloroethene | 10 U | 0.5 U | 10 UL | 0.5 U |
| Toluene | 10 U | 0.5 U | 10 UL | 0.5 U |
| Trichloroethene | 10 U | 0.5 U | 10 UL | 0.5 U |
| Vinyl chloride | 10 U | 0.5 U | 10 UL | 0.5 U |
| Xylene, total | 10 U | 0.5 U | 10 UL | 0.5 U |
| cis-1,2-Dichloroethene | 10 U | 0.5 U | 10 UL | 0.5 U |
| trans-1,2-Dichloroethene | 10 U | 0.5 U | 10 UL | 0.5 U |

**Notes:**
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B - Possible blank contamination
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L - Reported value may be biased low
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UJ - Analyte not detected, result may be estimated
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**TABLE 5-3**
Analytical Results for Bedrock Groundwater Samples (Detected Constituents)
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| **Station ID** | 12MW22S | | 12MW22D | |
|---|---|---|---|---|
| **Sample ID** | AS12-12MW22S-1206 | AS12-12MW22S-0607 | AS12-12MW22D-1206 | AS12-12MW22D-0607 |
| **Sample Date** | 12/06/06 | 06/13/07 | 12/06/06 | 06/13/07 |
| **Chemical Name** | | | | |
| | | | | |
| **Semi-volatile Organic Compounds (UG_L)** | | | | |
| 4-Methylphenol | NA | 10 U | NA | 10 U |
| Caprolactam | NA | 10 U | NA | 10 U |
| Di-n-butylphthalate | NA | 10 U | NA | 10 U |
| Naphthalene | NA | 10 U | NA | 10 U |
| Phenol | NA | 10 U | NA | 10 U |
| bis(2-Ethylhexyl)phthalate | NA | 3.9 B | NA | 2.5 B |
| | | | | |
| **Explosives (UG_L)** | | | | |
| Nitrobenzene | NA | NA | NA | NA |
| Perchlorate | NA | 0.0612 U | NA | 0.0612 U |
| | | | | |
| **Total Metals (UG_L)** | | | | |
| Aluminum | NA | 143 J | NA | 90.2 J |
| Antimony | NA | 60 U | NA | 60 U |
| Arsenic | NA | 4.6 K | NA | 3.8 K |
| Barium | NA | 25.9 J | NA | 15.8 J |
| Beryllium | NA | 5 U | NA | 5 U |
| Cadmium | NA | 0.39 B | NA | 5 U |
| Calcium | NA | 307,000 | NA | 380,000 |
| Chromium | NA | 2.7 J | NA | 1.3 J |
| Chromium (hexavalent) | NA | NA | NA | NA |
| Cobalt | NA | 0.85 B | NA | 1.3 B |
| Copper | NA | 9 B | NA | 2.7 B |
| Iron | NA | 1,140 | NA | 765 |
| Lead | NA | 10 U | NA | 10 U |
| Magnesium | NA | 111,000 | NA | 126,000 |
| Manganese | NA | 57.8 | NA | 15.4 |
| Mercury | NA | 0.2 U | NA | 0.2 U |
| Nickel | NA | 3.6 J | NA | 40 U |
| Potassium | NA | 3,690 J | NA | 3,920 J |
| Selenium | NA | 35 U | NA | 35 U |
| Sodium | NA | 15,900 | NA | 7,050 |
| Thallium | NA | 25 U | NA | 25 U |
| Vanadium | NA | 0.54 J | NA | 50 U |
| Zinc | NA | 28.4 B | NA | 14.9 B |

**Notes:**
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E - Exceeds calibration range
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Shading represents detect

**TABLE 5-3**
Analytical Results for Bedrock Groundwater Samples (Detected Constituents)
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| **Station ID** | 12MW22S | | 12MW22D | |
|---|---|---|---|---|
| **Sample ID** | AS12-12MW22S-1206 | AS12-12MW22S-0607 | AS12-12MW22D-1206 | AS12-12MW22D-0607 |
| **Sample Date** | 12/06/06 | 06/13/07 | 12/06/06 | 06/13/07 |
| **Chemical Name** | | | | |
| | | | | |
| **Dissolved Metals (UG_L)** | | | | |
| Aluminum | NA | 200 U | NA | 200 U |
| Antimony | NA | 60 U | NA | 60 U |
| Arsenic | NA | 10 U | NA | 10 U |
| Barium | NA | 21.1 J | NA | 14 J |
| Beryllium | NA | 5 U | NA | 5 U |
| Calcium | NA | 315,000 | NA | 378,000 |
| Chromium | NA | 10 U | NA | 10 U |
| Chromium (hexavalent) | NA | NA | NA | NA |
| Cobalt | NA | 0.72 B | NA | 0.89 B |
| Iron | NA | 1,010 | NA | 625 |
| Lead | NA | 10 U | NA | 10 U |
| Magnesium | NA | 113,000 | NA | 125,000 |
| Manganese | NA | 51.2 | NA | 12 J |
| Mercury | NA | 0.2 U | NA | 0.2 U |
| Nickel | NA | 2 J | NA | 40 U |
| Potassium | NA | 3,780 J | NA | 3,870 J |
| Selenium | NA | 35 U | NA | 35 U |
| Sodium | NA | 15,600 | NA | 6,370 |
| Thallium | NA | 25 U | NA | 25 U |
| Vanadium | NA | 50 U | NA | 50 U |
| Zinc | NA | 24.5 B | NA | 18.7 B |
| | | | | |
| **Wet Chemistry (MG_L)** | | | | |
| Alkalinity | 210 | NA | 210 | NA |
| Chloride | NA | 7.9 | NA | 6.2 |
| Hardness | NA | 1,400 | NA | 1,400 |
| Nitrate | NA | 0.1 U | NA | 0.1 U |
| Nitrogen | NA | 0.1 U | NA | 0.1 U |
| Sulfate | NA | 1,000 | NA | 1,300 |
| Total organic carbon (TOC) | 1.8 | 1 U | 1.3 | 1 U |

**Notes:**
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
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K - Reported value may be biased high
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Shading represents detect

**TABLE 5-4**
Analytical Results for Bedrock Groundwater Samples (Exceedances)
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Station ID | MCL-Groundwater | RBC-Tap Water | 12MW04S | | 12MW05D | | 12MW05S | | | 12MW07D | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | AS12-12MW04S-0605 | AS12-12MW04S-1206 | AS12-12MW05D-0505 | AS12-12MW05D-0607 | AS12-12MW05S-0505 | AS12-12MW05SP-0505 | AS12-12MW05S-0607 | AS12-12MW07D-0505 | AS12-12MW07DP-0505 | AS12-12MW07D-0607 | AS12-12MW07DP-0607 |
| Sample Date | | | 06/01/05 | 12/07/06 | 05/26/05 | 06/13/07 | 05/26/05 | 05/26/05 | 06/13/07 | 05/25/05 | 05/25/05 | 06/12/07 | 06/12/07 |
| **Chemical Name** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **Volatile Organic Compounds (UG_L)** | | | | | | | | | | | | | |
| 1,1,1-Trichloroethane | 200 | 9,100 | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | -- | 59,000 | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,1-Dichloroethane | -- | 900 | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,1-Dichloroethene | 7 | 350 | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 2-Butanone | -- | 7,000 | 5 U | 10 UL | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 2-Hexanone | -- | 6,300 | 5 U | 10 UL | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Acetone | -- | 5,500 | 5 U | 10 UL | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Bromochloromethane | -- | -- | 0.5 U | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Carbon disulfide | -- | 1,000 | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.61 | 0.5 U | 0.5 U |
| Chloromethane | -- | 190 | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Cyclohexane | -- | 12,000 | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Ethane | -- | -- | NA | NA | NA | 6.2 U | NA | NA | 6.2 U | NA | NA | 6.2 U | 6.2 U |
| Ethylbenzene | 700 | 1,300 | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Methane | -- | -- | NA | NA | NA | 3.3 U | NA | NA | 3.3 U | NA | NA | 3.3 U | 3.3 U |
| Methylene chloride | 5 | 4.1 | 4 B | 10 UL | 0.5 U | 0.46 B | 0.5 U | 0.5 U | 0.53 B | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Tetrachloroethene | 5 | 0.1 | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Toluene | 1,000 | 2,300 | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Trichloroethene | 5 | 0.026 | 1.4 | 2.1 L | 1 | 0.6 | 2.2 | 2.1 | 0.87 | 2.2 | 2.2 | 1.6 | 1.6 |
| Xylene, total | 10,000 | 210 | 0.5 U | 10 UL | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| cis-1,2-Dichloroethene | 70 | 61 | 0.5 UJ | 10 UL | 0.5 UJ | 0.5 U | 0.5 UJ | 0.5 U | 0.5 U | 0.5 U | 0.5 UJ | 0.5 U | 0.5 U |
| trans-1,2-Dichloroethene | 100 | 110 | 0.5 UJ | 10 UL | 0.5 UJ | 0.5 U | 0.5 UJ | 0.5 U | 0.5 U | 0.5 U | 0.5 UJ | 0.5 U | 0.5 U |
| | | | | | | | | | | | | | |
| **Semi-volatile Organic Compounds (UG_L)** | | | | | | | | | | | | | |
| Caprolactam | -- | 18,000 | 10 U | NA | 11 U | 11 U | 10 U | 1.9 J | 11 U | 10 U | 10 U | 10 U | 10 U |
| Di-n-butylphthalate | -- | 3,700 | 10 U | NA | 11 U | 11 U | 10 U | 1.8 J | 11 U | 10 U | 10 U | 10 U | 10 U |
| bis(2-Ethylhexyl)phthalate | 6 | 4.8 | 10 U | NA | 1.8 B | 2.9 B | 10 U | 2 B | 7.8 B | 10 U | 1.1 B | 2 B | 10 U |
| | | | | | | | | | | | | | |
| **Explosives (UG_L)** | | | | | | | | | | | | | |
| Perchlorate | -- | 26 | 5 U | NA | 2 U | 0.0612 U | 2 U | 2 U | 0.0612 U | 2 U | 2 U | 0.0612 U | 0.0612 U |
| | | | | | | | | | | | | | |
| **Total Metals (UG_L)** | | | | | | | | | | | | | |
| Aluminum | -- | 37,000 | 178 B | NA | 111 J | 90.8 J | 277 | 142 J | 215 | 302 | 396 | 235 | 213 |
| Antimony | 6 | 15 | 2.8 U | NA | 2.8 U | 60 U | 2.8 U | 2.8 U | 60 U | 2.8 U | 2.8 U | 60 U | 60 U |
| Arsenic | 10 | 0.045 | 3.6 U | NA | 3.6 U | 2.6 K | 3.6 U | 3.6 U | 10 U | 3.6 U | 5.5 J | 10 U | 10 U |
| Barium | 2,000 | 7,300 | 10.9 J | NA | 33.8 J | 39 J | 37 J | 36.6 J | 40.7 J | 37 J | 37.1 J | 41.2 J | 41.7 J |
| Beryllium | 4 | 73 | 0.1 U | NA | 0.1 U | 5 U | 0.1 U | 0.1 U | 5 U | 0.1 U | 0.1 U | 5 U | 5 U |
| Cadmium | 5 | 18 | 0.4 U | NA | 0.4 U | 5 U | 0.4 U | 0.4 U | 5 U | 0.4 U | 0.4 U | 5 U | 5 U |
| Calcium | -- | -- | 397,000 | NA | 111,000 | 111,000 | 110,000 | 111,000 | 109,000 | 109,000 | 108,000 | 108,000 | 111,000 |
| Chromium | 100 | 110 | 0.74 B | NA | 1.1 B | 2.8 J | 1.6 B | 1.3 B | 1.9 J | 3.2 J | 4.1 J | 2.2 B | 1.8 B |
| Cobalt | -- | 730 | 0.7 U | NA | 0.7 U | 50 U | 0.7 U | 0.7 U | 50 U | 0.7 U | 0.7 U | 0.61 B | 50 U |
| Copper | 1,300 | 1,500 | 1.5 B | NA | 2.7 B | 2.5 B | 2.6 B | 2.1 B | 3.3 B | 0.8 U | 0.8 U | 2.5 B | 3.3 B |
| Iron | -- | 26,000 | 1,090 | NA | 622 | 557 | 506 | 377 | 474 | 254 | 339 | 280 | 220 |
| Lead | 15 | 15 | 1.8 U | NA | 1.8 U | 10 U | 1.8 U | 1.8 U | 2.7 K | 1.8 U | 1.8 U | 2.3 J | 10 U |
| Magnesium | -- | -- | 140,000 | NA | 44,300 | 44,800 | 44,200 | 44,300 | 44,600 | 44,000 | 43,500 | 43,800 | 45,100 |
| Manganese | -- | 730 | 27.7 | NA | 62.8 | 13.7 J | 18 | 14.8 J | 7.7 J | 25 | 26.5 | 8.2 J | 4.4 B |
| Mercury | 2 | 11 | 0.1 U | NA | 0.1 U | 0.2 U | 0.1 U | 0.1 U | 0.2 U | 0.1 U | 0.1 U | 0.2 UL | 0.2 U |
| Nickel | -- | 730 | 1.2 U | NA | 1.7 J | 40 U | 1.2 U | 1.2 U | 1.3 J | 1.9 J | 2.4 J | 2.4 B | 40 U |
| Potassium | -- | -- | 5,630 | NA | 2,130 J | 2,060 J | 2,030 J | 2,010 J | 2,070 J | 2,600 J | 2,640 J | 2,130 J | 2,140 J |
| Selenium | 50 | 180 | 2.6 U | NA | 2.6 U | 35 U | 4 J | 2.6 U | 35 U | 2.6 U | 3.5 B | 35 U | 35 U |
| Sodium | -- | -- | 6,470 | NA | 7,610 | 9,520 | 8,230 | 8,290 | 7,880 | 7,250 | 7,130 | 9,240 | 9,440 |
| Thallium | 2 | 2.6 | 5.8 J | NA | 4.6 U | 25 U | 4.6 U | 4.6 U | 25 U | 6.2 J | 5.7 J | 25 U | 25 U |
| Vanadium | -- | 37 | 1.1 U | NA | 1.1 U | 50 U | 1.1 U | 1.1 U | 50 U | 1.1 U | 1.2 J | 50 U | 0.64 J |
| Zinc | -- | 11,000 | 6.9 B | NA | 12.3 B | 37.5 B | 5.9 B | 4.8 B | 18 B | 6 B | 6.2 B | 22.6 B | 10.1 B |

**TABLE 5-4**
Analytical Results for Bedrock Groundwater Samples (Exceedances)
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Station ID | MCL-Groundwater | RBC-Tap Water | 12MW04S | | 12MW05D | | 12MW05S | | | 12MW07D | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | AS12-12MW04S-0605 | AS12-12MW04S-1206 | AS12-12MW05D-0505 | AS12-12MW05D-0607 | AS12-12MW05S-0505 | AS12-12MW05SP-0505 | AS12-12MW05S-0607 | AS12-12MW07D-0505 | AS12-12MW07DP-0505 | AS12-12MW07D-0607 | AS12-12MW07DP-0607 |
| Sample Date | | | 06/01/05 | 12/07/06 | 05/26/05 | 06/13/07 | 05/26/05 | 05/26/05 | 06/13/07 | 05/25/05 | 05/25/05 | 06/12/07 | 06/12/07 |
| **Chemical Name** | | | | | | | | | | | | | |
| **Dissolved Metals (UG_L)** | | | | | | | | | | | | | |
| Aluminum | -- | 37,000 | 40.3 U | NA | 40.3 U | 200 U | 40.3 U | 40.3 U | 200 U | 40.3 U | 40.3 U | 200 U | 200 U |
| Antimony | 6 | 15 | 2.8 U | NA | 2.8 U | 60 U | 2.8 U | 2.8 U | 60 U | 4 J | 2.8 U | 60 U | 60 U |
| Arsenic | 10 | 0.045 | 3.6 U | NA | 3.6 U | 10 U | 3.6 U | 3.6 U | 3 K | 3.6 U | 3.6 U | 10 U | 10 U |
| Barium | 2,000 | 7,300 | 9.6 J | NA | 32.2 J | 38 J | 34.1 J | 34 J | 37.9 J | 36.5 J | 36.1 J | 39.6 J | 40.1 J |
| Beryllium | 4 | 73 | 0.1 U | NA | 0.1 U | 5 U | 0.1 U | 0.1 U | 5 U | 0.1 U | 0.1 U | 5 U | 5 U |
| Calcium | -- | -- | 392,000 | NA | 109,000 | 109,000 | 110,000 | 110,000 | 109,000 | 108,000 | 107,000 | 106,000 | 109,000 |
| Chromium | 100 | 110 | 0.6 U | NA | 0.6 U | 0.84 J | 0.6 U | 0.6 U | 0.99 J | 3 J | 1.9 J | 1 K | 0.9 J |
| Cobalt | -- | 730 | 0.7 U | NA | 0.7 U | 50 U | 0.7 U | 0.7 U | 50 U | 0.7 U | 0.7 U | 50 U | 50 U |
| Iron | -- | 26,000 | 968 | NA | 508 | 430 | 56.4 J | 54.1 J | 100 U | 16.3 U | 16.3 U | 100 U | 100 U |
| Lead | 15 | 15 | 1.8 U | NA | 1.8 U | 10 U | 1.8 U | 1.8 U | 10 U | 1.8 U | 1.8 U | 10 U | 10 U |
| Magnesium | -- | -- | 139,000 | NA | 43,400 | 44,400 | 44,100 | 44,100 | 44,500 | 44,000 | 43,600 | 43,300 | 44,100 |
| Manganese | -- | 730 | 24.1 | NA | 62.3 | 10.4 J | 8.5 J | 8.8 J | 2.3 J | 24.7 | 23.1 | 1.9 B | 2 B |
| Mercury | 2 | 11 | 0.1 U | NA | 0.1 U | 0.2 U | 0.1 U | 0.1 U | 0.2 U | 0.1 U | 0.1 U | 0.2 UL | 0.2 U |
| Nickel | -- | 730 | 1.6 J | NA | 1.2 U | 1.4 J | 1.4 J | 1.2 U | 40 U | 1.9 J | 1.5 J | 1.5 J | 1.6 J |
| Potassium | -- | -- | 5,590 | NA | 1,980 J | 2,010 J | 1,930 J | 1,970 J | 1,950 J | 2,610 J | 2,510 J | 2,050 J | 2,020 J |
| Selenium | 50 | 180 | 2.6 U | NA | 2.6 U | 35 U | 2.9 J | 2.6 U | 35 U | 2.6 U | 2.6 U | 35 U | 35 U |
| Sodium | -- | -- | 6,290 | NA | 7,510 | 9,430 | 8,040 | 8,030 | 7,680 | 7,290 | 6,950 | 9,120 | 9,060 |
| Thallium | 2 | 2.6 | 7.3 B | NA | 4.6 U | 25 U | 4.6 U | 4.6 U | 25 U | 4.6 U | 4.6 U | 25 U | 25 U |
| Zinc | -- | 11,000 | 6.1 B | NA | 4.8 B | 32.6 B | 3.1 B | 4.6 B | 15.5 B | 3.6 B | 2.9 B | 16 B | 7.7 B |
| | | | | | | | | | | | | | |
| **Wet Chemistry (MG_L)** | | | | | | | | | | | | | |
| Alkalinity | -- | -- | NA | 220 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Chloride | -- | -- | NA | NA | NA | 28 | NA | NA | 31 | NA | NA | 31 | 31 |
| Hardness | -- | -- | NA | NA | NA | 520 | NA | NA | 740 | NA | NA | 440 | 480 |
| Nitrate | 10 | 10 | NA | NA | NA | 0.15 | NA | NA | 0.14 | NA | NA | 0.2 | 0.2 |
| Sulfate | -- | -- | NA | NA | NA | 190 | NA | NA | 180 | NA | NA | 180 | 190 |
| Total organic carbon (TOC) | -- | -- | NA | 1 U | NA | 1 U | NA | NA | 1 U | NA | NA | 1 U | 1 U |

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Exceeds one or more criteria
-- No criteria established

**TABLE 5-4**
Analytical Results for Bedrock Groundwater Samples (Exceedances)
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Station ID | MCL-Groundwater | RBC-Tap Water | 12MW07S | | 12MW09D | | | | 12MW09S | | | 12MW11D | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | AS12-12MW07S-0505 | AS12-12MW07S-0607 | AS12-12MW09D-0605 | AS12-12MW09DP-0605 | AS12-12MW09D-1206 | AS12-12MW09D-0607 | AS12-12MW09S-0605 | AS12-12MW09S-1206 | AS12-12MW09S-0607 | AS12-12MW11D-0505 | AS12-12MW11D-1206 | AS12-12MW11D-0607 |
| Sample Date | | | 05/25/05 | 06/12/07 | 06/02/05 | 06/02/05 | 12/07/06 | 06/11/07 | 06/02/05 | 12/07/06 | 06/11/07 | 05/27/05 | 12/07/06 | 06/12/07 |
| **Chemical Name** | | | | | | | | | | | | | | |
| **Volatile Organic Compounds (UG_L)** | | | | | | | | | | | | | | |
| 1,1,1-Trichloroethane | 200 | 9,100 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 2 | 10 U | 1.3 | 0.5 U | 10 U | 0.5 U |
| 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | -- | 59,000 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,1-Dichloroethane | -- | 900 | 0.5 U | 0.5 U | 0.45 J | 0.42 J | 10 U | 0.5 U | 8 | 10 U | 9 | 0.5 U | 10 U | 0.5 U |
| 1,1-Dichloroethene | 7 | 350 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.43 J | 10 U | 0.61 | 0.5 U | 10 U | 0.5 U |
| 2-Butanone | -- | 7,000 | 5 U | 5 U | 5 U | 5 U | 10 U | 5 U | 5 U | 10 U | 5 U | 5 U | 10 U | 5 U |
| 2-Hexanone | -- | 6,300 | 5 U | 5 U | 5 U | 5 U | 10 U | 3.3 J | 5 U | 10 U | 2.5 J | 5 U | 10 U | 2.2 J |
| Acetone | -- | 5,500 | 5 U | 5 U | 5 U | 5 U | 10 U | 4.2 J | 5 U | 10 U | 7 | 5 UJ | 10 U | 5 U |
| Bromochloromethane | -- | -- | 0.5 U | 0.5 U | 0.5 U | 0.5 U | NA | 0.5 U | 1.1 | NA | 0.5 U | 0.5 U | NA | 0.5 U |
| Carbon disulfide | -- | 1,000 | 0.5 U | 0.5 U | 0.49 J | 0.5 U | 10 U | 0.5 U | 1 | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Chloromethane | -- | 190 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1.4 | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Cyclohexane | -- | 12,000 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 2.7 | 1.5 J | 2.8 | 0.5 U | 10 U | 0.5 U |
| Ethane | -- | -- | NA | 6.2 U | NA | NA | NA | 6.2 U | NA | NA | 31 U | NA | NA | 6.2 U |
| Ethylbenzene | 700 | 1,300 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.42 J | 0.5 U | 10 U | 0.5 U |
| Methane | -- | -- | NA | 3.3 U | NA | NA | NA | 9.8 | NA | NA | 70 | NA | NA | 3.3 U |
| Methylene chloride | 5 | 4.1 | 0.5 U | 0.5 U | 95 B | 98 B | 10 U | 0.59 B | 4,400 | 10 U | 540 J | 0.5 U | 10 U | 0.5 U |
| Tetrachloroethene | 5 | 0.1 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1.4 | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Toluene | 1,000 | 2,300 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 3.1 | 10 U | 0.45 J | 0.5 U | 10 U | 0.5 U |
| Trichloroethene | 5 | 0.026 | 8.9 | 3.8 | 0.5 U | 0.5 U | 10 U | 0.5 U | 4.3 | 1.5 J | 1.8 | 0.5 U | 10 U | 0.5 U |
| Xylene, total | 10,000 | 210 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.62 | 0.5 U | 10 U | 0.5 U |
| cis-1,2-Dichloroethene | 70 | 61 | 1.9 | 0.5 U | 0.5 U | 0.5 UJ | 10 U | 0.5 U | 2 J | 4.7 J | 11 | 0.5 U | 10 U | 0.5 U |
| trans-1,2-Dichloroethene | 100 | 110 | 0.5 U | 0.5 U | 0.5 U | 0.5 UJ | 10 U | 0.5 U | 2.2 J | 2.7 J | 3.1 | 0.5 U | 10 U | 0.5 U |
| **Semi-volatile Organic Compounds (UG_L)** | | | | | | | | | | | | | | |
| Caprolactam | -- | 18,000 | 10 U | 10 U | 10 U | 1.2 J | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Di-n-butylphthalate | -- | 3,700 | 10 U | 10 U | 10 U | 10 U | NA | 11 U | 10 U | NA | 1.4 J | 10 U | NA | 11 U |
| bis(2-Ethylhexyl)phthalate | 6 | 4.8 | 1.6 B | 10 U | 1.3 J | 21 | NA | 2.2 B | 3.2 J | NA | 2.4 B | 1.2 J | NA | 2.8 B |
| **Explosives (UG_L)** | | | | | | | | | | | | | | |
| Perchlorate | -- | 26 | 2 U | 0.0612 U | 5 U | 5 U | NA | 0.0612 U | 5 U | NA | 0.0612 U | 2 U | NA | 0.0612 U |
| **Total Metals (UG_L)** | | | | | | | | | | | | | | |
| Aluminum | -- | 37,000 | 284 | 176 J | 3,120 | 2,800 | NA | 17,100 J | 1,480 | NA | 10,900 J | 145 J | NA | 589 |
| Antimony | 6 | 15 | 3.3 J | 60 U | 2.8 U | 2.8 U | NA | 60 U | 2.8 U | NA | 60 U | 2.8 U | NA | 60 U |
| Arsenic | 10 | 0.045 | 3.6 U | 10 U | 6 J | 5 J | NA | 10.6 K | 3.6 U | NA | 9.3 K | 3.6 U | NA | 10 U |
| Barium | 2,000 | 7,300 | 35 J | 40.2 J | 41.2 J | 39.7 J | NA | 62.5 J | 57.9 J | NA | 102 J | 25.7 J | NA | 29.6 J |
| Beryllium | 4 | 73 | 0.1 U | 5 U | 0.18 J | 0.17 J | NA | 0.83 J | 0.1 U | NA | 0.47 J | 0.1 U | NA | 0.27 J |
| Cadmium | 5 | 18 | 0.4 U | 5 U | 0.4 U | 0.4 U | NA | 1 B | 0.4 U | NA | 0.93 B | 0.41 J | NA | 5 U |
| Calcium | -- | -- | 123,000 | 109,000 | 341,000 | 346,000 | NA | 382,000 | 213,000 | NA | 270,000 | 147,000 | NA | 139,000 |
| Chromium | 100 | 110 | 2 B | 1.6 B | 16.8 | 9 J | NA | 28.7 | 12.8 | NA | 250 | 6.2 B | NA | 8.3 K |
| Cobalt | -- | 730 | 0.7 U | 50 U | 4.1 J | 1.9 J | NA | 13.4 J | 3.2 J | NA | 11.8 J | 0.7 U | NA | 0.87 B |
| Copper | 1,300 | 1,500 | 0.8 U | 1.8 B | 5.6 B | 4.9 B | NA | 25.2 | 9.6 J | NA | 31.9 | 3.1 B | NA | 2.5 B |
| Iron | -- | 26,000 | 573 | 549 | 5,600 | 4,450 | NA | 19,500 | 5,390 | NA | 19,600 | 326 | NA | 809 |
| Lead | 15 | 15 | 1.8 U | 10 U | 3.5 | 2.2 J | NA | 18.5 K | 1.8 U | NA | 14.1 K | 1.8 J | NA | 10 U |
| Magnesium | -- | -- | 43,800 | 43,900 | 116,000 | 118,000 | NA | 129,000 | 69,700 | NA | 96,500 | 58,800 | NA | 57,200 |
| Manganese | -- | 730 | 88.4 | 7.8 J | 537 | 436 | NA | 629 | 738 | NA | 719 | 11.9 B | NA | 16.3 |
| Mercury | 2 | 11 | 0.1 U | 0.2 UL | 0.1 U | 0.1 U | NA | 0.2 U | 0.1 U | NA | 0.029 J | 0.1 U | NA | 0.2 UL |
| Nickel | -- | 730 | 3.7 B | 1.3 B | 13.5 J | 7.5 J | NA | 26.6 J | 22.8 J | NA | 163 | 4.2 B | NA | 7.2 B |
| Potassium | -- | -- | 2,960 J | 2,080 J | 5,080 | 5,000 | NA | 8,560 | 6,470 | NA | 7,350 | 3,300 J | NA | 3,130 J |
| Selenium | 50 | 180 | 2.6 U | 35 U | 2.6 U | 2.6 U | NA | 35 U | 2.9 J | NA | 35 U | 2.6 U | NA | 35 U |
| Sodium | -- | -- | 9,880 | 9,030 | 5,340 | 5,150 | NA | 4,620 J | 13,000 | NA | 16,900 | 2,460 J | NA | 2,350 J |
| Thallium | 2 | 2.6 | 4.6 U | 25 U | 4.6 U | 4.6 U | NA | 25 U | 4.6 U | NA | 25 U | 4.6 U | NA | 25 U |
| Vanadium | -- | 37 | 1.1 U | 50 U | 5.6 J | 4.2 J | NA | 28.4 J | 2.7 J | NA | 19.2 J | 1.1 U | NA | 0.82 J |
| Zinc | -- | 11,000 | 10.6 B | 16.9 B | 18.4 B | 15.8 B | NA | 99.9 B | 27.2 | NA | 86.2 B | 9.4 B | NA | 164 B |

**TABLE 5-4**
Analytical Results for Bedrock Groundwater Samples (Exceedances)
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Station ID | MCL-Groundwater | RBC-Tap Water | 12MW07S | | 12MW09D | | | | 12MW09S | | | 12MW11D | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | AS12-12MW07S-0505 | AS12-12MW07S-0607 | AS12-12MW09D-0605 | AS12-12MW09DP-0605 | AS12-12MW09D-1206 | AS12-12MW09D-0607 | AS12-12MW09S-0605 | AS12-12MW09S-1206 | AS12-12MW09S-0607 | AS12-12MW11D-0505 | AS12-12MW11D-1206 | AS12-12MW11D-0607 |
| Sample Date | | | 05/25/05 | 06/12/07 | 06/02/05 | 06/02/05 | 12/07/06 | 06/11/07 | 06/02/05 | 12/07/06 | 06/11/07 | 05/27/05 | 12/07/06 | 06/12/07 |
| **Chemical Name** | | | | | | | | | | | | | | |
| **Dissolved Metals (UG_L)** | | | | | | | | | | | | | | |
| Aluminum | -- | 37,000 | 40.3 U | 200 U | 40.3 U | 40.3 U | NA | 627 J | 40.3 U | NA | 200 UJ | 40.3 U | NA | 200 U |
| Antimony | 6 | 15 | 3.4 J | 60 U | 2.8 U | 2.8 U | NA | 60 U | 2.8 U | NA | 60 U | 2.8 U | NA | 60 U |
| Arsenic | 10 | 0.045 | 7.3 J | 10 U | 3.6 U | 3.6 U | NA | 10 U | 3.6 U | NA | 10 U | 3.6 U | NA | 10 U |
| Barium | 2,000 | 7,300 | 33.4 J | 39.2 J | 25.7 J | 25.9 J | NA | 15.5 J | 49.5 J | NA | 56.8 J | 24.7 J | NA | 26.5 J |
| Beryllium | 4 | 73 | 0.1 U | 5 U | 0.1 U | 0.1 U | NA | 5 U | 0.1 U | NA | 5 U | 0.1 U | NA | 0.36 J |
| Calcium | -- | -- | 122,000 | 109,000 | 335,000 | 338,000 | NA | 380,000 | 202,000 | NA | 257,000 | 144,000 | NA | 133,000 |
| Chromium | 100 | 110 | 0.6 U | 10 U | 0.6 U | 0.6 U | NA | 1.4 B | 0.6 U | NA | 0.85 B | 0.66 J | NA | 1.5 K |
| Cobalt | -- | 730 | 0.7 U | 50 U | 0.73 J | 0.7 U | NA | 50 U | 1.6 J | NA | 1.7 J | 0.7 U | NA | 0.72 B |
| Iron | -- | 26,000 | 241 | 100 U | 1,220 | 1,240 | NA | 573 | 2,330 | NA | 3,460 | 79.2 B | NA | 266 |
| Lead | 15 | 15 | 1.8 U | 10 U | 1.8 U | 1.8 U | NA | 10 U | 1.8 U | NA | 10 U | 1.8 U | NA | 10 U |
| Magnesium | -- | -- | 43,400 | 43,900 | 113,000 | 115,000 | NA | 127,000 | 66,700 | NA | 90,400 | 58,000 | NA | 54,400 |
| Manganese | -- | 730 | 88.7 | 4.2 J | 66.9 | 68.1 | NA | 30.6 | 621 | NA | 98.9 | 8.9 J | NA | 9.1 J |
| Mercury | 2 | 11 | 0.1 U | 0.2 UL | 0.1 U | 0.11 J | NA | 0.058 J | 0.1 U | NA | 0.2 U | 0.1 U | NA | 0.2 UL |
| Nickel | -- | 730 | 2.7 J | 1.5 J | 1.8 J | 1.7 J | NA | 1.2 B | 13.4 J | NA | 39.5 J | 1.2 U | NA | 2 J |
| Potassium | -- | -- | 2,890 J | 2,080 J | 4,050 J | 4,080 J | NA | 4,010 J | 5,680 | NA | 4,750 J | 3,270 J | NA | 2,890 J |
| Selenium | 50 | 180 | 5.6 B | 35 U | 2.6 U | 2.6 U | NA | 35 U | 2.6 U | NA | 35 U | 2.6 U | NA | 35 U |
| Sodium | -- | -- | 9,860 | 9,220 | 5,290 | 5,060 | NA | 4,510 J | 11,100 | NA | 13,900 | 2,530 J | NA | 2,370 J |
| Thallium | 2 | 2.6 | 4.6 U | 25 U | 4.6 U | 4.6 U | NA | 25 U | 4.6 U | NA | 25 U | 4.6 U | NA | 25 U |
| Zinc | -- | 11,000 | 3.4 B | 16.2 B | 4.6 B | 4.8 B | NA | 9.8 B | 12.5 B | NA | 16.2 B | 5.4 J | NA | 16 B |
| | | | | | | | | | | | | | | |
| **Wet Chemistry (MG_L)** | | | | | | | | | | | | | | |
| Alkalinity | -- | -- | NA | NA | NA | NA | 230 | NA | NA | 240 | NA | NA | 260 | NA |
| Chloride | -- | -- | NA | 28 | NA | NA | NA | 6.3 | NA | NA | 64 | NA | NA | 4.2 |
| Hardness | -- | -- | NA | 460 | NA | NA | NA | 1,700 | NA | NA | 1,300 | NA | NA | 600 |
| Nitrate | 10 | 10 | NA | 0.16 | NA | NA | NA | 0.1 U | NA | NA | 0.1 U | NA | NA | 0.1 U |
| Sulfate | -- | -- | NA | 200 | NA | NA | NA | 1,300 | NA | NA | 780 | NA | NA | 370 |
| Total organic carbon (TOC) | -- | -- | NA | 1 U | NA | NA | 1 U | 1 U | NA | 4.1 B | 2.5 | NA | 1 B | 1 U |

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Exceeds one or more criteria
-- No criteria established

**TABLE 5-4**
Analytical Results for Bedrock Groundwater Samples (Exceedances)
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Station ID | MCL-Groundwater | RBC-Tap Water | 12MW11S | | | 12MW13S | 12MW17D | | 12MW17S | | 12MW20D | 12MW20S |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | AS12-12MW11S-0605 | AS12-12MW11S-1206 | AS12-12MW11S-0607 | AS12-12MW13S-0505 | AS12-12MW17D-0505 | AS12-12MW17D-0607 | AS12-12MW17S-0505 | AS12-12MW17S-0607 | AS12-12MW20D-1206 | AS12-12MW20S-1206 |
| Sample Date | | | 06/02/05 | 12/07/06 | 06/13/07 | 05/23/05 | 05/24/05 | 06/12/07 | 05/24/05 | 06/12/07 | 12/07/06 | 12/06/06 |
| **Chemical Name** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Volatile Organic Compounds (UG_L)** | | | | | | | | | | | | |
| 1,1,1-Trichloroethane | 200 | 9,100 | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | -- | 59,000 | 0.5 U | 10 U | 0.5 U | 3.6 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| 1,1-Dichloroethane | -- | 900 | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| 1,1-Dichloroethene | 7 | 350 | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| 2-Butanone | -- | 7,000 | 5 U | 10 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 7.9 J | 10 UL |
| 2-Hexanone | -- | 6,300 | 5 U | 10 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 10 U | 10 UL |
| Acetone | -- | 5,500 | 5 U | 10 U | 5 U | 5 U | 5 U | 2.2 J | 5 U | 5 U | 10 U | 10 UL |
| Bromochloromethane | -- | -- | 0.5 U | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | NA | NA |
| Carbon disulfide | -- | 1,000 | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 | 10 UL |
| Chloromethane | -- | 190 | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| Cyclohexane | -- | 12,000 | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| Ethane | -- | -- | NA | NA | 6.2 U | NA | NA | 6.2 U | NA | 6.2 U | NA | NA |
| Ethylbenzene | 700 | 1,300 | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| Methane | -- | -- | NA | NA | 5.3 | NA | NA | 3.3 U | NA | 3.3 U | NA | NA |
| Methylene chloride | 5 | 4.1 | 0.82 | 10 U | 0.43 B | 2.3 B | 3.8 B | 0.49 B | 3.4 B | 0.5 U | 3 J | 10 UL |
| Tetrachloroethene | 5 | 0.1 | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| Toluene | 1,000 | 2,300 | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| Trichloroethene | 5 | 0.026 | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.81 | 0.5 U | 0.56 | 0.5 U | 1.8 J | 10 UL |
| Xylene, total | 10,000 | 210 | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| cis-1,2-Dichloroethene | 70 | 61 | 0.5 UJ | 10 U | 0.5 U | 0.5 U | 0.5 UJ | 0.5 U | 0.5 UJ | 0.5 U | 10 U | 10 UL |
| trans-1,2-Dichloroethene | 100 | 110 | 0.5 UJ | 10 U | 0.5 U | 0.5 U | 0.5 UJ | 0.5 U | 0.5 UJ | 0.5 U | 10 U | 10 UL |
| | | | | | | | | | | | | |
| **Semi-volatile Organic Compounds (UG_L)** | | | | | | | | | | | | |
| Caprolactam | -- | 18,000 | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Di-n-butylphthalate | -- | 3,700 | 10 U | NA | 11 U | 1.5 B | 11 U | 10 U | 10 U | 10 U | NA | NA |
| bis(2-Ethylhexyl)phthalate | 6 | 4.8 | 10 U | NA | 7.4 B | 3.2 B | 11 U | 10 U | 16 B | 1.6 B | NA | NA |
| | | | | | | | | | | | | |
| **Explosives (UG_L)** | | | | | | | | | | | | |
| Perchlorate | -- | 26 | 2 U | NA | 0.0612 U | 2 U | 2 U | 0.0612 U | 2 U | 0.402 | NA | NA |
| | | | | | | | | | | | | |
| **Total Metals (UG_L)** | | | | | | | | | | | | |
| Aluminum | -- | 37,000 | 1,570 | NA | 1,910 | 40.3 U | 488 | 1,430 | 365 | 667 | NA | NA |
| Antimony | 6 | 15 | 2.8 U | NA | 60 U | 2.8 U | 2.8 U | 60 U | 2.8 U | 60 U | NA | NA |
| Arsenic | 10 | 0.045 | 3.6 U | NA | 6.9 K | 3.6 U | 3.6 U | 10 U | 3.6 U | 10 U | NA | NA |
| Barium | 2,000 | 7,300 | 56.8 J | NA | 78.1 J | 53.6 J | 34.5 J | 49 J | 67.3 J | 86.2 J | NA | NA |
| Beryllium | 4 | 73 | 0.12 J | NA | 5 U | 0.1 U | 0.1 U | 5 U | 0.1 U | 5 U | NA | NA |
| Cadmium | 5 | 18 | 0.4 U | NA | 5 U | 0.4 U | 0.4 U | 5 U | 0.4 U | 5 U | NA | NA |
| Calcium | -- | -- | 105,000 | NA | 114,000 | 130,000 | 115,000 | 113,000 | 161,000 | 160,000 | NA | NA |
| Chromium | 100 | 110 | 4.2 J | NA | 37.2 | 0.6 U | 2.3 J | 3.8 B | 1.3 J | 6.3 B | NA | NA |
| Cobalt | -- | 730 | 0.7 U | NA | 1.3 B | 0.7 U | 0.7 U | 0.85 B | 0.7 U | 0.7 B | NA | NA |
| Copper | 1,300 | 1,500 | 5.5 B | NA | 6.8 B | 4.1 B | 0.8 U | 4.8 B | 1.2 B | 2.3 B | NA | NA |
| Iron | -- | 26,000 | 2,240 | NA | 4,590 | 61.3 B | 1,650 | 2,850 | 538 | 1,270 | NA | NA |
| Lead | 15 | 15 | 2.6 J | NA | 2.8 K | 1.8 U | 1.8 U | 10 U | 1.8 U | 10 U | NA | NA |
| Magnesium | -- | -- | 65,900 | NA | 48,400 | 30,600 | 43,600 | 46,200 | 41,000 | 43,100 | NA | NA |
| Manganese | -- | 730 | 77 | NA | 102 | 31.9 | 105 | 10.4 J | 7 J | 19.7 | NA | NA |
| Mercury | 2 | 11 | 0.1 U | NA | 0.023 J | 0.1 U | 0.1 U | 0.2 U | 0.1 U | 0.2 UL | NA | NA |
| Nickel | -- | 730 | 2.9 J | NA | 24.8 J | 1.2 U | 2.4 B | 2.5 B | 2 B | 4.2 B | NA | NA |
| Potassium | -- | -- | 17,600 | NA | 6,170 | 1,900 J | 2,290 J | 2,380 J | 2,250 J | 2,320 J | NA | NA |
| Selenium | 50 | 180 | 2.6 U | NA | 35 U | 2.6 U | 2.6 U | 35 U | 2.6 U | 35 U | NA | NA |
| Sodium | -- | -- | 20,000 | NA | 71,800 | 32,700 | 9,480 | 9,190 | 33,100 | 41,900 | NA | NA |
| Thallium | 2 | 2.6 | 4.6 U | NA | 25 U | 4.6 U | 4.6 U | 6.2 K | 4.6 U | 25 U | NA | NA |
| Vanadium | -- | 37 | 2.6 J | NA | 3.6 J | 1.1 U | 1.1 U | 2.7 J | 1.1 U | 50 U | NA | NA |
| Zinc | -- | 11,000 | 9.8 B | NA | 38.3 B | 8 J | 8.2 J | 14.2 B | 0.6 U | 13.1 B | NA | NA |

**TABLE 5-4**
Analytical Results for Bedrock Groundwater Samples (Exceedances)
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| **Station ID** | **MCL-Groundwater** | **RBC-Tap Water** | 12MW11S | | | 12MW13S | 12MW17D | | 12MW17S | | 12MW20D | 12MW20S |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | | | AS12-12MW11S-0605 | AS12-12MW11S-1206 | AS12-12MW11S-0607 | AS12-12MW13S-0505 | AS12-12MW17D-0505 | AS12-12MW17D-0607 | AS12-12MW17S-0505 | AS12-12MW17S-0607 | AS12-12MW20D-1206 | AS12-12MW20S-1206 |
| **Sample Date** | | | 06/02/05 | 12/07/06 | 06/13/07 | 05/23/05 | 05/24/05 | 06/12/07 | 05/24/05 | 06/12/07 | 12/07/06 | 12/06/06 |
| **Chemical Name** | | | | | | | | | | | | |
| **Dissolved Metals (UG_L)** | | | | | | | | | | | | |
| Aluminum | -- | 37,000 | 40.3 U | NA | 74.7 J | 40.3 U | 40.3 U | 200 U | 40.3 U | 200 U | NA | NA |
| Antimony | 6 | 15 | 2.8 U | NA | 60 U | 2.8 U | 2.8 U | 60 U | 2.8 U | 60 U | NA | NA |
| Arsenic | 10 | 0.045 | 3.6 U | NA | 10 U | 3.6 U | 3.7 J | 10 U | 3.6 U | 10 U | NA | NA |
| Barium | 2,000 | 7,300 | 42 J | NA | 36.4 J | 53.3 J | 31.1 J | 40.8 J | 59.8 J | 54.2 J | NA | NA |
| Beryllium | 4 | 73 | 0.1 U | NA | 5 U | 0.1 U | 0.1 U | 5 U | 0.1 U | 5 U | NA | NA |
| Calcium | -- | -- | 102,000 | NA | 95,000 | 129,000 | 114,000 | 109,000 | 164,000 | 131,000 | NA | NA |
| Chromium | 100 | 110 | 0.6 U | NA | 10 U | 0.6 U | 0.6 U | 0.9 J | 1 J | 2.1 K | NA | NA |
| Cobalt | -- | 730 | 0.7 U | NA | 50 U | 0.7 U | 0.7 U | 50 U | 0.7 U | 50 U | NA | NA |
| Iron | -- | 26,000 | 16.3 U | NA | 65 B | 16.3 U | 720 | 100 U | 16.3 U | 100 U | NA | NA |
| Lead | 15 | 15 | 1.8 U | NA | 10 U | 1.8 U | 1.8 U | 10 U | 1.8 U | 10 U | NA | NA |
| Magnesium | -- | -- | 64,200 | NA | 45,000 | 30,300 | 43,100 | 44,300 | 41,900 | 35,500 | NA | NA |
| Manganese | -- | 730 | 46 | NA | 23.9 | 29.9 | 102 | 2.7 B | 2.3 J | 1 B | NA | NA |
| Mercury | 2 | 11 | 0.1 U | NA | 0.2 U | 0.1 U | 0.1 U | 0.2 U | 0.1 U | 0.2 UL | NA | NA |
| Nickel | -- | 730 | 1.2 U | NA | 2.7 J | 1.3 J | 1.8 J | 40 U | 3 J | 2.9 J | NA | NA |
| Potassium | -- | -- | 15,200 | NA | 7,500 | 1,880 J | 2,160 J | 2,000 J | 2,210 J | 1,820 J | NA | NA |
| Selenium | 50 | 180 | 2.6 U | NA | 35 U | 2.6 U | 3.5 J | 35 U | 4.1 J | 35 U | NA | NA |
| Sodium | -- | -- | 13,000 | NA | 33,200 | 32,500 | 9,210 | 8,780 | 33,600 | 34,100 | NA | NA |
| Thallium | 2 | 2.6 | 4.6 U | NA | 25 U | 4.6 U | 10.2 B | 25 U | 4.6 U | 25 U | NA | NA |
| Zinc | -- | 11,000 | 3.7 B | NA | 41.4 B | 3.2 J | 4.6 J | 21.3 B | 0.6 U | 13.1 B | NA | NA |
| | | | | | | | | | | | | |
| **Wet Chemistry (MG_L)** | | | | | | | | | | | | |
| Alkalinity | -- | -- | NA | 220 | NA | NA | NA | NA | NA | NA | 230 | 220 |
| Chloride | -- | -- | NA | NA | 3.7 | NA | NA | 28 | NA | 94 | NA | NA |
| Hardness | -- | -- | NA | NA | 580 | NA | NA | 480 | NA | 600 | NA | NA |
| Nitrate | 10 | 10 | NA | NA | 0.1 U | NA | NA | 0.1 | NA | 1 | NA | NA |
| Sulfate | -- | -- | NA | NA | 340 | NA | NA | 200 | NA | 250 | NA | NA |
| Total organic carbon (TOC) | -- | -- | NA | 1.5 B | 2.6 | NA | NA | 1 U | NA | 1 U | 1 U | 1 U |

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Exceeds one or more criteria
-- No criteria established

**TABLE 5-4**
Analytical Results for Bedrock Groundwater Samples (Exceedances)
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

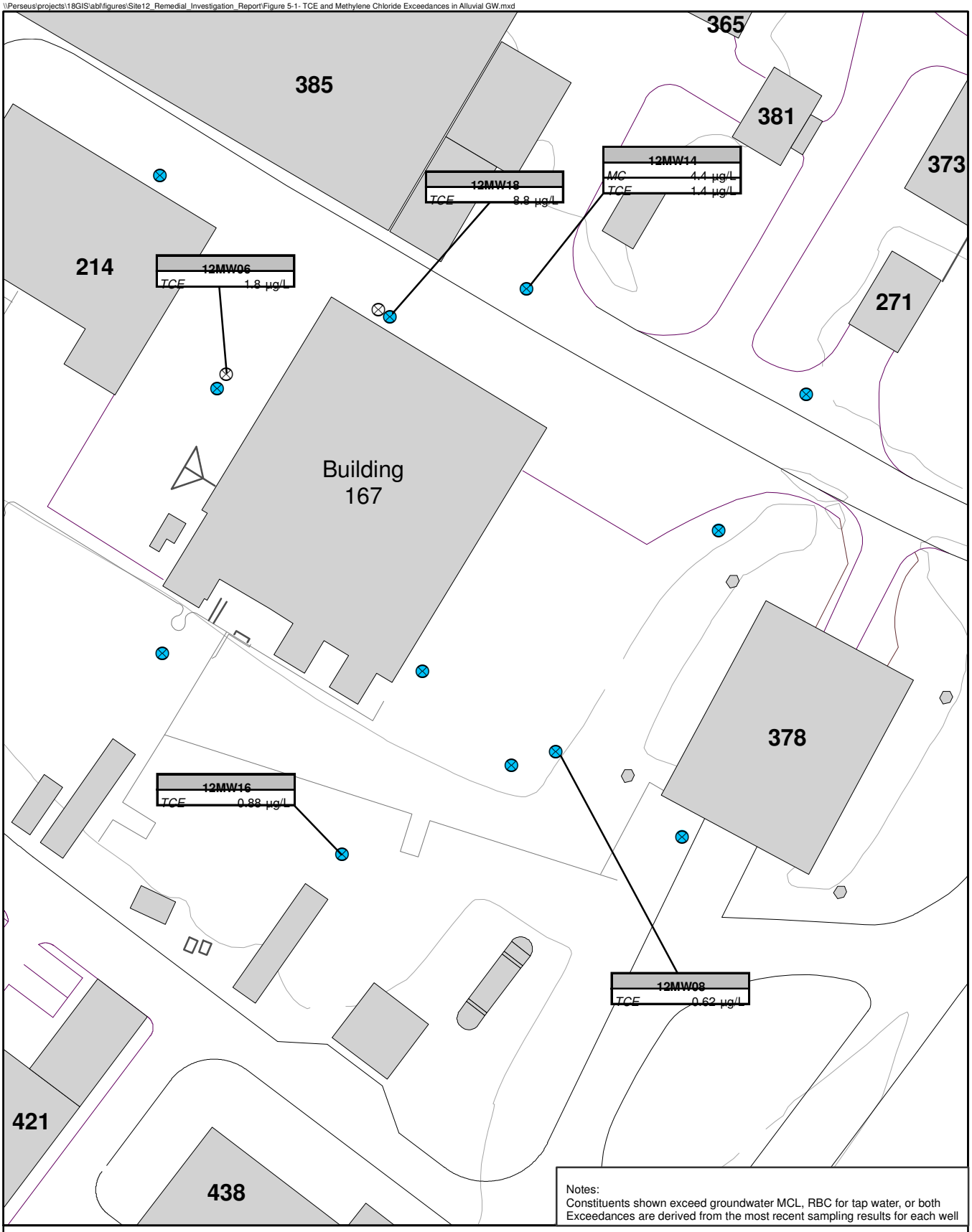
| **Station ID** | **MCL-Groundwater** | **RBC-Tap Water** | 12MW21D | | 12MW21S | | | 12MW22D | | 12MW22S | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | | | AS12-12MW21D-1206 | AS12-12MW21D-0607 | AS12-12MW21S-1206 | AS12-12MW21SP-1206 | AS12-12MW21S-0607 | AS12-12MW22D-1206 | AS12-12MW22D-0607 | AS12-12MW22S-1206 | AS12-12MW22S-0607 |
| **Sample Date** | | | 12/06/06 | 06/11/07 | 12/06/06 | 12/06/06 | 06/11/07 | 12/06/06 | 06/13/07 | 12/06/06 | 06/13/07 |
| **Chemical Name** | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Volatile Organic Compounds (UG_L)** | | | | | | | | | | | |
| 1,1,1-Trichloroethane | 200 | 9,100 | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U |
| 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | -- | 59,000 | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U |
| 1,1-Dichloroethane | -- | 900 | 10 U | 0.92 | 10 UL | 2.7 L | 0.91 | 10 UL | 0.5 U | 10 U | 0.5 U |
| 1,1-Dichloroethene | 7 | 350 | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U |
| 2-Butanone | -- | 7,000 | 10 UJ | 5 U | 10 UL | 10 UL | 5 U | 10 UL | 5 U | 10 UJ | 5 U |
| 2-Hexanone | -- | 6,300 | 10 UJ | 5 U | 10 UL | 10 UL | 2.5 J | 10 UL | 5 U | 10 UJ | 5 U |
| Acetone | -- | 5,500 | 10 U | 6.7 | 10 UL | 10 UL | 5 U | 16 L | 5 U | 10 U | 5 U |
| Bromochloromethane | -- | -- | NA | 0.5 U | NA | NA | 0.5 U | NA | 0.5 U | NA | 0.5 U |
| Carbon disulfide | -- | 1,000 | 3.2 J | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U |
| Chloromethane | -- | 190 | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U |
| Cyclohexane | -- | 12,000 | 10 U | 0.5 U | 1.4 L | 1.2 L | 0.52 | 10 UL | 0.5 U | 10 U | 0.5 U |
| Ethane | -- | -- | NA | 31 U | NA | NA | 6 J | NA | 12 U | NA | 120 U |
| Ethylbenzene | 700 | 1,300 | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U |
| Methane | -- | -- | NA | 43 | NA | NA | 70 E | NA | 69 E | NA | 700 E |
| Methylene chloride | 5 | 4.1 | 300 | 0.86 B | 29 L | 170 L | 0.5 U | 10 L | 0.58 B | 13 | 0.62 B |
| Tetrachloroethene | 5 | 0.1 | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U |
| Toluene | 1,000 | 2,300 | 2.1 J | 0.5 U | 1.7 L | 1.3 L | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U |
| Trichloroethene | 5 | 0.026 | 10 U | 0.5 U | 3 L | 2.9 L | 0.33 J | 10 UL | 0.5 U | 10 U | 0.5 U |
| Xylene, total | 10,000 | 210 | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U |
| cis-1,2-Dichloroethene | 70 | 61 | 10 U | 1.2 | 10 UL | 10 UL | 1.2 | 10 UL | 0.5 U | 10 U | 0.5 U |
| trans-1,2-Dichloroethene | 100 | 110 | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U |
| | | | | | | | | | | | |
| **Semi-volatile Organic Compounds (UG_L)** | | | | | | | | | | | |
| Caprolactam | -- | 18,000 | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U |
| Di-n-butylphthalate | -- | 3,700 | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U |
| bis(2-Ethylhexyl)phthalate | 6 | 4.8 | NA | 2.6 B | NA | NA | 2.8 B | NA | 2.5 B | NA | 3.9 B |
| | | | | | | | | | | | |
| **Explosives (UG_L)** | | | | | | | | | | | |
| Perchlorate | -- | 26 | NA | 0.0612 U | NA | NA | 0.0612 U | NA | 0.0612 U | NA | 0.0612 U |
| | | | | | | | | | | | |
| **Total Metals (UG_L)** | | | | | | | | | | | |
| Aluminum | -- | 37,000 | NA | 119 J | NA | NA | 200 UL | NA | 90.2 J | NA | 143 J |
| Antimony | 6 | 15 | NA | 60 U | NA | NA | 60 U | NA | 60 U | NA | 60 U |
| Arsenic | 10 | 0.045 | NA | 3.9 K | NA | NA | 4 K | NA | 3.8 K | NA | 4.6 K |
| Barium | 2,000 | 7,300 | NA | 26 J | NA | NA | 23.1 J | NA | 15.8 J | NA | 25.9 J |
| Beryllium | 4 | 73 | NA | 5 U | NA | NA | 5 U | NA | 5 U | NA | 5 U |
| Cadmium | 5 | 18 | NA | 5 U | NA | NA | 5 U | NA | 5 U | NA | 0.39 B |
| Calcium | -- | -- | NA | 318,000 | NA | NA | 356,000 | NA | 380,000 | NA | 307,000 |
| Chromium | 100 | 110 | NA | 34 | NA | NA | 1.7 B | NA | 1.3 J | NA | 2.7 J |
| Cobalt | -- | 730 | NA | 3.9 J | NA | NA | 50 U | NA | 1.3 B | NA | 0.85 B |
| Copper | 1,300 | 1,500 | NA | 6.6 B | NA | NA | 4.4 B | NA | 2.7 B | NA | 9 B |
| Iron | -- | 26,000 | NA | 3,540 | NA | NA | 2,400 | NA | 765 | NA | 1,140 |
| Lead | 15 | 15 | NA | 10 U | NA | NA | 10 U | NA | 10 U | NA | 10 U |
| Magnesium | -- | -- | NA | 112,000 | NA | NA | 123,000 | NA | 126,000 | NA | 111,000 |
| Manganese | -- | 730 | NA | 92.1 | NA | NA | 22.1 | NA | 15.4 | NA | 57.8 |
| Mercury | 2 | 11 | NA | 0.2 U | NA | NA | 0.2 U | NA | 0.2 U | NA | 0.2 U |
| Nickel | -- | 730 | NA | 29.8 J | NA | NA | 4.3 B | NA | 40 U | NA | 3.6 J |
| Potassium | -- | -- | NA | 4,090 J | NA | NA | 3,980 J | NA | 3,920 J | NA | 3,690 J |
| Selenium | 50 | 180 | NA | 35 U | NA | NA | 35 U | NA | 35 U | NA | 35 U |
| Sodium | -- | -- | NA | 13,300 | NA | NA | 5,800 | NA | 7,050 | NA | 15,900 |
| Thallium | 2 | 2.6 | NA | 25 U | NA | NA | 25 U | NA | 25 U | NA | 25 U |
| Vanadium | -- | 37 | NA | 0.67 J | NA | NA | 50 U | NA | 50 U | NA | 0.54 J |
| Zinc | -- | 11,000 | NA | 15.3 B | NA | NA | 10.8 B | NA | 14.9 B | NA | 28.4 B |

**TABLE 5-4**
Analytical Results for Bedrock Groundwater Samples (Exceedances)
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| **Station ID** | **MCL-Groundwater** | **RBC-Tap Water** | 12MW21D | | 12MW21S | | | 12MW22D | | 12MW22S | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | | | AS12-12MW21D-1206 | AS12-12MW21D-0607 | AS12-12MW21S-1206 | AS12-12MW21SP-1206 | AS12-12MW21S-0607 | AS12-12MW22D-1206 | AS12-12MW22D-0607 | AS12-12MW22S-1206 | AS12-12MW22S-0607 |
| **Sample Date** | | | 12/06/06 | 06/11/07 | 12/06/06 | 12/06/06 | 06/11/07 | 12/06/06 | 06/13/07 | 12/06/06 | 06/13/07 |
| **Chemical Name** | | | | | | | | | | | |
| **Dissolved Metals (UG_L)** | | | | | | | | | | | |
| Aluminum | -- | 37,000 | NA | 200 UJ | NA | NA | 1,100 J | NA | 200 U | NA | 200 U |
| Antimony | 6 | 15 | NA | 60 U | NA | NA | 60 U | NA | 60 U | NA | 60 U |
| Arsenic | 10 | 0.045 | NA | 5.3 K | NA | NA | 4.1 K | NA | 10 U | NA | 10 U |
| Barium | 2,000 | 7,300 | NA | 23.2 J | NA | NA | 25.6 J | NA | 14 J | NA | 21.1 J |
| Beryllium | 4 | 73 | NA | 5 U | NA | NA | 5 U | NA | 5 U | NA | 5 U |
| Calcium | -- | -- | NA | 338,000 | NA | NA | 333,000 | NA | 378,000 | NA | 315,000 |
| Chromium | 100 | 110 | NA | 2.6 B | NA | NA | 1.8 B | NA | 10 U | NA | 10 U |
| Cobalt | -- | 730 | NA | 1.4 J | NA | NA | 50 U | NA | 0.89 B | NA | 0.72 B |
| Iron | -- | 26,000 | NA | 2,010 | NA | NA | 2,220 | NA | 625 | NA | 1,010 |
| Lead | 15 | 15 | NA | 10 U | NA | NA | 2.3 K | NA | 10 U | NA | 10 U |
| Magnesium | -- | -- | NA | 118,000 | NA | NA | 116,000 | NA | 125,000 | NA | 113,000 |
| Manganese | -- | 730 | NA | 48.5 | NA | NA | 38.9 | NA | 12 J | NA | 51.2 |
| Mercury | 2 | 11 | NA | 0.2 U | NA | NA | 0.2 U | NA | 0.2 U | NA | 0.2 U |
| Nickel | -- | 730 | NA | 17.4 J | NA | NA | 4.1 B | NA | 40 U | NA | 2 J |
| Potassium | -- | -- | NA | 4,000 J | NA | NA | 3,830 J | NA | 3,870 J | NA | 3,780 J |
| Selenium | 50 | 180 | NA | 35 U | NA | NA | 35 U | NA | 35 U | NA | 35 U |
| Sodium | -- | -- | NA | 9,120 | NA | NA | 6,540 | NA | 6,370 | NA | 15,600 |
| Thallium | 2 | 2.6 | NA | 25 U | NA | NA | 5.8 K | NA | 25 U | NA | 25 U |
| Zinc | -- | 11,000 | NA | 12 B | NA | NA | 23.2 B | NA | 18.7 B | NA | 24.5 B |
| | | | | | | | | | | | |
| **Wet Chemistry (MG_L)** | | | | | | | | | | | |
| Alkalinity | -- | -- | 240 | NA | 230 | 220 | NA | 210 | NA | 210 | NA |
| Chloride | -- | -- | NA | 10 | NA | NA | 9.4 | NA | 6.2 | NA | 7.9 |
| Hardness | -- | -- | NA | 1,400 | NA | NA | 1,500 | NA | 1,400 | NA | 1,400 |
| Nitrate | 10 | 10 | NA | 0.1 U | NA | NA | 0.1 U | NA | 0.1 U | NA | 0.1 U |
| Sulfate | -- | -- | NA | 1,000 | NA | NA | 1,200 | NA | 1,300 | NA | 1,000 |
| Total organic carbon (TOC) | -- | -- | 2.7 | 1 | 1 U | 1 U | 1 U | 1.3 | 1 U | 1.8 | 1 U |

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Exceeds one or more criteria
-- No criteria established

\\Perseus\projects\18GIS\abl\figures\Site12_Remedial_Investigation_Report\Figure 5-1- TCE and Methylene Chloride Exceedances in Alluvial GW.mxd




Notes:
Constituents shown exceed groundwater MCL, RBC for tap water, or both
Exceedances are derived from the most recent sampling results for each well

**Legend**

- Alluvial Monitoring Well
- Abandoned Well
- Steam Lines
- Buildings

TCE - Trichloroethene
MC - Methylene Chloride
µg/L - micrograms per liter
J - Result may be estimated
L - Reported value may be biased low

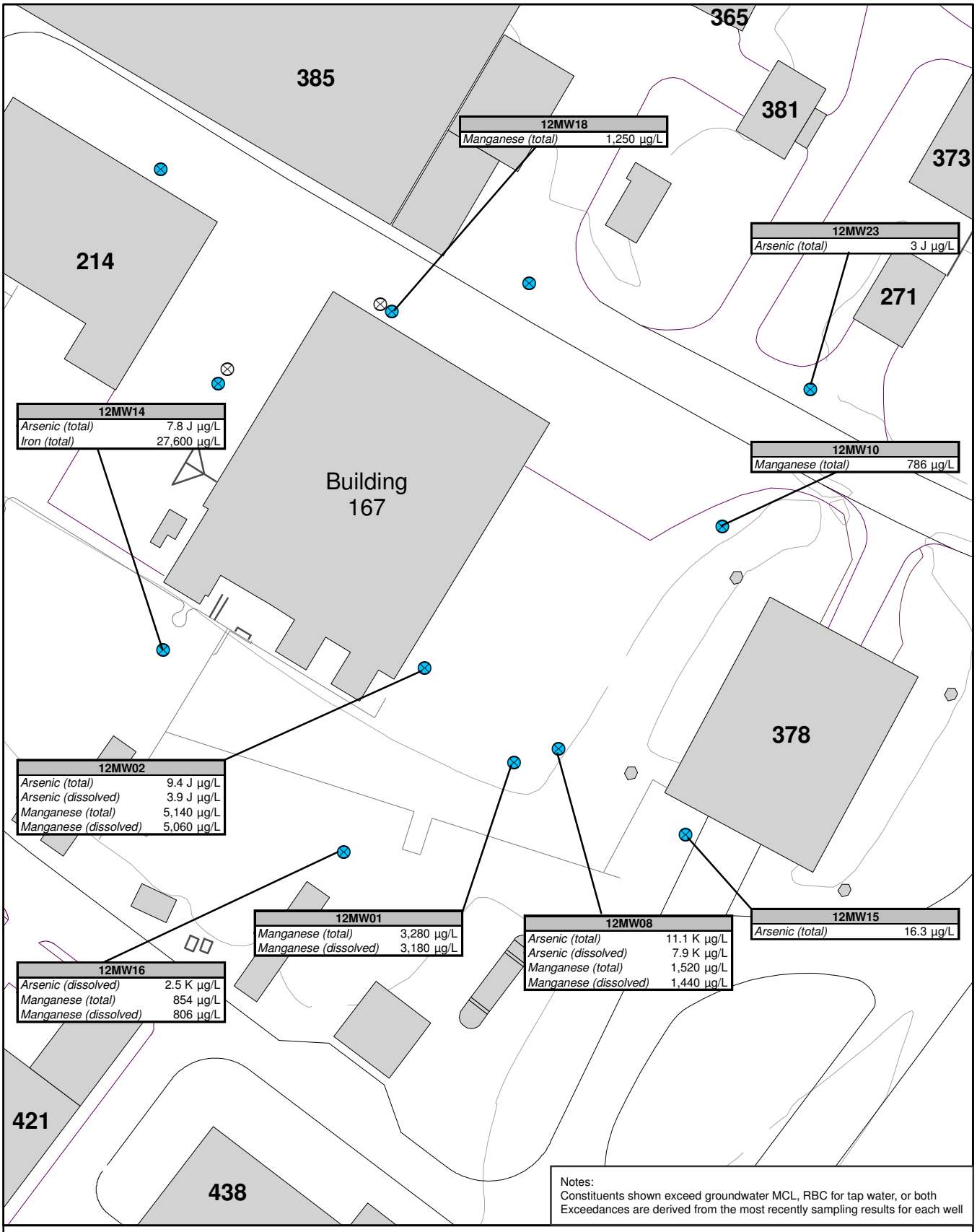
N

0 25 50 100 Feet

Figure 5-1
TCE and Methylene Chloride Exceedances in Alluvial Groundwater
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

CH2MHILL

\\Perseus\projects\18GIS\abl\figures\Site12_Remedial_Investigation_Report\Figure 5-2- Arsenic, Iron, and Manganese Exceedances in Alluvial GW.mxd




Notes:
Constituents shown exceed groundwater MCL, RBC for tap water, or both
Exceedances are derived from the most recently sampling results for each well

**Legend**

- Alluvial Monitoring Well
- Abandoned Well
- Steam Lines
- Buildings

µg/L - micrograms per liter
J - Result may be estimated
K - Reported value may be biased high

N

0 25 50 100 Feet

Figure 5-2
Arsenic, Iron, and Manganese
Exceedances in Alluvial Groundwater
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

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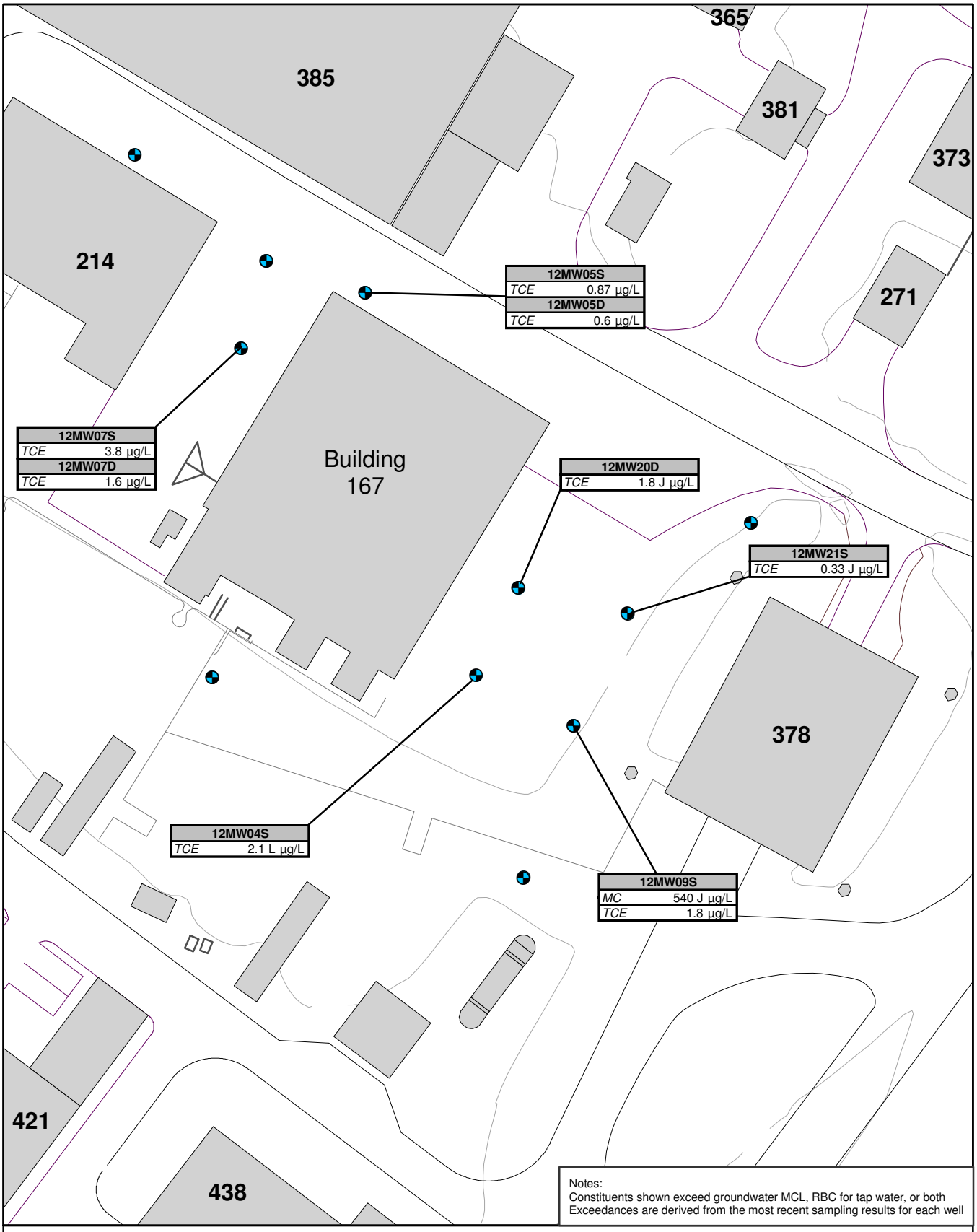


Notes:
Constituents shown exceed groundwater MCL, RBC for tap water, or both
Exceedances are derived from the most recent sampling results for each well

**Legend**

- Bedrock Well
- Steam Lines
- Buildings

TCE - Trichloroethene
MC - Methylene Chloride
µg/L - micrograms per liter
J - Result may be estimated
L - Reported value may be biased low

N

0 25 50 100 Feet

Figure 5-3
TCE and Methylene Chloride Exceedances in Bedrock Groundwater
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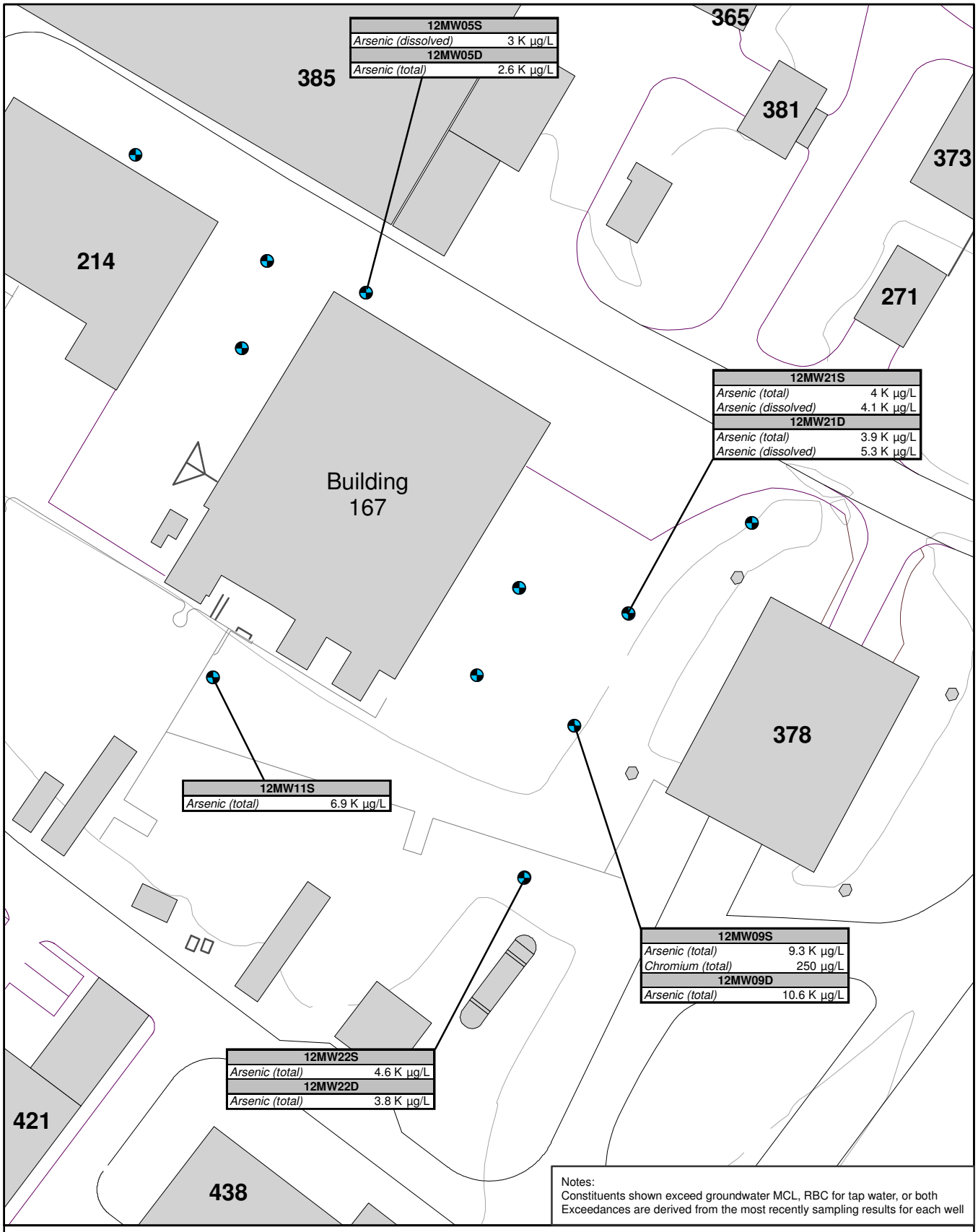


Notes:
Constituents shown exceed groundwater MCL, RBC for tap water, or both
Exceedances are derived from the most recently sampling results for each well

**Legend**

- Bedrock Well
- Steam Lines
- Buildings

µg/L - micrograms per liter
J - Result may be estimated
K - Reported value may be biased high

N

0 25 50 100 Feet

Figure 5-4
Arsenic and Chromium
Exceedances in Bedrock Groundwater
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

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SECTION 6

# Fate and Transport of Contamination

As outlined in Section 5, the most common constituents detected in Site 12 groundwater samples are VOCs and inorganics. The behavior of these constituents in the environment is influenced by the chemical composition and chemical properties of each individual constituent, as well as the characteristics of the transport medium. Because the soil contamination (i.e., source areas) at Site 12 has been removed, this section focuses on the fate and transport of the detected constituent groups in groundwater. The fate and transport discussion outlines how the primary contaminant groups (i.e., VOCs and inorganics) generally behave in the environment and evaluates the chemical and physical processes that may act to control the distribution of these constituents at Site 12.

## 6.1 Chemical Processes

For discussion purposes, the VOC and inorganic constituent groups are represented by representative individual constituents that were most commonly detected in Site 12 groundwater (Table 6-1). The list of constituents presented on Table 6-1 comprises those constituents that pose a potentially unacceptable risk to human health and/or the environment (as identified in Section 7 and 8). TCE and MC are also included in the discussion because these two compounds were historically considered the primary drivers behind environmental activities for Site 12 groundwater. Additionally, chromium and hexavalent chromium are discussed because of their association with the former alodine waste storage facilities at Site 12.

There are many basic physical and chemical processes that potentially affect the fate and transport of VOCs and inorganics in the environment. The four chemical processes listed below are likely most important for controlling the fate and transport of these constituents in groundwater at Site 12:

- Sorption
- Volatilization
- Degradation
- Transformation

The rate and effectiveness of the above listed processes are determined by specific properties of the constituents in question. The following sections discuss each of these processes with respect to each contaminant group, as applicable.

### 6.1.1 Sorption

Sorption is the tendency for chemicals to adsorb to solid materials that are present within the transport media. At Site 12, constituents detected in alluvial groundwater could adsorb onto soil grains in the unconsolidated alluvial deposits. Specifically, the clays and organic material present in the alluvium are the most favorable adsorption sites. A limited amount of unconsolidated material is available for contaminant adsorption in the bedrock aquifer;

however, the maximum concentration of constituents in bedrock groundwater samples were detected at sample stations that are located in an area where bedrock groundwater discharges upward from deep to shallow fractures, and then into the alluvial aquifer.

#### 6.1.1.1 VOCs

The VOC constituents detected in Site 12 groundwater are expected to have a low affinity for adsorbing to soil particles (ATSDR, 1990; ATSDR, 1992; ATSDR, 1996; ATSDR, 1997; ATSDR, 2000a). A conventional measure of sorption is the distribution coefficient ($K_d$) of soil and geologic material for an individual constituent. The $K_d$ for organic constituents is calculated as the product of a compound's partition coefficient ($K_{oc}$) and the fraction of organic carbon ($f_{oc}$) of the site soil. As a general rule, constituents with a $K_{oc}$ less than 1,000 ml/g (e.g., many VOCs) have lower degrees of adsorption and consequently higher mobility. All of the primary VOCs detected at Site 12 possess $K_{oc}$ values that are less than approximately 200 (Table 6-1). Therefore, these constituents are not easily adsorbed and would be expected to leach to and be readily transported in groundwater. In addition, since the primary source areas have been removed from Site 12, as discussed in Section 2.3.7, soil leaching from the vadose zone likely contributes very little to the current concentration of VOCs detected in groundwater at the site.

#### 6.1.1.2 Inorganics

In contrast to the VOCs, inorganic constituents tend to adsorb readily onto soil particles. The partition coefficients for inorganic constituents is a complex function of pH, soil organic content, and other factors, and actual coefficient values tend to be site- or material-specific. Published scientific studies for the primary inorganics detected at Site 12 suggest that these constituents form oxides, hydroxides and/or sulfates that bind tightly to the iron, manganese, and aluminum-based oxyhydroxide or oxide coatings that form on soil and sediment grains (Life Systems, Inc., 1992; ATSDR, 2000b; ATSDR, 2000b; ATSDR, 2007). The adsorption of inorganics to soil and sediment grains generally makes them highly immobile (ATSDR, 2000b; ATSDR, 2007).

### 6.1.2 Volatilization

Volatilization is the tendency for some constituents, particularly VOCs, to change from a liquid or adsorbed state to a gas. A conventional measure of volatility is Henry's Law Constant ($K_h$) (Table 6-1). Compounds with $K_h$ values higher than $10^{-3}$ atmosphere-cubic meter per mole (atm-m$^3$/M) are expected to volatilize readily from water to air, whereas those with $K_h$ values lower than $10^{-5}$ atm-m$^3$/M are relatively non-volatile. Volatilization to the atmosphere is the dominant process for removing VOCs from shallow, unsaturated soils. In addition, VOCs in shallow groundwater may volatilize into soil gas that overlies the water table. However, in groundwater, volatilization can occur only at the air/water interface between the saturated and unsaturated zones, and movement of aqueous-phase contaminants from bulk groundwater to the interface is largely diffusion-limited. Volatilization from groundwater in fractured bedrock, such as that at Site 12, is likely further complicated by the frequency and spacing of fractures in contact with the unsaturated zone. Volatilization is not an effective process by which the inorganic constituents detected at Site 12 would be removed from the environment (Life Systems, Inc., 1992).

### 6.1.3 Degradation

Degradation is the transformation of one chemical to another by such processes as hydrolysis, photolysis, and biodegradation. At Site 12, biodegradation, which is an important mechanism for the removal of chlorinated VOCs from groundwater, is likely to be operating to some degree in the subsurface (ATSDR, 1997; ATSDR, 2000a (CH2M HILL, 2005f). The general requirements and effects of biodegradation on the chlorinated VOCs are discussed below.

#### 6.1.3.1 Biodegradation of Chlorinated Hydrocarbons.

The biodegradation process uses soil organisms to degrade chlorinated hydrocarbons to innocuous byproducts, such as carbon dioxide and water. Not all contaminants are biodegradable, and chlorinated hydrocarbons, such as those detected in groundwater at Site 12, are only completely degraded under certain conditions. If these conditions are not met, or if one of the necessary requirements is limiting, the contaminant will not completely degrade.

Three processes govern the biodegradation of chlorinated hydrocarbons. They are reductive dechlorination, oxidation, and co-metabolism. In general, a chlorinated hydrocarbon contaminant must first be dechlorinated before complete degradation can occur. This process is called reductive dechlorination, where the contaminant acts as the terminal electron acceptor and hydrogen is the electron donor (Wiedemeier *et al,* 1999).

The following trends occur in environments that are undergoing reductive dechlorination through biodegradation:

- Reduction in parent concentrations (e.g. TCE)
- Increase in daughter product concentrations (e.g. cis-1,2 DCE, trans-1,2-DCE, vinyl chloride)
- Increase in ethene and ethane concentrations
- Elevated chloride concentrations
- Methane production
- Low redox conditions
- Production of iron (II)

These trends may be monitored to provide evidence for degradation via reductive dechlorination. The availability of data at Site 12 allows for a qualitative assessment of whether the reductive dechlorination process is occurring. Parameters such as chloride and methane have been analyzed only during one sampling event, so the trends cannot be evaluated. The results are provided in Tables 5-1 and 5-3. With regard to reducing versus oxidizing conditions, the ORP measurements in monitoring wells at Site 12 suggest that slightly reducing to slightly oxidizing conditions exist in the alluvial and bedrock aquifers. Reductive dechlorination is more likely to occur in reductive conditions (i.e., with lower ORP measurements).

An assessment of chlorinated hydrocarbon degradation is provided through analysis of the monitoring wells located in proximity to the source area (i.e. 12MW02, 12MW08 and 12MW09S), where TCE is consistently detected. In all three wells, the concentration of TCE decreases through time. In the bedrock well (12MW09S), the TCE concentration decrease is coupled with a slight increase in the concentration of cis-1,2-DCE, which is a common

constituent that results from reductive dechlorination of TCE. In the alluvial wells, the TCE concentration reduction is coupled with a decrease in the concentration of the common degradation products cis-1,2 DCE and trans-1,2-DCE. In 12MW08 the concentration of vinyl chloride decreases along with these constituents and in 12MW02 the concentration of vinyl chloride appears to increase over time. These results suggest that reductive dechlorination, possibly coupled with some additional degradation processes (e.g., oxidation and/or co-metabolism) may be acting to reduce the concentration of TCE in groundwater at Site 12.

### 6.1.4 Transformation

Oxidation-reduction reactions are probably the most common transformation reactions that occur in the environment. In addition to oxidation-reduction reactions, inorganic constituents such as arsenic may also be transformed by ligand exchange, precipitation, and biotransformation reactions (ATSDR, 2007). Any of these types of transformations may have a significant effect on the mobility of an inorganic constituent. Of the primary inorganic constituents listed on Table 6-1, the most studies on transformation reactions, specifically oxidation-reduction reactions, have been performed on arsenic and chromium.

The rate and outcome of the transformation reactions for arsenic and chromium in groundwater are affected by a number of site-specific factors that may include Eh and pH conditions, metal sulfide and sulfide ion concentrations, iron concentrations, temperature, salinity, distribution and composition of biota, season, and the nature and concentration of organic matter (ATSDR, 2007). Likely one of the most significant examples of transformation reactions for environmental purposes is the reduction of hexavalent chromium (Chromium VI) to a less toxic, and relatively immobile trivalent (Chromium III) state. The reaction factors can be complex, but in the presence of $Fe^{2+}$, $S^{2-}$, and reducing conditions, this reduction reaction appears to occur rapidly (ATSDR, 2000b). The transformation for arsenic in the environment are also complex, but the compounds that form from the various valence states of arsenic tend to be relatively immobile under most natural circumstances (ATSDR, 2007). In general, these types of transformation reactions serve to greatly reduce contaminant mobility.

## 6.2 Physical Processes and Characteristics of the Aquifer

Based on the hydrogeologic conceptual model for Site 12, it is believed that advection, dispersion, and dilution are three important physical processes that influence the contaminant distribution within the alluvial and bedrock aquifers beneath Site 12.

### 6.2.1 Advection

Advection is the transport of dissolved contaminants by the bulk motion of flowing groundwater along the hydraulic gradient. Advection controls the rate and direction of migration of mobile constituents. In the case of Site 12, advection explains the distribution of tracer dye observed during the dye study and also may account, in part, for the distribution of the primary VOCs and inorganics detected in the alluvial and bedrock aquifers.

The migration rates of dissolved contaminants range widely for different constituents because of their degree of adsorption. Compounds that do not tend to partition into soil

from water (e.g., VOCs) will tend to move by advection at a velocity that is comparable to groundwater flow velocity.

### 6.2.2 Dilution and Dispersion

Dilution and dispersion are considered together because both processes act to effectively reduce the observed concentration of groundwater contaminants. Dispersion is the spreading of dissolved contaminants from the path they would be expected to follow during advection. It results from the spatial variation in hydraulic conductivity, fluid mixing, and molecular diffusion. Dilution can reduce contaminant concentrations by adding "clean" water to the contaminant plume. Here, "clean" is defined as water with lower or no concentrations of contaminants. This process typically occurs at sites where water infiltrates the subsurface during a precipitation event and mixes with shallow groundwater. While this may occur to a limited degree at Site 12, most of the site is paved so dilution by infiltration is considered to be negligible. Dilution also occurs as areas of higher contaminant concentrations diffuse into areas of lower contaminant concentrations.

The hydrogeologic CSM for Site 12 suggests that the dilution and dispersion effects are likely promoted by groundwater recharge with the upward movement of relatively "clean" (VOC-free) bedrock groundwater sourced in the mountains south of the facility. This groundwater recharge occurs in the eastern portion of Site 12. This groundwater then migrates up from the bedrock and into the alluvial aquifer, causing mounding of the alluvial groundwater in the western side of the site. Over time this natural condition has diluted and dispersed constituent concentrations in the alluvial and bedrock aquifers. Additionally, dilution also occurs in the northwest portion of the site where relatively large bedrock fractures have been encountered. In this discharge area, alluvial and bedrock groundwater is transported rapidly away from the site via fracture flow in the bedrock. These bedrock fractures serve as conduits that allow high volumes of water to flow through the subsurface and eventually discharge to the North Branch Potomac River. During drilling activities, it was noted that this area of the bedrock produces a significant amount of flow, on the order of 140 to 180 gpm. This, dilution and advection processes serve to decrease the concentration of contaminants detected in bedrock and alluvial groundwater.

## 6.3 Summary

The chemical nature of the detected groundwater constituents and the hydrogeologic conditions encountered at Site 12 together promote attenuation of contaminant concentrations. The attenuation is evinced by a decrease in constituent concentrations throughout the RI monitoring period. The recent decrease in constituent concentrations is believed to be attributable to attenuation of contaminants following source removal activities conducted at Site 12 in 2000 and 2005 (CH2M HILL, 2005b; CH2M HILL, 2005d).

The attenuation of constituent concentrations is attributed to a number of physical and chemical processes, as discussed above. The recharge of groundwater in the eastern portion of the site provides a source of "clean" groundwater to the alluvial and bedrock aquifers, which serves to disperse and dilute constituent concentrations beneath the former source areas, thus affecting the contaminant concentrations. This natural condition provides a means to "flush" contaminants out of the bedrock aquifer and into the alluvial aquifer. Once

in the alluvial aquifer the VOCs are more likely to volatilize, become further diluted or degraded and the inorganics are more likely to adsorb to soil particles and/or be transformed. Furthermore, dilution also occurs in the northwest portion of the site where relatively large bedrock fractures have been encountered. In this discharge area, alluvial and bedrock groundwater is transported rapidly away from the site via fracture flow in the bedrock and eventually discharge to the North Branch Potomac River. The North Branch Potomac River offers the only pathway for exposure to groundwater by offsite receptors. Based upon low levels of VOCs downgradient of Site 12, it is unlikely that detectable levels of these compounds are being discharged to the river.

Results from the most recent Long-term Monitoring Report for Sites 1,5, and 10 indicated that TCE is the only VOC detected in the Site 1, surface water samples collected from the North Branch Potomac River that is also present in Site 12 groundwater at concentrations exceeding screening criteria. TCE was detected at Site 1 at an estimated concentration of 0.35 µg/L. TCE is the primary contaminant of concern in groundwater at Site 1 and unlikely to have migrated from Site 12 to the river at detectable concentrations. Because of the complex, interconnected, and transmissive characteristics of fractures in bedrock in the vicinity of Site 12, constituents that migrate from the former source areas are likely to be rapidly attenuated through advection, dilution, and dispersion. Additionally, prior to the start-up of the Site 1 extraction /treatment system, relatively low TCE concentrations were periodically detected in surface water samples. The surface water TCE concentrations declined to non-detect once groundwater extraction at Site 1 began (CH2M HILL, 2007b).

**TABLE 6-1**
Physical and Chemical Properties of Select Chemical Constituents
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Chemical Name | | Molecular Weight | Density ($g/cm^3$) | Water Solubility (variable) | Vapor Pressure (mm Hg) | Henry's Law Constant ($atm\text{-}m^3/mole$) | Log $K_{oc}$ (ml/g) |
|---|---|---|---|---|---|---|---|
| **Volatile Organic Compounds** | | | | | | | |
| Trichloroethylene | | 131.4 | 1.465 (20°C) | 1.366 g/L | 74 (25°C) | 1.10E-02 (25°C) | 2.03 - 2.66 |
| Methylene Chloride | | 84.93 | 1.3182 (20°C) | 16,700 mg/L | 349 (20°C) | 2.03E-03 (25°C) | 1.4 |
| 1,1-Dichloroethane | | 98.97 | 1.1747 (20°C) | 0.55 g/100 g (20°C) | 233 (25°C) | 4.20E-02 (25°C) | 1.76 |
| Cis-1,2-Dichloroethene | | 96.95 | 1.2837 (20°C) | 3.5 g/L | 180 (20°C) | 3.37E-03 (24.8°C) | 1.69 |
| 1,2-Dibromo-3-chloropropane | | 236.36 | 2.093 (20°C) | 1,230 mg/L (20°C) | 0.58 (20°C) | 1.47E-04 (20°C) | 2.17 |
| **Inorganic Compounds[1]** | | | | | | | |
| Arsenic | Arsenic | 74.92 | 5.778 (25°C) | Insoluble | 7.50E-03 (280°C) | NA | No Data |
| | Arsenic Trioxide | 197.84 | 3.865 | 17 g/L (16°C) | 2.47E-04 (25°C) | NA | No Data |
| | Disodium Arsenate | 185.91 | 1.87 | Soluble - 1:3 parts in water | No data | NA | No Data |
| | Sodium Arsenite | 130.92 | 1.87 | Freely soluble in water | No data | NA | No Data |
| Chromium | Ferrochromite ((Chromium (III)) | 223.84 | 4.97 (20°C) | Insoluble | No data | NA | NA |
| | Chromium(III)Oxide | 151.99 | 5.21 | Insoluble | No data | NA | NA |
| | Chromium(III)Sulfate | 392.16 | 3.012 | Insoluble | No data | NA | NA |
| | Calcium Chromate (Chromium (VI)) | 156.01 | 2.89 | 2.23 g/100 mL | No data | NA | NA |
| | Potassium Chromate (Chromium (VI)) | 194.2 | 2.732 (18°C) | 62.9 g/100 mL (20°C) | No data | NA | NA |
| Manganese | Manganese | 54.94 | 7.21 - 7.24 | Decomposes | 1 (1292°C) | No data | No Data |
| | Manganese(II,III)Oxide | 228.81 | 4.856 | Insoluble | No data | No data | No Data |
| | Manganese Carbonate | 114.95 | 3.125 | Insoluble | No data | No data | No Data |
| | Manganese Sulfate | 151 | 3.25 | 520 g/L (5°C) | No data | No data | No Data |
| Thallium | Thallium | 204.38 | 11.85 (20°C) | Insoluble | 10 (1000°C) | No data | No Data |
| | Thallium Oxide | 456.76 | 9.65 - 10.1 (21°C) | Insoluble | No data | No data | No Data |
| | Thallium Sulfate | 504.82 | 6.77 (20°C) | 48.7 g/L (20°C) | No data | No data | No Data |

**Notes:**
Data sources = Life Systems Inc., 1992; ASTDR, 1990; ASTDR, 1992; ASTDR, 1996; ASTDR,1997; ASTDR, 2000a; ASTDR, 2000b; ASTDR, 2000c; ASTDR, 2007
(25°C) = Experimental temperature shown for cases where the data was available
NA = Not Applicable
1 = The actual form of the inorganic compounds present at Site 12 is unknown. The listed inorganic compounds are considered to be relatively common in the environment. Data provided for comparison purposes only.

SECTION 7

# Baseline Human-Health Risk Assessment

## 7.1 Background

This section presents the results of the baseline human health risk assessment (HHRA) for Site 12 groundwater, without regard to whether or not the constituents included in the risk assessment are the result of a release from past activities at the site or are attributable to background conditions at the facility. Background conditions are considered after the risks were quantified in order to differentiate risks attributable to past activities from those attributable to background. Soil contamination at Site 12 has already been addressed through implementing removal actions, as discussed in Section 2.3.7. Sediment in the ditch adjacent to the site was addressed in the SWMU 27A investigation, as discussed in Section 2.3.6. The potential for vapor intrusion of site-related contaminants into facility structures is being evaluated under a separate report, which will ultimately be included in the remedial decision for Site 12, as applicable. This HHRA was conducted to assess if any further actions are needed at the site to be sufficiently protective of human health. This risk assessment has been prepared utilizing conservative assumptions, and the feasible exposure pathways have been considered based on current site conditions and potential future site use.

The HHRA incorporates the general methodology described in the following guidance:

- *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, (Part A)* (EPA December 1989)
- *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, (Part D, Standardizing Planning, Reporting and Review of Superfund Risk Assessments)* (EPA December 2001)
- *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, (Part E, Supplemental Guidance for Dermal Risk Assessment)* (EPA July 2004)
- EPA Region III *Selecting Exposure Routes and Contaminants of Concern by Risk-Based Screening* (EPA January 1993)
- U.S. Navy Human Health Risk Assessment Guidance (Naval Facilities Engineering Command December 2001)

Additional EPA guidance documents were used and are cited in the text and tables.

## 7.2 Scope of Risk Assessment

The HHRA for Site 12 comprises the following components:

- **Identification of Chemicals of Potential Concern (COPCs)**—identifies and characterizes the distribution of COPCs found on-site. Constituents identified in this screening were the focus of the subsequent evaluation in the risk assessment.
- **Exposure Assessment**—identifies potential pathways by which exposure could occur, characterizes the potentially exposed populations (e.g., residents, and construction workers), and estimates the magnitude, frequency, and duration of exposures.
- **Toxicity Assessment**—identifies the types of adverse health effects potentially associated with exposure to COPCs, lists available toxicity factors (e.g., carcinogenic slope factors and reference dose values), and summarizes the relationship between magnitude of exposure and occurrence of adverse health effects.
- **Risk Characterization**—integrates the results of the exposure assessment and toxicity assessment to estimate the potential risks to human health. Both carcinogenic and noncarcinogenic human health effects are evaluated. Pathways that pose an unacceptable risk are identified.
- **Uncertainty Assessment**—identifies sources of uncertainty associated with the data, methodology, and the values used in the risk assessment.

These components are described briefly in the following sections. Spreadsheets were prepared in accordance with EPA's *RAGS, Volume 1, Human Health Evaluation Manual, Part D* (EPA December 2001) to screen for COPCs, and to calculate risk estimates associated with the COPCs. These spreadsheets are presented in Appendix D (Tables 1 through 10).

## 7.3 Identification of Chemicals of Potential Concern

The identification of COPCs includes data collection, data evaluation, and data screening steps. The data used for the quantitative risk analysis were validated prior to use in the HHRA and met project-specific data quality objectives (DQOs). The data collection and evaluation steps were performed independently and involved gathering and reviewing the available site data to determine if the data were usable for risk assessment purposes. Screening against select criteria to identify COPCs further reduced the data set for each environmental medium evaluated for the site. Data that was not included consists of that which was obtained prior to the source removal actions, complete in 2005 and discussed in Section 2, as well as screening data that was obtained from temporary well points. Additionally data qualified with "R", meaning that it was an unreliable result, was not included in this risk assessment.

### 7.3.1 Data Evaluation and Selection

Previous field investigations and media sampling have generated information on the Site 12 contaminants. Data are available for constituents in the alluvial aquifer groundwater and the bedrock aquifer groundwater. Table 7-1 summarizes the samples that were used to

estimate potential exposures and risks from alluvial aquifer and bedrock aquifer groundwater. Data used in the risk assessment are presented in Section D-1 of Appendix D.

A review of the data and past discussions with EPA and the Navy identified the following criteria for data usability:

- Estimated values flagged with a J qualifier were treated as unqualified detected concentrations.
- Data qualified with an R (rejected) were not used in the risk assessment.
- Data qualified with a B (blank contamination) were used in the risk assessment as if the constituents were not detected, with the blank-related concentrations of each constituent used as the sample detection limit. One-half of the blank-related concentrations were used to calculate exposure point concentrations in the risk assessment.
- One-half of the sample detection limit (DL) was used in the risk assessment for cases where no detectable constituent quantities were found in that sample, but the constituent was detected in other samples from the same medium.
- For duplicate samples, the maximum concentration between the two samples was used as the sample concentration.

#### 7.3.1.1 Data Summary

All of the data used in the risk assessment have been fully validated and are assumed to represent current conditions. The alluvial aquifer and bedrock aquifer groundwater samples that were used in the risk assessment are listed in Table 7-1. Analytical sample results are presented in Appendix C.

Groundwater data from groundwater sampling conducted by CH2M HILL during May and June 2005, December 2006, and June 2007 were included in the HHRA. Not all parameters were analyzed during each of the four sampling events; therefore including data from all four sampling events ensures a conservative assessment was performed. Alluvial and bedrock aquifer groundwater data are evaluated separately in the risk assessment.

**Alluvial Aquifer Groundwater.** Alluvial groundwater samples were analyzed for TCL VOCs, SVOCs, explosives, and TAL total and dissolved inorganics. Analytical results for the alluvial aquifer groundwater samples are summarized in Appendix D, Table D-1-1. A statistical summary of constituents detected in the alluvial aquifer groundwater evaluated for the residential scenario is presented in Section D-3 in Appendix D, Tables 2.1 and 2.3. A statistical summary of constituents detected in the alluvial aquifer groundwater evaluated for construction worker scenario is presented in Section D-3 in Appendix D, Tables 2.2 and 2.4.

In accordance with the EPA Region III *Draft Guidance on the Selection of Analytical Metal Results from Monitoring Well Samples for Use in the Quantitative Assessment of Risk* (EPA, August 1992), filtered groundwater samples were used to determine inorganic constituent exposure concentrations for residential exposure to alluvial groundwater because a review of the groundwater data determined that the analytical results for aluminum, iron, and/or manganese in the filtered samples were not similar to the results for these constituents in the unfiltered groundwater samples. The concentrations of aluminum in the filtered samples from the majority of the monitoring wells and the concentrations of iron and manganese in

the filtered samples from many of the monitoring wells, were over an order of magnitude higher than the concentrations in the unfiltered samples. Unfiltered groundwater samples were used to determine inorganic constituent exposure concentrations for the construction worker since the construction worker would be exposed to the groundwater in an excavation, which would not be filtered prior to exposure.

**Bedrock Aquifer Groundwater.** Bedrock aquifer groundwater samples were analyzed for TCL or LC VOCs, SVOCs, explosives, and TAL total and dissolved inorganics. Analytical results for the bedrock aquifer groundwater samples are summarized in Appendix D, Table D-1-2. A statistical summary of constituents detected in the bedrock aquifer groundwater is presented in Section D-3 in Appendix D, Tables 2.5 and 2.6.

Following EPA Region III *Draft Guidance on the Selection of Analytical Metal Results from Monitoring Well Samples for Use in the Quantitative Assessment of Risk* (EPA, August 1992), unfiltered groundwater samples were used to determine inorganic constituent exposure concentrations for residential exposure to bedrock aquifer groundwater because a review of the groundwater data determined that the analytical results for aluminum, iron, and/or manganese in the filtered samples were similar to the results for these constituents in the unfiltered groundwater samples. Although not true for all samples, the concentrations of aluminum, iron and manganese in the unfiltered groundwater samples were generally within the same order of magnitude as the concentrations in the filtered samples.

### 7.3.2 Selection of Chemicals of Potential Concern (COPCs)

The selection of COPCs was based on the criteria presented in a EPA Region III technical guidance manual (EPA January 1993) and EPA's *RAGS Part D* (EPA December 2001). The maximum detected concentration of each constituent in each medium was compared to the criteria discussed below to select the COPCs for the medium. If the maximum concentration exceeded the criteria, the constituent was selected as a COPC. Constituents that were not detected in any of the samples were not retained as COPCs. The COPC screening is presented in Appendix D, Tables 2.1 through 2.6.

- **Comparison with Health-based Criteria for Groundwater:** Groundwater data were compared to the EPA Region III RBCs for tap water (EPA October 2007). RBCs that are based on noncarcinogenic effects were divided by 10 to account for exposure to multiple constituents. RBCs based on carcinogenic effects were used as presented in the RBC table. Groundwater data were also compared to the MCLs; however, this comparison was not used to select the groundwater COPCs. Appropriate constituents were chosen as surrogates for constituents not included in the EPA Region III RBC table (EPA, April 2007) and the surrogates' RBCs were used as the screening values. These constituents and their surrogates are identified on Tables 2.1 through 2.6, in Appendix D.

- **Comparison of Lead Concentrations in Groundwater:** Lead concentrations in groundwater were compared to the National Primary Drinking Water Regulations action level of 15 μg/L (EPA, Winter 2004).

- **Essential Human Nutrients:** Constituents that are considered essential nutrients, present at low concentrations (i.e., only slightly elevated above naturally occurring levels), and toxic only at very high doses were eliminated from the quantitative risk

analysis. These constituents comprise calcium, magnesium, potassium, and sodium. Although iron is also considered an essential nutrient and is only toxic at very high doses, iron was included in the HHRA since a provisional toxicity value is available.

- **Comparison to Background Concentrations:** A comparison to background concentrations was not used to select the COPCs. However, background concentrations are included in Appendix D, Tables 2-1 through 2.6. A comparison to background data is included in the summary discussion in Section 7.8 and discussed in greater detail in Section 5.

### 7.3.3 Chemicals of Potential Concern

Table 7-2 lists the chemicals that were selected as COPCs. The screening process is shown in Tables 2.1 through 2.6 in Appendix D.

## 7.4 Exposure Assessment

Exposure refers to the potential contact of an individual with a constituent. The exposure assessment identifies pathways and routes by which an individual may be exposed to the COPCs, and estimates the magnitude, frequency, and duration of potential exposure. Constituent intakes and associated health risks are quantified for only complete exposure pathways.

A conceptual exposure model showing potential exposure scenarios identified for potential future site-use conditions is presented in Figure 7-1. The following components of exposure assessment are discussed in this subsection:

- Site characteristics
- Conceptual exposure model for human health (characterization of exposure setting, identification of exposure pathways)
- Exposure point concentrations
- Exposure assumptions for potentially complete exposure pathways
- Calculation of COPC intakes

### 7.4.1 Site Characteristics and Use

Basic site characteristics, such as physical setting, climate, and groundwater hydrology are summarized in Section 4 of the RI Report.

Potentially exposed populations are identified based on their locations relative to the site, their activity patterns, and the presence of potential sensitive subpopulations. Table 7-3 summarizes the potentially exposed populations evaluated in this risk assessment.

The groundwater is not currently used and is not expected to be used in the future as a potable water supply at the facility. However, to provide a conservative assessment of risk at the site and an evaluation for unrestricted site use, the alluvial and bedrock aquifer

groundwater data were evaluated in the risk assessment for the future residential drinking water exposure scenario.

Construction workers are most likely the only receptors that will be exposed to and come into direct contact with alluvial groundwater at Site 12 (e.g., in an excavation that might occur to a depth no deeper than the alluvial aquifer). Due to its depth (i.e., 12 to 30 to bedrock), bedrock groundwater is not anticipated to be contacted by a construction worker; therefore, bedrock groundwater is not included in the assessment of risk to construction workers.

**7.4.1.1 Current Land Use.** ABL is a highly automated production facility for tactical propulsion systems and composite and metal structures. The facility consists of two plants and several additional sites. Alluvial and bedrock aquifer groundwater beneath Site 12 are not currently used as a potable water supply or an industrial water supply. While alluvial and bedrock groundwater at Site 12 are not used as a potable water or industrial water supply, water at ABL is used for industrial purposes. Treated groundwater from Site 1 and Site 10 at ABL is used for industrial purposes, as Process water for the adjacent steam plant.

**7.4.1.2 Future Land Use.** Future use of Site 12 is most likely the same as the current use of the site. There are currently no plans for re-development or change in use of the site. Although future use of the groundwater as potable water is not likely, as a conservative measure and to evaluate unrestricted site use, future potable use of alluvial and bedrock aquifer groundwater at Site 12 was evaluated as a complete exposure pathway, along with exposure to alluvial aquifer groundwater by construction workers.

## 7.4.2 Conceptual Exposure Model for Human Health

An exposure pathway can be described as a mechanism that moves a COPC from its source to an exposed population or individual, referred to as a receptor. An exposure pathway must be complete or exposure cannot occur. A complete exposure pathway has five elements:

- A source (e.g., constituent residues in soil)
- A mechanism for release and migration of chemical (e.g., leaching)
- An environmental transport medium (e.g., groundwater)
- A point or site of potential human contact (exposure point, e.g., drinking water)
- A route of intake (e.g., ingestion of groundwater used as a drinking water source)

All five elements must be present for a pathway to be considered complete. If one of these elements is not present, then the pathway is incomplete and there is no possibility of exposure, and therefore, there is no risk. The following subsections discuss the elements of the exposure pathway as these pertain to the site.

### 7.4.2.1 Contaminant Sources

Site 12 comprises nine individual SWMUs that were identified within and in the vicinity of Building 167. In the 1960s and 1970s, both TCE and MC were used as degreasing solvents in operations conducted at Building 167. The building housed two, 500 to 1,000 gallon solvent tanks and a solvent recovery unit, which were used for the storage and handling of solvent that contained MC. Historic features that are assumed to be the contaminant source areas are an unlined waste water sump (SWMU 37N) and an alodine treatment tank (SWMU 52).

As part of a SWMU removal action, the concrete and metal sump (SWMU 37N) and some associated soil were excavated and removed in November 2000. An additional removal action was completed in 2005 at AOC N, involving removal of approximately 237 tons of contaminated soil from the site (CH2M HILL, 2005b). The excavation extended to a depth of approximately 2 feet and encompassed the entire area of defined soil impacts, including the location of SWMUs 37N and 52. This activity met the remedial action goals and the ABL partnering team determined that no additional action was warranted for soil.

#### 7.4.2.2 Release and Transport Mechanisms

The fate and transport of chemicals in groundwater and soil are determined by physical characteristics of the site, as well as by the chemical and physical properties of the constituents. A detailed description of the fate and transport analysis of the site conditions is included in Section 6 of this report.

In addition to evaluation of ingestion and dermal contact, evaluation of chemical volatilization from groundwater during showering or during excavation activities was conducted as part of the HHRA to determine contaminant concentrations in air because there were volatile constituents selected as COPCs for the groundwater evaluation.

#### 7.4.2.3 Potentially Complete Exposure Routes

Exposure points are locations where humans could come in contact with contamination. On-site exposure points comprise the alluvial and bedrock aquifer groundwater beneath the site. Groundwater data from the site were conservatively used to assess potential risk for future residential and construction worker exposure scenarios.

Potential exposure routes are evaluated for potential future site use. Potential exposure pathways are illustrated in the conceptual exposure model (Figure 7-1)). Exposure scenarios and potentially complete pathways of exposure evaluated in this risk assessment are presented in Table 7-3. Although the off-site exposure pathways maybe complete, they were not evaluated as the use of on-site data and evaluation of on-site exposure pathways is a more conservative evaluation. Any risks associated with off-site exposure to contamination that may be transported down gradient of the site would be less than that directly on the site. Off-site exposure could include exposure to groundwater by future construction workers and residents downgradient of Site 12, but still on ABL, prior to the groundwater reaching the river.

**Current Exposure Routes.** Based on current site use, there are no potentially complete exposure routes for groundwater. The groundwater beneath Site 12 is not used as a potable supply or industrial supply, and therefore, there is no current exposure to Site 12 groundwater.

**Future Exposure Routes.** The property is currently owned by the Navy and the proposed future use of the site is expected to remain the same as the current use. Therefore, future exposure to groundwater is unlikely. However, the most likely future receptor, if any, would be construction workers who could contact alluvial aquifer groundwater while performing excavation and construction activities. A future residential scenario is also conservatively included in this HHRA to evaluate the site for unrestricted future site use. It

was conservatively assumed that groundwater from the alluvial aquifer and bedrock aquifer at the site may be used as a potable water supply in the future.

In summary, the future land use exposure routes comprise:

- Construction Worker: dermal contact with and inhalation of volatiles from alluvial aquifer groundwater.
- On-site resident (adult and child): ingestion of alluvial and bedrock aquifer groundwater, dermal contact with alluvial and bedrock aquifer groundwater, and inhalation (adults only) of volatiles from alluvial and bedrock aquifer groundwater. Children were not included for inhalation since it is assumed that most children would be taking baths instead of showers and volatilization from groundwater while showering is expected to be much greater than volatilization from groundwater while taking a bath.

### 7.4.3 Calculation of Exposure Point Concentrations

Exposure is quantified by estimating the exposure point concentrations (EPCs) of COPCs in environmental media and constituent intake by the receptor. EPCs are estimated constituent concentrations that a receptor may contact and are specific to each exposure medium. EPCs may be directly monitored or estimated using environmental models. Constituent concentrations in alluvial and bedrock groundwater were measured for this assessment. Concentrations of volatile constituents in bathroom air from volatilization from groundwater during showering were estimated using the Foster and Chrostowski shower model (Foster and Chrostowski, 1987), and concentrations of volatile constituents above an excavation from volatilization from groundwater were modeled using a two-film volatilization model and EPA's Screen 3 model. These models are shown in the Appendix D. Refer to Tables 7.1 RME, 7.5 RME, 7.1 CTE and 7.4 CTE.

The reasonable maximum exposure (RME) EPC for each COPC was calculated as a 95 percent upper confidence limit (UCL) of the arithmetic mean of the data set, using ProUCL Version 4.0 (Singh, et al., June 2007). First, the distribution of each data set was determined (normal, lognormal, and/or gamma; or non-parametric if data fit none of these distributions) using the Shapiro-Wilks test to test for a normal or lognormal distribution, and the Anderson-Darling and Kolmogorov-Smirnov Tests to test for a gamma distribution. Based on the distribution and the skewness of the data, ProUCL recommended a 95 percent UCL that was used as the RME EPC for the data set. In cases where the recommended 95 percent UCL exceeded the maximum detected concentration, the maximum concentration was used as the EPC. For data sets with more than one detected concentration, the non-detected values were entered into ProUCL and ProUCL calculated the EPCs using those data. For data sets with only one detected concentration, one-half the detection limits were entered into ProUCL and the program used the detection limit divided by two methods to calculate the statistics and EPCs.

The arithmetic mean of the dataset based on the distribution was used as the central tendency exposure (CTE) EPC regardless of distribution, except in cases where the data set consisted of one detected concentration. In this case, the mean based on raw statistics from ProUCL output was used as the CTE EPC.

Appendix D, Tables 3.1.RME through 3.6.CTE present the EPCs for the COPCs, and the rationale for the selected EPC.

### 7.4.4 Estimation of Chemical Intakes for Individual Pathways

Chemical intake is the amount of the chemical contaminant entering the receptor's body. Chemical intakes are generally expressed as follows:

$$I = \frac{C \ x \ CR \ x \ EF \ x \ ED}{BW \ x \ AT} = (mg/kg/day)$$

Where:

I = intake (mg/kg/day)

C = chemical concentration at exposure point (µg/L)

CR = contact rate, or amount of contaminated medium contacted per unit time or event (l/day, $m^3$/day)

EF = exposure frequency (days/year)

ED = exposure duration (years)

BW = body weight of exposed individual (kg)

AT = averaging time, or period over which exposure is averaged (days)

The intake equation requires specific exposure parameters for each exposure pathway. Exposure parameters are often assumed values, and their magnitude influences the estimates of potential exposure (and risk). The reliability of the values chosen can also contribute substantially to the uncertainty of the resulting risk estimates. Many of the exposure parameters have default values, which were used for this assessment. These assumptions, based on estimates of body weights, media intake levels, and exposure frequencies and duration are provided by EPA guidance. Other assumptions required consideration of location-specific information and were determined using professional judgment. Tables 4.1 through 4.4 in Appendix D present the exposure factors used for different receptor scenarios at the site. RME values are presented in Tables 4.1.RME through 4.4.RME and CTE values are included in Tables 4.1.CTE through 4.4.CTE.

For the dermal contact with water scenario, skin permeability rates were obtained from *RAGS E* (EPA, July 2004). Permeability constants used in the risk assessment are presented in the supplemental tables to Tables 7s in Appendix D.

In accordance with EPA guidance, COPCs with a mutagenic mode of action (MMOA) require separate exposure evaluations for age ranges 0 to <2, 2 to <16, and 16 and older (**EPA, 2005**) due to toxicity adjustments required for these age ranges. There was only one detected constituent that required these adjustments, 1,2-dibromo-3-chloropropane. The MMOA calculations are shown in Tables 7.3.RME Supplement A and 7.3.CTE Supplement A. As chemical-specific data are not available for this constituent, default age-dependent adjustment factors (ADAF), as included in the EPA Region III Memorandum, Derivation of RBCs for Carcinogens that Act Via a Mutagenic Mode of Action and Incorporate Default ADAFs (EPA, 2006), were used for the MMOA evaluation. In addition to the ADAF factors

from the Region III memorandum, the method EPA Region III uses to calculate the RBCs for these constituents were used to calculate the risks.

## 7.5 Toxicity Assessment

Toxicity assessment defines the relationship between the magnitude of exposure and possible severity of adverse effects, and weighs the quality of available toxicological evidence. Toxicity assessment generally consists of two steps: hazard identification and dose-response assessment. Hazard identification is the process of determining the potential adverse effects from exposure to the chemical along with the type of health effect involved. Dose-response assessment is the process of quantitatively evaluating the toxicity information and characterizing the relationship between the dose of the constituent administered or received and the incidence of adverse health effects in the exposed population. Toxicity criteria (e.g., reference doses and slope factors) are derived from the dose-response relationship.

EPA recommends that a tiered approach be used to obtain the toxicity values, the reference doses (RfDs) and cancer slope factors (CSFs), that are used to calculate non-cancer and cancer risks, respectively (EPA, December 2003). The sources of toxicity values were: (1) Integrated Risk Information System (IRIS), (2) Provisional Peer-Reviewed Toxicity values (PPRTV) and (3) other EPA and non-EPA sources including the National Center for Environmental Assessment (NCEA), Agency for Toxic Substances and Disease Registry (ATSDR), Health Effects Assessment Summary Tables (HEAST), California EPA (Cal EPA), and EPA's Office of Water, and the World Health Organization (WHO). The use of provisional toxicity values, such as those from the PPRTV database, in an HHRA increases the uncertainty of the quantitative risk estimate. If no toxicity values were available for a detected constituent, surrogate constituents were selected and their RBCs were used for the COPC selection process.

Health effects are divided into two broad groups: noncarcinogenic and carcinogenic effects. This division is based on the different mechanisms of action currently associated with each category. This section discusses noncarcinogenic and carcinogenic effects separately, and how these effects were assessed in this HHRA.

### 7.5.1 Toxicity Information for Noncarcinogenic Effects

Noncarcinogenic health effects include a variety of toxic effects on body systems, ranging from renal (i.e., kidney) toxicity to central nervous system disorders. The toxicity of a constituent is assessed through a review of toxic effects noted in short-term (acute) animal studies, long-term (chronic) animal studies, and epidemiological investigations.

EPA (December 1989) defines the chronic RfD as a dose that is likely to be without appreciable risk of deleterious effects during a lifetime of exposure. Chronic RfDs are specifically developed to be protective for long-term exposure to a compound (for example, 7 years to a lifetime), and consider uncertainty in the toxicological database and sensitive receptors. Chronic and subchronic RfDs are developed for both inhalation and oral exposures. Subchronic RfDs were used for the construction worker scenario because the exposure duration is less than seven years. Chronic RfDs were used for the residential scenario.

In the development of RfDs, all available studies examining the toxicity of a chemical following exposure are considered based on their scientific merit. Several uncertainty factors (UFs) may be applied to account for uncertainty. UFs account for uncertainties such as poor data quality, extrapolation of data from animal studies to human exposures, or the use of subchronic studies to develop chronic criteria. These UFs range between 10 to 10,000 and are based on the professional judgment.

EPA-derived oral and inhalation chronic RfDs and associated UFs for the COPCs at Site 12 are listed in Tables 5.1 and 5.2 in Appendix D.

Per EPA guidance, oral toxicity values (RfDs) were adjusted from administered doses (oral) to absorbed doses (dermal) for evaluating dermal toxicity when deemed appropriate. The RfDs were adjusted using oral absorption factors from EPA (EPA, July 2004). The adjusted dermal RfDs are summarized in Table 5.1 in Appendix D.

### 7.5.2 Toxicity Information for Carcinogenic Effects

Potential carcinogenic effects are quantified using oral and inhalation CSFs, or unit risk factors that convert estimated exposures directly to incremental lifetime carcinogenic risks. CSFs may be derived from the results of chronic animal bioassays, human epidemiological studies, or both. Animal bioassays are usually conducted at dose levels that are much higher than are likely to be encountered in the environment. This design detects possible adverse effects in the relatively small test populations used in the studies. The actual risks from exposure to a potential carcinogen are not likely to exceed the estimated risks, and are probably much lower or even zero. EPA-derived oral and inhalation CSFs are listed in Tables 6.1 and 6.2 in Appendix D.

In accordance with EPA guidance, oral CSFs were adjusted from administered doses to absorbed doses to evaluate dermal toxicity. When appropriate, the CSFs were adjusted using oral absorption factors from EPA (EPA, July 2004). The adjusted dermal CSFs are summarized in Table 6.1 in Appendix D.

In addition to deriving a quantitative estimate of carcinogenic potency, EPA also assigns weight-of-evidence classifications to potential carcinogens. Constituents are classified as Group A, Group B1, Group B2, Group C, Group D, or Group E carcinogens, as defined in Tables 6.1 an 6.2, Appendix D.

### 7.5.3 Constituents Without Available EPA Toxicity Values

Most of the constituents detected at Site 12 have toxicity factors and EPA Region III RBCs. Detected constituents that did not have RBCs were compared to RBCs for appropriate surrogate constituents during the COPC selection process. Surrogates were selected based on previous recommendations from EPA Region III. The surrogates are identified in the Tables 2.1 through 2.6 in Appendix D. Lead was the only COPC which did not have available published toxicity factors. Lead is regulated by EPA based on blood-lead uptake using a physiologically-based pharmacokinetic model referred to as the IEUBK model, in the event of lead concentrations above the lead screening value. The screening concentration for lead is the National Primary Drinking Water Regulations action level of 15 µg/L (EPA, Winter 2004).

Lead was detected in bedrock aquifer groundwater at a concentration above the screening level, and was therefore retained as a COPC for the bedrock aquifer groundwater. Residential exposure to lead was evaluated based on the EPA's Integrated Exposure/ Uptake Biokinetic (IEUBK) model.

The principal assumption associated with the use of the IEUBK model is that a child from age 0 to 6 years is the receptor for potential exposure to lead (in this case, lead in drinking water). The concentration of lead in groundwater was hypothetically assumed to be the same in drinking water. The results of the IEUBK are presented in Appendix D, Figure D-2. The IEUBK evaluation resulted in a geometric mean blood concentration of 3.4 micrograms per deciliter of blood (µg/dl) for children 0 to 72 months old as a result of ingestion of tap water, which is below EPA's recommended level of 10 µg/dl. Approximately 99 percent of this population had a blood lead level below EPA's recommended level of 10 µg/dl. With the exception of the lead drinking water concentration (which was set to equal the mean detected groundwater lead concentration), the default parameters associated with the IEUBK model were used in this evaluation (as shown in Appendix D, Figure D-2). The site-specific lead groundwater concentration is below the default lead concentration normally used in the model. Potential exposure to children by lead in the groundwater is not expected to result in blood-lead concentrations above EPA's recommended levels.

## 7.6 Risk Characterization

Risk characterization combines the results of the previous elements of the risk assessment to evaluate the potential health risks associated with exposure to the COPCs. The risk characterization is then used as an integral component in remedial decision-making and selection of potential remedies or actions, as necessary.

### 7.6.1 Noncarcinogenic and Carcinogenic Risk Estimation Methods

Potential human health risks are discussed independently for carcinogenic and noncarcinogenic constituents because of the different toxicological endpoints, relevant exposure duration, and methods used to characterize risk. Some constituents may produce both noncarcinogenic and carcinogenic effects, and were evaluated in both groups. The methodology used to estimate noncarcinogenic hazards and carcinogenic risks are described below. Following the description of the methodology, the noncarcinogenic hazards and carcinogenic risks for Site 12 are discussed.

#### 7.6.1.1 Noncarcinogenic Hazard Estimation

Noncarcinogenic health risks are estimated by comparing the calculated exposure levels to threshold concentrations (or RfDs). The calculated intake divided by the RfD is equal to the hazard quotient (HQ):

$$\text{Hazard Quotient (HQ)} = \text{Intake} / \text{RfD}$$

The intake and RfD are expressed in the same units (mg/kg/day) and represent the same exposure period (i.e., chronic and subchronic). The intake and RfD also represent the same exposure route (i.e., inhalation intakes are divided by the inhalation RfDs, oral intakes are

divided by the oral RfDs). An HQ that exceeds 1.0 (i.e., intake exceeds the RfD) indicates that there is a potential for adverse health effects associated with exposure to that chemical.

To assess the potential for noncarcinogenic health effects posed by exposure to multiple chemicals, a "hazard index" approach is used (EPA, December 1989). This approach assumes that noncarcinogenic hazards associated with exposure to more than one chemical are additive. Synergistic or antagonistic interactions between chemicals are not considered. The hazard index (HI) may exceed 1.0 even if all of the individual HQs are less than one. The chemicals may then be separated by similar mechanisms of toxicity and toxicological effects, and separate HIs derived based on mechanism and target organ affected. If the HI for each target organ/effect is not above 1, it can be assumed that there is no noncarcinogenic hazard to the receptor above EPA's target level.

#### 7.6.1.2 Carcinogenic Risk Estimation

The potential for carcinogenic effects due to exposure to site-related constituents is evaluated by estimating the excess lifetime carcinogenic risk (ELCR). ELCR is the incremental increase in the probability of developing cancer during one's lifetime in addition to the background probability of developing cancer.

Potential carcinogenic risks associated with exposure to individual carcinogens were calculated using the CSFs from IRIS and HEAST presented in the Toxicity Assessment section and the intakes calculated in the Exposure Assessment section. Risk is calculated by multiplying the intake by the CSF.

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

The combined risk from exposure to multiple constituents was evaluated by adding the risks from individual constituents. Risks were also added across the exposure routes if an individual would be exposed through multiple routes.

When a cumulative carcinogenic risk to an individual receptor under the assumed RME exposure conditions at the site exceeds 100 in a million (i.e., $10^{-4}$ excess carcinogenic risk), CERCLA generally requires remedial action to reduce risks at the site (EPA March 1991). If the cumulative risk is less than $10^{-4}$, action generally is not required, but may be warranted if a risk-based chemical-specific standard [for example, maximum constituent level (MCL)] is exceeded. All constituents that contribute cancer risks greater than $10^{-6}$ to total cancer risks above $10^{-4}$ were identified as contributing to the cancer risk in the following sections. A risk-based remedial decision could be superseded by the presence of noncarcinogenic impact or environmental impact requiring action at the site.

#### 7.6.1.3 Approach for Potential Mutagenic Effects

Consistent with the Cancer Guidelines and Supplemental Guidance (EPA, 2005a and 2005b), for COPCs which act via a MMOA, ELCRs were estimated using age-dependent adjustment factors (ADAFs). 1,2-Dibromo-3-chloropropane and vinyl chloride were the only COPCs that are categorized as chemicals with a MMOA. The calculation of ELCR using default ADAFs for 1,2-dibromo-3-chloropropane is presented in Tables 7.3.RME Supplement A and 7.3.CTE Supplement A of Appendix D. For vinyl chloride, chemical-specific ADAFs have been developed, as described in IRIS. Therefore, the method and equations described in EPA Region III's technical memorandum, *Derivation of Vinyl Chloride RBCs* (EPA Region III,

May 2001) was used to estimate ELCRs vinyl chloride for future residents exposed to groundwater. The ELCRs for vinyl chloride shown in Tables 7.3.RME and 7.3.CTE were calculated using this method.

#### 7.6.1.4 Approach for Residential Risk Calculations

Noncarcinogenic hazards are calculated separately for an adult and a child resident as they are based on exposure averaged over the exposure duration of the receptor (6 years for a young child, and 24 years for an adult). However, as carcinogenic risks are based on exposure averaged over the lifetime of the receptor, carcinogenic risks were calculated for an age-adjusted resident to incorporate the different contact rates (ingestion, dermal contact, etc.) of exposure during the first 30 years of life. The age-adjusted exposures were calculated using age-adjusted factors that combine exposure factors for small children (0-6 years) and adults (for a total of 24 years).

### 7.6.2 Risk Assessment Results

The risk calculation tables are presented in Appendix D, Tables 7.1.RME through 7.7.RME, and 7.1.CTE through 7.6.CTE. A summary of the RME results is shown in Table 7-4 and a summary of the CTE results is shown in Table 7-5. CTE risks were calculated when the RME hazards exceeded 1 or the RME carcinogenic risks exceeded $10^{-4}$.

#### 7.6.2.1 Future Adult Resident—Alluvial Groundwater

Table 9.1.RME, Appendix D, summarizes the noncarcinogenic hazards to a future adult resident for exposure to alluvial aquifer groundwater that is used as a potable water supply through ingestion and exposure while showering (dermal contact and inhalation). The noncarcinogenic hazard from exposure to the groundwater (8.8) exceeds EPA's target HI of 1.0. Manganese and thallium are the main hazard contributors with manganese contributing an HI = 3.9, while thallium contributes an HI = 2.4. The CTE noncarcinogenic hazard (2.1) is above EPA's target HI. The CTE noncarcinogenic hazard is associated with ingestion of thallium, which contributes an HI of 1.0 (Appendix D, Table 9.1.CTE).

#### 7.6.2.2 Future Child Resident—Alluvial Groundwater

Table 9.2.RME, Appendix D, summarizes the noncarcinogenic hazards to a future child resident for exposure to alluvial aquifer groundwater that is used as a potable water supply through ingestion and exposure while bathing (dermal contact). The noncarcinogenic hazard from exposure to the groundwater (20) exceeds EPA's target HI of 1.0. 1,2,-Dibromo-3-chloropropane (HI = 1.3), arsenic (HI = 1.0), manganese (HI = 9.4), and thallium (HI = 5.7) are the main hazard contributors. The CTE noncarcinogenic hazard (6.8) is above EPA's target HI. The CTE noncarcinogenic hazard is associated with ingestion of manganese (HI =2.1) and thallium (HI = 3.3) (Appendix D, Table 9.2.CTE).

#### 7.6.2.3 Future Lifetime Resident—Alluvial Aquifer

Table 9.3.RME, Appendix D, summarizes the carcinogenic risks to a future lifetime resident for exposure to alluvial aquifer groundwater that is used as a potable water supply through ingestion and exposure while showering (dermal contact and inhalation). The carcinogenic risk from exposure to the groundwater (CR = $6.0 \times 10^{-4}$) exceeds EPA's acceptable cancer risk range of $10^{-6}$ to $10^{-4}$. The risk is primarily associated with the ingestion, dermal contact and

inhalation of 1,1,2,2-tetrachloroethane (CR = $1.3x10^{-5}$), 1,1,2-trichloroethane (CR = $4.3x10^{-6}$), 1,2-dibromo-3-chloropropane (CR = $3.2x10^{-4}$), 1,4-dichlorobenzene (CR = $1.4x10^{-6}$), benzene (CR = $1.8x10^{-6}$), tetrachloroethene (CR = $1.9x10^{-6}$), and vinyl chloride (CR = $1.2x10^{-4}$) and ingestion of and dermal contact with arsenic (CR = $1.1x10^{-4}$). The CTE carcinogenic risk ($1.3x10^{-4}$) also exceeds the EPA's target risk range (Appendix D, Table 9.3.CTE).

#### 7.6.2.4 Future Construction Worker—Alluvial Groundwater

Table 9.4.RME, Appendix D, summarizes the noncarcinogenic hazards and carcinogenic risks to a future construction worker. The risk assessment assumed that a future construction worker could be exposed to Site 12 alluvial aquifer groundwater in an excavation pit during construction activities through dermal contact and inhalation of vapors. The noncarcinogenic hazard from exposure to the groundwater (0.72) is less than EPA's target HI of 1.0. The carcinogenic risk from exposure to the groundwater ($3.1x10^{-7}$) is less than EPA's acceptable cancer risk range of $10^{-6}$ to $10^{-4}$.

#### 7.6.2.5 Future Adult Resident—Bedrock Groundwater

Table 9.5.RME, Appendix D, summarizes the noncarcinogenic hazards to a future adult resident for exposure bedrock aquifer groundwater that is used as a potable water supply through ingestion and exposure while showering (dermal contact and inhalation). The noncarcinogenic hazard from exposure to the groundwater (5.6) exceeds EPA's target HI of 1.0. Thallium is the main hazard contributor with an HI of 2.3. The CTE noncarcinogenic hazard (1.8) is above EPA's target HI. The CTE noncarcinogenic hazard is associated with ingestion of thallium, which contributes an HI of 1.1 (Appendix D, Table 9.4.CTE).

#### 7.6.2.6 Future Child Resident—Bedrock Groundwater

Table 9.6.RME, Appendix D, summarizes the noncarcinogenic hazards to a future child resident for exposure to bedrock aquifer groundwater that is used as a potable water supply through ingestion and exposure while bathing (dermal contact). The noncarcinogenic hazard from exposure to the groundwater (13) exceeds EPA's target HI of 1.0. Bis(2-ethylhexylphthalate (HI = 1.0), arsenic (HI = 1.1), chromium (1.2), manganese (HI = 1.6), and thallium (HI = 5.5) are the main hazard contributors. The CTE noncarcinogenic hazard (5.9) is above EPA's target HI. The CTE noncarcinogenic hazard is associated with ingestion of thallium (HI = 3.6) (Appendix D, Table 9.5.CTE).

#### 7.6.2.7 Future Lifetime Resident—Bedrock Aquifer

Table 9.7.RME, Appendix D, summarizes the carcinogenic risks to a future lifetime resident for exposure to bedrock aquifer groundwater that is used as a potable water supply through ingestion and exposure while showering (dermal contact and inhalation). The carcinogenic risk from exposure to the groundwater ($2.4x10^{-4}$) exceeds EPA's acceptable cancer risk range of $10^{-6}$ to $10^{-4}$. The risk is primarily associated with the ingestion of arsenic (CR = $1.1x10^{-4}$) and ingestion, dermal contact, and inhalation of methylene chloride (CR = $4.6x10^{-5}$), tetrachloroethene (CR = $1.8x10^{-5}$), and ingestion and dermal contact with bis(2-ethylhexyl)phthalate (CR = $6.7x10^{-5}$).The CTE carcinogenic risk ($4.3x10^{-5}$) is within the EPA's target risk range (Appendix D, Table 9.6.CTE).

## 7.7 Uncertainty Associated with Human Health Assessment

The risk measures used in CERCLA risk assessments are not fully probabilistic estimates of risk but are conditional estimates given that a set of assumptions about exposure and toxicity are realized. Thus, it is important to specify the assumptions and uncertainties inherent in the risk assessment to place the risk estimates in proper perspective.

A site-specific discussion on the uncertainties associated with the individual components of the risk assessment is presented in the following sections.

### 7.7.1 General Uncertainty in COPC Selection

The uncertainty related to the selection of COPCs has been addressed by using conservative assumptions when applicable. For example, the sampling that was conducted focused on areas known or suspected to be impacted by site constituents, constructing a sufficient quantity of monitoring wells and sampling the wells often enough to characterize the Site. Therefore, the uncertainty in sampling and possibility of missing a location impacted by site constituents is expected to be minimal. The uncertainty associated with the data analysis is minimal, as the data have been fully validated prior to use in the risk assessment.

1,2-Dibromo-3-chloropropane is identified as a risk driver due to the concentration estimated present in sample data, but was detected only once in one of the alluvial groundwater samples of all the alluvial and bedrock groundwater samples historically obtained at Site 12. It was reported once at an estimated concentration below the detection limit (10 μg/L). The one detection was qualified with a J, indicating the concentration is estimated. It was detected in 12MW10 in December 2006, but was not detected during the previous or following sampling events, both having lower detection limits (0.5 μg/L) for this constituent. Furthermore, this constituent was not detected during any of the previous sampling events, leading up the RI. This single detection was not confirmed and therefore it does not appear that this compound is present in Site 12 groundwater.

A comparison of site concentrations to background concentrations was not used to select the COPCs, however background comparisons are discussed in Sections 5 and 7.3.2. This may result in including risks in the total site risk that may be associated with background conditions and are not necessarily site-related.

### 7.7.2 Uncertainty Associated with Exposure Assessment

Uncertainty in the exposure assessment was generally treated with conservative decision rules and assumptions, and therefore the uncertainty likely overestimates actual exposure to COPCs. Several exposure pathways evaluated by this HHRA, such as residential land use, are hypothetical and are not anticipated to exist in the future. Most of the exposure factors used to quantify exposure are generally conservative and reflect worst-case, or upper-bound, assumptions for the exposure.

Site-related contamination is expected to decrease with time. The risk assessment assumed concentrations would remain constant throughout the exposure period (30 years for the residential scenarios and 1 year for the construction worker). This may result in an over-estimation of risk.

### 7.7.3 Uncertainty Associated with Toxicity Assessment

Uncertainty associated with the noncarcinogenic toxicity factors is included in Appendix D, Tables 5.1 and 5.2. Several UFs were applied to extrapolate dose points from animal studies to humans. These UFs range between 1 and 3,000. Additional modification factors are also used based on the professional judgment of the EPA. Therefore, there is a high degree of uncertainty in the noncarcinogenic toxicity criteria, based on the available scientific data for each constituent. The noncarcinogenic toxicity factors are most likely an overestimate of actual toxicity.

Toxicity values for chromium VI were conservatively used in evaluating total chromium risks. In all likelihood, the chromium found at the site is trivalent chromium. This may result in an over-estimate of the risk associated with total chromium.

Use of provisional or withdrawn toxicity factors increases the uncertainty of the quantitative hazard and risk estimates. Provisional RfDs for aluminum, iron, thallium, chloroform, chlorobenzene, 1,2-dibromo-3-chloropropane, cis-1,2-dichloroethene, 1,4-dichlorobenzene, tetrachloroethene, and trichloroethene were used in this assessment. These provisional values were used to provide a quantitative estimate rather than a merely qualitative risk discussion; however these values should be interpreted cautiously since EPA has not approved these toxicity values.

The provisional toxicity values used for TCE in this assessment were provided by the National Center for Environmental Assessment (NCEA). NCEA developed these provisional toxicity values subsequent to the withdrawal of the TCE CSFs from IRIS in 1989. The NCEA CSFs were the same values that were withdrawn from IRIS in 1989 (oral CSF = $1.1 \times 10^{-2}$ per mg/kg-day and inhalation CSF = $6.0 \times 10^{-3}$ per mg/kg day). In 1992, NCEA also recommended a provisional noncarcinogenic toxicity value (oral RfD = $6.0 \times 10^{-3}$ mg/kg-day). As with all NCEA toxicity values, these are considered provisional, and are to be periodically reassessed to include up-to-date scientific understanding.

In August 2001, NCEA completed a draft health assessment of the health risks posed by TCE. The draft health assessment was made available for public comment and includes a disclaimer that it is a preliminary draft and "has not been formally released by EPA and should not at this stage be construed to represent Agency policy. It is being circulated for comment on its technical merit and policy implications," (EPA, 2001c). The draft health assessment proposed a provisional oral RfD of $3.0 \times 10^{-4}$ mg/kg-day based on effects to the liver, kidney, and developing fetuses. A provisional inhalation RfD of $1.0 \times 10^{-2}$ mg/kg-day was also suggested based on critical effects in the central nervous system, liver, and endocrine system. Several CSFs were developed in the 2001 draft health assessment, with most slope factors falling between $2 \times 10^{-2}$ and $4 \times 10^{-1}$ per mg/kg-day.

Because the toxicity values in the draft 2001 health assessment are different than the current provisional toxicity values, to characterize the uncertainty associated with the quantitative estimate of risk from exposure to TCE, a parallel set of risk calculations was performed using the toxicity values in the draft 2001 health assessment. The following toxicity values were used for these calculations:

- Oral CSF = $4.0 \times 10^{-1}$ $(\text{mg/kg-day})^{-1}$
- Inhalation CSF = $4.0 \times 10^{-1}$ $(\text{mg/kg-day})^{-1}$

- Oral RfD = $3.0 \times 10^{-4}$ mg/kg-day
- Inhalation RfD = $1.0 \times 10^{-2}$ mg/kg-day

Table 7-6 shows the results of the risk assessment using these toxicity values, and compares them to the results using the pre-2001 values. The following bullets show those scenarios in which use of the draft 2001 values would result in a different conclusion than the values used in the risk assessment:

- Future Construction Worker. Exposure to alluvial groundwater during construction would result in a noncarcinogenic hazard exceeding the acceptable risk levels. However, there would still be no target organ/effects with HIs above 1.0.

Although the oral RfD for manganese is not provisional (that is, the RfD has been approved by a EPA workgroup), the derivation of toxicity factors for essential nutrients is complicated, and therefore, warrants further discussion. Manganese is an essential human nutrient responsible for activating several enzymes (EPA, 2007). Disease states have been documented in humans associated with both deficiencies and excess intakes of manganese (EPA, 2007). The IRIS profile for manganese states, "The reference dose is estimated to be an intake for the general population that is not associated with adverse health effects; this is not meant to imply that intakes above the reference dose are necessarily associated with toxicity. Some individuals may, in fact, consume a diet that contributes more than 10 mg Mn/day without any cause for concern," (EPA, 2007). Ingestion of manganese in alluvial aquifer groundwater may result in an HI of 8.1 to a future child resident, based on a daily intake rate of 0.16 mg/kg-day, which corresponds to an intake of 2.4 mg/day (Appendix D, Table 7.3.RME). This intake is slightly above the RDA for manganese for a child 1 to 3 years of age is 1.2 mg/day (Institute of Medicine, 2005). However, the tolerable upper intake level (UL) range for the child ages 1 year to 8 is between 2 and 3 mg/day. Ingestion of manganese in bedrock aquifer groundwater may result in an HI of 1.3 to a future child resident, based on a daily intake rate of 0.027 mg/kg-day, which corresponds to an intake of 0.41 mg/day (Appendix D Table 7.6.RME). This intake is much lower than the RDA for manganese for a child 1 to 3 years of age is 1.2 mg/day (Institute of Medicine, 2005). Therefore, ingestion of manganese in the alluvial or bedrock groundwater is not expected to be a health concern for the child resident.

CSFs developed by EPA represent upper bound estimates. Carcinogenic risks generated in this assessment should be regarded as an upper bound estimate on the potential carcinogenic risks rather than an accurate representation of carcinogenic risk. The true carcinogenic risk is likely to be less than the predicted value (EPA December 1989).

Additional uncertainty is in the prediction of relative sensitivities of different species of animals and the applicability of animal data to humans.

There is uncertainty associated with the oral to dermal adjustment factors (based on constituent-specific gastrointestinal absorption factors) used to transform the oral RfDs based on administered doses to dermal RfDs based on absorbed doses. It is not known if the adjustment factor results in an underestimate or overestimate of the actual toxicity associated with dermal exposure.

### 7.7.4 Uncertainty in Risk Characterization

The uncertainties identified in each component of risk assessment ultimately contribute to uncertainty in risk characterization. The addition of risks and HIs across pathways and chemicals contributes to uncertainty based on the interaction of chemicals such as additivity, synergism, potentiation, susceptibility of exposed receptors, etc.

## 7.8 Human Health Risk Summary

The risk assessment was conducted to evaluate the potential human health risks associated with Site 12 alluvial and bedrock aquifer groundwater based on potential and unlikely (but conservative) receptor populations and exposure scenarios if no remedial action is implemented.

Appendix D, Tables 9.1.RME through 9.7.RME and Tables 9.1.CTE through 9.6.CTE summarize the RME and CTE potential hazards and risks to each receptor. Appendix D, Tables 10.1.RME through 10.6.RME and 10.1.CTE though 10. 5. CTE show only the constituents that contributed HIs greater than 0.1 to scenarios with total HIs greater than 1.0 or carcinogenic risks greater than $10^{-6}$ to scenarios with total carcinogenic risks greater $10^{-6}$. Tables 7-4 and 7-5 summarize the risks and hazards for the RME and CTE scenarios, respectively.

There are no carcinogenic risks or noncarcinogenic hazards that exceed EPA target levels (total HI above 1 and total carcinogenic risk above $10^{-4}$) for a construction worker exposed to alluvial groundwater during excavation and construction workers activities. Potable use of either alluvial or bedrock aquifer groundwater could result in carcinogenic risks and noncarcinogenic hazards that exceed EPA target levels. The alluvial aquifer and bedrock aquifer groundwater are not currently used as a potable-water supply and will most likely not be used as a potable-water supply in the foreseeable future. However, potable use of the groundwater was assessed to evaluate an unrestricted future site use scenario.

The risk drivers for potable use of alluvial aquifer groundwater are:

- Arsenic
- Manganese
- Thallium
- 1,2-Dibromo-3-chloropropane
- Vinyl Chloride
- Tetrachloroethene
- 1,1,2,2-Tetrachloroethane
- 1,1,2-Trichloroethane
- Benzene
- Chloroform

1,2-Dibromo-3-chloropropane, 1,1,2,2-tetrachloroethene, and 1,1,2-trichloroethene were identified as risk drivers (CR $>10^{-6}$), but were detected in only one of the alluvial groundwater samples of all the alluvial and bedrock groundwater samples obtained Site 12, historically. They were all reported at estimated concentrations below the reporting limit (10 µg/L). They were detected in 12MW10 in December 2006, but were not detected during the previous or following sampling events of this well in May 2005 or June 2007, both of

which have lower detection limits (0.5 µg/L) for these constituents. Therefore, these single detections were not confirmed and it does not appear that these compounds are present in Site 12 groundwater.

The rest of the VOCs identified as risk drivers were also only detected in a few of the groundwater samples, with vinyl chloride being detected the greatest at a frequency of five out of the 21 samples.

Dissolved arsenic was detected in six of 165 groundwater samples. It was detected in 12MW02, 12MW08, and 12MW16, and all detected concentrations were either qualified with a J (indicating the concentration was estimated) or K (indicating the concentration is biased high). As discussed in Sections 2 and 5, arsenic detections are not likely related to known site activities.

Dissolved manganese was detected in all of the alluvial aquifer groundwater samples evaluated in the risk assessment. Although the risk assessment indicated a hazard associated with manganese, as discussed in the uncertainty evaluation (Section 7.7), the concentrations detected in the groundwater result in intake of manganese slightly above the RDA. As discussed in Sections 2 and 5, manganese detections are not likely related to known site activities.

Dissolved thallium was detected in one of 16 groundwater samples and was not detected in any of the unfiltered alluvial aquifer groundwater samples. As discussed in Sections 2 and 5, the thallium detection is not likely related to known site activities.

The risk drivers for potable use of bedrock aquifer groundwater are:

- Arsenic
- Chromium
- Manganese
- Thallium
- Methylene Chloride
- Tetrachloroethene
- bis(2-Ethylhexyl)phthalate

Arsenic was detected in ten of 26 groundwater samples. All detected concentrations were either qualified with a J (indicating the concentration was estimated) or K (indicating the concentration is biased high). The highest and second highest detected concentrations were detected at the same well location (12MW09). All other detected concentrations were similar to background levels. As discussed in Sections 2 and 5, arsenic detections are not likely related to known site activities.

Chromium was detected in 15 of the 25 unfiltered groundwater samples. It was only detected in nine of the filtered groundwater samples. A number of the samples had "B" qualifiers, indicated that it was detected at a similar concentration in the blank sample as the monitoring well samples, these samples were not included as detected samples. Only four of the detected concentrations exceeded the background levels.

Manganese was detected in 25 of the 26 of the bedrock aquifer groundwater samples evaluated in the risk assessment. Although the risk assessment indicated a hazard

associated with manganese, as discussed in the uncertainty evaluation (Section 7.7), the concentrations detected in the groundwater would not result in intake of manganese above the RDA.

Thallium was detected in three of 26 groundwater samples and all concentrations were qualified with a J.

Methylene chloride is a common laboratory contaminant. In many of the samples it was detected in it was "B" qualified indicating it was also detected in the associated blank samples at a similar concentration. However, it was detected in eight of the 37 samples and retained as a COPC, and identified as a risk driver.

Bis(2-Ethylheyxl)phthalate is another common laboratory contaminant that was detected in three of the 26 samples analyzed for SVOCs. These three samples were collected from different wells in June 2005. In all of the other samples in which it was detected it was "B" qualified.

Tetrachloroethene was only detected in one of the 37 bedrock groundwater samples. It was detected in monitoring well 12MW09S in June 2005, however, it was not detected in this well in the samples collected in 2006 or 2007.

**TABLE 7-1**
Summary of Data Quantitatively Used in HHRA
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Medium | Date of Sampling | Sample Location | Sample | Parameters |
|---|---|---|---|---|
| **Alluvial Groundwater** | | | | |
| | 6/1/2005 | 12MW01 | AS12-12MW01-0605 | VOCs, SVOCs, total Metals, dissolved Metals, Explosives |
| | 12/7/2006 | 12MW01 | AS12-12MW01-1206 | VOCs |
| | 6/1/2005 | 12MW02 | AS12-12MW02-0605 | VOCs, SVOCs, total Metals, dissolved Metals, Explosives |
| | 12/7/2006 | 12MW02 | AS12-12MW02-1206 | VOCs |
| | 12/7/2006 | 12MW02 | AS12-12MW02P-1206[1] | VOCs |
| | 6/2/2005 | 12MW08 | AS12-12MW08-0605 | VOCs, SVOCs, total Metals, dissolved Metals, Explosives |
| | 12/7/2006 | 12MW08 | AS12-12MW08-1206 | VOCs |
| | 6/11/2007 | 12MW08 | AS12-12MW08-0607 | VOCs |
| | 5/27/2005 | 12MW10 | AS12-12MW10-0505 | VOCs, SVOCs, total Metals, dissolved Metals, Explosives |
| | 12/7/2006 | 12MW10 | AS12-12MW10-1206 | VOCs |
| | 6/12/2007 | 12MW10 | AS12-12MW10-0607 | VOCs, SVOCs, total Metals, dissolved Metals |
| | 5/24/2005 | 12MW12 | AS12-12MW12-0505 | VOCs, SVOCs, total Metals, dissolved Metals, Explosives |
| | 5/26/2005 | 12MW14 | AS12-12MW14-0505 | VOCs, SVOCs, total Metals, dissolved Metals, Explosives |
| | 6/1/2005 | 12MW16 | AS12-12MW16-0605 | VOCs, SVOCs, total Metals, dissolved Metals, Explosives |
| | 12/6/2006 | 12MW16 | AS12-12MW16-1206 | VOCs |
| | 6/13/2007 | 12MW16 | AS12-12MW16-0607 | VOCs, SVOCs, total Metals, dissolved Metals |
| | 5/26/2005 | 12MW18 | AS12-12MW18-0505 | VOCs, SVOCs, total Metals, dissolved Metals, Explosives |
| | 6/12/2007 | 12MW18 | AS12-12MW18-0607 | VOCs, SVOCs, total Metals, dissolved Metals |
| | 6/12/2007 | 12MW18 | AS12-12MW18P-0607[2] | VOCs, SVOCs, total Metals, dissolved Metals |
| | 5/25/2005 | 12MW19 | AS12-12MW19-0505 | VOCs, SVOCs, total Metals, dissolved Metals, Explosives |
| | 6/12/2007 | 12MW19 | AS12-12MW19-0607 | VOCs, SVOCs, total Metals, dissolved Metals |
| | 12/6/2006 | 12MW23 | AS12-12MW23-1206 | VOCs |
| | 6/12/2007 | 12MW23 | AS12-12MW23-0607 | VOCs, SVOCs, total Metals, dissolved Metals |
| | 6/12/2007 | 12MW23 | AS12-12MW23P-0607[3] | VOCs, SVOCs, total Metals, dissolved Metals |
| **Bedrock Groundwater** | | | | |
| | 6/1/2005 | 12MW04S | AS12-12MW04S-0605 | VOCs, SVOCs, total Metals, dissolved Metals, Explosives |
| | 12/7/2006 | 12MW04S | AS12-12MW04S-1206 | VOCs |
| | 5/26/2005 | 12MW05S | AS12-12MW05S-0505 | VOCs, SVOCs, total Metals, dissolved Metals, Explosives |
| | 5/26/2005 | 12MW05S | AS12-12MW05SP-0505[4] | VOCs, SVOCs, total Metals, dissolved Metals, Explosives |
| | 6/13/2007 | 12MW05S | AS12-12MW05S-0607 | VOCs, SVOCs, total Metals, dissolved Metals |
| | 5/25/2005 | 12MW07S | AS12-12MW07S-0505 | VOCs, SVOCs, total Metals, dissolved Metals, Explosives |
| | 6/12/2007 | 12MW07S | AS12-12MW07S-0607 | VOCs, SVOCs, total Metals, dissolved Metals |
| | 6/2/2005 | 12MW09S | AS12-12MW09S-0605 | VOCs, SVOCs, total Metals, dissolved Metals, Explosives |
| | 12/7/2006 | 12MW09S | AS12-12MW09S-1206 | VOCs |
| | 6/11/2007 | 12MW09S | AS12-12MW09S-0607 | VOCs, SVOCs, total Metals, dissolved Metals |
| | 6/2/2005 | 12MW11S | AS12-12MW11S-0605 | VOCs, SVOCs, total Metals, dissolved Metals, Explosives |
| | 6/13/2007 | 12MW11S | AS12-12MW11S-0607 | VOCs, SVOCs, total Metals, dissolved Metals |
| | 12/7/2006 | 12MW11S | AS12-12MW11S-1206 | VOCs |
| | 5/23/2005 | 12MW13S | AS12-12MW13S-0505 | VOCs, SVOCs, total Metals, dissolved Metals, Explosives |
| | 5/24/2005 | 12MW17S | AS12-12MW17S-0505 | VOCs, SVOCs, total Metals, dissolved Metals, Explosives |
| | 6/12/2007 | 12MW17S | AS12-12MW17S-0607 | VOCs, SVOCs, total Metals, dissolved Metals |
| | 12/6/2006 | 12MW20S | AS12-12MW20S-1206 | VOCs |
| | 12/6/2006 | 12MW21S | AS12-12MW21S-1206 | VOCs |
| | 12/6/2006 | 12MW21S | AS12-12MW21SP-1206[5] | VOCs |
| | 6/11/2007 | 12MW21S | AS12-12MW21S-0607 | VOCs, SVOCs, total Metals, dissolved Metals |
| | 12/6/2006 | 12MW22S | AS12-12MW22S-1206 | VOCs |
| | 6/13/2007 | 12MW22S | AS12-12MW22S-0607 | VOCs, SVOCs, total Metals, dissolved Metals |
| | 5/26/2005 | 12MW05D | AS12-12MW05D-0505 | VOCs, SVOCs, total Metals, dissolved Metals, Explosives |

**TABLE 7-1**
Summary of Data Quantitatively Used in HHRA
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Medium | Date of Sampling | Sample Location | Sample | Parameters |
|---|---|---|---|---|
| **Bedrock Groundwater (cont'd)** | | | | |
| | 6/13/2007 | 12MW05D | AS12-12MW05D-0607 | VOCs, SVOCs, total Metals, dissolved Metals |
| | 5/25/2005 | 12MW07D | AS12-12MW07D-0505 | VOCs, SVOCs, total Metals, dissolved Metals, Explosives |
| | 5/25/2005 | 12MW07D | AS12-12MW07DP-0505[6] | VOCs, SVOCs, total Metals, dissolved Metals, Explosives |
| | 6/12/2007 | 12MW07D | AS12-12MW07D-0607 | VOCs, SVOCs, total Metals, dissolved Metals |
| | 6/12/2007 | 12MW07D | AS12-12MW07DP-0607 | VOCs, SVOCs, total Metals, dissolved Metals |
| | 6/2/2005 | 12MW09D | AS12-12MW09D-0605 | VOCs, SVOCs, total Metals, dissolved Metals, Explosives |
| | 6/2/2005 | 12MW09D | AS12-12MW09DP-0605[7] | VOCs, SVOCs, total Metals, dissolved Metals, Explosives |
| | 12/7/2006 | 12MW09D | AS12-12MW09D-1206 | VOCs |
| | 6/11/2007 | 12MW09D | AS12-12MW09D-0607 | VOCs, SVOCs, total Metals, dissolved Metals |
| | 5/27/2005 | 12MW11D | AS12-12MW11D-0505 | VOCs, SVOCs, total Metals, dissolved Metals, Explosives |
| | 12/7/2006 | 12MW11D | AS12-12MW11D-1206 | VOCs |
| | 6/12/2007 | 12MW11D | AS12-12MW11D-0607 | VOCs, SVOCs, total Metals, dissolved Metals |
| | 5/24/2005 | 12MW17D | AS12-12MW17D-0505 | VOCs, SVOCs, total Metals, dissolved Metals, Explosives |
| | 6/12/2007 | 12MW17D | AS12-12MW17D-0607 | VOCs, SVOCs, total Metals, dissolved Metals |
| | 12/7/2006 | 12MW20D | AS12-12MW20D-1206 | VOCs |
| | 12/6/2006 | 12MW21D | AS12-12MW21D-1206 | VOCs |
| | 6/11/2007 | 12MW21D | AS12-12MW21D-0607 | VOCs, SVOCs, total Metals, dissolved Metals |
| | 6/13/2007 | 12MW22D | AS12-12MW22D-0607 | VOCs, SVOCs, total Metals, dissolved Metals |
| | 12/6/2006 | 12MW22D | AS12-12MW22D-1206 | VOCs |

Notes:
VOCs - Volatile organic constituents
SVOCs - Semi-volatile organic constituents
[1] Duplicate of sample AS12-12MW02-1206
[2] Duplicate of sample AS12-12MW18-0607
[3] Duplicate of sample AS12-12MW23-0607
[4] Dulicate of sample AS12-12MW05S-0505
[5] Dulicate of sample AS12-12MW21S-1206
[6] Dulicate of sample AS12-12MW07D-0505
[7] Dulicate of sample AS12-12MW09D-0605

**TABLE 7-2**
Summary of Chemicals of Potential Concern for the Baseline Risk Assessment
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Groundwater | |
|---|---|
| ***Alluvial Groundwater - Tap Water*** | ***Alluvial Groundwater - Excavation Pit*** |
| 1,1,2,2-Tetrachloroethane[a] | 1,1,2,2-Tetrachloroethane[b] |
| 1,1,2-Trichloroethane[a] | 1,1,2-Trichloroethane[b] |
| 1,2-Dibromo-3-chloropropane[a] | 1,2-Dibromo-3-chloropropane[b] |
| 1,2-Dichlorobenzene[a] | 1,2-Dichlorobenzene[b] |
| 1,2-Dichloropropane[a] | 1,2-Dichloropropane[b] |
| 1,4-Dichlorobenzene[a] | 1,4-Dichlorobenzene[b] |
| Benzene[a] | Benzene[b] |
| Bromodichloromethane[a] | Bromodichloromethane[b] |
| Chlorobenzene[a] | Chlorobenzene[b] |
| Chloroform[a] | Chloroform[b] |
| Methylene chloride[a] | Methylene chloride[b] |
| Tetrachloroethene[a] | Tetrachloroethene[b] |
| Trichloroethene[a] | Trichloroethene[b] |
| Vinyl chloride[a] | Vinyl chloride[b] |
| cis-1,2-Dichloroethene[a] | cis-1,2-Dichloroethene[b] |
| Arsenic-dissolved | Aluminum |
| Chromium (hexavalent)-dissolved | Arsenic |
| Iron-dissolved | Chromium |
| Manganese-dissolved | Chromium (hexavalent) |
| Nickel-dissolved | Iron |
| Thallium-dissolved | Manganese |
| | Nickel |
| | Vanadium |
| ***Bedrock Aquifer - Tap Water*** | |
| Methylene chloride[c] | |
| Tetrachloroethene[c] | |
| Trichloroethene[c] | |
| cis-1,2-Dichloroethene[c] | |
| bis(2-Ethylhexyl)phthalate | |
| Aluminum | |
| Antimony | |
| Arsenic | |
| Chromium | |
| Iron | |
| Lead | |
| Manganese | |
| Nickel | |
| Thallium | |
| Vanadium | |

NOTES:
[a] VOCs are COPCs for the Alluvial Aquifer - Water Vapors at Showerhead
[b] VOCs are COPCs for the Alluvial Aquifer - Volatilization from Water in Excavation Pit
[c] VOCs are COPCs for the Becrock Aquifer - Water Vapors at Showerhead

**TABLE 7-3**
Potentially Complete Human Health Exposure Pathways
Conceptual Site Model
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Land Use | Media | Potentially Exposed Populations | Exposure Route (Human Health) | Pathway Selected for Evaluation | Rationale |
|---|---|---|---|---|---|
| **Future** | | | | | |
| Residential | Alluvial Aquifer - Tap Water | Residents - Adults and Children | Ingestion and dermal contact | Yes | Groundwater is not currently used on-site as a water supply and the site is not expected to be developed for residential use; however, a future residential scenario is included for a conservative evaluation of unrestricted land use. |
| | Alluvial Aquifer - Water Vapors at Showerhead | Residents - Adults | Inhalation | Yes | Although unlikely, groundwater will be evaluated for use as a future potable water supply. Children assumed to bathe and not shower, therefore, inhalation exposure not as great for a child as that for adult. |
| | Bedrock Aquifer - Tap Water | Residents - Adults and Children | Ingestion and dermal contact | Yes | Groundwater is not currently used on-site as a water supply and the site is not expected to be developed for residential use; however, a future residential scenario is included for a conservative evaluation of unrestricted land use. |
| | Bedrock Aquifer - Water Vapors at Showerhead | Residents - Adults | Inhalation | Yes | Although unlikely, groundwater will be evaluated for use as a future potable water supply. Children assumed to bathe and not shower, therefore, inhalation exposure not as great for a child as that for adult. |
| | Alluvial Aquifer - Indoor Air | Residents - Adults and Children | Inhalation | No | Although pathway may be complete, pathway is not evaluated in this report, but will be evaluated in a facility-wide assessment. |
| Residential or Industrial | Alluivial Aquifer - Water in Excavation Pit | Construction Worker | Dermal contact | Yes | Workers may have exposed skin surfaces come into contact with shallow groundwater during excavation activities. |
| | Alluivial Aquifer - Volatilization from Water in Excavation Pit | Construction Worker | Inhalation | Yes | Workers may inhale volatiles from shallow groundwater during excavation activities. |
| **Current/Future** | | | | | |
| Industrial | Alluvial Aquifer - Indoor Air | Industrial Worker | Inhalation | No | Although pathway may be complete, pathway is not evaluated in this report, but will be evaluated in a facility-wide assessment. |

**TABLE 7-4**
Summary of RME Cancer Risks and Hazard Indices
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Receptor | Media | Exposure Route | Cancer Risk | Chemicals with Cancer Risks >$10^{-4}$ | Chemicals with Cancer Risks >$10^{-5}$ and <$10^{-4}$ | Chemicals with Cancer Risks >$10^{-6}$ and <$10^{-5}$ | Hazard Index | Chemicals with HI>1 |
|---|---|---|---|---|---|---|---|---|
| Future Resident Adult | Alluvial Aquifer Groundwater | Ingestion | N/A | | | | 7.7E+00 | Dissolved Manganese and Thallium |
| | | Dermal Contact | N/A | | | | 5.7E-01 | |
| | | Inhalation/Shower | 1.8E-04 | 1,2-Dibromo-3-chloropropane | | 1,1,2,2-Tetrachloroethane, 1,1,2-Trichloroethane, Chloroform | 5.3E-01 | |
| | | Total | 1.8E-04 | 1,2-Dibromo-3-chloropropane | | 1,1,2,2-Tetrachloroethane, 1,1,2-Trichloroethane, Chloroform | 8.8E+00 | Dissolved Manganese and Thallium |
| Future Resident Child | Alluvial Aquifer Groundwater | Ingestion | N/A | | | | 1.8E+01 | 1,2-Dibromo-3-chloropane, Dissolved Manganese and Thallium |
| | | Dermal Contact | N/A | | | | 1.6E+00 | Dissolved Manganese |
| | | Inhalation/Shower | N/A | | | | N/A | |
| | | Total | N/A | | | | 2.0E+01 | 1,2-Dibromo-3-chloropane, Dissolved Manganese and Thallium |
| Future Resident Adult/Child | Alluvial Aquifer Groundwater | Ingestion | 3.9E-04 | Dissolved Arsenic, 1,2-Dibromo-3-chloropropane, Vinyl Chloride | Tetrachloroethene | 1,1,2,2-Tetrachloroethane, 1,1,2-Trichloroethane, Benzene | N/A | |
| | | Dermal Contact | 3.1E-05 | | 1,2-Dibromo-3-chloropropane | 1,1,2,2-Tetrachloroethane, Tetrachloroethane, Vinyl chloride | N/A | |
| | | Inhalation[1]/Shower | 1.8E-04 | 1,2-Dibromo-3-chloropropane | | 1,1,2,2-Tetrachloroethane, 1,1,2-Trichloroethane, Chloroform | N/A | |
| | | Total | 6.0E-04 | 1,2-Dibromo-3-chloropropane, Vinyl Chloride, Dissolved Arsenic | 1,1,2,2-Tetrachloroethane, Tetrachloroethene | 1,1,2-Trichloroethane, 1,2-Dichloropropane, 1,4-Dichlorobenzene, Benzene, Chloroform, Trichloroethene | NA | |
| Future Construction Worker - Adult | Alluvial Aquifer Groundwater | Ingestion | N/A | | | | N/A | |
| | | Dermal Contact | 2.3E-07 | | | | 7.1E-01 | |
| | | Inhalation | 7.7E-08 | | | | 6.2E-03 | |
| | | Total | 3.1E-07 | | | | 7.2E-01 | |
| Future Resident Adult | Bedrock Aquifer | Ingestion | N/A | | | | 4.8E+00 | Thallium |
| | | Dermal Contact | N/A | | | | 7.2E-01 | |
| | | Inhalation/Shower | 5.1E-06 | | | Methylene chloride | 2.9E-02 | |
| | | Total | 5.1E-06 | | | Methylene chloride | 5.6E+00 | Thallium |
| Future Resident Child | Bedrock Aquifer | Ingestion | N/A | | | | 1.1E+01 | Arsenic, Manganese, Thallium |
| | | Dermal Contact | N/A | | | | 1.8E+00 | |
| | | Inhalation/Shower | N/A | | | | N/A | |
| | | Total | N/A | | | | 1.3E+01 | Arsenic, Chromium, Manganese, Thallium |
| Future Resident Adult/Child | Bedrock Aquifer Groundwater | Ingestion | 1.6E-04 | Arsenic | Methylene Chloride, Tetrachloroethene | | N/A | |
| | | Dermal Contact | 7.5E-05 | | bis(2-Ethylhexyl)phthalate | Methylene chloride, Tetrachloroethene | N/A | |
| | | Inhalation[1]/Shower | 5.1E-06 | | | Methylene chloride | N/A | |
| | | Total | 2.4E-04 | Arsenic | Methylene chloride,Tetrachloroethene, bis(2-Ethylhexyl)phthalate | | N/A | |

NA - Not applicable, pathway incomplete.
[1]Inhalation calculated for adult only.

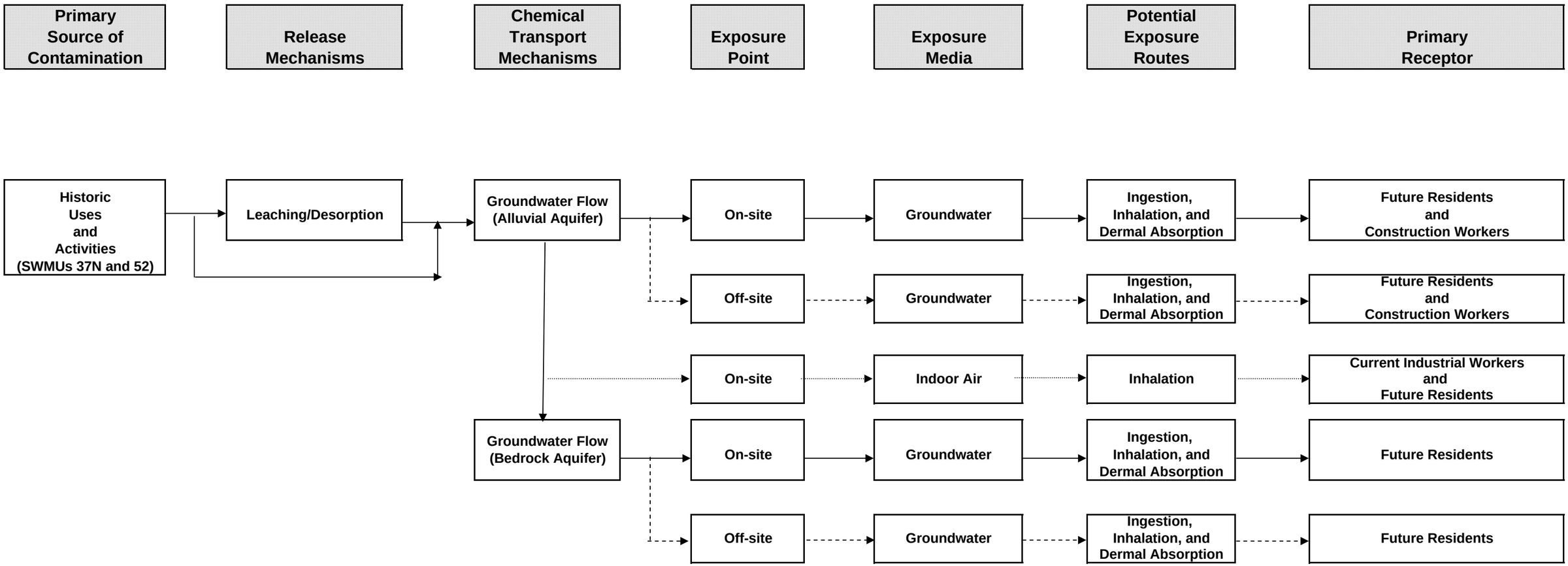
**TABLE 7-5**
Summary of CTE Cancer Risks and Hazard Indices
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Receptor | Media | Exposure Route | Cancer Risk | Chemicals with Cancer Risks >$10^{-4}$ | Chemicals with Cancer Risks >$10^{-5}$ and <$10^{-4}$ | Chemicals with Cancer Risks >$10^{-6}$ and <$10^{-5}$ | Hazard Index | Chemicals with HI>1 |
|---|---|---|---|---|---|---|---|---|
| Future Resident Adult | Alluvial Aquifer Groundwater | Ingestion | N/A | | | | 2.0E+00 | |
| | | Dermal Contact | N/A | | | | 6.7E-02 | |
| | | Inhalation/Shower | 6.2E-06 | | | 1,2-Dibromo-3-chloropropane | 7.3E-02 | |
| | | Total | 6.2E-06 | | | 1,2-Dibromo-3-chloropropane | 2.1E+00 | |
| Future Resident Child | Alluvial Aquifer Groundwater | Ingestion | N/A | | | | 6.6E+00 | Dissolved Manganese and Thallium |
| | | Dermal Contact | N/A | | | | 2.2E-01 | |
| | | Inhalation/Shower | N/A | | | | N/A | |
| | | Total | N/A | | | | 6.8E+00 | Dissolved Manganese and Thallium |
| Future Resident Adult/Child | Alluvial Aquifer Groundwater | Ingestion | 1.2E-04 | | 1,2-Dibromo-3-chloropropane, Vinyl Chloride, Dissolved Arsenic | 1,1,2,2-Tetrachloroethane, Tetrachloroethene | N/A | |
| | | Dermal Contact | 5.5E-06 | | | 1,2-Dibromo-3-chloropropane, Tetrachloroethene, Vinyl Chloride | N/A | |
| | | Inhalation[1]/Shower | 6.2E-06 | | | 1,2-Dibromo-3-chloropropane | N/A | |
| | | Total | 1.3E-04 | | 1,2-Dibromo-3-chloropropane, , Vinyl ChlorideDissolved Arsenic | 1,1,2,2-Tetrachloroethane, Tetrachloroethene | N/A | |
| Future Resident Adult | Bedrock Aquifer | Ingestion | N/A | | | | 1.7E+00 | Thallium |
| | | Dermal Contact | N/A | | | | 1.5E-01 | |
| | | Inhalation/Shower | 2.4E-07 | | | | 3.4E-03 | |
| | | Total | NA | | | | 1.8E+00 | Thallium |
| Future Resident Child | Bedrock Aquifer | Ingestion | N/A | | | | 5.6E+00 | Thallium |
| | | Dermal Contact | N/A | | | | 3.1E-01 | |
| | | Inhalation/Shower | N/A | | | | N/A | |
| | | Total | N/A | | | | 5.9E+00 | Thallium |
| Future Resident Adult/Child | Bedrock Aquifer Groundwater | Ingestion | 4.3E-05 | | Arsenic | Methylene chloride, Tetrachloroethene | N/A | |
| | | Dermal Contact | 5.6E-07 | | | | N/A | |
| | | Inhalation[1]/Shower | 2.4E-07 | | | | N/A | |
| | | Total | 4.3E-05 | | Arsenic | Methylene chloride, Tetrachloroethene | N/A | |

NA - Not applicable, pathway incomplete.
[1]Inhalation calculated for adult only.

**TABLE 7-6**
Effect of Use of Draft 2001 TCE Toxicity Values on Human Health Risk Assessment Results
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Receptor | Media | Pre-2001 | | Draft-2001 | |
|---|---|---|---|---|---|
| | | Cancer Risk | Hazard Index | Cancer Risk | Hazard Index |
| Future Resident - Adult | Alluvial Aquifer Groundwater | NA | 8.8E+00 | NA | 9.7E+00 |
| Future Resident - Child | Alluvial Aquifer Groundwater | NA | 2.0E+01 | NA | 2.0E+01 |
| Future Resident - Adult/Child | Alluvial Aquifer Groundwater | 6.0E-04 | NA | 8.0E-04 | NA |
| Future Construction Worker - Adult | Alluvial Aquifer Groundwater | 3.1E-07 | 7.2E-01 | 9.9E-07 | 1.1E+00 |
| Future Resident - Adult | Bedrock Aquifer Groundwater | NA | 5.6E+00 | NA | 6.4E+00 |
| Future Resident - Child | Bedrock Aquifer Groundwater | NA | 1.3E+01 | NA | 1.4E+01 |
| Future Resident - Adult/Child | Bedrock Aquifer Groundwater | 2.4E-04 | NA | 2.9E-04 | NA |




Complete Pathway

Incomplete Pathway

Complete Pathway, However, not evaluated in this assessment, will be evaluated in a facility-wide assessment

**Figure 7-1**
Conceptual Exposure Model, Potential Human Exposures
Site 12 Remedial Investigation Report
Allegany Ballistics Laboratory
Rocket Center, West Virginia

SECTION 8

# Ecological Risk Assessment

This section contains a qualitative ecological risk assessment (ERA) of groundwater at Site 12.

## 8.1 Problem Formulation

Problem formulation establishes the goals, scope, and focus of the ERA. As part of problem formulation, the environmental setting of Site 12 is characterized in terms of the habitats and biota known or likely to be present. The types and concentrations of chemicals that are present in ecologically relevant media are also described. A conceptual model is developed for Site 12 that describes potential sources, potential transport pathways, potential exposure pathways and routes, and potential receptors. Assessment endpoints, measurement endpoints, and risk hypotheses are then selected to evaluate those receptors for which complete exposure pathways are likely to exist.

### 8.1.1 Ecological Setting

A description of Site 12 and a summary of the site history are contained in Section 2. There are no wetland or aquatic habitats on Site 12 and extremely limited areas of terrestrial habitat. The site consists almost entirely of buildings and paved areas, with small patches of mowed grass and landscaped plants located adjacent to some of the buildings. Thus, the quality of available habitat is very low due to the nature and small size of the vegetated areas, and the developed nature of the surrounding landscape.

The North Branch Potomac River is located about 500 feet west of, and about 1,000 feet north of, Site 12 (Figure 2-1). The site is relatively flat. A drainage ditch runs along the southeastern side of the site, between the Building 167 parking area and Building 378. The ditch is a part of the facility-wide Plant 1 Drainage Ditch System which was originally identified as SWMU 27 and investigated as SWMU 27A. Alluvial and bedrock groundwater at the site is thought to flow primarily northeast (see Section 4.3.5) and eventually discharges to the river just west of Site 1. The freshwater habitats present in the river are expected to support a variety of aquatic biota, such as fish and aquatic invertebrates, based on studies conducted in the river as part of the investigation of Site 1 (located on the river downstream of Site 12).

### 8.1.2 Ecological Conceptual Model

Key components of the conceptual model include the identification of potential source areas, transport pathways, exposure media, exposure routes, and receptor groups.

#### 8.1.2.1 Source Areas

The potential source areas associated with Site 12 are discussed in detail in Section 2. The two primary source areas associated with Site 12 are the SWMU 37N wastewater sump and

the former alodine treatment tank (SWMU 52). Both of these structures and associated impacted soil have been removed from the site.

#### 8.1.2.2 Transport Pathways and Exposure Media

A transport pathway describes the mechanisms whereby chemicals may be transported from a source of contamination to ecologically relevant media. These transport pathways are shown on Figure 8-1. Potential contaminant transport pathways that may exist at Site 12 are currently limited to transport to surface water bodies (North Branch Potomac River) via groundwater. Soils at Site 12 were the subject of a previous risk assessment and a removal action (2005) that addressed both unacceptable human health and ecological risks. Sediment in the drainage ditch adjacent to Site 12 was addressed under the SWMU 27A closeout document and, as discussed in Section 2.3.6, this portion of the ditch is considered closed to further investigation and requires no further action under CERCLA.

#### 8.1.2.3 Exposure Pathways and Routes

An exposure pathway links a source of contamination with one or more receptors through exposure via one or more media and exposure routes. Exposure, and thus potential risk, can only occur if complete exposure pathways exist. Figure 8-1 shows the potentially complete exposure pathways to ecological receptors at Site 12.

There are currently no complete exposure pathways to terrestrial receptors at Site 12. Surface runoff pathways via drainage ditches have been addressed as part of the SWMU 27A closeout document and are thus incomplete for the purposes of this ERA. Potentially complete, but indirect, exposure pathways exist to aquatic (e.g., benthic invertebrates and fish) receptors utilizing the portion of the North Branch Potomac River in the downgradient groundwater flow direction. Alluvial and bedrock groundwater flow from the site is thought to be primarily to the northeast, towards the river (see Section 4.3.5), discharging west of Site 1. These aquatic exposure pathways are evaluated by comparing groundwater concentrations from Site 12 wells with surface water screening values, used as a surrogate for potential exposures in the river via the water column (surface water) and/or pore water (sediment). This is likely to result in a conservative evaluation of this potential pathway given the distance between Site 12 and the likely discharge point in the river (a distance of about 1,000 feet) and, as discussed in Section 6.2.2, the significant dilution and dispersion expected prior to discharge. In addition, the potential "contribution" of Site 12 to chemical concentrations in the river is qualitatively evaluated (see Section 8.4.3) for the chemicals of concern identified for the river in the Site 1 River ERA (CH2M HILL, 2008).

An exposure route describes the specific mechanism(s) by which a receptor is exposed to a chemical present in an environmental medium. Applicable exposure routes are depicted on Figure 8-1.

#### 8.1.2.4 Receptors

Lower trophic level receptor species were evaluated in the ERA based on those taxonomic groupings for which screening values have been developed; these groupings and screening values are typically used in most ERAs. As such, specific species of aquatic biota (e.g., fish and macroinvertebrates) were not chosen as receptors; aquatic biota were addressed on a community level via a comparison (of groundwater) to surface water screening values.

Since receptors (and their prey) are not exposed directly to groundwater, upper trophic level receptor (e.g., birds and mammals) exposures via the food web were not included as part of this ERA (this pathway is considered incomplete).

#### 8.1.2.5 Endpoints and Risk Hypotheses

The conclusion of the problem formulation includes the selection of ecological endpoints and risk hypotheses, which are based upon the conceptual model. Table 8-1 lists the assessment endpoints, risk hypotheses, and measurement endpoints used in the ERA, as well as the receptors associated with each endpoint.

### 8.1.3 Summary of Available Analytical Data

The groundwater data considered as part of this RI are discussed in Sections 3 and 5. This RI utilizes groundwater analytical data collected during five sampling events, which took place in July 2003, September 2003, May/June 2005, December 2006, and June 2007. The specific samples used in the RI (and ERA) are listed in Table 8-2. Not all constituents were analyzed for in all of the samples listed in Table 8-2. For samples with field duplicates, the higher of the two concentrations was used (or the detected concentration if the other sample was non-detect) in the screening statistics. Well locations are shown on Figure 3-1. The raw analytical data are provided in Appendix C.

## 8.2 Exposure Estimation

Mean concentrations in groundwater were used in the ERA to evaluate potential exposures associated with contaminant migration from Site 12 to the North Branch Potomac River. The mean concentration was used because groundwater discharge to the river is expected to be diffuse rather than concentrated at particular points in the river and this is best estimated using average concentrations from the available monitoring wells. The nature of potential ecological exposures does not warrant risk characterization based upon maximum concentrations. A conservative dilution factor of 10 was then applied. In the absence of site-specific dilution factors, Buchman (1999) recommends using a dilution factor of 10 to account for the dilution expected during migration to surface water bodies. The maximum HQ, mean HQ, and mean HQ (dilution factor of 10) are included in the Section 8 tables for reference.

With respected to inorganics, only dissolved inorganics data are considered in this ERA. Chemicals in groundwater are most likely to travel dissolved in water rather than adhered to particles because they must travel through soil pores or fractured rock. Similarly, when groundwater discharges to a water body (at which time ecological exposures become possible), the bulk of the discharged chemicals are likely to be dissolved in water since the discharge must pass through the pores in the underlying sediments. Thus, the dissolved concentrations are likely to be more representative of what would be transported via the groundwater than the total concentrations. Once discharged (at which point exposures can occur), the dissolved metal fraction in water is more representative of the bioavailable fraction to aquatic receptors than the total metal fraction (EPA, 1996). This is reflected in how the most recent Ambient Water Quality Criteria have been developed for many inorganics, that is, they are based upon the dissolved fraction.

Because receptors (and their prey) are not exposed directly to groundwater, food web exposures were not calculated based upon groundwater concentrations. Only detected constituents are evaluated in this ERA.

## 8.3 Effects Evaluation

The purpose of the effects evaluation is to establish chemical exposure levels (screening values) that represent conservative thresholds for adverse ecological effects. One set of screening values is typically developed for each selected assessment endpoint.

Medium-specific screening values are established for ecologically relevant media at Site 12. Based upon the conceptual model (Figure 8-1), indirect exposure via groundwater is a potentially complete pathway at Site 12. Although ecological receptors do not typically have direct exposure to groundwater, surface water screening values were compared to analytical groundwater data (with and without dilution factors) in order to provide a conservative evaluation of the potential for significant contaminant transport via groundwater to the North Branch Potomac River. The screening values used in the ERA are listed in Table 8-3. Surface water screening values for several divalent metals were adjusted using a water hardness value of 158 mg/L based upon the mean measured concentration in the North Branch Potomac River (the receiving water body) from the Site 1 ERA (CH2M HILL, 2008). Because the groundwater discharge to the river is expected to occur over a relatively large area, the average hardness is a more suitable value than the lowest-available hardness. Because the groundwater discharge to the river is expected to occur over a relatively large area, the average hardness is a more suitable value than the lowest-available hardness.

## 8.4 Risk Characterization

The risk characterization portion of the ERA uses the information generated during the three previous parts of the ERA (problem formulation, exposure assessment, and effects evaluation) to estimate potential risks to ecological receptors. In this step, arithmetic mean groundwater concentrations are compared with surface water screening values to derive risk estimates using the hazard quotient (HQ) method. HQs are calculated by dividing the constituent concentration in the medium by the corresponding constituent- and medium-specific screening value. HQs exceeding one indicate the potential for unacceptable risk since the constituent concentration (exposure) exceeds the screening value (effect). HQs less than or equal to one indicate that unacceptable risks are unlikely.

### 8.4.1 Alluvial Groundwater

Mean alluvial groundwater concentrations are compared to surface water screening values in Table 8-4. For duplicate samples, the higher of the two concentrations was used in the screening statistics tables.

Based upon this comparison, only barium had a HQ exceeding one based upon detected concentrations and a dilution factor of 10 (HQ = 1.83). However, the screening value for barium, which is a Secondary Chronic Value (SCV) from Suter and Tsao (1996), is very conservative and likely does not reflect the bioavailability of barium in the aquatic environment. Barium compounds have low toxicity to aquatic organisms, with the barium

ion responsible for the toxic effects (Federal Register, 62[2]:366-372, 3 January 1997). In aquatic media, barium compounds are likely to precipitate out of solution as barium sulfate ($BaSO_4$) or barium carbonate ($BaCO_3$) when they react with the sulfate or carbonate present in most surface water. Thus, the barium is rendered essentially non-toxic and does not represent a risk to aquatic organisms. Because of the expected fate of barium in surface waters, barium is not expected to pose an unacceptable risk to receptor populations in the surface water of the river upon discharge.

Two volatile organic compounds, bromodichloromethane and chloroethane, were detected but lacked screening values. Because these constituents were infrequently detected (1 of 38 and 3 of 38 samples, respectively) at concentrations less than the screening values for other, similar compounds, they are not expected to pose an unacceptable risk. A quantitative weight-of-evidence evaluation is not warranted based upon the nature of the potential exposures and the results of the screening.

None of the COPECs discussed in this section are considered significant bioaccumulators.

### 8.4.2 Bedrock Groundwater

Mean bedrock groundwater concentrations are compared to surface water screening values in Table 8-5. For duplicate samples, the higher of the two concentrations was used in the screening statistics tables.

Based upon this comparison, no constituent had a HQ exceeding one based on detected concentrations and a dilution factor of 10. Caprolactam, bromochloromethane, and 1,1,2-trichloro-1,2,2-trifluoroethane were detected but lacked screening values. Because these constituents were infrequently detected (2 of 26, 1 of 37, and 1 of 26 samples, respectively) at concentrations less than the screening values for other, similar compounds, they are not expected to pose an unacceptable risk. A quantitative weight-of-evidence evaluation is not warranted based upon the nature of the potential exposures and the results of the screening.

None of the COPECs discussed in this section are considered significant bioaccumulators.

### 8.4.3 Risk Evaluation

Based upon the results of this ERA, Site 12 is not a significant contributor to contamination in the North Branch Potomac River. This conclusion is based upon the following lines of evidence:

- The lack of screening value exceedances for groundwater samples based upon mean concentrations and a dilution factor of 10, except for barium in alluvial groundwater. Barium is not known to be a site-related constituent (or a chemical of concern in the river) and is unlikely to pose an unacceptable risk in surface water based upon its chemical properties in this medium.
- The hydrogeologic conceptual site model indicates that groundwater flow in both the alluvial and bedrock aquifers is primarily to the northeast and that discharge is ultimately to the North Branch Potomac River just west of Site 1. This area of likely discharge is approximately 1,000 feet from Site 12 and, as discussed in Section 6.2.2, significant dilution and dispersion is expected prior to discharge.

- As discussed in Section 6.3, constituent concentrations in groundwater at Site 12 have been decreasing over time.
- Chemicals of concern in the river sediment (the only medium of potential concern), as identified in the Site 1 ERA for the river (CH2M HILL, 2008), include copper, lead, mercury, nickel, silver, zinc, PAHs, and cis-1,2-DCE. These constituents were associated with Site 1 source areas in the river floodplain and the primary transport route was surface runoff (groundwater was not identified as an important transport pathway). With the exception of nickel in the alluvial aquifer, these constituents were either not detected or did not exceed surface water screening values in Site 12 groundwater. Nickel exceeded in 7 alluvial samples, most notably in MW-8. MW-8 is located in the area of Site 12 that had the highest VOC concentrations (the primary chemicals of concern in groundwater at Site 12). As discussed in Section 5.1.4, it is theorized that the higher levels of VOCs in this area are mobilizing the inorganics. Many of the maximum concentrations of the inorganics occurred in this well. However, nickel is not a site-related constituent based upon known site history and it is expected that the effect would be localized. Except for wells in the immediate site vicinity (MW-01, MW-02, and MW-08), there were no exceedances for nickel.

A quantitative weight-of-evidence evaluation is not warranted based upon the nature of the potential exposures and the results of the screening. Also, none of the "COPCs" discussed in Sections 8.4.1 and 8.4.2 are considered significant bioaccumulators.

## 8.5 Uncertainties

Uncertainties are present in all ERAs because of the limitations of the available data and the need to make certain assumptions and extrapolations based upon incomplete information. The uncertainty in this ERA is mainly attributable to the following factors:

- Duplicate Analyses—When evaluating samples with field duplicates, the value used in the ERA was always the detect when one result was a detect and the duplicate was a non-detect, regardless of whether or not the non-detected value was higher. In these cases, the use of the detect has less uncertainty since it represents an actual measured value (versus an upper limit bound) and the two samples will have identical or similar reporting limits.
- Evaluation of Groundwater—Although ecological receptors are not directly exposed to groundwater, groundwater concentrations were compared to surface water screening values. A dilution factor of 10 (Buchman, 1999) was used in the evaluation because site-specific factors were not available. This introduces some unknown level of uncertainty into the analysis. However, as discussed in Section 6.2.2, significant levels of dilution and dispersion are expected prior to groundwater discharge to the river, suggesting that the dilution factor of 10 is conservative.

## 8.6 Ecological Risk Assessment Conclusions

In conclusion, negligible risks to ecological receptors are expected at Site 12. Based upon current site conditions, there are no complete exposure pathways in terrestrial areas and no

unacceptable risks associated with drainage ditch sediments. Transport of site-related chemicals from Site 12 to the North Branch Potomac River via groundwater is a potential pathway based upon groundwater flow directions. Based upon this evaluation, site-related chemicals in groundwater potentially attributable to Site 12 are unlikely to contribute to an unacceptable risk to aquatic receptors in the river.

**TABLE 8-1**
Assessment Endpoints, Risk Hypotheses, and Measurement Endpoints
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Assessment Endpoint | Risk Hypothesis | Measurement Endpoint | Receptor |
|---|---|---|---|
| Survival, growth, and reproduction of aquatic communities | Are site-related chemical concentrations in groundwater discharging to surface water(North Branch Potomac River) at levels sufficient to adversely effect aquatic communities? | Comparison of chemical concentrations in groundwater with surface water screening values. | Freshwater plants, fish, and aquatic macroinvertebrates |

**TABLE 8-2**
Groundwater Samples Used in the ERA
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Station ID | Sample ID | Sample Date | Type |
|---|---|---|---|
| 12MW01 | AS12-12MW01-R02 | 09/11/03 | Alluvial |
| | AS12-12MW01-0605 | 06/01/05 | Alluvial |
| | AS12-12MW01-1206 | 12/07/06 | Alluvial |
| 12MW02 | AS12-12MW02-R02 | 09/11/03 | Alluvial |
| | AS12-12MW02-R02/DUP | 09/11/03 | Alluvial |
| | AS12-12MW02-0605 | 06/01/05 | Alluvial |
| | AS12-12MW02-1206 | 12/07/06 | Alluvial |
| | AS12-12MW02P-1206 | 12/07/06 | Alluvial |
| 12MW04S | AS12-12MW04S-0605 | 06/01/05 | Shallow Bedrock |
| | AS12-12MW04S-1206 | 12/07/06 | Shallow Bedrock |
| 12MW05D | AS12-12MW05D-0505 | 05/26/05 | Deep Bedrock |
| | AS12-12MW05D-0607 | 06/13/07 | Deep Bedrock |
| 12MW05S | AS12-12MW05S-0505 | 05/26/05 | Shallow Bedrock |
| | AS12-12MW05SP-0505 | 05/26/05 | Shallow Bedrock |
| | AS12-12MW05S-0607 | 06/13/07 | Shallow Bedrock |
| 12MW06 | AS12-12MW06-R01 | 07/10/03 | Alluvial |
| 12MW07D | AS12-12MW07D-0505 | 05/25/05 | Deep Bedrock |
| | AS12-12MW07DP-0505 | 05/25/05 | Deep Bedrock |
| | AS12-12MW07D-0607 | 06/12/07 | Deep Bedrock |
| | AS12-12MW07DP-0607 | 06/12/07 | Deep Bedrock |
| 12MW07S | AS12-12MW07S-0505 | 05/25/05 | Shallow Bedrock |
| | AS12-12MW07S-0607 | 06/12/07 | Shallow Bedrock |
| 12MW08 | AS12-12MW08-R01 | 07/09/03 | Alluvial |
| | AS12-12MW08-R02 | 09/15/03 | Alluvial |
| | AS12-12MW08-R02/DUP | 09/15/03 | Alluvial |
| | AS12-12MW08-0605 | 06/02/05 | Alluvial |
| | AS12-12MW08-1206 | 12/07/06 | Alluvial |
| | AS12-12MW08-0607 | 06/11/07 | Alluvial |
| 12MW09D | AS12-12MW09D-0605 | 06/02/05 | Deep Bedrock |
| | AS12-12MW09DP-0605 | 06/02/05 | Deep Bedrock |
| | AS12-12MW09D-1206 | 12/07/06 | Deep Bedrock |
| | AS12-12MW09D-0607 | 06/11/07 | Deep Bedrock |
| 12MW09S | AS12-12MW09S-0605 | 06/02/05 | Shallow Bedrock |
| | AS12-12MW09S-1206 | 12/07/06 | Shallow Bedrock |
| | AS12-12MW09S-0607 | 06/11/07 | Shallow Bedrock |
| 12MW10 | AS12-12MW10-R01 | 07/09/03 | Alluvial |
| | AS12-12MW10-R02 | 09/12/03 | Alluvial |
| | AS12-12MW10-0505 | 05/27/05 | Alluvial |
| | AS12-12MW10-1206 | 12/07/06 | Alluvial |
| | AS12-12MW10-0607 | 06/12/07 | Alluvial |
| 12MW11D | AS12-12MW11D-0505 | 05/27/05 | Deep Bedrock |
| | AS12-12MW11D-1206 | 12/07/06 | Deep Bedrock |
| | AS12-12MW11D-0607 | 06/12/07 | Deep Bedrock |
| 12MW11S | AS12-12MW11S-0605 | 06/02/05 | Shallow Bedrock |
| | AS12-12MW11S-1206 | 12/07/06 | Shallow Bedrock |
| | AS12-12MW11S-0607 | 06/13/07 | Shallow Bedrock |
| 12MW12 | AS12-12MW12-R02 | 09/11/03 | Alluvial |
| | AS12-12MW12-0505 | 05/24/05 | Alluvial |
| 12MW13S | AS12-12MW13S-0505 | 05/23/05 | Shallow Bedrock |

**TABLE 8-2**
Groundwater Samples Used in the ERA
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Station ID | Sample ID | Sample Date | Type |
|---|---|---|---|
| 12MW14 | AS12-12MW14-R02 | 09/11/03 | Alluvial |
| | AS12-12MW14-0505 | 05/26/05 | Alluvial |
| 12MW15 | AS12-12MW15-R01 | 07/10/03 | Alluvial |
| | AS12-12MW15-R02 | 09/15/03 | Alluvial |
| | AS12-12MW15-0505 | 05/27/05 | Alluvial |
| | AS12-12MW15-1206 | 12/07/06 | Alluvial |
| 12MW16 | AS12-12MW16-R01 | 07/10/03 | Alluvial |
| | AS12-12MW16-R02 | 09/12/03 | Alluvial |
| | AS12-12MW16-0605 | 06/01/05 | Alluvial |
| | AS12-12MW16-1206 | 12/06/06 | Alluvial |
| | AS12-12MW16-0607 | 06/13/07 | Alluvial |
| 12MW17D | AS12-12MW17D-0505 | 05/24/05 | Deep Bedrock |
| | AS12-12MW17D-0607 | 06/12/07 | Deep Bedrock |
| 12MW17S | AS12-12MW17S-0505 | 05/24/05 | Shallow Bedrock |
| | AS12-12MW17S-0607 | 06/12/07 | Shallow Bedrock |
| 12MW18 | AS12-12MW18-R02 | 09/11/03 | Alluvial |
| | AS12-12MW18-0505 | 05/26/05 | Alluvial |
| | AS12-12MW18-0607 | 06/12/07 | Alluvial |
| | AS12-12MW18P-0607 | 06/12/07 | Alluvial |
| 12MW19 | AS12-12MW19-R02 | 09/12/03 | Alluvial |
| | AS12-12MW19-0505 | 05/25/05 | Alluvial |
| | AS12-12MW19-0607 | 06/12/07 | Alluvial |
| 12MW20D | AS12-12MW20D-1206 | 12/07/06 | Deep Bedrock |
| 12MW20S | AS12-12MW20S-1206 | 12/06/06 | Shallow Bedrock |
| 12MW21D | AS12-12MW21D-1206 | 12/06/06 | Deep Bedrock |
| | AS12-12MW21D-0607 | 06/11/07 | Deep Bedrock |
| 12MW21S | AS12-12MW21S-1206 | 12/06/06 | Shallow Bedrock |
| | AS12-12MW21SP-1206 | 12/06/06 | Shallow Bedrock |
| | AS12-12MW21S-0607 | 06/11/07 | Shallow Bedrock |
| 12MW22D | AS12-12MW22D-1206 | 12/06/06 | Deep Bedrock |
| | AS12-12MW22D-0607 | 06/13/07 | Deep Bedrock |
| 12MW22S | AS12-12MW22S-1206 | 12/06/06 | Shallow Bedrock |
| | AS12-12MW22S-0607 | 06/13/07 | Shallow Bedrock |
| 12MW23 | AS12-12MW23-1206 | 12/06/06 | Alluvial |
| | AS12-12MW23-0607 | 06/12/07 | Alluvial |
| | AS12-12MW23P-0607 | 06/12/07 | Alluvial |

NOTES:
Not all constituents were analyzed in all samples.
Field duplicates are shaded. The higher of the two concentrations was used in the screening statistics tables.

**TABLE 8-3**
Screening Values Used in the ERA
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Constituent | Screening Value | Units | Reference | Hardness (mg/L) |
|---|---|---|---|---|
| Aluminum | 87.0 | ug/L | USEPA 2006a | |
| Antimony | 30.0 | ug/L | Suter and Tsao 1996 | |
| Arsenic | 150 | ug/L | USEPA 2006a | |
| Barium | 4.00 | ug/L | Suter and Tsao 1996 | |
| Beryllium | 0.66 | ug/L | Suter and Tsao 1996 | |
| Cadmium (dissolved) | 0.34 | ug/L | USEPA 2006a | 158 |
| Chromium (dissolved) | 11.0 | ug/L | USEPA 2006a | |
| Cobalt | 23.0 | ug/L | Suter and Tsao 1996 | |
| Copper (dissolved) | 13.2 | ug/L | USEPA 2006a | 158 |
| Iron | 1,000 | ug/L | USEPA 2006a | |
| Lead (dissolved) | 4.13 | ug/L | USEPA 2006a | 158 |
| Manganese | 120 | ug/L | Suter and Tsao 1996 | |
| Mercury (dissolved) | 0.77 | ug/L | USEPA 2006a | |
| Nickel (dissolved) | 76.6 | ug/L | USEPA 2006a | 158 |
| Selenium (dissolved) | 4.60 | ug/L | USEPA 2006a | |
| Thallium | 12.0 | ug/L | Suter and Tsao 1996 | |
| Vanadium | 20.0 | ug/L | Suter and Tsao 1996 | |
| Zinc (dissolved) | 174 | ug/L | USEPA 2006a | 158 |
| 2-Methylphenol | 13.0 | ug/L | Suter and Tsao 1996 | |
| bis(2-Ethylhexyl)phthalate | 16.0 | ug/L | USEPA 2006b | |
| Di-n-butylphthalate | 33.0 | ug/L | USEPA 1996 | |
| Naphthalene | 24.0 | ug/L | USEPA 1996 | |
| Nitrobenzene | 270 | ug/L | USEPA 1999 | |
| Perchlorate | 600 | ug/L | USEPA 2002 | |
| Phenol | 110 | ug/L | Suter and Tsao 1996 | |
| 1,1,1-Trichloroethane | 11.0 | ug/L | Suter and Tsao 1996 | |
| 1,1,2,2-Tetrachloroethane | 420 | ug/L | USEPA 1996 | |
| 1,1,2-Trichloroethane | 1,200 | ug/L | Suter and Tsao 1996 | |
| 1,1-Dichloroethane | 47.0 | ug/L | Suter and Tsao 1996 | |
| 1,1-Dichloroethene | 25.0 | ug/L | Suter and Tsao 1996 | |
| 1,2,4-Trichlorobenzene | 110 | ug/L | Suter and Tsao 1996 | |
| 1,2-Dibromo-3-chloropropane | 216 | ug/L | AQUIRE 2002 | |
| 1,2-Dichlorobenzene | 14.0 | ug/L | Suter and Tsao 1996 | |
| 1,2-Dichloropropane | 525 | ug/L | USEPA 1999 | |
| 1,3-Dichlorobenzene | 71.0 | ug/L | Suter and Tsao 1996 | |
| 1,4-Dichlorobenzene | 15.0 | ug/L | Suter and Tsao 1996 | |
| 2-Butanone | 14,000 | ug/L | Suter and Tsao 1996 | |
| 2-Hexanone | 99.0 | ug/L | Suter and Tsao 1996 | |
| 4-Methyl-2-pentanone | 170 | ug/L | Suter and Tsao 1996 | |
| Acetone | 1,500 | ug/L | Suter and Tsao 1996 | |
| Benzene | 130 | ug/L | Suter and Tsao 1996 | |
| Carbon disulfide | 0.92 | ug/L | Suter and Tsao 1996 | |

**TABLE 8-3**
Screening Values Used in the ERA
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Constituent | Screening Value | Units | Reference | Hardness (mg/L) |
|---|---|---|---|---|
| Chlorobenzene | 130 | ug/L | USEPA 1996 | |
| Chloroform | 28.0 | ug/L | Suter and Tsao 1996 | |
| Chloromethane | 5,500 | ug/L | USEPA 1999 | |
| cis-1,2-Dichloroethene | 590 | ug/L | Suter and Tsao 1996 | |
| Cyclohexane | 329 | ug/L | AQUIRE 2002 | |
| Ethylbenzene | 290 | ug/L | USEPA 1996 | |
| Isopropylbenzene | 2.60 | ug/L | USEPA 2006b | |
| Methylcyclohexane | 452 | ug/L | AQUIRE 2002 | |
| Methylene chloride | 2,200 | ug/L | Suter and Tsao 1996 | |
| Tetrachloroethene | 120 | ug/L | USEPA 1996 | |
| Toluene | 9.80 | ug/L | Suter and Tsao 1996 | |
| trans-1,2-Dichloroethene | 590 | ug/L | Suter and Tsao 1996 | |
| Trichloroethene | 350 | ug/L | USEPA 1996 | |
| Vinyl chloride | 930 | ug/L | USEPA 2006b | |
| Xylene, total | 13.0 | ug/L | Suter and Tsao 1996 | |

NOTE:
Surface water screening values were adjusted using a water hardness value of 158 mg/L based upon the mean measured concentration in the North Branch Potomac River (the receiving water body) from the Site 1 ERA

**TABLE 8-4**
Screening Statistics - Site 12 Groundwater (Alluvial) - Detected Constituents
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Constituent | Range of Non-Detect Values | Frequency of Detection | Maximum Concentration Detected | Sample ID of Maximum Detected Concentration | Arithmetic Mean | Standard Deviation of Mean | Screening Value | Frequency of Exceedance | Maximum Hazard Quotient | Mean Hazard Quotient | Mean HQ (DF = 10) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Dissolved Metals (UG/L)** | | | | | | | | | | | |
| Aluminum | 15.1 - 229 | 8 / 26 | 4,210 | AS12-12MW16-R02 | 401 | 878 | 87.0 | 7 / 26 | 48.4 | 4.61 | 0.46 |
| Arsenic | 3.60 - 10.0 | 6 / 26 | 8.90 | AS12-12MW08-R02 | 3.59 | 2.27 | 150 | 0 / 26 | 0.06 | 0.02 | 0.002 |
| Barium | -- - -- | 26 / 26 | 279 | AS12-12MW01-R02 | 73.2 | 62.2 | 4.00 | 26 / 26 | 69.8 | 18.3 | 1.83 |
| Beryllium | 0.08 - 5.00 | 2 / 26 | 0.24 | AS12-12MW18-0607 | 0.44 | 0.90 | 0.66 | 0 / 26 | 0.36 | -- | 0.04 |
| Calcium [1] | -- - -- | 26 / 26 | 321,000 | AS12-12MW08-0607 | 190,331 | 54,081 | NSV | -- / -- | -- | -- | -- |
| Chromium | 0.60 - 10.0 | 9 / 26 | 19.6 | AS12-12MW16-R02 | 2.17 | 3.85 | 11.0 | 1 / 26 | 1.78 | 0.20 | 0.02 |
| Chromium (hexavalent) | 10.0 - 10.0 | 1 / 20 | 11.0 | AS12-12MW08-0605 | 5.30 | 1.34 | 11.0 | 0 / 20 | 1.00 | 0.48 | 0.05 |
| Cobalt | 0.70 - 50.0 | 11 / 26 | 15.8 | AS12-12MW08-R02 | 3.99 | 6.09 | 23.0 | 0 / 26 | 0.69 | 0.17 | 0.02 |
| Iron | 16.3 - 100 | 16 / 26 | 50,300 | AS12-12MW08-R02 | 6,451 | 12,600 | 1,000 | 10 / 26 | 50.3 | 6.45 | 0.65 |
| Lead | 1.80 - 10.0 | 1 / 26 | 2.40 | AS12-12MW19-0607 | 1.79 | 1.63 | 4.13 | 0 / 26 | 0.58 | 0.43 | 0.04 |
| Magnesium [1] | -- - -- | 26 / 26 | 90,300 | AS12-12MW08-0607 | 48,888 | 19,241 | NSV | -- / -- | -- | -- | -- |
| Manganese | 13.4 - 13.4 | 25 / 26 | 5,060 | AS12-12MW02-0605 | 1,060 | 1,532 | 120 | 16 / 26 | 42.2 | 8.83 | 0.88 |
| Nickel | 1.20 - 1.20 | 25 / 26 | 318 | AS12-12MW08-0605 | 49.9 | 87.4 | 76.6 | 7 / 26 | 4.15 | 0.65 | 0.07 |
| Potassium [1] | -- - -- | 26 / 26 | 3,620 | AS12-12MW10-R02 | 2,190 | 825 | NSV | -- / -- | -- | -- | -- |
| Selenium | 2.60 - 35.0 | 1 / 26 | 3.80 | AS12-12MW02-R02 | 5.32 | 6.83 | 4.60 | 0 / 26 | 0.83 | -- | 0.08 |
| Sodium [1] | -- - -- | 26 / 26 | 106,000 | AS12-12MW08-R02 | 34,783 | 25,038 | NSV | -- / -- | -- | -- | -- |
| Thallium | 4.60 - 25.0 | 1 / 26 | 6.20 | AS12-12MW08-0607 | 4.66 | 3.97 | 12.0 | 0 / 26 | 0.52 | 0.39 | 0.04 |
| Vanadium | 0.70 - 50.0 | 4 / 26 | 7.00 | AS12-12MW16-R02 | 5.65 | 9.73 | 20.0 | 0 / 26 | 0.35 | 0.28 | 0.03 |
| Zinc | 3.20 - 47.8 | 2 / 26 | 6.90 | AS12-12MW12-0505 | 5.70 | 4.71 | 174 | 0 / 26 | 0.04 | 0.03 | 0.003 |
| **Semivolatile Organic Compounds (UG/L)** | | | | | | | | | | | |
| 4-Methylphenol | 5.00 - 12.0 | 1 / 26 | 2.90 | AS12-12MW08-R02 | 4.30 | 1.33 | 13.0 | 0 / 26 | 0.22 | -- | 0.02 |
| Di-n-butylphthalate | 5.00 - 12.0 | 2 / 26 | 10.0 | AS12-12MW08-R02 | 4.42 | 1.80 | 33.0 | 0 / 26 | 0.30 | 0.13 | 0.01 |
| Naphthalene | 5.00 - 12.0 | 1 / 26 | 1.30 | AS12-12MW08-R02 | 4.24 | 1.43 | 24.0 | 0 / 26 | 0.05 | -- | 0.01 |
| Phenol | 5.00 - 12.0 | 1 / 26 | 10.0 | AS12-12MW08-R02 | 4.57 | 1.71 | 110 | 0 / 26 | 0.09 | 0.04 | 0.004 |
| bis(2-Ethylhexyl)phthalate | 1.30 - 11.0 | 3 / 26 | 2.50 | AS12-12MW08-0605 | 2.94 | 1.62 | 16.0 | 0 / 26 | 0.16 | -- | 0.02 |
| **Explosives (UG/L)** | | | | | | | | | | | |
| Nitrobenzene | 0.26 - 12.0 | 1 / 38 | 0.044 | AS12-12MW15-0505 | 2.51 | -- | 270 | 0 / 17 | 0.0002 | -- | 0.00002 |
| Perchlorate | 0.061 - 5.00 | 3 / 26 | 13.0 | AS12-12MW08-R02 | 1.66 | 2.46 | 600 | 0 / 26 | 0.02 | 0.003 | 0.0003 |
| **Volatile Organic Compounds (UG/L)** | | | | | | | | | | | |
| 1,1,1-Trichloroethane | 0.50 - 10.0 | 2 / 38 | 11.0 | AS12-12MW01-R02 | 1.44 | 2.44 | 11.0 | 1 / 38 | 1.00 | 0.13 | 0.01 |

NSV - No Screening Value
1 - Macronutrient - Not considered to be a COPC

**TABLE 8-4**
Screening Statistics - Site 12 Groundwater (Alluvial) - Detected Constituents
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Constituent | Range of Non-Detect Values | Frequency of Detection | Maximum Concentration Detected | Sample ID of Maximum Detected Concentration | Arithmetic Mean | Standard Deviation of Mean | Screening Value | Frequency of Exceedance | Maximum Hazard Quotient | Mean Hazard Quotient | Mean HQ (DF = 10) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,1,2,2-Tetrachloroethane | 0.50 - 10.0 | 1 / 38 | 3.20 | AS12-12MW10-1206 | 1.11 | 1.77 | 420 | 0 / 38 | 0.01 | 0.003 | 0.0003 |
| 1,1,2-Trichloroethane | 0.50 - 10.0 | 3 / 38 | 3.40 | AS12-12MW10-1206 | 1.14 | 1.77 | 1,200 | 0 / 38 | 0.003 | 0.001 | 0.0001 |
| 1,1-Dichloroethane | 0.50 - 10.0 | 22 / 38 | 42.0 | AS12-12MW01-R02 | 4.41 | 7.56 | 47.0 | 0 / 38 | 0.89 | 0.09 | 0.01 |
| 1,1-Dichloroethene | 0.50 - 10.0 | 3 / 38 | 4.20 | AS12-12MW01-R02 | 1.26 | 1.91 | 25.0 | 0 / 38 | 0.17 | 0.05 | 0.01 |
| 1,2,4-Trichlorobenzene | 0.50 - 10.0 | 1 / 38 | 1.30 | AS12-12MW10-1206 | 1.06 | 1.74 | 110 | 0 / 38 | 0.012 | 0.010 | 0.001 |
| 1,2-Dibromo-3-chloropropane | 0.50 - 10.0 | 1 / 26 | 3.80 | AS12-12MW10-1206 | 1.17 | 1.80 | 216 | 0 / 26 | 0.018 | 0.005 | 0.0005 |
| 1,2-Dichlorobenzene | 0.50 - 10.0 | 12 / 38 | 87.0 | AS12-12MW02-1206 | 7.05 | 20.3 | 14.0 | 3 / 38 | 6.21 | 0.50 | 0.05 |
| 1,2-Dichloropropane | 0.50 - 10.0 | 1 / 38 | 0.96 | AS12-12MW14-0505 | 1.18 | 1.85 | 525 | 0 / 38 | 0.002 | -- | 0.0002 |
| 1,3-Dichlorobenzene | 0.50 - 10.0 | 1 / 38 | 0.76 | AS12-12MW02-R02 | 1.17 | 1.85 | 71.0 | 0 / 38 | 0.011 | -- | 0.0011 |
| 1,4-Dichlorobenzene | 0.50 - 10.0 | 3 / 38 | 2.10 | AS12-12MW02-0605 | 1.14 | 1.74 | 15.0 | 0 / 38 | 0.14 | 0.08 | 0.008 |
| 2-Hexanone | 5.00 - 10.0 | 1 / 38 | 2.00 | AS12-12MW23-0607 | 2.95 | 0.99 | 99.0 | 0 / 38 | 0.02 | 0.03 | 0.003 |
| 4-Methyl-2-pentanone | 5.00 - 10.0 | 2 / 38 | 5.10 | AS12-12MW01-R02 | 3.07 | 1.05 | 170 | 0 / 38 | 0.030 | 0.018 | 0.0018 |
| Acetone | 1.50 - 10.0 | 3 / 34 | 38.0 | AS12-12MW23-1206 | 3.75 | 6.18 | 1,500 | 0 / 34 | 0.025 | 0.0025 | 0.00025 |
| Benzene | 0.50 - 10.0 | 6 / 38 | 1.80 | AS12-12MW02-0605 | 1.03 | 1.61 | 130 | 0 / 38 | 0.014 | 0.008 | 0.0008 |
| Bromodichloromethane | 0.50 - 10.0 | 1 / 38 | 0.61 | AS12-12MW14-0505 | 1.17 | 1.85 | NSV | -- / -- | NSV | NSV | NSV |
| Carbon disulfide | 0.31 - 10.0 | 6 / 38 | 1.10 | AS12-12MW06-R01 | 1.27 | 1.81 | 0.92 | 1 / 38 | 1.20 | -- | 0.12 |
| Chlorobenzene | 0.50 - 10.0 | 7 / 37 | 94.0 | AS12-12MW02-1206 | 5.10 | 17.0 | 130 | 0 / 37 | 0.72 | 0.04 | 0.004 |
| Chloroethane | 0.50 - 10.0 | 3 / 38 | 8.40 | AS12-12MW08-R01 | 1.48 | 2.19 | NSV | -- / -- | NSV | NSV | NSV |
| Chloroform | 0.50 - 10.0 | 1 / 38 | 2.20 | AS12-12MW14-0505 | 1.21 | 1.85 | 28.0 | 0 / 38 | 0.079 | 0.043 | 0.0043 |
| Cyclohexane | 0.50 - 10.0 | 8 / 38 | 370 | AS12-12MW08-R02 | 22.6 | 76.5 | 329 | 1 / 38 | 1.12 | 0.07 | 0.007 |
| Ethylbenzene | 0.50 - 10.0 | 5 / 38 | 53.0 | AS12-12MW08-R01 | 3.71 | 10.8 | 290 | 0 / 38 | 0.18 | 0.01 | 0.001 |
| Isopropylbenzene | 0.50 - 10.0 | 4 / 38 | 4.20 | AS12-12MW08-R02 | 1.40 | 1.95 | 2.60 | 2 / 38 | 1.62 | 0.54 | 0.054 |
| Methylcyclohexane | 0.50 - 10.0 | 3 / 38 | 3.40 | AS12-12MW08-R01 | 1.34 | 1.90 | 452 | 0 / 38 | 0.008 | 0.003 | 0.0003 |
| Methylene chloride | 0.50 - 11.0 | 3 / 38 | 2,900 | AS12-12MW01-R02 | 78.9 | 470 | 2,200 | 1 / 38 | 1.32 | 0.04 | 0.004 |
| Tetrachloroethene | 0.50 - 10.0 | 5 / 38 | 2.00 | AS12-12MW01-R02 | 1.05 | 1.61 | 120 | 0 / 38 | 0.017 | 0.009 | 0.0009 |
| Toluene | 0.50 - 10.0 | 3 / 38 | 20.0 | AS12-12MW08-R02 | 2.06 | 3.99 | 9.80 | 2 / 38 | 2.04 | 0.21 | 0.02 |
| Trichloroethene | 0.50 - 10.0 | 24 / 38 | 24.0 | AS12-12MW18-R02 | 2.93 | 4.75 | 350 | 0 / 38 | 0.07 | 0.008 | 0.0008 |
| Vinyl chloride | 0.50 - 10.0 | 13 / 38 | 8.60 | AS12-12MW01-R02 | 2.03 | 2.48 | 930 | 0 / 38 | 0.01 | 0.002 | 0.0002 |
| Xylene, total | 0.50 - 10.0 | 2 / 38 | 11.0 | AS12-12MW08-R02 | 1.66 | 2.70 | 13.0 | 0 / 38 | 0.85 | 0.13 | 0.01 |
| cis-1,2-Dichloroethene | 0.50 - 10.0 | 21 / 38 | 52.0 | AS12-12MW02-R02 | 5.19 | 9.79 | 590 | 0 / 38 | 0.09 | 0.01 | 0.001 |
| trans-1,2-Dichloroethene | 0.50 - 10.0 | 16 / 38 | 27.0 | AS12-12MW01-R02 | 2.32 | 4.57 | 590 | 0 / 38 | 0.05 | 0.004 | 0.0004 |

NSV - No Screening Value
1 - Macronutrient - Not considered to be a COPC

**TABLE 8-5**
Screening Statistics - Site 12 Groundwater (Bedrock) - Detected Constituents
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Constituent | Range of Non-Detect Values | Frequency of Detection | Maximum Concentration Detected | Sample ID of Maximum Detected Concentration | Arithmetic Mean | Standard Deviation of Mean | Screening Value | Frequency of Exceedance | Maximum Hazard Quotient | Mean Hazard Quotient | Mean HQ (DF = 10) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Dissolved Metals (UG/L)** | | | | | | | | | | | |
| Aluminum | 40.3 - 200 | 3 / 26 | 1,100 | AS12-12MW21S-0607 | 121 | 232 | 87.0 | 2 / 26 | 12.6 | 1.39 | 0.14 |
| Antimony | 2.80 - 60.0 | 2 / 26 | 4.00 | AS12-12MW07D-0505 | 17.0 | 14.4 | 30.0 | 0 / 26 | 0.13 | -- | 0.013 |
| Arsenic | 3.60 - 10.0 | 5 / 26 | 7.30 | AS12-12MW07S-0505 | 3.71 | 1.68 | 150 | 0 / 26 | 0.049 | 0.025 | 0.0025 |
| Barium | -- - -- | 26 / 26 | 59.8 | AS12-12MW17S-0505 | 34.7 | 13.2 | 4.00 | 26 / 26 | 15.0 | 8.67 | 0.87 |
| Beryllium | 0.10 - 5.00 | 1 / 26 | 0.36 | AS12-12MW11D-0607 | 1.29 | 1.24 | 0.66 | 0 / 26 | 0.55 | -- | 0.05 |
| Calcium [1] | -- - -- | 26 / 26 | 392,000 | AS12-12MW04S-0605 | 189,962 | 107,641 | NSV | -- / -- | -- | -- | -- |
| Chromium | 0.60 - 10.0 | 9 / 26 | 3.00 | AS12-12MW07D-0505 | 1.46 | 1.66 | 11.0 | 0 / 26 | 0.27 | 0.13 | 0.013 |
| Cobalt | 0.70 - 50.0 | 4 / 26 | 1.70 | AS12-12MW09S-0607 | 9.04 | 11.8 | 23.0 | 0 / 26 | 0.07 | -- | 0.007 |
| Iron | 16.3 - 100 | 15 / 26 | 3,460 | AS12-12MW09S-0607 | 654 | 907 | 1,000 | 6 / 26 | 3.46 | 0.65 | 0.065 |
| Lead | 1.80 - 10.0 | 1 / 26 | 2.30 | AS12-12MW21S-0607 | 3.00 | 2.05 | 4.13 | 0 / 26 | 0.56 | -- | 0.056 |
| Magnesium [1] | -- - -- | 26 / 26 | 139,000 | AS12-12MW04S-0605 | 68,408 | 35,268 | NSV | -- / -- | -- | -- | -- |
| Manganese | 1.00 - 2.70 | 23 / 26 | 621 | AS12-12MW09S-0605 | 54.6 | 120 | 120 | 1 / 26 | 5.18 | 0.46 | 0.046 |
| Mercury | 0.10 - 0.20 | 2 / 26 | 0.11 | AS12-12MW09D-0605 | 0.078 | 0.026 | 0.77 | 0 / 26 | 0.14 | 0.10 | 0.01 |
| Nickel | 1.20 - 40.0 | 18 / 26 | 39.5 | AS12-12MW09S-0607 | 6.32 | 9.53 | 76.6 | 0 / 26 | 0.52 | 0.08 | 0.008 |
| Potassium [1] | -- - -- | 26 / 26 | 15,200 | AS12-12MW11S-0605 | 3,695 | 2,756 | NSV | -- / -- | -- | -- | -- |
| Selenium | 2.60 - 35.0 | 3 / 26 | 4.10 | AS12-12MW17S-0505 | 10.3 | 7.92 | 4.60 | 0 / 26 | 0.89 | -- | 0.09 |
| Sodium [1] | -- - -- | 26 / 26 | 34,100 | AS12-12MW17S-0607 | 12,160 | 9,696 | NSV | -- / -- | -- | -- | -- |
| Thallium | 4.60 - 25.0 | 1 / 26 | 5.80 | AS12-12MW21S-0607 | 7.69 | 4.97 | 12.0 | 0 / 26 | 0.48 | -- | 0.05 |
| Zinc | 0.60 - 41.4 | 3 / 26 | 5.40 | AS12-12MW11D-0505 | 6.67 | 4.81 | 174 | 0 / 26 | 0.031 | -- | 0.003 |
| **Semivolatile Organic Compounds (UG/L)** | | | | | | | | | | | |
| Caprolactam | 10.0 - 11.0 | 2 / 26 | 1.90 | AS12-12MW05S-0505 | 4.93 | 1.03 | NSV | -- / -- | NSV | NSV | NSV |
| Di-n-butylphthalate | 1.50 - 11.0 | 2 / 26 | 1.80 | AS12-12MW05S-0505 | 4.75 | 1.29 | 33.0 | 0 / 26 | 0.055 | -- | 0.005 |
| bis(2-Ethylhexyl)phthalate | 1.60 - 16.0 | 3 / 26 | 21.0 | AS12-12MW09D-0605 | 3.72 | 4.06 | 16.0 | 1 / 26 | 1.31 | 0.23 | 0.023 |
| **Explosives (UG/L)** | | | | | | | | | | | |
| Perchlorate | 0.061 - 5.00 | 1 / 26 | 0.40 | AS12-12MW17S-0607 | 0.67 | 0.81 | 600 | 0 / 26 | 0.001 | 0.0011 | 0.00011 |
| **Volatile Organic Compounds (UG_L)** | | | | | | | | | | | |
| 1,1,1-Trichloroethane | 0.50 - 10.0 | 2 / 37 | 2.00 | AS12-12MW09S-0605 | 1.74 | 2.18 | 11.0 | 0 / 37 | 0.18 | 0.16 | 0.016 |
| 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-11 | 0.50 - 10.0 | 1 / 37 | 3.60 | AS12-12MW13S-0505 | 1.75 | 2.21 | NSV | -- / -- | NSV | NSV | NSV |

NSV - No Screening Value
1 - Macronutrient - Not considered to be a COPC

**TABLE 8-5**
Screening Statistics - Site 12 Groundwater (Bedrock) - Detected Constituents
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Constituent | Range of Non-Detect Values | Frequency of Detection | Maximum Concentration Detected | Sample ID of Maximum Detected Concentration | Arithmetic Mean | Standard Deviation of Mean | Screening Value | Frequency of Exceedance | Maximum Hazard Quotient | Mean Hazard Quotient | Mean HQ (DF = 10) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,1-Dichloroethane | 0.50 - 10.0 | 6 / 37 | 9.00 | AS12-12MW09S-0607 | 2.09 | 2.60 | 47.0 | 0 / 37 | 0.19 | 0.044 | 0.004 |
| 1,1-Dichloroethene | 0.50 - 10.0 | 2 / 37 | 0.61 | AS12-12MW09S-0607 | 1.68 | 2.19 | 25.0 | 0 / 37 | 0.024 | -- | 0.002 |
| 2-Butanone | 5.00 - 10.0 | 1 / 37 | 7.90 | AS12-12MW20D-1206 | 3.32 | 1.36 | 14,000 | 0 / 37 | 0.001 | 0.0002 | 0.00002 |
| 2-Hexanone | 5.00 - 10.0 | 4 / 37 | 3.30 | AS12-12MW09D-0607 | 3.26 | 1.16 | 99.0 | 0 / 37 | 0.033 | 0.033 | 0.0033 |
| Acetone | 5.00 - 10.0 | 5 / 37 | 16.0 | AS12-12MW22D-1206 | 3.81 | 2.48 | 1,500 | 0 / 37 | 0.011 | 0.0025 | 0.00025 |
| Bromochloromethane | 0.50 - 0.50 | 1 / 26 | 1.10 | AS12-12MW09S-0605 | 0.28 | 0.17 | NSV | -- / -- | NSV | NSV | NSV |
| Carbon disulfide | 0.50 - 10.0 | 5 / 37 | 10.0 | AS12-12MW20D-1206 | 1.79 | 2.47 | 0.92 | 3 / 37 | 10.9 | 1.94 | 0.19 |
| Chloromethane | 0.50 - 10.0 | 1 / 37 | 1.40 | AS12-12MW09S-0605 | 1.69 | 2.19 | 5,500 | 0 / 37 | 0.0003 | -- | 0.00003 |
| Cyclohexane | 0.50 - 10.0 | 5 / 37 | 2.80 | AS12-12MW09S-0607 | 1.61 | 2.04 | 329 | 0 / 37 | 0.009 | 0.005 | 0.0005 |
| Ethylbenzene | 0.50 - 10.0 | 1 / 37 | 0.42 | AS12-12MW09S-0607 | 1.67 | 2.20 | 290 | 0 / 37 | 0.0014 | -- | 0.00014 |
| Methylene chloride | 0.43 - 98.0 | 8 / 37 | 4,400 | AS12-12MW09S-0605 | 149 | 725 | 2,200 | 1 / 37 | 2.00 | 0.07 | 0.007 |
| Tetrachloroethene | 0.50 - 10.0 | 1 / 37 | 1.40 | AS12-12MW09S-0605 | 1.69 | 2.19 | 120 | 0 / 37 | 0.012 | -- | 0.0012 |
| Toluene | 0.50 - 10.0 | 4 / 37 | 3.10 | AS12-12MW09S-0605 | 1.58 | 2.05 | 9.80 | 0 / 37 | 0.32 | 0.16 | 0.016 |
| Trichloroethene | 0.50 - 10.0 | 18 / 37 | 8.90 | AS12-12MW07S-0505 | 2.07 | 2.16 | 350 | 0 / 37 | 0.025 | 0.0059 | 0.00059 |
| Xylene, total | 0.50 - 10.0 | 1 / 37 | 0.62 | AS12-12MW09S-0607 | 1.67 | 2.20 | 13.0 | 0 / 37 | 0.048 | -- | 0.0048 |
| cis-1,2-Dichloroethene | 0.50 - 10.0 | 6 / 37 | 11.0 | AS12-12MW09S-0607 | 2.09 | 2.60 | 590 | 0 / 37 | 0.019 | 0.0035 | 0.00035 |
| trans-1,2-Dichloroethene | 0.50 - 10.0 | 3 / 37 | 3.10 | AS12-12MW09S-0607 | 1.73 | 2.12 | 590 | 0 / 37 | 0.0053 | 0.0029 | 0.00029 |

NSV - No Screening Value
1 - Macronutrient - Not considered to be a COPC

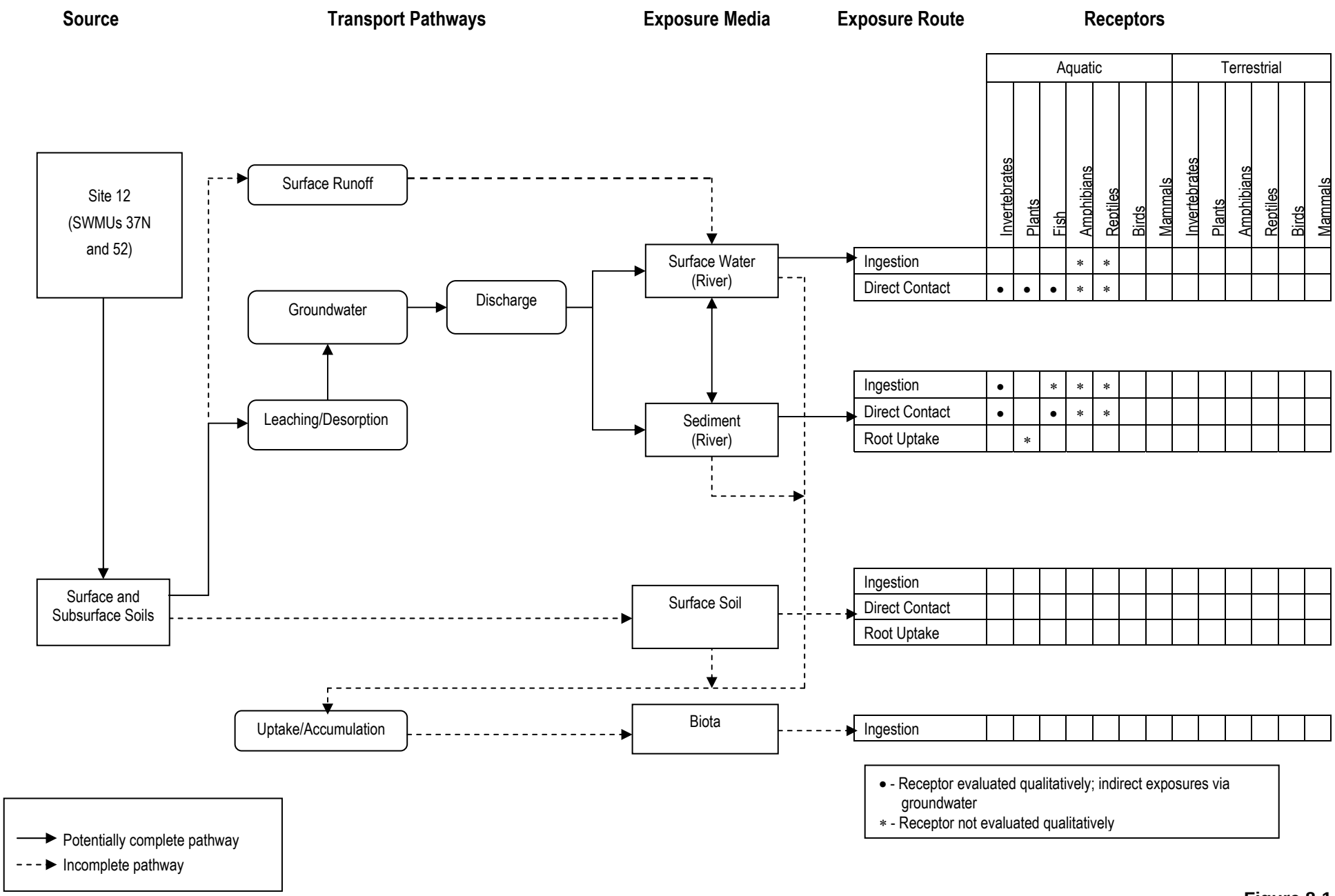



**Figure 8-1**
Ecological Conceptual Model
Allegany Ballistics Laboratory

SECTION 9

# Conclusions and Recommendations

This Section presents a summary of the findings of the RI conducted at Site 12, specifically related to the nature and extent of contamination, contaminant fate and transport, the human health and ecological risk assessments. Conclusions and recommendations based upon these findings are also presented.

## 9.1 Nature and Extent of Contamination

### 9.1.1 Soil

Soil analytical results from the Phase I, II, and III SWMU/AOC investigations at Site 12 indicated that the primary human health and ecological risks were associated with impacted shallow soils (<2 feet), near the locations of SWMU 37N and SWMU 52, as discussed in Section 2 (CH2M HILL, 2004; CH2M HILL, 2004b). A soil removal action at Site 12 was completed in 2005. This removal action included the removal of approximately 237 tons of soil from the site, collecting confirmatory soil samples, and performing site restoration activities (CH2M HILL, 2005b). The soil excavation extended to a depth of approximately 2 feet and encompassed the entire area of defined soil impacts, including the former location of SWMUs 37N and 52.

Average concentrations of VOCs, SVOCs, and the metals cadmium and chromium were detected at concentrations below cleanup goals. Mercury was detected in three side wall samples at concentrations ranging from 5.8 to 67.2 mg/kg. The cleanup goal for mercury was 0.31 mg/kg. The elevated mercury appeared to be present in a localized area near the former alodine treatment tank. Mercury was identified as a COC based upon potential exposure to ecological receptors. The detected concentrations are not expected to pose an unacceptable risk to human receptors and there is a limited pathway present to ecological receptors. Based upon these factors, in May 2005, the ABL Partnering Team determined that no additional removal action was required for soil (CH2M HILL, 2005b).

### 9.1.2 Sediment

Sediment samples were collected from the drainage ditch that runs along the southeastern side of Site 12. Analytical data for the sediment samples are presented in the Phase III/IV investigation report and the results were subjected to human health risk screening, as presented in the SWMU/AOC Closeout Documentation (CH2M HILL, 2005c; CH2M HILL, 2002a). Results from the risk-screening indicated that sediment located within SWMU 27A poses no unacceptable risk to human health and the environment (CH2M HILL, 2002a). Consequently, no further action was necessary for select portions of SWMU 27A, which included the ditch at Site 12.

### 9.1.3 Groundwater

The extent of the TCE groundwater plume, as determined by monitoring well results, is generally similar to the plume extent that was defined during the Phase III Groundwater Investigation. The results revealed elevated concentrations of TCE in the vicinity of Building 167 and the former location of SWMU 37N.

The extent of the MC groundwater plume is also similar to results of the Phase III Investigation. MC was previously detected in wells 12MW01, 12MW08, 12MW21S/D, and 12MW22S/D, and was detected sporadically in well 12MW09S; all of which were located near former SWMU 37N. The MC plume does not appear to be vertically stratified, but the average concentration of MC is highest in samples obtained from shallow bedrock monitoring wells. However, the elevated average concentration in the shallow bedrock wells is likely skewed by the relatively high concentration of MC detected in 12MW09S.

1,2-Dibromo-3-chloropropane, a risk driver, was detected only once at an estimated concentration in a single alluvial groundwater sample. This constituent was not detected during any of the previous sampling events leading up the RI, nor during other confirmatory sampling events following the detection. Therefore, this single detection was not confirmed and it does not appear that this compound is present in Site 12 groundwater.

The RI data support the conclusion that former SWMU 37N was a primary source of groundwater contamination at Site 12. Specifically, this conclusion is supported by the fact that the largest number and highest concentration of VOC detections were collected from monitoring wells located near the former SWMU. The nature of the constituents detected in these wells is generally consistent with the historic use of SWMU 37N, as a sump that received wastewater from operations in Building 167. These building operations included the distillation and storage of solvents that contained TCE and MC. SWMU 37N also likely received waste water from alodining operations as evidenced by hexavalent chromium and elevated chromium detections in wells located near the former SWMU. As stated in Section 2, SWMU 37N was removed in November 2000.

It is not definitively known if SWMU 37N was the only source area for Site 12 groundwater contamination. The Phase III Groundwater Investigation results suggest that the floor drains inside of Building 167 may have served as a source for an alluvial TCE plume centered beneath the building. However, the RI results do not suggest the presence of two distinct plumes. The most recent groundwater data indicate that TCE at low concentrations near or below its MCL downgradient of Building 167. This TCE may represent the remnants of a plume sourced beneath Building 167 or sourced at SWMU 37N.

A major difference between the Phase III Investigation results and the RI results is the magnitude of the TCE and MC concentrations. The concentrations of TCE and MC are much lower in samples collected in support of the RI, especially the more recent results. While some of the decrease in constituent concentrations may be attributed to differences in sampling methodology, the analytical results from the RI show a decreasing trend over the course of the investigation.

The analytical data presented in this section support the CSMs presented in Section 4. The hydrogeologic CSM for Site 12 suggests that alluvial groundwater can move rather rapidly beneath the site and that the alluvial groundwater is recharged by clean bedrock

groundwater. Upwelling of clean bedrock groundwater flowing from the mountains to the south may recharge the alluvium and bedrock aquifers along the eastern (source area) side of Site 12. This would cause contaminated groundwater to flow to the west. This groundwater would then be captured by the highly transmissive bedrock fractures in the northwestern portion of the site and subsequently transported to the northeast, eventually discharging to the North Branch Potomac River.

## 9.2 Contaminant Fate and Transport

The conditions encountered at Site 12 appear to promote attenuation of contaminant concentrations., as evidenced by a general decrease in concentrations throughout the RI monitoring period. Although not definitive, the decrease coincides with the source removal activities conducted at Site 12 in 2000 and 2005 (CH2M HILL, 2005b; CH2M HILL, 2005d).

The attenuation of constituent concentrations may be attributed to a number of physical and chemical processes discussed in Section 6. The recharge of groundwater in the eastern portion of the site provides a source of clean groundwater to the alluvial and bedrock aquifers, which serves to disperse and dilute constituent concentrations beneath the former source areas, thus affecting the contaminant concentrations. This natural condition provides a means to flush contaminants out of the bedrock aquifer and into the alluvial aquifer. Once in the alluvial aquifer the VOCs are more likely to volatilize, become further diluted or degraded and the inorganics are more likely to adsorb to soil particles and/or be transformed.

Furthermore, dilution also occurs in the northwest portion of the site where relatively large bedrock fractures have been encountered. In this discharge area, alluvial and bedrock groundwater is transported rapidly away from the site via fracture flow in the bedrock and eventually discharge to the North Branch Potomac River. The North branch Potomac River offers the only pathway for exposure to groundwater by offsite receptors. Based upon low levels of VOCs downgradient of Site 12, it is unlikely that detectable levels of these compounds are being discharged to the river. Because of the complex, interconnected, and transmissive characteristics of fractures in bedrock in the vicinity of Site 12, constituents that migrate from the former source areas are likely to be rapidly attenuated through advection, dilution, and dispersion.

## 9.3 Human Health Risk Assessment

The risk assessment was conducted to evaluate the potential human health risks associated with Site 12 alluvial and bedrock aquifer groundwater based on potential and unlikely receptor populations and exposure scenarios, if no remedial action is implemented. The future land use exposure routes include:

- Construction Worker: dermal contact with and inhalation of volatiles from alluvial aquifer groundwater.
- On-site resident (adult and child): ingestion of alluvial and bedrock aquifer groundwater, dermal contact with alluvial and bedrock aquifer groundwater, and inhalation (adults only) of volatiles from alluvial and bedrock aquifer groundwater.

There are no carcinogenic risks or noncarcinogenic hazards that exceed EPA target levels (total HI above 1 and total carcinogenic risk above $10^{-4}$) for a construction worker exposed to alluvial groundwater during excavation and construction workers activities. Potable use of either alluvial or bedrock aquifer groundwater could result in carcinogenic risks and noncarcinogenic hazards that exceed EPA target levels, as summarized below.

The risk drivers for potable use of alluvial aquifer groundwater are as follows:

- 1,2-Dibromo-3-chloropropane
- Arsenic
- Manganese
- Thallium

1,2-Dibromo-3-chloropropane was only detected once, at an estimated concentration that was not confirmed. Therefore it does not appear that this compound is present in Site 12 groundwater, as discussed in Sections 5 and 7.

The risk drivers for potable use of bedrock aquifer groundwater are as follows:

- Arsenic
- Chromium
- Manganese
- Thallium

The property is currently owned by the government and the proposed future use of the site is expected to remain the same as the current use. Therefore, future exposure to groundwater is unlikely. It was conservatively assumed that groundwater from the alluvial aquifer and bedrock aquifer at the site may be used as a potable water supply in the future.

## 9.4 Ecological Risk Assessment

Negligible risks to ecological receptors are expected at Site 12. Based upon current site conditions, there are no complete exposure pathways in terrestrial areas and no unacceptable risks associated with drainage ditch sediments. Transport of site-related chemicals from Site 12 to the North Branch Potomac River via groundwater is a potential pathway based upon groundwater flow directions. However, based upon the concentrations detected and their distance form the river, site-related chemicals in groundwater potentially attributable to Site 12 are unlikely to pose an unacceptable risk to aquatic receptors in the river.

## 9.5 Conclusions

Based upon the findings summarized above, the source area removal actions at Site 12 were effective at removing the continuing sources in soil and reducing concentrations of site related contamination in groundwater. There are no current or planned uses of the alluvial or bedrock aquifers for industrial or residential purposes. The source removal and associated reduction in contaminant mass, coupled with the lack of current or planned use of the aquifer at Site 12 and the ongoing natural attenuation processes, suggest that the source area removal actions were successful at improving groundwater quality at Site 12.

## 9.6 Recommendations

Because risks were identified for potable of Site 12 groundwater and there are MCL exceedances, it is recommended that a feasibility study be completed. The feasibility study should consider monitored natural attenuation as a viable groundwater remedy. It is also recommended that the vapor intrusion of site-related contaminants into facility structures (which is being evaluated under a separate report) be considered in the remedial decision for Site 12, as applicable.

SECTION 10

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# Appendix A
# Soil Boring Logs and Well Construction Diagrams

CH2MHILL

PROJECT NUMBER: 152786.FI.FI

WELL NUMBER: 1EW35

# WELL COMPLETION DIAGRAM

PROJECT:

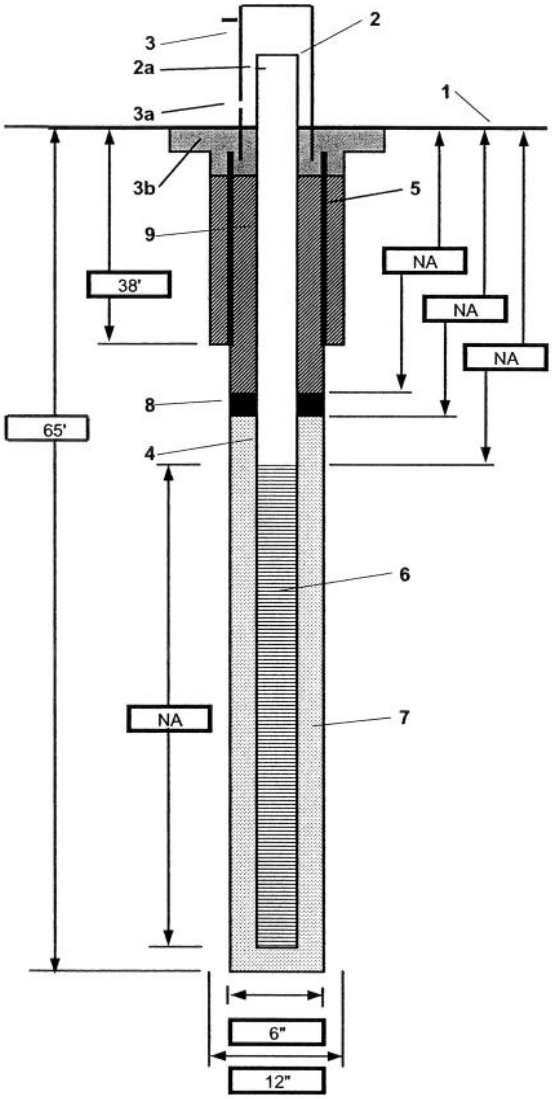
LOCATION : Allegany Ballistics Laboratory, Rocket Center, WV

DRILLING CONTRACTOR : Eichelbergers

DRILLING METHOD AND EQUIPMENT USED: Air hammer with simultaneous casing advancement to install surface casing, then air hammer

WATER LEVELS :

START : 07/26/2000 END: 7/26/2000 LOGGER : F. Calef




1- Ground elevation at well: 674.06

2- Top of casing elevation: 676.43
a) vent hole?: None

3- Wellhead protection cover type: 10" Steel
a) weep hole?: None
b) concrete pad dimensions: None

4- Dia./type of well casing: None

5- Dia./type of surface casing: 10" Steel

6- Type/slot size of screen: None

7- Type screen filter: None
a) Quantity used:

8- Type of seal: None
a) Quantity used:

9- Grout
a) Grout mix used: Portland/Bentonite
b) Method of placement: Tremie
c) Vol. of surface casing grout:
d) Vol. of well casing grout:

Development method: Air Lift

Development time: 1 hr. 21 min.

Estimated development volume: 4,000 gal.

Comments: Surface Casing Set at 38.5' (bgs); Open Borehole to 65' (bgs); Fracture at 58' to 59' (bgs). Well Development Completed on 7/26/00.

| PROJECT NUMBER | WELL NUMBER | |
|---|---|---|
| 138649.FI.MW | 11GW11 | SHEET 1 OF 2 |

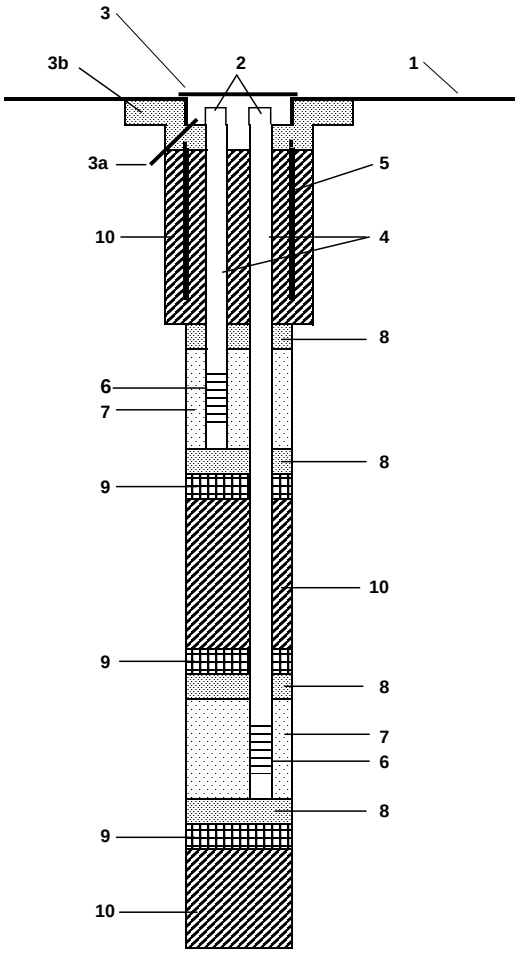
# WELL COMPLETION DIAGRAM

PROJECT : Allegany Ballistics Laboratory Superfund Site LOCATION : Site 11

DRILLING CONTRACTOR : Eichelbergers Drilling, Inc.

DRILLING METHOD AND EQUIPMENT USED Hollow Stem Auger Drill Rig/Air Rotary Drill Rig

WATER LEVELS : START : Jul-98 END : Sept-98 LOGGER : James Hutton




| | |
|---|---|
| 1- Ground elevation at well | 670.10 amsl |
| 2- Top of casing elevation | |
| a) shallow | 669.89 amsl |
| b) deep | 669.75 amsl |
| 3- Wellhead protection cover type | Flush mount |
| a) drain tube? | No |
| b) concrete pad dimensions | |
| 4- Dia./type of well casing | |
| a) shallow | 2 inch dia/ Schedule 40 PVC |
| b) deep | 2 inch dia/Schedule 40 PVC |
| 5- Dia./type surface casing | 8 inch dia/Steel |
| 6- Type/slot/size of screen | |
| a) shallow | |
| b) deep | |
| 7- Type screen filter | #2 Sand |
| a) Quantity used | |
| 8- Type of seal filter | #00 Sand |
| a) Quantity used | |
| 9- Type of seal | Bentonite chips/pellets |
| a) Quantity used | |
| 10- Grout | |
| a) Grout mix used | |
| b) Method of placement | |
| c) Vol. of surface casing grout | |
| d) Vol. of well casing grout | |
| Development method | |
| a) shallow | |
| b) deep | |
| Development time | |
| a) shallow | |
| b) deep | |
| Estimated purge volume | |
| a) shallow | |
| b) deep | |

Comments:
Voids located at 30, 47.5, 110, 115, 130, 135, 147.5, 160, and 180 feet bgs.

| | PROJECT NUMBER | WELL NUMBER |
|---|---|---|
| CH2MHILL | 138649.FI.MW | 11GW11 SHEET 2 OF 2 |

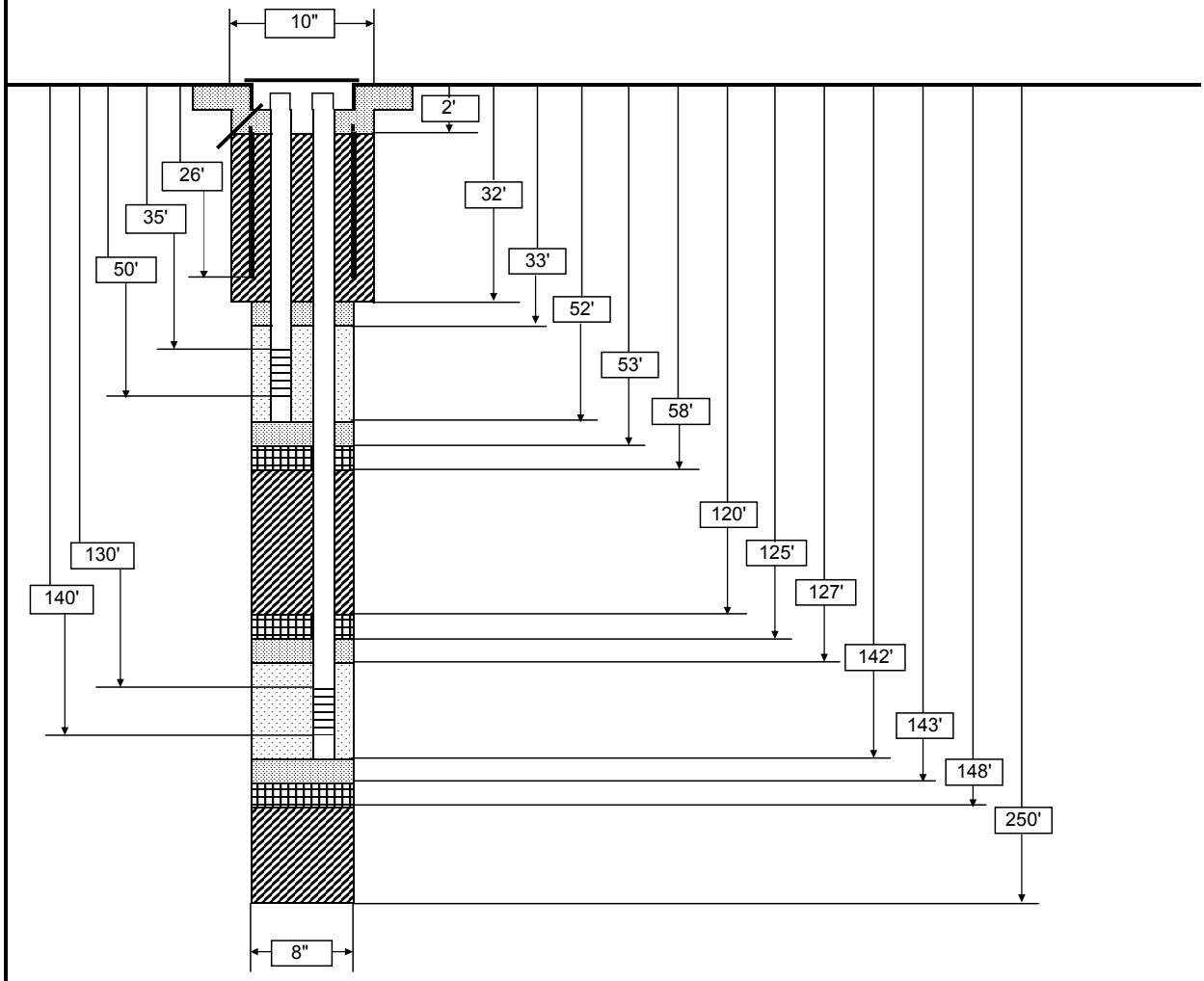
# WELL COMPLETION DIAGRAM

PROJECT : Allegany Ballistics Laboratory Superfund Site LOCATION : Site 11

DRILLING CONTRACTOR : Eichelbergers Drilling, Inc

DRILLING METHOD AND EQUIPMENT USED Hollow Stem Auger Drill Rig/Air Rotary Drill Rig

WATER LEVELS : START : Jul-98 END : Sept-98 LOGGER : James Hutton



| | PROJECT NUMBER | CTO-022 |
|---|---|---|
| CH2MHILL | 138762.FI.MW | Boring Number: 12MW01 |

# SOIL BORING LOG

PROJECT : Phase II SWMU Investigation LOCATION : Allegany Ballistics Laboratory, Rocket Center, West Virginia

ELEVATION : DRILLING CONTRACTOR : Green Services

SAMPLING EQUIPMENT :2" dia. Splitspoon advanced by Geoprobe Direct Push DRILLING METHOD AND EQUIPMENT:Schramm Model 450 Air F using a 7&7/8" Diameter bit.

WATER LEVELS : START : 3/23/99 END : 3/23/99 LOGGER : R. Pierpont

| DEPTH BELOW SURFACE (FT) | INTERVAL (FT) | Recovery (Inches) | USGS CODE | Moisture Content | Munsell Code | CORE DESCRIPTION: SOIL NAME, COLOR RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY. | COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. PID (ppm) |
|---|---|---|---|---|---|---|---|
| 2_ | | | | | | | |
| 4_ | | | | | | | |
| 6_ | 5' - 7' | 14" | CL | Dry | 10YR 4/2 | Sandy CLAY<br>Core sample is very firm<br>Sand is very fine<br>Dark Yellow Brown | 0.0ppm |
| 8_ | | | | | | | |
| 10__ | 10' - 12' | 12" | CL<br>CL - SW | Dry<br>Moist | 10YR 4/2<br>10YR 6/2 | Sandy CLAY<br>Core sample is very firm throughout.<br>Medium to coarse Sandy CLAY with Sandstone Fragments become prevelent. Pale Yellowish Brown | 0.0ppm<br>0.0ppm |
| 12_ | | | | | | | |
| 14_ | | | | | | | |
| 16_ | 15' - 17' | 4" | CL - SW | Very Wet | 10YR 5/4 | Sandy CLAY with cobbles of sandstone.<br>Sand is medium to coarse grained.<br>Moderate Yellow Brown | 0.0ppm<br>Refusal of spoon leaving little recovery. |
| 18_ | | | | | | | |
| 20__ | 20 - 20.5 | N/A | SW | Wet | Not Reported | SAND with Cobbles | 0.0ppm |
| 22_ | | | | | | | |

End of Boring

| | PROJECT NUMBER | CTO-022 |
|---|---|---|
| CH2MHILL | 138762.FI.MW | Boring Number: 12MW02 |

# SOIL BORING LOG

PROJECT : Phase II SWMU Investigation LOCATION : Allegany Ballistics Laboratory, Rocket Center, West Virginia

ELEVATION : DRILLING CONTRACTOR : Green Services

SAMPLING EQUIPMENT :2" dia. Splitspoon advanced by Geoprobe Direct Push DRILLING METHOD AND EQUIPMENT:Schramm Model 450 Air Rig using a 7&7/8" Diameter bit. WATER LEVELS : START : 4/1/00 END : 4/1/00 LOGGER : R. Pierpont

| DEPTH BELOW SURFACE (FT) | INTERVAL (FT) | Recovery (Inches) | USGS CODE | Moisture Content | Munsell Code | CORE DESCRIPTION: SOIL NAME, COLOR RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY. | COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. PID (ppm) | |
|---|---|---|---|---|---|---|---|---|
| 2_ | | | | | | | | |
| 4_ | | | | | | | | |
| 6_ | 5' - 7' | 24" | CL | Moist | 10YR 5/4 | Sandy CLAY CLAY is very plastic.<br>Core sample is very firm<br>Sand is very fine<br>Moderate Yellow Brown | 0.0ppm | No readings above background levels. |
| 8_ | | | | | | | | |
| 10__ | 10' - 12' | 15" | CH - SW | Moist | 10YR 5/4 | Sandy CLAY Moderate yellow brown<br>Core sample is firm to soft down spoon.<br>CLAY is plastic<br>Broken limestone fragments present | 0.0ppm | No readings above background levels |
| 12_ | | | | | | | | |
| 14_ | | | | | | | | |
| 16_ | 15' - 17' | 2" | CL - SW | DRY | 10YR 5/4 | Sandy CLAY with cobbles of sandstone.<br>Sand is fine to medium grained.<br>Moderate Yellow Brown<br>Core sample is firm throughout | 0.0ppm | No readings above background levels |
| 18_ | | | | | | | | |
| 20__ | 20 - 22 | N/A | | | | No sample taken<br>Limestone fragments seen in drill cuttings<br>Competant bedrock hit at 24' | N/A | |
| 22_ | | | | | | End of Boring | | |

| PROJECT NUMBER | CTO-022 |
|---|---|
| 138762.FI.MW | Boring Number: 12MW03 |

# SOIL BORING LOG

PROJECT : Phase II SWMU Investigation LOCATION : Allegany Ballistics Laboratory, Rocket Center, West Virginia

ELEVATION : DRILLING CONTRACTOR : Green Services

SAMPLING EQUIPMENT :2" dia. Splitspoon advanced by Geoprobe Direct Push DRILLING METHOD AND EQUIPMENT:Schramm Model 450 Air R using a 7&7/8" Diameter bit. WATER LEVELS : START : 4/1/99 END : 4/1/99 LOGGER : R. Pierpont

| DEPTH BELOW SURFACE (FT) | INTERVAL (FT) | Recovery (Inches) | USGS CODE | Moisture Content | Munsell Code | CORE DESCRIPTION<br>SOIL NAME, COLOR RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY. | COMMENTS<br>DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.<br>PID (ppm) |
|---|---|---|---|---|---|---|---|
| 2_ | | | | | | | |
| 4_ | | | | | | | |
| 6_ | 5' - 7' | 12" | CL | Dry | 10YR 5/4 | Sandy CLAY<br>Core sample is very firm<br>Sand is very fine<br>Moderate Yellow Brown | 0.0ppm |
| 8_ | | | | | | | |
| 10__ | 10' - 12' | 24" | CL - SW | Dry | 10YR 5/4 | Sandy CLAY<br>Core sample is very firm throughout.<br>At 11.5' bgs color becomes more brown and pebbles of 1/4" dia. become prevelent. Sand is very fine | 0.0ppm |
| 12_ | | | | | | | |
| 14_ | | | | | | | |
| 16_ | 15' - 17' | 2" | CL - SW | DRY | 10YR 5/4 | Sandy CLAY with cobbles of sandstone.<br>Sand is medium to coarse grained.<br>Moderate Yellow Brown | 0.0ppm<br>Refusal of spoon leaving little recovery. |
| 18_ | | | | | | | |
| 20__ | 20 - 22 | N/A | SW | Moist | Not Reported | SAND with Cobbles<br>SAND is medium to coarse grained<br>SAND is firm. | 0.0ppm |
| 22_ | | | | | | End of Boring | |

| CH2MHILL | PROJECT NUMBER 152130.FI.MW | BORING NUMBER 11GW14 |
|---|---|---|

# SOIL BORING LOG

PROJECT : ABL Drilling and MW Insta LOCATION : Allegeny Ballistics Laboratory, Rocket Center, WV; Site 12

DRILLING CONTRACTOR : Miller Drilling DRILLING METHOD & EQUIPMENT USED:

DEPTH TO WATER (ft. Bgs): START :3/21/03 END : 3/21/03 LOGGER : L. Kurylo

| DEPTH BELOW SURFACE (FT) | INTERVAL (FT) | RECOVERY (IN) | #/TYPE | STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N) | CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY. | USCS | COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole |
|---|---|---|---|---|---|---|---|
| 5 | 0-5 | | | | ORGANIC SILT<br>Brown, moist, soft(?), high plasticity | OH/OL | FID reading same as ambient air. |
| 10 | 5-9 | | | | LEAN CLAY(?)<br>Could not get sample as drill curtain was placed around drill table, thereby cutting off LMK's access to cuttings. | CL? | Driller reports drilling from 5'-9' feels like clay. |
| 15 | 10-14 | | | | WELL GRADED GRAVEL<br>LMK still could not get sample | GW? | Driller reports drilling at 9' bgs feels like gravel; reports groundwater at 9' bgs. |
| 20 | 14.5+ | | | | BEDROCK<br>LMK unable to obtain sample | | Borehole drilled to 15' bgs.<br><br>Driller added approx. 20 gallons of water to help blow out cuttings. |

| CH2MHILL | PROJECT NUMBER 152130.FI.MW | BORING NUMBER 12MW08 |
|---|---|---|

# SOIL BORING LOG

PROJECT : ABL Drilling and MW Insta LOCATION : Allegeny Ballistics Laboratory, Rocket Center, WV; Site 12

DRILLING CONTRACTOR : Miller Drilling DRILLING METHOD & EQUIPMENT USED:

DEPTH TO WATER (ft. Bgs): START :3/21/03 END : 3/21/03 LOGGER : L. Kurylo

| DEPTH BELOW SURFACE (FT) | INTERVAL (FT) | RECOVERY (IN) | #/TYPE | STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N) | CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY. | USCS | COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole |
|---|---|---|---|---|---|---|---|
| 5 | 0-5 | | | | LEAN CLAY<br>Brown, moist, soft (?), medium plasticity, trace fine sand, trace gravel. | CL | No FID available |
| 10 | 5-10 | | | | LEAN CLAY<br>Same as above | CL | No FID available<br>Drilling rate approx 2'/min |
| | 10-14 | | | | LEAN CLAY<br>Same as above | CL | No FID avaiable |
| 15<br>20 | 14-20 | | | | WELL GRADED SAND WITH CLAY AND GRAVEL<br>Brown, wet, dense(?), fine to coarse, sand(!55%), fine to medium gravel (!35%), ~10% silt/clay | SW-SC | No FID avaiable |
| | 20-21 | | | | Same as above | SW-SC | No FID avaiable |
| 25 | 21+ | | | | LIMESTONE<br>Black to dark gray, strong HCl reaction | | Driller added approx. 30 gallons of water to help blow out cuttings over entire hole. |

| CH2MHILL | PROJECT NUMBER | BORING NUMBER |
|---|---|---|
| | 152130.FI.MW | 12MW10 |

# SOIL BORING LOG

PROJECT : ABL Drilling and MW Instal LOCATION : Allegeny Ballistics Laboratory, Rocket Center, WV; Site 12

DRILLING CONTRACTOR : Miller Drilling DRILLING METHOD & EQUIPMENT USED:

DEPTH TO WATER (ft. Bgs): START :3/19/03 END : 3/19/03 LOGGER : L. Kurylo

| DEPTH BELOW SURFACE (FT) | INTERVAL (FT) | RECOVERY (IN) | #/TYPE | STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N) | CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY. | USCS | COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole |
|---|---|---|---|---|---|---|---|
| 5 | 0-5 | | | | LEAN SILT<br>Ligth brown to brown, moist, soft(?), medium plasticity, ~10% sand, trace gravel | ML | FID reading same as ambient air |
| 10 | 5-10 | | | | Same as above (SAA), but trace gravel and sand not observed. | ML | FID same as ambient in driller breathing zone (BZ) and cyclone BZ |
| 15 | 10-15 | | | | SANDY LEAN CLAY<br>Light brown, moist, soft(?), medium plasticity, ~30% fine sand | CL | FID reading same as ambient air<br><br>Drill rate approx. 0.8'/min |
| 20 | 15-20 | | | | POORLY GRADED GRAVEL WITH SAND<br>Light brown, moist, dense(?), ~25% fine to coarse sand, ~5% silt/clay, medium gravel | GP | FID reading same as ambient air |
| 25 | 20-25 | | | | CLAYEY GRAVEL WITH SAND<br>Tan to light brown, moist, dense(?), poorly graded medium gravel, ~20% fine to coarse sand, ~20% clay/silt<br><br>Driller reporst groundwater at 22' bgs | GC | Ambient air in driller BZ<br>0.2 ppm in cyclone BZ<br>0.5 ppm at cyclone |
| 30 | 25-30 | | | | SAA | GC | 0.4 ppm in driller BZ<br>Ambient in cyclone BZ |
| | 30-32 | | | | SAA | GC | Not neasured |
| 35 | | | | | LIMESTONE<br>Black to dark grey, strong HCl reaction | | Not neasured |

| CH2MHILL | PROJECT NUMBER | BORING NUMBER |
|---|---|---|
| | 152130.FI.MW | 12MW12 |

# SOIL BORING LOG

PROJECT : ABL Drilling and MW Insta LOCATION : Allegeny Ballistics Laboratory, Rocket Center, WV; Site 12; north side of Bldg. 214

DRILLING CONTRACTOR : Miller Drilling DRILLING METHOD & EQUIPMENT USED: Schramm T450, 6" casing advance ODEX

DEPTH TO WATER (ft. Bgs): START :8/15/03 END : 8/15/03 LOGGER : E. Spande

| DEPTH BELOW SURFACE (FT) | INTERVAL (FT) | RECOVERY (IN) | #/TYPE | STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N) | CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY. | USCS | COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole |
|---|---|---|---|---|---|---|---|
| 5 | 0-10 | | | | Clay - brown, most to dry at top<br>Some medium to fine gravel | CE | Lithology and intervals are indistinct due to casing advance method, which ejects soil through a cyclone. |
| 10 | | | | | | | |
| 15 | | | | | | | Driller noted no difference going to bedrock. No cobble zone encountered. |
| 20 | | | | | | | |
| 25 | | | | | BEDROCK AT 25' BGS | | |
| 30 | | | | | | | |

| CH2MHILL | PROJECT NUMBER | BORING NUMBER |
|---|---|---|
| | 152130.FI.MW | 12MW14 |

# SOIL BORING LOG

PROJECT : ABL Drilling and MW Insta LOCATION : Allegeny Ballistics Laboratory, Rocket Center, WV; Site 12; E. of Bldg. 385, S of Bldg. 365, N.of Bld

DRILLING CONTRACTOR : Miller Drilling DRILLING METHOD & EQUIPMENT USED: Schramm T450, 6" casing advance,

DEPTH TO WATER (ft. Bgs): START :8/12/03 END : 8/13/03 LOGGER : E. Spande

| DEPTH BELOW SURFACE (FT) | INTERVAL (FT) | RECOVERY (IN) | #/TYPE | STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N) | CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY. | USCS | COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole |
|---|---|---|---|---|---|---|---|
| 5 | 0-5 | | | | Indeterminate - mixed rock, gravel chips, and silt<br>Silt - brown, firm, clayey; some coarse rounded gravel and sand | ME | logged from discharge out of air dishcarge<br>STOP 8/12/03 1733 |
| 10<br>15<br>20<br>25 | 5-25 | | | | Silty gravel - brown, moist, fine-medium rounded gravel<br>Cobbles*, hole does not stay open past 22' bgs | GM | START 8/13/03 0840<br>0905 Coupling at top of casing comes loose. Stop to repair.<br>Indistinct contact depth and lithology. Cuttings captured from cyclone.<br>No odors or PID/FID above background |
| 30 | | | | | BEDROCK AT 25' BGS<br>TD 25' BGS | | * Driller reports large cobbles that were ground through approx. 23-25' bgs, and shale-like material for bedrock. |

| CH2MHILL | PROJECT NUMBER 152130.FI.MW | BORING NUMBER 12MW15 |
|---|---|---|

# SOIL BORING LOG

PROJECT : ABL Drilling and MW Insta LOCATION : Allegeny Ballistics Laboratory, Rocket Center, WV; Site 12; near Bldg. 167

DRILLING CONTRACTOR : Miller Drilling DRILLING METHOD & EQUIPMENT USED: 6" air hammer / 6" tri-cone roller bit

DEPTH TO WATER (ft. Bgs): START :3/20/03 END : 3/20/03 LOGGER : L. Kurylo

| DEPTH BELOW SURFACE (FT) | INTERVAL (FT) | RECOVERY (IN) | #/TYPE | STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N) | CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY. | USCS | COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole |
|---|---|---|---|---|---|---|---|
| 5 | 0-5.5 | | | | LEAN CLAY<br>Brown, moist, soft(?), high plasticity, trace sand | CL | FID reading same as ambient air.<br>Using 6" air hammer |
| | 5.5-8 | | | | LEAN CLAY<br>Brown, moist, soft(?), high plasticity, trace sand | CL | FID reading same as ambient air.<br>Switch to 6" tri-cone roller bit for safety<br>Driller reports groundwater at 8' bgs. |
| 10 | 8-12 | | | | WELL GRADED GRAVEL WITH SAND<br>Multi-colored gravel (black, dark gray, brown, dark red), wet, dense(?), ~30% fine to coarse sand, ~5% silt/clay, fine to medium grained gravel | GW | FID reading same as ambient air.<br>Drill rate ~ 2'/min |
| 15 | 12-13 | | | | LIMESTONE<br>Possibly siltstone/shale; dark gray to black, fissility absent, no HCl reaction | | FID reading same as ambient air.<br>Driller added ~30 gallons (maximum) of water to help remove cuttings |
| 20 | | | | | | | |

| CH2MHILL | PROJECT NUMBER 152130.FI.MW | BORING NUMBER 12MW16 |
|---|---|---|

# SOIL BORING LOG

PROJECT : ABL Drilling and MW Instal LOCATION : Allegeny Ballistics Laboratory, Rocket Center, WV; Site 12

DRILLING CONTRACTOR : Miller Drilling DRILLING METHOD & EQUIPMENT USED:

DEPTH TO WATER (ft. Bgs): START :3/21/03 END : 3/21/03 LOGGER : L. Kurylo

| DEPTH BELOW SURFACE (FT) | INTERVAL (FT) | RECOVERY (IN) | #/TYPE | STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N) | CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY. | USCS | COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole |
|---|---|---|---|---|---|---|---|
| 5 | 0-5 | | | | ORGANIC SILT<br>Brown, moist, (soft?), high plasticity | OH/OL | FID reading same as ambient air |
| 10 | 5-10 | | | | UNKNOWN<br>Could not procure sample as curtain was placed around drill table, thereby cutting off LMK"s access to fresh soil cuttings. | | Drill rate approx. 2'/min<br>Groundwater at 10' bgs |
| 15 | 10-17.7 | | | | WELL GRADED GRAVEL WITH SAND<br>Brown, wet, dense (?), ~20% fine to coarse sand, fine to medium gravel | | |
| 20<br>25 | | | | | LIMESTONE BEDROCK<br>Black to dark gray, strong HCl reaction | | Driller added approx. 50 gallons of water (maximum) over entire borehole to help recover cuttings. |

| CH2MHILL | PROJECT NUMBER | BORING NUMBER |
|---|---|---|
| | 152130.FI.MW | 12MW18 |

# SOIL BORING LOG

PROJECT : ABL Drilling and MW Insta LOCATION : Allegeny Ballistics Laboratory, Rocket Center, WV; Site 12; north side of Bldg.167

DRILLING CONTRACTOR : Miller Drilling DRILLING METHOD & EQUIPMENT USED: Schramm T450, 6" casing advance

DEPTH TO WATER (ft. Bgs): START :8/17/03 END : 8/17/03 LOGGER : E. Spande

| DEPTH BELOW SURFACE (FT) | INTERVAL (FT) | RECOVERY (IN) | #/TYPE | STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N) | CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY. | USCS | COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole |
|---|---|---|---|---|---|---|---|
| | | | | | Clay - brown, moist to dry | CE | Depths and soil depositions are indistinct since logged from cyclone cuttings |
| 5 | | | | | | | |
| 10 | | | | | Cuttings dry, some rounded gravel and sand | | Diverter plugged - removed diverter and cleaned |
| 15 | | | | | Increased coarse gravel, dry clayey gravel | GC | |
| 20 | | | | | | | Odor briefly noticed at 20' bgs |
| | | | | | 20' - 22 ' Cobble zone | | No PID reading in breathing zone. Odor was "rotten." Wet at base of section. |
| 25 | | | | | BEDROCK AT 23' BGS shale or somewhat fissile limestone | | |
| 30 | | | | | | | |

| CH2MHILL | PROJECT NUMBER | BORING NUMBER |
|---|---|---|
| | 152130.FI.MW | 12MW19 |

# SOIL BORING LOG

PROJECT : ABL Drilling and MW Insta LOCATION : Allegeny Ballistics Laboratory, Rocket Center, WV; Site 12; west side of Bldg.167

DRILLING CONTRACTOR : Miller Drilling DRILLING METHOD & EQUIPMENT USED: Schramm T450, 6" casing advance

DEPTH TO WATER (ft. Bgs): START :8/17/03 END : 8/17/03 LOGGER : E. Spande

| DEPTH BELOW SURFACE (FT) | INTERVAL (FT) | RECOVERY (IN) | #/TYPE | STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N) | CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY. | USCS | COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole |
|---|---|---|---|---|---|---|---|
| | | | | | Clay - brown, moist, silty | CE | Soil logged from cuttings from cyclone. Lithology and intervals indistinct. |
| 5 | | | | | | | No odors or FID/PID readings above ambient observed during drilling |
| | | | | | | | Set replacement well 12MW06 |
| 10 | | | | | | | |
| 15 | | | | | Increasing coarse rounded gravel at 15' (clayey gravel) | | |
| | | | | | Sandy, silt and gravel, dry, brown at 18' (silty sand with gravel) | | |
| 20 | | | | | | | |
| 25 | | | | | Wet, mostly angular shale* fragments | | |
| 30 | | | | | TD 26' BGS<br>* shale could be somewhat fissile black limestone | | |

| PROJECT NUMBER | WELL NUMBER | |
|---|---|---|
| 152130.FI.MW | 11GW14 | SHEET 1 OF 1 |

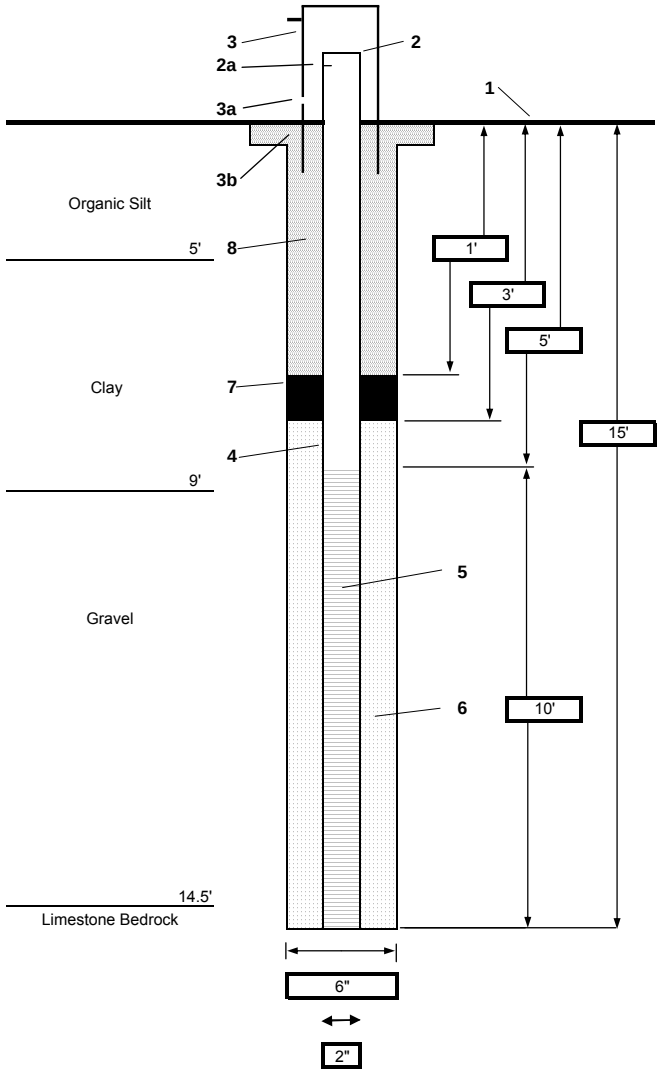
# WELL COMPLETION DIAGRAM

PROJECT : Allegany Ballistics Laboratory Site 12 Remedial Investigation LOCATION : Site 12

DRILLING CONTRACTOR : Miller Drilling Company, Inc.

DRILLING METHOD AND EQUIPMENT USED : 6" Tri-cone Roller Bit

WATER LEVELS : 9' During Drilling START : March 2003 END : March 2003 LOGGER : Leo Kurylo




| | |
|---|---|
| 1- Ground elevation at well | 668.70 feet amsl |
| 2- Top of casing elevation | 671.12 feet amsl |
| a) vent hole? | Yes |
| 3- Wellhead protection cover type | Steel aboveground casing |
| a) weep hole? | Yes |
| b) concrete pad dimensions | 3' x 3' x 6" |
| 4- Dia./type of well casing | 2-inch diameter PVC |
| 5- Type/slot size of screen | PVC<br>0.01" |
| 6- Type screen filter | Morie #2 Sand |
| a) Quantity used | 250 lbs |
| 7- Type of seal | Bentonite Pellets |
| a) Quantity used | 50 lbs |
| 8- Grout | |
| a) Grout mix used | None (see below) |
| b) Method of placement | |
| c) Vol. of well casing grout | |
| Development method | Bailer (see below) |
| Development time | 20 Minutes |
| Estimated purge volume | 1.7 gallons |

Comments Due to space constraints, well was completed with concrete placed directly on top of bentonite seal.

Only 0.85 gallons of water present in well during development -- not enough water to pump. Well was purged dry with a bailer.

| | PROJECT NUMBER:138762.FI.MW | WELL NUMBER:12MW01 |
|---|---|---|

CH2MHILL

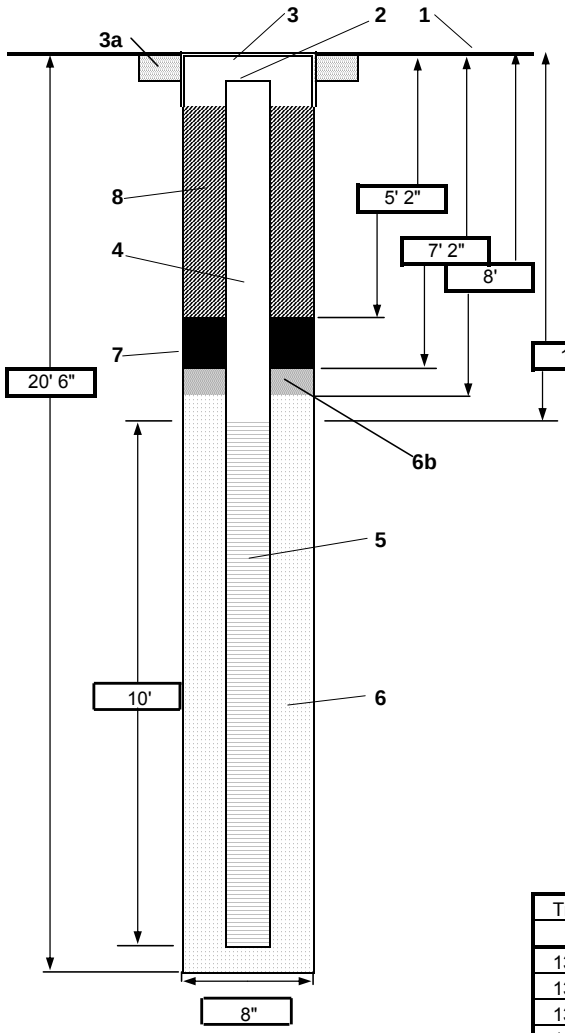
# WELL COMPLETION DIAGRAM

PROJECT :ABL SWMU Investigation — LOCATION :Allegany Ballistics Laboratory, Rocket Center, West Virginia

DRILLING CONTRACTOR :Eichelbergers

DRILLING METHOD AND EQUIPMENT USED :Schramm Model 450 Air Rig, 7&7/8" Diameter bit.

WATER LEVELS : — START :3/23/99 — END :4/5/99 — LOGGER : J. Hutton




1- Ground elevation at well

2- Top of casing elevation

3- Wellhead protection cover type: Flushmount
(a) concrete pad dimensions

4- Dia./type of well casing: 2" Schedule PVC Riser

5- Type/slot size of screen: 10 Slot Screen
2" Schedule PVC screen

6- Type screen filter: Morie #2 Sand
a) Quantity used: 8 x 50lb bags
b) Other type: Morie #00 (1 bag)

7- Type of seal: Bentonite Seal
a) Quantity used: 1 x 50lb bags

8- Grout
a) Grout mix used: Grout/Bentonite
b) Method of placement: Tremmie
c) Vol. of well casing grout: 25 bags used in 15 gallons of grout.

Development method: Purging

Development time: One hour

Estimated purge volume: Approximately 110 gallons.

Comments: No Comments

| Time | pH | Conductivity S/m | Turbidity NTU | DO mg/l | Temperature Celcius | Salinity per mil |
|---|---|---|---|---|---|---|
| 1300 | 7.37 | 2.75 | 600 | 1.49 | 13.5 | 0.13 |
| 1310 | 7.44 | 2.75 | 545 | 3.36 | 13.3 | 0.13 |
| 1315 | 7.74 | 2.71 | 369 | 2.08 | 13.0 | 0.13 |
| 1320 | 7.71 | 2.74 | 350 | 2 | 12.8 | 0.13 |

| | PROJECT NUMBER:138762.FI.MW | WELL NUMBER:12MW02 |
|---|---|---|

CH2MHILL

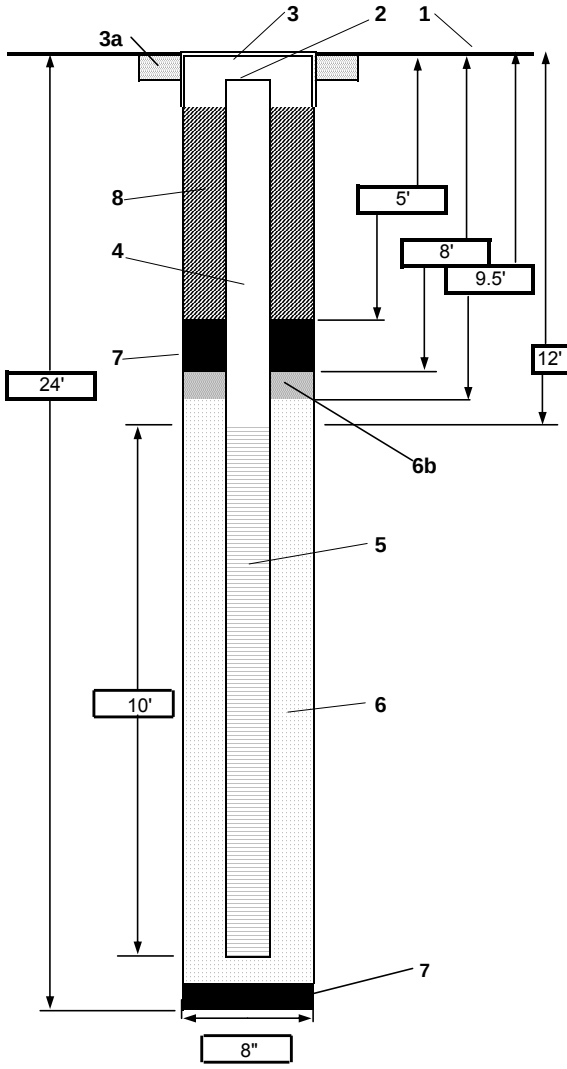
# WELL COMPLETION DIAGRAM

PROJECT :ABL SWMU Investigation — LOCATION :Allegany Ballistics Laboratory, Rocket Center, West Virginia

DRILLING CONTRACTOR :Eichelbergers

DRILLING METHOD AND EQUIPMENT USED :Schramm Model 450 Air Rig, 7&7/8" Diameter bit.

WATER LEVELS : — START :4/1/99 — END :4/5/99 — LOGGER : J. Hutton




| | |
|---|---|
| 1- Ground elevation at well | |
| 2- Top of casing elevation | |
| 3- Wellhead protection cover type | Flushmount |
| (a) concrete pad dimensions | |
| 4- Dia./type of well casing | 2" Schedule PVC Riser |
| 5- Type/slot size of screen | 10 Slot Screen |
| | 2" Schedule PVC screen |
| 6- Type screen filter | Morie #2 Sand |
| a) Quantity used | 12 x 50lb bags |
| b) Other type | Morie #00 (1 bag) |
| 7- Type of seal | Bentonite Seal |
| a) Quantity used | 1 x 50lb bags |
| 8- Grout | |
| a) Grout mix used | Grout/Bentonite |
| b) Method of placement | Tremmie |
| c) Vol. of well casing grout | 24 bags used in 13 gallons of grout. |
| Development method | Purging |
| Development time | 20 Minutes |
| Estimated purge volume | Approximately 110 gallons. |
| Comments | Water was initially turbid. Water cleared only slightly |

| Time | pH | Conductivity | DO | Temperature | Salinity |
|---|---|---|---|---|---|
| | | S/m | mg/l | Celcius | per mil |
| 1330 | 7.99 | 1.58 | 9.42 | 13.8 | 0.07 |
| 1340 | 8.04 | 1.61 | 5.08 | 13.8 | 0.07 |
| 1350 | 8.06 | 1.58 | 5.68 | 13.9 | 0.07 |

| | | |
|---|---|---|
| CH2MHILL | PROJECT NUMBER:138762.FI.MW | WELL NUMBER:12MW03 |

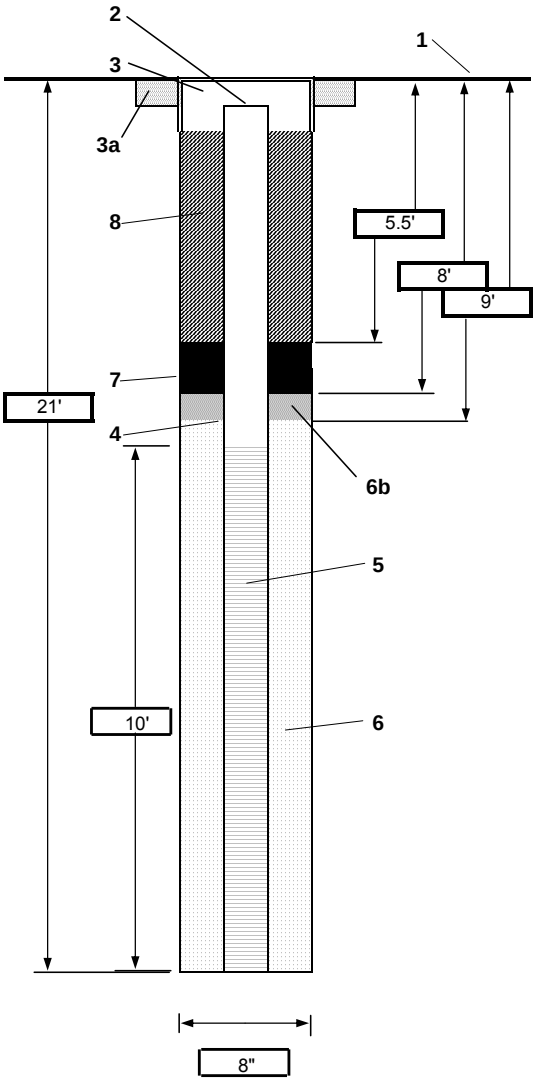
# WELL COMPLETION DIAGRAM

PROJECT :ABL SWMU Investigation — LOCATION :Allegany Ballistics Laboratory, Rocket Center, West Virginia

DRILLING CONTRACTOR :Eichelbergers

DRILLING METHOD AND EQUIPMENT USED :Schramm Model 450 Air Rig, 7&7/8" Diameter bit.

WATER LEVELS : — START :3/22/99 — END :4/5/99 — LOGGER : J. Hutton




| | |
|---|---|
| 1- Ground elevation at well | |
| 2- Top of casing elevation | |
| 3- Wellhead protection cover type | Flushmount |
| a) concrete pad dimensions | |
| 4- Dia./type of well casing | 2" Schedule PVC Riser |
| 5- Type/slot size of screen | 10 Slot Screen<br>2" Schedule PVC screen |
| 6- Type screen filter | Morie #2 Sand |
| a) Quantity used | 8 x 50lb bags |
| b) Other type | Morie #00 Sand |
| 7- Type of seal | Bentonite Seal |
| a) Quantity used | 2 x 50lb bags |
| 8- Grout | |
| a) Grout mix used | Grout/Bentonite |
| b) Method of placement | Tremmie |
| c) Vol. of well casing grout | 25 bags used in 13.5 gallons of grout. |
| Development method | Purging |
| Development time | 40 minutes |
| Estimated purge volume | Approximately 70 gallons. |
| Comments | Water was initially turbid.<br>Well ran dry regularly. |

| Time | pH | Conductivity | DO | Temperature | Salinity |
|---|---|---|---|---|---|
| | | S/m | mg/l | Celcius | per mil |
| 1540 | 8.64 | 0.95 | 4.47 | 14.4 | 0.04 |
| 1600 | 8.53 | 0.94 | 5.36 | 14.6 | 0.04 |
| 1620 | 8.55 | 0.96 | 5.12 | 14.7 | 0.04 |

| PROJECT NUMBER | WELL NUMBER | |
|---|---|---|
| 152130.FI.MW | 12MW06 | SHEET 1 OF 1 |

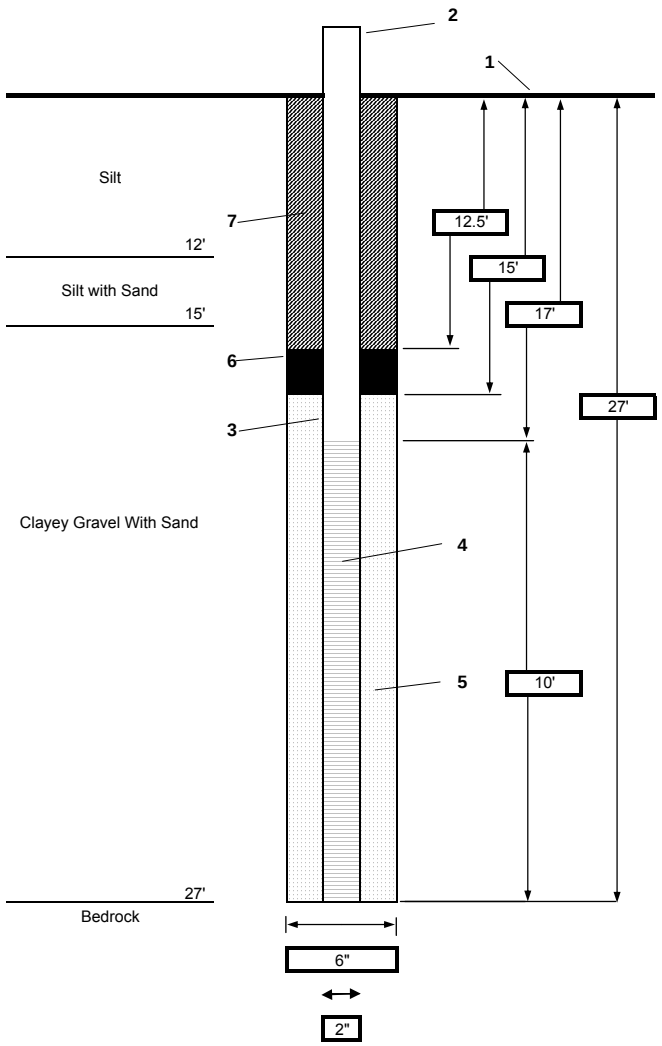
# WELL COMPLETION DIAGRAM

PROJECT : Allegany Ballistics Laboratory Site 12 Remedial Investigation LOCATION : Site 12

DRILLING CONTRACTOR : Miller Drilling Company, Inc.

DRILLING METHOD AND EQUIPMENT USED : 6" Tri-cone Roller Bit

WATER LEVELS : 16' During Drilling START : March 2003 END : March 2003 LOGGER : Leo Kurylo




| | |
|---|---|
| 1- Ground elevation at well | 657.28 feet amsl |
| 2- Top of casing elevation | 673.97 feet amsl |
| a) vent hole? | Yes |
| 3- Dia./type of well casing | 2-inch diameter PVC |
| 4- Type/slot size of screen | PVC<br>0.01" |
| 5- Type screen filter | Morie #2 Sand |
| a) Quantity used | 250 lbs |
| 6- Type of seal | Bentonite Pellets |
| a) Quantity used | 50 lbs |
| 7- Grout | |
| a) Grout mix used | Portland Cement/Bentonite Powder |
| b) Method of placement | Tremie Pipe |
| c) Vol. of well casing grout | 65 gallons |
| Development method | Downhole pump |
| Development time | 2.75 hours |
| Estimated purge volume | 55 gallons |

Comments Wellhead protector not installed because final grade had not been established during drilling. Although marked with construction cones, well was damaged in June 2003 due to construction activities adjacent to Building 167.

| PROJECT NUMBER | WELL NUMBER | |
|---|---|---|
| 152130.FI.MW | 12MW08 | SHEET 1 OF 1 |

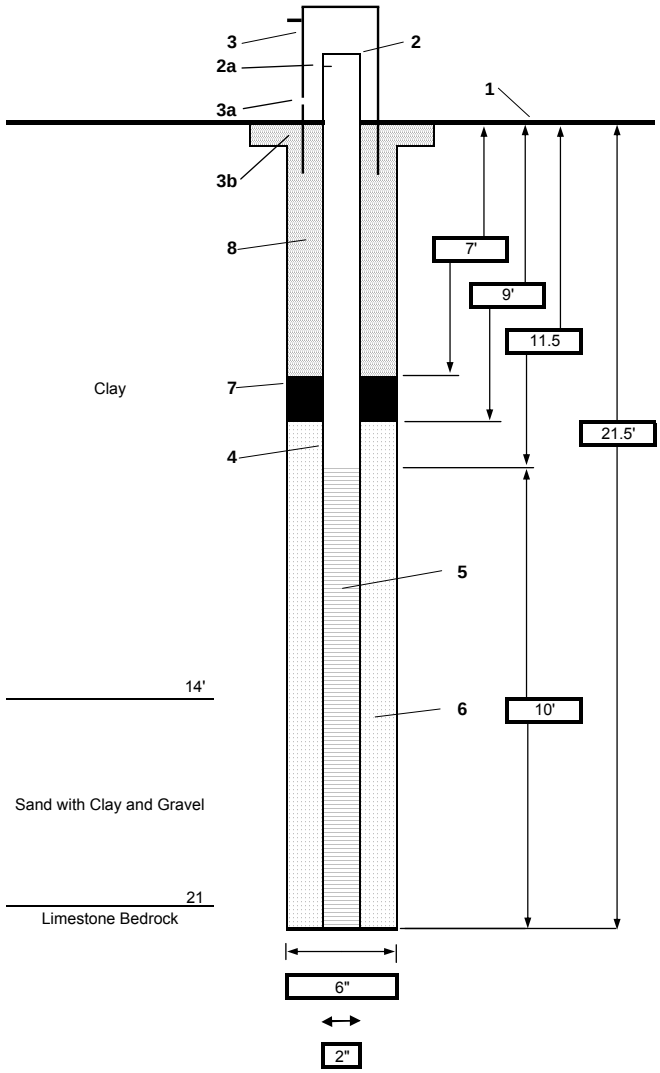
# WELL COMPLETION DIAGRAM

PROJECT : Allegany Ballistics Laboratory Site 12 Remedial Investigation LOCATION : Site 12

DRILLING CONTRACTOR : Miller Drilling Company, Inc.

DRILLING METHOD AND EQUIPMENT USED : 6" Tri-cone Roller Bit

WATER LEVELS : 14' During Drilling START : March 2003 END : March 2003 LOGGER : Leo Kurylo




| | |
|---|---|
| 1- Ground elevation at well | 669.68 feet amsl |
| 2- Top of casing elevation | 671.64 feet amsl |
| a) vent hole? | Yes |
| 3- Wellhead protection cover type | Steel aboveground casing |
| a) weep hole? | Yes |
| b) concrete pad dimensions | 3' x 3' x 6" |
| 4- Dia./type of well casing | 2-inch diameter PVC |
| 5- Type/slot size of screen | PVC<br>0.01" |
| 6- Type screen filter | Morie #2 Sand |
| a) Quantity used | 650 lbs |
| 7- Type of seal | Bentonite Pellets |
| a) Quantity used | 50 lbs |
| 8- Grout | |
| a) Grout mix used | Portland Cement / Bentonite Powder |
| b) Method of placement | Tremmie Pipe |
| c) Vol. of well casing grout | ~ 35 gallons |
| Development method | Downhole pump |
| Development time | 1.0 Hours |
| Estimated purge volume | not recorded |

Comments

| CH2MHILL | PROJECT NUMBER 152130.FI.MW | WELL NUMBER 12MW10 SHEET 1 OF 1 |
|---|---|---|

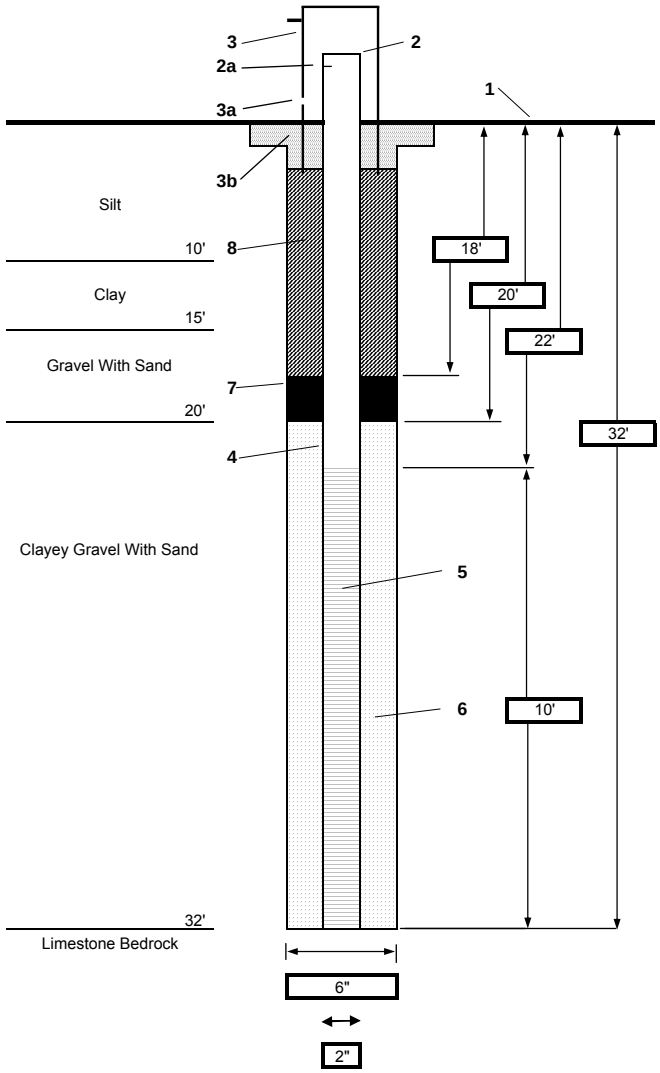
# WELL COMPLETION DIAGRAM

PROJECT : Allegany Ballistics Laboratory Site 12 Remedial Investigation LOCATION : Site 12

DRILLING CONTRACTOR : Miller Drilling Company, Inc.

DRILLING METHOD AND EQUIPMENT USED : 6" Tri-cone Roller Bit

WATER LEVELS : 22' During Drilling START : March 2003 END : March 2003 LOGGER : Leo Kurylo




| | |
|---|---|
| 1- Ground elevation at well | 670.07 feet amsl |
| 2- Top of casing elevation | 672.44 feet amsl |
| a) vent hole? | Yes |
| 3- Wellhead protection cover type | Steel aboveground casing |
| a) weep hole? | Yes |
| b) concrete pad dimensions | 3' x 3' x 6" |
| 4- Dia./type of well casing | 2-inch diameter PVC |
| 5- Type/slot size of screen | PVC<br>0.01" |
| 6- Type screen filter | Morie #2 Sand |
| a) Quantity used | 800 lbs |
| 7- Type of seal | Bentonite Pellets |
| a) Quantity used | 50 lbs |
| 8- Grout | |
| a) Grout mix used | Portland Cement/Bentonite Powder |
| b) Method of placement | Tremie Pipe |
| c) Vol. of well casing grout | ~ 94 gallons |
| Development method | Downhole pump |
| Development time | 1.5 hours |
| Estimated purge volume | 40 gallons |
| Comments | |

| PROJECT NUMBER | WELL NUMBER | |
|---|---|---|
| 152130.FI.MW | 12MW12 | SHEET 1 OF 1 |

CH2MHILL

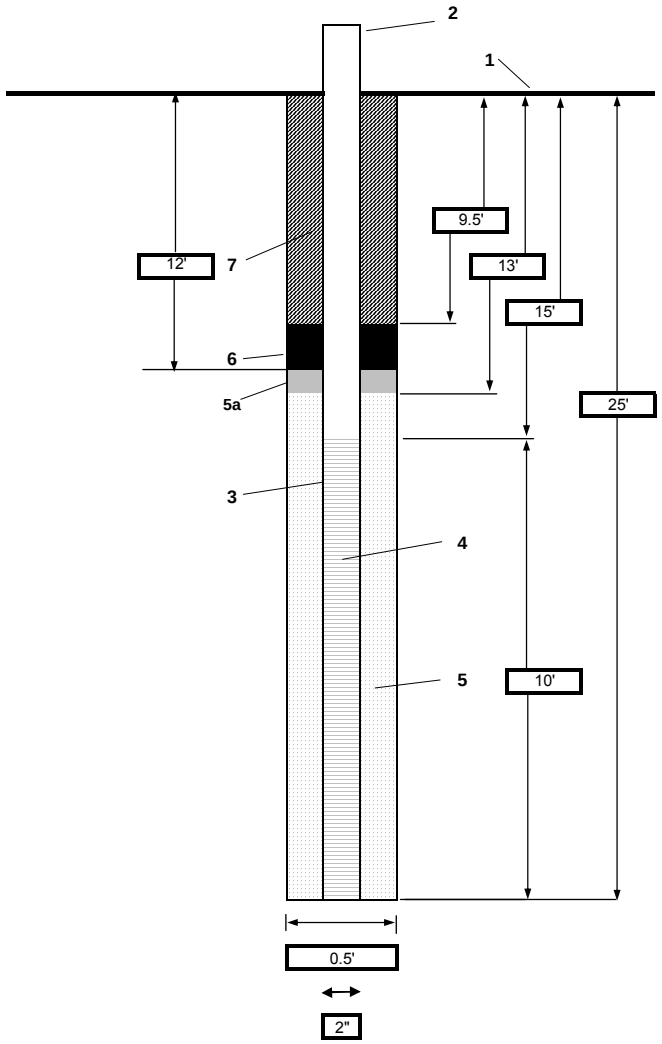
# WELL COMPLETION DIAGRAM

PROJECT : Allegany Ballistics Laboratory Site 12 Drilling and MW Installation LOCATION : Site 12, North Side of Bldg. 214

DRILLING CONTRACTOR Miller Drilling, Tracy Thrasher

DRILLING METHOD AND EQUIPMENT USED : Schramm T450 Rotodrill, 6" Dia. Casing Advancement

WATER LEVELS : START : 08/15/2003 END : 08/15/2003 LOGGER : E. Spande




| | | |
|---|---|---|
| 1- | Ground elevation at well | |
| 2- | Top of casing elevation | |
| | a) vent hole? | |
| 3- | Dia./type of well casing | 2" Diameter, Schedule 40 PVC |
| 4- | Type/slot size of screen | 0.010 Slot |
| 5- | Type screen filter | #2 Coarse sand, 7 50-lb bags |
| 5a- | Type screen filter | #0 Fine sand, 1/2 bag |
| 6- | Type of seal | 3/8" Bentonite pellets* |
| | a) Quantity used | 1 5-gal bucket |
| 7- | Type of seal | Cement grout |

| | |
|---|---|
| Development method | Surge block and pump |
| Development time | 1 hr. 45 min. |
| Estimated purge volume | 51 gal |

Comments #2 quartz sand, Filpro, US Silica
#0 Fine sand (quartz)

* Bentonite hydrated with 5 gal. Potable water.

| PROJECT NUMBER | WELL NUMBER | |
|---|---|---|
| 152130.FI.MW | 12MW14 | SHEET 1 OF 1 |

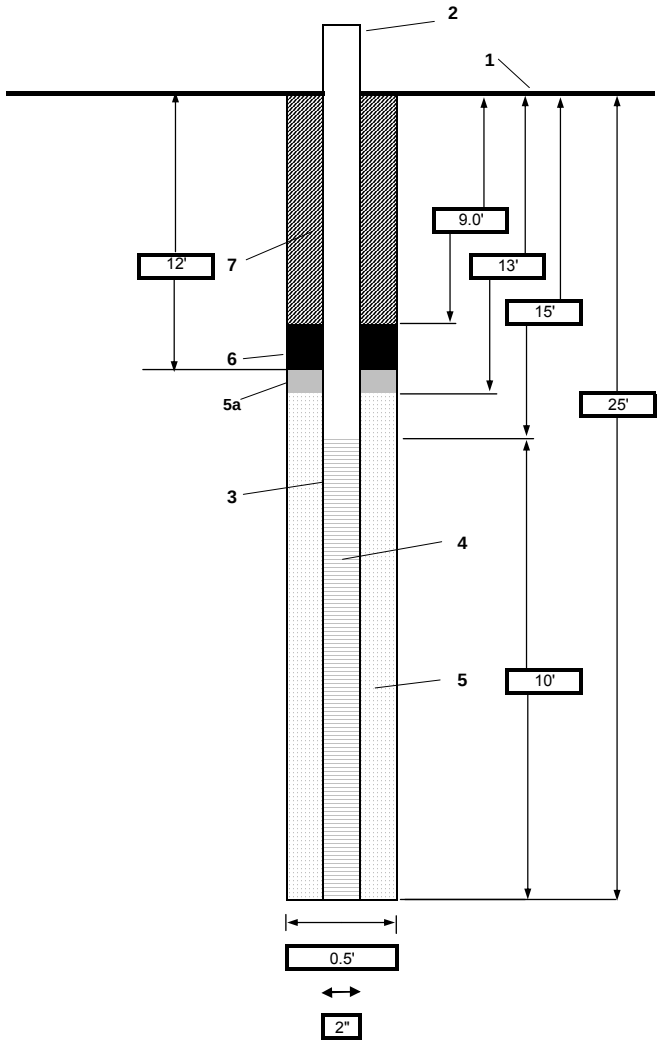
# WELL COMPLETION DIAGRAM

PROJECT : Allegany Ballistics Laboratory Site 12 Drilling and MW Installation LOCATION : Site 12, E. of Bldg. 385, S of Bldg. 365, N.of Bldg. 167

DRILLING CONTRACTOR Miller Drilling, Tracy Thrasher

DRILLING METHOD AND EQUIPMENT USED : Schramm T450 Rotodrill, 6" Dia. Casing Advancement

WATER LEVELS : START : 08/14/2003 END : 08/14/2003 LOGGER : E. Spande




| | | |
|---|---|---|
| 1- | Ground elevation at well | |
| 2- | Top of casing elevation | |
| | a) vent hole? | |
| 3- | Dia./type of well casing | 2" Diameter, Schedule 40 PVC |
| 4- | Type/slot size of screen | 0.010 Slot |
| 5- | Type screen filter | #2 Coarse sand, 8 50-lb bags |
| 5a- | Type screen filter | #0 Fine sand, 1/2 bag |
| 6- | Type of seal | 3/8" Bentonite pellets* |
| | a) Quantity used | 1 5-gal bucket |
| 7- | Type of seal | Cement grout |

| | |
|---|---|
| Development method | Surge block and pump |
| Development time | 1 hr. 40 min. |
| Estimated purge volume | 97 gal |

Comments #2 quartz sand, Filpro, US Silica
#0 Fine sand (quartz)

* Bentonite hydrated with 5 gal. Potable water.

| PROJECT NUMBER | WELL NUMBER | |
|---|---|---|
| 152130.FI.MW | 12MW15 | SHEET 1 OF 1 |

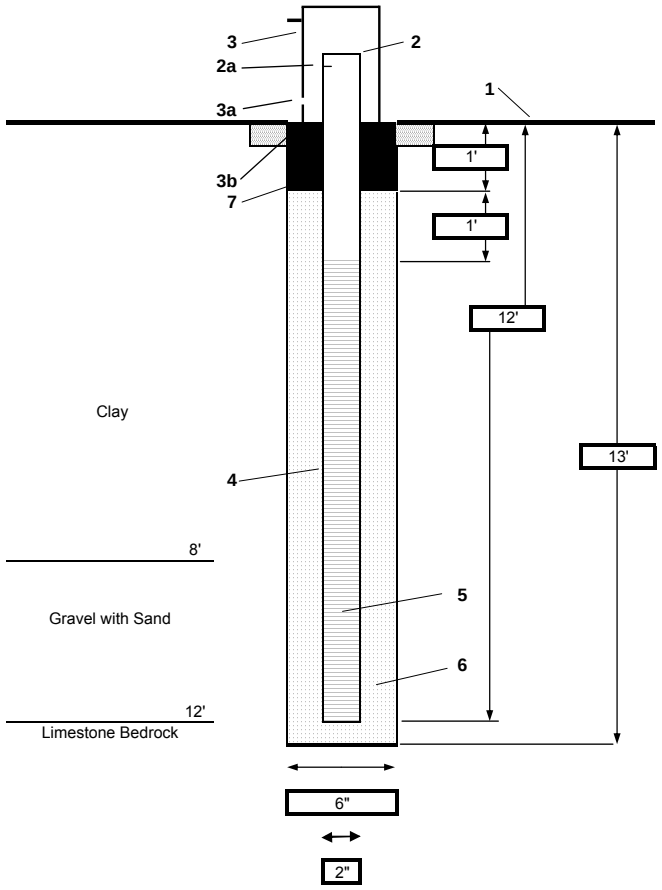
# WELL COMPLETION DIAGRAM

PROJECT : Allegany Ballistics Laboratory Site 12 Remedial Investigation LOCATION : Site 12

DRILLING CONTRACTOR : Miller Drilling Company, Inc.

DRILLING METHOD AND EQUIPMENT USED : 6" Tri-cone Roller Bit

WATER LEVELS : 8' During Drilling START : March 2003 END : March 2003 LOGGER : Leo Kurylo




| | |
|---|---|
| 1- Ground elevation at well | 667.25 feet amsl |
| 2- Top of casing elevation | 669.59 feet amsl |
| a) vent hole? | Yes |
| 3- Wellhead protection cover type | Steel aboveground casing |
| a) weep hole? | Yes |
| b) concrete pad dimensions | 3' x 3' x 6" |
| 4- Dia./type of well casing | 2-inch diameter PVC |
| 5- Type/slot size of screen | PVC<br>0.01" |
| 6- Type screen filter | Morie #2 Sand |
| a) Quantity used | 250 lbs |
| 7- Type of seal | Bentonite Pellets |
| a) Quantity used | 50 lbs |
| 8- Grout | |
| a) Grout mix used | None (see below) |
| b) Method of placement | |
| c) Vol. of well casing grout | |
| Development method | Downhole pump |
| Development time | 1 hour |
| Estimated purge volume | 60 gallons |

Comments Due to space constraints, well was completed with concrete placed directly on top of bentonite seal.

| PROJECT NUMBER | WELL NUMBER | |
|---|---|---|
| 152130.FI.MW | 12MW16 | SHEET 1 OF 1 |

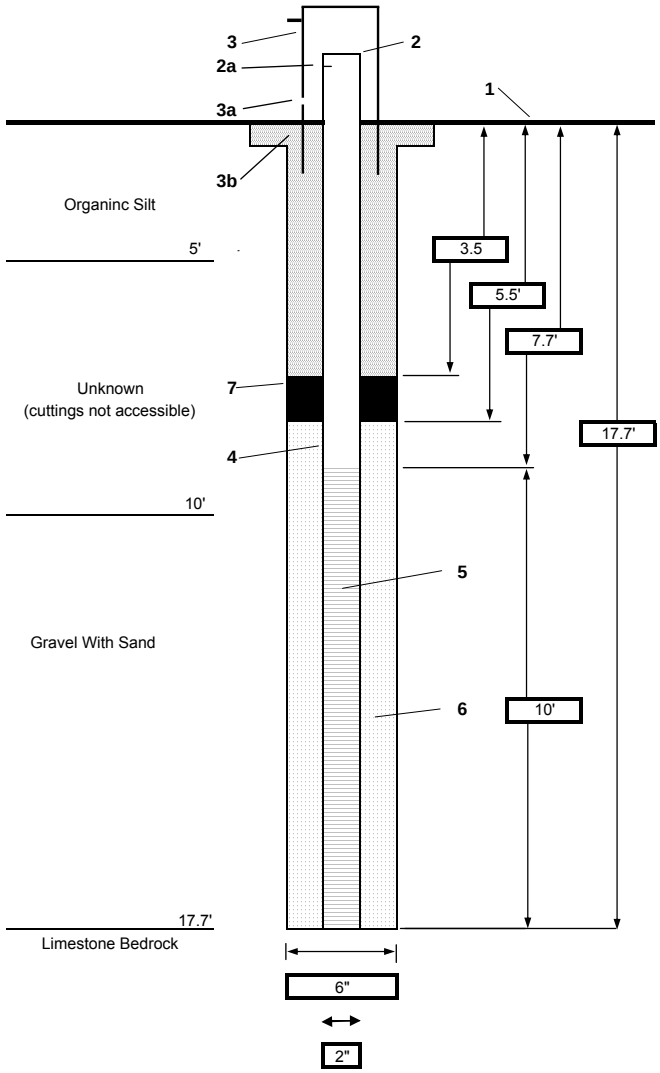
# WELL COMPLETION DIAGRAM

PROJECT : Allegany Ballistics Laboratory Site 12 Remedial Investigation LOCATION : Site 12

DRILLING CONTRACTOR : Miller Drilling Company, Inc.

DRILLING METHOD AND EQUIPMENT USED : 6" Tri-cone Roller Bit

WATER LEVELS : 10' During Drilling START : March 2003 END : March 2003 LOGGER : Leo Kurylo




| | |
|---|---|
| 1- Ground elevation at well | 668.61 feet amsl |
| 2- Top of casing elevation | 671.12 feet amsl |
| a) vent hole? | Yes |
| 3- Wellhead protection cover type | Steel aboveground casing |
| a) weep hole? | Yes |
| b) concrete pad dimensions | 3' x 3' x 6" |
| 4- Dia./type of well casing | 2-inch diameter PVC |
| 5- Type/slot size of screen | PVC<br>0.01" |
| 6- Type screen filter | Morie #2 Sand |
| a) Quantity used | 250 lbs |
| 7- Type of seal | Bentonite Pellets |
| a) Quantity used | 50 lbs |
| 8- Grout | |
| a) Grout mix used | None (see below) |
| b) Method of placement | |
| c) Vol. of well casing grout | |
| Development method | Downhole pump |
| Development time | 4 Hours |
| Estimated purge volume | 35 gallons |

Comments Due to space constraints, well was completed with concrete placed directly on top of bentonite seal.

| PROJECT NUMBER | WELL NUMBER | |
|---|---|---|
| 152130.FI.MW | 12MW18 | SHEET 1 OF 1 |

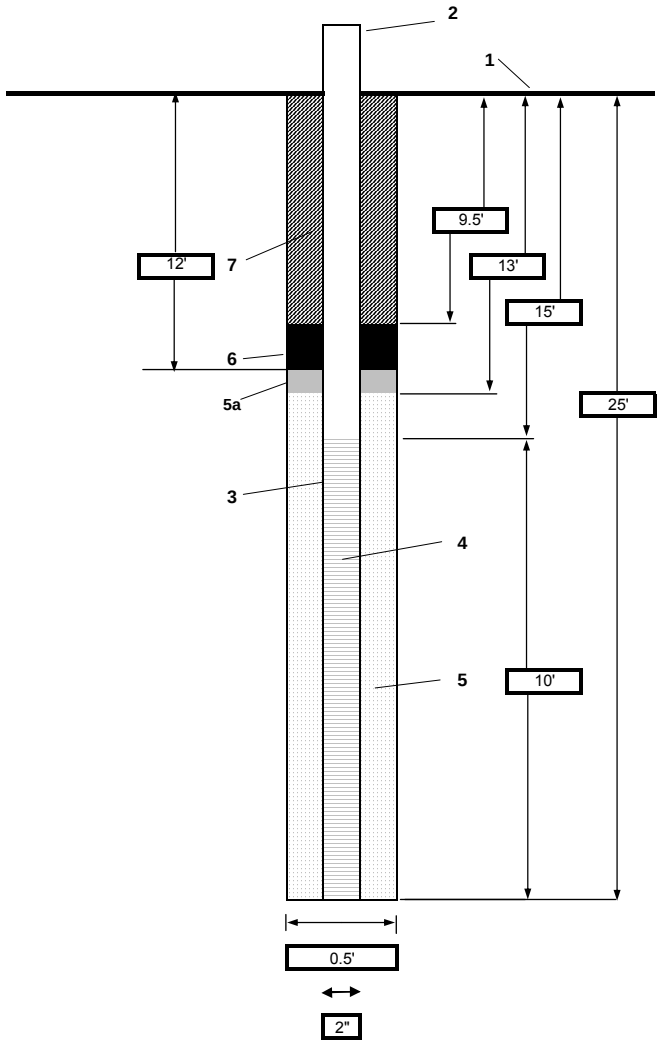
# WELL COMPLETION DIAGRAM

PROJECT : Allegany Ballistics Laboratory Site 12 Drilling and MW Installation LOCATION : Site 12, North Side of Bldg. 167

DRILLING CONTRACTOR Miller Drilling, Tracy Thrasher

DRILLING METHOD AND EQUIPMENT USED : Schramm T450 Rotodrill, 6" Dia. Casing Advancement

WATER LEVELS : START : 08/17/2003 END : 08/17/2003 LOGGER : E. Spande




| | | |
|---|---|---|
| 1- | Ground elevation at well | |
| 2- | Top of casing elevation | |
| | a) vent hole? | |
| 3- | Dia./type of well casing | 2" Diameter, Schedule 40 PVC |
| 4- | Type/slot size of screen | 0.010 Slot |
| 5- | Type screen filter | #2 Coarse sand, 7 50-lb bags |
| 5a- | Type screen filter | #0 Fine sand, 1/2 bag |
| 6- | Type of seal | 3/8" Bentonite pellets* |
| | a) Quantity used | 1 5-gal bucket |
| 7- | Type of seal | Cement grout |

| | |
|---|---|
| Development method | Surge block andpump |
| Development time | 1 hr. 40 min. |
| Estimated purge volume | 82 gal |

Comments #2 quartz sand, Filpro, US Silica
#0 Fine sand (quartz)

* Bentonite hydrated with 5 gal. Potable water.

| PROJECT NUMBER | WELL NUMBER | |
|---|---|---|
| 152130.FI.MW | 12MW19 | SHEET 1 OF 1 |

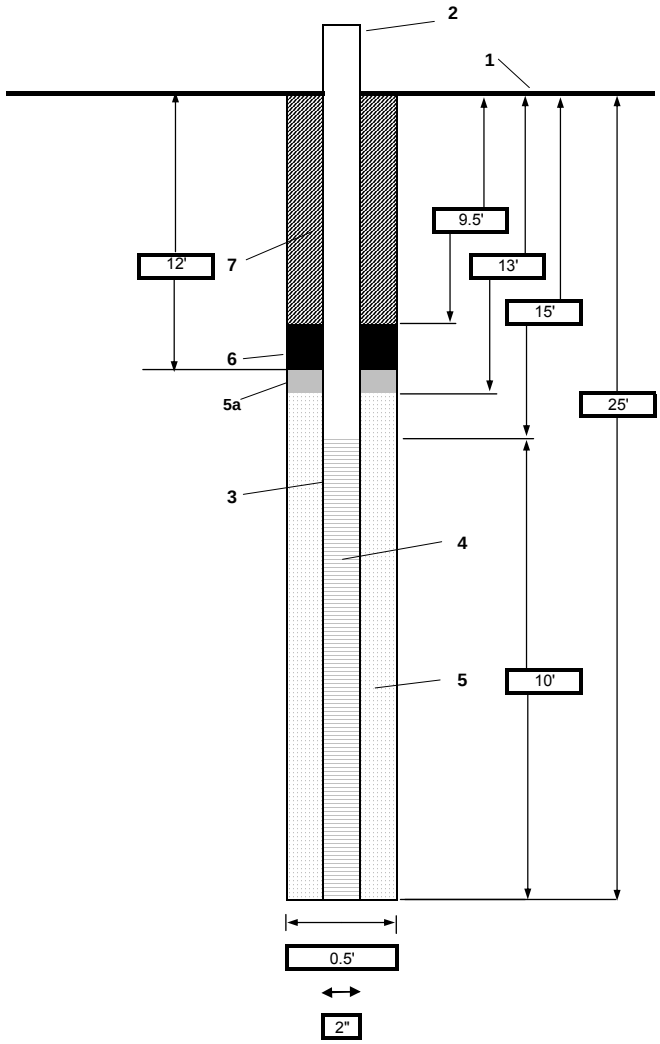
# WELL COMPLETION DIAGRAM

PROJECT : Allegany Ballistics Laboratory Site 12 Drilling and MW Installation LOCATION : Site 12, Between Bldgs. 214 and 167

DRILLING CONTRACTOR Miller Drilling, Tracy Thrasher

DRILLING METHOD AND EQUIPMENT USED : Schramm T450 Rotodrill, 6" Dia. Casing Advancement

WATER LEVELS : START : 08/17/2003 END : 08/17/2003 LOGGER : E. Spande




| | | |
|---|---|---|
| 1- | Ground elevation at well | |
| 2- | Top of casing elevation | |
| | a) vent hole? | |
| 3- | Dia./type of well casing | 2" Diameter, Schedule 40 PVC |
| 4- | Type/slot size of screen | 0.010 Slot |
| 5- | Type screen filter | #2 Coarse sand, 6 50-lb bags |
| 5a- | Type screen filter | #0 Fine sand, 1/2 bag |
| 6- | Type of seal | 3/8" Bentonite pellets* |
| | a) Quantity used | 1 5-gal bucket |
| 7- | Type of seal | Cement grout |

| | |
|---|---|
| Development method | Surge block and pump |
| Development time | 1 hr. 55 min. |
| Estimated purge volume | 117 gal |

Comments #2 quartz sand, Filpro, US Silica
#0 Fine sand (quartz)

* Bentonite hydrated with 5 gal. Potable water.

Note - Replacement well for original 12MW06 which was damaged during road construction.

| PROJECT NUMBER: | WELL NUMBER: |
|---|---|
| 344182.FI.MW.99 | 12MW23 |

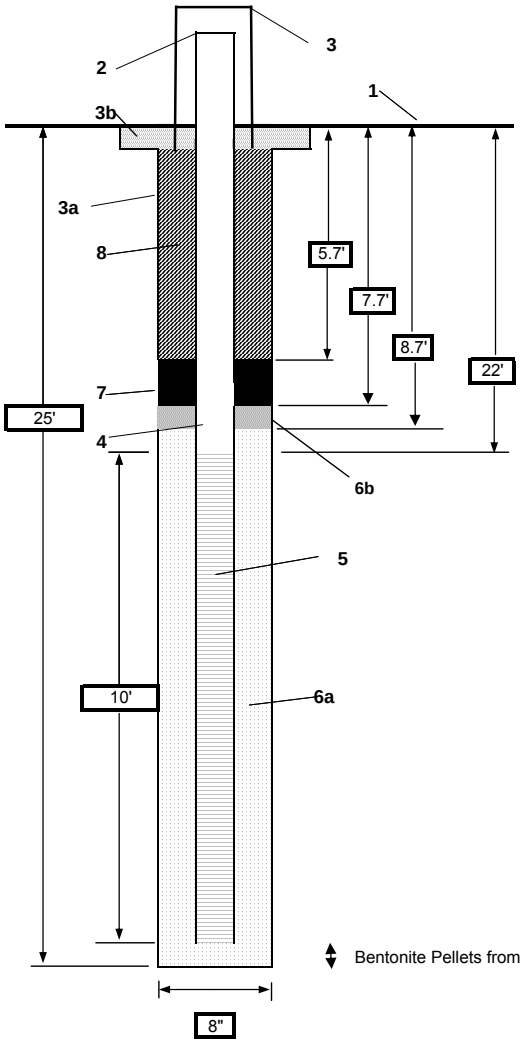
# WELL COMPLETION DIAGRAM

PROJECT : ABL MW Installation Sites 11, 12 and Range Road — LOCATION : Allegany Ballistics laboratory, Rocket Center, WV

DRILLING CONTRACTOR : Eichelbergers

DRILLING METHOD AND EQUIPMENT USED : Air Rotary

| WATER LEVELS: | START: | END: |
|---|---|---|




Bentonite Pellets from 25' - 22'

| | |
|---|---|
| 1- Ground elevation at well | 667.19' |
| 2- Top of casing elevation | 666.48' |
| 3- Wellhead protection cover type | Steel Flush Mount |
| a) Type of outer surface casing | 8" Steel |
| b) concrete pad dimensions | 2' x 2' x 2' |
| 4- Dia./type of inner well casing | 2.04" |
| 5- Type/slot size of screen | Schedule 40/ 0.01" slot |
| 6- Type screen filter | Filpro W.G #1 |
| a) #1 Quantity used | 34 bags |
| b) #00 Quantity used | 1/4 bag |
| 7- Type of seal | Bentonite Chips |
| a) Quantity used | 1 bag |
| 8- Grout | |
| a) Grout mix used | Portland w/ Bentonite 3-4% |
| b) Method of placement | |
| Development method | Whale Pump |
| Development time | 2 hours |
| Estimated purge volume | 250 gallons |

Final parameter: pH: 6.64, Conductivity: 1.25, Turbidity:39, DO:0.83, Temperature:17.9

CH2MHILL

| PROJECT NUMBER | BORING NUMBER |
|---|---|
| 152130.FI.MW | 12MW04 S/D |

# SOIL BORING LOG

PROJECT : ABL Drilling and MW Insta LOCATION : Site 12

DRILLING CONTRACTOR : Miller Drilling DRILLING METHOD & EQUIPMENT USED: Air hammer/ODEX bit

DEPTH TO WATER (ft. Bgs): START :3/8/03 END : 3/9/03 GGER : L. Kurylo

| DEPTH BELOW SURFACE (FT) | INTERVAL (FT) | RECOVERY (IN) | #/TYPE | STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N) | CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY. | USCS | COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole |
|---|---|---|---|---|---|---|---|
| | 0-3 | | | | Asphalt / concrete / fill - cuttings not conclusive | NA | FID = ambient |
| 5 | 3-5 | | | | Lean clay - brown, moist, soft (?), high plasticity, trace sand | CL | FID = ambient |
| 10 | 5-10 | | | | Lean clay - brown, moist, stiff (?), high plasticity, trace sand | CL | FID = ambient |
| 15 | 10-15 | | | | Lean clay - same as above (SAA) | CL | FID = ambient<br>Drill rate = 0.9 ft/min |
| 20 | 15-20 | | | | Clayey gravel with sand - brown, wet (?), dense (?), well graded gravel (fine to coarse), ~30% well graded fine to coarse sand, ~20% clay | GC | Water table at 15' bgs<br>FID = ambient<br>Driller added ~50 gallons of water to blow out cuttings |
| | 20-24 | | | | Clayey gravel with sand - SAA | GC | FID = ambient |
| 25<br>30 | 24-34 | | | | Limestone (possibly siltstone/shale) - black to dark gray, white mineral-filled seams/fractures, strong HCl rxn.<br>Driller reports fractures/easy drilling 31'-32' bgs | | Driller BZ, FID = ambient<br>Clyclone BZ, FID = 0.72 ppm<br>Cyclone, FID = 2.14 ppm |
| 35<br>40 | 34-41 | | | | Limestone - SAA | | Driller BZ, FID = ambient<br>Clyclone BZ, FID = 0.8 ppm<br>Cyclone, FID = 5.84 ppm |
| 45 | | | | | | | |

| CH2MHILL | PROJECT NUMBER 152130.FI.MW | BORING NUMBER 12MW04 S/D |
|---|---|---|

# ROCK BORING LOG

PROJECT : ABL Drilling and MW Install LOCATION : Site 12

DRILLING CONTRACTOR : Miller Drilling DRILLING METHOD & EQUIPMENT USED: 8" diameter air hammer

DEPTH TO WATER (ft. Bgs): START :3/30/03 END :3/30/03 LOGGER : L. Kurylo

| DEPTH BELOW SURFACE (FT) | INTERVAL (FT) | RECOVERY (IN) | #/TYPE | STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N) | LITHOLOGY Rock type, color, mineralogy, texture, weathering, hardnesss, and rock mass characteristics | USCS | COMMENTS Size and depth of casing, fluid loss, advance rate and smoothness, test results, etc. |
|---|---|---|---|---|---|---|---|
| 40 | | | | | SEE SOIL BORING LOG | | |
| 50, 60 | 41-60 | | | | Limestone (possibly siltstone/shale) - black to dark gray, CaCO3 veins slightly more common than 21' to 41' bgs, strong HCl rxn. | | |
| 70, 80 | 60-80 | | | | Limestone rock chips same as above (SAA). | | Drager tube for vinyl chloride is clogged with cuttings. No reading possible.<br><br>60 ' - Drill Rate = 1 ft/min |
| 90 | 80-90 | | | | Limestone - SAA | | Drillers added ~5 gallons of water to help blow out cuttings. |
| 100 | | | | | | | |

| CH2MHILL | PROJECT NUMBER 152130.FI.MW | BORING NUMBER 12MW05 S/D |
|---|---|---|

# SOIL BORING LOG

PROJECT : ABL Drilling and MW Install LOCATION : Site 12

DRILLING CONTRACTOR : Miller Drilling DRILLING METHOD & EQUIPMENT USED: Schramm T450 air rig and 12" diameter tri-cone roller bit

DEPTH TO WATER (ft. Bgs): START :3/4/03 END : 3/4/03 LOGGER : L. Kurylo

| DEPTH BELOW SURFACE (FT) | INTERVAL (FT) | RECOVERY (IN) | #/TYPE | STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N) | CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY. | USCS | COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole |
|---|---|---|---|---|---|---|---|
| 5 | 0-5 | | | | Lean clay - brown, moist, soft (?), low plasticity, trace sand and gravel | CL | Breathing zone (BZ) = ambien |
| 10 | 5-10 | | | | Lean clay - light brown to gray, moist, soft (?), medium plasticity, trace gravel | CL | BZ = 0.1 ppm above ambient<br>FID jumpiness may be due to dust, humidity from hole |
| 15 | 10-14 | | | | Lean clay - brown, moist, soft (?), medium plasticity, ~10% gravel | CL | BZ = 0.23 ppm above ambient<br>Drill rate ~0.5 ft/min |
| 20 | 14-20 | | | | Poorly graded sand - brown, dry, medium density (?), fine to medium grained, trace silt, trace gravel | SP | BZ = 0.39 ppm above ambient<br>Rig chatter |
| | 20-22 | | | | Poorly graded sand with silt - brown, wet, medium density, fine to medium grained, trace gravel, groundwater 21' bgs | SP-SM | BZ = 0.20 ppm above ambient |
| 25 | 22-27 | | | | Limestone - possibly siltstone/shale, dark gray to black, fissility not evident | | BZ = 0.14 ppm above ambient |
| 30 | | | | | | | |

| PROJECT NUMBER | BORING NUMBER |
|---|---|
| 152130.FI.MW | 12MW05 S/D |

# ROCK BORING LOG

PROJECT : ABL Drilling and MW Instal LOCATION : Site 12

DRILLING CONTRACTOR : Miller Drilling DRILLING METHOD & EQUIPMENT USED:

DEPTH TO WATER (ft. Bgs): START :4/1/03 END :4/1/03 LOGGER : L. Kurylo

| DEPTH BELOW SURFACE (FT) | INTERVAL (FT) | RECOVERY (IN) | #/TYPE | STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N) | LITHOLOGY Rock type, color, mineralogy, texture, weathering, hardnesss, and rock mass characteristics | USCS | COMMENTS Size and depth of casing, fluid loss, advance rate and smoothness, test results, etc. |
|---|---|---|---|---|---|---|---|
| 20 | | | | | SEE SOIL BORING LOG | | |
| 30 | 27-35 | | | | Missed rock cuttings. Will assume this interval is the same as 35' to 40' as 35' to 40' is the same as 22' to 27' with minor differences. | | |
| | 35-40 | | | | Limesone - dark gray to black, strong reaction to HCl, ~5% white $CaCO_3$ veins in rock chips | | |
| 40 | 40-45 | | | | Same as above (SAA), distinct sulfur odor present | | Driller BZ = 0.5 ppm on FID<br>At Cyclone, FID=3.6 ppm<br>Cyclone BZ, FID=0.0 ppm |
| | 45-50 | | | | Limestone - SAA<br>Brown substance (apppears to be naturally occuring) floating on drill cuttings water/mud | | Driller reports soft drilling at 50' bgs<br>Drill rate = 2.5 ft/min |
| 50 | 50-55 | | | | Limestone - SAA | | |
| | 55-60 | | | | Limestone - SAA | | |
| 60 | | | | | | | |
| 70 | | | | | | | |
| 80 | | | | | | | |

| PROJECT NUMBER | BORING NUMBER |
|---|---|
| 152130.FI.MW | 12MW07 S/D |

# SOIL BORING LOG

PROJECT : ABL Drilling and MW Instal LOCATION : Site 12

DRILLING CONTRACTOR : Miller Drilling DRILLING METHOD & EQUIPMENT USED: 12" diameter ODEX

DEPTH TO WATER (ft. Bgs): START :3/6/03 END : 3/6/03 LOGGER : L. Kurylo

| DEPTH BELOW SURFACE (FT) | INTERVAL (FT) | RECOVERY (IN) | #/TYPE | STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N) | CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY. | USCS | COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole |
|---|---|---|---|---|---|---|---|
| | 0-1 | | | | Asphalt | NA | |
| 5 | 1-5 | | | | Lean clay - brown, moist, soft (?), medium to high plasticity, trace sand | CL | FID = ambient |
| 10 | 5-10 | | | | Lean clay - same as above (SAA) | CL | FID = ambient |
| 15 | 10-15 | | | | Lean clay - SAA | CL | FID = ambient<br>Drill rate ~0.4 ft/min |
| | 15-17 | | | | Lean clay - SAA | CL | FID = ambient |
| | 17-18 | | | | Poorly graded gravel - large cobble or boulder, HCl rxn - limestone or dolostone | GP | FID = ambient<br>Groundwater 17'-18' bgs |
| 20 | 18-21 | | | | Lean clay with gravel - brwon, wet, very soft (?), high plasticity (?), fine to medium grained grave (~20%) | CL | FID = ambient |
| | 21-23 | | | | Lean clay with gravel - SAA | CL | Cyclone FID = 2.15 ppm<br>Breathing zone, FID = ambient |
| 25 | 23-28 | | | | Limestone (possibly siltstone/shale) - black to dark gray, strong HCl rxn, fissility not apparent | | Breathing zone, FID = ambient<br>Driller added ~75 total gallons of water to help remove cuttings. |
| 30 | | | | | | | |

| CH2MHILL | PROJECT NUMBER 152130.FI.MW | BORING NUMBER 12MW07 S/D |
|---|---|---|

# ROCK BORING LOG

PROJECT : ABL Drilling and MW Insta LOCATION : Site 12

DRILLING CONTRACTOR : Miller Drilling DRILLING METHOD & EQUIPMENT USED: 8" diameter air hammer

DEPTH TO WATER (ft. Bgs): START :3/18/03 END : 4/1/03 LOGGER : L. Kurylo

| DEPTH BELOW SURFACE (FT) | INTERVAL (FT) | RECOVERY (IN) | #/TYPE | STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N) | LITHOLOGY Rock type, color, mineralogy, texture, weathering, hardnesss, and rock mass characteristics | USCS | COMMENTS Size and depth of casing, fluid loss, advance rate and smoothness, test results, etc. |
|---|---|---|---|---|---|---|---|
| 20 | | | | | SEE SOIL BORING LOG | | |
| 30 | 28-30 | | | | Limestone - black to dark gray, strong HCl rxn, fissility not apparent | | |
| | 30-35 | | | | Limestone - same as above (SAA)<br>Drilling stopped due to fumes | | Cyclone BZ, FID = 30.18 ppm<br>Driller BZ, FID = 2.65 ppm |
| 40 | 35-40 | | | | Limestone - black to dark gray, strong HCl rxn, fissility not apparent, ~10% white to light gray calcite veins | | Driller BZ. FID = 0.0 ppm<br>Cyclone, FID = 0.0 ppm<br>Drager tube for vinyl chloride = non-detect |
| | 40-45 | | | | SAA | | |
| 50 | 45-50 | | | | SAA | | All cuttings deposited in roll-off bin |
| | 50-55 | | | | SAA | | Drilling rate = 4 ft/min |
| 60 | 55-60 | | | | SAA | | Drager tube for methylene chloride = non-detect at drill rods |
| | 60-65 | | | | SAA | | |
| 70 | 65-70 | | | | SAA | | Driller BZ, FID = 0.0 ppm |
| | 70-75 | | | | SAA | | Cyclone, FID = 0.0 ppm |
| 80 | 75-80 | | | | SAA | | Exclusion zone perimeter, FID = 0.0 ppm<br>Drilling rate = 2.5 ft/miin |
| | 80-85 | | | | SAA | | Driller BZ, FID = 0.0 ppm |
| 90 | 85-90 | | | | SAA - dark brown organic substance floating on drill cutting water/mud (appears to be naturally occuring) | | Cyclone, FID = 4.2 ppm (at 86' bgs) |
| | | | | | | | |

| CH2MHILL | PROJECT NUMBER 152130.FI.MW | BORING NUMBER 12MW09 S/D |
|---|---|---|

# SOIL BORING LOG

PROJECT : ABL Drilling and MW Insta LOCATION : Site 12

DRILLING CONTRACTOR : Miller Drilling DRILLING METHOD & EQUIPMENT USED: Air hammer/ODEX bit

DEPTH TO WATER (ft. Bgs): START :3/11/03 END : 3/29/03 GGER : L. Kurylo

| DEPTH BELOW SURFACE (FT) | INTERVAL (FT) | RECOVERY (IN) | #/TYPE | STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N) | CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY. | USCS | COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole |
|---|---|---|---|---|---|---|---|
| 5 | 0-5 | | | | Organic soil - dark brown, moist, soft (?), low plasticity, trace fine sand, ~10% light brown/orange mottling | OH/OL | FID = ambient |
| 10 | 5-10 | | | | Lean clay - brown, moist (? - driller adding water), soft (?), high plasticity, trace sand | CL | Driller breathing zone (BZ), FID = ambient<br>Cylcone BZ, FID = 0.64 ppm<br>Cyclone, FID = 1.19 ppm |
| 15 | 10-15 | | | | Poorly graded gravel with clay - brown, moist (? - driller adding water), dense (?), ~10% clay, medium grained gravel, distinct odor at cyclone. | GP-GC | Driller BZ, FID = ambient<br>Cylcone BZ, FID = 0.64 ppm<br>Cyclone, FID = 7.84 ppm |
| 20 | 15-20 | | | | Poorly graded gravel with clay - same as above (SAA) | GP-GC | Driller BZ, FID = ambient<br>Cylcone BZ, FID = 0.83 ppm<br>Cyclone, FID = 9.91 ppm<br>Drilling stopped due to high FID readings. Resumed 3/29/03 |
| 25 | 20-26 | | | | Poorly graded gravel with clay - SAA | GP-GC | Driller BZ, FID between 3 and 5 ppm |
| 30 | 26-34 | | | | Limestone - black to dark gray, strong HCl reaction, light gray to white veins of $CaCO_3$ rare (~5%) | | FID = ambient<br>Drager tube non-detect for vinyl chloride<br>Drill rate = 0.5 ft/min |
| 35 | | | | | | | |
| 40 | | | | | | | |

| CH2MHILL | PROJECT NUMBER 152130.FI.MW | BORING NUMBER 12MW09 S/D |
|---|---|---|

# ROCK BORING LOG

PROJECT : ABL Drilling and MW Install LOCATION : Site 12

DRILLING CONTRACTOR : Miller Drilling DRILLING METHOD & EQUIPMENT USED: 8" diameter air hammer

DEPTH TO WATER (ft. Bgs): START :3/17/03 END :3/18/03 LOGGER : L. Kurylo

| DEPTH BELOW SURFACE (FT) | INTERVAL (FT) | RECOVERY (IN) | #/TYPE | STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N) | LITHOLOGY Rock type, color, mineralogy, texture, weathering, hardnesss, and rock mass characteristics | USCS | COMMENTS Size and depth of casing, fluid loss, advance rate and smoothness, test results, etc. |
|---|---|---|---|---|---|---|---|
| 30 | | | | | SEE SOIL BORING LOG | | |
| 40<br>50<br>60 | 34-60 | | | | Limestone - rock chips are similar to 26' to 34' drilling - black to dark gray, strong HCl reaction, light gray to white veins of CaCO3 rare (~5%) | | Drill rate = 1.5 ft/min<br>Driller reports fractures at 57' bgs |
| 70<br>80 | 60-80 | | | | Limestone - rock chips same as above (SAA) | | Driller reports soft drilling at 70' bgs |
| 90 | 80-90 | | | | Limestone - SAA | | |

| CH2MHILL | PROJECT NUMBER 152130.FI.MW | BORING NUMBER 12MW11 S/D |
|---|---|---|

# SOIL BORING LOG

PROJECT : ABL Drilling and MW Install LOCATION : Site 12

DRILLING CONTRACTOR : Miller Drilling DRILLING METHOD & EQUIPMENT USED:

DEPTH TO WATER (ft. Bgs): START :3/10/03 END : 3/10/03 LOGGER : L. Kurylo

| DEPTH BELOW SURFACE (FT) | INTERVAL (FT) | RECOVERY (IN) | #/TYPE | STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N) | CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY. | USCS | COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole |
|---|---|---|---|---|---|---|---|
| 5 | 0-5 | | | | Lean clay - brown, moist, soft (?), medium plasticity, trace fine to coarse gravel | CL | Breathing zone (BZ) = ambient |
| 10 | 5-10 | | | | Lean clay - brown, moist, soft (?), medium plasticity, trace fine to coarse gravel | CL | Breathing zone (BZ), FID = ambient<br>Cyclone, FID = 0.7 ppm<br>Warm, moist air from cyclone may be affecting FID readings<br>Driller added ~5 gal. Of water to blow out cuttings. |
| 15 | 10-15 | | | | Poorly graded gravel with sand - Brown, wet (? - driller adding water), dense (?), ~20% sand, trace clay/silt | GP | BZ, FID = ambient<br>Down wind of yclone, FID = 0.2 ppm<br>Drill rate = 0.5 ft/min<br>Driller reports groundwater at 15' bgs |
| 20 | 15-20 | | | | Poorly graded gravel with clay and sand - Brown, wet (? - driller adding water), dense (?), ~20% sand, ~10% clay | GP-GC | Breathing zone (BZ), FID = ambient<br>Cyclone, FID = 0.2 ppm |
| | 20-22 | | | | Poorly graded gravel with clay and sand - Brown, wet (? - driller adding water), dense (?), ~20% sand, ~10% clay | GP-GC | BZ, FID = ambient<br>Down wind of yclone, FID = 0.4 ppm |
| 25<br>30 | 22-30 | | | | Limestong (possibly siltstone/shale) - Dark gray to black, stong HCl reaction<br>Dark organic substance on rock cuttings | | Breathing zone (BZ), FID = ambient<br>Cyclone, FID = 0.6 ppm<br>Cyclone BZ, FID = 0.3 ppm<br>Driller added 50 gallons of water to help blow out cuttings. |

| CH2MHILL | PROJECT NUMBER 152130.FI.MW | BORING NUMBER 12MW11 S/D |
|---|---|---|

# ROCK BORING LOG

PROJECT : ABL Drilling and MW Install LOCATION : Site 12

DRILLING CONTRACTOR : Miller Drilling DRILLING METHOD & EQUIPMENT USED:

DEPTH TO WATER (ft. Bgs): START :3/17/03 END :3/18/03 LOGGER : L. Kurylo

| DEPTH BELOW SURFACE (FT) | INTERVAL (FT) | RECOVERY (IN) | #/TYPE | STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N) | LITHOLOGY Rock type, color, mineralogy, texture, weathering, hardnesss, and rock mass characteristics | USCS | COMMENTS Size and depth of casing, fluid loss, advance rate and smoothness, test results, etc. |
|---|---|---|---|---|---|---|---|
| 30 | | | | | SEE SOIL BORING LOG | | |
| | 30-35 | | | | Limestone - Dark gray to black, HCl reaction, black organic substance on drill water (appears to be naturally occuring) | | Driller breathing zone (BZ), FID = 0.2 ppm |
| 40 | 35-42 | | | | Limestone - same as above (SAA) | | Driller BZ, FID = 0.2 ppm<br>End drilling - rig's water line broke |
| | 42-45 | | | | Limestone - SAA | | Not measured<br>Driller reports easy drilling |
| 50 | 45-50 | | | | Limestone - SAA | | Cyclone BZ, FID = 0.92 ppm<br>Cyclone, FID = 4.28 ppm<br>Drill rate = 2 ft/min |
| | 50-55 | | | | Limestone - SAA | | Driller BZ, FID = ambient<br>Cyclone BZ, FID = ambient |
| 60 | 55-60 | | | | Limestone - SAA | | Driller BZ, FID = ambient<br>Cyclone BZ, FID = ambient |
| | 60-65 | | | | Linestone - SAA | | Driller BZ, FID = ambient<br>Cyclone BZ, FID = ambient |
| 70 | 65-70 | | | | Limestone - SAA | | Driller BZ, FID = ambient<br>Cyclone BZ, FID = ambient<br>Driller reports harder rock at 70' bgs |
| | 70-75 | | | | Limestone - SAA | | Not measured |
| 80 | 75-80 | | | | Limestone - SAA | | Driller BZ, FID = ambient<br>Cyclone BZ, FID = 0.81ppm<br>Cyclone, FID = 3.26 ppm |
| | 80-85 | | | | Limestone - SAA | | Driller BZ, FID = ambient<br>Cyclone BZ, FID = ambient |
| 90 | 85-90 | | | | Limestone - SAA | | Driller BZ, FID = ambient<br>Cyclone BZ, FID = ambient<br>Driller reports adding 150 gal. water to help blow out cuttings from 30' - 90' bgs |

| CH2MHILL | PROJECT NUMBER 152130.FI.MW | BORING NUMBER 12MW13 S/D |
|---|---|---|

# SOIL BORING LOG

PROJECT : ABL Drilling and MW Install LOCATION : Allegeny Ballistics Laboratory, Rocket Center, WV; north side of Bldg. 214

DRILLING CONTRACTOR : Miller Drilling DRILLING METHOD & EQUIPMENT USED: Schramm T450, 6" casing advance ODEX

DEPTH TO WATER (ft. Bgs): START :8/13/03 END : 8/14/03 LOGGER : E. Spande

| DEPTH BELOW SURFACE (FT) | INTERVAL (FT) | RECOVERY (IN) | #/TYPE | STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N) | CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY. | USCS | COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole |
|---|---|---|---|---|---|---|---|
| 5, 10 | 0-10 | | | | Silt - brown, moist, some fine gravel, clayey<br>Clay - brown, moist, sility; some grey clay | ME<br>CE | Soil bogged from soil and rock fragments at the top of the borehole and from cyclone discharge during air rotary. Intervals and lithologic classifications uncertain. |
| 15, 20 | 10-22 | | | | Clay and silt, same as above<br>More sand and pulverized rock, moist-dry<br>Mostly sand, may have finely pulberided rock, dry | ME, CE<br>CC<br>SC | No odors to 22' bgs<br>Driller reports more sandat 15' bgs. No water until approx. 22' bgs. Very little rock. |
| 25 | | | | | Gravel with sand and silt<br>Brown and grey, wet, gravel and rock chips, fine-coarse, some gravel rounded | GM | End 8/13/03 1900<br>Start 8/14/03 0825 |
| 30 | | | | | BEDROCK AT 25' BGS | | Bedrock - black shale, may be black limestone<br>Set isolation casing to 31' bgs |

| CH2MHILL | PROJECT NUMBER 152130.FI.MW | BORING NUMBER 12MW13 S/D |
|---|---|---|

# ROCK BORING LOG

PROJECT : ABL Drilling and MW Install LOCATION : Allegeny Ballistics Laboratory, Rocket Center, WV; north side of Bldg. 214, between Bldgs. 214 and 385

DRILLING CONTRACTOR : Miller Drilling DRILLING METHOD & EQUIPMENT USED: Schramm T450, 6" casing advance ODEX

DEPTH TO WATER (ft. Bgs): START :8/16/03 END : 8/16/03 LOGGER : E. Spande

| DEPTH BELOW SURFACE (FT) | INTERVAL (FT) | RECOVERY (IN) | #/TYPE | STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N) | LITHOLOGY Rock type, color, mineralogy, texture, weathering, hardnesss, and rock mass characteristics | USCS | COMMENTS Size and depth of casing, fluid loss, advance rate and smoothness, test results, etc. |
|---|---|---|---|---|---|---|---|
| 20 | | | | | | | |
| | 25-30 | | | | shale*, black clogged from chips | | Bedrock at 25.5 ft bgs |
| 30 | | | | | | | |
| | 30-60 | | | | shale*, dark grey, dry<br><br>Hit water at 38', water yellow brown | | Isolation casting set to 31' bgs<br><br>Possible fracture zone at approx. 45'. Stopped rig. Too much water. Going to get poly tank.<br><br>Note significant coarse sand in black shale cuttings. Water very silty.<br><br>Increased water discharge. Driller reports ~1ft drop by a void approx. 55 ft bgs. Discharge rate approx 80-100 gpm (6 min. drill, 500 gal water)<br><br>TD 59' bgs on 8/16/03 |
| 40 | | | | | | | |
| 50 | | | | | | | |
| 60 | | | | | | | |
| 70 | | | | | | | |

Notes * could be somewhat fissile black limestone

| CH2MHILL | PROJECT NUMBER 152130.FI.MW | BORING NUMBER 12MW17 S/D |
|---|---|---|

# SOIL BORING LOG

PROJECT : ABL Drilling and MW Install LOCATION : Allegeny Ballistics Laboratory, Rocket Center, WV; between Bldgs. 214 and 167

DRILLING CONTRACTOR : Miller Drilling DRILLING METHOD & EQUIPMENT USED: Schramm T450, 12" casing advance

DEPTH TO WATER (ft. Bgs): START :8/27/03 END : 8/28/03 LOGGER : E. Spande

| DEPTH BELOW SURFACE (FT) | INTERVAL (FT) | RECOVERY (IN) | #/TYPE | STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N) | CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY. | USCS | COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole |
|---|---|---|---|---|---|---|---|
| 5 | 0-10 | | | | Clay - brown, moist, silty, some fine gravel. | Ce | PID and FID readings in fieldbook<br>Logged from cuttings from cyclone. Lithologies and intervals indistinct. |
| 10 | | | | | | | End 8/27/03 1600 |
| | | | | | | | Resume 8/28/03 0810 |
| 15 | | | | | 14' - clay with gravel - brown, moist, gravel fine-coarse, subrounded to angular | CE | |
| | | | | | 17' - clayey gravel- brown, moist, gravel fine-coarse, subrounded to fractured. | GM | |
| 20 | | | | | 19' - limestone with sand and silt - likely soft or decomposed dedrock, dry, "limestone" dark grey, could be shale | | Bedrock |
| 25 | | | | | 22' - bedrock - hard | | |
| 30 | | | | | TD 26' bgs | | |

| CH2MHILL | PROJECT NUMBER 152130.FI.MW | BORING NUMBER 12MW17 S/D |
|---|---|---|

# ROCK BORING LOG

PROJECT : ABL Drilling and MW Install LOCATION : Allegeny Ballistics Laboratory, Rocket Center, WV; between Bldgs. 214 and 167

DRILLING CONTRACTOR : Miller Drilling DRILLING METHOD & EQUIPMENT USED: Schramm T450 Rotodrill, 8" air hammer

DEPTH TO WATER (ft. Bgs): START :8/16/03 END : 8/16/03 LOGGER : E. Spande

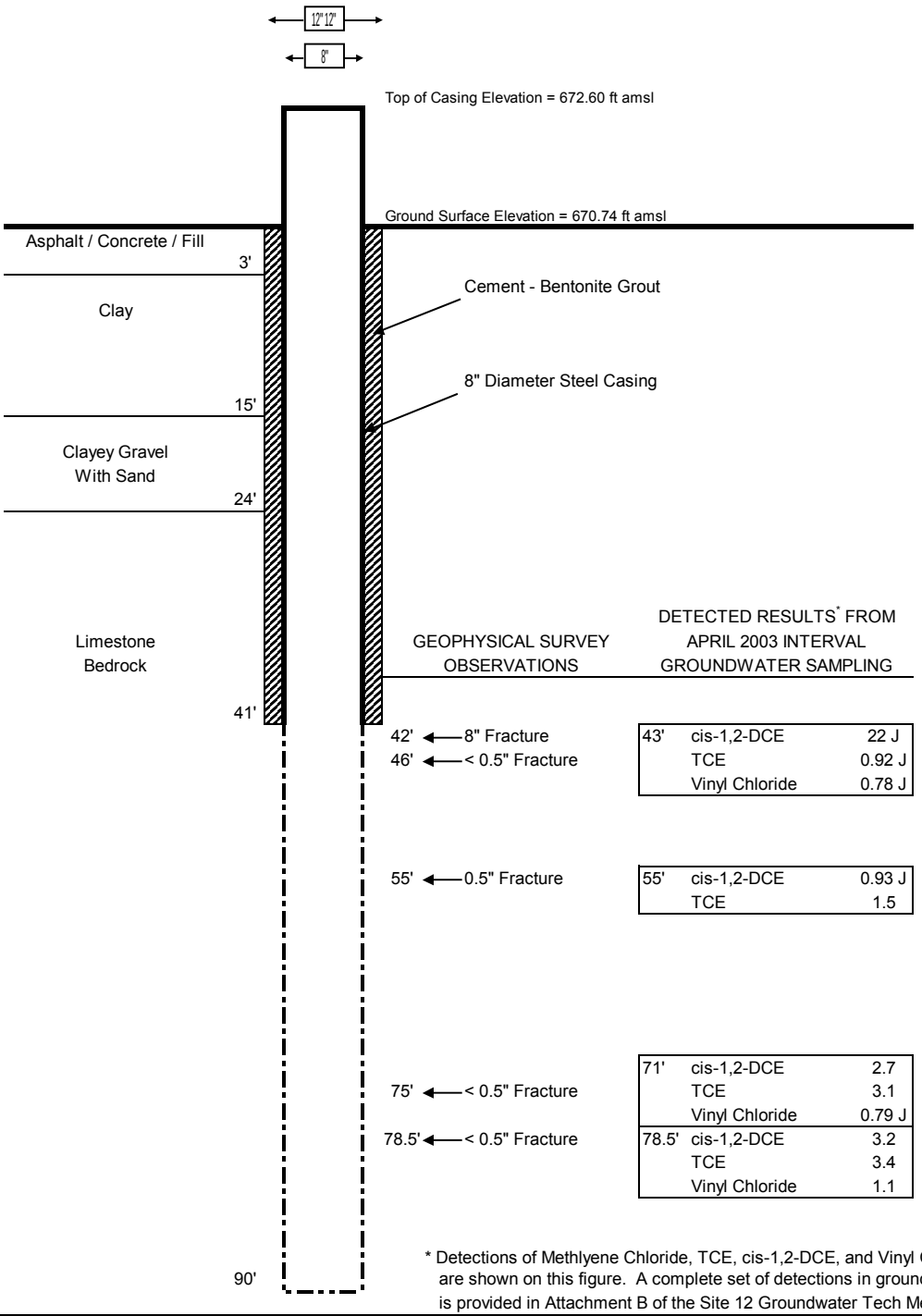
| DEPTH BELOW SURFACE (FT) | INTERVAL (FT) | RECOVERY (IN) | #/TYPE | STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N) | LITHOLOGY Rock type, color, mineralogy, texture, weathering, hardnesss, and rock mass characteristics | USCS | COMMENTS Size and depth of casing, fluid loss, advance rate and smoothness, test results, etc. |
|---|---|---|---|---|---|---|---|
| 20 | | | | | 19' bgs - shale*, dark grey, soft<br>22' bgs - firmer<br>Base of isolation casing | | |
| 30 | | | | | Shale, dark grey, almost pulverized, some coarse sand sized white chips (chert?) and some yellow-brown chert fragments(1-2 cm)<br>FRACTURE ZONE - 30'<br>bit drop | | Start of 8" air hammer<br>Minimal water production, black organic-looking material on water (similar to what was seen when drilling through shale)<br>0857 150 gal (approx 15 gpm) |
| 40 | | | | | | | |
| 50 | | | | | FRACTURE ZONE - 50'<br>bit drop<br>FRACTURE ZONE - 53'<br>bit drop | | 0902 300 gal (25 gpm)<br>0909 550 gal, stop to decant water at 61' bgs<br>0936 Restart, having a hard time keeping up (70 gpm pump and bail with bucket)<br>0940 150 gal<br>-Overflow into plastic-lined basin<br>0944 200 gal, stop too much at 71'<br>-pump clogged with cuttings<br>-continue to pump into polly<br>0951 Restart, pump able to catch up when not clogged<br>0953 Stop, Q rate approx 60 gmp, 75' bgs<br>1022 Restart, poly at 100 gal, 70 gpm, pump not keeping up and overflow to plastic-lined basin<br>1027 Stop, shut down power and pump stopped |
| 60 | | | | | | | |
| 70 | | | | | | | |
| 80 | | | | | TD 78' BGS | | |

Notes * shale could be organic limestone, rock is almost too pulverized to tell

| CH2MHILL | PROJECT NUMBER | WELL NUMBER |
|---|---|---|
| | 152130.FI.MW | 12MW4S/D |

# BOREHOLE COMPLETION DIAGRAM

PROJECT : Allegany Ballistics Laboratory Site 12 Remedial Investigation LOCATION: Site 12
DRILLING CONTRACTOR: Miller Drilling Company, Inc.
DRILLING METHOD AND EQUIPMENT USED: 12" Casing Advancement / 8" Air Hammer
WATER LEVELS : 15' During Drilling START: March 2003 END: April 2003 LOGGER: Leo Kurylo



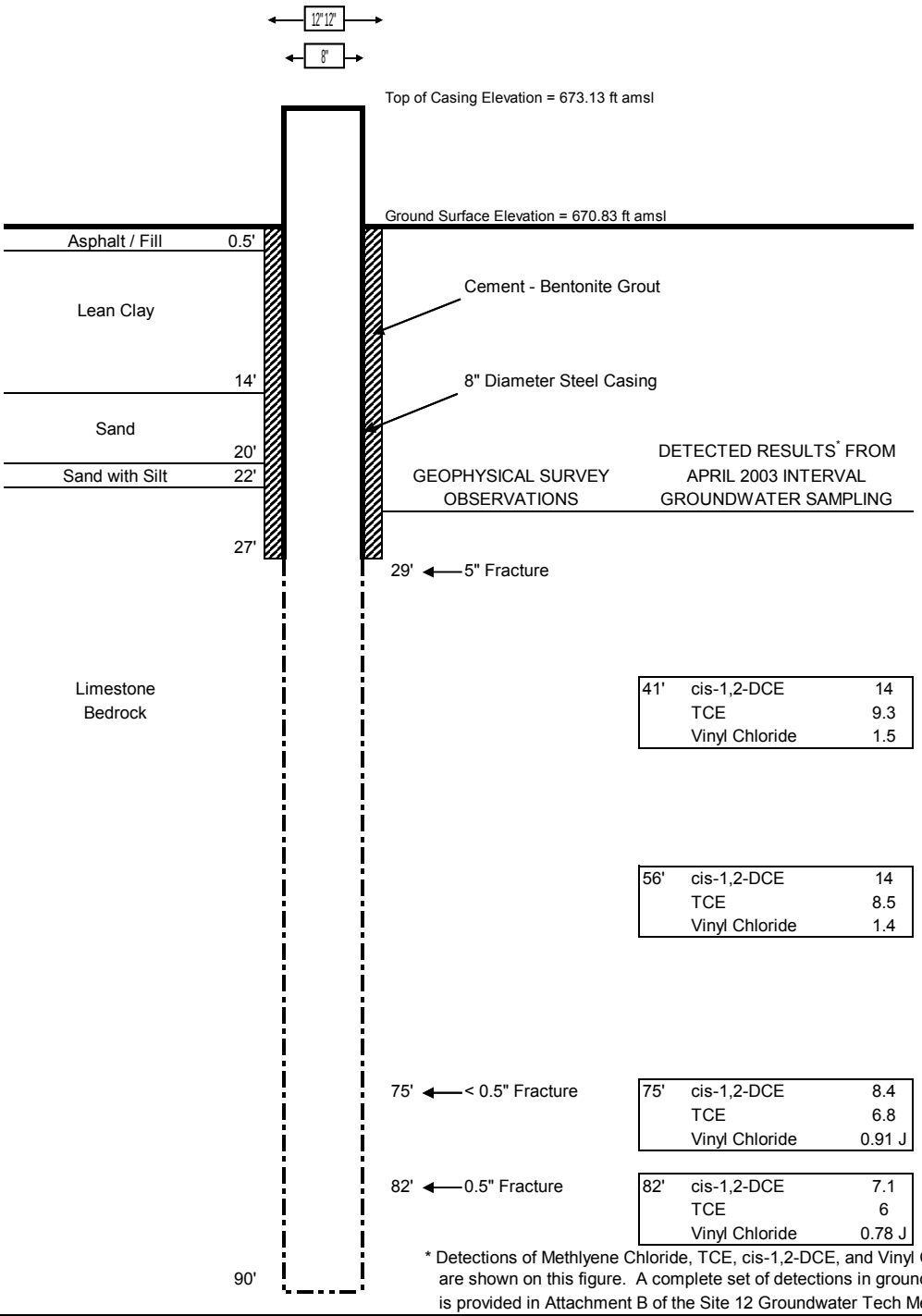

| GEOPHYSICAL SURVEY OBSERVATIONS | DETECTED RESULTS* FROM APRIL 2003 INTERVAL GROUNDWATER SAMPLING | | |
|---|---|---|---|
| 42' 8" Fracture | 43' | cis-1,2-DCE | 22 J |
| 46' < 0.5" Fracture | | TCE | 0.92 J |
| | | Vinyl Chloride | 0.78 J |
| 55' 0.5" Fracture | 55' | cis-1,2-DCE | 0.93 J |
| | | TCE | 1.5 |
| | 71' | cis-1,2-DCE | 2.7 |
| 75' < 0.5" Fracture | | TCE | 3.1 |
| | | Vinyl Chloride | 0.79 J |
| 78.5' < 0.5" Fracture | 78.5' | cis-1,2-DCE | 3.2 |
| | | TCE | 3.4 |
| | | Vinyl Chloride | 1.1 |

* Detections of Methlyene Chloride, TCE, cis-1,2-DCE, and Vinyl Chloride are shown on this figure. A complete set of detections in groundwater is provided in Attachment B of the Site 12 Groundwater Tech Memo.

| CH2MHILL | PROJECT NUMBER | WELL NUMBER |
|---|---|---|
| | 152130.FI.MW | 12MW5S/D |

# BOREHOLE COMPLETION DIAGRAM

PROJECT : Allegany Ballistics Laboratory Site 12 Remedial Investigation LOCATION: Site 12
DRILLING CONTRACTOR: Miller Drilling Company, Inc.
DRILLING METHOD AND EQUIPMENT USED: 12" Casing Advancement / 8" Air Hammer
WATER LEVELS : 21' During Drilling START: March 2003 END: April 2003 LOGGER: Leo Kurylo

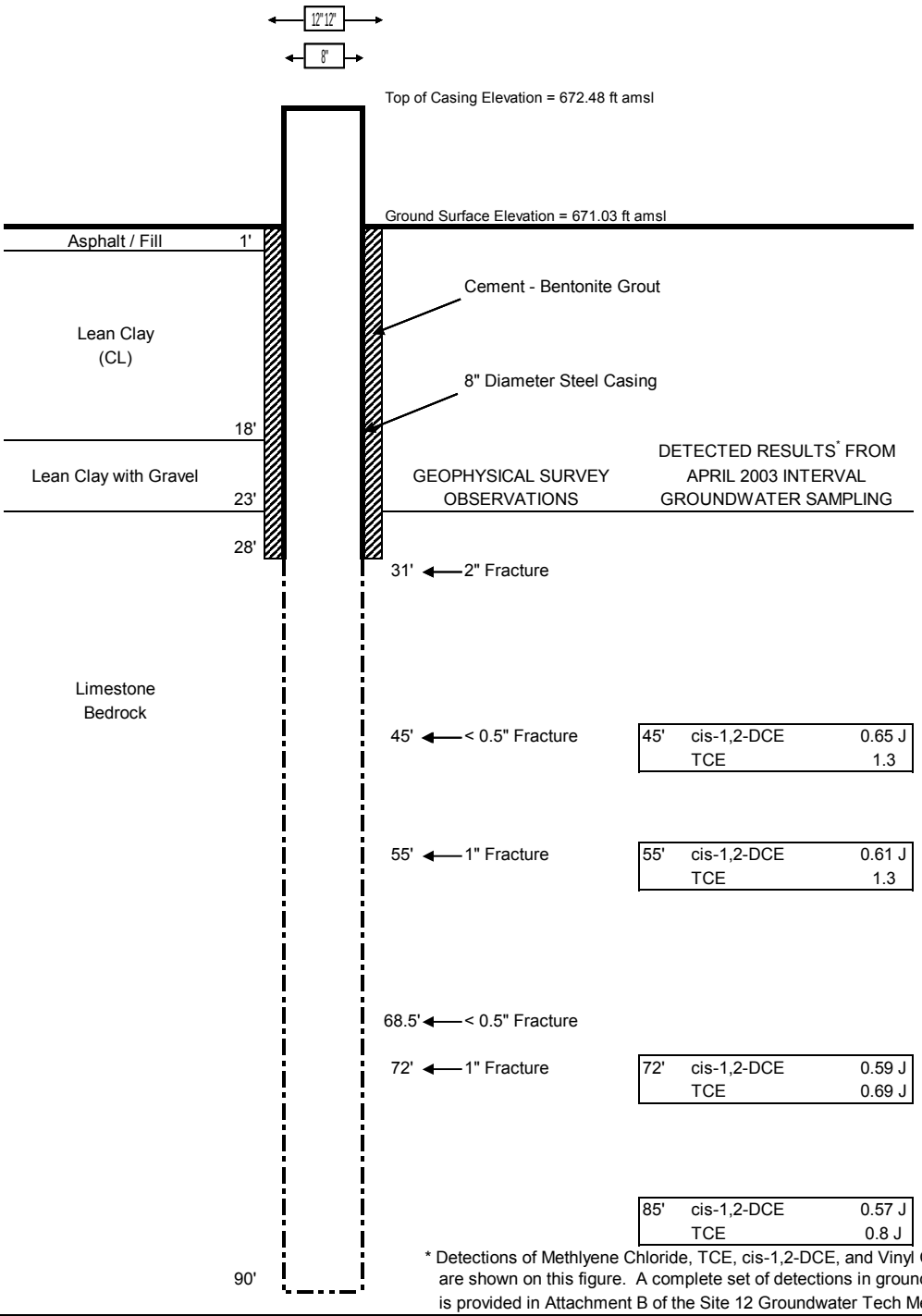



* Detections of Methlyene Chloride, TCE, cis-1,2-DCE, and Vinyl Chloride are shown on this figure. A complete set of detections in groundwater is provided in Attachment B of the Site 12 Groundwater Tech Memo.

| CH2MHILL | PROJECT NUMBER | WELL NUMBER |
|---|---|---|
| | 152130.FI.MW | 12MW7S/D |

# BOREHOLE COMPLETION DIAGRAM

PROJECT : Allegany Ballistics Laboratory Site 12 Remedial Investigation LOCATION: Site 12
DRILLING CONTRACTOR: Miller Drilling Company, Inc.
DRILLING METHOD AND EQUIPMENT USED: 12" Casing Advancement / 8" Air Hammer
WATER LEVELS : 17' During Drilling START: March 2003 END: April 2003 LOGGER: Leo Kurylo




* Detections of Methlyene Chloride, TCE, cis-1,2-DCE, and Vinyl Chloride are shown on this figure. A complete set of detections in groundwater is provided in Attachment B of the Site 12 Groundwater Tech Memo.

| PROJECT NUMBER | WELL NUMBER |
|---|---|
| 152130.FI.MW | 12MW9S/D |

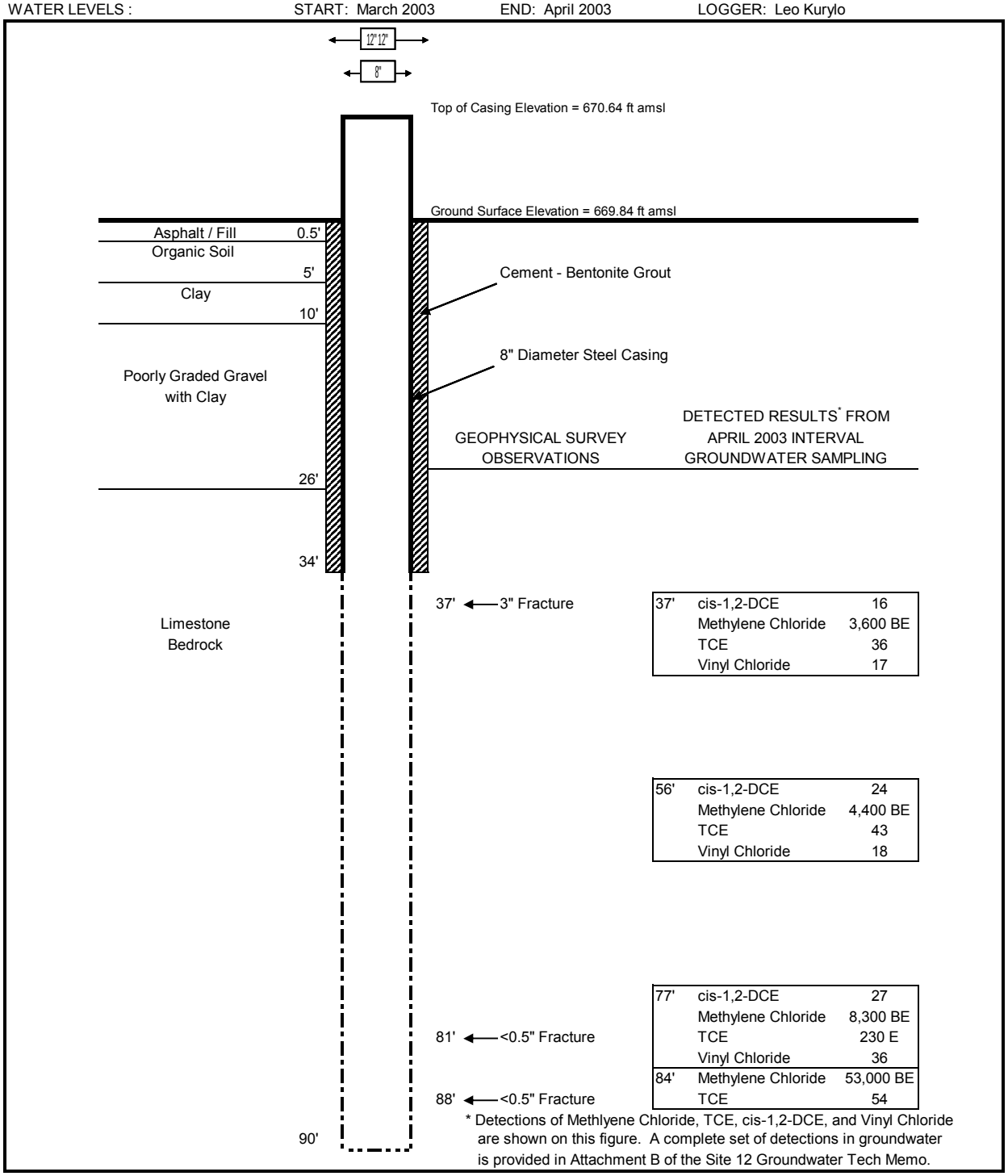
# BOREHOLE COMPLETION DIAGRAM

PROJECT : Allegany Ballistics Laboratory Site 12 Remedial Investigation — LOCATION: Site 12

DRILLING CONTRACTOR: Miller Drilling Company, Inc.

DRILLING METHOD AND EQUIPMENT USED: 12" Casing Advancement / 8" Air Hammer

WATER LEVELS : START: March 2003 — END: April 2003 — LOGGER: Leo Kurylo




| | | |
|---|---|---|
| 37' | cis-1,2-DCE | 16 |
| | Methylene Chloride | 3,600 BE |
| | TCE | 36 |
| | Vinyl Chloride | 17 |

| | | |
|---|---|---|
| 56' | cis-1,2-DCE | 24 |
| | Methylene Chloride | 4,400 BE |
| | TCE | 43 |
| | Vinyl Chloride | 18 |

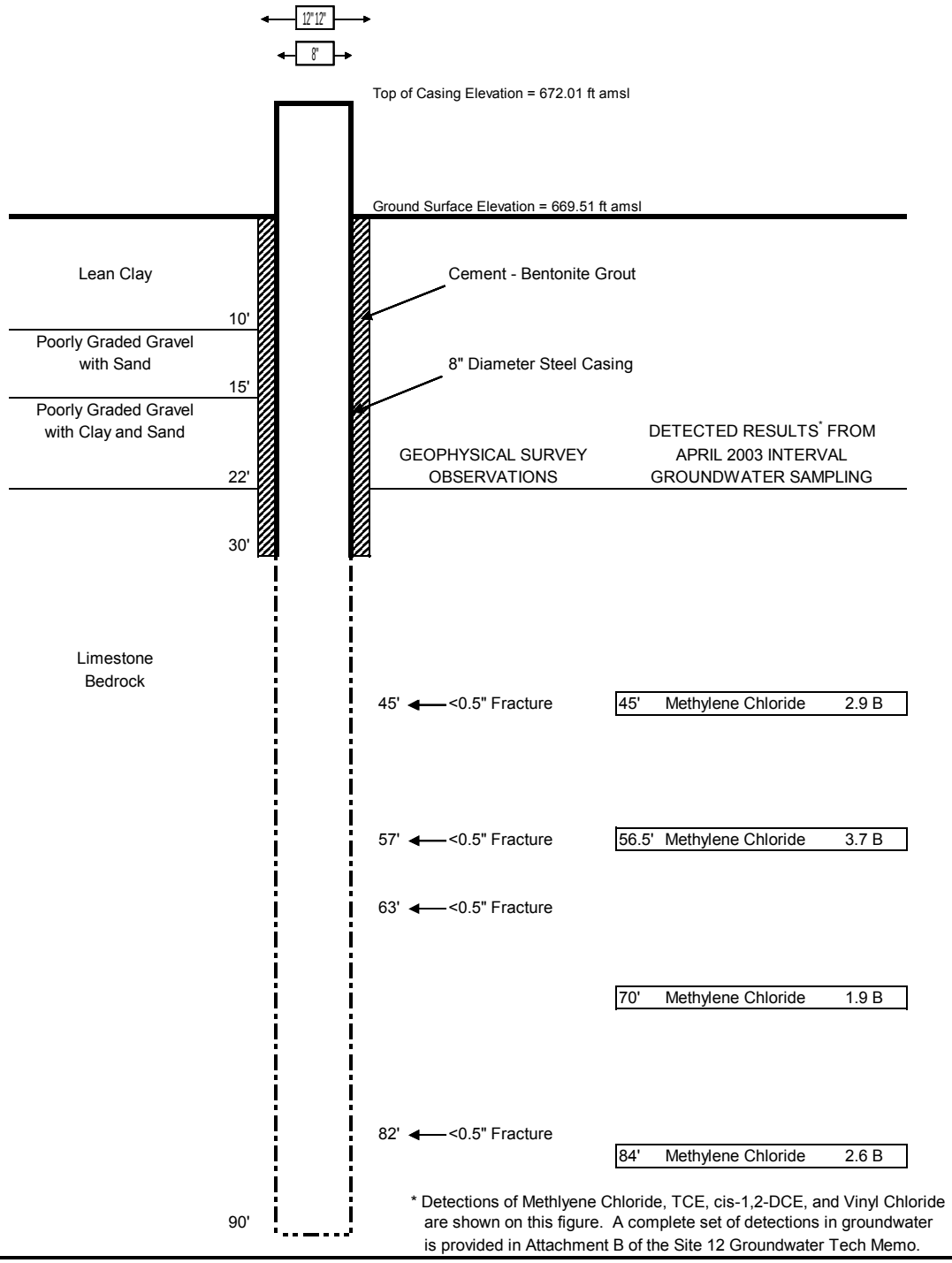
| | | |
|---|---|---|
| 77' | cis-1,2-DCE | 27 |
| | Methylene Chloride | 8,300 BE |
| | TCE | 230 E |
| | Vinyl Chloride | 36 |
| 84' | Methylene Chloride | 53,000 BE |
| | TCE | 54 |

* Detections of Methlyene Chloride, TCE, cis-1,2-DCE, and Vinyl Chloride are shown on this figure. A complete set of detections in groundwater is provided in Attachment B of the Site 12 Groundwater Tech Memo.

| PROJECT NUMBER | WELL NUMBER |
|---|---|
| 152130.FI.MW | 12MW11S/D |

# BOREHOLE COMPLETION DIAGRAM

PROJECT : Allegany Ballistics Laboratory Site 12 Remedial Investigation LOCATION: Site 12
DRILLING CONTRACTOR: Miller Drilling Company, Inc.
DRILLING METHOD AND EQUIPMENT USED: 12" Casing Advancement / 8" Air Hammer
WATER LEVELS : 15' During Drilling START: March 2003 END: April 2003 LOGGER: Leo Kurylo




* Detections of Methlyene Chloride, TCE, cis-1,2-DCE, and Vinyl Chloride are shown on this figure. A complete set of detections in groundwater is provided in Attachment B of the Site 12 Groundwater Tech Memo.

| PROJECT NUMBER | WELL NUMBER |
|---|---|
| 344182.FI.MW.99 | 12MW20S/D SHEET 1 OF 2 |

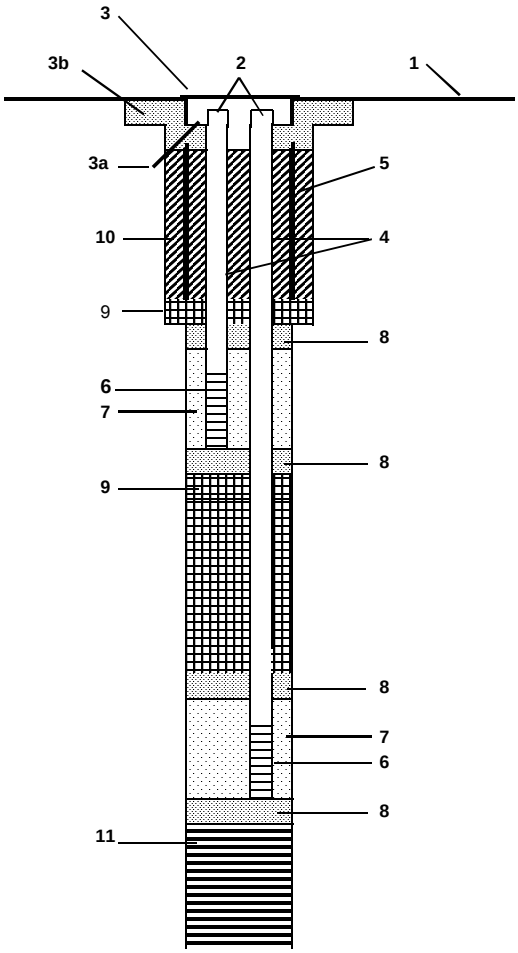
# WELL COMPLETION DIAGRAM

PROJECT : ABL MW Insatllation Sites 11, 12 and Range Road LOCATION : Allegany Ballistic Laboratory, Rocket City, WV

DRILLING CONTRACTOR : Eichelbergers

DRILLING METHOD AND EQUIPMENT USED Air Rotary w/Casing Advancement

WATER LEVELS : START : END : LOGGER :




| | | |
|---|---|---|
| 1- | Ground elevation at well | 668.60' |
| 2- | Top of casing elevation | |
| | a) shallow | 668.32' |
| | b) deep | 668.15' |
| 3- | Wellhead protection cover type | |
| | a) drain tube? | hole in casing |
| | b) concrete pad dimensions | 3' x 3' x 2' |
| 4- | Inner Dia./type of well casing | |
| | a) shallow | 1.9" |
| | b) deep | 1.9" |
| 5- | Dia./type surface casing | 8" Steel Flush Mount |
| 6- | Type/slot/size of screen | |
| | a) shallow | Schedule 80/0.01"/10' |
| | b) deep | Schedule 80/0.01"/10' |
| 7- | Type screen filter | Filpro #1 |
| | a) Quantity used | 13 bags |
| 8- | Type of seal filter | Filpro #00 |
| | a) Quantity used | 4 bags |
| 9- | Type of seal | Bentonite Chips |
| | a) Quantity used | 3 bags/2 buckets |
| 10- | Grout | |
| | a) Grout mix used | |
| | b) Method of placement | Tremmie pipe |
| 11- | Type of seal | Bentonite Pellets |
| | Quantity used | 2 buckets |
| | Development method | |
| | a) shallow | Whale Pump |
| | b) deep | Grunfos Pump |
| | Development time | |
| | a) shallow | 3 hours |
| | b) deep | 2.5 hours |
| | Estimated purge volume | |
| | a) shallow | 125 gallons |
| | b) deep | 150 gallons |

Comments:

MW20S Final parameter: pH: 7.15, Conductivity: 2.25, Turbidity:0, DO:0.16, Temperature:

MW20D Final parameter: pH: 7.20, Conductivity: 2.40, Turbidity:6, DO:0.20, Temperature:

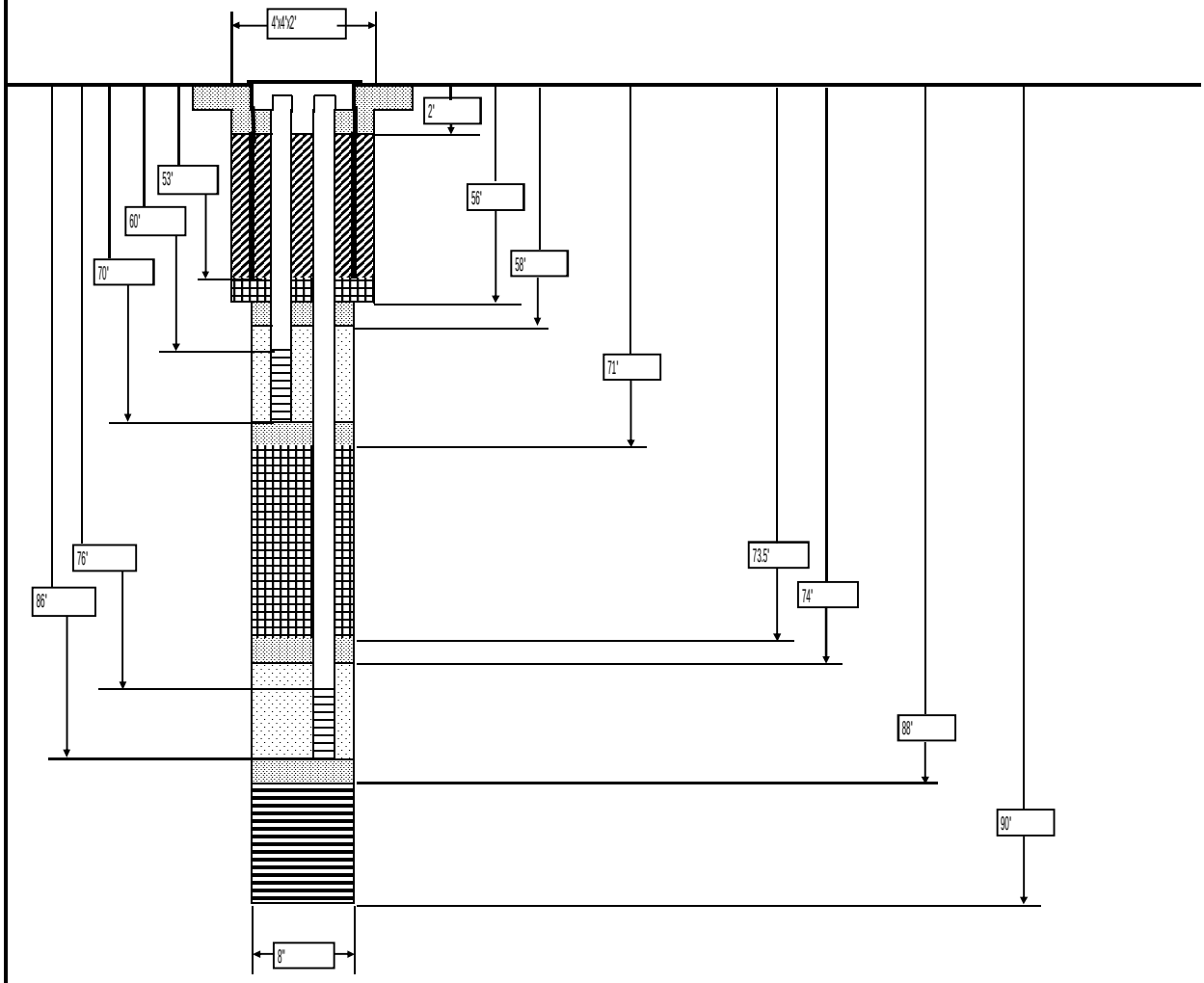
| | PROJECT NUMBER | WELL NUMBER |
|---|---|---|
| CH2MHILL | 344182.FI.MW.99 | 12MW20S/D SHEET 2 OF 2 |

# WELL COMPLETION DIAGRAM

PROJECT : ABL MW Installation Sites 11, 12 and Range Rd. LOCATION : Allegany Ballistics Laboratory, Rocket City, WV

DRILLING CONTRACTOR : Eichelbergers

DRILLING METHOD AND EQUIPMENT USED Air Rotary w/Casing Advancement



| PROJECT NUMBER | WELL NUMBER |
|---|---|
| 344182.FI.MW.99 | 12MW21S/D SHEET 1 OF 2 |

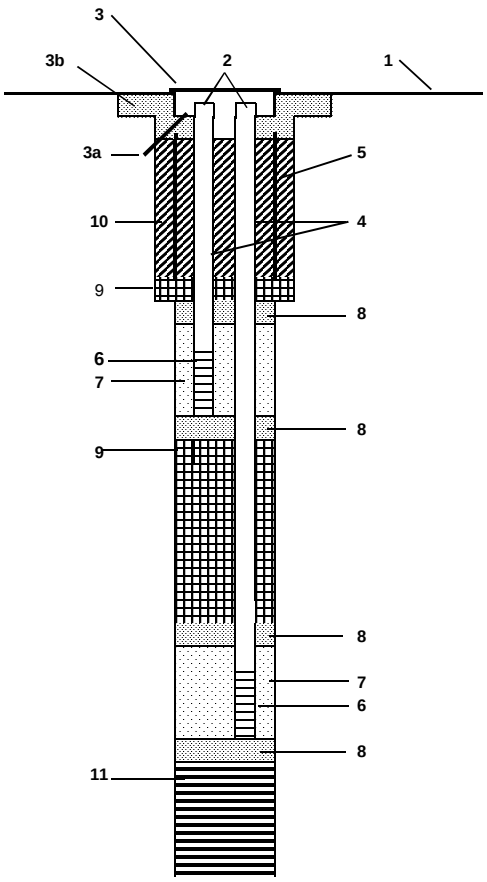
# WELL COMPLETION DIAGRAM

PROJECT : ABL MW Insatllation Sites 11, 12 and Range Road LOCATION : Allegany Ballistic Laboratory, Rocket City, WV

DRILLING CONTRACTOR : Eichelbergers

DRILLING METHOD AND EQUIPMENT USED : Air Rotary w/Casing Advancement

WATER LEVELS : START : END : LOGGER :




| | | |
|---|---|---|
| 1- | Ground elevation at well | 667.99 |
| 2- | Top of casing elevation | |
| | a) shallow | 669.97' |
| | b) deep | 670.16' |
| 3- | Wellhead protection cover type | |
| | a) drain tube? | hole in casing |
| | b) concrete pad dimensions | 3' x 3' x 2' |
| 4- | Inner Dia./type of well casing | |
| | a) shallow | 1.9" |
| | b) deep | 1.9" |
| 5- | Dia./type surface casing | 8" Steel Flush Mount |
| 6- | Type/slot/size of screen | |
| | a) shallow | Schedule 80/0.01"/10' |
| | b) deep | Schedule 80/0.01"/10' |
| 7- | Type screen filter | Filpro #1 |
| | a) Quantity used | 13 bags |
| 8- | Type of seal filter | Filpro #00 |
| | a) Quantity used | 3 bags |
| 9- | Type of seal | Bentonite Chips |
| | a) Quantity used | 2 bags |
| 10- | Grout | |
| | a) Grout mix used | |
| | b) Method of placement | Tremmie pipe |
| 11- | Type of seal | Bentonite Pellets |
| | Quantity used | 2 buckets |
| | Development method | |
| | a) shallow | Whale Pump |
| | b) deep | Grunfos Pump |
| | Development time | |
| | a) shallow | 3.2 hours |
| | b) deep | 2.5 hours |
| | Estimated purge volume | |
| | a) shallow | 125 gallons |
| | b) deep | 150 gallons |

Comments:

MW21S Final parameter: pH: 7.32, Conductivity: 0.911, Turbidity:0, DO:0.17, Temperature:14.6

MW21D Final parameter: pH: 7.50, Conductivity: 1.90, Turbidity:106, DO:3.7, Temperature:14

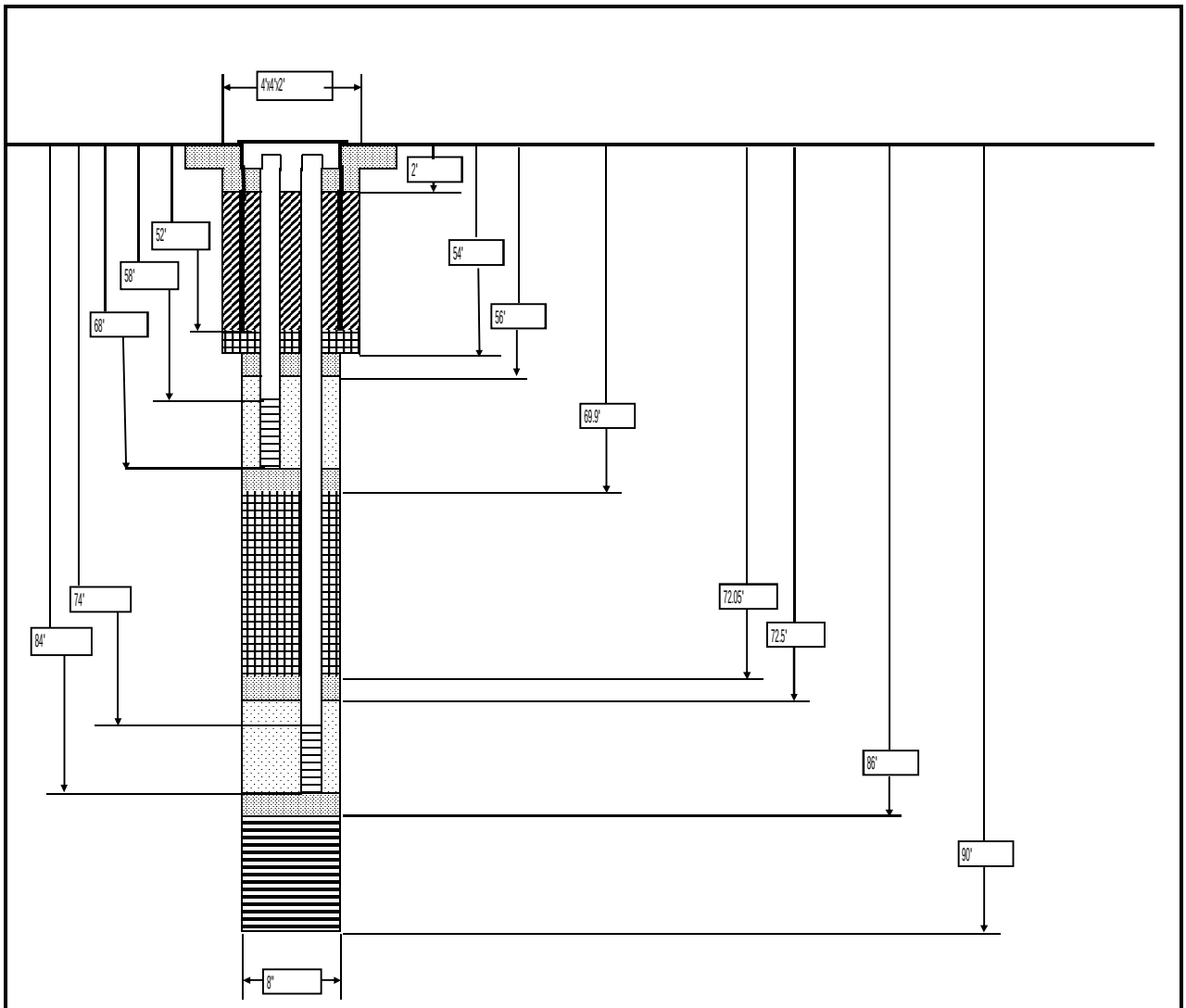
| | PROJECT NUMBER | WELL NUMBER |
|---|---|---|
| CH2MHILL | 344182.FI.MW.99 | 12MW21S/D SHEET 2 OF 2 |

# WELL COMPLETION DIAGRAM

PROJECT : ABL MW Installation Sites 11, 12 and Range Rd. LOCATION : Allegany Ballistics Laboratory, Rocket City, WV

DRILLING CONTRACTOR : Eichelbergers

DRILLING METHOD AND EQUIPMENT USED Air Rotary w/Casing Advancement



| PROJECT NUMBER | WELL NUMBER |
|---|---|
| 344182.FI.MW.99 | 12MW22S/D SHEET 1 OF 2 |

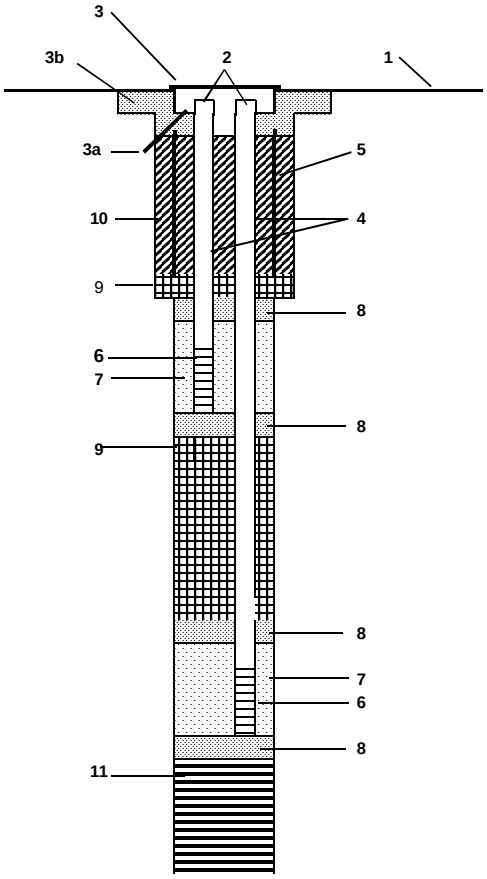
# WELL COMPLETION DIAGRAM

PROJECT : ABL MW Insatllation Sites 11, 12 and Range Road LOCATION : Allegany Ballistic Laboratory, Rocket City, WV

DRILLING CONTRACTOR : Eichelbergers

DRILLING METHOD AND EQUIPMENT USED : Air Rotary w/Casing Advancement

WATER LEVELS : START : END : LOGGER :




| | |
|---|---|
| 1- Ground elevation at well | 666.06' |
| 2- Top of casing elevation | |
| a) shallow | 668.63' |
| b) deep | 668.67' |
| 3- Wellhead protection cover type | |
| a) drain tube? | hole in casing |
| b) concrete pad dimensions | 3' x 3' x 2' |
| 4- Inner Dia./type of well casing | |
| a) shallow | 2.04" |
| b) deep | 2.04" |
| 5- Dia./type surface casing | 8" Steel Flush Mount |
| 6- Type/slot/size of screen | |
| a) shallow | Schedule 40/0.01"/10' |
| b) deep | Schedule 40/0.01"/10' |
| 7- Type screen filter | Filpro #1 |
| a) Quantity used | 14 bags |
| 8- Type of seal filter | Filpro #00 |
| a) Quantity used | 3 bags |
| 9- Type of seal | Bentonite Chips |
| a) Quantity used | 2 bags |
| 10- Grout | |
| a) Grout mix used | |
| b) Method of placement | Tremmie pipe |
| 11- Type of seal | Bentonite Pellets |
| Quantity used | 2 buckets |
| Development method | |
| a) shallow | Whale Pump |
| b) deep | Grunfos Pump |
| Development time | |
| a) shallow | 3.5 hours |
| b) deep | 2.5 hours |
| Estimated purge volume | |
| a) shallow | 210 gallons |
| b) deep | 150 gallons |

Comments:

MW22S Final parameter: pH: 7.40, Conductivity: 1.80, Turbidity:100, DO:0.8, Temperature:11

MW22D Final parameter: pH: 7.30, Conductivity: 2.0, Turbidity:16, DO:0.20 Temperature:15

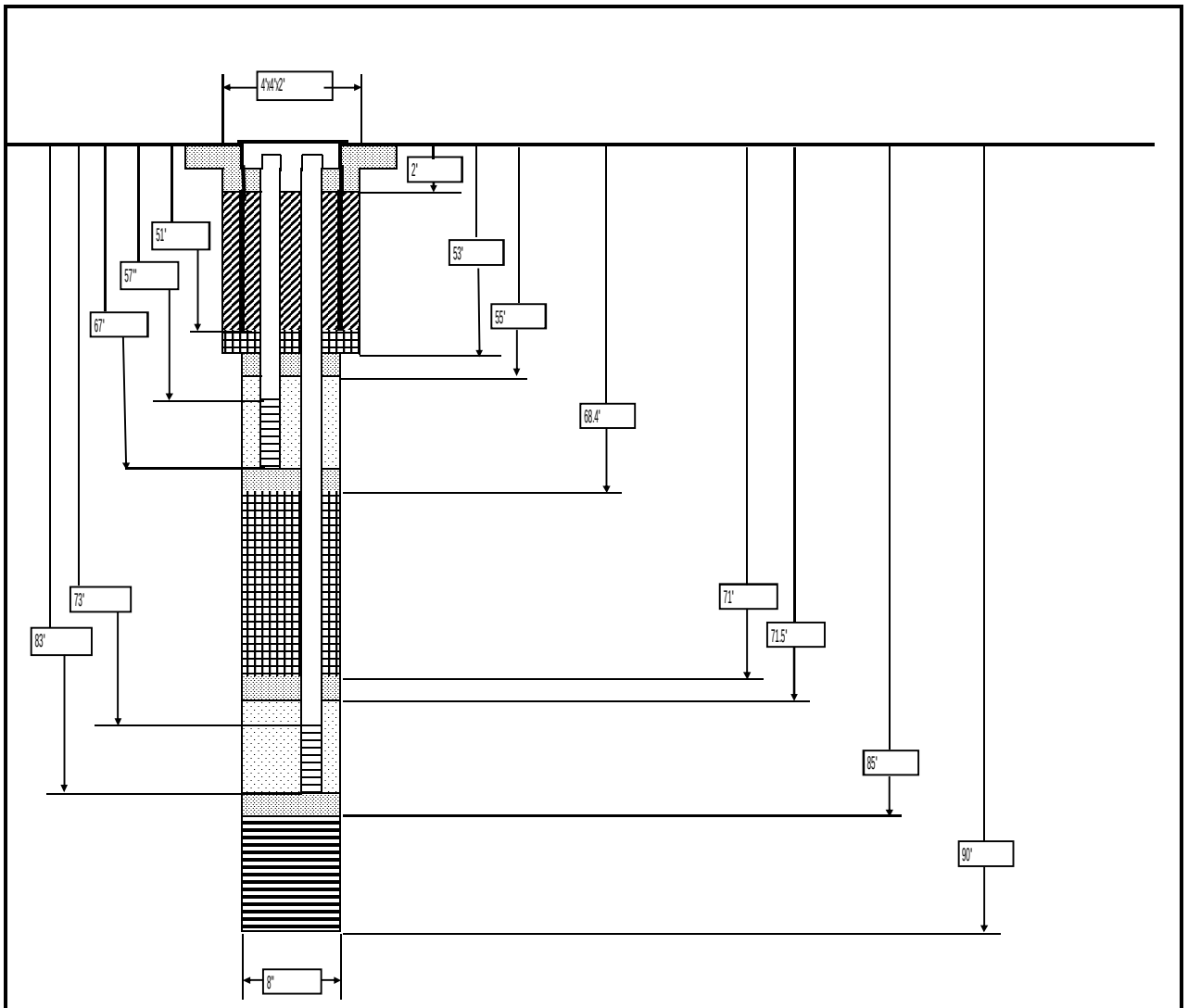
| | PROJECT NUMBER | WELL NUMBER |
|---|---|---|
| CH2MHILL | 344182.FI.MW.99 | 12MW21S/D SHEET 2 OF 2 |

# WELL COMPLETION DIAGRAM

PROJECT : ABL MW Installation Sites 11, 12 and Range Rd. LOCATION : Allegany Ballistics Laboratory, Rocket City, WV

DRILLING CONTRACTOR : Eichelbergers

DRILLING METHOD AND EQUIPMENT USED Air Rotary w/Casing Advancement



# Appendix B
# Geophysical Logs

CH2MHILL

PROJECT NUMBER

BORING NUMBER: 12MW04 S/D

# Geophysical Survey Results

PROJECT: Geophysical Survey LOCATION: Site 12

GEOPHYSICS CONTRACTOR : Earth Data, Inc. METHODS USED: Temperature, Caliper, Conductivity, Heat Pulse, Impeller Flow Logging under static and pumping conditions.

Date: April and Dec. 2003 LOGGER : R. Murley Total Depth: 82 ft. Casing Depth: 41 ft.

| Feet BGS | Caliper | Fluid Conductivity | Temperature | Heat Pulse | Impeller Flow Logging | |
|---|---|---|---|---|---|---|
| | | | | | Static | Pumping |
| 41 | | Steady | Steady decline from 42 - 70 feet BGS. | Upward 43.403 seconds | Upwards flow ranging from 0.75 - 1.75 in./Min. | |
| 42 | | | | | | |
| 43 | Increase of 1.3 in. Base of casing. | | | | | |
| 44 | | | | | | |
| 45 | | | | | Upwards flow decreasing from 1.75 down to 0.2 in./Min., with downwards flow of 0.2 in./min. at 45 feet BGS. | Upwards flow ranging from 1.50 - 3.50 in./Min., with peak at 49 feet BGS. |
| 46 | <0.5 in. at 46 ft. | | | | | |
| 47 | Steady | | | | | |
| 48 | | | | | | |
| 49 | | Steady decline | | | | |
| 50 | | | | | | |
| 51 | | | | | Steady upwards flow at rate of 1.50 in./min. | |
| 52 | | | | | | |
| 53 | | | | | | |
| 54 | | | | | | |
| 55 | 0.5 in. at 55 ft. | | | Upward 40.712 seconds | | |
| 56 | Steady | | | | | Steady upwards flow at rate of 1.50 in./min. |
| 57 | | | | | | |
| 58 | | | | | | |
| 59 | | | | | | |
| 60 | | | | | | |
| 61 | | | | | | |
| 62 | | | | | | |
| 63 | | | | | | |
| 64 | | | | | | |
| 65 | | | | | | |
| 66 | <0.5 in. at the range 66 - 72 ft. | | | | | |
| 67 | | | | | | |
| 68 | | | | | | |
| 69 | | | | | | |
| 70 | | Sharp increase at 71 feet BGS. | Decline slowed | | | |
| 71 | | | Steady from 70 - 83 feet BGS | Upward 60.597 seconds | | |
| 72 | | Steady | | | | |
| 73 | | | | | | |
| 74 | | | | | | |
| 75 | <0.5 at 75 ft. | | | | | |
| 76 | | | | | | |
| 77 | | | | | | |
| 78 | <0.5 at 78.5 ft. | | | | | |
| 79 | | | | | | |
| 80 | | | | | | |
| 81 | | | | | | |
| 82 | | | | | | |

- Proposed location of screens

CH2MHILL

PROJECT NUMBER

BORING NUMBER: 12MW05 S/D

# Geophysical Survey Results

PROJECT: Geophysical Survey LOCATION: Site 12

GEOPHYSICS CONTRACTOR : Earth Data, Inc. METHODS USED: Temperature, Caliper, Conductivity, Heat Pulse, Impeller Flow Logging under static and pumping conditions.

Date: April and Dec. 2003 LOGGER : R. Murley Total Depth: 90 ft. Casing Depth: 27 ft.

| Feet BGS | Caliper | Fluid Conductivity | Temperature | Heat Pulse | Impeller Flow Logging | |
|---|---|---|---|---|---|---|
| | | | | | Static | Pumping |
| 27 | | Steady to slight increase with depth | Increasing with depth | | Upwards flow increasing with depth from 0.25 - 2.00 in./min. | |
| 28 | Increase of 5.0 in. Base of casing. | | | | | |
| 29 | | | | | | |
| 30 | Steady | | | | | |
| 31 | | | | | | |
| 32 | | | | | | |
| 33 | | | | | | |
| 34 | | | | | | |
| 35 | | | | | | |
| 36 | | | Steady | | Steady upwards flow at rate of 1.00 -1.50 in./min. | |
| 37 | | | | | | |
| 38 | | | | | | |
| 39 | | Decreasing with depth | | | | |
| 40 | | | | | | |
| 41 | <0.5 in. at 41 ft. | | Decreasing with depth | Upward 75.434 seconds | | |
| 42 | Steady | | | | | |
| 43 | | | | | | |
| 44 | | | | | | |
| 45 | | | | | | |
| 46 | | | | | | Upwards flow decreasing with depth from 2.00 - 0.75 in./min. |
| 47 | | | | | | |
| 48 | | | | | | |
| 49 | | | | | | |
| 50 | | | | | | |
| 51 | | | | | | Flow increasing with depth from 0.75 - 2.00 in./min. |
| 52 | | | | | | |
| 53 | | | | | | |
| 54 | | | | | | |
| 55 | | | | | | |
| 56 | | | | Upward 50.695 seconds | | |
| 57 | | | | | | |
| 58 | | | | | | |
| 59 | | | | | | |
| 60 | | | | | | |
| 61 | | | | | | |
| 62 | | | | | | |
| 63 | | | | | | Steady upwards flow decreasing with depth from 2.00 - 0.75 in./min. |
| 64 | | | | | | |
| 65 | | | | | | |
| 66 | | | | | | |
| 67 | | | | | | |
| 68 | | | | | | |
| 69 | | | | | | |
| 70 | | | | | | |
| 71 | | | | | | |
| 72 | | | | | | |
| 73 | | | | | | |
| 74 | | | | | | |
| 75 | 0.5 in. at 75 feet | | | Upward 51.042 seconds | | |
| 76 | Steady | Steady | | | | |
| 77 | | | | | | |
| 78 | | | | | | |
| 79 | | | | | | |
| 80 | | | | | | |
| 81 | | | | | | |
| 82 | 0.5 in. at 82 feet | | | Upward 34.722 seconds | | |
| 83 | Steady | | | | | |
| 84 | | | | | | |
| 85 | | | | | | |
| 86 | | | | | | |
| 87 | | | | | | |
| 88 | | | | | | |
| 89 | | | | | | |
| 90 | | | | | | |

- Proposed location of screens

CH2MHILL

PROJECT NUMBER

BORING NUMBER: 12MW07 S/D

# Geophysical Survey Results

PROJECT: Geophysical Survey LOCATION: Site 12

GEOPHYSICS CONTRACTOR : Earth Data, Inc. METHODS USED: Temperature, Caliper, Conductivity, Heat Pulse, Impeller Flow Logging under static and pumping conditions.

Date: April and Dec. 2003 LOGGER : R. Murley Total Depth: 90 ft. Casing Depth: 28 ft.

| Feet BGS | Caliper | Fluid Conductivity | Temperature | Heat Pulse | Impeller Flow Logging | |
|---|---|---|---|---|---|---|
| | | | | | Static | Pumping |
| 28 | Increase of 1.5 in. | | | | | |
| 29 | Base of casing. | | | | | |
| 30 | | | | | | |
| 31 | | | | | | |
| 32 | | | | | | |
| 33 | | Increasing with depth | Increasing with depth | | | |
| 34 | | | | | | |
| 35 | | | | | | |
| 36 | | | | | | |
| 37 | | | | | | |
| 38 | | | | | | |
| 39 | | | | | | |
| 40 | | | | | | |
| 41 | Steady | | | | | |
| 42 | | | | | | |
| 43 | | | | | | |
| 44 | | | | | | |
| 45 | | | | Upward 50.00 seconds | | |
| 46 | | | | | | |
| 47 | | | | | | |
| 48 | | | | | | |
| 49 | | | | | | |
| 50 | | | | | | |
| 51 | | Steady | | | | |
| 52 | | | | | | |
| 53 | | | | | | |
| 54 | | | | | | |
| 55 | | | | Upward 56.16 seconds | | |
| 56 | 1.0 in. at 56 feet | | | | Upwards flow with a peak of 1.8 in./min. | |
| 57 | | | | | | |
| 58 | | | | | | |
| 59 | | | | | | |
| 60 | | | | | | |
| 61 | | | | | | |
| 62 | | | | | | |
| 63 | Steady | Sharp decrease | | | | Upwards flow sharp decrease at 63 ft |
| 64 | | | | | | |
| 65 | | | | | | |
| 66 | | | | | | |
| 67 | | | | | | |
| 68 | | | | | | |
| 69 | | | | | | |
| 70 | | | | | | |
| 71 | | | | | | |
| 72 | 1.5 in. at 70 - 73 feet | | | Upward 44.531 seconds | | |
| 73 | | | | | | |
| 74 | | | | | | |
| 75 | | | | | | |
| 76 | | | | | | |
| 77 | | | | | | |
| 78 | | | | | | |
| 79 | | | | | | |
| 80 | | Sharp decrease | | | | |
| 81 | Steady | | | | | |
| 82 | | | | | | |
| 83 | | | | | | |
| 84 | | | | | | |
| 85 | | | | Upward 52.251 seconds | | |
| 86 | | | | | | |
| 87 | | | | | | |
| 88 | | | | | | |
| 89 | | | | | | |
| 90 | | | | | | |

Steady upwards flow at rate of 1.00 -1.50 in./min.

Upwards flow decreasing with depth from 2.60 - 2.00 in./min.

Steady decrease with depth

Steady upwards flow at rate of 1.00 -1.50 in./min.

Upwards flow decreasing with depth from 2.25 - 1.25 in./min.

- Proposed location of screens

CH2MHILL

| PROJECT NUMBER | BORING NUMBER: 12MW09 S/D |
|---|---|

# Geophysical Survey Results

PROJECT: Geophysical Survey LOCATION: Site 12
GEOPHYSICS CONTRACTOR : Earth Data, Inc. METHODS USED: Temperature, Caliper, Conductivity, Heat Pulse, Impeller Flow Logging under static and pumping conditions.
Date: April and Dec. 2003 LOGGER : R. Murley Total Depth: 90 ft. Casing Depth: 34 ft.

| Feet BGS | Caliper | Fluid Conductivity | Temperature | Heat Pulse | Impeller Flow Logging | |
|---|---|---|---|---|---|---|
| | | | | | Static | Pumping |
| 34 | Increase of 2.5 in. Base of casing. | | Increasing with depth | Upward 61.111 seconds | Steady upwards flow at rate of 0.60 -1.60 in./min. | Upwards flow decreasing with depth from 1.50 - 0.50 in./min. |
| 35 | | | | | | |
| 36 | Steady | Increasing with depth | | | | |
| 37 | | | | | | |
| 38 | | | | | | |
| 39 | | | | | | |
| 40 | | | | | | |
| 41 | | Steady | Steady | | | |
| 42 | | | | | | |
| 43 | | | | | | |
| 44 | | | | | | |
| 45 | | | | | | |
| 46 | | | | | | |
| 47 | | | | | | |
| 48 | | | | | | |
| 49 | | | | | | |
| 50 | | | | | | |
| 51 | | | | | | |
| 52 | | | | | | |
| 53 | | | | | | |
| 54 | | | | | | |
| 55 | | | | Upward 26.8 seconds | | |
| 56 | | | | | | |
| 57 | | | | | | |
| 58 | | | | | | |
| 59 | | | | | | |
| 60 | | | | | | |
| 61 | | | | | | |
| 62 | | | | | | |
| 63 | | | | | | |
| 64 | | Sharp decrease | Steady decrease with depth | | | |
| 65 | | | | | | |
| 66 | | Steady decrease | | | | |
| 67 | | | | | | |
| 68 | | | | | | |
| 69 | | | | | | |
| 70 | | | | | | |
| 71 | | | | | | |
| 72 | | | | | | |
| 73 | | | | | | |
| 74 | | | | | | |
| 75 | | | | | | |
| 76 | | | | | | |
| 77 | | | | Upward 28.0 seconds | | |
| 78 | | Slight increase | | | | |
| 79 | | | | | | |
| 80 | | | | | | |
| 81 | | | | | | |
| 82 | <0.5 at 81 ft. | | | | | |
| 83 | Steady | | | | | |
| 84 | | | | Upward 50.0 seconds | | |
| 85 | | | | | | |
| 86 | | | | | | |
| 87 | | | | | | |
| 88 | | | | | | |
| 89 | | | | | | |
| 90 | | | | | | |

- Bore hole to remain as an open Bore hole

CH2MHILL

PROJECT NUMBER

BORING NUMBER: 12MW11 S/D

# Geophysical Survey Results

PROJECT: Geophysical Survey LOCATION: Site 12

GEOPHYSICS CONTRACTOR : Earth Data, Inc. METHODS USED: Temperature, Caliper, Conductivity, Heat Pulse, Impeller Flow Logging under static and pumping conditions.

Date: April and Dec. 2003 LOGGER : R. Murley Total Depth: 90 ft. Casing Depth: 30 ft.

| Feet BGS | Caliper | Fluid Conductivity | Temperature | Heat Pulse | Impeller Flow Logging | |
|---|---|---|---|---|---|---|
| | | | | | Static | Pumping |
| 30–43 | Steady | Increasing with depth | Increasing with depth at a declining rate | | Steady upwards flow at rate of 1.00 - 1.25 in./min. | Upwards flow ranging from 0.75 - 2.00 in./min. |
| 44–46 | <0.5 in. at 45 feet | | | Upward 50.0 seconds | | |
| 47–52 | Steady | | | | | |
| 52–53 | | Sharp increase | | | | |
| 54–57 | | Steady increase | | Upward 54.4 seconds | | |
| 58 | | | Inflection point | | | |
| 59–62 | | | Slight decline | | | |
| 63–64 | <0.5 in. at 63 feet | | | | | |
| 65–70 | Steady | | | | | |
| 70 | | | | Upward 59.0 seconds | | |
| 71–81 | | | | | | Increasing from 0.80 - 1.65 in./min. |
| 82 | <0.5 in. at 82 feet | | | Upward 60.6 seconds | | |
| 83–90 | | Sharp increase | | | | |

- Proposed location of screens

| CH2MHILL | PROJECT NUMBER | BORING NUMBER: 12MW13 S/D |
|---|---|---|

# Geophysical Survey Results

PROJECT: Geophysical Survey LOCATION: Site 12
GEOPHYSICS CONTRACTOR : Earth Data, Inc. METHODS USED: Temperature, Caliper, Conductivity, Heat Pulse, Impeller Flow Logging under static and pumping conditions.
Date: Dec. 2003 LOGGER : R. Murley Total Depth: 50 ft. Casing Depth: 25 ft.

| Feet BGS | Caliper | Fluid Conductivity | Temperature | Heat Pulse | Impeller Flow Logging | |
|---|---|---|---|---|---|---|
| | | | | | Static | Pumping |
| 25 | Steady | Steady | Steady | | Steady upwards flow increasing with depth from 1.00 to 1.25 in./min. | Upwards flow decreasing with depth from 3.60 - 0.00 in./min. |
| 26 | | | | | | |
| 27 | | | | | | |
| 28 | | | | | | |
| 29 | | | | | | |
| 30 | | | | | | |
| 31 | | | | | | |
| 32 | | | | | | |
| 33 | <0.5 in at 34.5 ft. | | | | | |
| 34 | | | | | | |
| 35 | | | | | | |
| 36 | | | | | | |
| 37 | 2.0 in at 38 ft. | | | Upward 50.4 seconds | | |
| 38 | | | | | | |
| 39 | | | | | | |
| 40 | | | | | | |
| 41 | 3.5 in at 41 ft. | | | Upward 57.5 seconds | | |
| 42 | | Slight increase | | | | |
| 43 | Steady | Steady | | | | |
| 44 | | | | | | |
| 45 | | | | | | |
| 46 | | | | | | |
| 47 | | | | | | |
| 48 | | | | | | |
| 49 | | | | Upward 54.7 seconds | | |
| 50 | | | | | | |
| 51 | 1.0 in at 51 ft. | Slight decrease | | | | |

- Bore hole to be abandoned

CH2MHILL

| PROJECT NUMBER | BORING NUMBER: 12MW17 S/D |
|---|---|

# Geophysical Survey Results

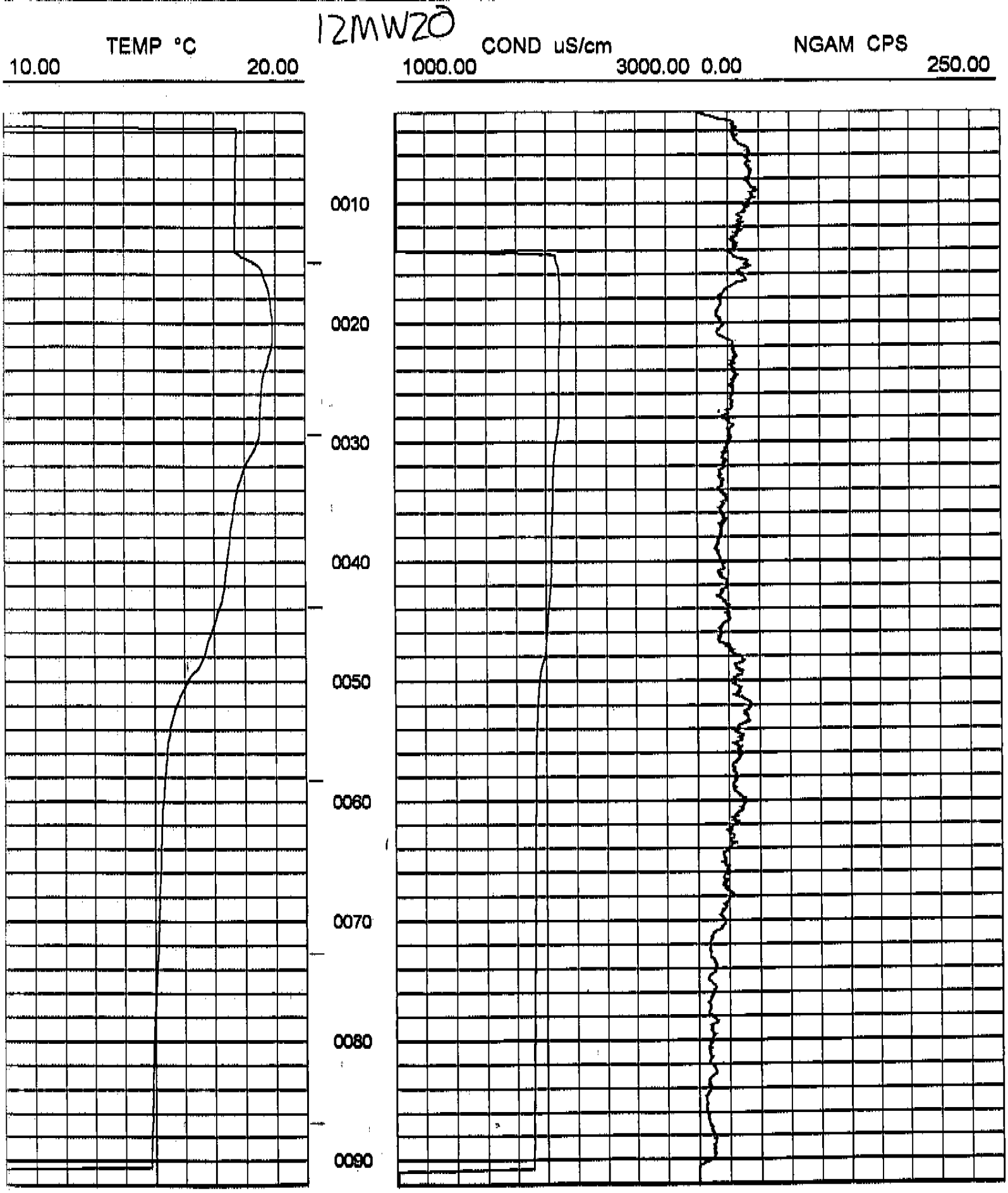
PROJECT: Geophysical Survey LOCATION: Site 12
GEOPHYSICS CONTRACTOR : Earth Data, Inc. METHODS USED: Temperature, Caliper, Conductivity, Heat Pulse, Impeller Flow Logging under static and pumping conditions.
Date: Dec. 2003 LOGGER : R. Murley Total Depth: 90 ft. Casing Depth: 24 ft.

| Feet BGS | Caliper | Fluid Conductivity | Temperature | Heat Pulse | Impeller Flow Logging | |
|---|---|---|---|---|---|---|
| | | | | | Static | Pumping |
| 24 | | | | | | |
| 25 | | | | | | |
| 26 | | | | | | |
| 27 | | | | | | |
| 28 | <0.5 in. fracture set from 29 to 34 ft. | | | | | |
| 29 | | | | Upward 55.04 seconds | | |
| 30 | | Slight decrease | Slight decrease | | | |
| 31 | | | | | | |
| 32 | | | | | | |
| 33 | Steady | | | | | |
| 34 | | | | | | |
| 35 | | | | | | |
| 36 | | | | | | |
| 37 | | | | | | |
| 38 | | | | | | |
| 39 | | | | | | |
| 40 | | | | | | |
| 41 | | | | | | |
| 42 | | | | | | |
| 43 | | | | | | |
| 44 | | | | | | |
| 45 | | | | | | |
| 46 | | | | | | |
| 47 | | | | | | |
| 48 | | | | | | |
| 49 | | | | | | |
| 50 | | | | | | |
| 51 | | | | | | |
| 52 | | | | | | |
| 53 | | | | | | |
| 54 | | | | | | |
| 55 | | | | | | |
| 56 | | | | | | |
| 57 | | | | | | |
| 58 | | | | | | |
| 59 | | Steady | Steady | | Steady upwards flow increasing with depth from 0.75 to 1.50 in./min. | Upwards flow decreasing with depth from 2.30 - 1.30 in./min. |
| 60 | | | | | | |
| 61 | | | | | | |
| 62 | | | | | | |
| 63 | | | | | | |
| 64 | | | | | | |
| 65 | | | | | | |
| 66 | | | | | | |
| 67 | 0.5 in at 69 ft. | | | Upward 44.8 seconds | | |
| 68 | | | | | | |
| 69 | | | | | | |
| 70 | | | | | | |
| 71 | | | | | | |
| 72 | | | | | | |
| 73 | <0.5 in fracture set from 74 to 80 ft. | | | | | |
| 74 | | | | | | |
| 75 | | | | | | |
| 76 | | | | Upward 42.8 seconds | | |
| 77 | | | | | | |
| 78 | | | | | | |
| 79 | | | | | | |
| 80 | 1.2 in at 82 ft. | | | Upward 47.7 seconds | | |
| 81 | | | | | | |
| 82 | | | | | | |
| 83 | | | | | | |
| 84 | | | | | | |
| 85 | | | | | | |
| 86 | | | | | | |
| 87 | | | | | | |
| 88 | | | | | | |

- Proposed location of screens

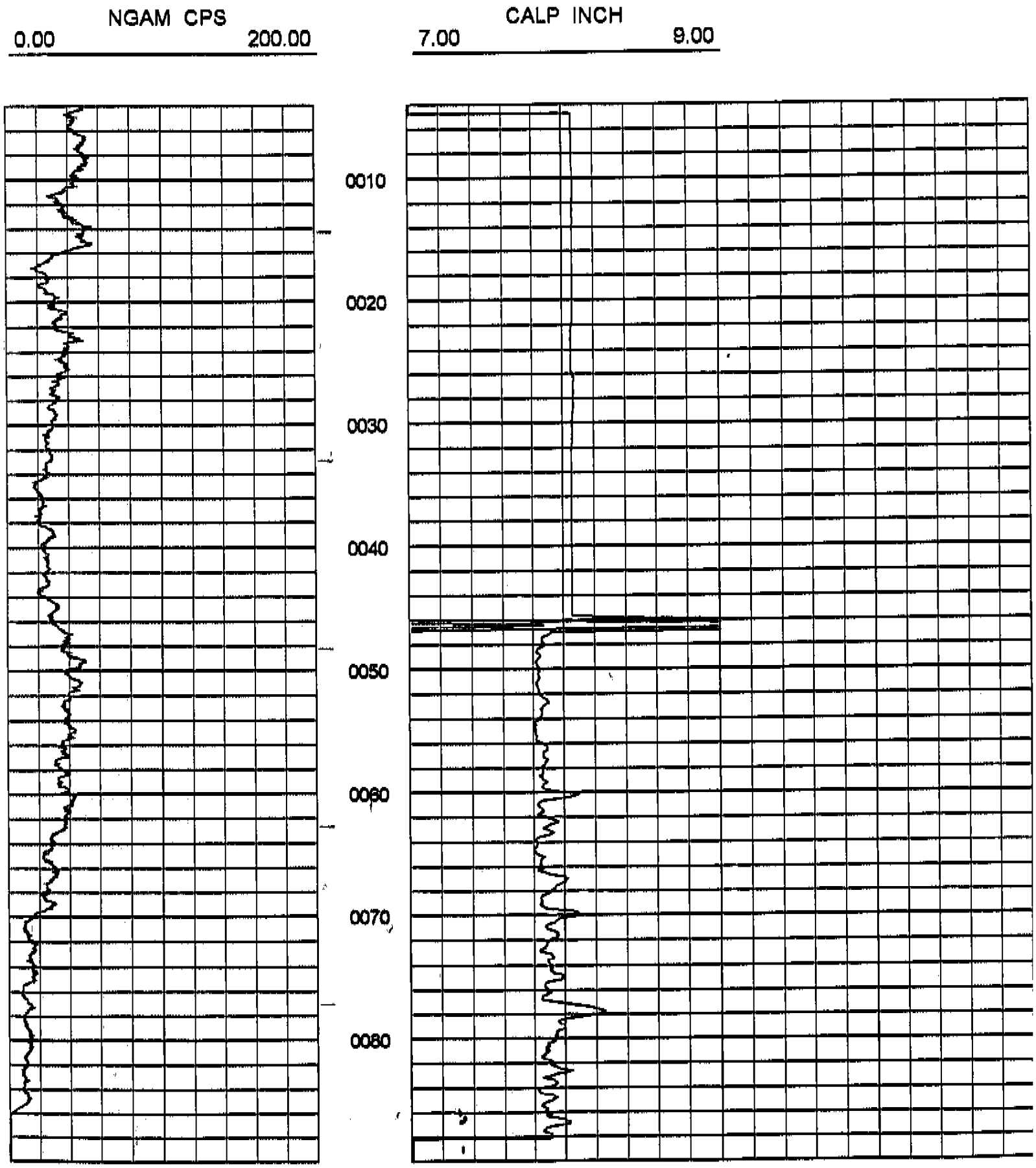
Depth: 91.00 ft Date: 14 Nov 2006 Time: 11:47:58 File: "C:\WINLOGGER\DATA\100620-12-MW20-TCDS-DN.LOG"

12MW20

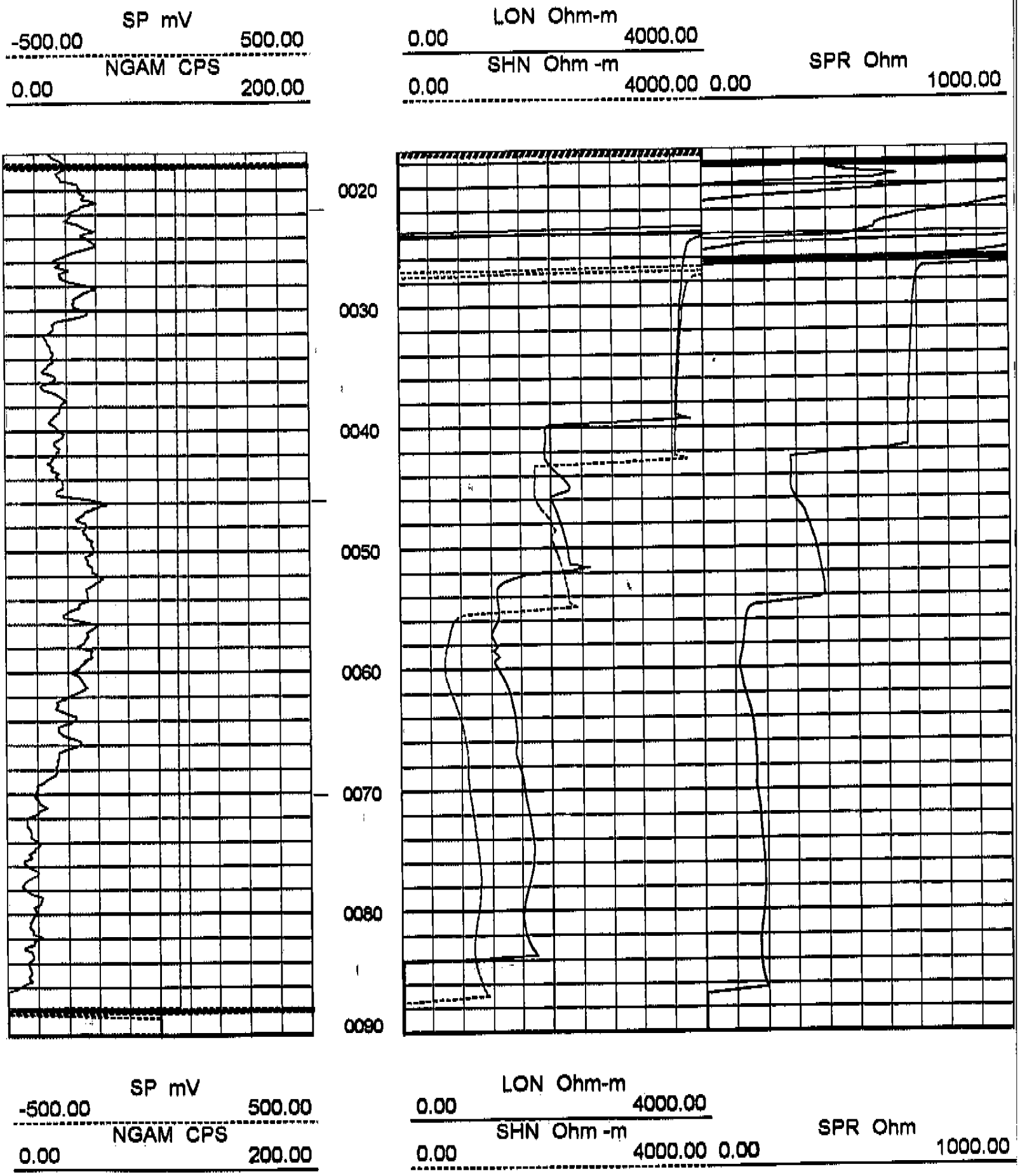


Depth: 5.00 ft Date: 14 Nov 2006 Time: 12:10:22 File: "C:\WINLOGGER\DATA\100620-12MW20-3ACS-UP.LOG"

12MW20

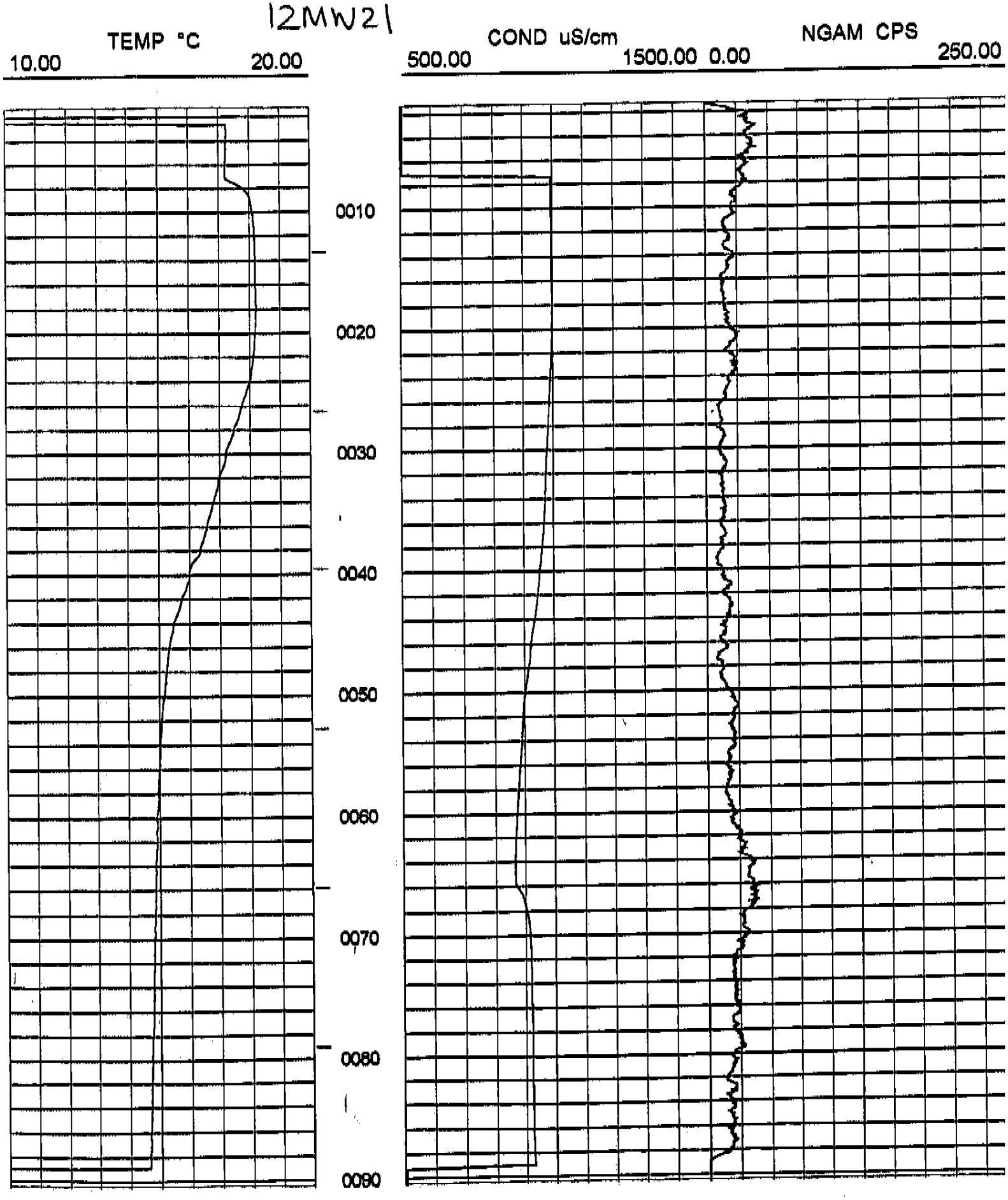


12MW20


SP mV
-500.00
500.00
NGAM CPS
0.00
200.00
LON Ohm-m
0.00
4000.00
SHN Ohm -m
0.00
4000.00
SPR Ohm
0.00
1000.00
0020
0030
0040
0050
0060
0070
0080
0090
SP mV
-500.00
500.00
NGAM CPS
0.00
200.00
LON Ohm-m
0.00
4000.00
SHN Ohm -m
0.00
4000.00
SPR Ohm
0.00
1000.00

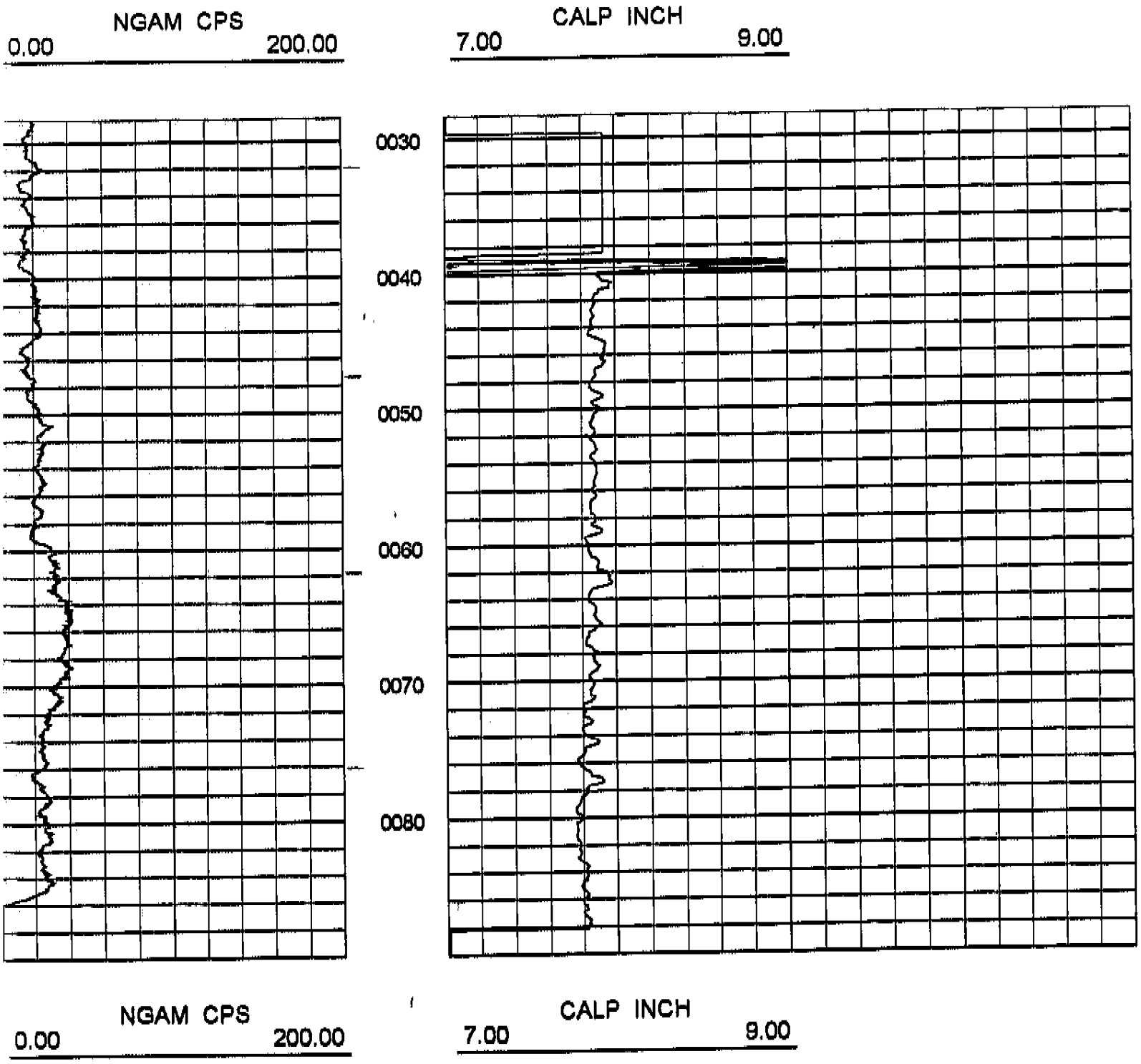
Depth: 89.00 ft Date: 14 Nov 2006 Time: 14:00:41 File: "C:\WINLOGGER\DATA\[illegible]

12MW21

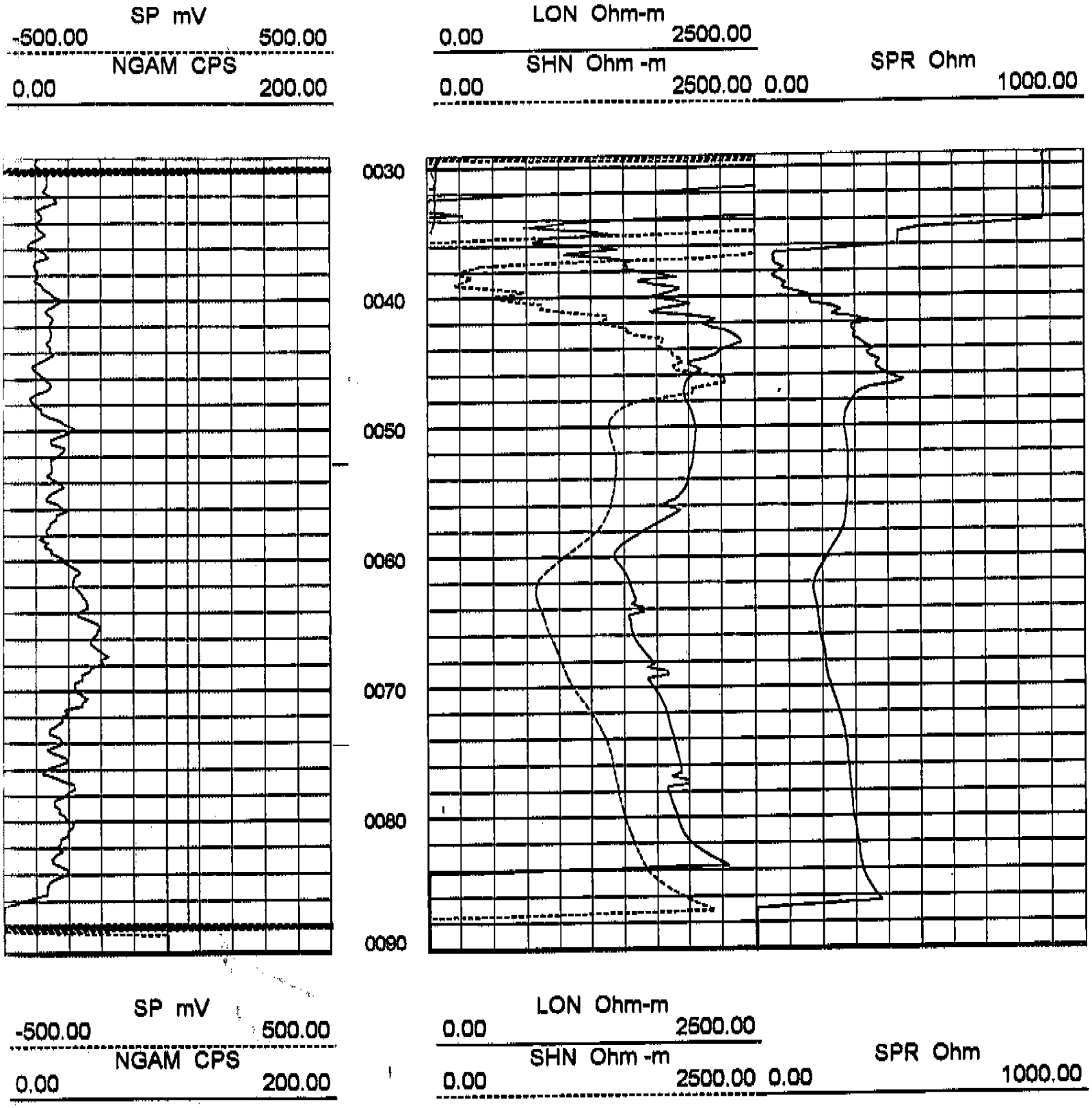


Depth: 29.00 ft Date: 14 Nov 2006 Time: 14:16:49 File: "C:\WINLOGGER\DATA\100620-12MW21-3ACS-UP.LOG"

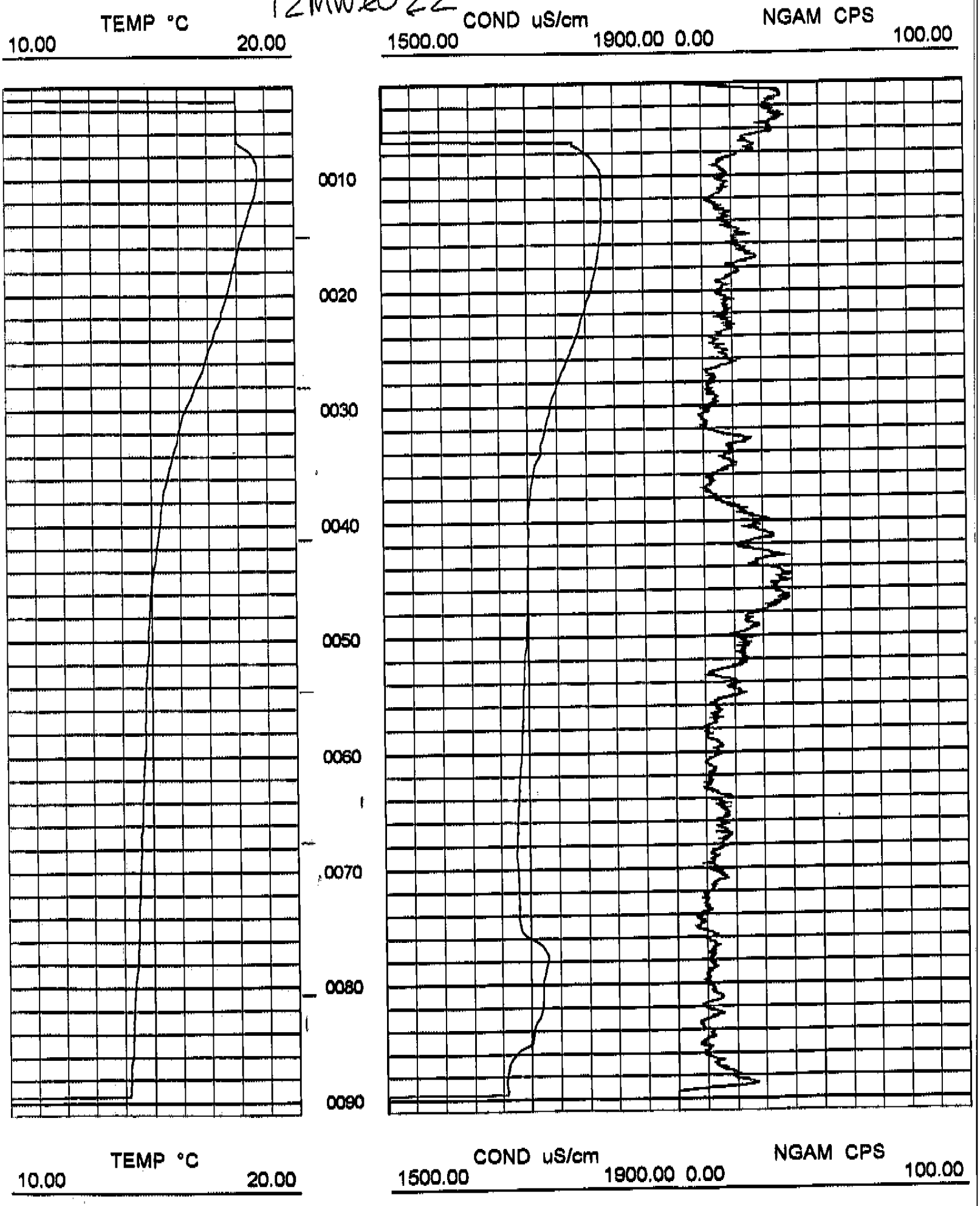
12MW21



12MW21

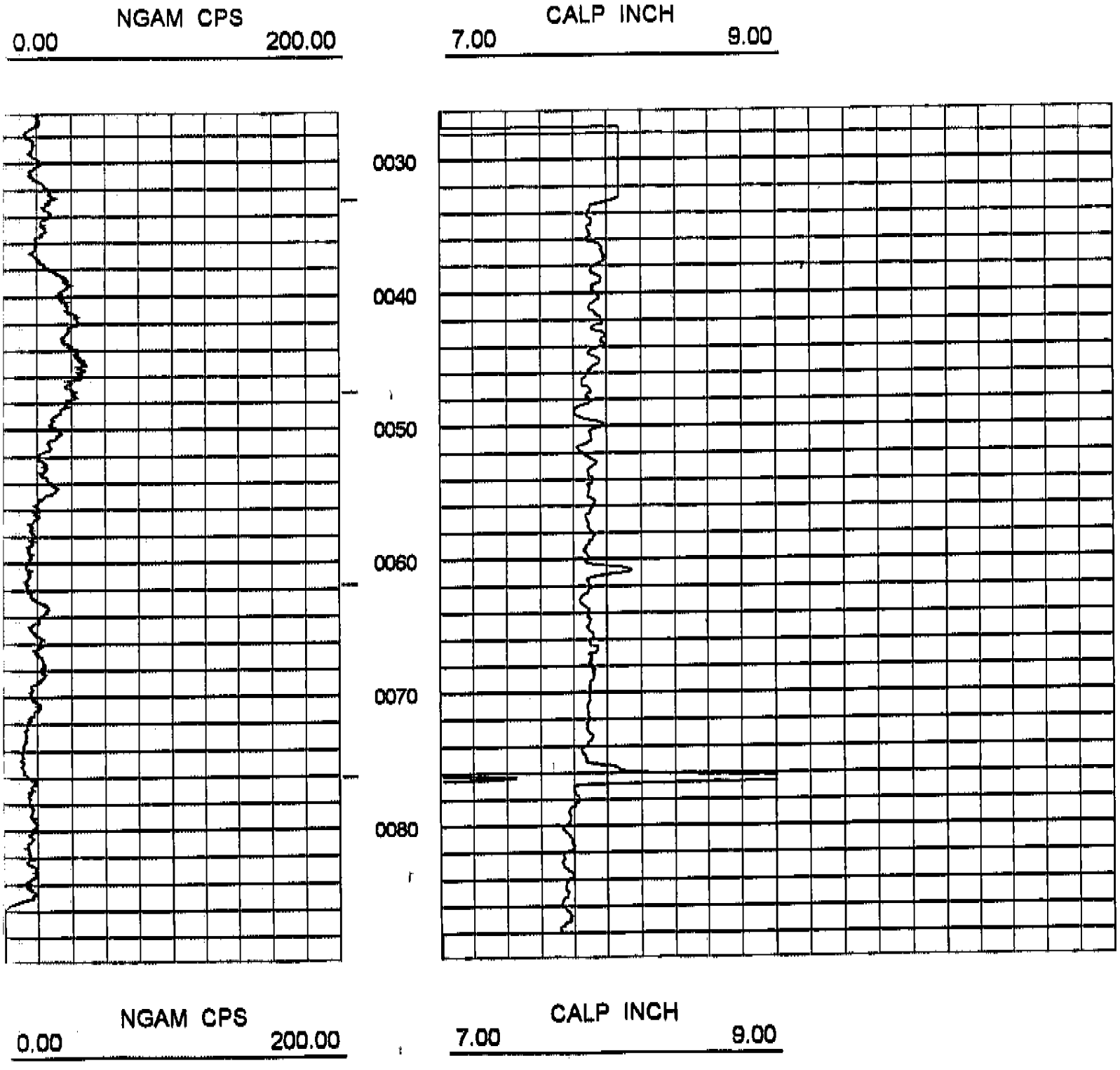

SP mV
-500.00
500.00
NGAM CPS
0.00
200.00
LON Ohm-m
0.00
2500.00
SHN Ohm -m
0.00
2500.00
SPR Ohm
0.00
1000.00
0030
0040
0050
0060
0070
0080
0090
SP mV
-500.00
500.00
NGAM CPS
0.00
200.00
LON Ohm-m
0.00
2500.00
SHN Ohm -m
0.00
2500.00
SPR Ohm
0.00
1000.00

12MW2022


TEMP °C
10.00
20.00
COND uS/cm
1500.00
1900.00
0.00
NGAM CPS
100.00
0010
0020
0030
0040
0050
0060
0070
0080
0090
TEMP °C
10.00
20.00
COND uS/cm
1500.00
1900.00
0.00
NGAM CPS
100.00

Depth: 27.00 ft Date: 14 Nov 2006 Time: 13:19:25 File: "C:\WINLOGGER\DATA\100620-12MW22-3ACS-UP.LOG"

12MW22



Depth: 6.00 ft Date: 14 Nov 2006 Time: 13:35:15 File: "C:\WINLOGGER\DATA\100820-12MW22-ELXG-UP.LOG"

/12MW22

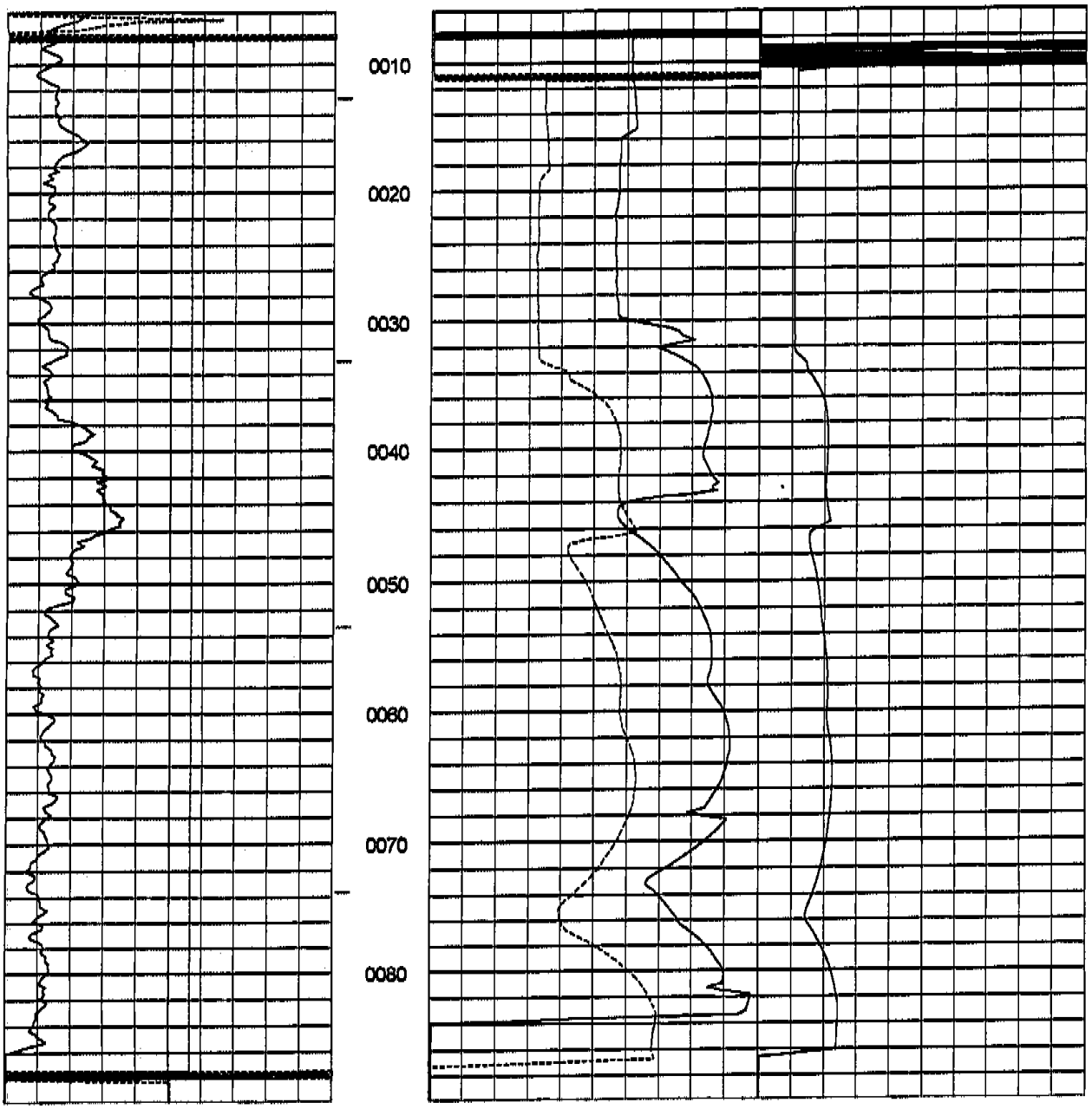
SP mV
-500.00 500.00

NGAM CPS
0.00 200.00

LON Ohm-m
0.00 2000.00

SHN Ohm -m
0.00 2000.00

SPR Ohm
0.00 1000.00




SP mV
-500.00 500.00

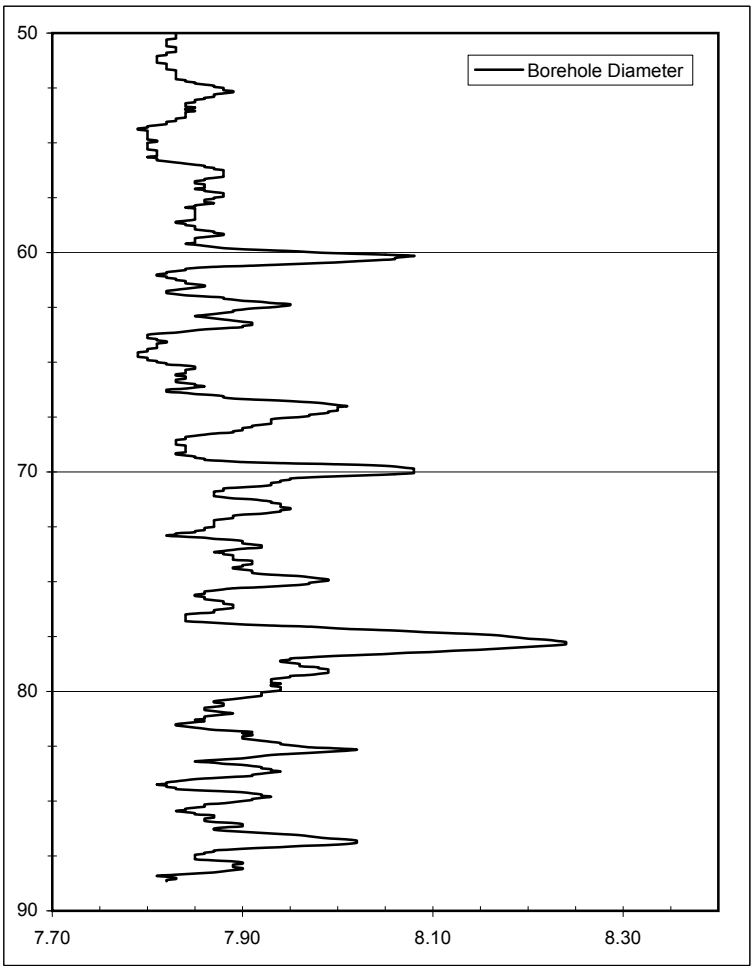
NGAM CPS
0.00 200.00

LON Ohm-m
0.00 2000.00

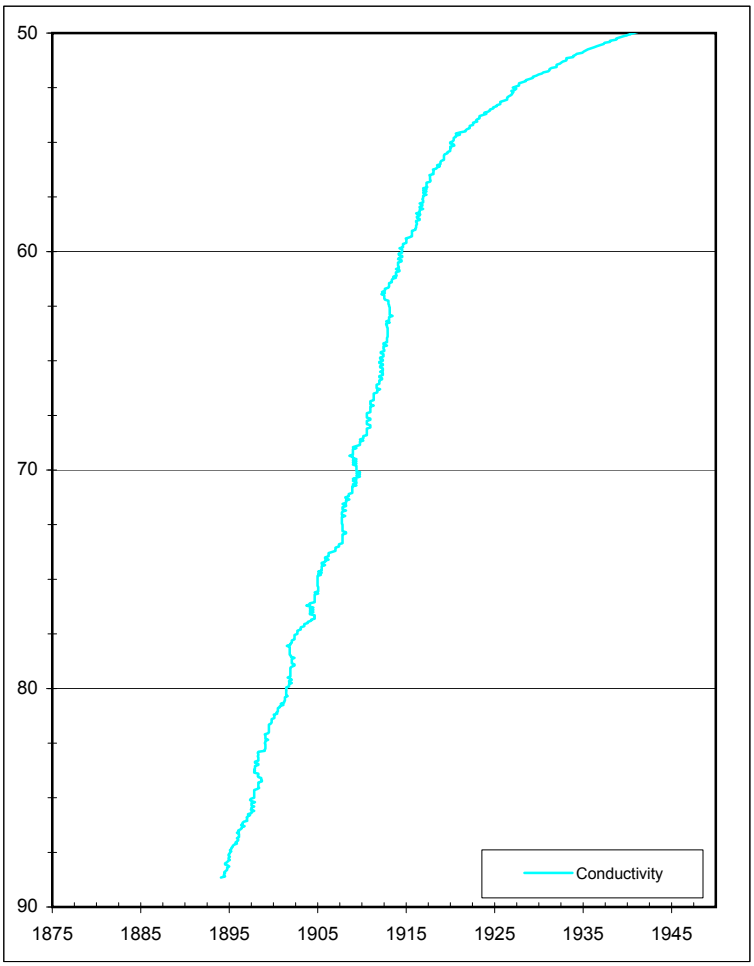
SHN Ohm -m
0.00 2000.00

SPR Ohm
0.00 1000.00

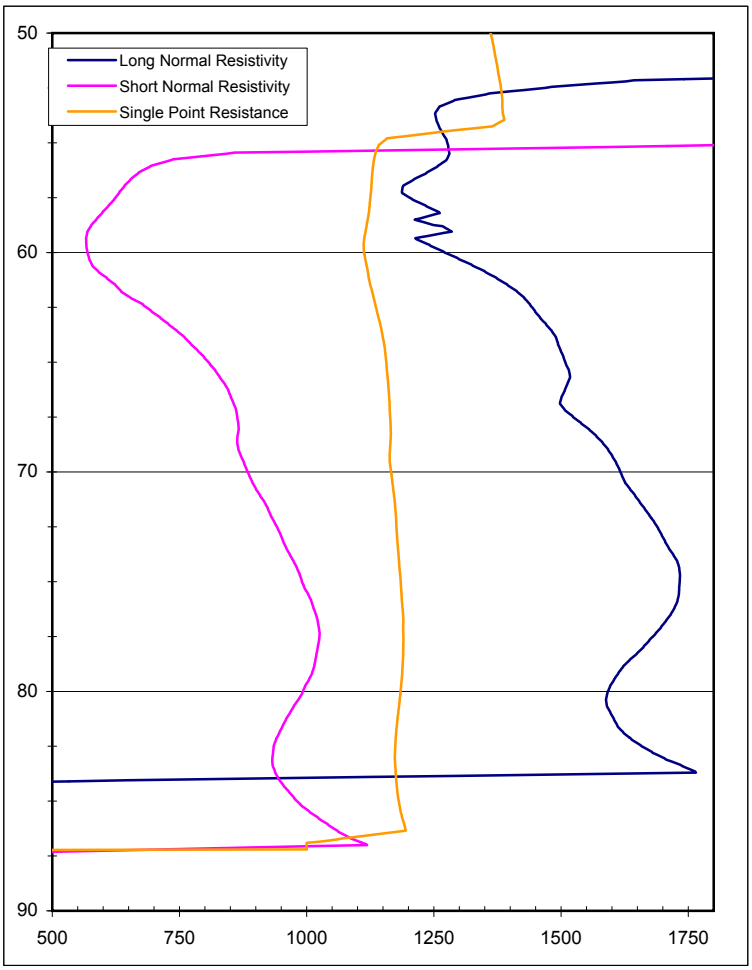
# 12MW20



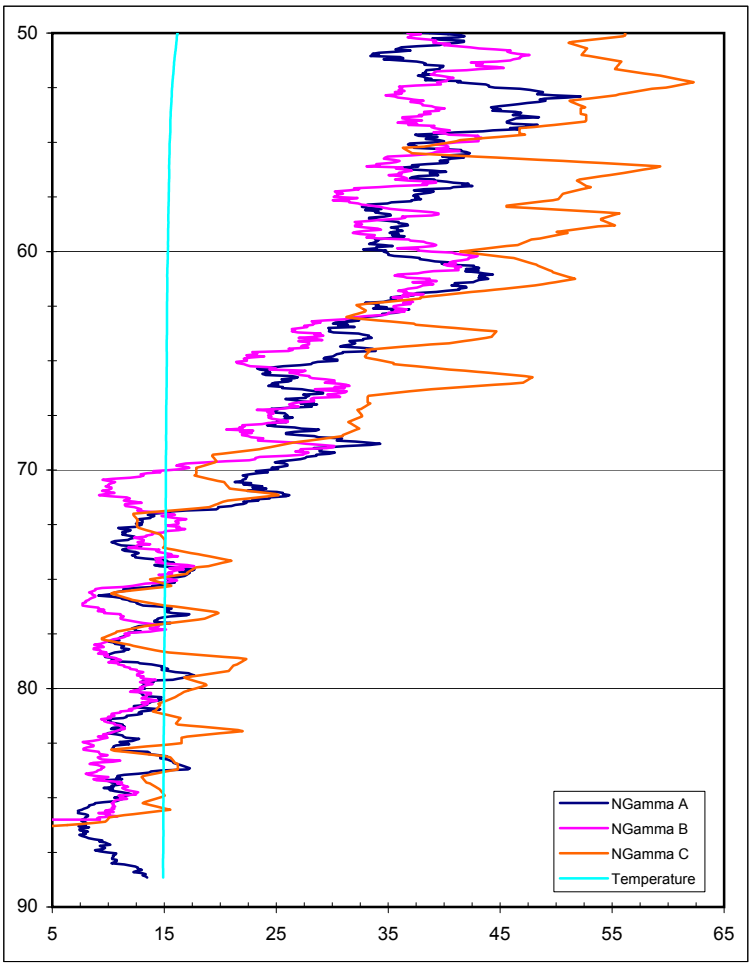
# 12MW20


50
60
70
80
90
1875
1885
1895
1905
1915
1925
1935
1945
Conductivity

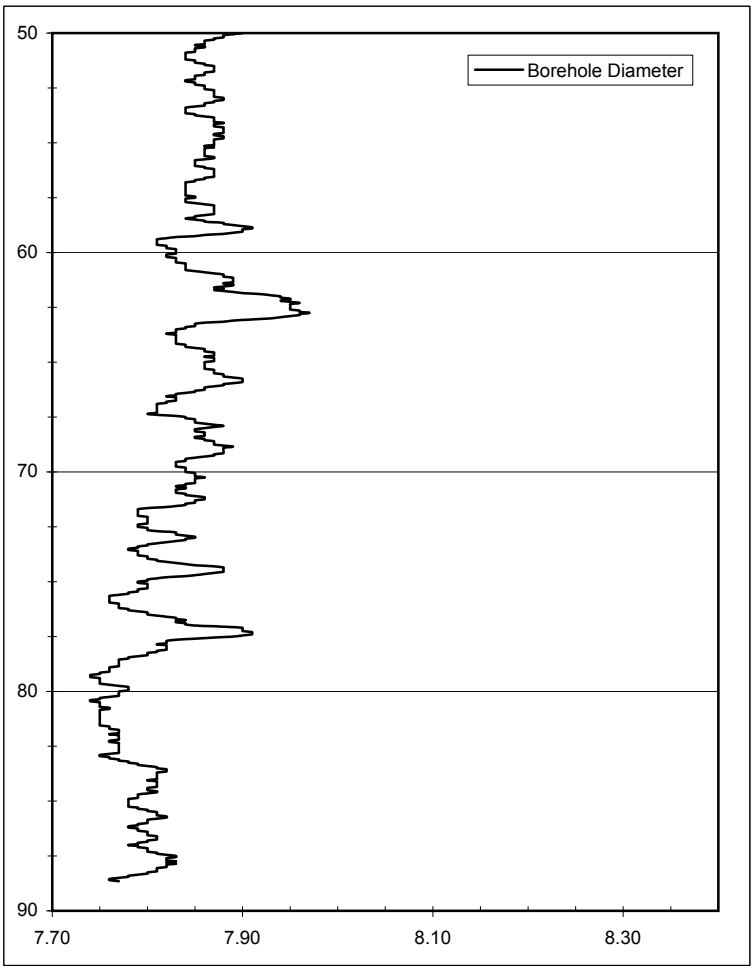
# 12MW20


Long Normal Resistivity
Short Normal Resistivity
Single Point Resistance
50
60
70
80
90
500
750
1000
1250
1500
1750

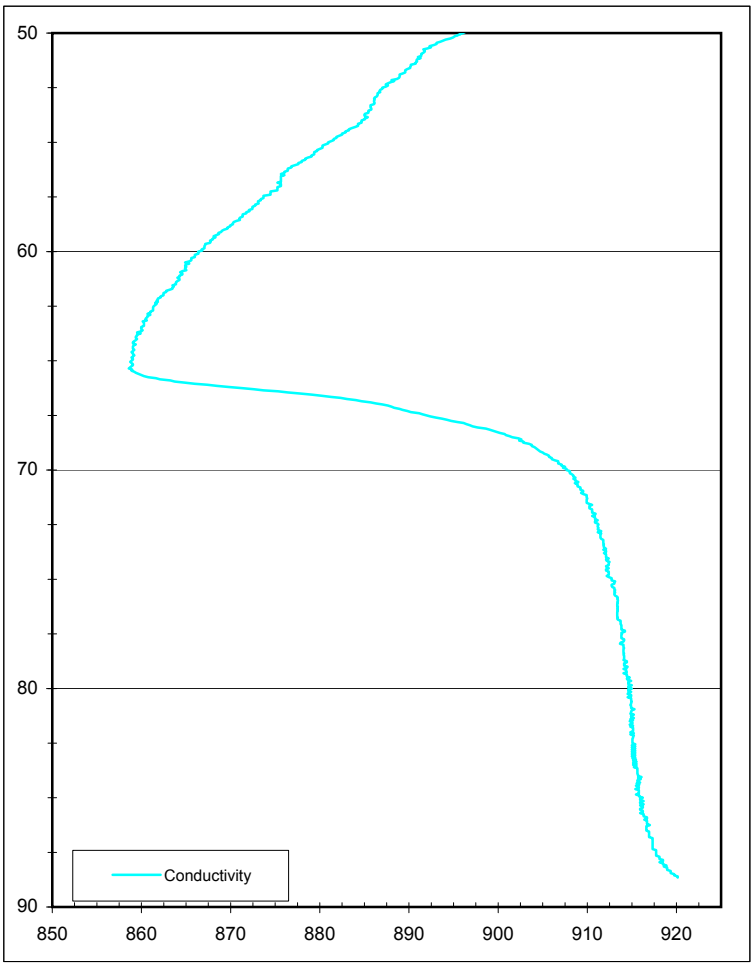
# 12MW20


50
60
70
80
90
5
15
25
35
45
55
65
NGamma A
NGamma B
NGamma C
Temperature

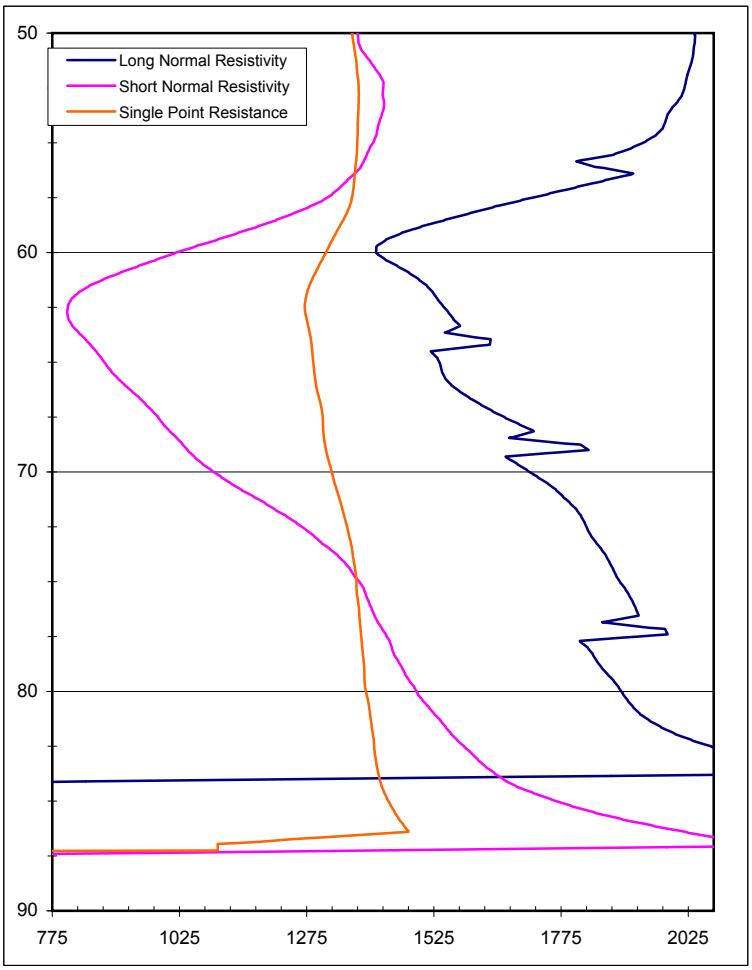
# 12MW21



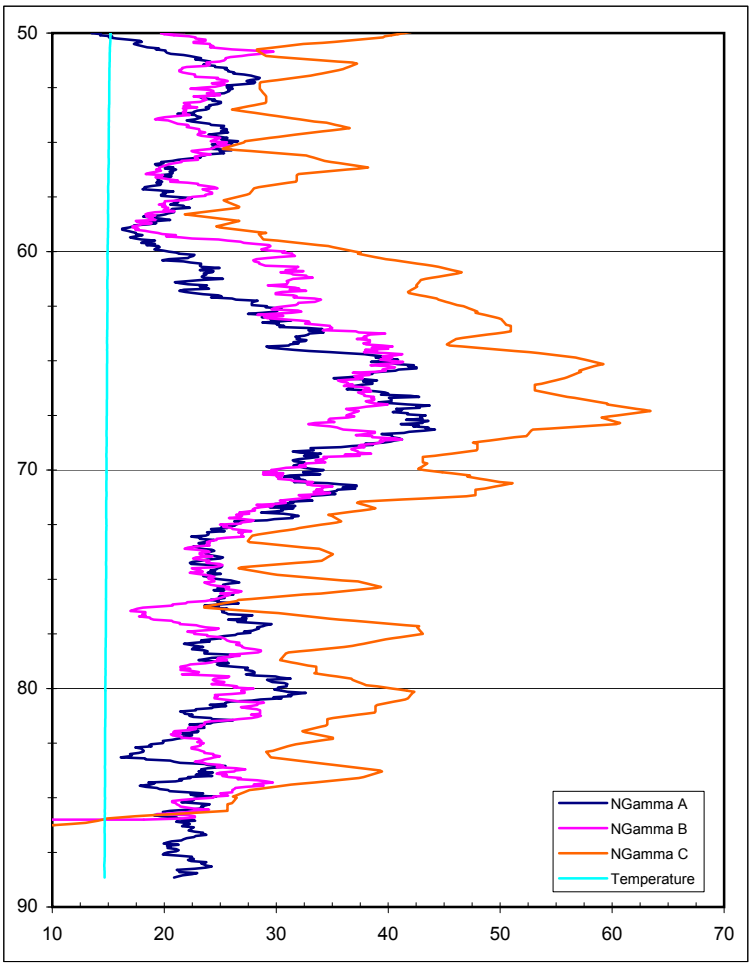
# 12MW21



# 12MW21


Long Normal Resistivity
Short Normal Resistivity
Single Point Resistance
50
60
70
80
90
775
1025
1275
1525
1775
2025

# 12MW21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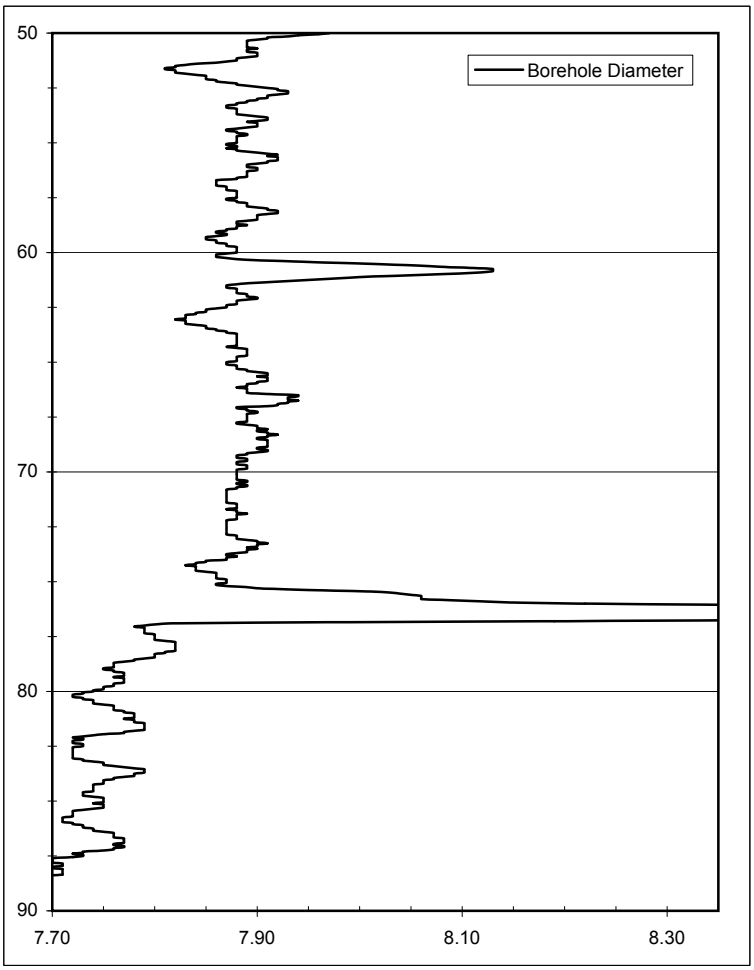
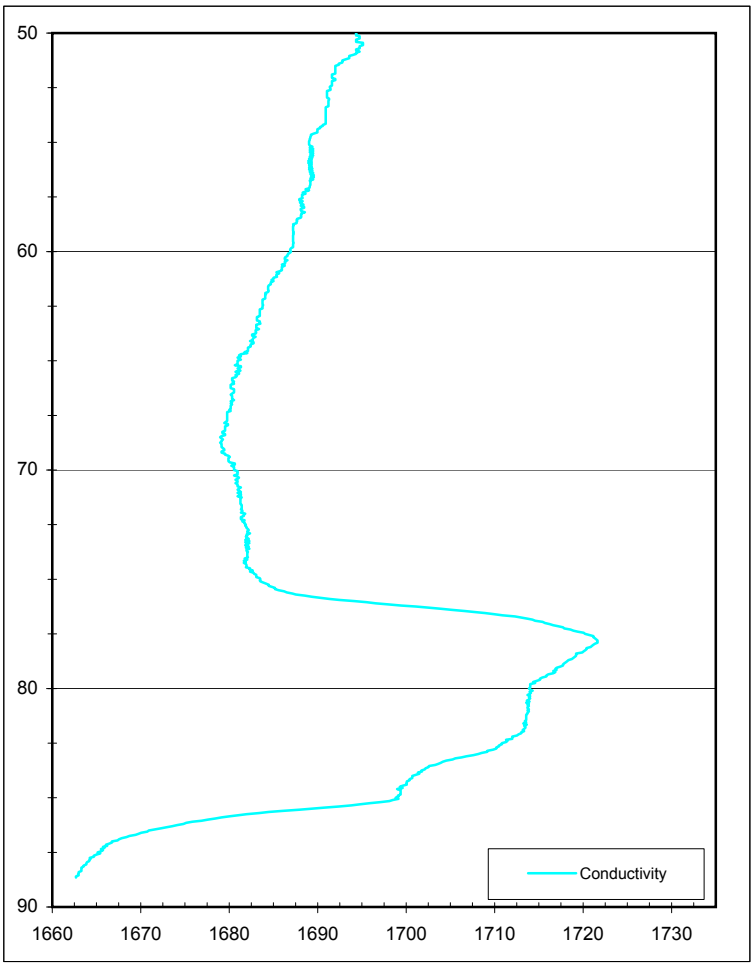
60
70
80
90
10
20
30
40
50
60
70
NGamma A
NGamma B
NGamma C
Temperature

# 12MW22



# 12MW22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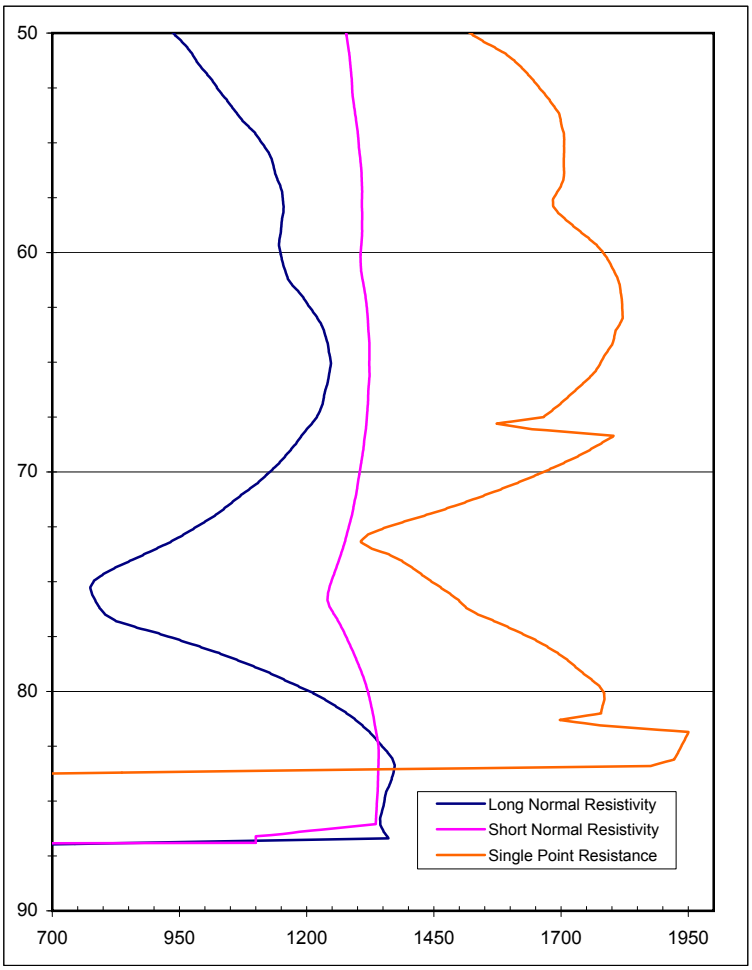
80
90
1660
1670
1680
1690
1700
1710
1720
1730
Conductivity

# 12MW22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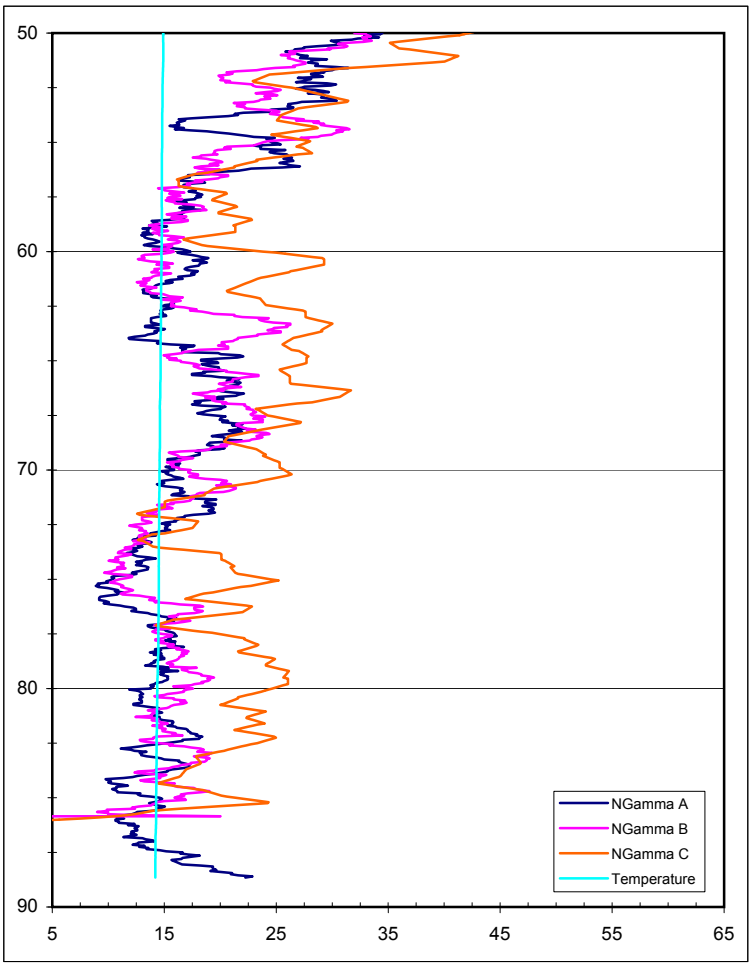
60
70
80
90
700
950
1200
1450
1700
1950
Long Normal Resistivity
Short Normal Resistivity
Single Point Resistance

# 12MW22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60
70
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5
15
25
35
45
55
65
NGamma A
NGamma B
NGamma C
Temperature

# Appendix C
# Raw Analytical Tables

**Alluvial Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 11GW14 | 12MW01 | | | | 12MW02 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-11GW14-R01 | AOCN-GGW14-1 | AS12-12MW01-R02 | AS12-12MW01-0605 | AS12-12MW01-1206 | AOCN-GGW15-1 | AOCN-GGW15-1/DUP | AS12-12MW02-R02 | AS12-12MW02-R02/DUP | AS12-12MW02-0605 | AS12-12MW02-1206 | AS12-12MW02P-1206 |
| **Sample Date** | 07/10/03 | 07/06/00 | 09/11/03 | 06/01/05 | 12/07/06 | 07/06/00 | 07/06/00 | 09/11/03 | 09/11/03 | 06/01/05 | 12/07/06 | 12/07/06 |
| **Chemical Name** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Volatile Organic Compounds (UG_L)** | | | | | | | | | | | | |
| 1,1,1-Trichloroethane | 1 U | 1 U | 11 J | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| 1,1,2,2-Tetrachloroethane | 1 U | 1 U | 0.5 UJ | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | 1 U | NA | 0.5 UJ | 0.5 U | 10 UL | NA | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| 1,1,2-Trichloroethane | 1 U | 1 U | 0.5 UJ | 0.5 U | 10 UL | 5.6 U | NA | 0.77 | 0.81 | 0.5 U | 10 UL | 10 UL |
| 1,1-Dichloroethane | 1 U | 15 | 42 J | 13 | 3.8 L | 15 | NA | 6.7 | 6.7 | 9 | 10 UL | 4.8 L |
| 1,1-Dichloroethene | 1 U | 1 U | 4.2 J | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| 1,2,3-Trichlorobenzene | NA | NA | 0.5 UJ | 0.5 U | NA | NA | NA | 0.5 U | 0.5 U | 0.5 U | NA | NA |
| 1,2,4-Trichlorobenzene | 1 U | NA | 0.5 UJ | 0.5 U | 10 UL | NA | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| 1,2-Dibromo-3-chloropropane | 1 U | NA | 130 R | 0.5 U | 10 UL | NA | NA | 2.5 R | 2.5 R | 0.5 U | 10 UL | 10 UL |
| 1,2-Dibromoethane | 1 U | NA | 0.5 UJ | 0.5 U | 10 UL | NA | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| 1,2-Dichlorobenzene | 1 U | NA | 0.64 J | 0.5 U | 1.6 L | NA | NA | 50 | 52 | 82 | 10 UJ | 87 J |
| 1,2-Dichloroethane | 1 U | 1 U | 0.5 UJ | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| 1,2-Dichloroethene (total) | NA | 0.8 J | NA | NA | NA | 120 | NA | NA | NA | NA | NA | NA |
| 1,2-Dichloropropane | 1 U | 1 U | 0.5 UJ | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| 1,3-Dichlorobenzene | 1 U | NA | 0.5 UJ | 0.5 U | 10 UL | NA | NA | 0.76 | 0.5 U | 0.5 U | 10 UL | 10 UL |
| 1,4-Dichlorobenzene | 1 U | NA | 0.5 UJ | 0.5 U | 10 UL | NA | NA | 0.5 U | 0.83 | 2.1 | 10 UL | 1.8 L |
| 2-Butanone | 5 U | 5 R | 1,300 R | 5 U | 10 UL | 28 R | NA | 25 R | 25 R | 5 U | 10 UL | 10 UL |
| 2-Hexanone | 5 U | 5 U | 5 UJ | 5 U | 10 UL | 28 U | NA | 5 U | 5 U | 5 U | 10 UL | 10 UL |
| 4-Methyl-2-pentanone | 5 U | 1 U | 5.1 J | 5 U | 10 UL | 5.6 U | NA | 5 U | 5 U | 5 U | 10 UL | 10 UL |
| Acetone | 2.4 B | 5 R | 5.5 B | 5 U | 10 UL | 28 R | NA | 2.2 B | 28 R | 5 U | 10 UL | 10 UL |
| Benzene | 1 U | 0.23 J | 0.5 UJ | 0.5 U | 10 UL | 1.3 J | NA | 0.63 | 0.65 | 1.8 | 10 UL | 1.4 L |
| Bromochloromethane | NA | NA | 0.5 UJ | 0.5 U | NA | NA | NA | 0.5 U | 0.5 U | 0.5 U | NA | NA |
| Bromodichloromethane | 1 U | 1 U | 0.5 UJ | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Bromoform | 1 U | 1 U | 0.5 UJ | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Bromomethane | 1 U | 1 U | 0.5 UJ | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Carbon disulfide | 0.42 J | 0.16 J | 0.5 UJ | 0.88 | 10 UL | 5.6 U | NA | 0.3 B | 0.59 B | 0.5 U | 10 UL | 10 UL |
| Carbon tetrachloride | 1 U | 1 U | 0.5 UJ | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Chlorobenzene | 1 U | 0.48 J | 0.5 UJ | 0.5 U | 2.4 L | 43 | NA | 49 | 49 | 99 R | 4 J | 94 J |
| Chloroethane | 1 U | 1 U | 0.5 UJ | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Chloroform | 1 U | 1 U | 0.5 UJ | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Chloromethane | 1 U | 1 U | 0.5 UJ | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Cyclohexane | 1 U | NA | 40 J | 9.6 | 1.3 L | NA | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Dibromochloromethane | 1 U | 1 U | 0.5 UJ | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Dichlorodifluoromethane (Freon-12) | 1 U | NA | 0.5 UJ | 0.5 U | 10 UL | NA | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Ethane | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Ethene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Ethylbenzene | 1 U | 1 U | 5.3 J | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Isopropylbenzene | 1 U | NA | 0.33 J | 0.5 U | 10 UL | NA | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Methane | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Methyl acetate | 1 U | NA | 0.5 UJ | 0.5 U | 10 UL | NA | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Methyl-tert-butyl ether (MTBE) | 1 U | NA | 0.5 UJ | 0.5 U | 10 UL | NA | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Methylcyclohexane | 1 U | NA | 0.5 UJ | 0.5 U | 10 UL | NA | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Methylene chloride | 0.76 B | 6.7 B | 2,900 J | 2.9 B | 10 UL | 6.3 B | NA | 0.82 B | 0.7 B | 4 B | 10 UL | 10 UL |
| Styrene | 1 U | 1 U | 0.5 UJ | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Tetrachloroethene | 1 U | 1 U | 2 J | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 1.9 L | 10 UL |
| Toluene | 1 U | 1 U | 13 J | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Trichloroethene | 1.6 | 0.1 J | 16 J | 0.5 U | 10 UL | 4.7 J | NA | 3.4 | 3.2 | 1.9 | 1.7 L | 10 UL |
| Trichlorofluoromethane(Freon-11) | 1 U | NA | 0.5 UJ | 0.5 U | 10 UL | NA | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| Vinyl chloride | 1 U | 3.4 | 8.6 J | 3.1 | 10 UL | 15 | NA | 4.3 | 4.4 | 7.6 | 10 UL | 10 UL |
| Xylene, total | 1 U | 1 U | 8.7 J | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| cis-1,2-Dichloroethene | 1 U | NA | 25 J | 1.2 J | 10 UL | NA | NA | 51 | 52 | 22 | 2.4 J | 16 J |
| cis-1,3-Dichloropropene | 1 U | 1 U | 0.5 UJ | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| trans-1,2-Dichloroethene | 1 U | NA | 27 J | 1.3 J | 10 UL | NA | NA | 1.5 | 1.5 | 1.4 J | 10 UL | 10 UL |
| trans-1,3-Dichloropropene | 1 U | 1 U | 0.5 UJ | 0.5 U | 10 UL | 5.6 U | NA | 0.5 U | 0.5 U | 0.5 U | 10 UL | 10 UL |
| | | | | | | | | | | | | |
| **Semi-volatile Organic Compounds (UG_L)** | | | | | | | | | | | | |
| 1,1-Biphenyl | NA | NA | 5.8 U | 10 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | NA |
| 1,2,4,5-Tetrachlorobenzene | NA | NA | 5.8 U | NA | NA | NA | NA | 5.3 U | 5.3 U | NA | NA | NA |
| 2,2'-Oxybis(1-chloropropane) | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| 2,4,5-Trichlorophenol | NA | 5 U | 23 U | 26 U | NA | 5 U | 5 UJ | 21 U | 21 U | 28 U | NA | NA |
| 2,4,6-Trichlorophenol | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |

**Alluvial Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 11GW14 | 12MW01 | | | | 12MW02 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-11GW14-R01 | AOCN-GGW14-1 | AS12-12MW01-R02 | AS12-12MW01-0605 | AS12-12MW01-1206 | AOCN-GGW15-1 | AOCN-GGW15-1/DUP | AS12-12MW02-R02 | AS12-12MW02-R02/DUP | AS12-12MW02-0605 | AS12-12MW02-1206 | AS12-12MW02P-1206 |
| **Sample Date** | 07/10/03 | 07/06/00 | 09/11/03 | 06/01/05 | 12/07/06 | 07/06/00 | 07/06/00 | 09/11/03 | 09/11/03 | 06/01/05 | 12/07/06 | 12/07/06 |
| **Chemical Name** | | | | | | | | | | | | |
| 2,4-Dichlorophenol | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| 2,4-Dimethylphenol | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| 2,4-Dinitrophenol | NA | 20 U | 23 U | 26 U | NA | 20 U | 20 UJ | 21 U | 21 U | 28 U | NA | NA |
| 2,4-Dinitrotoluene | NA | NA | 5.8 U | 10 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | NA |
| 2,6-Dinitrotoluene | NA | NA | 5.8 U | 10 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | NA |
| 2-Chloronaphthalene | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| 2-Chlorophenol | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| 2-Methylnaphthalene | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| 2-Methylphenol | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| 2-Nitroaniline | NA | 20 U | 23 U | 26 U | NA | 20 U | 20 UJ | 21 U | 21 U | 28 U | NA | NA |
| 2-Nitrophenol | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| 3,3'-Dichlorobenzidine | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| 3-Nitroaniline | NA | 20 U | 23 U | 26 U | NA | 20 U | 20 UJ | 21 U | 21 U | 28 U | NA | NA |
| 4,6-Dinitro-2-methylphenol | NA | 20 U | 23 U | 26 U | NA | 20 U | 20 UJ | 21 U | 21 U | 28 U | NA | NA |
| 4-Bromophenyl-phenylether | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| 4-Chloro-3-methylphenol | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| 4-Chloroaniline | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| 4-Chlorophenyl-phenylether | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| 4-Methylphenol | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| 4-Nitroaniline | NA | 20 U | 23 U | 26 U | NA | 20 U | 20 UJ | 21 U | 21 U | 28 U | NA | NA |
| 4-Nitrophenol | NA | 20 U | 23 U | 26 U | NA | 20 U | 20 UJ | 21 U | 21 U | 28 U | NA | NA |
| Acenaphthene | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Acenaphthylene | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Acetophenone | NA | NA | 5.8 U | 10 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | NA |
| Anthracene | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Atrazine | NA | NA | 5.8 UJ | 10 UJ | NA | NA | NA | 5.3 UJ | 5.3 UJ | 11 UJ | NA | NA |
| Benzaldehyde | NA | NA | 5.8 UJ | 10 U | NA | NA | NA | 5.3 UJ | 5.3 UJ | 11 U | NA | NA |
| Benzo(a)anthracene | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Benzo(a)pyrene | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Benzo(b)fluoranthene | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Benzo(g,h,i)perylene | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Benzo(k)fluoranthene | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Butylbenzylphthalate | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Caprolactam | NA | NA | 5.8 U | 10 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | NA |
| Carbazole | NA | 5 U | NA | 10 U | NA | 5 U | 5 UJ | NA | NA | 11 U | NA | NA |
| Chrysene | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Di-n-butylphthalate | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Di-n-octylphthalate | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Dibenz(a,h)anthracene | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Dibenzofuran | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Diethylphthalate | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Dimethyl phthalate | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Fluoranthene | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Fluorene | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Hexachlorobenzene | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Hexachlorobutadiene | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Hexachlorocyclopentadiene | NA | 5 U | 5.8 UJ | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 UJ | 11 U | NA | NA |
| Hexachloroethane | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Indeno(1,2,3-cd)pyrene | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Isophorone | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Naphthalene | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Nitrobenzene | NA | NA | 5.8 U | 10 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | NA |
| Pentachlorophenol | NA | 20 U | 5.8 U | 26 U | NA | 20 U | 20 UJ | 5.3 U | 5.3 U | 28 U | NA | NA |
| Phenanthrene | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Phenol | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| Pyrene | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| bis(2-Chloroethoxy)methane | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| bis(2-Chloroethyl)ether | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| bis(2-Ethylhexyl)phthalate | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 1 B | 5.3 U | 5.3 U | 11 U | NA | NA |
| n-Nitroso-di-n-propylamine | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |
| n-Nitrosodiphenylamine | NA | 5 U | 5.8 U | 10 U | NA | 5 U | 5 UJ | 5.3 U | 5.3 U | 11 U | NA | NA |

**Alluvial Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 11GW14 | 12MW01 | | | | 12MW02 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-11GW14-R01 | AOCN-GGW14-1 | AS12-12MW01-R02 | AS12-12MW01-0605 | AS12-12MW01-1206 | AOCN-GGW15-1 | AOCN-GGW15-1/DUP | AS12-12MW02-R02 | AS12-12MW02-R02/DUP | AS12-12MW02-0605 | AS12-12MW02-1206 | AS12-12MW02P-1206 |
| **Sample Date** | 07/10/03 | 07/06/00 | 09/11/03 | 06/01/05 | 12/07/06 | 07/06/00 | 07/06/00 | 09/11/03 | 09/11/03 | 06/01/05 | 12/07/06 | 12/07/06 |
| **Chemical Name** | | | | | | | | | | | | |
| **Explosives (UG_L)** | | | | | | | | | | | | |
| 1,3,5-Trinitrobenzene | NA | NA | 0.26 U | 0.26 U | NA | NA | NA | 0.26 U | 0.26 U | 0.26 U | NA | NA |
| 1,3-Dinitrobenzene | NA | NA | 0.26 U | 0.26 U | NA | NA | NA | 0.26 U | 0.26 U | 0.26 U | NA | NA |
| 2,4,6-Trinitrotoluene | NA | NA | 0.26 U | 0.26 U | NA | NA | NA | 0.26 U | 0.26 U | 0.26 U | NA | NA |
| 2,4-Dinitrotoluene | NA | 5 U | NA | 0.26 U | NA | 5 U | 5 UJ | NA | NA | 0.26 U | NA | NA |
| 2,6-Dinitrotoluene | NA | 5 U | NA | 0.26 U | NA | 5 U | 5 UJ | NA | NA | 0.26 U | NA | NA |
| 2-Amino-4,6-dinitrotoluene | NA | NA | 0.26 U | 0.26 U | NA | NA | NA | 0.26 U | 0.26 U | 0.26 U | NA | NA |
| 2-Nitrotoluene | NA | NA | 0.52 U | 0.52 U | NA | NA | NA | 0.52 U | 0.52 U | 0.52 U | NA | NA |
| 3-Nitrotoluene | NA | NA | 0.52 U | 0.52 U | NA | NA | NA | 0.52 U | 0.52 U | 0.52 U | NA | NA |
| 4-Amino-2,6-dinitrotoluene | NA | NA | 0.26 U | 0.26 U | NA | NA | NA | 0.26 U | 0.26 U | 0.26 U | NA | NA |
| 4-Nitrotoluene | NA | NA | 0.52 U | 0.52 U | NA | NA | NA | 0.52 U | 0.52 U | 0.52 U | NA | NA |
| HMX | NA | NA | 0.52 U | 0.52 U | NA | NA | NA | 0.52 U | 0.52 U | 0.52 U | NA | NA |
| Nitrobenzene | NA | 5 U | NA | 0.26 U | NA | 5 U | 5 UJ | NA | NA | 0.26 U | NA | NA |
| Nitroglycerin | NA | NA | 1,000 U | 2,000 U | NA | NA | NA | 1,000 U | 1,000 U | 2,000 U | NA | NA |
| Perchlorate | NA | NA | 2 U | 5 U | NA | NA | NA | 2 U | 2 U | 5 U | NA | NA |
| RDX | NA | NA | 0.52 U | 0.52 U | NA | NA | NA | 0.52 U | 0.52 U | 0.52 U | NA | NA |
| Tetryl | NA | NA | 0.52 U | 0.52 U | NA | NA | NA | 0.52 U | 0.52 U | 0.52 U | NA | NA |
| | | | | | | | | | | | | |
| **Total Metals (UG_L)** | | | | | | | | | | | | |
| Aluminum | NA | 2,080 J | 2,970 | 1,200 | NA | 304 B | NA | 2,710 K | 747 | 7,090 | NA | NA |
| Antimony | NA | 4.3 U | 2.5 U | 2.8 U | NA | 4.3 U | NA | 2.5 U | 2.5 U | 4.2 B | NA | NA |
| Arsenic | NA | 12.1 | 8.3 J | 3.6 U | NA | 6.1 J | NA | 5.2 J | 5 U | 9.4 J | NA | NA |
| Barium | NA | 316 | 288 J | 166 J | NA | 90.8 B | NA | 72.5 J | 68.7 J | 113 J | NA | NA |
| Beryllium | NA | 0.69 B | 0.25 B | 0.1 J | NA | 0.2 U | NA | 0.08 U | 0.08 U | 0.32 J | NA | NA |
| Cadmium | NA | 0.44 J | 0.89 B | 0.4 U | NA | 0.4 U | NA | 0.4 U | 0.4 U | 0.4 U | NA | NA |
| Calcium | NA | 206,000 | 228,000 | 145,000 | NA | 216,000 | NA | 145,000 | 139,000 | 165,000 | NA | NA |
| Chromium | NA | 7.1 B | 8.7 J | 11.3 | NA | 2.7 B | NA | 5.9 J | 3.7 B | 9.6 B | NA | NA |
| Chromium (hexavalent) | NA | 20 L | 10 U | 10 U | NA | 50 L | 40 L | 10 U | 10 U | 65 | NA | NA |
| Cobalt | NA | 8.3 B | 4.7 J | 2.8 J | NA | 13.9 J | NA | 11.5 J | 9 J | 14 J | NA | NA |
| Copper | NA | 2.2 B | 7 B | 3.6 B | NA | 1.9 U | NA | 5.7 B | 5.3 B | 7.9 B | NA | NA |
| Cyanide | NA | 2.8 B | 10 U | 5 U | NA | 4.3 B | NA | 10 U | 10 U | 5 U | NA | NA |
| Iron | NA | 40,900 J | 30,100 | 21,300 | NA | 9,450 J | NA | 7,810 | 4,400 | 20,400 | NA | NA |
| Lead | NA | 11.3 | 3.9 B | 2.6 J | NA | 1.8 J | NA | 3.9 B | 1.9 B | 6.2 | NA | NA |
| Magnesium | NA | 41,200 | 46,400 | 33,100 | NA | 52,800 | NA | 35,500 | 32,600 | 41,400 | NA | NA |
| Manganese | NA | 5,760 J | 4,800 | 3,280 | NA | 6,290 J | NA | 3,800 | 3,860 | 5,140 | NA | NA |
| Mercury | NA | 0.1 UL | 0.1 UL | 0.1 U | NA | 0.1 UL | NA | 0.1 UL | 0.1 UL | 0.1 U | NA | NA |
| Nickel | NA | 168 | 150 | 89.7 | NA | 120 | NA | 77.3 | 70.2 | 84.9 | NA | NA |
| Potassium | NA | 1,590 J | 3,420 J | 1,510 J | NA | 1,620 J | NA | 2,370 J | 1,750 J | 3,740 J | NA | NA |
| Selenium | NA | 4.3 UL | 3.4 J | 2.6 U | NA | 4.3 UL | NA | 3.7 J | 3.2 UL | 2.6 U | NA | NA |
| Silver | NA | 3.1 U | 0.6 U | 0.7 U | NA | 3.1 U | NA | 0.6 U | 0.6 U | 0.7 U | NA | NA |
| Sodium | NA | 75,400 | 91,600 | 57,900 | NA | 54,300 | NA | 40,700 | 40,500 | 46,100 | NA | NA |
| Thallium | NA | 14.6 B | 5.8 U | 4.6 U | NA | 6.9 B | NA | 5.8 U | 5.8 U | 4.6 U | NA | NA |
| Vanadium | NA | 6.4 J | 5.6 J | 2.6 J | NA | 1.4 U | NA | 5.2 J | 0.7 U | 12.3 J | NA | NA |
| Zinc | NA | 41.6 | 20 B | 10.3 B | NA | 11.2 B | NA | 15.1 J | 11.6 B | 21.9 | NA | NA |
| | | | | | | | | | | | | |
| **Dissolved Metals (UG_L)** | | | | | | | | | | | | |
| Aluminum | NA | NA | 641 | 67.4 J | NA | NA | NA | 15.1 U | 15.1 U | 40.3 U | NA | NA |
| Antimony | NA | NA | 2.5 U | 2.8 U | NA | NA | NA | 4.4 B | 2.5 U | 2.8 U | NA | NA |
| Arsenic | NA | NA | 5 U | 3.6 U | NA | NA | NA | 7.3 J | 5 U | 3.9 J | NA | NA |
| Barium | NA | NA | 279 J | 161 J | NA | NA | NA | 54.8 J | 56.8 J | 68 J | NA | NA |
| Beryllium | NA | NA | 0.096 B | 0.1 U | NA | NA | NA | 0.08 U | 0.08 U | 0.1 U | NA | NA |
| Cadmium | NA | NA | 0.76 B | 0.4 U | NA | NA | NA | 0.4 U | 0.45 B | 0.4 U | NA | NA |
| Calcium | NA | NA | 237,000 | 148,000 | NA | NA | NA | 151,000 | 144,000 | 169,000 | NA | NA |
| Chromium | NA | NA | 2.9 B | 2.7 J | NA | NA | NA | 0.89 B | 0.7 U | 0.6 U | NA | NA |
| Chromium (hexavalent) | NA | NA | 10 U | 10 U | NA | NA | NA | 10 U | 10 U | 10 U | NA | NA |
| Cobalt | NA | NA | 2.7 B | 1.7 J | NA | NA | NA | 13.4 J | 10.9 J | 12.7 J | NA | NA |
| Copper | NA | NA | 4.1 B | 1.1 B | NA | NA | NA | 1.7 B | 3.6 B | 1 B | NA | NA |
| Iron | NA | NA | 26,200 | 19,300 | NA | NA | NA | 3,170 | 3,140 | 7,550 | NA | NA |
| Lead | NA | NA | 1.9 U | 1.8 U | NA | NA | NA | 1.9 U | 1.9 U | 1.8 U | NA | NA |
| Magnesium | NA | NA | 48,000 | 33,900 | NA | NA | NA | 37,600 | 35,400 | 41,600 | NA | NA |
| Manganese | NA | NA | 4,880 | 3,180 | NA | NA | NA | 4,130 | 4,000 | 5,060 | NA | NA |
| Mercury | NA | NA | 0.1 UL | 0.1 U | NA | NA | NA | 0.1 UL | 0.1 UL | 0.1 U | NA | NA |
| Nickel | NA | NA | 143 | 85.2 | NA | NA | NA | 91.8 | 83.5 | 87 | NA | NA |

**Alluvial Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 11GW14 | 12MW01 | | | | 12MW02 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-11GW14-R01 | AOCN-GGW14-1 | AS12-12MW01-R02 | AS12-12MW01-0605 | AS12-12MW01-1206 | AOCN-GGW15-1 | AOCN-GGW15-1/DUP | AS12-12MW02-R02 | AS12-12MW02-R02/DUP | AS12-12MW02-0605 | AS12-12MW02-1206 | AS12-12MW02P-1206 |
| **Sample Date** | 07/10/03 | 07/06/00 | 09/11/03 | 06/01/05 | 12/07/06 | 07/06/00 | 07/06/00 | 09/11/03 | 09/11/03 | 06/01/05 | 12/07/06 | 12/07/06 |
| **Chemical Name** | | | | | | | | | | | | |
| Potassium | NA | NA | 3,180 J | 1,320 J | NA | NA | NA | 1,550 J | 1,480 J | 1,280 J | NA | NA |
| Selenium | NA | NA | 3.2 UL | 2.6 U | NA | NA | NA | 3.8 J | 3.2 UL | 2.6 U | NA | NA |
| Silver | NA | NA | 0.6 U | 0.7 U | NA | NA | NA | 0.6 U | 0.6 U | 0.7 U | NA | NA |
| Sodium | NA | NA | 90,700 | 57,800 | NA | NA | NA | 43,500 | 43,200 | 47,900 | NA | NA |
| Thallium | NA | NA | 5.8 U | 4.6 U | NA | NA | NA | 5.8 U | 5.8 U | 4.6 U | NA | NA |
| Vanadium | NA | NA | 1.6 B | 1.1 U | NA | NA | NA | 0.9 B | 0.7 U | 1.1 U | NA | NA |
| Zinc | NA | NA | 6.6 B | 3.2 B | NA | NA | NA | 8.1 B | 7.5 B | 7.5 B | NA | NA |
| | | | | | | | | | | | | |
| **Wet Chemistry (MG_L)** | | | | | | | | | | | | |
| Alkalinity | NA | NA | NA | NA | 230 | NA | NA | NA | NA | NA | 200 | 210 |
| Chloride | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Hardness | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Nitrate | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Nitrogen | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Sulfate | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Total organic carbon (TOC) | NA | NA | NA | NA | 1.4 B | NA | NA | NA | NA | NA | 2.2 B | 2.2 B |

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Shading represents detect

**Alluvial Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| Station ID | 12MW06 | | | 12MW08 | | | | | | 12MW10 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | AOCN-GGW16-1 | AOCN-GGW16-2 | AS12-12MW06-R01 | AS12-12MW08-R01 | AS12-12MW08-R02 | AS12-12MW08-R02/DUP | AS12-12MW08-0605 | AS12-12MW08-1206 | AS12-12MW08-0607 | AS12-12MW10-R01 | AS12-12MW10-R02 | AS12-12MW10-0505 | AS12-12MW10-1206 | AS12-12MW10-0607 |
| Sample Date | 07/06/00 | 07/17/02 | 07/10/03 | 07/09/03 | 09/15/03 | 09/15/03 | 06/02/05 | 12/07/06 | 06/11/07 | 07/09/03 | 09/12/03 | 05/27/05 | 12/07/06 | 06/12/07 |
| **Chemical Name** | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| **Volatile Organic Compounds (UG_L)** | | | | | | | | | | | | | | |
| 1,1,1-Trichloroethane | 1.2 | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,1,2,2-Tetrachloroethane | 1.2 U | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 3.2 J | 0.5 U |
| 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | NA | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,1,2-Trichloroethane | 1.2 U | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 3.4 J | 0.5 U |
| 1,1-Dichloroethane | 2.8 | NA | 1 U | 15 | 15 | 14 | 12 | 6.2 J | 2.4 | 1.5 | 1.4 | 1.1 | 10 U | 0.64 |
| 1,1-Dichloroethene | 0.25 J | NA | 1 U | 0.46 J | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,2,3-Trichlorobenzene | NA | NA | NA | NA | 0.5 U | 0.5 U | 0.5 U | NA | 0.5 U | NA | 0.5 U | 0.5 U | NA | 0.5 U |
| 1,2,4-Trichlorobenzene | NA | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 1.3 J | 0.5 U |
| 1,2-Dibromo-3-chloropropane | NA | NA | 1 U | 1 U | 13 R | 13 R | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 R | 0.5 U | 3.8 J | 0.5 U |
| 1,2-Dibromoethane | NA | NA | 1 U | 1 U | 0.5 UJ | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,2-Dichlorobenzene | NA | NA | 1 U | 0.76 J | 1.2 | 1.2 | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,2-Dichloroethane | 1.2 U | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,2-Dichloroethene (total) | 20 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1,2-Dichloropropane | 1.2 U | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,3-Dichlorobenzene | NA | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,4-Dichlorobenzene | NA | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 2-Butanone | 6.2 R | NA | 5 U | 5 U | 130 R | 130 R | 5 U | 10 U | 5 U | 5 U | 5 R | 5 U | 10 U | 5 U |
| 2-Hexanone | 6.2 U | NA | 5 U | 5 U | 5 U | 5 U | 5 U | 10 U | 5 U | 5 U | 5 U | 5 U | 10 U | 5 U |
| 4-Methyl-2-pentanone | 1.2 U | NA | 5 U | 5 U | 3.4 J | 4.2 J | 5 U | 10 U | 5 U | 5 U | 5 U | 5 U | 10 U | 5 U |
| Acetone | 6.2 R | NA | 5 U | 3.4 B | 4 B | 4 B | 5 U | 10 U | 3.8 J | 1.8 B | 2.7 B | 5 UJ | 10 U | 5 U |
| Benzene | 0.14 J | NA | 1 U | 0.43 J | 0.44 J | 0.39 J | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 1.8 J | 0.5 U |
| Bromochloromethane | NA | NA | NA | NA | 0.5 U | 0.5 U | 0.5 U | NA | 0.5 U | NA | 0.5 U | 0.5 U | NA | 0.5 U |
| Bromodichloromethane | 1.2 U | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Bromoform | 1.2 U | NA | 1 U | 1 U | 0.5 UJ | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Bromomethane | 1.2 U | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 UJ |
| Carbon disulfide | 1.2 U | NA | 1.1 | 0.57 J | 2.3 B | 1.9 B | 0.87 | 10 U | 0.5 U | 0.7 J | 1.7 B | 0.5 U | 10 U | 0.5 U |
| Carbon tetrachloride | 1.2 U | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Chlorobenzene | 5.9 | NA | 1 U | 1 U | 0.86 | 0.83 | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Chloroethane | 1.2 U | NA | 1 U | 8.4 | 2.8 | 3 | 1.8 | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Chloroform | 1.2 U | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Chloromethane | 0.27 B | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Cyclohexane | NA | NA | 1 U | 300 | 370 J | 370 | 81 | 18 | 4.8 | 1 U | 0.96 B | 0.5 U | 10 U | 0.5 U |
| Dibromochloromethane | 1.2 U | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Dichlorodifluoromethane (Freon-12) | NA | NA | 1 U | 1 U | 0.5 UJ | 0.5 U | 0.5 U | 10 U | 0.5 UJ | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 UJ |
| Ethane | NA | NA | NA | NA | NA | NA | NA | NA | 1,200 U | NA | NA | NA | NA | 12 U |
| Ethene | NA | NA | NA | NA | NA | NA | NA | NA | 1,200 U | NA | NA | NA | NA | 12 U |
| Ethylbenzene | 1.2 U | NA | 1 U | 53 | 42 | 43 | 0.45 J | 1.4 J | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Isopropylbenzene | NA | NA | 1 U | 3.9 | 4.2 | 3.8 | 2 | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Methane | NA | NA | NA | NA | NA | NA | NA | NA | 2,400 | NA | NA | NA | NA | 30 |
| Methyl acetate | NA | NA | 1 U | 1 U | 13 R | 13 R | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 R | 0.5 U | 10 U | 0.5 U |
| Methyl-tert-butyl ether (MTBE) | NA | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Methylcyclohexane | NA | NA | 1 U | 3.4 | 3.3 | 3.1 | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Methylene chloride | 9.2 B | NA | 0.67 B | 2 B | 31 J | 36 J | 11 B | 10 U | 0.62 B | 1.2 B | 1.2 B | 0.5 U | 10 U | 0.5 U |
| Styrene | 1.2 U | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Tetrachloroethene | 0.76 J | NA | 0.82 J | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 1.4 J | 0.5 U |
| Toluene | 1.2 U | NA | 1 U | 2.4 | 20 | 19 | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Trichloroethene | 28 | NA | 1.8 | 2 | 0.73 | 0.76 | 0.5 U | 10 U | 0.62 | 0.87 J | 0.78 | 0.5 U | 2.6 J | 0.5 U |
| Trichlorofluoromethane(Freon-11) | NA | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Vinyl chloride | 1.3 | NA | 1 U | 6 | 2.5 | 2.4 | 0.55 | 10 U | 0.5 U | 1.4 | 0.53 | 0.66 | 10 U | 0.5 UJ |
| Xylene, total | 1.2 U | NA | 1 U | 1 U | 11 | 11 | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| cis-1,2-Dichloroethene | NA | NA | 0.98 J | 4 | 3.1 | 3.2 | 0.4 J | 10 U | 0.5 U | 1.3 | 1.1 | 1.3 | 3 J | 0.66 |
| cis-1,3-Dichloropropene | 1.2 U | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| trans-1,2-Dichloroethene | NA | NA | 1 U | 7.4 | 5.1 | 5 | 0.79 | 10 U | 0.92 | 1.2 | 0.99 | 0.73 | 2.1 J | 0.44 J |
| trans-1,3-Dichloropropene | 1.2 U | NA | 1 U | 1 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| | | | | | | | | | | | | | | |
| **Semi-volatile Organic Compounds (UG_L)** | | | | | | | | | | | | | | |
| 1,1-Biphenyl | NA | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| 1,2,4,5-Tetrachlorobenzene | NA | NA | NA | NA | 5.3 U | 5.3 U | NA | NA | NA | NA | 5.3 U | NA | NA | NA |
| 2,2'-Oxybis(1-chloropropane) | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| 2,4,5-Trichlorophenol | 5 U | NA | NA | NA | 21 U | 21 U | 28 U | NA | 28 U | NA | 21 U | 27 U | NA | 26 U |
| 2,4,6-Trichlorophenol | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |

**Alluvial Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| Station ID | 12MW06 | | | 12MW08 | | | | | | 12MW10 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | AOCN-GGW16-1 | AOCN-GGW16-2 | AS12-12MW06-R01 | AS12-12MW08-R01 | AS12-12MW08-R02 | AS12-12MW08-R02/DUP | AS12-12MW08-0605 | AS12-12MW08-1206 | AS12-12MW08-0607 | AS12-12MW10-R01 | AS12-12MW10-R02 | AS12-12MW10-0505 | AS12-12MW10-1206 | AS12-12MW10-0607 |
| Sample Date | 07/06/00 | 07/17/02 | 07/10/03 | 07/09/03 | 09/15/03 | 09/15/03 | 06/02/05 | 12/07/06 | 06/11/07 | 07/09/03 | 09/12/03 | 05/27/05 | 12/07/06 | 06/12/07 |
| **Chemical Name** | | | | | | | | | | | | | | |
| 2,4-Dichlorophenol | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| 2,4-Dimethylphenol | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| 2,4-Dinitrophenol | 20 U | NA | NA | NA | 21 U | 21 U | 28 U | NA | 28 U | NA | 21 U | 27 U | NA | 26 U |
| 2,4-Dinitrotoluene | NA | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | NA | 11 U | NA | 10 U |
| 2,6-Dinitrotoluene | NA | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | NA | 11 U | NA | 10 U |
| 2-Chloronaphthalene | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| 2-Chlorophenol | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| 2-Methylnaphthalene | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| 2-Methylphenol | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| 2-Nitroaniline | 20 U | NA | NA | NA | 21 U | 21 U | 28 U | NA | 28 U | NA | 21 U | 27 U | NA | 26 U |
| 2-Nitrophenol | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| 3,3'-Dichlorobenzidine | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| 3-Nitroaniline | 20 U | NA | NA | NA | 21 U | 21 U | 28 U | NA | 28 U | NA | 21 U | 27 U | NA | 26 U |
| 4,6-Dinitro-2-methylphenol | 20 U | NA | NA | NA | 21 U | 21 U | 28 U | NA | 28 U | NA | 21 U | 27 U | NA | 26 U |
| 4-Bromophenyl-phenylether | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| 4-Chloro-3-methylphenol | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| 4-Chloroaniline | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| 4-Chlorophenyl-phenylether | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| 4-Methylphenol | 5 U | NA | NA | NA | 2.5 J | 2.9 J | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| 4-Nitroaniline | 20 U | NA | NA | NA | 21 U | 21 U | 28 U | NA | 28 U | NA | 21 U | 27 U | NA | 26 U |
| 4-Nitrophenol | 20 U | NA | NA | NA | 21 U | 21 U | 28 U | NA | 28 U | NA | 21 U | 27 U | NA | 26 U |
| Acenaphthene | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Acenaphthylene | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Acetophenone | NA | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Anthracene | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Atrazine | NA | NA | NA | NA | 5.3 UJ | 5.3 UJ | 11 U | NA | 11 R | NA | 5.3 UJ | 11 UJ | NA | 10 R |
| Benzaldehyde | NA | NA | NA | NA | 5.3 UJ | 5.3 UJ | 11 U | NA | 11 U | NA | 5.3 UJ | 11 U | NA | 10 U |
| Benzo(a)anthracene | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Benzo(a)pyrene | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Benzo(b)fluoranthene | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Benzo(g,h,i)perylene | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Benzo(k)fluoranthene | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Butylbenzylphthalate | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Caprolactam | NA | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Carbazole | 5 U | NA | NA | NA | NA | NA | 11 U | NA | 11 U | NA | NA | 11 U | NA | 10 U |
| Chrysene | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Di-n-butylphthalate | 5 U | NA | NA | NA | 8.4 | 10 | 1.5 J | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Di-n-octylphthalate | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Dibenz(a,h)anthracene | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Dibenzofuran | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Diethylphthalate | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Dimethyl phthalate | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Fluoranthene | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Fluorene | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Hexachlorobenzene | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Hexachlorobutadiene | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Hexachlorocyclopentadiene | 5 U | NA | NA | NA | 5.3 UJ | 5.3 UJ | 11 U | NA | 11 UJ | NA | 5.3 U | 11 U | NA | 10 U |
| Hexachloroethane | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Indeno(1,2,3-cd)pyrene | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Isophorone | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Naphthalene | 5 U | NA | NA | NA | 1.1 J | 1.3 J | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Nitrobenzene | NA | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | NA | 11 U | NA | 10 U |
| Pentachlorophenol | 20 U | NA | NA | NA | 5.3 U | 5.3 U | 28 U | NA | 28 U | NA | 5.3 U | 27 U | NA | 26 U |
| Phenanthrene | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Phenol | 5 U | NA | NA | NA | 8.5 | 10 | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| Pyrene | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| bis(2-Chloroethoxy)methane | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| bis(2-Chloroethyl)ether | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| bis(2-Ethylhexyl)phthalate | 5 U | NA | NA | NA | 5.3 U | 1.1 J | 2.5 J | NA | 2.5 B | NA | 5.3 U | 11 U | NA | 10 U |
| n-Nitroso-di-n-propylamine | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |
| n-Nitrosodiphenylamine | 5 U | NA | NA | NA | 5.3 U | 5.3 U | 11 U | NA | 11 U | NA | 5.3 U | 11 U | NA | 10 U |

**Alluvial Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| Station ID | 12MW06 | | | 12MW08 | | | | | | 12MW10 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | AOCN-GGW16-1 | AOCN-GGW16-2 | AS12-12MW06-R01 | AS12-12MW08-R01 | AS12-12MW08-R02 | AS12-12MW08-R02/DUP | AS12-12MW08-0605 | AS12-12MW08-1206 | AS12-12MW08-0607 | AS12-12MW10-R01 | AS12-12MW10-R02 | AS12-12MW10-0505 | AS12-12MW10-1206 | AS12-12MW10-0607 |
| Sample Date | 07/06/00 | 07/17/02 | 07/10/03 | 07/09/03 | 09/15/03 | 09/15/03 | 06/02/05 | 12/07/06 | 06/11/07 | 07/09/03 | 09/12/03 | 05/27/05 | 12/07/06 | 06/12/07 |
| **Chemical Name** | | | | | | | | | | | | | | |
| **Explosives (UG_L)** | | | | | | | | | | | | | | |
| 1,3,5-Trinitrobenzene | NA | NA | NA | NA | 0.26 U | 0.26 U | 0.26 U | NA | NA | NA | 0.26 U | 0.26 U | NA | NA |
| 1,3-Dinitrobenzene | NA | NA | NA | NA | 0.26 U | 0.26 U | 0.26 U | NA | NA | NA | 0.26 U | 0.26 U | NA | NA |
| 2,4,6-Trinitrotoluene | NA | NA | NA | NA | 0.26 U | 0.26 U | 0.26 U | NA | NA | NA | 0.26 U | 0.26 U | NA | NA |
| 2,4-Dinitrotoluene | 5 U | NA | NA | NA | NA | NA | 0.26 U | NA | NA | NA | 0.26 U | 0.26 U | NA | NA |
| 2,6-Dinitrotoluene | 5 U | NA | NA | NA | NA | NA | 0.26 U | NA | NA | NA | 0.26 U | 0.26 U | NA | NA |
| 2-Amino-4,6-dinitrotoluene | NA | NA | NA | NA | 0.26 U | 0.26 U | 0.26 U | NA | NA | NA | 0.26 U | 0.26 U | NA | NA |
| 2-Nitrotoluene | NA | NA | NA | NA | 0.52 U | 0.52 U | 0.52 U | NA | NA | NA | 0.52 U | 0.52 U | NA | NA |
| 3-Nitrotoluene | NA | NA | NA | NA | 0.52 U | 0.52 U | 0.52 U | NA | NA | NA | 0.52 U | 0.52 U | NA | NA |
| 4-Amino-2,6-dinitrotoluene | NA | NA | NA | NA | 0.26 U | 0.26 U | 0.26 U | NA | NA | NA | 0.26 U | 0.26 U | NA | NA |
| 4-Nitrotoluene | NA | NA | NA | NA | 0.52 U | 0.52 U | 0.52 U | NA | NA | NA | 0.52 U | 0.52 U | NA | NA |
| HMX | NA | NA | NA | NA | 0.52 U | 0.52 U | 0.52 U | NA | NA | NA | 0.52 U | 0.52 U | NA | NA |
| Nitrobenzene | 5 U | NA | NA | NA | NA | NA | 0.26 U | NA | NA | NA | 0.26 U | 0.26 U | NA | NA |
| Nitroglycerin | NA | NA | NA | NA | 1,000 U | 1,000 U | 2,000 U | NA | NA | NA | 1,000 U | 2,000 U | NA | NA |
| Perchlorate | NA | 4 U | NA | NA | 13 | 13 | 2 U | NA | 0.0612 U | NA | 3 U | 5 U | NA | 0.0612 U |
| RDX | NA | NA | NA | NA | 0.52 U | 0.52 U | 0.52 U | NA | NA | NA | 0.52 U | 0.52 U | NA | NA |
| Tetryl | NA | NA | NA | NA | 0.52 U | 0.52 U | 0.52 U | NA | NA | NA | 0.52 U | 0.52 U | NA | NA |
| | | | | | | | | | | | | | | |
| **Total Metals (UG_L)** | | | | | | | | | | | | | | |
| Aluminum | 5,650 J | NA | NA | NA | 3,140 K | 3,310 K | 1,270 | NA | 960 J | NA | 3,830 | 6,570 | NA | 1,450 |
| Antimony | 4.3 U | NA | NA | NA | 2.5 U | 2.5 U | 2.8 U | NA | 60 U | NA | 2.5 U | 2.8 U | NA | 60 U |
| Arsenic | 6.5 J | NA | NA | NA | 12 K | 7.3 J | 12 | NA | 11.1 K | NA | 5 U | 3.6 U | NA | 10 U |
| Barium | 141 J | NA | NA | NA | 179 J | 182 J | 130 J | NA | 173 J | NA | 30.9 J | 44.8 J | NA | 25.8 J |
| Beryllium | 0.8 B | NA | NA | NA | 0.12 B | 0.08 U | 0.11 J | NA | 5 U | NA | 0.24 B | 0.32 J | NA | 0.32 J |
| Cadmium | 0.4 U | NA | NA | NA | 0.4 U | 0.4 U | 0.4 U | NA | 5 U | NA | 0.57 B | 0.57 J | NA | 5 U |
| Calcium | 224,000 | NA | NA | NA | 102,000 | 102,000 | 88,800 | NA | 320,000 | NA | 223,000 | 234,000 | NA | 218,000 |
| Chromium | 34.4 | NA | NA | NA | 7.7 J | 7.8 J | 4 J | NA | 3.9 B | NA | 4.9 J | 8.2 B | NA | 2.7 B |
| Chromium (hexavalent) | 50 L | NA | NA | NA | 10 U | 10 U | 24 | NA | 10 U | NA | 10 U | 64 | NA | 10 U |
| Cobalt | 13.7 J | NA | NA | NA | 18.2 J | 18.5 J | 8.6 J | NA | 3.8 J | NA | 3.1 B | 4.2 J | NA | 2.5 B |
| Copper | 23.8 B | NA | NA | NA | 3.8 B | 4.2 B | 3.3 B | NA | 4.6 B | NA | 6.1 B | 8.3 B | NA | 2.4 B |
| Cyanide | 1.4 B | NA | NA | NA | 10 U | 10 U | 5 U | NA | 5 U | NA | 10 U | 5 U | NA | 5 U |
| Iron | 13,900 J | NA | NA | NA | 48,500 | 48,900 | 36,400 | NA | 20,500 | NA | 4,870 | 7,660 | NA | 1,800 |
| Lead | 13.1 | NA | NA | NA | 4.4 B | 4 B | 1.8 U | NA | 10 U | NA | 4.4 B | 5.1 | NA | 2.4 J |
| Magnesium | 33,400 | NA | NA | NA | 17,600 | 17,600 | 18,000 | NA | 89,700 | NA | 71,300 | 72,800 | NA | 69,100 |
| Manganese | 1,200 J | NA | NA | NA | 1,730 | 1,730 | 1,340 | NA | 1,520 | NA | 479 | 786 | NA | 582 |
| Mercury | 0.1 UL | NA | NA | NA | 0.1 UJ | 0.1 UL | 0.1 U | NA | 0.2 U | NA | 0.1 U | 0.1 U | NA | 0.2 UL |
| Nickel | 70 L | NA | NA | NA | 324 | 324 | 337 | NA | 116 | NA | 8.6 B | 10.9 B | NA | 5.2 B |
| Potassium | 3,210 J | NA | NA | NA | 1,740 J | 1,840 J | 955 J | NA | 3,300 J | NA | 4,300 J | 4,830 J | NA | 3,070 J |
| Selenium | 4.3 UL | NA | NA | NA | 3.2 UL | 3.2 UL | 4.2 B | NA | 35 U | NA | 4.8 B | 2.6 U | NA | 35 U |
| Silver | 3.1 U | NA | NA | NA | 0.6 U | 0.6 U | 0.7 U | NA | 10 U | NA | 0.6 U | 0.7 U | NA | 10 U |
| Sodium | 18,500 | NA | NA | NA | 108,000 | 107,000 | 73,700 | NA | 33,100 | NA | 7,730 | 4,680 J | NA | 4,320 J |
| Thallium | 5.3 UL | NA | NA | NA | 5.8 U | 5.8 U | 4.6 U | NA | 25 U | NA | 5.8 U | 4.6 U | NA | 25 U |
| Vanadium | 9 J | NA | NA | NA | 8.1 J | 7.7 J | 3.6 J | NA | 2.2 J | NA | 6.1 J | 11.7 B | NA | 2.4 J |
| Zinc | 36.8 L | NA | NA | NA | 19.8 J | 20.4 K | 13.8 B | NA | 14.3 B | NA | 30.9 B | 50.5 | NA | 24.8 B |
| | | | | | | | | | | | | | | |
| **Dissolved Metals (UG_L)** | | | | | | | | | | | | | | |
| Aluminum | NA | NA | NA | NA | 1,050 K | 1,200 K | 40.3 U | NA | 200 UJ | NA | 1,630 J | 40.3 U | NA | 200 U |
| Antimony | NA | NA | NA | NA | 2.5 U | 2.5 U | 2.8 U | NA | 60 U | NA | 2.5 U | 2.8 U | NA | 60 U |
| Arsenic | NA | NA | NA | NA | 8.9 J | 8.7 J | 8.5 J | NA | 7.9 K | NA | 5 U | 3.6 U | NA | 10 U |
| Barium | NA | NA | NA | NA | 176 J | 186 J | 121 J | NA | 164 J | NA | 22.8 J | 21 J | NA | 20.4 J |
| Beryllium | NA | NA | NA | NA | 0.08 U | 0.08 U | 0.1 U | NA | 5 U | NA | 0.18 B | 0.1 U | NA | 5 U |
| Cadmium | NA | NA | NA | NA | 0.4 U | 0.4 U | 0.4 U | NA | 0.34 B | NA | 0.48 B | 0.4 U | NA | 5 U |
| Calcium | NA | NA | NA | NA | 106,000 | 112,000 | 87,600 | NA | 321,000 | NA | 223,000 | 234,000 | NA | 223,000 |
| Chromium | NA | NA | NA | NA | 4 B | 4.8 J | 0.6 U | NA | 2.1 B | NA | 2.2 B | 0.6 U | NA | 10 U |
| Chromium (hexavalent) | NA | NA | NA | NA | 10 U | 10 U | 11 | NA | NA | NA | 10 U | 10 U | NA | NA |
| Cobalt | NA | NA | NA | NA | 15.8 J | 14.7 J | 7.3 J | NA | 3.1 J | NA | 2.2 B | 1.1 B | NA | 1.7 B |
| Copper | NA | NA | NA | NA | 2.1 B | 2.6 B | 1.5 B | NA | 3.4 B | NA | 4.2 B | 1.5 B | NA | 1.7 B |
| Iron | NA | NA | NA | NA | 47,400 | 50,300 | 32,600 | NA | 17,400 | NA | 2,220 | 28.7 B | NA | 24.2 J |
| Lead | NA | NA | NA | NA | 1.9 U | 3.9 B | 1.8 U | NA | 10 U | NA | 2 B | 1.8 U | NA | 10 U |
| Magnesium | NA | NA | NA | NA | 18,000 | 19,100 | 17,500 | NA | 90,300 | NA | 71,400 | 72,400 | NA | 71,300 |
| Manganese | NA | NA | NA | NA | 1,800 | 1,920 | 1,360 | NA | 1,440 | NA | 470 | 513 | NA | 455 |
| Mercury | NA | NA | NA | NA | 0.1 UL | 0.1 UL | 0.1 U | NA | 0.2 U | NA | 0.1 U | 0.1 U | NA | 0.2 UL |
| Nickel | NA | NA | NA | NA | 314 | 291 | 318 | NA | 101 | NA | 5.9 J | 4.5 J | NA | 4.1 J |

**Alluvial Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW06 | | | 12MW08 | | | | | | 12MW10 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AOCN-GGW16-1 | AOCN-GGW16-2 | AS12-12MW06-R01 | AS12-12MW08-R01 | AS12-12MW08-R02 | AS12-12MW08-R02/DUP | AS12-12MW08-0605 | AS12-12MW08-1206 | AS12-12MW08-0607 | AS12-12MW10-R01 | AS12-12MW10-R02 | AS12-12MW10-0505 | AS12-12MW10-1206 | AS12-12MW10-0607 |
| **Sample Date** | 07/06/00 | 07/17/02 | 07/10/03 | 07/09/03 | 09/15/03 | 09/15/03 | 06/02/05 | 12/07/06 | 06/11/07 | 07/09/03 | 09/12/03 | 05/27/05 | 12/07/06 | 06/12/07 |
| **Chemical Name** | | | | | | | | | | | | | | |
| Potassium | NA | NA | NA | NA | 1,280 J | 1,280 J | 690 J | NA | 3,280 J | NA | 3,620 J | 2,740 J | NA | 2,700 J |
| Selenium | NA | NA | NA | NA | 3.2 UL | 3.2 UL | 2.6 U | NA | 35 U | NA | 3.2 U | 2.6 U | NA | 35 U |
| Silver | NA | NA | NA | NA | 0.6 U | 0.6 U | 0.7 U | NA | 10 U | NA | 0.6 U | 0.7 U | NA | 10 U |
| Sodium | NA | NA | NA | NA | 106,000 | 100,000 | 71,200 | NA | 31,000 | NA | 7,570 K | 4,460 J | NA | 4,230 J |
| Thallium | NA | NA | NA | NA | 5.8 U | 5.8 U | 4.6 U | NA | 6.2 K | NA | 5.8 U | 4.6 U | NA | 25 U |
| Vanadium | NA | NA | NA | NA | 4.1 J | 4.2 J | 1.1 J | NA | 50 U | NA | 2.4 B | 1.1 U | NA | 50 U |
| Zinc | NA | NA | NA | NA | 9.7 B | 12 B | 7 B | NA | 8.1 B | NA | 17.8 B | 3.4 B | NA | 12.6 B |
| | | | | | | | | | | | | | | |
| **Wet Chemistry (MG_L)** | | | | | | | | | | | | | | |
| Alkalinity | NA | NA | NA | NA | NA | NA | NA | 220 | NA | NA | NA | NA | 240 | NA |
| Chloride | NA | NA | NA | NA | NA | NA | NA | NA | 53 | NA | NA | NA | NA | 42 |
| Hardness | NA | NA | NA | NA | NA | NA | NA | NA | 1,400 | NA | NA | NA | NA | 870 |
| Nitrate | NA | NA | NA | NA | NA | NA | NA | NA | 0.1 U | NA | NA | NA | NA | 0.1 U |
| Nitrogen | NA | NA | NA | NA | NA | NA | NA | NA | 0.16 | NA | NA | NA | NA | 0.1 U |
| Sulfate | NA | NA | NA | NA | NA | NA | NA | NA | 1,000 | NA | NA | NA | NA | 610 |
| Total organic carbon (TOC) | NA | NA | NA | NA | NA | NA | NA | 6.1 B | 2.9 | NA | NA | NA | 1 U | 1.3 |

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Shading represents detect

**Alluvial Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW12 | | 12MW14 | | 12MW15 | | | | 12MW16 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW12-R02 | AS12-12MW12-0505 | AS12-12MW14-R02 | AS12-12MW14-0505 | AS12-12MW15-R01 | AS12-12MW15-R02 | AS12-12MW15-0505 | AS12-12MW15-1206 | AS12-12MW16-R01 | AS12-12MW16-R02 | AS12-12MW16-0605 | AS12-12MW16-1206 | AS12-12MW16-0607 |
| **Sample Date** | 09/11/03 | 05/24/05 | 09/11/03 | 05/26/05 | 07/10/03 | 09/15/03 | 05/27/05 | 12/07/06 | 07/10/03 | 09/12/03 | 06/01/05 | 12/06/06 | 06/13/07 |
| **Chemical Name** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **Volatile Organic Compounds (UG_L)** | | | | | | | | | | | | | |
| 1,1,1-Trichloroethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| 1,1,2,2-Tetrachloroethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| 1,1,2-Trichloroethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 UJ | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| 1,1-Dichloroethane | 0.5 U | 0.5 U | 2.4 | 1.8 | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.32 J | 1.1 | 10 UL | 0.5 U |
| 1,1-Dichloroethene | 0.5 U | 0.5 U | 0.36 J | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| 1,2,3-Trichlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | NA | 0.5 U | 0.5 U | NA | NA | 0.5 U | 0.5 U | NA | 0.5 U |
| 1,2,4-Trichlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| 1,2-Dibromo-3-chloropropane | 0.5 R | 0.5 U | 0.5 R | 0.5 U | 1 U | 0.5 R | 0.5 U | 10 UL | 1 U | 0.5 R | 0.5 U | 10 R | 0.5 U |
| 1,2-Dibromoethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| 1,2-Dichlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.39 J | 2.4 | 10 UL | 0.58 |
| 1,2-Dichloroethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| 1,2-Dichloroethene (total) | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1,2-Dichloropropane | 0.5 U | 0.5 U | 0.5 U | 0.96 | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| 1,3-Dichlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| 1,4-Dichlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| 2-Butanone | 5 R | 5 U | 5 R | 5 U | 5 U | 5 R | 5 U | 10 UL | 5 U | 5 R | 5 U | 10 UL | 5 U |
| 2-Hexanone | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 10 UL | 5 U | 5 U | 5 U | 10 UL | 5 U |
| 4-Methyl-2-pentanone | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 10 UL | 5 U | 5 U | 5 U | 10 UL | 5 U |
| Acetone | 2.1 B | 5 U | 5 R | 5 U | 1.5 B | 5 R | 5 UJ | 10 UL | 4.5 B | 5 R | 5 U | 10 UL | 5 U |
| Benzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| Bromochloromethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | NA | 0.5 U | 0.5 U | NA | NA | 0.5 U | 0.5 U | NA | 0.5 U |
| Bromodichloromethane | 0.5 U | 0.5 U | 0.5 U | 0.61 | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| Bromoform | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| Bromomethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 UJ |
| Carbon disulfide | 0.58 B | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.31 B | 0.5 U | 10 UL | 0.77 J | 1.3 B | 0.5 U | 10 UL | 0.5 U |
| Carbon tetrachloride | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 UJ |
| Chlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 3.5 | 10 UL | 0.5 U |
| Chloroethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| Chloroform | 0.5 U | 0.5 U | 0.5 U | 2.2 | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| Chloromethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| Cyclohexane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| Dibromochloromethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| Dichlorodifluoromethane (Freon-12) | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 UJ |
| Ethane | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 6.2 U |
| Ethene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 5.8 U |
| Ethylbenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| Isopropylbenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| Methane | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 5.3 |
| Methyl acetate | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 R | 0.5 U | 10 UL | 0.5 U |
| Methyl-tert-butyl ether (MTBE) | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| Methylcyclohexane | 0.5 U | 0.5 U | 0.5 U | 1.3 | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| Methylene chloride | 0.8 B | 3.2 B | 0.79 B | 4.4 | 0.57 B | 0.5 UJ | 0.5 U | 10 UL | 0.69 B | 1.3 B | 3.4 B | 10 UL | 0.72 B |
| Styrene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| Tetrachloroethene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| Toluene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| Trichloroethene | 0.46 J | 0.5 U | 2.4 | 1.4 | 1 U | 0.5 U | 0.5 U | 10 UL | 0.89 J | 1.5 | 2.9 | 2.4 L | 0.88 |
| Trichlorofluoromethane(Freon-11) | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| Vinyl chloride | 0.5 U | 0.5 U | 0.4 J | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.48 J | 10 UL | 0.5 U |
| Xylene, total | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 U | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| cis-1,2-Dichloroethene | 0.5 U | 0.5 U | 2.5 | 1.6 | 1 U | 0.5 UJ | 0.5 U | 10 UL | 1 U | 0.5 U | 1.7 | 10 UL | 0.5 U |
| cis-1,3-Dichloropropene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 UJ | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| trans-1,2-Dichloroethene | 0.5 U | 0.5 U | 1.4 | 0.5 U | 1 U | 0.5 UJ | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| trans-1,3-Dichloropropene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1 U | 0.5 UJ | 0.5 U | 10 UL | 1 U | 0.5 U | 0.5 U | 10 UL | 0.5 U |
| | | | | | | | | | | | | | |
| **Semi-volatile Organic Compounds (UG_L)** | | | | | | | | | | | | | |
| 1,1-Biphenyl | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| 1,2,4,5-Tetrachlorobenzene | 5 U | NA | 5.3 U | NA | NA | 5.3 U | NA | NA | NA | 5.3 U | NA | NA | NA |
| 2,2'-Oxybis(1-chloropropane) | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| 2,4,5-Trichlorophenol | 20 U | 26 U | 21 U | 27 U | NA | 21 U | 28 U | NA | NA | 21 U | 26 U | NA | 26 U |
| 2,4,6-Trichlorophenol | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |

**Alluvial Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW12 | | 12MW14 | | 12MW15 | | | | 12MW16 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW12-R02 | AS12-12MW12-0505 | AS12-12MW14-R02 | AS12-12MW14-0505 | AS12-12MW15-R01 | AS12-12MW15-R02 | AS12-12MW15-0505 | AS12-12MW15-1206 | AS12-12MW16-R01 | AS12-12MW16-R02 | AS12-12MW16-0605 | AS12-12MW16-1206 | AS12-12MW16-0607 |
| **Sample Date** | 09/11/03 | 05/24/05 | 09/11/03 | 05/26/05 | 07/10/03 | 09/15/03 | 05/27/05 | 12/07/06 | 07/10/03 | 09/12/03 | 06/01/05 | 12/06/06 | 06/13/07 |
| **Chemical Name** | | | | | | | | | | | | | |
| 2,4-Dichlorophenol | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| 2,4-Dimethylphenol | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| 2,4-Dinitrophenol | 20 U | 26 U | 21 U | 27 U | NA | 21 U | 28 U | NA | NA | 21 U | 26 U | NA | 26 U |
| 2,4-Dinitrotoluene | NA | 10 U | NA | 11 U | NA | NA | 11 U | NA | NA | NA | 10 U | NA | 11 U |
| 2,6-Dinitrotoluene | NA | 10 U | NA | 11 U | NA | NA | 11 U | NA | NA | NA | 10 U | NA | 11 U |
| 2-Chloronaphthalene | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| 2-Chlorophenol | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| 2-Methylnaphthalene | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| 2-Methylphenol | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| 2-Nitroaniline | 20 U | 26 U | 21 U | 27 U | NA | 21 U | 28 U | NA | NA | 21 U | 26 U | NA | 26 U |
| 2-Nitrophenol | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| 3,3'-Dichlorobenzidine | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| 3-Nitroaniline | 20 U | 26 U | 21 U | 27 U | NA | 21 U | 28 U | NA | NA | 21 U | 26 U | NA | 26 U |
| 4,6-Dinitro-2-methylphenol | 20 U | 26 U | 21 U | 27 U | NA | 21 U | 28 U | NA | NA | 21 U | 26 U | NA | 26 U |
| 4-Bromophenyl-phenylether | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| 4-Chloro-3-methylphenol | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| 4-Chloroaniline | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| 4-Chlorophenyl-phenylether | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| 4-Methylphenol | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| 4-Nitroaniline | 20 U | 26 U | 21 U | 27 U | NA | 21 U | 28 U | NA | NA | 21 U | 26 U | NA | 26 U |
| 4-Nitrophenol | 20 U | 26 U | 21 U | 27 U | NA | 21 U | 28 U | NA | NA | 21 U | 26 U | NA | 26 U |
| Acenaphthene | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Acenaphthylene | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Acetophenone | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Anthracene | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Atrazine | 5 UJ | 10 UJ | 5.3 UJ | 11 UJ | NA | 5.3 UJ | 11 UJ | NA | NA | 5.3 UJ | 10 UJ | NA | 11 R |
| Benzaldehyde | 5 UJ | 10 U | 5.3 UJ | 11 U | NA | 5.3 UJ | 11 U | NA | NA | 5.3 UJ | 10 U | NA | 11 U |
| Benzo(a)anthracene | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Benzo(a)pyrene | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Benzo(b)fluoranthene | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Benzo(g,h,i)perylene | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Benzo(k)fluoranthene | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Butylbenzylphthalate | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Caprolactam | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Carbazole | NA | 10 U | NA | 11 U | NA | NA | 11 U | NA | NA | NA | 10 U | NA | 11 U |
| Chrysene | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Di-n-butylphthalate | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Di-n-octylphthalate | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Dibenz(a,h)anthracene | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Dibenzofuran | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Diethylphthalate | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Dimethyl phthalate | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Fluoranthene | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Fluorene | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Hexachlorobenzene | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Hexachlorobutadiene | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Hexachlorocyclopentadiene | 5 UJ | 10 U | 5.3 UJ | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 UJ |
| Hexachloroethane | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Indeno(1,2,3-cd)pyrene | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Isophorone | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Naphthalene | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Nitrobenzene | NA | 10 U | NA | 11 U | NA | NA | 11 U | NA | NA | NA | 10 U | NA | 11 U |
| Pentachlorophenol | 5 U | 26 U | 5.3 U | 27 U | NA | 5.3 U | 28 U | NA | NA | 5.3 U | 26 U | NA | 26 U |
| Phenanthrene | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Phenol | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| Pyrene | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| bis(2-Chloroethoxy)methane | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| bis(2-Chloroethyl)ether | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| bis(2-Ethylhexyl)phthalate | 5 U | 1.4 B | 5.3 U | 5.3 B | NA | 5.3 U | 1.1 J | NA | NA | 5.3 U | 10 U | NA | 3.1 B |
| n-Nitroso-di-n-propylamine | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |
| n-Nitrosodiphenylamine | 5 U | 10 U | 5.3 U | 11 U | NA | 5.3 U | 11 U | NA | NA | 5.3 U | 10 U | NA | 11 U |

**Alluvial Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW12 | | 12MW14 | | 12MW15 | | | | 12MW16 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW12-R02 | AS12-12MW12-0505 | AS12-12MW14-R02 | AS12-12MW14-0505 | AS12-12MW15-R01 | AS12-12MW15-R02 | AS12-12MW15-0505 | AS12-12MW15-1206 | AS12-12MW16-R01 | AS12-12MW16-R02 | AS12-12MW16-0605 | AS12-12MW16-1206 | AS12-12MW16-0607 |
| **Sample Date** | 09/11/03 | 05/24/05 | 09/11/03 | 05/26/05 | 07/10/03 | 09/15/03 | 05/27/05 | 12/07/06 | 07/10/03 | 09/12/03 | 06/01/05 | 12/06/06 | 06/13/07 |
| **Chemical Name** | | | | | | | | | | | | | |
| **Explosives (UG_L)** | | | | | | | | | | | | | |
| 1,3,5-Trinitrobenzene | 0.26 U | 0.26 U | 0.26 U | 0.26 U | NA | 0.26 U | 0.26 U | NA | NA | 0.26 U | 0.26 U | NA | NA |
| 1,3-Dinitrobenzene | 0.26 U | 0.26 U | 0.26 U | 0.26 U | NA | 0.26 U | 0.26 U | NA | NA | 0.26 U | 0.26 U | NA | NA |
| 2,4,6-Trinitrotoluene | 0.26 U | 0.26 U | 0.26 U | 0.26 U | NA | 0.26 U | 0.26 U | NA | NA | 0.26 U | 0.26 U | NA | NA |
| 2,4-Dinitrotoluene | 0.26 U | 0.26 U | 0.26 U | 0.26 U | NA | 0.26 U | 0.26 U | NA | NA | 0.26 U | 0.26 U | NA | NA |
| 2,6-Dinitrotoluene | 0.26 U | 0.26 U | 0.26 U | 0.26 U | NA | 0.26 U | 0.26 U | NA | NA | 0.26 U | 0.26 U | NA | NA |
| 2-Amino-4,6-dinitrotoluene | 0.26 U | 0.26 U | 0.26 U | 0.26 U | NA | 0.26 U | 0.26 U | NA | NA | 0.26 U | 0.26 U | NA | NA |
| 2-Nitrotoluene | 0.52 U | 0.52 U | 0.52 U | 0.52 U | NA | 0.52 U | 0.52 U | NA | NA | 0.52 U | 0.52 U | NA | NA |
| 3-Nitrotoluene | 0.52 U | 0.52 U | 0.52 U | 0.52 U | NA | 0.52 U | 0.52 U | NA | NA | 0.52 U | 0.52 U | NA | NA |
| 4-Amino-2,6-dinitrotoluene | 0.26 U | 0.26 U | 0.26 U | 0.26 U | NA | 0.26 U | 0.26 U | NA | NA | 0.26 U | 0.26 U | NA | NA |
| 4-Nitrotoluene | 0.52 U | 0.52 U | 0.52 U | 0.52 U | NA | 0.52 U | 0.52 U | NA | NA | 0.52 U | 0.52 U | NA | NA |
| HMX | 0.52 U | 0.52 U | 0.52 U | 0.52 U | NA | 0.52 U | 0.52 U | NA | NA | 0.52 U | 0.52 U | NA | NA |
| Nitrobenzene | 0.26 U | 0.26 U | 0.26 U | 0.26 U | NA | 0.26 U | 0.044 J | NA | NA | 0.26 U | 0.26 U | NA | NA |
| Nitroglycerin | 1,000 U | 1,000 U | 1,000 U | 2,000 U | NA | 1,000 U | 2,000 U | NA | NA | 1,000 U | 2,000 U | NA | NA |
| Perchlorate | 2 U | 2 U | 4 U | 2 U | NA | 3 U | 5 U | NA | NA | 2 U | 5 U | NA | 0.0612 U |
| RDX | 0.52 U | 0.52 U | 0.52 U | 0.52 U | NA | 0.52 U | 0.52 U | NA | NA | 0.52 U | 0.52 U | NA | NA |
| Tetryl | 0.52 U | 0.52 U | 0.52 U | 0.52 U | NA | 0.52 U | 0.52 U | NA | NA | 0.52 U | 0.52 U | NA | NA |
| | | | | | | | | | | | | | |
| **Total Metals (UG_L)** | | | | | | | | | | | | | |
| Aluminum | 662 | 229 B | 1,940 | 17,200 | NA | 1,010 | 69.8 J | NA | NA | 6,430 | 2,790 | NA | 129 J |
| Antimony | 2.5 U | 2.8 U | 4.7 B | 2.8 U | NA | 2.5 U | 2.8 U | NA | NA | 2.5 U | 2.8 U | NA | 60 U |
| Arsenic | 5 U | 3.6 U | 5 U | 7.8 J | NA | 5 U | 16.3 | NA | NA | 5 U | 3.6 U | NA | 10 U |
| Barium | 65.2 J | 57.3 J | 81.7 J | 165 J | NA | 19.1 J | 14 J | NA | NA | 59.2 J | 41.9 J | NA | 23.8 J |
| Beryllium | 0.08 U | 0.1 U | 0.1 B | 0.85 J | NA | 0.15 B | 0.28 J | NA | NA | 0.32 B | 0.11 J | NA | 5 U |
| Cadmium | 0.4 U | 0.4 U | 0.48 B | 0.62 J | NA | 0.4 U | 0.4 U | NA | NA | 0.4 U | 0.4 U | NA | 5 U |
| Calcium | 147,000 | 137,000 | 201,000 | 205,000 | NA | 280,000 | 283,000 | NA | NA | 199,000 | 206,000 | NA | 230,000 |
| Chromium | 1.4 B | 10.7 | 14.8 | 37.2 | NA | 16.1 | 1.2 B | NA | NA | 13.3 | 6.5 B | NA | 2.4 J |
| Chromium (hexavalent) | 10 U | 10 U | 10 U | 10 U | NA | 10 U | 10 U | NA | NA | 10 U | 68 | NA | 10 U |
| Cobalt | 0.7 U | 0.7 U | 2.3 B | 8.6 J | NA | 1.1 B | 0.7 U | NA | NA | 4.6 J | 4.1 J | NA | 2.4 B |
| Copper | 3.8 B | 2 B | 9.8 B | 19.3 J | NA | 4.8 B | 1.9 B | NA | NA | 8.2 B | 3.8 B | NA | 3.6 B |
| Cyanide | 10 U | 5 U | 10 U | 5 U | NA | 10 U | 5 U | NA | NA | 10 U | 5 U | NA | 5 U |
| Iron | 827 | 405 | 2,450 | 27,600 | NA | 2,110 | 13,900 | NA | NA | 5,920 | 2,470 | NA | 85.8 B |
| Lead | 1.9 U | 1.8 U | 1.9 B | 14.6 | NA | 1.9 U | 1.8 U | NA | NA | 3.7 B | 2.2 J | NA | 10 U |
| Magnesium | 35,900 | 30,600 | 49,100 | 56,700 | NA | 78,200 | 79,800 | NA | NA | 54,600 | 54,900 | NA | 61,000 |
| Manganese | 19.1 | 20.6 | 242 | 655 | NA | 81.4 | 20.5 | NA | NA | 742 | 892 | NA | 854 |
| Mercury | 0.1 UL | 0.1 U | 0.1 UL | 0.1 U | NA | 0.1 U | 0.1 U | NA | NA | 0.1 U | 0.1 U | NA | 0.2 U |
| Nickel | 1.9 B | 9.4 J | 23.3 J | 38.1 J | NA | 11.2 J | 1.2 U | NA | NA | 16.2 J | 11.3 J | NA | 3.7 J |
| Potassium | 2,380 J | 2,040 J | 2,220 J | 6,380 | NA | 3,790 J | 3,160 J | NA | NA | 4,080 J | 2,830 J | NA | 2,220 J |
| Selenium | 3.2 UL | 2.6 U | 3.2 UL | 3 J | NA | 3.2 UL | 2.6 U | NA | NA | 3.2 UL | 2.6 U | NA | 35 U |
| Silver | 0.6 U | 0.7 U | 0.6 U | 0.7 U | NA | 0.6 U | 0.7 U | NA | NA | 0.6 U | 0.7 U | NA | 10 U |
| Sodium | 34,700 | 36,300 | 33,400 | 27,800 | NA | 5,230 K | 4,180 J | NA | NA | 21,500 | 23,100 | NA | 21,200 |
| Thallium | 5.8 U | 4.6 U | 5.8 U | 4.6 U | NA | 5.8 U | 4.6 U | NA | NA | 5.8 U | 4.9 B | NA | 25 U |
| Vanadium | 0.86 B | 1.1 U | 2.6 B | 29.6 J | NA | 1.2 B | 1.1 U | NA | NA | 9.7 J | 4.4 J | NA | 0.54 J |
| Zinc | 7.8 B | 7 J | 20.4 B | 42.6 | NA | 14.4 B | 9 B | NA | NA | 24.1 B | 11.4 B | NA | 27.6 B |
| | | | | | | | | | | | | | |
| **Dissolved Metals (UG_L)** | | | | | | | | | | | | | |
| Aluminum | 675 | 40.3 U | 766 | 40.3 U | NA | 85.9 B | 40.3 U | NA | NA | 4,210 J | 40.3 U | NA | 200 U |
| Antimony | 2.5 U | 2.8 U | 2.5 U | 2.8 U | NA | 2.5 U | 2.8 U | NA | NA | 2.5 U | 2.8 U | NA | 60 U |
| Arsenic | 5 U | 3.6 U | 5 U | 3.6 U | NA | 5 U | 3.6 U | NA | NA | 5 U | 3.6 U | NA | 2.5 K |
| Barium | 64.4 J | 55.2 J | 71.6 J | 77.4 J | NA | 14.3 J | 12 J | NA | NA | 68.1 J | 27.6 J | NA | 23.4 J |
| Beryllium | 0.08 U | 0.1 U | 0.08 U | 0.1 U | NA | 0.08 U | 0.1 U | NA | NA | 0.24 B | 0.1 U | NA | 5 U |
| Cadmium | 0.4 U | 0.4 U | 0.42 B | 0.4 U | NA | 0.44 B | 0.4 U | NA | NA | 0.45 B | 0.4 U | NA | 0.32 B |
| Calcium | 141,000 | 133,000 | 198,000 | 202,000 | NA | 278,000 | 280,000 | NA | NA | 178,000 | 231,000 | NA | 226,000 |
| Chromium | 1.1 B | 3.1 J | 3.3 B | 0.6 U | NA | 1.8 B | 0.6 U | NA | NA | 19.6 | 0.6 U | NA | 0.9 J |
| Chromium (hexavalent) | 10 U | 10 U | 10 U | 10 U | NA | 10 U | 10 U | NA | NA | 10 U | 10 U | NA | NA |
| Cobalt | 0.7 U | 0.7 U | 1.4 B | 1.5 J | NA | 0.99 B | 0.7 U | NA | NA | 4.3 J | 3.4 J | NA | 2.1 B |
| Copper | 3.9 B | 1.2 B | 6.7 B | 2.7 B | NA | 3.7 B | 1.6 B | NA | NA | 7.8 B | 1.5 B | NA | 3.7 B |
| Iron | 914 | 16.3 U | 1,280 | 16.3 U | NA | 606 | 431 | NA | NA | 4,590 | 16.3 U | NA | 100 U |
| Lead | 1.9 U | 1.8 U | 1.9 U | 1.8 U | NA | 1.9 U | 1.8 U | NA | NA | 3.1 B | 1.8 U | NA | 10 U |
| Magnesium | 34,400 | 29,700 | 48,900 | 51,100 | NA | 77,700 | 78,900 | NA | NA | 47,000 | 62,700 | NA | 59,700 |
| Manganese | 21.7 | 8.9 J | 261 | 2.6 J | NA | 42.4 | 19.3 | NA | NA | 647 | 1,050 | NA | 806 |
| Mercury | 0.1 UL | 0.1 U | 0.1 UL | 0.1 U | NA | 0.1 U | 0.1 U | NA | NA | 0.1 U | 0.1 U | NA | 0.2 U |
| Nickel | 2.2 J | 7.4 J | 16.9 J | 10.9 J | NA | 2.5 J | 1.2 U | NA | NA | 22.9 J | 10.5 J | NA | 3.7 J |

**Alluvial Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW12 | | 12MW14 | | 12MW15 | | | | 12MW16 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW12-R02 | AS12-12MW12-0505 | AS12-12MW14-R02 | AS12-12MW14-0505 | AS12-12MW15-R01 | AS12-12MW15-R02 | AS12-12MW15-0505 | AS12-12MW15-1206 | AS12-12MW16-R01 | AS12-12MW16-R02 | AS12-12MW16-0605 | AS12-12MW16-1206 | AS12-12MW16-0607 |
| **Sample Date** | 09/11/03 | 05/24/05 | 09/11/03 | 05/26/05 | 07/10/03 | 09/15/03 | 05/27/05 | 12/07/06 | 07/10/03 | 09/12/03 | 06/01/05 | 12/06/06 | 06/13/07 |
| **Chemical Name** | | | | | | | | | | | | | |
| Potassium | 2,330 J | 1,950 J | 1,910 J | 1,370 J | NA | 3,580 J | 3,080 J | NA | NA | 3,420 J | 2,270 J | NA | 2,200 J |
| Selenium | 3.2 UL | 2.6 U | 3.2 UL | 2.6 U | NA | 3.2 UL | 2.6 U | NA | NA | 3.2 U | 2.6 U | NA | 35 U |
| Silver | 0.6 U | 0.7 U | 0.6 U | 0.7 U | NA | 0.6 U | 0.7 U | NA | NA | 0.6 U | 0.7 U | NA | 10 U |
| Sodium | 33,800 | 35,500 | 31,600 | 27,900 | NA | 4,820 J | 3,780 J | NA | NA | 19,600 | 23,200 | NA | 21,800 |
| Thallium | 5.8 U | 5.4 B | 5.8 U | 4.6 U | NA | 5.8 U | 4.6 U | NA | NA | 5.8 U | 4.6 U | NA | 25 U |
| Vanadium | 0.7 U | 1.1 U | 0.7 U | 1.1 U | NA | 0.7 U | 1.1 U | NA | NA | 7 J | 1.1 U | NA | 0.59 J |
| Zinc | 7.5 B | 6.9 J | 13.9 B | 4.5 B | NA | 9.5 B | 3.3 J | NA | NA | 21 B | 4.6 B | NA | 18.8 B |
| | | | | | | | | | | | | | |
| **Wet Chemistry (MG_L)** | | | | | | | | | | | | | |
| Alkalinity | NA | NA | NA | NA | NA | NA | NA | 1 U | NA | NA | NA | 240 | NA |
| Chloride | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 29 |
| Hardness | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 1,800 |
| Nitrate | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 1.2 |
| Nitrogen | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0.1 U |
| Sulfate | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 660 |
| Total organic carbon (TOC) | NA | NA | NA | NA | NA | NA | NA | 1 U | NA | NA | NA | 1.1 | 1 U |

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Shading represents detect

**Alluvial Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW18 | | | | 12MW19 | | | 12MW23 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW18-R02 | AS12-12MW18-0505 | AS12-12MW18-0607 | AS12-12MW18P-0607 | AS12-12MW19-R02 | AS12-12MW19-0505 | AS12-12MW19-0607 | AS12-12MW23-1206 | AS12-12MW23-0607 | AS12-12MW23P-0607 |
| **Sample Date** | 09/11/03 | 05/26/05 | 06/12/07 | 06/12/07 | 09/12/03 | 05/25/05 | 06/12/07 | 12/06/06 | 06/12/07 | 06/12/07 |
| **Chemical Name** | | | | | | | | | | |
| | | | | | | | | | | |
| **Volatile Organic Compounds (UG_L)** | | | | | | | | | | |
| 1,1,1-Trichloroethane | 0.31 J | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,1,2,2-Tetrachloroethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,1,2-Trichloroethane | 0.79 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,1-Dichloroethane | 1.7 | 1.3 | 0.83 | 0.83 | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,1-Dichloroethene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,2,3-Trichlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | NA | 0.5 U | 0.5 U |
| 1,2,4-Trichlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,2-Dibromo-3-chloropropane | 0.5 R | 0.5 U | 0.5 U | 0.5 U | 0.5 R | 0.5 U | 0.5 U | 10 R | 0.5 U | 0.5 U |
| 1,2-Dibromoethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,2-Dichlorobenzene | 5.6 | 0.5 U | 2.4 | 2.5 | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,2-Dichloroethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,2-Dichloroethene (total) | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1,2-Dichloropropane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,3-Dichlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,4-Dichlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 2-Butanone | 5 R | 5 U | 5 U | 5 U | 5 R | 5 U | 5 U | 10 UL | 5 U | 5 U |
| 2-Hexanone | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 10 UL | 2 J | 5 U |
| 4-Methyl-2-pentanone | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 10 UL | 5 U | 5 U |
| Acetone | 1.8 B | 5 U | 5 U | 3.6 J | 5 R | 5 U | 5 U | 38 L | 5 U | 5 U |
| Benzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Bromochloromethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | NA | 0.5 U | 0.5 U |
| Bromodichloromethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Bromoform | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Bromomethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 UJ | 10 UL | 0.5 UJ | 0.5 UJ |
| Carbon disulfide | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Carbon tetrachloride | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Chlorobenzene | 3.8 | 0.5 U | 2.6 | 2.7 | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Chloroethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Chloroform | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Chloromethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Cyclohexane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Dibromochloromethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Dichlorodifluoromethane (Freon-12) | 0.5 U | 0.5 U | 0.5 UJ | 0.5 UJ | 0.5 U | 0.5 U | 0.5 UJ | 10 UL | 0.5 UJ | 0.5 UJ |
| Ethane | NA | NA | 6.2 U | 6.2 U | NA | NA | 6.2 U | NA | 6.2 U | 6.2 U |
| Ethene | NA | NA | 5.8 U | 5.8 U | NA | NA | 5.8 U | NA | 5.8 U | 5.8 U |
| Ethylbenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Isopropylbenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Methane | NA | NA | 3.3 U | 9.2 | NA | NA | 3.3 U | NA | 3.3 U | 6.4 |
| Methyl acetate | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 R | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Methyl-tert-butyl ether (MTBE) | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Methylcyclohexane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Methylene chloride | 0.78 B | 0.5 U | 0.5 U | 0.46 B | 1.4 B | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Styrene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Tetrachloroethene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.87 | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Toluene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Trichloroethene | 24 | 9.4 | 8.8 | 8.6 | 0.78 | 0.41 J | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Trichlorofluoromethane(Freon-11) | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Vinyl chloride | 0.59 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Xylene, total | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| cis-1,2-Dichloroethene | 12 | 7.5 | 11 | 11 | 0.33 J | 0.5 UJ | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| cis-1,3-Dichloropropene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| trans-1,2-Dichloroethene | 0.71 | 0.5 U | 0.42 J | 0.51 | 0.5 U | 0.5 UJ | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| trans-1,3-Dichloropropene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| | | | | | | | | | | |
| **Semi-volatile Organic Compounds (UG_L)** | | | | | | | | | | |
| 1,1-Biphenyl | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| 1,2,4,5-Tetrachlorobenzene | 5.1 U | NA | NA | NA | 5.3 U | NA | NA | NA | NA | NA |
| 2,2'-Oxybis(1-chloropropane) | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| 2,4,5-Trichlorophenol | 20 U | 26 U | 26 U | 26 U | 21 U | 26 U | 25 U | NA | 26 U | 29 U |
| 2,4,6-Trichlorophenol | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |

**Alluvial Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW18 | | | | 12MW19 | | | 12MW23 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW18-R02 | AS12-12MW18-0505 | AS12-12MW18-0607 | AS12-12MW18P-0607 | AS12-12MW19-R02 | AS12-12MW19-0505 | AS12-12MW19-0607 | AS12-12MW23-1206 | AS12-12MW23-0607 | AS12-12MW23P-0607 |
| **Sample Date** | 09/11/03 | 05/26/05 | 06/12/07 | 06/12/07 | 09/12/03 | 05/25/05 | 06/12/07 | 12/06/06 | 06/12/07 | 06/12/07 |
| **Chemical Name** | | | | | | | | | | |
| 2,4-Dichlorophenol | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| 2,4-Dimethylphenol | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| 2,4-Dinitrophenol | 20 U | 26 U | 26 U | 26 U | 21 U | 26 U | 25 U | NA | 26 U | 29 U |
| 2,4-Dinitrotoluene | NA | 10 U | 11 U | 11 U | NA | 10 U | 10 U | NA | 11 U | 12 U |
| 2,6-Dinitrotoluene | NA | 10 U | 11 U | 11 U | NA | 10 U | 10 U | NA | 11 U | 12 U |
| 2-Chloronaphthalene | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| 2-Chlorophenol | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| 2-Methylnaphthalene | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| 2-Methylphenol | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| 2-Nitroaniline | 20 U | 26 U | 26 U | 26 U | 21 U | 26 U | 25 U | NA | 26 U | 29 U |
| 2-Nitrophenol | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| 3,3'-Dichlorobenzidine | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| 3-Nitroaniline | 20 U | 26 U | 26 U | 26 U | 21 U | 26 U | 25 U | NA | 26 U | 29 U |
| 4,6-Dinitro-2-methylphenol | 20 U | 26 U | 26 U | 26 U | 21 U | 26 U | 25 U | NA | 26 U | 29 U |
| 4-Bromophenyl-phenylether | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| 4-Chloro-3-methylphenol | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| 4-Chloroaniline | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| 4-Chlorophenyl-phenylether | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| 4-Methylphenol | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| 4-Nitroaniline | 20 U | 26 U | 26 U | 26 U | 21 U | 26 U | 25 U | NA | 26 U | 29 U |
| 4-Nitrophenol | 20 U | 26 U | 26 U | 26 U | 21 U | 26 U | 25 U | NA | 26 U | 29 U |
| Acenaphthene | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Acenaphthylene | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Acetophenone | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Anthracene | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Atrazine | 5.1 UJ | 10 UJ | 11 R | 11 R | 5.3 UJ | 10 UJ | 10 R | NA | 11 R | 12 R |
| Benzaldehyde | 5.1 UJ | 10 U | 11 U | 11 U | 5.3 UJ | 10 U | 10 U | NA | 11 U | 12 U |
| Benzo(a)anthracene | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Benzo(a)pyrene | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Benzo(b)fluoranthene | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Benzo(g,h,i)perylene | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Benzo(k)fluoranthene | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Butylbenzylphthalate | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Caprolactam | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Carbazole | NA | 10 U | 11 U | 11 U | NA | 10 U | 10 U | NA | 11 U | 12 U |
| Chrysene | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Di-n-butylphthalate | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Di-n-octylphthalate | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Dibenz(a,h)anthracene | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Dibenzofuran | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Diethylphthalate | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Dimethyl phthalate | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Fluoranthene | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Fluorene | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Hexachlorobenzene | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Hexachlorobutadiene | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Hexachlorocyclopentadiene | 5.1 UJ | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Hexachloroethane | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Indeno(1,2,3-cd)pyrene | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Isophorone | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Naphthalene | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Nitrobenzene | NA | 10 U | 11 U | 11 U | NA | 10 U | 10 U | NA | 11 U | 12 U |
| Pentachlorophenol | 5.1 U | 26 U | 26 U | 26 U | 5.3 U | 26 U | 25 U | NA | 26 U | 29 U |
| Phenanthrene | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Phenol | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| Pyrene | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| bis(2-Chloroethoxy)methane | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| bis(2-Chloroethyl)ether | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| bis(2-Ethylhexyl)phthalate | 5.1 U | 1.3 B | 11 U | 2.8 B | 5.3 U | 1.5 B | 10 U | NA | 7.8 B | 2.6 B |
| n-Nitroso-di-n-propylamine | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |
| n-Nitrosodiphenylamine | 5.1 U | 10 U | 11 U | 11 U | 5.3 U | 10 U | 10 U | NA | 11 U | 12 U |

**Alluvial Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW18 | | | | 12MW19 | | | 12MW23 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW18-R02 | AS12-12MW18-0505 | AS12-12MW18-0607 | AS12-12MW18P-0607 | AS12-12MW19-R02 | AS12-12MW19-0505 | AS12-12MW19-0607 | AS12-12MW23-1206 | AS12-12MW23-0607 | AS12-12MW23P-0607 |
| **Sample Date** | 09/11/03 | 05/26/05 | 06/12/07 | 06/12/07 | 09/12/03 | 05/25/05 | 06/12/07 | 12/06/06 | 06/12/07 | 06/12/07 |
| **Chemical Name** | | | | | | | | | | |
| **Explosives (UG_L)** | | | | | | | | | | |
| 1,3,5-Trinitrobenzene | 0.26 U | 0.26 U | NA | NA | 0.26 U | 0.26 U | NA | NA | NA | NA |
| 1,3-Dinitrobenzene | 0.26 U | 0.26 U | NA | NA | 0.26 U | 0.26 U | NA | NA | NA | NA |
| 2,4,6-Trinitrotoluene | 0.26 U | 0.26 U | NA | NA | 0.26 U | 0.26 U | NA | NA | NA | NA |
| 2,4-Dinitrotoluene | 0.26 U | 0.26 U | NA | NA | 0.26 U | 0.26 U | NA | NA | NA | NA |
| 2,6-Dinitrotoluene | 0.26 U | 0.26 U | NA | NA | 0.26 U | 0.26 U | NA | NA | NA | NA |
| 2-Amino-4,6-dinitrotoluene | 0.26 U | 0.26 U | NA | NA | 0.26 U | 0.26 U | NA | NA | NA | NA |
| 2-Nitrotoluene | 0.52 U | 0.52 U | NA | NA | 0.52 U | 0.52 U | NA | NA | NA | NA |
| 3-Nitrotoluene | 0.52 U | 0.52 U | NA | NA | 0.52 U | 0.52 U | NA | NA | NA | NA |
| 4-Amino-2,6-dinitrotoluene | 0.26 U | 0.26 U | NA | NA | 0.26 U | 0.26 U | NA | NA | NA | NA |
| 4-Nitrotoluene | 0.52 U | 0.52 U | NA | NA | 0.52 U | 0.52 U | NA | NA | NA | NA |
| HMX | 0.52 U | 0.52 U | NA | NA | 0.52 U | 0.52 U | NA | NA | NA | NA |
| Nitrobenzene | 0.26 U | 0.26 U | NA | NA | 0.26 U | 0.26 U | NA | NA | NA | NA |
| Nitroglycerin | 1,000 U | 2,000 U | NA | NA | 1,000 U | 2,000 U | NA | NA | NA | NA |
| Perchlorate | 4 U | 2 U | 0.0612 U | 0.0612 U | 2 U | 2 U | 0.329 | NA | 0.19 J | 0.216 |
| RDX | 0.52 U | 0.52 U | NA | NA | 0.52 U | 0.52 U | NA | NA | NA | NA |
| Tetryl | 0.52 U | 0.52 U | NA | NA | 0.52 U | 0.52 U | NA | NA | NA | NA |
| | | | | | | | | | | |
| **Total Metals (UG_L)** | | | | | | | | | | |
| Aluminum | 3,720 | 2,590 | 2,580 | 2,590 | 316 | 989 | 759 | NA | 8,360 | 7,720 |
| Antimony | 2.5 U | 2.8 U | 60 U | 60 U | 2.5 U | 2.8 U | 60 U | NA | 60 U | 60 U |
| Arsenic | 5 U | 3.6 U | 10 U | 10 U | 5 U | 5.7 J | 10 U | NA | 3.7 J | 3 J |
| Barium | 98.4 J | 71.8 J | 77.8 J | 77.1 J | 50.3 J | 54.1 J | 64.6 J | NA | 84.8 J | 79.1 J |
| Beryllium | 0.25 B | 0.16 J | 0.57 J | 5 U | 0.08 U | 0.1 U | 5 U | NA | 0.51 J | 0.46 J |
| Cadmium | 0.4 U | 0.4 U | 5 U | 5 U | 0.4 U | 0.4 U | 5 U | NA | 5 U | 5 U |
| Calcium | 156,000 | 153,000 | 178,000 | 184,000 | 170,000 | 173,000 | 171,000 | NA | 180,000 | 178,000 |
| Chromium | 8.8 J | 6.3 J | 4.4 B | 3.9 B | 3.4 B | 5.6 B | 4.1 B | NA | 13.7 K | 14.1 K |
| Chromium (hexavalent) | 10 U | 10 U | 10 U | 10 U | 10 U | 16 | 10 U | NA | 10 U | 10 U |
| Cobalt | 6.2 J | 5.2 J | 8.1 J | 8.5 J | 0.7 U | 0.7 U | 1.1 B | NA | 5.7 J | 4.9 J |
| Copper | 9.1 B | 7.1 B | 5.6 B | 7.2 B | 2.8 B | 0.8 U | 2.7 B | NA | 11.6 J | 11.6 J |
| Cyanide | 10 U | 5 U | 5 U | 5 U | 10 U | 5 U | 5 U | NA | 5 U | 5 U |
| Iron | 6,610 | 3,480 | 3,560 | 3,340 | 499 | 1,330 | 1,140 | NA | 12,800 | 11,500 |
| Lead | 4.6 B | 1.8 U | 2.7 J | 10 U | 1.9 U | 1.8 U | 10 U | NA | 6.8 J | 5.7 J |
| Magnesium | 29,100 | 28,500 | 34,800 | 36,400 | 45,300 | 46,100 | 48,600 | NA | 51,400 | 50,900 |
| Manganese | 788 | 1,230 | 1,080 | 1,250 | 19.5 B | 32.7 | 91 | NA | 357 | 335 |
| Mercury | 0.1 UL | 0.1 U | 0.2 UL | 0.2 UL | 0.1 U | 0.1 U | 0.2 UL | NA | 0.2 UL | 0.2 UL |
| Nickel | 30.3 J | 19.8 J | 17.7 J | 17.8 J | 2.5 B | 4.9 B | 3.7 B | NA | 19.3 J | 18.6 J |
| Potassium | 3,040 J | 2,150 J | 2,170 J | 2,200 J | 2,520 J | 2,570 J | 2,560 J | NA | 3,890 J | 3,800 J |
| Selenium | 3.2 UL | 2.6 U | 35 U | 35 U | 4.2 B | 2.6 U | 35 U | NA | 35 U | 35 U |
| Silver | 0.6 U | 0.7 U | 10 U | 10 U | 0.6 U | 0.7 U | 10 U | NA | 10 U | 10 U |
| Sodium | 41,500 | 32,900 | 34,900 | 34,900 | 39,700 | 32,200 | 40,800 | NA | 19,800 | 19,700 |
| Thallium | 5.8 U | 4.6 U | 25 U | 25 U | 5.8 U | 4.6 U | 25 U | NA | 25 U | 25 U |
| Vanadium | 6.3 J | 4.7 J | 3.7 J | 4.2 J | 0.7 U | 1.6 J | 1 J | NA | 13.9 J | 13.1 J |
| Zinc | 21 B | 10.2 B | 23.7 B | 25.1 B | 10.6 B | 9.1 B | 15.9 B | NA | 45.3 B | 39.8 B |
| | | | | | | | | | | |
| **Dissolved Metals (UG_L)** | | | | | | | | | | |
| Aluminum | 282 | 40.3 U | 200 U | 200 U | 229 B | 40.3 U | 200 U | NA | 200 U | 200 U |
| Antimony | 2.5 U | 2.8 U | 60 U | 60 U | 2.5 U | 2.8 U | 60 U | NA | 60 U | 60 U |
| Arsenic | 5 U | 3.6 U | 10 U | 10 U | 5 U | 3.6 U | 10 U | NA | 10 U | 10 U |
| Barium | 73.4 J | 57.3 J | 64 J | 64.9 J | 49.2 J | 49 J | 55.6 J | NA | 38.5 J | 38.8 J |
| Beryllium | 0.08 U | 0.1 U | 0.24 J | 5 U | 0.08 U | 0.1 U | 0.21 J | NA | 5 U | 5 U |
| Cadmium | 0.4 U | 0.4 U | 5 U | 5 U | 0.4 U | 0.4 U | 5 U | NA | 5 U | 5 U |
| Calcium | 156,000 | 147,000 | 181,000 | 189,000 | 168,000 | 176,000 | 166,000 | NA | 170,000 | 174,000 |
| Chromium | 0.7 U | 1.1 J | 10 U | 10 U | 1.6 B | 2.1 J | 0.98 K | NA | 1.1 K | 10 U |
| Chromium (hexavalent) | 10 U | 10 U | NA | NA | 10 U | 10 U | NA | NA | NA | NA |
| Cobalt | 4 J | 1.4 J | 3 B | 3.6 B | 0.7 U | 0.7 U | 50 U | NA | 1.1 B | 0.86 B |
| Copper | 4.2 B | 4.1 B | 3.1 B | 4.6 B | 2.7 B | 0.8 U | 2.3 B | NA | 2.6 B | 4 B |
| Iron | 517 | 16.3 U | 100 U | 100 U | 381 | 16.3 U | 100 U | NA | 100 U | 100 U |
| Lead | 1.9 U | 1.8 U | 10 U | 10 U | 1.9 U | 1.8 U | 2.4 J | NA | 10 U | 10 U |
| Magnesium | 28,400 | 27,000 | 34,900 | 36,700 | 44,900 | 46,500 | 47,300 | NA | 45,800 | 47,100 |
| Manganese | 707 | 49.7 | 474 | 504 | 13.4 B | 1.8 J | 5.1 J | NA | 7.6 J | 8 J |
| Mercury | 0.1 UL | 0.1 U | 0.2 UL | 0.2 UL | 0.1 U | 0.1 U | 0.2 UL | NA | 0.2 UL | 0.2 UL |
| Nickel | 23.3 J | 14.2 J | 13.6 J | 14.3 J | 2 J | 4.1 J | 2.4 J | NA | 4 J | 4.6 J |

**Alluvial Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW18 | | | | 12MW19 | | | 12MW23 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW18-R02 | AS12-12MW18-0505 | AS12-12MW18-0607 | AS12-12MW18P-0607 | AS12-12MW19-R02 | AS12-12MW19-0505 | AS12-12MW19-0607 | AS12-12MW23-1206 | AS12-12MW23-0607 | AS12-12MW23P-0607 |
| **Sample Date** | 09/11/03 | 05/26/05 | 06/12/07 | 06/12/07 | 09/12/03 | 05/25/05 | 06/12/07 | 12/06/06 | 06/12/07 | 06/12/07 |
| **Chemical Name** | | | | | | | | | | |
| Potassium | 1,720 J | 1,240 J | 1,310 J | 1,340 J | 2,420 J | 2,340 J | 2,350 J | NA | 1,770 J | 1,780 J |
| Selenium | 3.2 UL | 2.6 U | 35 U | 35 U | 6.5 B | 3.5 B | 35 U | NA | 35 U | 35 U |
| Silver | 0.6 U | 0.7 U | 10 U | 10 U | 0.6 U | 0.7 U | 10 U | NA | 10 U | 10 U |
| Sodium | 39,500 | 31,900 | 34,900 | 35,600 | 38,700 | 32,000 | 40,500 | NA | 19,500 | 19,800 |
| Thallium | 5.8 U | 4.6 U | 25 U | 25 U | 5.8 U | 4.6 U | 25 U | NA | 25 U | 25 U |
| Vanadium | 0.7 U | 1.1 U | 50 U | 50 U | 0.7 U | 1.1 U | 50 U | NA | 50 U | 50 U |
| Zinc | 7.3 B | 5.2 B | 13.7 B | 25 B | 4.6 B | 4.9 B | 47.8 B | NA | 11.6 B | 14.9 B |
| | | | | | | | | | | |
| **Wet Chemistry (MG_L)** | | | | | | | | | | |
| Alkalinity | NA | NA | NA | NA | NA | NA | NA | 270 | NA | NA |
| Chloride | NA | NA | 89 | 71 | NA | NA | 87 | NA | 36 | 42 |
| Hardness | NA | NA | 620 | 620 | NA | NA | 620 | NA | 690 | 630 |
| Nitrate | NA | NA | 0.18 | 0.18 | NA | NA | 0.84 | NA | 0.31 | 0.32 |
| Nitrogen | NA | NA | 0.1 U | 0.1 U | NA | NA | 0.1 U | NA | 0.1 U | 0.1 U |
| Sulfate | NA | NA | 330 | 340 | NA | NA | 340 | NA | 440 | 440 |
| Total organic carbon (TOC) | NA | NA | 1.9 | 2.3 | NA | NA | 1.1 | 1 U | 1 U | 1 U |

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Shading represents detect

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 11GW11S/D | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS11-11GW11D-R01 | AS11-11GW11DP-R01 | AS11-11GW11S-R01 | AS11-11GW11SP-R01 | AS11-11GW11D-R02 | AS11-11GW11S-R02 | AS11-11GW11D-R03 | AS11-11GW11S-R03 | AS11-11GW11D-R04 | AS11-11GW11S-R04 | AS11-11GW11D-R05 |
| **Sample Date** | 08/05/99 | 08/05/99 | 08/05/99 | 08/05/99 | 05/03/00 | 05/04/00 | 08/23/00 | 08/23/00 | 11/01/00 | 11/01/00 | 02/08/01 |
| **Chemical Name** | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Volatile Organic Compounds (UG_L)** | | | | | | | | | | | |
| 1,1,1-Trichloroethane | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| 1,1,2,2-Tetrachloroethane | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1,1,2-Trichloroethane | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| 1,1-Dichloroethane | 1 U | NA | 0.7 J | 0.8 J | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| 1,1-Dichloroethene | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| 1,2,3-Trichlorobenzene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1,2,4-Trichlorobenzene | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| 1,2-Dibromo-3-chloropropane | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| 1,2-Dibromoethane | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| 1,2-Dichlorobenzene | 1 U | NA | 5 | 5 | 1 U | 1.17 | 1 U | 1 U | 1 U | 1.17 | 1 UJ |
| 1,2-Dichloroethane | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| 1,2-Dichloropropane | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| 1,3-Dichlorobenzene | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| 1,4-Dichlorobenzene | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| 2-Butanone | NA | NA | NA | NA | NA | NA | 5 U | 5 U | 5 R | 5 R | 5 UJ |
| 2-Chloroethyl vinyl ether | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2-Hexanone | 5 U | NA | 5 U | 5 U | NA | NA | 5 U | 5 U | 5 UJ | 5 U | 5 UJ |
| 4-Methyl-2-pentanone | 5 U | NA | 5 U | 5 U | 1 U | 1 U | 5 U | 5 U | 5 UJ | 5 U | 5 UJ |
| Acetone | 4 L | NA | 4 L | 5 L | NA | NA | 5 U | 5 U | 5 R | 5 R | 5 UJ |
| Benzene | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| Bromochloromethane | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| Bromodichloromethane | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| Bromoform | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| Bromomethane | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| Carbon disulfide | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| Carbon tetrachloride | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| Chlorobenzene | 1 U | NA | 5 | 6 | 1 U | 1.44 | 1 U | 1.04 | 1 U | 1.96 | 1 UJ |
| Chloroethane | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| Chloroform | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| Chloromethane | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| Cyclohexane | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Dibromochloromethane | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| Dichlorodifluoromethane (Freon-12) | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Ethane | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Ethene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Ethylbenzene | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| Isopropylbenzene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Methane | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Methyl acetate | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Methyl-tert-butyl ether (MTBE) | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Methylcyclohexane | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Methylene chloride | 0.6 B | NA | 0.8 B | 0.8 B | 1 U | 1 U | 1.66 J | 2.04 | 2.61 B | 1.84 B | 2 UJ |
| Styrene | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| Tetrachloroethene | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| Toluene | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| Trichloroethene | 1 U | NA | 3 | 3 | 1 U | 1.63 | 1 U | 1.51 | 1 U | 4.27 | 1 UJ |
| Trichlorofluoromethane(Freon-11) | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Vinyl chloride | 1 U | NA | 1 U | 0.6 J | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| Xylene, total | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| cis-1,2-Dichloroethene | 1 U | NA | 1 | 2 | 1 U | 1 U | 1 U | 1 U | 1 U | 1.44 | 1 UJ |
| cis-1,3-Dichloropropene | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| m- and p-Xylene | NA | NA | NA | NA | NA | NA | 2 U | 2 U | 1 U | 1 U | 2 UJ |
| o-Xylene | NA | NA | NA | NA | NA | NA | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| trans-1,2-Dichloroethene | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |
| trans-1,3-Dichloropropene | 1 U | NA | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 UJ |

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 11GW11S/D | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS11-11GW11D-R01 | AS11-11GW11DP-R01 | AS11-11GW11S-R01 | AS11-11GW11SP-R01 | AS11-11GW11D-R02 | AS11-11GW11S-R02 | AS11-11GW11D-R03 | AS11-11GW11S-R03 | AS11-11GW11D-R04 | AS11-11GW11S-R04 | AS11-11GW11D-R05 |
| **Sample Date** | 08/05/99 | 08/05/99 | 08/05/99 | 08/05/99 | 05/03/00 | 05/04/00 | 08/23/00 | 08/23/00 | 11/01/00 | 11/01/00 | 02/08/01 |
| **Chemical Name** | | | | | | | | | | | |
| **Semi-volatile Organic Compounds (UG_L)** | | | | | | | | | | | |
| 1,1-Biphenyl | NA | NA | NA | NA | NA | NA | NA | NA | 10 U | 10 U | NA |
| 2,2'-Oxybis(1-chloropropane) | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| 2,4,5-Trichlorophenol | 20 U | NA | 20 U | 20 U | 25 U | 25 U | 25 U | 25 U | 25 U | 25 U | NA |
| 2,4,6-Trichlorophenol | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| 2,4-Dichlorophenol | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| 2,4-Dimethylphenol | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| 2,4-Dinitrophenol | 20 U | NA | 20 U | 20 U | 25 U | 25 U | 25 U | 25 U | 25 U | 25 U | NA |
| 2,4-Dinitrotoluene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,6-Dinitrotoluene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2-Chloronaphthalene | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| 2-Chlorophenol | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| 2-Methylnaphthalene | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| 2-Methylphenol | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| 2-Nitroaniline | 20 U | NA | 20 U | 20 U | 25 U | 25 U | 25 U | 25 U | 25 U | 25 U | NA |
| 2-Nitrophenol | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| 3,3'-Dichlorobenzidine | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| 3-Nitroaniline | 20 U | NA | 20 U | 20 U | 25 U | 25 U | 25 U | 25 U | 25 U | 25 U | NA |
| 4,6-Dinitro-2-methylphenol | 20 U | NA | 20 U | 20 U | 25 U | 25 U | 25 U | 25 U | 25 U | 25 U | NA |
| 4-Bromophenyl-phenylether | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| 4-Chloro-3-methylphenol | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| 4-Chloroaniline | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| 4-Chlorophenyl-phenylether | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| 4-Methylphenol | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| 4-Nitroaniline | 20 U | NA | 20 U | 20 U | 25 U | 25 U | 25 U | 25 U | 25 U | 25 U | NA |
| 4-Nitrophenol | 20 U | NA | 20 U | 20 U | 25 U | 25 U | 25 U | 25 U | 25 U | 25 U | NA |
| Acenaphthene | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Acenaphthylene | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Acetophenone | NA | NA | NA | NA | NA | NA | NA | NA | 10 U | 10 U | NA |
| Anthracene | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Atrazine | NA | NA | NA | NA | NA | NA | NA | NA | 10 U | 10 U | NA |
| Benzaldehyde | NA | NA | NA | NA | NA | NA | NA | NA | 10 U | 10 U | NA |
| Benzo(a)anthracene | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Benzo(a)pyrene | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Benzo(b)fluoranthene | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Benzo(g,h,i)perylene | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Benzo(k)fluoranthene | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Butylbenzylphthalate | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Caprolactam | NA | NA | NA | NA | NA | NA | NA | NA | 10 U | 10 U | NA |
| Carbazole | NA | NA | NA | NA | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Chrysene | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Di-n-butylphthalate | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Di-n-octylphthalate | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Dibenz(a,h)anthracene | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Dibenzofuran | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Diethylphthalate | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Dimethyl phthalate | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Fluoranthene | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Fluorene | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Hexachlorobenzene | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Hexachlorobutadiene | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Hexachlorocyclopentadiene | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Hexachloroethane | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Indeno(1,2,3-cd)pyrene | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Isophorone | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Naphthalene | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Nitrobenzene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Pentachlorophenol | 20 U | NA | 20 U | 20 U | 25 U | 25 U | 25 U | 25 U | 25 U | 25 U | NA |
| Phenanthrene | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Phenol | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Pyrene | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| bis(2-Chloroethoxy)methane | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| bis(2-Chloroethyl)ether | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 11GW11S/D | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS11-11GW11D-R01 | AS11-11GW11DP-R01 | AS11-11GW11S-R01 | AS11-11GW11SP-R01 | AS11-11GW11D-R02 | AS11-11GW11S-R02 | AS11-11GW11D-R03 | AS11-11GW11S-R03 | AS11-11GW11D-R04 | AS11-11GW11S-R04 | AS11-11GW11D-R05 |
| **Sample Date** | 08/05/99 | 08/05/99 | 08/05/99 | 08/05/99 | 05/03/00 | 05/04/00 | 08/23/00 | 08/23/00 | 11/01/00 | 11/01/00 | 02/08/01 |
| **Chemical Name** | | | | | | | | | | | |
| bis(2-Ethylhexyl)phthalate | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 1 J | 10 U | 10 U | 10 U | NA |
| n-Nitroso-di-n-propylamine | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| n-Nitrosodiphenylamine | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_L)** | | | | | | | | | | | |
| 4,4'-DDD | 0.02 U | NA | 0.02 U | 0.02 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| 4,4'-DDE | 0.02 U | NA | 0.02 U | 0.02 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| 4,4'-DDT | 0.02 U | NA | 0.02 U | 0.02 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Aldrin | 0.01 U | NA | 0.01 U | 0.01 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U |
| Aroclor-1016 | 0.2 U | NA | 0.2 U | 0.2 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| Aroclor-1221 | 0.4 U | NA | 0.4 U | 0.4 U | 2 U | 2 U | 2 U | 2 U | 2 U | 2 U | 2 U |
| Aroclor-1232 | 0.2 U | NA | 0.2 U | 0.2 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| Aroclor-1242 | 0.2 U | NA | 0.2 U | 0.2 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| Aroclor-1248 | 0.2 U | NA | 0.2 U | 0.2 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| Aroclor-1254 | 0.2 U | NA | 0.2 U | 0.2 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| Aroclor-1260 | 0.2 U | NA | 0.2 U | 0.2 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| Dieldrin | 0.02 U | NA | 0.02 U | 0.02 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Endosulfan I | 0.01 U | NA | 0.01 U | 0.01 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U |
| Endosulfan II | 0.02 U | NA | 0.02 U | 0.02 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Endosulfan sulfate | 0.02 U | NA | 0.02 U | 0.02 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Endrin | 0.02 U | NA | 0.02 U | 0.02 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Endrin aldehyde | 0.02 U | NA | 0.02 U | 0.02 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Endrin ketone | 0.02 U | NA | 0.02 U | 0.02 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Heptachlor | 0.01 U | NA | 0.01 U | 0.01 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U |
| Heptachlor epoxide | 0.01 U | NA | 0.01 U | 0.01 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U |
| Methoxychlor | 0.1 U | NA | 0.1 U | 0.1 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Toxaphene | 1 U | NA | 1 U | 1 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| alpha-BHC | 0.01 U | NA | 0.01 U | 0.01 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U |
| alpha-Chlordane | 0.01 U | NA | 0.01 U | 0.01 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U |
| beta-BHC | 0.01 U | NA | 0.01 U | 0.01 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U |
| delta-BHC | 0.01 U | NA | 0.01 U | 0.01 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U |
| gamma-BHC (Lindane) | 0.01 U | NA | 0.01 U | 0.01 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U |
| gamma-Chlordane | 0.01 U | NA | 0.01 U | 0.01 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U |
| | | | | | | | | | | | |
| **Explosives (UG_L)** | | | | | | | | | | | |
| 1,3,5-Trinitrobenzene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1,3-Dinitrobenzene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4,6-Trinitrotoluene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4-Dinitrotoluene | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| 2,6-Dinitrotoluene | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| 2-Amino-4,6-dinitrotoluene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2-Nitrotoluene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 3-Nitrotoluene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4-Amino-2,6-dinitrotoluene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4-Nitrotoluene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| HMX | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Nitrobenzene | 5 U | NA | 5 U | 5 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA |
| Nitroglycerin | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Perchlorate | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| RDX | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Tetryl | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | | | | | | | | | |
| **Total Metals (UG_L)** | | | | | | | | | | | |
| Aluminum | 3,910 | 4,490 | 151 J | 164 J | 66 U | 524 | 50.5 U | 399 B | 343 | 50.5 U | 539 B |
| Antimony | 2.5 U | 2.5 U | 2.5 U | 2.5 U | 2.8 J | 2.7 U | 2.6 U | 2.6 U | 2.6 U | 2.6 U | 5.1 U |
| Arsenic | 4.4 J | 2.8 U | 2.8 U | 2.8 U | 3.1 U | 3.1 U | 2.3 U | 2.3 U | 2.3 UL | 2.3 UL | 4.2 U |
| Barium | 101 J | 110 J | 39.7 J | 42 J | 36.2 B | 65.5 J | 39.2 J | 57.1 J | 40.1 J | 48.5 J | 53 J |
| Beryllium | 0.41 U | 1.41 J | 0.41 U | 0.41 U | 0.6 U | 0.6 U | 0.72 U | 0.83 J | 0.72 U | 0.72 U | 0.97 U |
| Cadmium | 0.33 U | 0.33 U | 0.33 U | 0.33 U | 0.54 U | 0.54 U | 0.25 U | 0.25 U | 0.25 UL | 0.25 UL | 0.72 U |
| Calcium | 93,600 | 106,180 | 116,000 | 118,000 | 87,500 | 144,000 | 97,000 J | 164,000 J | 95,500 | 154,000 | 96,000 |
| Chromium | 13.3 | 17.8 | 3.5 U | 3.5 U | 8.4 U | 8.4 U | 6.2 U | 6.2 U | 6.2 UJ | 6.9 B | 8.2 U |
| Chromium (hexavalent) | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Cobalt | 4.7 J | 4.68 J | 2.8 U | 2.8 U | 5.2 U | 5.2 U | 4.2 U | 4.2 U | 4.2 U | 4.2 U | 10.8 U |

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 11GW11S/D | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS11-11GW11D-R01 | AS11-11GW11DP-R01 | AS11-11GW11S-R01 | AS11-11GW11SP-R01 | AS11-11GW11D-R02 | AS11-11GW11S-R02 | AS11-11GW11D-R03 | AS11-11GW11S-R03 | AS11-11GW11D-R04 | AS11-11GW11S-R04 | AS11-11GW11D-R05 |
| **Sample Date** | 08/05/99 | 08/05/99 | 08/05/99 | 08/05/99 | 05/03/00 | 05/04/00 | 08/23/00 | 08/23/00 | 11/01/00 | 11/01/00 | 02/08/01 |
| **Chemical Name** | | | | | | | | | | | |
| Copper | 3.6 J | 5.79 J | 3.5 U | 3.5 U | 18.9 J | 5.4 U | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 5.3 U |
| Cyanide | 0.22 U | NA | 0.22 U | 0.22 U | 0.2 U | 0.2 U | 0.2 R | 0.2 R | 0.2 UL | 0.2 UL | 0.2 UL |
| Iron | 4,100 | 4,645 | 226 | 232 | 90.1 B | 626 | 32.6 B | 506 | 340 J | 154 J | 738 |
| Lead | 7.8 | 8.29 | 2.2 U | 2.2 U | 2.1 U | 2.1 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 2.1 J |
| Magnesium | 30,000 | 33,360 | 31,100 | 31,700 | 31,600 | 41,500 | 39,400 | 47,800 | 33,500 J | 38,500 J | 34,500 J |
| Manganese | 172 | 194 | 173 | 172 | 24.8 | 87.8 | 12 J | 60.2 | 41.7 B | 87 | 54.3 |
| Mercury | 0.05 U | 0.0512 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.09 U | 0.09 U | 0.11 UL | 0.09 UL | 0.06 UL |
| Nickel | 4.8 U | 9.1 J | 4.8 U | 6.1 J | 9.2 B | 7.7 U | 9.2 U | 9.2 U | 9.2 U | 12.6 B | 11.1 U |
| Potassium | 5,170 | 5,758 | 2,980 J | 2,950 J | 17,600 | 2,300 J | 6,620 | 2,550 J | 3,000 | 2,560 | 2,250 J |
| Selenium | 4 U | 4 U | 4 U | 4 U | 2.7 B | 2.7 U | 2.8 U | 2.8 U | 2.8 U | 2.8 U | 4 UL |
| Silver | 2.3 U | 2.3 U | 2.3 U | 2.3 U | 5.7 U | 9.4 J | 26 U | 26 U | 5.2 UL | 5.2 UL | 5.3 U |
| Sodium | 19,800 | 21,610 | 12,400 | 12,600 | 22,300 | 12,700 | 11,200 | 12,900 | 9,580 | 14,000 | 8,570 J |
| Thallium | 1.7 U | 1.7 U | 1.7 U | 1.7 U | 2.1 U | 2.1 U | 3 U | 3 U | 3 U | 3 U | 7.6 U |
| Vanadium | 4.1 U | 4.6 J | 4.1 U | 4.1 U | 4.4 U | 4.4 U | 6.3 U | 6.3 U | 6.7 B | 6.3 U | 5 U |
| Zinc | 34.6 B | 38.4 | 9 U | 9 U | 17.4 B | 86.1 | 15.1 B | 20.4 B | 26.9 B | 22.6 B | 14.8 B |
| | | | | | | | | | | | |
| **Dissolved Metals (UG_L)** | | | | | | | | | | | |
| Aluminum | 34.2 U | 34.2 U | 34.2 U | 34.2 U | 66 U | 66 U | 50.5 U | 50.5 U | 50.5 U | 50.5 U | 296 |
| Antimony | 2.5 U | 2.5 U | 2.5 U | 2.5 U | 2.7 U | 2.7 U | 2.6 U | 2.6 U | 2.6 U | 2.6 U | 5.1 U |
| Arsenic | 2.8 U | 2.8 U | 2.8 U | 2.8 U | 3.1 U | 3.1 U | 2.3 U | 2.3 U | 2.3 U | 2.3 U | 4.2 U |
| Barium | 36.3 J | 35.7 J | 37.4 J | 37.4 J | 37.5 J | 43.5 J | 33.1 J | 38 J | 38.4 B | 52.4 B | 34.5 J |
| Beryllium | 0.41 U | 0.41 U | 0.41 U | 0.41 U | 0.72 B | 0.6 U | 0.72 U | 0.72 U | 0.72 U | 0.72 U | 0.97 U |
| Cadmium | 0.33 U | 0.33 U | 0.33 U | 0.33 U | 0.54 U | 0.54 U | 0.25 U | 0.25 U | 0.25 U | 0.25 U | 0.72 U |
| Calcium | 91,700 | 87,593 | 114,000 | 120,000 | 84,300 | 159,000 | 87,200 | 143,000 | 90,800 | 154,000 | 96,100 |
| Chromium | 3.5 U | 8.9 J | 5.9 J | 3.5 U | 8.4 U | 8.4 U | 6.2 U | 6.2 U | 10.2 | 6.2 U | 8.2 U |
| Chromium (hexavalent) | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Cobalt | 2.8 U | 2.8 U | 4.7 J | 2.8 U | 5.2 U | 5.2 U | 4.2 U | 4.2 U | 10 B | 7.5 B | 10.8 U |
| Copper | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 5.4 U | 6.7 J | 6.8 U | 6.8 U | 6.8 U | 6.8 U | 5.3 U |
| Iron | 12.1 J | 9.57 J | 40.8 J | 18.5 J | 94.6 B | 21.9 B | 29.5 B | 26.9 B | 40 B | 94.9 B | 168 |
| Lead | 2.2 U | 2.2 U | 2.2 U | 2.2 U | 2.1 UL | 2.1 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 2.7 J |
| Magnesium | 31,000 | 29,655 | 31,100 | 31,500 | 30,500 | 45,200 | 36,200 | 43,000 | 35,900 | 42,100 | 39,700 |
| Manganese | 14.8 J | 14.8 J | 169 | 173 | 31.9 | 72.9 | 2.7 U | 36.9 | 18.5 | 83.4 | 10.2 J |
| Mercury | 0.05 U | 0.0508 U | 0.05 U | 0.05 U | 0.05 UL | 0.05 U | 0.09 U | 0.09 U | 0.11 U | 0.09 U | 0.06 UL |
| Nickel | 4.8 U | 4.8 U | 4.8 U | 4.8 U | 7.7 U | 7.7 U | 9.2 U | 9.2 U | 9.2 U | 9.2 U | 11.1 U |
| Potassium | 4,530 J | 4,455 J | 3,030 J | 3,160 J | 20,100 | 2,480 J | 5,800 | 2,270 J | 2,350 B | 1,940 B | 2,350 J |
| Selenium | 4 U | 4 U | 4 U | 4 U | 2.7 UL | 2.7 U | 2.8 U | 2.8 U | 2.8 U | 2.8 U | 4 K |
| Silver | 2.3 U | 2.3 U | 2.3 U | 2.3 U | 8.8 J | 8.2 J | 26 U | 26 U | 5.2 U | 5.2 U | 5.3 U |
| Sodium | 19,000 | 18,068 | 12,600 | 13,200 | 23,100 | 13,700 | 10,200 | 11,600 | 9,240 | 13,800 | 8,880 |
| Thallium | 1.7 U | 1.7 U | 1.7 U | 1.7 U | 2.1 U | 2.1 U | 3 U | 3 U | 3 U | 3 U | 7.6 U |
| Vanadium | 4.1 U | 4.1 U | 4.1 U | 4.1 U | 4.4 U | 4.4 U | 6.3 U | 6.3 U | 7 B | 6.3 U | 5 U |
| Zinc | 11.7 J | 11.7 J | 15.6 J | 15.6 J | 19.7 B | 9.6 B | 8.4 J | 14.7 J | 15.7 B | 13.5 B | 13.9 J |
| | | | | | | | | | | | |
| **Wet Chemistry (MG_L)** | | | | | | | | | | | |
| Alkalinity | 220 | NA | 242 | 176 | NA | NA | 260 L | 240 L | 269 | 246 | 222 |
| Chloride | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Hardness | 357 | NA | 419 | 424 | NA | NA | 405 | 606 | 376 | 543 | 382 |
| Nitrate | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Nitrogen | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Sulfate | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Total organic carbon (TOC) | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | | | | | | | | | |
| **Total Petroleum Hydrocarbons (UG_L)** | | | | | | | | | | | |
| Bunker oil | 100 U | NA | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | NA |
| Compressor oil | 100 U | NA | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | NA |
| Creosote (mixture) | 100 U | NA | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | NA |
| Diesel fuel | 100 U | NA | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | NA |
| Fuel oil #2 | 100 U | NA | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | NA |
| Fuel oil #4 | 100 U | NA | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | NA |
| Fuel oil #5 | 100 U | NA | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | NA |
| Fuel oil #6 | 100 U | NA | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | NA |
| Hydraulic jack oil | 100 U | NA | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | NA |
| JP-4 | 100 U | NA | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | NA |
| JP-5 | 100 U | NA | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | NA |

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 11GW11S/D | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS11-11GW11D-R01 | AS11-11GW11DP-R01 | AS11-11GW11S-R01 | AS11-11GW11SP-R01 | AS11-11GW11D-R02 | AS11-11GW11S-R02 | AS11-11GW11D-R03 | AS11-11GW11S-R03 | AS11-11GW11D-R04 | AS11-11GW11S-R04 | AS11-11GW11D-R05 |
| **Sample Date** | 08/05/99 | 08/05/99 | 08/05/99 | 08/05/99 | 05/03/00 | 05/04/00 | 08/23/00 | 08/23/00 | 11/01/00 | 11/01/00 | 02/08/01 |
| **Chemical Name** | | | | | | | | | | | |
| JP-8 | 100 U | NA | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | NA |
| Jet fuel A | 100 U | NA | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | NA |
| Kerosene | 100 U | NA | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | NA |
| Lubricating oil | 100 U | NA | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | NA |
| Mineral oil | 100 U | NA | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | NA |
| Mineral spirits | 100 U | NA | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | NA |
| Motor oil | 100 U | NA | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | NA |
| Naphtha | 100 U | NA | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | NA |
| TPH-diesel range | 100 U | NA | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U |
| TPH-gas range | 50 U | NA | 50 U | 50 U | 50 U | 50 U | NA | NA | 50 U | 50 U | 50 U |
| Transmission fluid | 100 U | NA | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | NA |

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Shading represents detect

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | | | | | | | 12MW04S | | 12MW05D | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS11-11GW11S-R05 | AS11-11GW11D-R05A | AS11-11GW11D-0505 | AS11-11GW11S-0505 | AS11-11GW11D-0607 | AS11-11GW11S-0607 | AS12-12MW04S-0605 | AS12-12MW04S-1206 | AS12-12MW05D-0505 | AS12-12MW05D-0607 |
| **Sample Date** | 02/08/01 | 02/15/01 | 05/31/05 | 05/31/05 | 06/13/07 | 06/13/07 | 06/01/05 | 12/07/06 | 05/26/05 | 06/13/07 |
| **Chemical Name** | | | | | | | | | | |
| | | | | | | | | | | |
| **Volatile Organic Compounds (UG_L)** | | | | | | | | | | |
| 1,1,1-Trichloroethane | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,1,2,2-Tetrachloroethane | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | NA | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,1,2-Trichloroethane | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,1-Dichloroethane | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,1-Dichloroethene | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,2,3-Trichlorobenzene | NA | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | NA | 0.5 U | 0.5 U |
| 1,2,4-Trichlorobenzene | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,2-Dibromo-3-chloropropane | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,2-Dibromoethane | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,2-Dichlorobenzene | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,2-Dichloroethane | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,2-Dichloropropane | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,3-Dichlorobenzene | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 1,4-Dichlorobenzene | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| 2-Butanone | 5 UJ | NA | 5 U | 5 U | 5 U | 5 U | 5 U | 10 UL | 5 U | 5 U |
| 2-Chloroethyl vinyl ether | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2-Hexanone | 5 UJ | NA | 5 U | 5 U | 5 U | 5 U | 5 U | 10 UL | 5 U | 5 U |
| 4-Methyl-2-pentanone | 5 UJ | NA | 5 U | 5 U | 5 U | 5 U | 5 U | 10 UL | 5 U | 5 U |
| Acetone | 5 UJ | NA | 5 UJ | 5 UJ | 5 U | 5 U | 5 U | 10 UL | 5 U | 5 U |
| Benzene | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Bromochloromethane | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | NA | 0.5 U | 0.5 U |
| Bromodichloromethane | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Bromoform | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Bromomethane | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 UJ | 0.5 UJ | 0.5 U | 10 UL | 0.5 U | 0.5 UJ |
| Carbon disulfide | 1 UJ | NA | 0.52 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Carbon tetrachloride | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 UJ | 0.5 UJ | 0.5 U | 10 UL | 0.5 U | 0.5 UJ |
| Chlorobenzene | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Chloroethane | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Chloroform | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Chloromethane | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Cyclohexane | NA | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Dibromochloromethane | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Dichlorodifluoromethane (Freon-12) | NA | NA | 0.5 U | 0.5 U | 0.5 UJ | 0.5 UJ | 0.5 U | 10 UL | 0.5 U | 0.5 UJ |
| Ethane | NA | NA | NA | NA | 6.2 U | 6.2 U | NA | NA | NA | 6.2 U |
| Ethene | NA | NA | NA | NA | 5.8 U | 5.8 U | NA | NA | NA | 5.8 U |
| Ethylbenzene | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Isopropylbenzene | NA | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Methane | NA | NA | NA | NA | 3.3 U | 3.3 U | NA | NA | NA | 3.3 U |
| Methyl acetate | NA | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Methyl-tert-butyl ether (MTBE) | NA | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Methylcyclohexane | NA | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Methylene chloride | 2 UJ | NA | 0.5 U | 0.5 U | 0.64 B | 0.43 B | 4 B | 10 UL | 0.5 U | 0.46 B |
| Styrene | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Tetrachloroethene | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Toluene | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Trichloroethene | 4.92 J | NA | 0.5 U | 1.4 | 0.5 U | 1.2 | 1.4 | 2.1 L | 1 | 0.6 |
| Trichlorofluoromethane(Freon-11) | NA | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Vinyl chloride | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| Xylene, total | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| cis-1,2-Dichloroethene | 1.9 J | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 UJ | 10 UL | 0.5 UJ | 0.5 U |
| cis-1,3-Dichloropropene | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |
| m- and p-Xylene | 2 UJ | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| o-Xylene | 1 UJ | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| trans-1,2-Dichloroethene | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 UJ | 10 UL | 0.5 UJ | 0.5 U |
| trans-1,3-Dichloropropene | 1 UJ | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 UL | 0.5 U | 0.5 U |

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | | | | | | | 12MW04S | | 12MW05D | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS11-11GW11S-R05 | AS11-11GW11D-R05A | AS11-11GW11D-0505 | AS11-11GW11S-0505 | AS11-11GW11D-0607 | AS11-11GW11S-0607 | AS12-12MW04S-0605 | AS12-12MW04S-1206 | AS12-12MW05D-0505 | AS12-12MW05D-0607 |
| **Sample Date** | 02/08/01 | 02/15/01 | 05/31/05 | 05/31/05 | 06/13/07 | 06/13/07 | 06/01/05 | 12/07/06 | 05/26/05 | 06/13/07 |
| **Chemical Name** | | | | | | | | | | |
| **Semi-volatile Organic Compounds (UG_L)** | | | | | | | | | | |
| 1,1-Biphenyl | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| 2,2'-Oxybis(1-chloropropane) | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| 2,4,5-Trichlorophenol | 25 U | 25 U | 26 U | 26 U | 26 U | 26 U | 26 U | NA | 28 U | 26 U |
| 2,4,6-Trichlorophenol | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| 2,4-Dichlorophenol | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| 2,4-Dimethylphenol | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| 2,4-Dinitrophenol | 25 U | 25 U | 26 U | 26 U | 26 U | 26 U | 26 U | NA | 28 U | 26 U |
| 2,4-Dinitrotoluene | NA | NA | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| 2,6-Dinitrotoluene | NA | NA | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| 2-Chloronaphthalene | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| 2-Chlorophenol | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| 2-Methylnaphthalene | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| 2-Methylphenol | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| 2-Nitroaniline | 25 U | 25 U | 26 U | 26 U | 26 U | 26 U | 26 U | NA | 28 U | 26 U |
| 2-Nitrophenol | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| 3,3'-Dichlorobenzidine | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| 3-Nitroaniline | 25 U | 25 U | 26 U | 26 U | 26 U | 26 U | 26 U | NA | 28 U | 26 U |
| 4,6-Dinitro-2-methylphenol | 25 U | 25 U | 26 U | 26 U | 26 U | 26 U | 26 U | NA | 28 U | 26 U |
| 4-Bromophenyl-phenylether | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| 4-Chloro-3-methylphenol | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| 4-Chloroaniline | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| 4-Chlorophenyl-phenylether | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| 4-Methylphenol | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| 4-Nitroaniline | 25 U | 25 U | 26 U | 26 U | 26 U | 26 U | 26 U | NA | 28 U | 26 U |
| 4-Nitrophenol | 25 U | 25 U | 26 U | 26 U | 26 U | 26 U | 26 U | NA | 28 U | 26 U |
| Acenaphthene | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Acenaphthylene | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Acetophenone | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Anthracene | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Atrazine | 10 U | 10 U | 10 UJ | 10 UJ | 11 R | 11 R | 10 UJ | NA | 11 UJ | 11 R |
| Benzaldehyde | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Benzo(a)anthracene | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Benzo(a)pyrene | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Benzo(b)fluoranthene | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Benzo(g,h,i)perylene | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Benzo(k)fluoranthene | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Butylbenzylphthalate | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Caprolactam | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Carbazole | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Chrysene | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Di-n-butylphthalate | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Di-n-octylphthalate | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Dibenz(a,h)anthracene | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Dibenzofuran | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Diethylphthalate | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Dimethyl phthalate | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Fluoranthene | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Fluorene | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Hexachlorobenzene | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Hexachlorobutadiene | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Hexachlorocyclopentadiene | 10 U | 10 U | 10 U | 10 U | 11 UJ | 11 UJ | 10 U | NA | 11 U | 11 UJ |
| Hexachloroethane | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Indeno(1,2,3-cd)pyrene | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Isophorone | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Naphthalene | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Nitrobenzene | NA | NA | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Pentachlorophenol | 25 U | 25 U | 26 U | 26 U | 26 U | 26 U | 26 U | NA | 28 U | 26 U |
| Phenanthrene | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Phenol | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| Pyrene | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| bis(2-Chloroethoxy)methane | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| bis(2-Chloroethyl)ether | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | | | | | | | 12MW04S | | 12MW05D | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS11-11GW11S-R05 | AS11-11GW11D-R05A | AS11-11GW11D-0505 | AS11-11GW11S-0505 | AS11-11GW11D-0607 | AS11-11GW11S-0607 | AS12-12MW04S-0605 | AS12-12MW04S-1206 | AS12-12MW05D-0505 | AS12-12MW05D-0607 |
| **Sample Date** | 02/08/01 | 02/15/01 | 05/31/05 | 05/31/05 | 06/13/07 | 06/13/07 | 06/01/05 | 12/07/06 | 05/26/05 | 06/13/07 |
| **Chemical Name** | | | | | | | | | | |
| bis(2-Ethylhexyl)phthalate | 10 U | 10 U | 2.4 J | 4 J | 1.6 B | 16 B | 10 U | NA | 1.8 B | 2.9 B |
| n-Nitroso-di-n-propylamine | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| n-Nitrosodiphenylamine | 10 U | 10 U | 10 U | 10 U | 11 U | 11 U | 10 U | NA | 11 U | 11 U |
| | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_L)** | | | | | | | | | | |
| 4,4'-DDD | 0.1 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDE | 0.1 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDT | 0.1 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aldrin | 0.05 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1016 | 1 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1221 | 2 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1232 | 1 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1242 | 1 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1248 | 1 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1254 | 1 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1260 | 1 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Dieldrin | 0.1 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endosulfan I | 0.05 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endosulfan II | 0.1 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endosulfan sulfate | 0.1 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endrin | 0.1 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endrin aldehyde | 0.1 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endrin ketone | 0.1 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Heptachlor | 0.05 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Heptachlor epoxide | 0.05 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Methoxychlor | 0.5 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Toxaphene | 5 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| alpha-BHC | 0.05 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| alpha-Chlordane | 0.05 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| beta-BHC | 0.05 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| delta-BHC | 0.05 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| gamma-BHC (Lindane) | 0.05 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| gamma-Chlordane | 0.05 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | | | | | | | | |
| **Explosives (UG_L)** | | | | | | | | | | |
| 1,3,5-Trinitrobenzene | NA | NA | 0.26 U | 0.26 U | NA | NA | 0.26 U | NA | 0.26 U | NA |
| 1,3-Dinitrobenzene | NA | NA | 0.26 U | 0.26 U | NA | NA | 0.26 U | NA | 0.26 U | NA |
| 2,4,6-Trinitrotoluene | NA | NA | 0.26 U | 0.26 U | NA | NA | 0.26 U | NA | 0.26 U | NA |
| 2,4-Dinitrotoluene | 10 U | 10 U | 0.26 U | 0.26 U | NA | NA | 0.26 U | NA | 0.26 U | NA |
| 2,6-Dinitrotoluene | 10 U | 10 U | 0.26 U | 0.26 U | NA | NA | 0.26 U | NA | 0.26 U | NA |
| 2-Amino-4,6-dinitrotoluene | NA | NA | 0.26 U | 0.26 U | NA | NA | 0.26 U | NA | 0.26 U | NA |
| 2-Nitrotoluene | NA | NA | 0.52 U | 0.52 U | NA | NA | 0.52 U | NA | 0.52 U | NA |
| 3-Nitrotoluene | NA | NA | 0.52 U | 0.52 U | NA | NA | 0.52 U | NA | 0.52 U | NA |
| 4-Amino-2,6-dinitrotoluene | NA | NA | 0.26 U | 0.26 U | NA | NA | 0.26 U | NA | 0.26 U | NA |
| 4-Nitrotoluene | NA | NA | 0.52 U | 0.52 U | NA | NA | 0.52 U | NA | 0.52 U | NA |
| HMX | NA | NA | 0.52 U | 0.52 U | NA | NA | 0.52 U | NA | 0.52 U | NA |
| Nitrobenzene | 10 U | 10 U | 0.26 U | 0.26 U | NA | NA | 0.26 U | NA | 0.26 U | NA |
| Nitroglycerin | NA | NA | 2,000 U | 2,000 U | NA | NA | 2,000 U | NA | 2,000 U | NA |
| Perchlorate | NA | NA | 2 U | 2 U | 0.112 J | 0.248 | 5 U | NA | 2 U | 0.0612 U |
| RDX | NA | NA | 0.52 U | 0.52 U | NA | NA | 0.52 U | NA | 0.52 U | NA |
| Tetryl | NA | NA | 0.52 U | 0.52 U | NA | NA | 0.52 U | NA | 0.52 U | NA |
| | | | | | | | | | | |
| **Total Metals (UG_L)** | | | | | | | | | | |
| Aluminum | 293 B | NA | 465 | 40.3 U | 113 J | 98.5 J | 178 B | NA | 111 J | 90.8 J |
| Antimony | 5.1 U | NA | 2.8 U | 2.9 J | 60 U | 60 U | 2.8 U | NA | 2.8 U | 60 U |
| Arsenic | 4.2 U | NA | 3.6 U | 3.6 U | 10 U | 10 U | 3.6 U | NA | 3.6 U | 2.6 K |
| Barium | 36 J | NA | 47.1 J | 44.8 J | 48.2 J | 57.2 J | 10.9 J | NA | 33.8 J | 39 J |
| Beryllium | 0.97 U | NA | 0.1 U | 0.1 U | 5 U | 5 U | 0.1 U | NA | 0.1 U | 5 U |
| Cadmium | 0.72 U | NA | 0.4 U | 0.4 U | 5 U | 5 U | 0.4 U | NA | 0.4 U | 5 U |
| Calcium | 136,000 | NA | 115,000 | 176,000 | 116,000 | 214,000 | 397,000 | NA | 111,000 | 111,000 |
| Chromium | 8.2 U | NA | 1.1 B | 0.6 U | 9.1 J | 1.3 J | 0.74 B | NA | 1.1 B | 2.8 J |
| Chromium (hexavalent) | NA | NA | 10 U | 10 U | 10 U | 10 U | 10 U | NA | 10 U | 10 U |
| Cobalt | 10.8 U | NA | 0.7 U | 0.75 J | 50 U | 50 U | 0.7 U | NA | 0.7 U | 50 U |

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | | | | | | | 12MW04S | | 12MW05D | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS11-11GW11S-R05 | AS11-11GW11D-R05A | AS11-11GW11D-0505 | AS11-11GW11S-0505 | AS11-11GW11D-0607 | AS11-11GW11S-0607 | AS12-12MW04S-0605 | AS12-12MW04S-1206 | AS12-12MW05D-0505 | AS12-12MW05D-0607 |
| **Sample Date** | 02/08/01 | 02/15/01 | 05/31/05 | 05/31/05 | 06/13/07 | 06/13/07 | 06/01/05 | 12/07/06 | 05/26/05 | 06/13/07 |
| **Chemical Name** | | | | | | | | | | |
| Copper | 5.3 U | NA | 1.5 B | 2.1 B | 4 B | 3.2 B | 1.5 B | NA | 2.7 B | 2.5 B |
| Cyanide | 0.2 UL | NA | 5 U | 5 U | 5 U | 5 U | 5 U | NA | 5 U | 5 U |
| Iron | 233 B | NA | 357 | 16.3 U | 306 | 178 | 1,090 | NA | 622 | 557 |
| Lead | 2.1 J | NA | 1.8 U | 1.8 U | 10 U | 10 U | 1.8 U | NA | 1.8 U | 10 U |
| Magnesium | 39,500 J | NA | 42,600 | 50,800 | 43,300 | 58,500 | 140,000 | NA | 44,300 | 44,800 |
| Manganese | 26.5 | NA | 235 | 8.1 J | 94.4 | 43.3 | 27.7 | NA | 62.8 | 13.7 J |
| Mercury | 0.06 UL | NA | 0.1 U | 0.1 U | 0.2 U | 0.2 U | 0.1 U | NA | 0.1 U | 0.2 U |
| Nickel | 11.1 U | NA | 1.8 B | 1.6 B | 7.4 J | 1.9 J | 1.2 U | NA | 1.7 J | 40 U |
| Potassium | 2,050 J | NA | 3,930 J | 2,890 J | 2,700 J | 2,620 J | 5,630 | NA | 2,130 J | 2,060 J |
| Selenium | 4 UL | NA | 2.6 U | 3.2 J | 35 U | 35 U | 2.6 U | NA | 2.6 U | 35 U |
| Silver | 5.3 U | NA | 0.7 U | 0.7 U | 10 U | 10 U | 0.7 U | NA | 0.7 U | 10 U |
| Sodium | 10,900 J | NA | 10,400 | 30,400 | 10,500 | 38,300 | 6,470 | NA | 7,610 | 9,520 |
| Thallium | 7.6 U | NA | 5.8 B | 4.6 U | 25 U | 25 U | 5.8 J | NA | 4.6 U | 25 U |
| Vanadium | 5 U | NA | 1.1 U | 1.1 U | 0.56 J | 50 U | 1.1 U | NA | 1.1 U | 50 U |
| Zinc | 12.3 B | NA | 7.1 B | 3.4 B | 25.1 B | 20.5 B | 6.9 B | NA | 12.3 B | 37.5 B |
| | | | | | | | | | | |
| **Dissolved Metals (UG_L)** | | | | | | | | | | |
| Aluminum | 36.1 U | NA | 40.3 U | 40.3 U | 200 U | 200 U | 40.3 U | NA | 40.3 U | 200 U |
| Antimony | 5.1 U | NA | 2.8 U | 2.8 U | 60 U | 60 U | 2.8 U | NA | 2.8 U | 60 U |
| Arsenic | 4.2 U | NA | 3.6 U | 3.6 U | 10 U | 10 U | 3.6 U | NA | 3.6 U | 10 U |
| Barium | 30.2 J | NA | 42.3 J | 44.9 J | 43.9 J | 54.6 J | 9.6 J | NA | 32.2 J | 38 J |
| Beryllium | 0.97 U | NA | 0.1 U | 0.1 U | 5 U | 5 U | 0.1 U | NA | 0.1 U | 5 U |
| Cadmium | 0.72 U | NA | 0.4 U | 0.4 U | 5 U | 5 U | 0.4 U | NA | 0.4 U | 0.44 B |
| Calcium | 128,000 | NA | 115,000 | 174,000 | 116,000 | 207,000 | 392,000 | NA | 109,000 | 109,000 |
| Chromium | 8.2 U | NA | 0.6 U | 0.6 U | 1.2 J | 0.91 J | 0.6 U | NA | 0.6 U | 0.84 J |
| Chromium (hexavalent) | NA | NA | 10 U | 10 U | NA | NA | 10 U | NA | 10 U | NA |
| Cobalt | 10.8 U | NA | 0.7 U | 0.7 U | 50 U | 0.58 B | 0.7 U | NA | 0.7 U | 50 U |
| Copper | 5.3 U | NA | 1.6 J | 1.1 J | 3.1 B | 3.2 B | 1.2 B | NA | 2.4 B | 2.9 B |
| Iron | 12.9 U | NA | 21 J | 16.3 U | 48.3 B | 61.1 B | 968 | NA | 508 | 430 |
| Lead | 2 U | NA | 1.8 U | 1.8 U | 10 U | 10 U | 1.8 U | NA | 1.8 U | 10 U |
| Magnesium | 39,700 | NA | 42,700 | 50,700 | 43,700 | 57,200 | 139,000 | NA | 43,400 | 44,400 |
| Manganese | 20.3 | NA | 153 | 11.3 J | 102 | 46.2 | 24.1 | NA | 62.3 | 10.4 J |
| Mercury | 0.06 UL | NA | 0.1 U | 0.1 U | 0.2 U | 0.2 U | 0.1 U | NA | 0.1 U | 0.2 U |
| Nickel | 11.1 U | NA | 1.4 J | 1.7 J | 1.2 J | 1.4 J | 1.6 J | NA | 1.2 U | 1.4 J |
| Potassium | 1,730 J | NA | 3,300 J | 3,160 J | 2,910 J | 2,600 J | 5,590 | NA | 1,980 J | 2,010 J |
| Selenium | 4.1 K | NA | 2.6 U | 2.6 U | 35 U | 35 U | 2.6 U | NA | 2.6 U | 35 U |
| Silver | 5.3 U | NA | 0.7 U | 0.7 U | 10 U | 10 U | 0.7 U | NA | 0.7 U | 10 U |
| Sodium | 9,580 | NA | 10,300 | 32,400 | 10,700 | 38,100 | 6,290 | NA | 7,510 | 9,430 |
| Thallium | 7.6 U | NA | 5.9 J | 4.6 J | 25 U | 25 U | 7.3 B | NA | 4.6 U | 25 U |
| Vanadium | 5 U | NA | 1.1 U | 1.1 U | 50 U | 50 U | 1.1 U | NA | 1.1 U | 50 U |
| Zinc | 8.7 J | NA | 2.5 B | 2.7 B | 30.6 B | 25.7 B | 6.1 B | NA | 4.8 B | 32.6 B |
| | | | | | | | | | | |
| **Wet Chemistry (MG_L)** | | | | | | | | | | |
| Alkalinity | 218 | NA | NA | NA | NA | NA | NA | 220 | NA | NA |
| Chloride | NA | NA | NA | NA | 34 | 77 | NA | NA | NA | 28 |
| Hardness | 503 | NA | NA | NA | 570 | 840 | NA | NA | NA | 520 |
| Nitrate | NA | NA | NA | NA | 0.13 | 0.8 | NA | NA | NA | 0.15 |
| Nitrogen | NA | NA | NA | NA | 0.1 U | 0.1 U | NA | NA | NA | 0.1 U |
| Sulfate | NA | NA | NA | NA | 180 | 500 | NA | NA | NA | 190 |
| Total organic carbon (TOC) | NA | NA | NA | NA | 1 U | 1 U | NA | 1 U | NA | 1 U |
| | | | | | | | | | | |
| **Total Petroleum Hydrocarbons (UG_L)** | | | | | | | | | | |
| Bunker oil | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Compressor oil | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Creosote (mixture) | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Diesel fuel | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Fuel oil #2 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Fuel oil #4 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Fuel oil #5 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Fuel oil #6 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Hydraulic jack oil | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| JP-4 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| JP-5 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | | | | | | | 12MW04S | | 12MW05D | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS11-11GW11S-R05 | AS11-11GW11D-R05A | AS11-11GW11D-0505 | AS11-11GW11S-0505 | AS11-11GW11D-0607 | AS11-11GW11S-0607 | AS12-12MW04S-0605 | AS12-12MW04S-1206 | AS12-12MW05D-0505 | AS12-12MW05D-0607 |
| **Sample Date** | 02/08/01 | 02/15/01 | 05/31/05 | 05/31/05 | 06/13/07 | 06/13/07 | 06/01/05 | 12/07/06 | 05/26/05 | 06/13/07 |
| **Chemical Name** | | | | | | | | | | |
| JP-8 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Jet fuel A | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Kerosene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Lubricating oil | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Mineral oil | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Mineral spirits | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Motor oil | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Naphtha | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| TPH-diesel range | 100 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| TPH-gas range | 50 U | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Transmission fluid | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Shading represents detect

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW05S | | | 12MW07D | | | | 12MW07S | |
|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW05S-0505 | AS12-12MW05SP-0505 | AS12-12MW05S-0607 | AS12-12MW07D-0505 | AS12-12MW07DP-0505 | AS12-12MW07D-0607 | AS12-12MW07DP-0607 | AS12-12MW07S-0505 | AS12-12MW07S-0607 |
| **Sample Date** | 05/26/05 | 05/26/05 | 06/13/07 | 05/25/05 | 05/25/05 | 06/12/07 | 06/12/07 | 05/25/05 | 06/12/07 |
| **Chemical Name** | | | | | | | | | |
| | | | | | | | | | |
| **Volatile Organic Compounds (UG_L)** | | | | | | | | | |
| 1,1,1-Trichloroethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,1,2,2-Tetrachloroethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,1,2-Trichloroethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,1-Dichloroethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,1-Dichloroethene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,2,3-Trichlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,2,4-Trichlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,2-Dibromo-3-chloropropane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,2-Dibromoethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,2-Dichlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,2-Dichloroethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,2-Dichloropropane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,3-Dichlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,4-Dichlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 2-Butanone | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 2-Chloroethyl vinyl ether | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2-Hexanone | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 4-Methyl-2-pentanone | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Acetone | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Benzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Bromochloromethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Bromodichloromethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Bromoform | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Bromomethane | 0.5 U | 0.5 U | 0.5 UJ | 0.5 U | 0.5 U | 0.5 UJ | 0.5 UJ | 0.5 U | 0.5 UJ |
| Carbon disulfide | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.61 | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Carbon tetrachloride | 0.5 U | 0.5 U | 0.5 UJ | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Chlorobenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Chloroethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Chloroform | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Chloromethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Cyclohexane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Dibromochloromethane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Dichlorodifluoromethane (Freon-12) | 0.5 U | 0.5 U | 0.5 UJ | 0.5 U | 0.5 U | 0.5 UJ | 0.5 UJ | 0.5 U | 0.5 UJ |
| Ethane | NA | NA | 6.2 U | NA | NA | 6.2 U | 6.2 U | NA | 6.2 U |
| Ethene | NA | NA | 5.8 U | NA | NA | 5.8 U | 5.8 U | NA | 5.8 U |
| Ethylbenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Isopropylbenzene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Methane | NA | NA | 3.3 U | NA | NA | 3.3 U | 3.3 U | NA | 3.3 U |
| Methyl acetate | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Methyl-tert-butyl ether (MTBE) | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Methylcyclohexane | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Methylene chloride | 0.5 U | 0.5 U | 0.53 B | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Styrene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Tetrachloroethene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Toluene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Trichloroethene | 2.2 | 2.1 | 0.87 | 2.2 | 2.2 | 1.6 | 1.6 | 8.9 | 3.8 |
| Trichlorofluoromethane(Freon-11) | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Vinyl chloride | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Xylene, total | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| cis-1,2-Dichloroethene | 0.5 UJ | 0.5 U | 0.5 U | 0.5 U | 0.5 UJ | 0.5 U | 0.5 U | 1.9 | 0.5 U |
| cis-1,3-Dichloropropene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| m- and p-Xylene | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| o-Xylene | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| trans-1,2-Dichloroethene | 0.5 UJ | 0.5 U | 0.5 U | 0.5 U | 0.5 UJ | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| trans-1,3-Dichloropropene | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW05S | | | 12MW07D | | | | 12MW07S | |
|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW05S-0505 | AS12-12MW05SP-0505 | AS12-12MW05S-0607 | AS12-12MW07D-0505 | AS12-12MW07DP-0505 | AS12-12MW07D-0607 | AS12-12MW07DP-0607 | AS12-12MW07S-0505 | AS12-12MW07S-0607 |
| **Sample Date** | 05/26/05 | 05/26/05 | 06/13/07 | 05/25/05 | 05/25/05 | 06/12/07 | 06/12/07 | 05/25/05 | 06/12/07 |
| **Chemical Name** | | | | | | | | | |
| **Semi-volatile Organic Compounds (UG_L)** | | | | | | | | | |
| 1,1-Biphenyl | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 2,2'-Oxybis(1-chloropropane) | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 2,4,5-Trichlorophenol | 26 U | 27 U | 26 U | 26 U | 25 U | 25 U | 25 U | 26 U | 25 U |
| 2,4,6-Trichlorophenol | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 2,4-Dichlorophenol | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 2,4-Dimethylphenol | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 2,4-Dinitrophenol | 26 U | 27 U | 26 U | 26 U | 25 U | 25 U | 25 U | 26 U | 25 U |
| 2,4-Dinitrotoluene | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 2,6-Dinitrotoluene | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 2-Chloronaphthalene | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 2-Chlorophenol | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 2-Methylnaphthalene | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 2-Methylphenol | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 2-Nitroaniline | 26 U | 27 U | 26 U | 26 U | 25 U | 25 U | 25 U | 26 U | 25 U |
| 2-Nitrophenol | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 3,3'-Dichlorobenzidine | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 3-Nitroaniline | 26 U | 27 U | 26 U | 26 U | 25 U | 25 U | 25 U | 26 U | 25 U |
| 4,6-Dinitro-2-methylphenol | 26 U | 27 U | 26 U | 26 U | 25 U | 25 U | 25 U | 26 U | 25 U |
| 4-Bromophenyl-phenylether | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 4-Chloro-3-methylphenol | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 4-Chloroaniline | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 4-Chlorophenyl-phenylether | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 4-Methylphenol | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 4-Nitroaniline | 26 U | 27 U | 26 U | 26 U | 25 U | 25 U | 25 U | 26 U | 25 U |
| 4-Nitrophenol | 26 U | 27 U | 26 U | 26 U | 25 U | 25 U | 25 U | 26 U | 25 U |
| Acenaphthene | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Acenaphthylene | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Acetophenone | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Anthracene | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Atrazine | 10 UJ | 11 UJ | 11 R | 10 UJ | 10 UJ | 10 R | 10 R | 10 UJ | 10 R |
| Benzaldehyde | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Benzo(a)anthracene | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Benzo(a)pyrene | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Benzo(b)fluoranthene | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Benzo(g,h,i)perylene | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Benzo(k)fluoranthene | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Butylbenzylphthalate | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Caprolactam | 10 U | 1.9 J | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Carbazole | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Chrysene | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Di-n-butylphthalate | 10 U | 1.8 J | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Di-n-octylphthalate | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Dibenz(a,h)anthracene | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Dibenzofuran | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Diethylphthalate | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Dimethyl phthalate | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Fluoranthene | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Fluorene | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Hexachlorobenzene | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Hexachlorobutadiene | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Hexachlorocyclopentadiene | 10 U | 11 U | 11 UJ | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Hexachloroethane | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Indeno(1,2,3-cd)pyrene | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Isophorone | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Naphthalene | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Nitrobenzene | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Pentachlorophenol | 26 U | 27 U | 26 U | 26 U | 25 U | 25 U | 25 U | 26 U | 25 U |
| Phenanthrene | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Phenol | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Pyrene | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| bis(2-Chloroethoxy)methane | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| bis(2-Chloroethyl)ether | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW05S | | | 12MW07D | | | | 12MW07S | |
|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW05S-0505 | AS12-12MW05SP-0505 | AS12-12MW05S-0607 | AS12-12MW07D-0505 | AS12-12MW07DP-0505 | AS12-12MW07D-0607 | AS12-12MW07DP-0607 | AS12-12MW07S-0505 | AS12-12MW07S-0607 |
| **Sample Date** | 05/26/05 | 05/26/05 | 06/13/07 | 05/25/05 | 05/25/05 | 06/12/07 | 06/12/07 | 05/25/05 | 06/12/07 |
| **Chemical Name** | | | | | | | | | |
| bis(2-Ethylhexyl)phthalate | 10 U | 2 B | 7.8 B | 10 U | 1.1 B | 2 B | 10 U | 1.6 B | 10 U |
| n-Nitroso-di-n-propylamine | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| n-Nitrosodiphenylamine | 10 U | 11 U | 11 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_L)** | | | | | | | | | |
| 4,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aldrin | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1016 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1221 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1232 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1242 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1248 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1254 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1260 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Dieldrin | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endosulfan I | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endosulfan II | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endosulfan sulfate | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endrin | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endrin aldehyde | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endrin ketone | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Heptachlor | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Heptachlor epoxide | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Methoxychlor | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Toxaphene | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| alpha-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| alpha-Chlordane | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| beta-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| delta-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| gamma-BHC (Lindane) | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| gamma-Chlordane | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | | | | | | | |
| **Explosives (UG_L)** | | | | | | | | | |
| 1,3,5-Trinitrobenzene | 0.26 U | 0.26 U | NA | 0.26 U | 0.26 U | NA | NA | 0.26 U | NA |
| 1,3-Dinitrobenzene | 0.26 U | 0.26 U | NA | 0.26 U | 0.26 U | NA | NA | 0.26 U | NA |
| 2,4,6-Trinitrotoluene | 0.26 U | 0.26 U | NA | 0.26 U | 0.26 U | NA | NA | 0.26 U | NA |
| 2,4-Dinitrotoluene | 0.26 U | 0.26 U | NA | 0.26 U | 0.26 U | NA | NA | 0.26 U | NA |
| 2,6-Dinitrotoluene | 0.26 U | 0.26 U | NA | 0.26 U | 0.26 U | NA | NA | 0.26 U | NA |
| 2-Amino-4,6-dinitrotoluene | 0.26 U | 0.26 U | NA | 0.26 U | 0.26 U | NA | NA | 0.26 U | NA |
| 2-Nitrotoluene | 0.52 U | 0.52 U | NA | 0.52 U | 0.52 U | NA | NA | 0.52 U | NA |
| 3-Nitrotoluene | 0.52 U | 0.52 U | NA | 0.52 U | 0.52 U | NA | NA | 0.52 U | NA |
| 4-Amino-2,6-dinitrotoluene | 0.26 U | 0.26 U | NA | 0.26 U | 0.26 U | NA | NA | 0.26 U | NA |
| 4-Nitrotoluene | 0.52 U | 0.52 U | NA | 0.52 U | 0.52 U | NA | NA | 0.52 U | NA |
| HMX | 0.52 U | 0.52 U | NA | 0.52 U | 0.52 U | NA | NA | 0.52 U | NA |
| Nitrobenzene | 0.26 U | 0.26 U | NA | 0.26 U | 0.26 U | NA | NA | 0.26 U | NA |
| Nitroglycerin | 2,000 U | 2,000 U | NA | 2,000 U | 2,000 U | NA | NA | 2,000 U | NA |
| Perchlorate | 2 U | 2 U | 0.0612 U | 2 U | 2 U | 0.0612 U | 0.0612 U | 2 U | 0.0612 U |
| RDX | 0.52 U | 0.52 U | NA | 0.52 U | 0.52 U | NA | NA | 0.52 U | NA |
| Tetryl | 0.52 U | 0.52 U | NA | 0.52 U | 0.52 U | NA | NA | 0.52 U | NA |
| | | | | | | | | | |
| **Total Metals (UG_L)** | | | | | | | | | |
| Aluminum | 277 | 142 J | 215 | 302 | 396 | 235 | 213 | 284 | 176 J |
| Antimony | 2.8 U | 2.8 U | 60 U | 2.8 U | 2.8 U | 60 U | 60 U | 3.3 J | 60 U |
| Arsenic | 3.6 U | 3.6 U | 10 U | 3.6 U | 5.5 J | 10 U | 10 U | 3.6 U | 10 U |
| Barium | 37 J | 36.6 J | 40.7 J | 37 J | 37.1 J | 41.2 J | 41.7 J | 35 J | 40.2 J |
| Beryllium | 0.1 U | 0.1 U | 5 U | 0.1 U | 0.1 U | 5 U | 5 U | 0.1 U | 5 U |
| Cadmium | 0.4 U | 0.4 U | 5 U | 0.4 U | 0.4 U | 5 U | 5 U | 0.4 U | 5 U |
| Calcium | 110,000 | 111,000 | 109,000 | 109,000 | 108,000 | 108,000 | 111,000 | 123,000 | 109,000 |
| Chromium | 1.6 B | 1.3 B | 1.9 J | 3.2 J | 4.1 J | 2.2 B | 1.8 B | 2 B | 1.6 B |
| Chromium (hexavalent) | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Cobalt | 0.7 U | 0.7 U | 50 U | 0.7 U | 0.7 U | 0.61 B | 50 U | 0.7 U | 50 U |

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW05S | | | 12MW07D | | | | 12MW07S | |
|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW05S-0505 | AS12-12MW05SP-0505 | AS12-12MW05S-0607 | AS12-12MW07D-0505 | AS12-12MW07DP-0505 | AS12-12MW07D-0607 | AS12-12MW07DP-0607 | AS12-12MW07S-0505 | AS12-12MW07S-0607 |
| **Sample Date** | 05/26/05 | 05/26/05 | 06/13/07 | 05/25/05 | 05/25/05 | 06/12/07 | 06/12/07 | 05/25/05 | 06/12/07 |
| **Chemical Name** | | | | | | | | | |
| Copper | 2.6 B | 2.1 B | 3.3 B | 0.8 U | 0.8 U | 2.5 B | 3.3 B | 0.8 U | 1.8 B |
| Cyanide | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Iron | 506 | 377 | 474 | 254 | 339 | 280 | 220 | 573 | 549 |
| Lead | 1.8 U | 1.8 U | 2.7 K | 1.8 U | 1.8 U | 2.3 J | 10 U | 1.8 U | 10 U |
| Magnesium | 44,200 | 44,300 | 44,600 | 44,000 | 43,500 | 43,800 | 45,100 | 43,800 | 43,900 |
| Manganese | 18 | 14.8 J | 7.7 J | 25 | 26.5 | 8.2 J | 4.4 B | 88.4 | 7.8 J |
| Mercury | 0.1 U | 0.1 U | 0.2 U | 0.1 U | 0.1 U | 0.2 UL | 0.2 U | 0.1 U | 0.2 UL |
| Nickel | 1.2 U | 1.2 U | 1.3 J | 1.9 J | 2.4 J | 2.4 B | 40 U | 3.7 B | 1.3 B |
| Potassium | 2,030 J | 2,010 J | 2,070 J | 2,600 J | 2,640 J | 2,130 J | 2,140 J | 2,960 J | 2,080 J |
| Selenium | 4 J | 2.6 U | 35 U | 2.6 U | 3.5 B | 35 U | 35 U | 2.6 U | 35 U |
| Silver | 0.7 U | 0.7 U | 10 U | 0.7 U | 0.7 U | 10 U | 10 U | 0.7 U | 10 U |
| Sodium | 8,230 | 8,290 | 7,880 | 7,250 | 7,130 | 9,240 | 9,440 | 9,880 | 9,030 |
| Thallium | 4.6 U | 4.6 U | 25 U | 6.2 J | 5.7 J | 25 U | 25 U | 4.6 U | 25 U |
| Vanadium | 1.1 U | 1.1 U | 50 U | 1.1 U | 1.2 J | 50 U | 0.64 J | 1.1 U | 50 U |
| Zinc | 5.9 B | 4.8 B | 18 B | 6 B | 6.2 B | 22.6 B | 10.1 B | 10.6 B | 16.9 B |
| | | | | | | | | | |
| **Dissolved Metals (UG_L)** | | | | | | | | | |
| Aluminum | 40.3 U | 40.3 U | 200 U | 40.3 U | 40.3 U | 200 U | 200 U | 40.3 U | 200 U |
| Antimony | 2.8 U | 2.8 U | 60 U | 4 J | 2.8 U | 60 U | 60 U | 3.4 J | 60 U |
| Arsenic | 3.6 U | 3.6 U | 3 K | 3.6 U | 3.6 U | 10 U | 10 U | 7.3 J | 10 U |
| Barium | 34.1 J | 34 J | 37.9 J | 36.5 J | 36.1 J | 39.6 J | 40.1 J | 33.4 J | 39.2 J |
| Beryllium | 0.1 U | 0.1 U | 5 U | 0.1 U | 0.1 U | 5 U | 5 U | 0.1 U | 5 U |
| Cadmium | 0.4 U | 0.4 U | 0.32 B | 0.4 U | 0.4 U | 5 U | 5 U | 0.4 U | 5 U |
| Calcium | 110,000 | 110,000 | 109,000 | 108,000 | 107,000 | 106,000 | 109,000 | 122,000 | 109,000 |
| Chromium | 0.6 U | 0.6 U | 0.99 J | 3 J | 1.9 J | 1 K | 0.9 J | 0.6 U | 10 U |
| Chromium (hexavalent) | 10 U | 10 U | NA | 10 U | 10 U | NA | NA | 10 U | NA |
| Cobalt | 0.7 U | 0.7 U | 50 U | 0.7 U | 0.7 U | 50 U | 50 U | 0.7 U | 50 U |
| Copper | 2.8 B | 1.9 B | 2.7 B | 0.8 U | 0.8 U | 2.4 B | 4.4 B | 0.8 U | 1.7 B |
| Iron | 56.4 J | 54.1 J | 100 U | 16.3 U | 16.3 U | 100 U | 100 U | 241 | 100 U |
| Lead | 1.8 U | 1.8 U | 10 U | 1.8 U | 1.8 U | 10 U | 10 U | 1.8 U | 10 U |
| Magnesium | 44,100 | 44,100 | 44,500 | 44,000 | 43,600 | 43,300 | 44,100 | 43,400 | 43,900 |
| Manganese | 8.5 J | 8.8 J | 2.3 J | 24.7 | 23.1 | 1.9 B | 2 B | 88.7 | 4.2 J |
| Mercury | 0.1 U | 0.1 U | 0.2 U | 0.1 U | 0.1 U | 0.2 UL | 0.2 U | 0.1 U | 0.2 UL |
| Nickel | 1.4 J | 1.2 U | 40 U | 1.9 J | 1.5 J | 1.5 J | 1.6 J | 2.7 J | 1.5 J |
| Potassium | 1,930 J | 1,970 J | 1,950 J | 2,610 J | 2,510 J | 2,050 J | 2,020 J | 2,890 J | 2,080 J |
| Selenium | 2.9 J | 2.6 U | 35 U | 2.6 U | 2.6 U | 35 U | 35 U | 5.6 B | 35 U |
| Silver | 0.7 U | 0.7 U | 10 U | 0.7 U | 0.7 U | 10 U | 10 U | 0.7 U | 10 U |
| Sodium | 8,040 | 8,030 | 7,680 | 7,290 | 6,950 | 9,120 | 9,060 | 9,860 | 9,220 |
| Thallium | 4.6 U | 4.6 U | 25 U | 4.6 U | 4.6 U | 25 U | 25 U | 4.6 U | 25 U |
| Vanadium | 1.1 U | 1.1 U | 50 U | 1.1 U | 1.1 U | 50 U | 50 U | 1.1 U | 50 U |
| Zinc | 3.1 B | 4.6 B | 15.5 B | 3.6 B | 2.9 B | 16 B | 7.7 B | 3.4 B | 16.2 B |
| | | | | | | | | | |
| **Wet Chemistry (MG_L)** | | | | | | | | | |
| Alkalinity | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Chloride | NA | NA | 31 | NA | NA | 31 | 31 | NA | 28 |
| Hardness | NA | NA | 740 | NA | NA | 440 | 480 | NA | 460 |
| Nitrate | NA | NA | 0.14 | NA | NA | 0.2 | 0.2 | NA | 0.16 |
| Nitrogen | NA | NA | 0.1 U | NA | NA | 0.1 U | 0.1 U | NA | 0.1 U |
| Sulfate | NA | NA | 180 | NA | NA | 180 | 190 | NA | 200 |
| Total organic carbon (TOC) | NA | NA | 1 U | NA | NA | 1 U | 1 U | NA | 1 U |
| | | | | | | | | | |
| **Total Petroleum Hydrocarbons (UG_L)** | | | | | | | | | |
| Bunker oil | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Compressor oil | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Creosote (mixture) | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Diesel fuel | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Fuel oil #2 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Fuel oil #4 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Fuel oil #5 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Fuel oil #6 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Hydraulic jack oil | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| JP-4 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| JP-5 | NA | NA | NA | NA | NA | NA | NA | NA | NA |

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW05S | | | 12MW07D | | | | 12MW07S | |
|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW05S-0505 | AS12-12MW05SP-0505 | AS12-12MW05S-0607 | AS12-12MW07D-0505 | AS12-12MW07DP-0505 | AS12-12MW07D-0607 | AS12-12MW07DP-0607 | AS12-12MW07S-0505 | AS12-12MW07S-0607 |
| **Sample Date** | 05/26/05 | 05/26/05 | 06/13/07 | 05/25/05 | 05/25/05 | 06/12/07 | 06/12/07 | 05/25/05 | 06/12/07 |
| **Chemical Name** | | | | | | | | | |
| JP-8 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Jet fuel A | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Kerosene | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Lubricating oil | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Mineral oil | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Mineral spirits | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Motor oil | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Naphtha | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| TPH-diesel range | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| TPH-gas range | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Transmission fluid | NA | NA | NA | NA | NA | NA | NA | NA | NA |

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Shading represents detect

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW09D | | | | 12MW09S | | | 12MW11D | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW09D-0605 | AS12-12MW09DP-0605 | AS12-12MW09D-1206 | AS12-12MW09D-0607 | AS12-12MW09S-0605 | AS12-12MW09S-1206 | AS12-12MW09S-0607 | AS12-12MW11D-0505 | AS12-12MW11D-1206 | AS12-12MW11D-0607 |
| **Sample Date** | 06/02/05 | 06/02/05 | 12/07/06 | 06/11/07 | 06/02/05 | 12/07/06 | 06/11/07 | 05/27/05 | 12/07/06 | 06/12/07 |
| **Chemical Name** | | | | | | | | | | |
| | | | | | | | | | | |
| **Volatile Organic Compounds (UG_L)** | | | | | | | | | | |
| 1,1,1-Trichloroethane | 0.5 U | 0.5 U | 10 U | 0.5 U | 2 | 10 U | 1.3 | 0.5 U | 10 U | 0.5 U |
| 1,1,2,2-Tetrachloroethane | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,1,2-Trichloroethane | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,1-Dichloroethane | 0.45 J | 0.42 J | 10 U | 0.5 U | 8 | 10 U | 9 | 0.5 U | 10 U | 0.5 U |
| 1,1-Dichloroethene | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.43 J | 10 U | 0.61 | 0.5 U | 10 U | 0.5 U |
| 1,2,3-Trichlorobenzene | 0.5 U | 0.5 U | NA | 0.5 U | 0.5 U | NA | 0.5 U | 0.5 U | NA | 0.5 U |
| 1,2,4-Trichlorobenzene | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,2-Dibromo-3-chloropropane | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,2-Dibromoethane | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,2-Dichlorobenzene | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,2-Dichloroethane | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,2-Dichloropropane | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,3-Dichlorobenzene | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 1,4-Dichlorobenzene | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| 2-Butanone | 5 U | 5 U | 10 U | 5 U | 5 U | 10 U | 5 U | 5 U | 10 U | 5 U |
| 2-Chloroethyl vinyl ether | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2-Hexanone | 5 U | 5 U | 10 U | 3.3 J | 5 U | 10 U | 2.5 J | 5 U | 10 U | 2.2 J |
| 4-Methyl-2-pentanone | 5 U | 5 U | 10 U | 5 U | 5 U | 10 U | 5 U | 5 U | 10 U | 5 U |
| Acetone | 5 U | 5 U | 10 U | 4.2 J | 5 U | 10 U | 7 | 5 UJ | 10 U | 5 U |
| Benzene | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Bromochloromethane | 0.5 U | 0.5 U | NA | 0.5 U | 1.1 | NA | 0.5 U | 0.5 U | NA | 0.5 U |
| Bromodichloromethane | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Bromoform | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Bromomethane | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Carbon disulfide | 0.49 J | 0.5 U | 10 U | 0.5 U | 1 | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Carbon tetrachloride | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Chlorobenzene | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Chloroethane | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Chloroform | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Chloromethane | 0.5 U | 0.5 U | 10 U | 0.5 U | 1.4 | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Cyclohexane | 0.5 U | 0.5 U | 10 U | 0.5 U | 2.7 | 1.5 J | 2.8 | 0.5 U | 10 U | 0.5 U |
| Dibromochloromethane | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Dichlorodifluoromethane (Freon-12) | 0.5 U | 0.5 U | 10 U | 0.5 UJ | 0.5 U | 10 U | 0.5 UJ | 0.5 U | 10 U | 0.5 UJ |
| Ethane | NA | NA | NA | 6.2 U | NA | NA | 31 U | NA | NA | 6.2 U |
| Ethene | NA | NA | NA | 5.8 U | NA | NA | 29 U | NA | NA | 5.8 U |
| Ethylbenzene | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.42 J | 0.5 U | 10 U | 0.5 U |
| Isopropylbenzene | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Methane | NA | NA | NA | 9.8 | NA | NA | 70 | NA | NA | 3.3 U |
| Methyl acetate | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Methyl-tert-butyl ether (MTBE) | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Methylcyclohexane | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Methylene chloride | 95 B | 98 B | 10 U | 0.59 B | 4,400 | 10 U | 540 J | 0.5 U | 10 U | 0.5 U |
| Styrene | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Tetrachloroethene | 0.5 U | 0.5 U | 10 U | 0.5 U | 1.4 | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Toluene | 0.5 U | 0.5 U | 10 U | 0.5 U | 3.1 | 10 U | 0.45 J | 0.5 U | 10 U | 0.5 U |
| Trichloroethene | 0.5 U | 0.5 U | 10 U | 0.5 U | 4.3 | 1.5 J | 1.8 | 0.5 U | 10 U | 0.5 U |
| Trichlorofluoromethane(Freon-11) | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Vinyl chloride | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| Xylene, total | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.62 | 0.5 U | 10 U | 0.5 U |
| cis-1,2-Dichloroethene | 0.5 U | 0.5 UJ | 10 U | 0.5 U | 2 J | 4.7 J | 11 | 0.5 U | 10 U | 0.5 U |
| cis-1,3-Dichloropropene | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |
| m- and p-Xylene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| o-Xylene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| trans-1,2-Dichloroethene | 0.5 U | 0.5 UJ | 10 U | 0.5 U | 2.2 J | 2.7 J | 3.1 | 0.5 U | 10 U | 0.5 U |
| trans-1,3-Dichloropropene | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U | 0.5 U | 10 U | 0.5 U |

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW09D | | | | 12MW09S | | | 12MW11D | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW09D-0605 | AS12-12MW09DP-0605 | AS12-12MW09D-1206 | AS12-12MW09D-0607 | AS12-12MW09S-0605 | AS12-12MW09S-1206 | AS12-12MW09S-0607 | AS12-12MW11D-0505 | AS12-12MW11D-1206 | AS12-12MW11D-0607 |
| **Sample Date** | 06/02/05 | 06/02/05 | 12/07/06 | 06/11/07 | 06/02/05 | 12/07/06 | 06/11/07 | 05/27/05 | 12/07/06 | 06/12/07 |
| **Chemical Name** | | | | | | | | | | |
| **Semi-volatile Organic Compounds (UG_L)** | | | | | | | | | | |
| 1,1-Biphenyl | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| 2,2'-Oxybis(1-chloropropane) | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| 2,4,5-Trichlorophenol | 26 U | 25 U | NA | 28 U | 26 U | NA | 28 U | 26 U | NA | 26 U |
| 2,4,6-Trichlorophenol | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| 2,4-Dichlorophenol | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| 2,4-Dimethylphenol | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| 2,4-Dinitrophenol | 26 U | 25 U | NA | 28 U | 26 U | NA | 28 U | 26 U | NA | 26 U |
| 2,4-Dinitrotoluene | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| 2,6-Dinitrotoluene | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| 2-Chloronaphthalene | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| 2-Chlorophenol | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| 2-Methylnaphthalene | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| 2-Methylphenol | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| 2-Nitroaniline | 26 U | 25 U | NA | 28 U | 26 U | NA | 28 U | 26 U | NA | 26 U |
| 2-Nitrophenol | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| 3,3'-Dichlorobenzidine | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| 3-Nitroaniline | 26 U | 25 U | NA | 28 U | 26 U | NA | 28 U | 26 U | NA | 26 U |
| 4,6-Dinitro-2-methylphenol | 26 U | 25 U | NA | 28 U | 26 U | NA | 28 U | 26 U | NA | 26 U |
| 4-Bromophenyl-phenylether | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| 4-Chloro-3-methylphenol | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| 4-Chloroaniline | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| 4-Chlorophenyl-phenylether | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| 4-Methylphenol | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| 4-Nitroaniline | 26 U | 25 U | NA | 28 U | 26 U | NA | 28 U | 26 U | NA | 26 U |
| 4-Nitrophenol | 26 U | 25 U | NA | 28 U | 26 U | NA | 28 U | 26 U | NA | 26 U |
| Acenaphthene | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Acenaphthylene | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Acetophenone | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Anthracene | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Atrazine | 10 U | 10 U | NA | 11 R | 10 U | NA | 11 R | 10 UJ | NA | 11 R |
| Benzaldehyde | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Benzo(a)anthracene | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Benzo(a)pyrene | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Benzo(b)fluoranthene | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Benzo(g,h,i)perylene | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Benzo(k)fluoranthene | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Butylbenzylphthalate | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Caprolactam | 10 U | 1.2 J | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Carbazole | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Chrysene | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Di-n-butylphthalate | 10 U | 10 U | NA | 11 U | 10 U | NA | 1.4 J | 10 U | NA | 11 U |
| Di-n-octylphthalate | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Dibenz(a,h)anthracene | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Dibenzofuran | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Diethylphthalate | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Dimethyl phthalate | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Fluoranthene | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Fluorene | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Hexachlorobenzene | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Hexachlorobutadiene | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Hexachlorocyclopentadiene | 10 U | 10 U | NA | 11 UJ | 10 U | NA | 11 UJ | 10 U | NA | 11 U |
| Hexachloroethane | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Indeno(1,2,3-cd)pyrene | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Isophorone | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Naphthalene | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Nitrobenzene | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Pentachlorophenol | 26 U | 25 U | NA | 28 U | 26 U | NA | 28 U | 26 U | NA | 26 U |
| Phenanthrene | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Phenol | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| Pyrene | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| bis(2-Chloroethoxy)methane | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| bis(2-Chloroethyl)ether | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW09D | | | | 12MW09S | | | 12MW11D | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW09D-0605 | AS12-12MW09DP-0605 | AS12-12MW09D-1206 | AS12-12MW09D-0607 | AS12-12MW09S-0605 | AS12-12MW09S-1206 | AS12-12MW09S-0607 | AS12-12MW11D-0505 | AS12-12MW11D-1206 | AS12-12MW11D-0607 |
| **Sample Date** | 06/02/05 | 06/02/05 | 12/07/06 | 06/11/07 | 06/02/05 | 12/07/06 | 06/11/07 | 05/27/05 | 12/07/06 | 06/12/07 |
| **Chemical Name** | | | | | | | | | | |
| bis(2-Ethylhexyl)phthalate | 1.3 J | 21 | NA | 2.2 B | 3.2 J | NA | 2.4 B | 1.2 J | NA | 2.8 B |
| n-Nitroso-di-n-propylamine | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| n-Nitrosodiphenylamine | 10 U | 10 U | NA | 11 U | 10 U | NA | 11 U | 10 U | NA | 11 U |
| | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_L)** | | | | | | | | | | |
| 4,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aldrin | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1016 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1221 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1232 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1242 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1248 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1254 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1260 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Dieldrin | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endosulfan I | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endosulfan II | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endosulfan sulfate | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endrin | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endrin aldehyde | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endrin ketone | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Heptachlor | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Heptachlor epoxide | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Methoxychlor | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Toxaphene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| alpha-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| alpha-Chlordane | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| beta-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| delta-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| gamma-BHC (Lindane) | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| gamma-Chlordane | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | | | | | | | | |
| **Explosives (UG_L)** | | | | | | | | | | |
| 1,3,5-Trinitrobenzene | 0.26 U | 0.26 U | NA | NA | 0.26 U | NA | NA | 0.26 U | NA | NA |
| 1,3-Dinitrobenzene | 0.26 U | 0.26 U | NA | NA | 0.26 U | NA | NA | 0.26 U | NA | NA |
| 2,4,6-Trinitrotoluene | 0.26 U | 0.26 U | NA | NA | 0.26 U | NA | NA | 0.26 U | NA | NA |
| 2,4-Dinitrotoluene | 0.26 U | 0.26 U | NA | NA | 0.26 U | NA | NA | 0.26 U | NA | NA |
| 2,6-Dinitrotoluene | 0.26 U | 0.26 U | NA | NA | 0.26 U | NA | NA | 0.26 U | NA | NA |
| 2-Amino-4,6-dinitrotoluene | 0.26 U | 0.26 U | NA | NA | 0.26 U | NA | NA | 0.26 U | NA | NA |
| 2-Nitrotoluene | 0.52 U | 0.52 U | NA | NA | 0.52 U | NA | NA | 0.52 U | NA | NA |
| 3-Nitrotoluene | 0.52 U | 0.52 U | NA | NA | 0.52 U | NA | NA | 0.52 U | NA | NA |
| 4-Amino-2,6-dinitrotoluene | 0.26 U | 0.26 U | NA | NA | 0.26 U | NA | NA | 0.26 U | NA | NA |
| 4-Nitrotoluene | 0.52 U | 0.52 U | NA | NA | 0.52 U | NA | NA | 0.52 U | NA | NA |
| HMX | 0.52 U | 0.52 U | NA | NA | 0.52 U | NA | NA | 0.52 U | NA | NA |
| Nitrobenzene | 0.26 U | 0.26 U | NA | NA | 0.26 U | NA | NA | 0.26 U | NA | NA |
| Nitroglycerin | 2,000 U | 2,000 U | NA | NA | 2,000 U | NA | NA | 2,000 U | NA | NA |
| Perchlorate | 5 U | 5 U | NA | 0.0612 U | 5 U | NA | 0.0612 U | 2 U | NA | 0.0612 U |
| RDX | 0.52 U | 0.52 U | NA | NA | 0.52 U | NA | NA | 0.52 U | NA | NA |
| Tetryl | 0.52 U | 0.52 U | NA | NA | 0.52 U | NA | NA | 0.52 U | NA | NA |
| | | | | | | | | | | |
| **Total Metals (UG_L)** | | | | | | | | | | |
| Aluminum | 3,120 | 2,800 | NA | 17,100 J | 1,480 | NA | 10,900 J | 145 J | NA | 589 |
| Antimony | 2.8 U | 2.8 U | NA | 60 U | 2.8 U | NA | 60 U | 2.8 U | NA | 60 U |
| Arsenic | 6 J | 5 J | NA | 10.6 K | 3.6 U | NA | 9.3 K | 3.6 U | NA | 10 U |
| Barium | 41.2 J | 39.7 J | NA | 62.5 J | 57.9 J | NA | 102 J | 25.7 J | NA | 29.6 J |
| Beryllium | 0.18 J | 0.17 J | NA | 0.83 J | 0.1 U | NA | 0.47 J | 0.1 U | NA | 0.27 J |
| Cadmium | 0.4 U | 0.4 U | NA | 1 B | 0.4 U | NA | 0.93 B | 0.41 J | NA | 5 U |
| Calcium | 341,000 | 346,000 | NA | 382,000 | 213,000 | NA | 270,000 | 147,000 | NA | 139,000 |
| Chromium | 16.8 | 9 J | NA | 28.7 | 12.8 | NA | 250 | 6.2 B | NA | 8.3 K |
| Chromium (hexavalent) | 10 U | 10 U | NA | 10 U | 10 U | NA | 10 U | 10 U | NA | 10 U |
| Cobalt | 4.1 J | 1.9 J | NA | 13.4 J | 3.2 J | NA | 11.8 J | 0.7 U | NA | 0.87 B |

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW09D | | | | 12MW09S | | | 12MW11D | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW09D-0605 | AS12-12MW09DP-0605 | AS12-12MW09D-1206 | AS12-12MW09D-0607 | AS12-12MW09S-0605 | AS12-12MW09S-1206 | AS12-12MW09S-0607 | AS12-12MW11D-0505 | AS12-12MW11D-1206 | AS12-12MW11D-0607 |
| **Sample Date** | 06/02/05 | 06/02/05 | 12/07/06 | 06/11/07 | 06/02/05 | 12/07/06 | 06/11/07 | 05/27/05 | 12/07/06 | 06/12/07 |
| **Chemical Name** | | | | | | | | | | |
| Copper | 5.6 B | 4.9 B | NA | 25.2 | 9.6 J | NA | 31.9 | 3.1 B | NA | 2.5 B |
| Cyanide | 5 U | 5 U | NA | 5 U | 5 U | NA | 5 U | 5 U | NA | 5 U |
| Iron | 5,600 | 4,450 | NA | 19,500 | 5,390 | NA | 19,600 | 326 | NA | 809 |
| Lead | 3.5 | 2.2 J | NA | 18.5 K | 1.8 U | NA | 14.1 K | 1.8 J | NA | 10 U |
| Magnesium | 116,000 | 118,000 | NA | 129,000 | 69,700 | NA | 96,500 | 58,800 | NA | 57,200 |
| Manganese | 537 | 436 | NA | 629 | 738 | NA | 719 | 11.9 B | NA | 16.3 |
| Mercury | 0.1 U | 0.1 U | NA | 0.2 U | 0.1 U | NA | 0.029 J | 0.1 U | NA | 0.2 UL |
| Nickel | 13.5 J | 7.5 J | NA | 26.6 J | 22.8 J | NA | 163 | 4.2 B | NA | 7.2 B |
| Potassium | 5,080 | 5,000 | NA | 8,560 | 6,470 | NA | 7,350 | 3,300 J | NA | 3,130 J |
| Selenium | 2.6 U | 2.6 U | NA | 35 U | 2.9 J | NA | 35 U | 2.6 U | NA | 35 U |
| Silver | 0.7 U | 0.7 U | NA | 10 U | 0.7 U | NA | 10 U | 0.7 U | NA | 10 U |
| Sodium | 5,340 | 5,150 | NA | 4,620 J | 13,000 | NA | 16,900 | 2,460 J | NA | 2,350 J |
| Thallium | 4.6 U | 4.6 U | NA | 25 U | 4.6 U | NA | 25 U | 4.6 U | NA | 25 U |
| Vanadium | 5.6 J | 4.2 J | NA | 28.4 J | 2.7 J | NA | 19.2 J | 1.1 U | NA | 0.82 J |
| Zinc | 18.4 B | 15.8 B | NA | 99.9 B | 27.2 | NA | 86.2 B | 9.4 B | NA | 164 B |
| | | | | | | | | | | |
| **Dissolved Metals (UG_L)** | | | | | | | | | | |
| Aluminum | 40.3 U | 40.3 U | NA | 627 J | 40.3 U | NA | 200 UJ | 40.3 U | NA | 200 U |
| Antimony | 2.8 U | 2.8 U | NA | 60 U | 2.8 U | NA | 60 U | 2.8 U | NA | 60 U |
| Arsenic | 3.6 U | 3.6 U | NA | 10 U | 3.6 U | NA | 10 U | 3.6 U | NA | 10 U |
| Barium | 25.7 J | 25.9 J | NA | 15.5 J | 49.5 J | NA | 56.8 J | 24.7 J | NA | 26.5 J |
| Beryllium | 0.1 U | 0.1 U | NA | 5 U | 0.1 U | NA | 5 U | 0.1 U | NA | 0.36 J |
| Cadmium | 0.4 U | 0.4 U | NA | 5 U | 0.4 U | NA | 5 U | 0.4 U | NA | 5 U |
| Calcium | 335,000 | 338,000 | NA | 380,000 | 202,000 | NA | 257,000 | 144,000 | NA | 133,000 |
| Chromium | 0.6 U | 0.6 U | NA | 1.4 B | 0.6 U | NA | 0.85 B | 0.66 J | NA | 1.5 K |
| Chromium (hexavalent) | 10 U | 10 U | NA | NA | 10 U | NA | NA | 10 U | NA | NA |
| Cobalt | 0.73 J | 0.7 U | NA | 50 U | 1.6 J | NA | 1.7 J | 0.7 U | NA | 0.72 B |
| Copper | 1.3 B | 0.8 U | NA | 3.8 B | 2.3 B | NA | 3.3 B | 2 B | NA | 25 U |
| Iron | 1,220 | 1,240 | NA | 573 | 2,330 | NA | 3,460 | 79.2 B | NA | 266 |
| Lead | 1.8 U | 1.8 U | NA | 10 U | 1.8 U | NA | 10 U | 1.8 U | NA | 10 U |
| Magnesium | 113,000 | 115,000 | NA | 127,000 | 66,700 | NA | 90,400 | 58,000 | NA | 54,400 |
| Manganese | 66.9 | 68.1 | NA | 30.6 | 621 | NA | 98.9 | 8.9 J | NA | 9.1 J |
| Mercury | 0.1 U | 0.11 J | NA | 0.058 J | 0.1 U | NA | 0.2 U | 0.1 U | NA | 0.2 UL |
| Nickel | 1.8 J | 1.7 J | NA | 1.2 B | 13.4 J | NA | 39.5 J | 1.2 U | NA | 2 J |
| Potassium | 4,050 J | 4,080 J | NA | 4,010 J | 5,680 | NA | 4,750 J | 3,270 J | NA | 2,890 J |
| Selenium | 2.6 U | 2.6 U | NA | 35 U | 2.6 U | NA | 35 U | 2.6 U | NA | 35 U |
| Silver | 0.7 U | 0.7 U | NA | 10 U | 0.7 U | NA | 10 U | 0.7 U | NA | 10 U |
| Sodium | 5,290 | 5,060 | NA | 4,510 J | 11,100 | NA | 13,900 | 2,530 J | NA | 2,370 J |
| Thallium | 4.6 U | 4.6 U | NA | 25 U | 4.6 U | NA | 25 U | 4.6 U | NA | 25 U |
| Vanadium | 1.1 U | 1.1 U | NA | 50 U | 1.1 U | NA | 50 U | 1.1 U | NA | 50 U |
| Zinc | 4.6 B | 4.8 B | NA | 9.8 B | 12.5 B | NA | 16.2 B | 5.4 J | NA | 16 B |
| | | | | | | | | | | |
| **Wet Chemistry (MG_L)** | | | | | | | | | | |
| Alkalinity | NA | NA | 230 | NA | NA | 240 | NA | NA | 260 | NA |
| Chloride | NA | NA | NA | 6.3 | NA | NA | 64 | NA | NA | 4.2 |
| Hardness | NA | NA | NA | 1,700 | NA | NA | 1,300 | NA | NA | 600 |
| Nitrate | NA | NA | NA | 0.1 U | NA | NA | 0.1 U | NA | NA | 0.1 U |
| Nitrogen | NA | NA | NA | 0.1 U | NA | NA | 0.1 U | NA | NA | 0.1 U |
| Sulfate | NA | NA | NA | 1,300 | NA | NA | 780 | NA | NA | 370 |
| Total organic carbon (TOC) | NA | NA | 1 U | 1 U | NA | 4.1 B | 2.5 | NA | 1 B | 1 U |
| | | | | | | | | | | |
| **Total Petroleum Hydrocarbons (UG_L)** | | | | | | | | | | |
| Bunker oil | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Compressor oil | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Creosote (mixture) | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Diesel fuel | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Fuel oil #2 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Fuel oil #4 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Fuel oil #5 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Fuel oil #6 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Hydraulic jack oil | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| JP-4 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| JP-5 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW09D | | | | 12MW09S | | | 12MW11D | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW09D-0605 | AS12-12MW09DP-0605 | AS12-12MW09D-1206 | AS12-12MW09D-0607 | AS12-12MW09S-0605 | AS12-12MW09S-1206 | AS12-12MW09S-0607 | AS12-12MW11D-0505 | AS12-12MW11D-1206 | AS12-12MW11D-0607 |
| **Sample Date** | 06/02/05 | 06/02/05 | 12/07/06 | 06/11/07 | 06/02/05 | 12/07/06 | 06/11/07 | 05/27/05 | 12/07/06 | 06/12/07 |
| **Chemical Name** | | | | | | | | | | |
| JP-8 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Jet fuel A | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Kerosene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Lubricating oil | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Mineral oil | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Mineral spirits | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Motor oil | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Naphtha | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| TPH-diesel range | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| TPH-gas range | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Transmission fluid | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Shading represents detect

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW11S | | | 12MW13S | 12MW17D | | 12MW17S | | 12MW20D | 12MW20S |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW11S-0605 | AS12-12MW11S-1206 | AS12-12MW11S-0607 | AS12-12MW13S-0505 | AS12-12MW17D-0505 | AS12-12MW17D-0607 | AS12-12MW17S-0505 | AS12-12MW17S-0607 | AS12-12MW20D-1206 | AS12-12MW20S-1206 |
| **Sample Date** | 06/02/05 | 12/07/06 | 06/13/07 | 05/23/05 | 05/24/05 | 06/12/07 | 05/24/05 | 06/12/07 | 12/07/06 | 12/06/06 |
| **Chemical Name** | | | | | | | | | | |
| | | | | | | | | | | |
| **Volatile Organic Compounds (UG_L)** | | | | | | | | | | |
| 1,1,1-Trichloroethane | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| 1,1,2,2-Tetrachloroethane | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | 0.5 U | 10 U | 0.5 U | 3.6 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| 1,1,2-Trichloroethane | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| 1,1-Dichloroethane | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| 1,1-Dichloroethene | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| 1,2,3-Trichlorobenzene | 0.5 U | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | NA | NA |
| 1,2,4-Trichlorobenzene | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| 1,2-Dibromo-3-chloropropane | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 R |
| 1,2-Dibromoethane | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| 1,2-Dichlorobenzene | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| 1,2-Dichloroethane | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| 1,2-Dichloropropane | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| 1,3-Dichlorobenzene | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| 1,4-Dichlorobenzene | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| 2-Butanone | 5 U | 10 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 7.9 J | 10 UL |
| 2-Chloroethyl vinyl ether | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2-Hexanone | 5 U | 10 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 10 U | 10 UL |
| 4-Methyl-2-pentanone | 5 U | 10 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 10 U | 10 UL |
| Acetone | 5 U | 10 U | 5 U | 5 U | 5 U | 2.2 J | 5 U | 5 U | 10 U | 10 UL |
| Benzene | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| Bromochloromethane | 0.5 U | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | NA | NA |
| Bromodichloromethane | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| Bromoform | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| Bromomethane | 0.5 U | 10 U | 0.5 UJ | 0.5 U | 0.5 U | 0.5 UJ | 0.5 U | 0.5 UJ | 10 U | 10 UL |
| Carbon disulfide | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 | 10 UL |
| Carbon tetrachloride | 0.5 U | 10 U | 0.5 UJ | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| Chlorobenzene | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| Chloroethane | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| Chloroform | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| Chloromethane | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| Cyclohexane | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| Dibromochloromethane | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| Dichlorodifluoromethane (Freon-12) | 0.5 U | 10 U | 0.5 UJ | 0.5 U | 0.5 U | 0.5 UJ | 0.5 U | 0.5 UJ | 10 U | 10 UL |
| Ethane | NA | NA | 6.2 U | NA | NA | 6.2 U | NA | 6.2 U | NA | NA |
| Ethene | NA | NA | 5.8 U | NA | NA | 5.8 U | NA | 5.8 U | NA | NA |
| Ethylbenzene | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| Isopropylbenzene | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| Methane | NA | NA | 5.3 | NA | NA | 3.3 U | NA | 3.3 U | NA | NA |
| Methyl acetate | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| Methyl-tert-butyl ether (MTBE) | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| Methylcyclohexane | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| Methylene chloride | 0.82 | 10 U | 0.43 B | 2.3 B | 3.8 B | 0.49 B | 3.4 B | 0.5 U | 3 J | 10 UL |
| Styrene | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| Tetrachloroethene | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| Toluene | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| Trichloroethene | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.81 | 0.5 U | 0.56 | 0.5 U | 1.8 J | 10 UL |
| Trichlorofluoromethane(Freon-11) | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| Vinyl chloride | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| Xylene, total | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| cis-1,2-Dichloroethene | 0.5 UJ | 10 U | 0.5 U | 0.5 U | 0.5 UJ | 0.5 U | 0.5 UJ | 0.5 U | 10 U | 10 UL |
| cis-1,3-Dichloropropene | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |
| m- and p-Xylene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| o-Xylene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| trans-1,2-Dichloroethene | 0.5 UJ | 10 U | 0.5 U | 0.5 U | 0.5 UJ | 0.5 U | 0.5 UJ | 0.5 U | 10 U | 10 UL |
| trans-1,3-Dichloropropene | 0.5 U | 10 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 10 U | 10 UL |

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW11S | | | 12MW13S | 12MW17D | | 12MW17S | | 12MW20D | 12MW20S |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW11S-0605 | AS12-12MW11S-1206 | AS12-12MW11S-0607 | AS12-12MW13S-0505 | AS12-12MW17D-0505 | AS12-12MW17D-0607 | AS12-12MW17S-0505 | AS12-12MW17S-0607 | AS12-12MW20D-1206 | AS12-12MW20S-1206 |
| **Sample Date** | 06/02/05 | 12/07/06 | 06/13/07 | 05/23/05 | 05/24/05 | 06/12/07 | 05/24/05 | 06/12/07 | 12/07/06 | 12/06/06 |
| **Chemical Name** | | | | | | | | | | |
| **Semi-volatile Organic Compounds (UG_L)** | | | | | | | | | | |
| 1,1-Biphenyl | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| 2,2'-Oxybis(1-chloropropane) | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| 2,4,5-Trichlorophenol | 26 U | NA | 26 U | 26 U | 27 U | 25 U | 26 U | 25 U | NA | NA |
| 2,4,6-Trichlorophenol | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| 2,4-Dichlorophenol | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| 2,4-Dimethylphenol | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| 2,4-Dinitrophenol | 26 U | NA | 26 U | 26 U | 27 U | 25 U | 26 U | 25 U | NA | NA |
| 2,4-Dinitrotoluene | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| 2,6-Dinitrotoluene | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| 2-Chloronaphthalene | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| 2-Chlorophenol | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| 2-Methylnaphthalene | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| 2-Methylphenol | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| 2-Nitroaniline | 26 U | NA | 26 U | 26 U | 27 U | 25 U | 26 U | 25 U | NA | NA |
| 2-Nitrophenol | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| 3,3'-Dichlorobenzidine | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| 3-Nitroaniline | 26 U | NA | 26 U | 26 U | 27 U | 25 U | 26 U | 25 U | NA | NA |
| 4,6-Dinitro-2-methylphenol | 26 U | NA | 26 U | 26 U | 27 U | 25 U | 26 U | 25 U | NA | NA |
| 4-Bromophenyl-phenylether | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| 4-Chloro-3-methylphenol | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| 4-Chloroaniline | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| 4-Chlorophenyl-phenylether | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| 4-Methylphenol | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| 4-Nitroaniline | 26 U | NA | 26 U | 26 U | 27 U | 25 U | 26 U | 25 U | NA | NA |
| 4-Nitrophenol | 26 U | NA | 26 U | 26 U | 27 U | 25 U | 26 U | 25 U | NA | NA |
| Acenaphthene | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Acenaphthylene | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Acetophenone | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Anthracene | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Atrazine | 10 U | NA | 11 R | 10 UJ | 11 UJ | 10 R | 10 UJ | 10 R | NA | NA |
| Benzaldehyde | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Benzo(a)anthracene | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Benzo(a)pyrene | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Benzo(b)fluoranthene | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Benzo(g,h,i)perylene | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Benzo(k)fluoranthene | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Butylbenzylphthalate | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Caprolactam | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Carbazole | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Chrysene | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Di-n-butylphthalate | 10 U | NA | 11 U | 1.5 B | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Di-n-octylphthalate | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Dibenz(a,h)anthracene | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Dibenzofuran | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Diethylphthalate | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Dimethyl phthalate | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Fluoranthene | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Fluorene | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Hexachlorobenzene | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Hexachlorobutadiene | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Hexachlorocyclopentadiene | 10 U | NA | 11 UJ | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Hexachloroethane | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Indeno(1,2,3-cd)pyrene | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Isophorone | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Naphthalene | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Nitrobenzene | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Pentachlorophenol | 26 U | NA | 26 U | 26 U | 27 U | 25 U | 26 U | 25 U | NA | NA |
| Phenanthrene | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Phenol | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| Pyrene | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| bis(2-Chloroethoxy)methane | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| bis(2-Chloroethyl)ether | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW11S | | | 12MW13S | 12MW17D | | 12MW17S | | 12MW20D | 12MW20S |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW11S-0605 | AS12-12MW11S-1206 | AS12-12MW11S-0607 | AS12-12MW13S-0505 | AS12-12MW17D-0505 | AS12-12MW17D-0607 | AS12-12MW17S-0505 | AS12-12MW17S-0607 | AS12-12MW20D-1206 | AS12-12MW20S-1206 |
| **Sample Date** | 06/02/05 | 12/07/06 | 06/13/07 | 05/23/05 | 05/24/05 | 06/12/07 | 05/24/05 | 06/12/07 | 12/07/06 | 12/06/06 |
| **Chemical Name** | | | | | | | | | | |
| bis(2-Ethylhexyl)phthalate | 10 U | NA | 7.4 B | 3.2 B | 11 U | 10 U | 16 B | 1.6 B | NA | NA |
| n-Nitroso-di-n-propylamine | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| n-Nitrosodiphenylamine | 10 U | NA | 11 U | 10 U | 11 U | 10 U | 10 U | 10 U | NA | NA |
| | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_L)** | | | | | | | | | | |
| 4,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aldrin | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1016 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1221 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1232 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1242 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1248 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1254 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1260 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Dieldrin | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endosulfan I | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endosulfan II | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endosulfan sulfate | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endrin | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endrin aldehyde | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endrin ketone | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Heptachlor | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Heptachlor epoxide | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Methoxychlor | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Toxaphene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| alpha-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| alpha-Chlordane | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| beta-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| delta-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| gamma-BHC (Lindane) | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| gamma-Chlordane | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | | | | | | | | |
| **Explosives (UG_L)** | | | | | | | | | | |
| 1,3,5-Trinitrobenzene | 0.26 U | NA | NA | 0.26 U | 0.26 U | NA | 0.26 U | NA | NA | NA |
| 1,3-Dinitrobenzene | 0.26 U | NA | NA | 0.26 U | 0.26 U | NA | 0.26 U | NA | NA | NA |
| 2,4,6-Trinitrotoluene | 0.26 U | NA | NA | 0.26 U | 0.26 U | NA | 0.26 U | NA | NA | NA |
| 2,4-Dinitrotoluene | 0.26 U | NA | NA | 0.26 U | 0.26 U | NA | 0.26 U | NA | NA | NA |
| 2,6-Dinitrotoluene | 0.26 U | NA | NA | 0.26 U | 0.26 U | NA | 0.26 U | NA | NA | NA |
| 2-Amino-4,6-dinitrotoluene | 0.26 U | NA | NA | 0.26 U | 0.26 U | NA | 0.26 U | NA | NA | NA |
| 2-Nitrotoluene | 0.52 U | NA | NA | 0.52 U | 0.52 U | NA | 0.52 U | NA | NA | NA |
| 3-Nitrotoluene | 0.52 U | NA | NA | 0.52 U | 0.52 U | NA | 0.52 U | NA | NA | NA |
| 4-Amino-2,6-dinitrotoluene | 0.26 U | NA | NA | 0.26 U | 0.26 U | NA | 0.26 U | NA | NA | NA |
| 4-Nitrotoluene | 0.52 U | NA | NA | 0.52 U | 0.52 U | NA | 0.52 U | NA | NA | NA |
| HMX | 0.52 U | NA | NA | 0.52 U | 0.52 U | NA | 0.52 U | NA | NA | NA |
| Nitrobenzene | 0.26 U | NA | NA | 0.26 U | 0.26 U | NA | 0.26 U | NA | NA | NA |
| Nitroglycerin | 2,000 U | NA | NA | 1,000 U | 1,000 U | NA | 1,000 U | NA | NA | NA |
| Perchlorate | 2 U | NA | 0.0612 U | 2 U | 2 U | 0.0612 U | 2 U | 0.402 | NA | NA |
| RDX | 0.52 U | NA | NA | 0.52 U | 0.52 U | NA | 0.52 U | NA | NA | NA |
| Tetryl | 0.52 U | NA | NA | 0.52 U | 0.52 U | NA | 0.52 U | NA | NA | NA |
| | | | | | | | | | | |
| **Total Metals (UG_L)** | | | | | | | | | | |
| Aluminum | 1,570 | NA | 1,910 | 40.3 U | 488 | 1,430 | 365 | 667 | NA | NA |
| Antimony | 2.8 U | NA | 60 U | 2.8 U | 2.8 U | 60 U | 2.8 U | 60 U | NA | NA |
| Arsenic | 3.6 U | NA | 6.9 K | 3.6 U | 3.6 U | 10 U | 3.6 U | 10 U | NA | NA |
| Barium | 56.8 J | NA | 78.1 J | 53.6 J | 34.5 J | 49 J | 67.3 J | 86.2 J | NA | NA |
| Beryllium | 0.12 J | NA | 5 U | 0.1 U | 0.1 U | 5 U | 0.1 U | 5 U | NA | NA |
| Cadmium | 0.4 U | NA | 5 U | 0.4 U | 0.4 U | 5 U | 0.4 U | 5 U | NA | NA |
| Calcium | 105,000 | NA | 114,000 | 130,000 | 115,000 | 113,000 | 161,000 | 160,000 | NA | NA |
| Chromium | 4.2 J | NA | 37.2 | 0.6 U | 2.3 J | 3.8 B | 1.3 J | 6.3 B | NA | NA |
| Chromium (hexavalent) | 10 U | NA | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | NA | NA |
| Cobalt | 0.7 U | NA | 1.3 B | 0.7 U | 0.7 U | 0.85 B | 0.7 U | 0.7 B | NA | NA |

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW11S | | | 12MW13S | 12MW17D | | 12MW17S | | 12MW20D | 12MW20S |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW11S-0605 | AS12-12MW11S-1206 | AS12-12MW11S-0607 | AS12-12MW13S-0505 | AS12-12MW17D-0505 | AS12-12MW17D-0607 | AS12-12MW17S-0505 | AS12-12MW17S-0607 | AS12-12MW20D-1206 | AS12-12MW20S-1206 |
| **Sample Date** | 06/02/05 | 12/07/06 | 06/13/07 | 05/23/05 | 05/24/05 | 06/12/07 | 05/24/05 | 06/12/07 | 12/07/06 | 12/06/06 |
| **Chemical Name** | | | | | | | | | | |
| Copper | 5.5 B | NA | 6.8 B | 4.1 B | 0.8 U | 4.8 B | 1.2 B | 2.3 B | NA | NA |
| Cyanide | 5 U | NA | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | NA | NA |
| Iron | 2,240 | NA | 4,590 | 61.3 B | 1,650 | 2,850 | 538 | 1,270 | NA | NA |
| Lead | 2.6 J | NA | 2.8 K | 1.8 U | 1.8 U | 10 U | 1.8 U | 10 U | NA | NA |
| Magnesium | 65,900 | NA | 48,400 | 30,600 | 43,600 | 46,200 | 41,000 | 43,100 | NA | NA |
| Manganese | 77 | NA | 102 | 31.9 | 105 | 10.4 J | 7 J | 19.7 | NA | NA |
| Mercury | 0.1 U | NA | 0.023 J | 0.1 U | 0.1 U | 0.2 U | 0.1 U | 0.2 UL | NA | NA |
| Nickel | 2.9 J | NA | 24.8 J | 1.2 U | 2.4 B | 2.5 B | 2 B | 4.2 B | NA | NA |
| Potassium | 17,600 | NA | 6,170 | 1,900 J | 2,290 J | 2,380 J | 2,250 J | 2,320 J | NA | NA |
| Selenium | 2.6 U | NA | 35 U | 2.6 U | 2.6 U | 35 U | 2.6 U | 35 U | NA | NA |
| Silver | 0.7 U | NA | 10 U | 0.7 U | 0.7 U | 10 U | 0.7 U | 10 U | NA | NA |
| Sodium | 20,000 | NA | 71,800 | 32,700 | 9,480 | 9,190 | 33,100 | 41,900 | NA | NA |
| Thallium | 4.6 U | NA | 25 U | 4.6 U | 4.6 U | 6.2 K | 4.6 U | 25 U | NA | NA |
| Vanadium | 2.6 J | NA | 3.6 J | 1.1 U | 1.1 U | 2.7 J | 1.1 U | 50 U | NA | NA |
| Zinc | 9.8 B | NA | 38.3 B | 8 J | 8.2 J | 14.2 B | 0.6 U | 13.1 B | NA | NA |
| | | | | | | | | | | |
| **Dissolved Metals (UG_L)** | | | | | | | | | | |
| Aluminum | 40.3 U | NA | 74.7 J | 40.3 U | 40.3 U | 200 U | 40.3 U | 200 U | NA | NA |
| Antimony | 2.8 U | NA | 60 U | 2.8 U | 2.8 U | 60 U | 2.8 U | 60 U | NA | NA |
| Arsenic | 3.6 U | NA | 10 U | 3.6 U | 3.7 J | 10 U | 3.6 U | 10 U | NA | NA |
| Barium | 42 J | NA | 36.4 J | 53.3 J | 31.1 J | 40.8 J | 59.8 J | 54.2 J | NA | NA |
| Beryllium | 0.1 U | NA | 5 U | 0.1 U | 0.1 U | 5 U | 0.1 U | 5 U | NA | NA |
| Cadmium | 0.4 U | NA | 5 U | 0.4 U | 0.4 U | 5 U | 0.4 U | 5 U | NA | NA |
| Calcium | 102,000 | NA | 95,000 | 129,000 | 114,000 | 109,000 | 164,000 | 131,000 | NA | NA |
| Chromium | 0.6 U | NA | 10 U | 0.6 U | 0.6 U | 0.9 J | 1 J | 2.1 K | NA | NA |
| Chromium (hexavalent) | 10 U | NA | NA | 10 U | 10 U | NA | 10 U | NA | NA | NA |
| Cobalt | 0.7 U | NA | 50 U | 0.7 U | 0.7 U | 50 U | 0.7 U | 50 U | NA | NA |
| Copper | 1.4 B | NA | 2.9 B | 1.9 B | 0.88 B | 2.9 B | 1.5 B | 1.5 B | NA | NA |
| Iron | 16.3 U | NA | 65 B | 16.3 U | 720 | 100 U | 16.3 U | 100 U | NA | NA |
| Lead | 1.8 U | NA | 10 U | 1.8 U | 1.8 U | 10 U | 1.8 U | 10 U | NA | NA |
| Magnesium | 64,200 | NA | 45,000 | 30,300 | 43,100 | 44,300 | 41,900 | 35,500 | NA | NA |
| Manganese | 46 | NA | 23.9 | 29.9 | 102 | 2.7 B | 2.3 J | 1 B | NA | NA |
| Mercury | 0.1 U | NA | 0.2 U | 0.1 U | 0.1 U | 0.2 U | 0.1 U | 0.2 UL | NA | NA |
| Nickel | 1.2 U | NA | 2.7 J | 1.3 J | 1.8 J | 40 U | 3 J | 2.9 J | NA | NA |
| Potassium | 15,200 | NA | 7,500 | 1,880 J | 2,160 J | 2,000 J | 2,210 J | 1,820 J | NA | NA |
| Selenium | 2.6 U | NA | 35 U | 2.6 U | 3.5 J | 35 U | 4.1 J | 35 U | NA | NA |
| Silver | 0.7 U | NA | 10 U | 0.7 U | 0.7 U | 10 U | 0.7 U | 10 U | NA | NA |
| Sodium | 13,000 | NA | 33,200 | 32,500 | 9,210 | 8,780 | 33,600 | 34,100 | NA | NA |
| Thallium | 4.6 U | NA | 25 U | 4.6 U | 10.2 B | 25 U | 4.6 U | 25 U | NA | NA |
| Vanadium | 1.1 U | NA | 50 U | 1.1 U | 1.1 U | 50 U | 1.1 U | 50 U | NA | NA |
| Zinc | 3.7 B | NA | 41.4 B | 3.2 J | 4.6 J | 21.3 B | 0.6 U | 13.1 B | NA | NA |
| | | | | | | | | | | |
| **Wet Chemistry (MG_L)** | | | | | | | | | | |
| Alkalinity | NA | 220 | NA | NA | NA | NA | NA | NA | 230 | 220 |
| Chloride | NA | NA | 3.7 | NA | NA | 28 | NA | 94 | NA | NA |
| Hardness | NA | NA | 580 | NA | NA | 480 | NA | 600 | NA | NA |
| Nitrate | NA | NA | 0.1 U | NA | NA | 0.1 | NA | 1 | NA | NA |
| Nitrogen | NA | NA | 0.1 U | NA | NA | 0.1 U | NA | 0.1 U | NA | NA |
| Sulfate | NA | NA | 340 | NA | NA | 200 | NA | 250 | NA | NA |
| Total organic carbon (TOC) | NA | 1.5 B | 2.6 | NA | NA | 1 U | NA | 1 U | 1 U | 1 U |
| | | | | | | | | | | |
| **Total Petroleum Hydrocarbons (UG_L)** | | | | | | | | | | |
| Bunker oil | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Compressor oil | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Creosote (mixture) | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Diesel fuel | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Fuel oil #2 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Fuel oil #4 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Fuel oil #5 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Fuel oil #6 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Hydraulic jack oil | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| JP-4 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| JP-5 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW11S | | | 12MW13S | 12MW17D | | 12MW17S | | 12MW20D | 12MW20S |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW11S-0605 | AS12-12MW11S-1206 | AS12-12MW11S-0607 | AS12-12MW13S-0505 | AS12-12MW17D-0505 | AS12-12MW17D-0607 | AS12-12MW17S-0505 | AS12-12MW17S-0607 | AS12-12MW20D-1206 | AS12-12MW20S-1206 |
| **Sample Date** | 06/02/05 | 12/07/06 | 06/13/07 | 05/23/05 | 05/24/05 | 06/12/07 | 05/24/05 | 06/12/07 | 12/07/06 | 12/06/06 |
| **Chemical Name** | | | | | | | | | | |
| JP-8 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Jet fuel A | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Kerosene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Lubricating oil | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Mineral oil | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Mineral spirits | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Motor oil | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Naphtha | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| TPH-diesel range | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| TPH-gas range | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Transmission fluid | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Shading represents detect

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW21D | | 12MW21S | | | 12MW22D | | 12MW22S | | 1GW40 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW21D-1206 | AS12-12MW21D-0607 | AS12-12MW21S-1206 | AS12-12MW21SP-1206 | AS12-12MW21S-0607 | AS12-12MW22D-1206 | AS12-12MW22D-0607 | AS12-12MW22S-1206 | AS12-12MW22S-0607 | AS01-1EW35-PTA | AS01-1EW35-PTB |
| **Sample Date** | 12/06/06 | 06/11/07 | 12/06/06 | 12/06/06 | 06/11/07 | 12/06/06 | 06/13/07 | 12/06/06 | 06/13/07 | 08/03/00 | 08/03/00 |
| **Chemical Name** | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Volatile Organic Compounds (UG_L)** | | | | | | | | | | | |
| 1,1,1-Trichloroethane | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | 1.5 U | 1.5 U |
| 1,1,2,2-Tetrachloroethane | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | 1.7 U | 1.7 U |
| 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | NA | NA |
| 1,1,2-Trichloroethane | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | 1.6 U | 1.6 U |
| 1,1-Dichloroethane | 10 U | 0.92 | 10 UL | 2.7 L | 0.91 | 10 UL | 0.5 U | 10 U | 0.5 U | 1.7 U | 1.7 U |
| 1,1-Dichloroethene | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | 2 U | 2 U |
| 1,2,3-Trichlorobenzene | NA | 0.5 U | NA | NA | 0.5 U | NA | 0.5 U | NA | 0.5 U | NA | NA |
| 1,2,4-Trichlorobenzene | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | NA | NA |
| 1,2-Dibromo-3-chloropropane | 10 U | 0.5 U | 10 R | 10 R | 0.5 U | 10 R | 0.5 U | 10 U | 0.5 U | NA | NA |
| 1,2-Dibromoethane | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | NA | NA |
| 1,2-Dichlorobenzene | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | 1.6 U | 1.6 U |
| 1,2-Dichloroethane | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | 1.4 U | 1.4 U |
| 1,2-Dichloropropane | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | 1.9 U | 1.9 U |
| 1,3-Dichlorobenzene | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | 1.7 U | 1.7 U |
| 1,4-Dichlorobenzene | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | 1.7 U | 1.7 U |
| 2-Butanone | 10 UJ | 5 U | 10 UL | 10 UL | 5 U | 10 UL | 5 U | 10 UJ | 5 U | NA | NA |
| 2-Chloroethyl vinyl ether | NA | NA | NA | NA | NA | NA | NA | NA | NA | 1.5 U | 1.5 U |
| 2-Hexanone | 10 UJ | 5 U | 10 UL | 10 UL | 2.5 J | 10 UL | 5 U | 10 UJ | 5 U | NA | NA |
| 4-Methyl-2-pentanone | 10 UJ | 5 U | 10 UL | 10 UL | 5 U | 10 UL | 5 U | 10 UJ | 5 U | NA | NA |
| Acetone | 10 U | 6.7 | 10 UL | 10 UL | 5 U | 16 L | 5 U | 10 U | 5 U | NA | NA |
| Benzene | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | 1.7 U | 1.7 U |
| Bromochloromethane | NA | 0.5 U | NA | NA | 0.5 U | NA | 0.5 U | NA | 0.5 U | NA | NA |
| Bromodichloromethane | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | 1.5 U | 1.5 U |
| Bromoform | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | 1.8 U | 1.8 U |
| Bromomethane | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 UJ | 10 U | 0.5 UJ | 1.8 U | 1.8 U |
| Carbon disulfide | 3.2 J | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | NA | NA |
| Carbon tetrachloride | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 UJ | 10 U | 0.5 UJ | 1.3 U | 1.3 U |
| Chlorobenzene | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | 1.4 U | 1.4 U |
| Chloroethane | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | 2.2 U | 2.2 U |
| Chloroform | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | 1.4 U | 1.4 U |
| Chloromethane | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | 2.4 U | 2.4 U |
| Cyclohexane | 10 U | 0.5 U | 1.4 L | 1.2 L | 0.52 | 10 UL | 0.5 U | 10 U | 0.5 U | NA | NA |
| Dibromochloromethane | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | 1.2 U | 1.2 U |
| Dichlorodifluoromethane (Freon-12) | 10 U | 0.5 UJ | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 UJ | 10 U | 0.5 UJ | NA | NA |
| Ethane | NA | 31 U | NA | NA | 6 J | NA | 12 U | NA | 120 U | NA | NA |
| Ethene | NA | 29 U | NA | NA | 12 U | NA | 12 U | NA | 120 U | NA | NA |
| Ethylbenzene | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | 1.2 U | 1.2 U |
| Isopropylbenzene | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | NA | NA |
| Methane | NA | 43 | NA | NA | 70 E | NA | 69 E | NA | 700 E | NA | NA |
| Methyl acetate | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | NA | NA |
| Methyl-tert-butyl ether (MTBE) | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | NA | NA |
| Methylcyclohexane | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | NA | NA |
| Methylene chloride | 300 | 0.86 B | 29 L | 170 L | 0.5 U | 10 L | 0.58 B | 13 | 0.62 B | 1.9 U | 1.9 U |
| Styrene | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | NA | NA |
| Tetrachloroethene | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | 1.4 U | 1.4 U |
| Toluene | 2.1 J | 0.5 U | 1.7 L | 1.3 L | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | 1.4 U | 1.4 U |
| Trichloroethene | 10 U | 0.5 U | 3 L | 2.9 L | 0.33 J | 10 UL | 0.5 U | 10 U | 0.5 U | 14 | 10 |
| Trichlorofluoromethane(Freon-11) | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | 4.3 | 2.4 U |
| Vinyl chloride | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | 1.9 U | 1.9 U |
| Xylene, total | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | NA | NA |
| cis-1,2-Dichloroethene | 10 U | 1.2 | 10 UL | 10 UL | 1.2 | 10 UL | 0.5 U | 10 U | 0.5 U | NA | NA |
| cis-1,3-Dichloropropene | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | 1.4 U | 1.4 U |
| m- and p-Xylene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| o-Xylene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| trans-1,2-Dichloroethene | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | 1.7 U | 1.7 U |
| trans-1,3-Dichloropropene | 10 U | 0.5 U | 10 UL | 10 UL | 0.5 U | 10 UL | 0.5 U | 10 U | 0.5 U | 1.4 U | 1.4 U |

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW21D | | 12MW21S | | | 12MW22D | | 12MW22S | | 1GW40 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW21D-1206 | AS12-12MW21D-0607 | AS12-12MW21S-1206 | AS12-12MW21SP-1206 | AS12-12MW21S-0607 | AS12-12MW22D-1206 | AS12-12MW22D-0607 | AS12-12MW22S-1206 | AS12-12MW22S-0607 | AS01-1EW35-PTA | AS01-1EW35-PTB |
| **Sample Date** | 12/06/06 | 06/11/07 | 12/06/06 | 12/06/06 | 06/11/07 | 12/06/06 | 06/13/07 | 12/06/06 | 06/13/07 | 08/03/00 | 08/03/00 |
| **Chemical Name** | | | | | | | | | | | |
| **Semi-volatile Organic Compounds (UG_L)** | | | | | | | | | | | |
| 1,1-Biphenyl | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| 2,2'-Oxybis(1-chloropropane) | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| 2,4,5-Trichlorophenol | NA | 28 U | NA | NA | 28 U | NA | 26 U | NA | 26 U | NA | NA |
| 2,4,6-Trichlorophenol | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| 2,4-Dichlorophenol | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| 2,4-Dimethylphenol | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| 2,4-Dinitrophenol | NA | 28 U | NA | NA | 28 U | NA | 26 U | NA | 26 U | NA | NA |
| 2,4-Dinitrotoluene | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| 2,6-Dinitrotoluene | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| 2-Chloronaphthalene | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| 2-Chlorophenol | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| 2-Methylnaphthalene | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| 2-Methylphenol | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| 2-Nitroaniline | NA | 28 U | NA | NA | 28 U | NA | 26 U | NA | 26 U | NA | NA |
| 2-Nitrophenol | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| 3,3'-Dichlorobenzidine | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| 3-Nitroaniline | NA | 28 U | NA | NA | 28 U | NA | 26 U | NA | 26 U | NA | NA |
| 4,6-Dinitro-2-methylphenol | NA | 28 U | NA | NA | 28 U | NA | 26 U | NA | 26 U | NA | NA |
| 4-Bromophenyl-phenylether | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| 4-Chloro-3-methylphenol | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| 4-Chloroaniline | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| 4-Chlorophenyl-phenylether | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| 4-Methylphenol | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| 4-Nitroaniline | NA | 28 U | NA | NA | 28 U | NA | 26 U | NA | 26 U | NA | NA |
| 4-Nitrophenol | NA | 28 U | NA | NA | 28 U | NA | 26 U | NA | 26 U | NA | NA |
| Acenaphthene | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Acenaphthylene | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Acetophenone | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Anthracene | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Atrazine | NA | 11 R | NA | NA | 11 R | NA | 10 R | NA | 10 R | NA | NA |
| Benzaldehyde | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Benzo(a)anthracene | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Benzo(a)pyrene | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Benzo(b)fluoranthene | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Benzo(g,h,i)perylene | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Benzo(k)fluoranthene | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Butylbenzylphthalate | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Caprolactam | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Carbazole | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Chrysene | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Di-n-butylphthalate | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Di-n-octylphthalate | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Dibenz(a,h)anthracene | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Dibenzofuran | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Diethylphthalate | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Dimethyl phthalate | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Fluoranthene | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Fluorene | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Hexachlorobenzene | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Hexachlorobutadiene | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Hexachlorocyclopentadiene | NA | 11 UJ | NA | NA | 11 UJ | NA | 10 UJ | NA | 10 UJ | NA | NA |
| Hexachloroethane | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Indeno(1,2,3-cd)pyrene | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Isophorone | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Naphthalene | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Nitrobenzene | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Pentachlorophenol | NA | 28 U | NA | NA | 28 U | NA | 26 U | NA | 26 U | NA | NA |
| Phenanthrene | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Phenol | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| Pyrene | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| bis(2-Chloroethoxy)methane | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| bis(2-Chloroethyl)ether | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW21D | | 12MW21S | | | 12MW22D | | 12MW22S | | 1GW40 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW21D-1206 | AS12-12MW21D-0607 | AS12-12MW21S-1206 | AS12-12MW21SP-1206 | AS12-12MW21S-0607 | AS12-12MW22D-1206 | AS12-12MW22D-0607 | AS12-12MW22S-1206 | AS12-12MW22S-0607 | AS01-1EW35-PTA | AS01-1EW35-PTB |
| **Sample Date** | 12/06/06 | 06/11/07 | 12/06/06 | 12/06/06 | 06/11/07 | 12/06/06 | 06/13/07 | 12/06/06 | 06/13/07 | 08/03/00 | 08/03/00 |
| **Chemical Name** | | | | | | | | | | | |
| bis(2-Ethylhexyl)phthalate | NA | 2.6 B | NA | NA | 2.8 B | NA | 2.5 B | NA | 3.9 B | NA | NA |
| n-Nitroso-di-n-propylamine | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| n-Nitrosodiphenylamine | NA | 11 U | NA | NA | 11 U | NA | 10 U | NA | 10 U | NA | NA |
| | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_L)** | | | | | | | | | | | |
| 4,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aldrin | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1016 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1221 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1232 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1242 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1248 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1254 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1260 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Dieldrin | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endosulfan I | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endosulfan II | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endosulfan sulfate | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endrin | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endrin aldehyde | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Endrin ketone | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Heptachlor | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Heptachlor epoxide | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Methoxychlor | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Toxaphene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| alpha-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| alpha-Chlordane | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| beta-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| delta-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| gamma-BHC (Lindane) | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| gamma-Chlordane | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | | | | | | | | | |
| **Explosives (UG_L)** | | | | | | | | | | | |
| 1,3,5-Trinitrobenzene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1,3-Dinitrobenzene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4,6-Trinitrotoluene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4-Dinitrotoluene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,6-Dinitrotoluene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2-Amino-4,6-dinitrotoluene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2-Nitrotoluene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 3-Nitrotoluene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4-Amino-2,6-dinitrotoluene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4-Nitrotoluene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| HMX | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Nitrobenzene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Nitroglycerin | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Perchlorate | NA | 0.0612 U | NA | NA | 0.0612 U | NA | 0.0612 U | NA | 0.0612 U | NA | NA |
| RDX | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Tetryl | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | | | | | | | | | |
| **Total Metals (UG_L)** | | | | | | | | | | | |
| Aluminum | NA | 119 J | NA | NA | 200 UL | NA | 90.2 J | NA | 143 J | NA | NA |
| Antimony | NA | 60 U | NA | NA | 60 U | NA | 60 U | NA | 60 U | NA | NA |
| Arsenic | NA | 3.9 K | NA | NA | 4 K | NA | 3.8 K | NA | 4.6 K | NA | NA |
| Barium | NA | 26 J | NA | NA | 23.1 J | NA | 15.8 J | NA | 25.9 J | NA | NA |
| Beryllium | NA | 5 U | NA | NA | 5 U | NA | 5 U | NA | 5 U | NA | NA |
| Cadmium | NA | 5 U | NA | NA | 5 U | NA | 5 U | NA | 0.39 B | NA | NA |
| Calcium | NA | 318,000 | NA | NA | 356,000 | NA | 380,000 | NA | 307,000 | NA | NA |
| Chromium | NA | 34 | NA | NA | 1.7 B | NA | 1.3 J | NA | 2.7 J | NA | NA |
| Chromium (hexavalent) | NA | 10 U | NA | NA | 10 U | NA | 10 U | NA | 10 U | NA | NA |
| Cobalt | NA | 3.9 J | NA | NA | 50 U | NA | 1.3 B | NA | 0.85 B | NA | NA |

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW21D | | 12MW21S | | | 12MW22D | | 12MW22S | | 1GW40 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW21D-1206 | AS12-12MW21D-0607 | AS12-12MW21S-1206 | AS12-12MW21SP-1206 | AS12-12MW21S-0607 | AS12-12MW22D-1206 | AS12-12MW22D-0607 | AS12-12MW22S-1206 | AS12-12MW22S-0607 | AS01-1EW35-PTA | AS01-1EW35-PTB |
| **Sample Date** | 12/06/06 | 06/11/07 | 12/06/06 | 12/06/06 | 06/11/07 | 12/06/06 | 06/13/07 | 12/06/06 | 06/13/07 | 08/03/00 | 08/03/00 |
| **Chemical Name** | | | | | | | | | | | |
| Copper | NA | 6.6 B | NA | NA | 4.4 B | NA | 2.7 B | NA | 9 B | NA | NA |
| Cyanide | NA | 5 U | NA | NA | 5 U | NA | 5 U | NA | 5 U | NA | NA |
| Iron | NA | 3,540 | NA | NA | 2,400 | NA | 765 | NA | 1,140 | NA | NA |
| Lead | NA | 10 U | NA | NA | 10 U | NA | 10 U | NA | 10 U | NA | NA |
| Magnesium | NA | 112,000 | NA | NA | 123,000 | NA | 126,000 | NA | 111,000 | NA | NA |
| Manganese | NA | 92.1 | NA | NA | 22.1 | NA | 15.4 | NA | 57.8 | NA | NA |
| Mercury | NA | 0.2 U | NA | NA | 0.2 U | NA | 0.2 U | NA | 0.2 U | NA | NA |
| Nickel | NA | 29.8 J | NA | NA | 4.3 B | NA | 40 U | NA | 3.6 J | NA | NA |
| Potassium | NA | 4,090 J | NA | NA | 3,980 J | NA | 3,920 J | NA | 3,690 J | NA | NA |
| Selenium | NA | 35 U | NA | NA | 35 U | NA | 35 U | NA | 35 U | NA | NA |
| Silver | NA | 10 U | NA | NA | 10 U | NA | 10 U | NA | 10 U | NA | NA |
| Sodium | NA | 13,300 | NA | NA | 5,800 | NA | 7,050 | NA | 15,900 | NA | NA |
| Thallium | NA | 25 U | NA | NA | 25 U | NA | 25 U | NA | 25 U | NA | NA |
| Vanadium | NA | 0.67 J | NA | NA | 50 U | NA | 50 U | NA | 0.54 J | NA | NA |
| Zinc | NA | 15.3 B | NA | NA | 10.8 B | NA | 14.9 B | NA | 28.4 B | NA | NA |
| | | | | | | | | | | | |
| **Dissolved Metals (UG_L)** | | | | | | | | | | | |
| Aluminum | NA | 200 UJ | NA | NA | 1,100 J | NA | 200 U | NA | 200 U | NA | NA |
| Antimony | NA | 60 U | NA | NA | 60 U | NA | 60 U | NA | 60 U | NA | NA |
| Arsenic | NA | 5.3 K | NA | NA | 4.1 K | NA | 10 U | NA | 10 U | NA | NA |
| Barium | NA | 23.2 J | NA | NA | 25.6 J | NA | 14 J | NA | 21.1 J | NA | NA |
| Beryllium | NA | 5 U | NA | NA | 5 U | NA | 5 U | NA | 5 U | NA | NA |
| Cadmium | NA | 5 U | NA | NA | 0.3 B | NA | 5 U | NA | 5 U | NA | NA |
| Calcium | NA | 338,000 | NA | NA | 333,000 | NA | 378,000 | NA | 315,000 | NA | NA |
| Chromium | NA | 2.6 B | NA | NA | 1.8 B | NA | 10 U | NA | 10 U | NA | NA |
| Chromium (hexavalent) | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Cobalt | NA | 1.4 J | NA | NA | 50 U | NA | 0.89 B | NA | 0.72 B | NA | NA |
| Copper | NA | 3.9 B | NA | NA | 4 B | NA | 2.9 B | NA | 2.9 B | NA | NA |
| Iron | NA | 2,010 | NA | NA | 2,220 | NA | 625 | NA | 1,010 | NA | NA |
| Lead | NA | 10 U | NA | NA | 2.3 K | NA | 10 U | NA | 10 U | NA | NA |
| Magnesium | NA | 118,000 | NA | NA | 116,000 | NA | 125,000 | NA | 113,000 | NA | NA |
| Manganese | NA | 48.5 | NA | NA | 38.9 | NA | 12 J | NA | 51.2 | NA | NA |
| Mercury | NA | 0.2 U | NA | NA | 0.2 U | NA | 0.2 U | NA | 0.2 U | NA | NA |
| Nickel | NA | 17.4 J | NA | NA | 4.1 B | NA | 40 U | NA | 2 J | NA | NA |
| Potassium | NA | 4,000 J | NA | NA | 3,830 J | NA | 3,870 J | NA | 3,780 J | NA | NA |
| Selenium | NA | 35 U | NA | NA | 35 U | NA | 35 U | NA | 35 U | NA | NA |
| Silver | NA | 10 U | NA | NA | 10 U | NA | 10 U | NA | 10 U | NA | NA |
| Sodium | NA | 9,120 | NA | NA | 6,540 | NA | 6,370 | NA | 15,600 | NA | NA |
| Thallium | NA | 25 U | NA | NA | 5.8 K | NA | 25 U | NA | 25 U | NA | NA |
| Vanadium | NA | 50 U | NA | NA | 50 U | NA | 50 U | NA | 50 U | NA | NA |
| Zinc | NA | 12 B | NA | NA | 23.2 B | NA | 18.7 B | NA | 24.5 B | NA | NA |
| | | | | | | | | | | | |
| **Wet Chemistry (MG_L)** | | | | | | | | | | | |
| Alkalinity | 240 | NA | 230 | 220 | NA | 210 | NA | 210 | NA | NA | NA |
| Chloride | NA | 10 | NA | NA | 9.4 | NA | 6.2 | NA | 7.9 | NA | NA |
| Hardness | NA | 1,400 | NA | NA | 1,500 | NA | 1,400 | NA | 1,400 | NA | NA |
| Nitrate | NA | 0.1 U | NA | NA | 0.1 U | NA | 0.1 U | NA | 0.1 U | NA | NA |
| Nitrogen | NA | 0.1 U | NA | NA | 0.1 U | NA | 0.1 U | NA | 0.1 U | NA | NA |
| Sulfate | NA | 1,000 | NA | NA | 1,200 | NA | 1,300 | NA | 1,000 | NA | NA |
| Total organic carbon (TOC) | 2.7 | 1 | 1 U | 1 U | 1 U | 1.3 | 1 U | 1.8 | 1 U | NA | NA |
| | | | | | | | | | | | |
| **Total Petroleum Hydrocarbons (UG_L)** | | | | | | | | | | | |
| Bunker oil | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Compressor oil | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Creosote (mixture) | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Diesel fuel | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Fuel oil #2 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Fuel oil #4 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Fuel oil #5 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Fuel oil #6 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Hydraulic jack oil | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| JP-4 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| JP-5 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

**Bedrock Groundwater Raw Analytical Data**

Site 12 Remedial Investigation Report
Alleganey Ballistics Laboratory
Rocket Center, West Virginia

| **Station ID** | 12MW21D | | 12MW21S | | | 12MW22D | | 12MW22S | | 1GW40 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | AS12-12MW21D-1206 | AS12-12MW21D-0607 | AS12-12MW21S-1206 | AS12-12MW21SP-1206 | AS12-12MW21S-0607 | AS12-12MW22D-1206 | AS12-12MW22D-0607 | AS12-12MW22S-1206 | AS12-12MW22S-0607 | AS01-1EW35-PTA | AS01-1EW35-PTB |
| **Sample Date** | 12/06/06 | 06/11/07 | 12/06/06 | 12/06/06 | 06/11/07 | 12/06/06 | 06/13/07 | 12/06/06 | 06/13/07 | 08/03/00 | 08/03/00 |
| **Chemical Name** | | | | | | | | | | | |
| JP-8 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Jet fuel A | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Kerosene | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Lubricating oil | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Mineral oil | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Mineral spirits | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Motor oil | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Naphtha | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| TPH-diesel range | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| TPH-gas range | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Transmission fluid | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected, quantitation limit is probably higher
Shading represents detect

# Appendix D
# Human Health Risk Assessment Tables

TABLE 1

SELECTION OF EXPOSURE PATHWAYS

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

| Scenario Timeframe | Medium | Exposure Medium | Exposure Point | Receptor Population | Receptor Age | Exposure Route | On-Site/ Off-Site | Type of Analysis | Rationale for Selection or Exclusion of Exposure Pathway |
|---|---|---|---|---|---|---|---|---|---|
| Future | Groundwater | Groundwater | Alluvial Aquifer-Tap Water | Resident | Adult | Dermal Absorption | On-site | Quant | Although unlikely, groundwater will be evaluated for use as future potable water supply. |
| | | | | | | Ingestion | On-site | Quant | Although unlikely, groundwater will be evaluated for use as future potable water supply. |
| | | | | | Child | Dermal Absorption | On-site | Quant | Although unlikely, groundwater will be evaluated for use as future potable water supply. Child is assumed to bathe, and adult is assumed to shower. |
| | | | | | | Ingestion | On-site | Quant | Although unlikely, groundwater will be evaluated for use as future potable water supply. |
| | | | | | Child/Adult | Dermal Absorption | On-site | Quant | Although unlikely, groundwater will be evaluated for use as future potable water supply. This is for cancer risk only. |
| | | | | | | Ingestion | On-site | Quant | Although unlikely, groundwater will be evaluated for use as future potable water supply. This is for cancer risk only. |
| | | | Alluvial Aquifer-Water in Excavation Pit | Construction Worker | Adult | Dermal Absorption | On-site | Quant | Construction workers may contact groundwater while performing construction or excavation activities. |
| | | | | | | Ingestion | On-site | None | Ingestion of groundwater during construction activities expected to be minimal. |
| | | Air | Alluvial Aquifer-Water Vapors at Showerhead | Resident | Adult | Inhalation | On-site | Quant | Although unlikely, groundwater will be evaluated for use as future potable water supply. |
| | | | | | Child | Inhalation | On-site | None | Children are assumed to bath and not to shower; therefore, exposure via inhalation will be minimal compared to exposure via dermal absorption. |
| | | | Alluvial Aquifer-Volatilization from Water in Excavation Pit | Construction Worker | Adult | Inhalation | On-site | Quant | Construction workers may inhale vapors from groundwater while performing construction or excavation activities. |
| | | Groundwater | Bedrock Aquifer-Tap Water | Resident | Adult | Dermal Absorption | On-site | Quant | Although unlikely, groundwater will be evaluated for use as future potable water supply. |
| | | | | | | Ingestion | On-site | Quant | Although unlikely, groundwater will be evaluated for use as future potable water supply. |
| | | | | | Child | Dermal Absorption | On-site | Quant | Although unlikely, groundwater will be evaluated for use as future potable water supply. Child is assumed to bathe, and adult is assumed to shower. |
| | | | | | | Ingestion | On-site | Quant | Although unlikely, groundwater will be evaluated for use as future potable water supply. |
| | | | | | Child/Adult | Dermal Absorption | On-site | Quant | Although unlikely, groundwater will be evaluated for use as future potable water supply. This is for cancer risk only. |
| | | | | | | Ingestion | On-site | Quant | Although unlikely, groundwater will be evaluated for use as future potable water supply. This is for cancer risk only. |
| | | Air | Bedrock Aquifer-Water Vapors at Showerhead | Resident | Adult | Inhalation | On-site | Quant | Although unlikely, groundwater will be evaluated for use as future potable water supply. |
| | | | | | Child | Inhalation | On-site | None | Children are assumed to bath and not to shower; therefore, exposure via inhalation will be minimal compared to exposure via dermal absorption. |

Table 2.1

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

| Exposure Point | CAS Number | Chemical | Minimum [1] Concentration Qualifier | Maximum [1] Concentration Qualifier | Units | Location of Maximum Concentration | Detection Frequency | Range of Detection Limits | Concentration [2] Used for Screening | Background [3] Value | Screening [4] Toxicity Value | Potential ARAR/TBC Value | Potential ARAR/TBC Source | COPC Flag | Rationale for [5] Contaminant Deletion or Selection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alluvial Aquifer - Tap Water | 79-34-5 | 1,1,2,2-Tetrachloroethane | 3.2E+00 J | 3.2E+00 J | UG_L | AS12-12MW10-1206 | 1/21 | 0.5 - 10 | 3.2E+00 | N/A | 5.3E-02 C | N/A | N/A | YES | ASL |
| | 79-00-5 | 1,1,2-Trichloroethane | 3.4E+00 J | 3.4E+00 J | UG_L | AS12-12MW10-1206 | 1/21 | 0.5 - 10 | 3.4E+00 | N/A | 1.9E-01 C | 5.0E+00 | MCL | YES | ASL |
| | 75-34-3 | 1,1-Dichloroethane | 6.4E-01 | 1.3E+01 | UG_L | AS12-12MW01-0605 | 13/21 | 0.5 - 10 | 1.3E+01 | N/A | 9.0E+01 N | N/A | N/A | NO | BSL |
| | 120-82-1 | 1,2,4-Trichlorobenzene | 1.3E+00 J | 1.3E+00 J | UG_L | AS12-12MW10-1206 | 1/21 | 0.5 - 10 | 1.3E+00 | N/A | 6.1E+00 N | 7.0E+01 | MCL | NO | BSL |
| | 96-12-8 | 1,2-Dibromo-3-chloropropane | 3.8E+00 J | 3.8E+00 J | UG_L | AS12-12MW10-1206 | 1/19 | 0.5 - 10 | 3.8E+00 | N/A | 2.0E-04 C | N/A | N/A | YES | ASL |
| | 95-50-1 | 1,2-Dichlorobenzene | 5.8E-01 | 8.7E+01 J | UG_L | AS12-12MW02P-1206 | 6/21 | 0.5 - 10 | 8.7E+01 | N/A | 2.7E+01 N | 6.0E+02 | MCL | YES | ASL |
| | 78-87-5 | 1,2-Dichloropropane | 9.6E-01 | 9.6E-01 | UG_L | AS12-12MW14-0505 | 1/21 | 0.5 - 10 | 9.6E-01 | N/A | 2.6E-01 C | N/A | N/A | YES | ASL |
| | 106-46-7 | 1,4-Dichlorobenzene | 1.8E+00 L | 2.1E+00 | UG_L | AS12-12MW02-0605 | 2/21 | 0.5 - 10 | 2.1E+00 | N/A | 2.8E-01 C | 7.5E+01 | MCL | YES | ASL |
| | 591-78-6 | 2-Hexanone | 2.0E+00 J | 2.0E+00 J | UG_L | AS12-12MW23-0607 | 1/21 | 5 - 10 | 2.0E+00 | N/A | 6.3E+02 N | N/A | N/A | NO | BSL |
| | 67-64-1 | Acetone | 3.6E+00 J | 3.8E+01 L | UG_L | AS12-12MW23-1206 | 3/21 | 5 - 10 | 3.8E+01 | N/A | 5.5E+02 N | N/A | N/A | NO | BSL |
| | 71-43-2 | Benzene | 1.4E+00 L | 1.8E+00 J | UG_L | AS12-12MW02-0605 AS12-12MW10-1206 | 3/21 | 0.5 - 10 | 1.8E+00 | N/A | 3.4E-01 C | 5.0E+00 | MCL | YES | ASL |
| | 75-27-4 | Bromodichloromethane | 6.1E-01 | 6.1E-01 | UG_L | AS12-12MW14-0505 | 1/21 | 0.5 - 10 | 6.1E-01 | N/A | 1.7E-01 C | 8.0E+01 | MCL | YES | ASL |
| | 75-15-0 | Carbon disulfide | 8.7E-01 | 8.8E-01 | UG_L | AS12-12MW01-0605 | 2/21 | 0.5 - 10 | 8.8E-01 | N/A | 1.0E+02 N | N/A | N/A | NO | BSL |
| | 108-90-7 | Chlorobenzene | 2.4E+00 L | 9.4E+01 J | UG_L | AS12-12MW02P-1206 | 4/20 | 0.5 - 10 | 9.4E+01 | N/A | 9.0E+00 N | 1.0E+02 | MCL | YES | ASL |
| | 75-00-3 | Chloroethane | 1.8E+00 | 1.8E+00 | UG_L | AS12-12MW08-0605 | 1/21 | 0.5 - 10 | 1.8E+00 | N/A | 3.6E+00 C | N/A | N/A | NO | BSL |
| | 67-66-3 | Chloroform | 2.2E+00 | 2.2E+00 | UG_L | AS12-12MW14-0505 | 1/21 | 0.5 - 10 | 2.2E+00 | N/A | 1.5E-01 C | 8.0E+01 | MCL | YES | ASL |
| | 110-82-7 | Cyclohexane | 1.3E+00 L | 8.1E+01 | UG_L | AS12-12MW08-0605 | 5/21 | 0.5 - 10 | 8.1E+01 | N/A | 1.2E+03 N | N/A | N/A | NO | BSL |
| | 100-41-4 | Ethylbenzene | 4.5E-01 J | 1.4E+00 J | UG_L | AS12-12MW08-1206 | 2/21 | 0.5 - 10 | 1.4E+00 | N/A | 1.3E+02 N | 7.0E+02 | MCL | NO | BSL |
| | 98-82-8 | Isopropylbenzene | 2.0E+00 | 2.0E+00 | UG_L | AS12-12MW08-0605 | 1/21 | 0.5 - 10 | 2.0E+00 | N/A | 6.6E+01 N | N/A | N/A | NO | BSL |
| | 108-87-2 | Methylcyclohexane | 1.3E+00 | 1.3E+00 | UG_L | AS12-12MW14-0505 | 1/21 | 0.5 - 10 | 1.3E+00 | N/A | 6.3E+02 N | 5.0E+00 | MCL | NO | BSL |
| | 75-09-2 | Methylene chloride | 4.4E+00 | 4.4E+00 | UG_L | AS12-12MW14-0505 | 1/21 | 0.5 - 10 | 4.4E+00 | N/A | 4.1E+00 C | 5.0E+00 | MCL | YES | ASL |
| | 127-18-4 | Tetrachloroethene | 1.4E+00 J | 1.9E+00 L | UG_L | AS12-12MW02-1206 | 2/21 | 0.5 - 10 | 1.9E+00 | N/A | 1.0E-01 C | 5.0E+00 | MCL | YES | ASL |
| | 79-01-6 | Trichloroethene | 4.1E-01 J | 9.4E+00 | UG_L | AS12-12MW18-0505 | 11/21 | 0.5 - 10 | 9.4E+00 | N/A | 2.6E-02 C | 2.0E+00 | MCL | YES | ASL |
| | 75-01-4 | Vinyl chloride | 4.8E-01 J | 7.6E+00 | UG_L | AS12-12MW02-0605 | 5/21 | 0.5 - 10 | 7.6E+00 | N/A | 1.5E-02 C | 7.0E+01 | MCL | YES | ASL |
| | 156-59-2 | cis-1,2-Dichloroethene | 4.0E-01 J | 2.2E+01 | UG_L | AS12-12MW02-0605 | 11/21 | 0.5 - 10 | 2.2E+01 | N/A | 6.1E+00 N | 1.0E+02 | MCL | YES | ASL |
| | 156-60-5 | trans-1,2-Dichloroethene | 4.4E-01 J | 2.1E+00 J | UG_L | AS12-12MW10-1206 | 8/21 | 0.5 - 10 | 2.1E+00 | N/A | 1.1E+01 N | N/A | N/A | NO | BSL |
| | 84-74-2 | Di-n-butylphthalate | 1.5E+00 J | 1.5E+00 J | UG_L | AS12-12MW08-0605 | 1/15 | 10 - 12 | 1.5E+00 | N/A | 3.7E+02 N | 6.0E+00 | MCL | NO | BSL |
| | 117-81-7 | bis(2-Ethylhexyl)phthalate | 2.5E+00 J | 2.5E+00 J | UG_L | AS12-12MW08-0605 | 1/15 | 10 - 12 | 2.5E+00 | 1.1E+00 | 4.8E+00 C | N/A | N/A | NO | BSL |
| | 14797-73-0 | Perchlorate | 2.2E-01 | 3.3E-01 | UG_L | AS12-12MW19-0607 | 2/15 | 0.2 - 5 | 3.3E-01 | N/A | 2.6E+00 N | N/A | N/A | NO | BSL |
| | 7429-90-5 | Aluminum-dissolved | 6.7E+01 J | 6.7E+01 J | UG_L | AS12-12MW01-0605 | 1/15 | 200 - 200 | 6.7E+01 | N/A | 3.7E+03 N | 50-200 | SMCL | NO | BSL |
| | 7440-38-2 | Arsenic-dissolved | 2.5E+00 K | 8.5E+00 J | UG_L | AS12-12MW08-0605 | 4/15 | 10 - 10 | 8.5E+00 | N/A | 4.5E-02 C | 1.0E+01 | MCL | YES | ASL |
| | 7440-39-3 | Barium-dissolved | 2.0E+01 J | 1.6E+02 J | UG_L | AS12-12MW08-0607 | 15/15 | 200 - 200 | 1.6E+02 | 1.2E+01 | 7.3E+02 N | 2.0E+03 | MCL | NO | BSL |
| | 7440-41-7 | Beryllium-dissolved | 2.1E-01 J | 2.4E-01 J | UG_L | AS12-12MW18-0607 | 2/15 | 5 - 5 | 2.4E-01 | N/A | 7.3E+00 N | 4.0E+00 | MCL | NO | BSL |
| | 7440-70-2 | Calcium-dissolved | 8.8E+04 | 3.2E+05 | UG_L | AS12-12MW08-0607 | 15/15 | 5000 - 5000 | 3.2E+05 | 2.8E+05 | N/A | N/A | N/A | NO | NUT |
| | 7440-47-3 | Chromium-dissolved | 9.0E-01 J | 3.1E+00 J | UG_L | AS12-12MW12-0505 | 7/15 | 10 - 10 | 3.1E+00 | N/A | 1.1E+01 N | 1.0E+02 | MCL | NO | BSL |

Table 2.1

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

| Exposure Point | CAS Number | Chemical | Minimum [1] Concentration Qualifier | | Maximum [1] Concentration Qualifier | | Units | Location of Maximum Concentration | Detection Frequency | Range of Detection Limits | Concentration [2] Used for Screening | Background [3] Value | Screening [4] Toxicity Value | | Potential ARAR/TBC Value | Potential ARAR/TBC Source | COPC Flag | Rationale for [5] Contaminant Deletion or Selection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7440-47-3 | Chromium (hexavalent)-dissolved | 1.1E+01 | J | 1.1E+01 | J | UG_L | AS12-12MW08-0605 | 1/9 | 10 - 10 | 1.1E+01 | N/A | 1.1E+01 | N | 1.0E+02 | MCL | YES | ASL |
| | 7440-48-4 | Cobalt-dissolved | 1.4E+00 | J | 1.3E+01 | J | UG_L | AS12-12MW02-0605 | 7/15 | 50 - 50 | 1.3E+01 | N/A | 7.3E+01 | N | N/A | N/A | NO | BSL |
| | 7439-89-6 | Iron-dissolved | 2.4E+01 | J | 3.3E+04 | | UG_L | AS12-12MW08-0605 | 5/15 | 100 - 100 | 3.3E+04 | 4.3E+02 | 2.6E+03 | N | 3.0E+02 | SMCL | YES | ASL |
| | 7439-92-1 | Lead-dissolved | 2.4E+00 | J | 2.4E+00 | J | UG_L | AS12-12MW19-0607 | 1/15 | 3 - 10 | 2.4E+00 | N/A | 1.5E+01 | | 1.5E+01 | AL | NO | BSL |
| | 7439-95-4 | Magnesium-dissolved | 1.8E+04 | | 9.0E+04 | | UG_L | AS12-12MW08-0607 | 15/15 | 5000 - 5000 | 9.0E+04 | 7.9E+04 | N/A | | N/A | N/A | NO | NUT |
| | 7439-96-5 | Manganese-dissolved | 1.8E+00 | J | 5.1E+03 | | UG_L | AS12-12MW02-0605 | 15/15 | 15 - 15 | 5.1E+03 | 1.9E+01 | 7.3E+01 | N | 5.0E+01 | SMCL | YES | ASL |
| | 7440-02-0 | Nickel-dissolved | 2.4E+00 | J | 3.2E+02 | | UG_L | AS12-12MW08-0605 | 15/15 | 40 - 40 | 3.2E+02 | N/A | 7.3E+01 | N | N/A | N/A | YES | ASL |
| | 7440-09-7 | Potassium-dissolved | 6.9E+02 | J | 3.3E+03 | J | UG_L | AS12-12MW08-0607 | 15/15 | 5000 - 5000 | 3.3E+03 | 3.1E+03 | N/A | | N/A | N/A | NO | NUT |
| | 7440-23-5 | Sodium-dissolved | 4.2E+03 | J | 7.1E+04 | | UG_L | AS12-12MW08-0605 | 15/15 | 5000 - 5000 | 7.1E+04 | 3.8E+03 | N/A | | N/A | N/A | NO | NUT |
| | 7440-28-0 | Thallium-dissolved | 6.2E+00 | K | 6.2E+00 | K | UG_L | AS12-12MW08-0607 | 1/15 | 10 - 25 | 6.2E+00 | N/A | 2.6E-01 | N | 2.0E+00 | MCL | YES | ASL |
| | 7440-62-2 | Vanadium-dissolved | 5.9E-01 | J | 1.1E+00 | J | UG_L | AS12-12MW08-0605 | 2/15 | 50 - 50 | 1.1E+00 | N/A | 3.7E+00 | N | N/A | N/A | NO | BSL |
| | 7440-66-6 | Zinc-dissolved | 6.9E+00 | J | 6.9E+00 | J | UG_L | AS12-12MW12-0505 | 1/15 | 20 - 60 | 6.9E+00 | 3.3E+00 | 1.1E+03 | N | 5.0E+02 | SMCL | NO | BSL |

Following USEPA Region III guidance, dissolved inorganic groundwater data used for tap water because an order of magnitude difference noted between dissolved and total results.

[1] Minimum/Maximum detected concentration.

[2] Maximum concentration is used for screening.

[3] Background values are maximum concentration for monitoring well 12MW15.

[4] Risk-Based Concentration Table, October 11, 2007, U.S. EPA Region III, Jennifer Hubbard.

RBC value for methyl isobutyl ketone used as surrogate for 2-hexanone

RBC value for cadmium-water used for cadmium.

RBC value for hexavalent chromium used for total chromium.

Cobalt was withdrawn from October 2005 RBC Table due to expiration of NCEA provisional toxicity values. Value is from the April 2005 RBC table.

The tap water value of 15 ug/L for lead is the action level provided in the Drinking Water Regulations and Health Advisories.

RBC value for manganese-nonfood used for manganese.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered

J = Estimated Value

K = Biased High

L = Biased Low

C = Carcinogenic

N = Noncarcinogenic

MCL = Maximum Contaminant Level, Primary Drinking Water Standards

SMCL = Maximum Contaminant Level, Secondary Drinking Water Standards

AL = Action Level, Safe Drinking Water Act

N/A Not available or not applicable

Table 2.2

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

| Exposure Point | CAS Number | Chemical | Minimum [1] Concentration Qualifier | Maximum [1] Concentration Qualifier | Units | Location of Maximum Concentration | Detection Frequency | Range of Detection Limits | Concentration [2] Used for Screening | Background [3] Value | Screening [4] Toxicity Value | Potential ARAR/TBC Value | Potential ARAR/TBC Source | COPC Flag | Rationale for [5] Contaminant Deletion or Selection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alluvial Aquifer - Water in Excavation Pit | 79-34-5 | 1,1,2,2-Tetrachloroethane | 3.2E+00 J | 3.2E+00 J | UG_L | AS12-12MW10-1206 | 1/21 | 0.5 - 10 | 3.2E+00 | N/A | 5.3E-02 C | N/A | N/A | YES | ASL |
| | 79-00-5 | 1,1,2-Trichloroethane | 3.4E+00 J | 3.4E+00 J | UG_L | AS12-12MW10-1206 | 1/21 | 0.5 - 10 | 3.4E+00 | N/A | 1.9E-01 C | 5.0E+00 | MCL | YES | ASL |
| | 75-34-3 | 1,1-Dichloroethane | 6.4E-01 | 1.3E+01 | UG_L | AS12-12MW01-0605 | 13/21 | 0.5 - 10 | 1.3E+01 | N/A | 9.0E+01 N | N/A | N/A | NO | BSL |
| | 120-82-1 | 1,2,4-Trichlorobenzene | 1.3E+00 J | 1.3E+00 J | UG_L | AS12-12MW10-1206 | 1/21 | 0.5 - 10 | 1.3E+00 | N/A | 6.1E+00 N | 7.0E+01 | MCL | NO | BSL |
| | 96-12-8 | 1,2-Dibromo-3-chloropropane | 3.8E+00 J | 3.8E+00 J | UG_L | AS12-12MW10-1206 | 1/19 | 0.5 - 10 | 3.8E+00 | N/A | 2.0E-04 C | N/A | N/A | YES | ASL |
| | 95-50-1 | 1,2-Dichlorobenzene | 5.8E-01 | 8.7E+01 J | UG_L | AS12-12MW02P-1206 | 6/21 | 0.5 - 10 | 8.7E+01 | N/A | 2.7E+01 N | 6.0E+02 | MCL | YES | ASL |
| | 78-87-5 | 1,2-Dichloropropane | 9.6E-01 | 9.6E-01 | UG_L | AS12-12MW14-0505 | 1/21 | 0.5 - 10 | 9.6E-01 | N/A | 2.6E-01 C | N/A | N/A | YES | ASL |
| | 106-46-7 | 1,4-Dichlorobenzene | 1.8E+00 L | 2.1E+00 | UG_L | AS12-12MW02-0605 | 2/21 | 0.5 - 10 | 2.1E+00 | N/A | 2.8E-01 C | 7.5E+01 | MCL | YES | ASL |
| | 591-78-6 | 2-Hexanone | 2.0E+00 J | 2.0E+00 J | UG_L | AS12-12MW23-0607 | 1/21 | 5 - 10 | 2.0E+00 | N/A | 6.3E+02 N | N/A | N/A | NO | BSL |
| | 67-64-1 | Acetone | 3.6E+00 J | 3.8E+01 L | UG_L | AS12-12MW23-1206 | 3/21 | 5 - 10 | 3.8E+01 | N/A | 5.5E+02 N | N/A | N/A | NO | BSL |
| | 71-43-2 | Benzene | 1.4E+00 L | 1.8E+00 J | UG_L | AS12-12MW02-0605 AS12-12MW10-1206 | 3/21 | 0.5 - 10 | 1.8E+00 | N/A | 3.4E-01 C | 5.0E+00 | MCL | YES | ASL |
| | 75-27-4 | Bromodichloromethane | 6.1E-01 | 6.1E-01 | UG_L | AS12-12MW14-0505 | 1/21 | 0.5 - 10 | 6.1E-01 | N/A | 1.7E-01 C | 8.0E+01 | MCL | YES | ASL |
| | 75-15-0 | Carbon disulfide | 8.7E-01 | 8.8E-01 | UG_L | AS12-12MW01-0605 | 2/21 | 0.5 - 10 | 8.8E-01 | N/A | 1.0E+02 N | N/A | N/A | NO | BSL |
| | 108-90-7 | Chlorobenzene | 2.4E+00 L | 9.4E+01 J | UG_L | AS12-12MW02P-1206 | 4/20 | 0.5 - 10 | 9.4E+01 | N/A | 9.0E+00 N | 1.0E+02 | MCL | YES | ASL |
| | 75-00-3 | Chloroethane | 1.8E+00 | 1.8E+00 | UG_L | AS12-12MW08-0605 | 1/21 | 0.5 - 10 | 1.8E+00 | N/A | 3.6E+00 C | N/A | N/A | NO | BSL |
| | 67-66-3 | Chloroform | 2.2E+00 | 2.2E+00 | UG_L | AS12-12MW14-0505 | 1/21 | 0.5 - 10 | 2.2E+00 | N/A | 1.5E-01 C | 8.0E+01 | MCL | YES | ASL |
| | 110-82-7 | Cyclohexane | 1.3E+00 L | 8.1E+01 | UG_L | AS12-12MW08-0605 | 5/21 | 0.5 - 10 | 8.1E+01 | N/A | 1.2E+03 N | N/A | N/A | NO | BSL |
| | 100-41-4 | Ethylbenzene | 4.5E-01 J | 1.4E+00 J | UG_L | AS12-12MW08-1206 | 2/21 | 0.5 - 10 | 1.4E+00 | N/A | 1.3E+02 N | 7.0E+02 | MCL | NO | BSL |
| | 98-82-8 | Isopropylbenzene | 2.0E+00 | 2.0E+00 | UG_L | AS12-12MW08-0605 | 1/21 | 0.5 - 10 | 2.0E+00 | N/A | 6.6E+01 N | N/A | N/A | NO | BSL |
| | 108-87-2 | Methylcyclohexane | 1.3E+00 | 1.3E+00 | UG_L | AS12-12MW14-0505 | 1/21 | 0.5 - 10 | 1.3E+00 | N/A | 6.3E+02 N | 5.0E+00 | MCL | NO | BSL |
| | 75-09-2 | Methylene chloride | 4.4E+00 | 4.4E+00 | UG_L | AS12-12MW14-0505 | 1/21 | 0.5 - 10 | 4.4E+00 | N/A | 4.1E+00 C | 5.0E+00 | MCL | YES | ASL |
| | 127-18-4 | Tetrachloroethene | 1.4E+00 J | 1.9E+00 L | UG_L | AS12-12MW02-1206 | 2/21 | 0.5 - 10 | 1.9E+00 | N/A | 1.0E-01 C | 5.0E+00 | MCL | YES | ASL |
| | 79-01-6 | Trichloroethene | 4.1E-01 J | 9.4E+00 | UG_L | AS12-12MW18-0505 | 11/21 | 0.5 - 10 | 9.4E+00 | N/A | 2.6E-02 C | 2.0E+00 | MCL | YES | ASL |
| | 75-01-4 | Vinyl chloride | 4.8E-01 J | 7.6E+00 | UG_L | AS12-12MW02-0605 | 5/21 | 0.5 - 10 | 7.6E+00 | N/A | 1.5E-02 C | 7.0E+01 | MCL | YES | ASL |
| | 156-59-2 | cis-1,2-Dichloroethene | 4.0E-01 J | 2.2E+01 | UG_L | AS12-12MW02-0605 | 11/21 | 0.5 - 10 | 2.2E+01 | N/A | 6.1E+00 N | 1.0E+02 | MCL | YES | ASL |
| | 156-60-5 | trans-1,2-Dichloroethene | 4.4E-01 J | 2.1E+00 J | UG_L | AS12-12MW10-1206 | 8/21 | 0.5 - 10 | 2.1E+00 | N/A | 1.1E+01 N | N/A | N/A | NO | BSL |
| | 84-74-2 | Di-n-butylphthalate | 1.5E+00 J | 1.5E+00 J | UG_L | AS12-12MW08-0605 | 1/15 | 10 - 12 | 1.5E+00 | N/A | 3.7E+02 N | 6.0E+00 | MCL | NO | BSL |
| | 117-81-7 | bis(2-Ethylhexyl)phthalate | 2.5E+00 J | 2.5E+00 J | UG_L | AS12-12MW08-0605 | 1/15 | 10 - 12 | 2.5E+00 | 1.1E+00 | 4.8E+00 C | N/A | N/A | NO | BSL |
| | 14797-73-0 | Perchlorate | 2.2E-01 | 3.3E-01 | UG_L | AS12-12MW19-0607 | 2/15 | 0.2 - 5 | 3.3E-01 | N/A | 2.6E+00 N | N/A | N/A | NO | BSL |
| | 7429-90-5 | Aluminum | 1.3E+02 J | 1.7E+04 | UG_L | AS12-12MW14-0505 | 14/15 | 200 - 200 | 1.7E+04 | 7.0E+01 | 3.7E+03 N | 50-200 | SMCL | YES | ASL |
| | 7440-38-2 | Arsenic | 3.7E+00 J | 1.2E+01 | UG_L | AS12-12MW08-0605 | 6/15 | 10 - 10 | 1.2E+01 | 1.6E+01 | 4.5E-02 C | 1.0E+01 | MCL | YES | ASL |
| | 7440-39-3 | Barium | 2.4E+01 J | 1.7E+02 J | UG_L | AS12-12MW08-0607 | 15/15 | 200 - 200 | 1.7E+02 | 1.4E+01 | 7.3E+02 N | 2.0E+03 | MCL | NO | BSL |
| | 7440-41-7 | Beryllium | 1.0E-01 J | 8.5E-01 J | UG_L | AS12-12MW14-0505 | 10/15 | 5 - 5 | 8.5E-01 | 2.8E-01 | 7.3E+00 N | 4.0E+00 | MCL | NO | BSL |
| | 7440-43-9 | Cadmium | 5.7E-01 J | 6.2E-01 J | UG_L | AS12-12MW14-0505 | 2/15 | 5 - 5 | 6.2E-01 | 2.8E+05 | 1.8E+00 N | 5.0E+00 | MCL | NO | BSL |
| | 7440-70-2 | Calcium | 8.9E+04 | 3.2E+05 | UG_L | AS12-12MW08-0607 | 15/15 | 5000 - 5000 | 3.2E+05 | 2.8E-01 | N/A | N/A | N/A | NO | NUT |

Table 2.2

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

| Exposure Point | CAS Number | Chemical | Minimum [1] Concentration Qualifier | Maximum [1] Concentration Qualifier | Units | Location of Maximum Concentration | Detection Frequency | Range of Detection Limits | Concentration [2] Used for Screening | Background [3] Value | Screening [4] Toxicity Value | Potential ARAR/TBC Value | Potential ARAR/TBC Source | COPC Flag | Rationale for [5] Contaminant Deletion or Selection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7440-47-3 | Chromium | 2.4E+00 J | 3.7E+01 | UG_L | AS12-12MW14-0505 | 7/15 | 10 - 10 | 3.7E+01 | N/A | 1.1E+01 N | 1.0E+02 | MCL | YES | ASL |
| | 18540-29-9 | Chromium (hexavalent) | 1.6E+01 | 6.8E+01 | UG_L | AS12-12MW16-0605 | 5/9 | 10 - 10 | 6.8E+01 | N/A | 1.1E+01 N | 1.0E+02 | MCL | YES | ASL |
| | 7440-48-4 | Cobalt | 2.8E+00 J | 1.4E+01 J | UG_L | AS12-12MW02-0605 | 10/15 | 50 - 50 | 1.4E+01 | N/A | 7.3E+01 N | N/A | N/A | NO | BSL |
| | 7440-50-8 | Copper | 1.2E+01 J | 1.9E+01 J | UG_L | AS12-12MW14-0505 | 2/15 | 25 - 25 | 1.9E+01 | N/A | 1.5E+02 N | 1.3E+03 | AL | NO | BSL |
| | 7439-89-6 | Iron | 4.1E+02 | 3.6E+04 | UG_L | AS12-12MW08-0605 | 14/15 | 100 - 100 | 3.6E+04 | 1.4E+04 | 2.6E+03 N | 3.0E+02 | SMCL | YES | ASL |
| | 7439-92-1 | Lead | 2.2E+00 J | 1.5E+01 | UG_L | AS12-12MW14-0505 | 8/15 | 3 - 10 | 1.5E+01 | N/A | 1.5E+01 | 1.5E+01 | AL | NO | BSL |
| | 7439-95-4 | Magnesium | 1.8E+04 | 9.0E+04 | UG_L | AS12-12MW08-0607 | 15/15 | 5000 - 5000 | 9.0E+04 | 8.0E+04 | N/A | N/A | N/A | NO | NUT |
| | 7439-96-5 | Manganese | 2.1E+01 | 5.1E+03 | UG_L | AS12-12MW02-0605 | 15/15 | 15 - 15 | 5.1E+03 | 2.1E+01 | 7.3E+01 N | 5.0E+01 | SMCL | YES | ASL |
| | 7440-02-0 | Nickel | 3.7E+00 J | 3.4E+02 | UG_L | AS12-12MW08-0605 | 11/15 | 40 - 40 | 3.4E+02 | N/A | 7.3E+01 N | N/A | N/A | YES | ASL |
| | 7440-09-7 | Potassium | 9.6E+02 J | 6.4E+03 | UG_L | AS12-12MW14-0505 | 15/15 | 5000 - 5000 | 6.4E+03 | 3.2E+03 | N/A | N/A | N/A | NO | NUT |
| | 7782-49-2 | Selenium | 3.0E+00 J | 3.0E+00 J | UG_L | AS12-12MW14-0505 | 1/15 | 5 - 35 | 3.0E+00 | 4.2E+03 | 1.8E+01 N | 5.0E+01 | MCL | NO | BSL |
| | 7440-23-5 | Sodium | 4.3E+03 J | 7.4E+04 | UG_L | AS12-12MW08-0605 | 15/15 | 5000 - 5000 | 7.4E+04 | N/A | N/A | N/A | N/A | NO | NUT |
| | 7440-62-2 | Vanadium | 5.4E-01 J | 3.0E+01 J | UG_L | AS12-12MW14-0505 | 13/15 | 50 - 50 | 3.0E+01 | N/A | 3.7E+00 N | N/A | N/A | YES | ASL |
| | 7440-66-6 | Zinc | 7.0E+00 J | 5.1E+01 | UG_L | AS12-12MW10-0505 | 4/15 | 20 - 60 | 5.1E+01 | N/A | 1.1E+03 N | 5.0E+02 | SMCL | NO | BSL |

Total inorganic groundwater data used for water in excavation pit because construction worker would be exposed to the water in the excavation pit that has not been filtered.

[1] Minimum/Maximum detected concentration.

[2] Maximum concentration is used for screening.

[3] Background values from alluvial well 12MW15.

[4] Risk-Based Concentration Table, October 11, 2007, U.S. EPA Region III, Jennifer Hubbard.

RBC value for methyl isobutyl ketone used as surrogate for 2-hexanone

RBC value for cadmium-water used for cadmium.

RBC value for hexavalent chromium used for total chromium.

Cobalt was withdrawn from October 2005 RBC Table due to expiration of NCEA provisional toxicity values. Value is from the April 2005 RBC table.

The tap water value of 15 ug/L for lead is the action level provided in the Drinking Water Regulations and Health Advisories.

RBC value for manganese-nonfood used for manganese.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered

J = Estimated Value

K = Biased High

L = Biased Low

C = Carcinogenic

N = Noncarcinogenic

MCL = Maximum Contaminant Level, Primary Drinking Water Standards

SMCL = Maximum Contaminant Level, Secondary Drinking Water Standards

AL = Action Level, Safe Drinking Water Act

N/A Not available or not applicable

Table 2.3

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air

| Exposure Point | CAS Number | Chemical | Minimum [1] Concentration Qualifier | Maximum [1] Concentration Qualifier | Units | Location of Maximum Concentration | Detection Frequency | Range of Detection Limits | Concentration [2] Used for Screening | Background [3] Value | Screening [4] Toxicity Value | Potential ARAR/TBC Value | Potential ARAR/TBC Source | COPC Flag | Rationale for [5] Contaminant Deletion or Selection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alluvial Aquifer - Water Vapors at Showerhead | 79-34-5 | 1,1,2,2-Tetrachloroethane | 3.2E+00 J | 3.2E+00 J | UG_L | AS12-12MW10-1206 | 1/21 | 0.5 - 10 | 3.2E+00 | N/A | 5.3E-02 C | N/A | N/A | YES | ASL |
| | 79-00-5 | 1,1,2-Trichloroethane | 3.4E+00 J | 3.4E+00 J | UG_L | AS12-12MW10-1206 | 1/21 | 0.5 - 10 | 3.4E+00 | N/A | 1.9E-01 C | 5.0E+00 | MCL | YES | ASL |
| | 75-34-3 | 1,1-Dichloroethane | 6.4E-01 | 1.3E+01 | UG_L | AS12-12MW01-0605 | 13/21 | 0.5 - 10 | 1.3E+01 | N/A | 9.0E+01 N | N/A | N/A | NO | BSL |
| | 120-82-1 | 1,2,4-Trichlorobenzene | 1.3E+00 J | 1.3E+00 J | UG_L | AS12-12MW10-1206 | 1/21 | 0.5 - 10 | 1.3E+00 | N/A | 6.1E+00 N | 7.0E+01 | MCL | NO | BSL |
| | 96-12-8 | 1,2-Dibromo-3-chloropropane | 3.8E+00 J | 3.8E+00 J | UG_L | AS12-12MW10-1206 | 1/19 | 0.5 - 10 | 3.8E+00 | N/A | 2.0E-04 C | N/A | N/A | YES | ASL |
| | 95-50-1 | 1,2-Dichlorobenzene | 5.8E-01 | 8.7E+01 J | UG_L | AS12-12MW02P-1206 | 6/21 | 0.5 - 10 | 8.7E+01 | N/A | 2.7E+01 N | 6.0E+02 | MCL | YES | ASL |
| | 78-87-5 | 1,2-Dichloropropane | 9.6E-01 | 9.6E-01 | UG_L | AS12-12MW14-0505 | 1/21 | 0.5 - 10 | 9.6E-01 | N/A | 2.6E-01 C | N/A | N/A | YES | ASL |
| | 106-46-7 | 1,4-Dichlorobenzene | 1.8E+00 L | 2.1E+00 | UG_L | AS12-12MW02-0605 | 2/21 | 0.5 - 10 | 2.1E+00 | N/A | 2.8E-01 C | 7.5E+01 | MCL | YES | ASL |
| | 591-78-6 | 2-Hexanone | 2.0E+00 J | 2.0E+00 J | UG_L | AS12-12MW23-0607 | 1/21 | 5 - 10 | 2.0E+00 | N/A | 6.3E+02 N | N/A | N/A | NO | BSL |
| | 67-64-1 | Acetone | 3.6E+00 J | 3.8E+01 L | UG_L | AS12-12MW23-1206 | 3/21 | 5 - 10 | 3.8E+01 | N/A | 5.5E+02 N | N/A | N/A | NO | BSL |
| | 71-43-2 | Benzene | 1.4E+00 L | 1.8E+00 J | UG_L | AS12-12MW02-0605 AS12-12MW10-1206 | 3/21 | 0.5 - 10 | 1.8E+00 | N/A | 3.4E-01 C | 5.0E+00 | MCL | YES | ASL |
| | 75-27-4 | Bromodichloromethane | 6.1E-01 | 6.1E-01 | UG_L | AS12-12MW14-0505 | 1/21 | 0.5 - 10 | 6.1E-01 | N/A | 1.7E-01 C | 8.0E+01 | MCL | YES | ASL |
| | 75-15-0 | Carbon disulfide | 8.7E-01 | 8.8E-01 | UG_L | AS12-12MW01-0605 | 2/21 | 0.5 - 10 | 8.8E-01 | N/A | 1.0E+02 N | N/A | N/A | NO | BSL |
| | 108-90-7 | Chlorobenzene | 2.4E+00 L | 9.4E+01 J | UG_L | AS12-12MW02P-1206 | 4/20 | 0.5 - 10 | 9.4E+01 | N/A | 9.0E+00 N | 1.0E+02 | MCL | YES | ASL |
| | 75-00-3 | Chloroethane | 1.8E+00 | 1.8E+00 | UG_L | AS12-12MW08-0605 | 1/21 | 0.5 - 10 | 1.8E+00 | N/A | 3.6E+00 C | N/A | N/A | NO | BSL |
| | 67-66-3 | Chloroform | 2.2E+00 | 2.2E+00 | UG_L | AS12-12MW14-0505 | 1/21 | 0.5 - 10 | 2.2E+00 | N/A | 1.5E-01 C | 8.0E+01 | MCL | YES | ASL |
| | 110-82-7 | Cyclohexane | 1.3E+00 L | 8.1E+01 | UG_L | AS12-12MW08-0605 | 5/21 | 0.5 - 10 | 8.1E+01 | N/A | 1.2E+03 N | N/A | N/A | NO | BSL |
| | 100-41-4 | Ethylbenzene | 4.5E-01 J | 1.4E+00 J | UG_L | AS12-12MW08-1206 | 2/21 | 0.5 - 10 | 1.4E+00 | N/A | 1.3E+02 N | 7.0E+02 | MCL | NO | BSL |
| | 98-82-8 | Isopropylbenzene | 2.0E+00 | 2.0E+00 | UG_L | AS12-12MW08-0605 | 1/21 | 0.5 - 10 | 2.0E+00 | N/A | 6.6E+01 N | N/A | N/A | NO | BSL |
| | 108-87-2 | Methylcyclohexane | 1.3E+00 | 1.3E+00 | UG_L | AS12-12MW14-0505 | 1/21 | 0.5 - 10 | 1.3E+00 | N/A | 6.3E+02 N | 5.0E+00 | MCL | NO | BSL |
| | 75-09-2 | Methylene chloride | 4.4E+00 | 4.4E+00 | UG_L | AS12-12MW14-0505 | 1/21 | 0.5 - 10 | 4.4E+00 | N/A | 4.1E+00 C | 5.0E+00 | MCL | YES | ASL |
| | 127-18-4 | Tetrachloroethene | 1.4E+00 J | 1.9E+00 L | UG_L | AS12-12MW02-1206 | 2/21 | 0.5 - 10 | 1.9E+00 | N/A | 1.0E-01 C | 5.0E+00 | MCL | YES | ASL |
| | 79-01-6 | Trichloroethene | 4.1E-01 J | 9.4E+00 | UG_L | AS12-12MW18-0505 | 11/21 | 0.5 - 10 | 9.4E+00 | N/A | 2.6E-02 C | 2.0E+00 | MCL | YES | ASL |
| | 75-01-4 | Vinyl chloride | 4.8E-01 J | 7.6E+00 | UG_L | AS12-12MW02-0605 | 5/21 | 0.5 - 10 | 7.6E+00 | N/A | 1.5E-02 C | 7.0E+01 | MCL | YES | ASL |
| | 156-59-2 | cis-1,2-Dichloroethene | 4.0E-01 J | 2.2E+01 | UG_L | AS12-12MW02-0605 | 11/21 | 0.5 - 10 | 2.2E+01 | N/A | 6.1E+00 N | 1.0E+02 | MCL | YES | ASL |
| | 156-60-5 | trans-1,2-Dichloroethene | 4.4E-01 J | 2.1E+00 J | UG_L | AS12-12MW10-1206 | 8/21 | 0.5 - 10 | 2.1E+00 | N/A | 1.1E+01 N | N/A | N/A | NO | BSL |

[1] Minimum/Maximum detected concentration.

[2] Maximum concentration is used for screening.

[3] Background values are maximum concentration for monitoring well 12MW15.

[4] Risk-Based Concentration Table, October 11, 2007, U.S. EPA Region III, Jennifer Hubbard.

RBC value for methyl isobutyl ketone used as surrogate for 2-hexanone

RBC value for cadmium-water used for cadmium.

RBC value for hexavalent chromium used for total chromium.

Cobalt was withdrawn from October 2005 RBC Table due to expiration of NCEA provisional toxicity values. Value is from the April 2005 RBC table.

The tap water value of 15 ug/L for lead is the action level provided in the Drinking Water Regulations and Health Advisories.

RBC value for manganese-nonfood used for manganese.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered

J = Estimated Value

K = Biased High

L = Biased Low

C = Carcinogenic

N = Noncarcinogenic

MCL = Maximum Contaminant Level, Primary Drinking Water Standards

SMCL = Maximum Contaminant Level, Secondary Drinking Water Standards

AL = Action Level, Safe Drinking Water Act

N/A Not available or not applicable

Table 2.4

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air

| Exposure Point | CAS Number | Chemical | Minimum [1] Concentration Qualifier | Maximum [1] Concentration Qualifier | Units | Location of Maximum Concentration | Detection Frequency | Range of Detection Limits | Concentration [2] Used for Screening | Background [3] Value | Screening [4] Toxicity Value | Potential ARAR/TBC Value | Potential ARAR/TBC Source | COPC Flag | Rationale for [5] Contaminant Deletion or Selection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alluvial Aquifer - Volatilization from Water in Excavation Pit | 79-34-5 | 1,1,2,2-Tetrachloroethane | 3.2E+00 J | 3.2E+00 J | UG_L | AS12-12MW10-1206 | 1/21 | 0.5 - 10 | 3.2E+00 | N/A | 5.3E-02 C | N/A | N/A | YES | ASL |
| | 79-00-5 | 1,1,2-Trichloroethane | 3.4E+00 J | 3.4E+00 J | UG_L | AS12-12MW10-1206 | 1/21 | 0.5 - 10 | 3.4E+00 | N/A | 1.9E-01 C | 5.0E+00 | MCL | YES | ASL |
| | 75-34-3 | 1,1-Dichloroethane | 6.4E-01 | 1.3E+01 | UG_L | AS12-12MW01-0605 | 13/21 | 0.5 - 10 | 1.3E+01 | N/A | 9.0E+01 N | N/A | N/A | NO | BSL |
| | 120-82-1 | 1,2,4-Trichlorobenzene | 1.3E+00 J | 1.3E+00 J | UG_L | AS12-12MW10-1206 | 1/21 | 0.5 - 10 | 1.3E+00 | N/A | 6.1E+00 N | 7.0E+01 | MCL | NO | BSL |
| | 96-12-8 | 1,2-Dibromo-3-chloropropane | 3.8E+00 J | 3.8E+00 J | UG_L | AS12-12MW10-1206 | 1/19 | 0.5 - 10 | 3.8E+00 | N/A | 2.0E-04 C | N/A | N/A | YES | ASL |
| | 95-50-1 | 1,2-Dichlorobenzene | 5.8E-01 | 8.7E+01 J | UG_L | AS12-12MW02P-1206 | 6/21 | 0.5 - 10 | 8.7E+01 | N/A | 2.7E+01 N | 6.0E+02 | MCL | YES | ASL |
| | 78-87-5 | 1,2-Dichloropropane | 9.6E-01 | 9.6E-01 | UG_L | AS12-12MW14-0505 | 1/21 | 0.5 - 10 | 9.6E-01 | N/A | 2.6E-01 C | N/A | N/A | YES | ASL |
| | 106-46-7 | 1,4-Dichlorobenzene | 1.8E+00 L | 2.1E+00 | UG_L | AS12-12MW02-0605 | 2/21 | 0.5 - 10 | 2.1E+00 | N/A | 2.8E-01 C | 7.5E+01 | MCL | YES | ASL |
| | 591-78-6 | 2-Hexanone | 2.0E+00 J | 2.0E+00 J | UG_L | AS12-12MW23-0607 | 1/21 | 5 - 10 | 2.0E+00 | N/A | 6.3E+02 N | N/A | N/A | NO | BSL |
| | 67-64-1 | Acetone | 3.6E+00 J | 3.8E+01 L | UG_L | AS12-12MW23-1206 | 3/21 | 5 - 10 | 3.8E+01 | N/A | 5.5E+02 N | N/A | N/A | NO | BSL |
| | 71-43-2 | Benzene | 1.4E+00 L | 1.8E+00 J | UG_L | AS12-12MW02-0605 AS12-12MW10-1206 | 3/21 | 0.5 - 10 | 1.8E+00 | N/A | 3.4E-01 C | 5.0E+00 | MCL | YES | ASL |
| | 75-27-4 | Bromodichloromethane | 6.1E-01 | 6.1E-01 | UG_L | AS12-12MW14-0505 | 1/21 | 0.5 - 10 | 6.1E-01 | N/A | 1.7E-01 C | 8.0E+01 | MCL | YES | ASL |
| | 75-15-0 | Carbon disulfide | 8.7E-01 | 8.8E-01 | UG_L | AS12-12MW01-0605 | 2/21 | 0.5 - 10 | 8.8E-01 | N/A | 1.0E+02 N | N/A | N/A | NO | BSL |
| | 108-90-7 | Chlorobenzene | 2.4E+00 L | 9.4E+01 J | UG_L | AS12-12MW02P-1206 | 4/20 | 0.5 - 10 | 9.4E+01 | N/A | 9.0E+00 N | 1.0E+02 | MCL | YES | ASL |
| | 75-00-3 | Chloroethane | 1.8E+00 | 1.8E+00 | UG_L | AS12-12MW08-0605 | 1/21 | 0.5 - 10 | 1.8E+00 | N/A | 3.6E+00 C | N/A | N/A | NO | BSL |
| | 67-66-3 | Chloroform | 2.2E+00 | 2.2E+00 | UG_L | AS12-12MW14-0505 | 1/21 | 0.5 - 10 | 2.2E+00 | N/A | 1.5E-01 C | 8.0E+01 | MCL | YES | ASL |
| | 110-82-7 | Cyclohexane | 1.3E+00 L | 8.1E+01 | UG_L | AS12-12MW08-0605 | 5/21 | 0.5 - 10 | 8.1E+01 | N/A | 1.2E+03 N | N/A | N/A | NO | BSL |
| | 100-41-4 | Ethylbenzene | 4.5E-01 J | 1.4E+00 J | UG_L | AS12-12MW08-1206 | 2/21 | 0.5 - 10 | 1.4E+00 | N/A | 1.3E+02 N | 7.0E+02 | MCL | NO | BSL |
| | 98-82-8 | Isopropylbenzene | 2.0E+00 | 2.0E+00 | UG_L | AS12-12MW08-0605 | 1/21 | 0.5 - 10 | 2.0E+00 | N/A | 6.6E+01 N | N/A | N/A | NO | BSL |
| | 108-87-2 | Methylcyclohexane | 1.3E+00 | 1.3E+00 | UG_L | AS12-12MW14-0505 | 1/21 | 0.5 - 10 | 1.3E+00 | N/A | 6.3E+02 N | 5.0E+00 | MCL | NO | BSL |
| | 75-09-2 | Methylene chloride | 4.4E+00 | 4.4E+00 | UG_L | AS12-12MW14-0505 | 1/21 | 0.5 - 10 | 4.4E+00 | N/A | 4.1E+00 C | 5.0E+00 | MCL | YES | ASL |
| | 127-18-4 | Tetrachloroethene | 1.4E+00 J | 1.9E+00 L | UG_L | AS12-12MW02-1206 | 2/21 | 0.5 - 10 | 1.9E+00 | N/A | 1.0E-01 C | 5.0E+00 | MCL | YES | ASL |
| | 79-01-6 | Trichloroethene | 4.1E-01 J | 9.4E+00 | UG_L | AS12-12MW18-0505 | 11/21 | 0.5 - 10 | 9.4E+00 | N/A | 2.6E-02 C | 2.0E+00 | MCL | YES | ASL |
| | 75-01-4 | Vinyl chloride | 4.8E-01 J | 7.6E+00 | UG_L | AS12-12MW02-0605 | 5/21 | 0.5 - 10 | 7.6E+00 | N/A | 1.5E-02 C | 7.0E+01 | MCL | YES | ASL |
| | 156-59-2 | cis-1,2-Dichloroethene | 4.0E-01 J | 2.2E+01 | UG_L | AS12-12MW02-0605 | 11/21 | 0.5 - 10 | 2.2E+01 | N/A | 6.1E+00 N | 1.0E+02 | MCL | YES | ASL |
| | 156-60-5 | trans-1,2-Dichloroethene | 4.4E-01 J | 2.1E+00 J | UG_L | AS12-12MW10-1206 | 8/21 | 0.5 - 10 | 2.1E+00 | N/A | 1.1E+01 N | N/A | N/A | NO | BSL |

[1] Minimum/Maximum detected concentration.

[2] Maximum concentration is used for screening.

[3] Background values from alluvial well 12MW15.

[4] Risk-Based Concentration Table, October 11, 2007, U.S. EPA Region III, Jennifer Hubbard.
RBC value for methyl isobutyl ketone used as surrogate for 2-hexanone
RBC value for cadmium-water used for cadmium.
RBC value for hexavalent chromium used for total chromium.
Cobalt was withdrawn from October 2005 RBC Table due to expiration of NCEA provisional toxicity values. Value is from the April 2005 RBC table.
The tap water value of 15 ug/L for lead is the action level provided in the Drinking Water Regulations and Health Advisories.
RBC value for manganese-nonfood used for manganese.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
J = Estimated Value
K = Biased High
L = Biased Low
C = Carcinogenic
N = Noncarcinogenic
MCL = Maximum Contaminant Level, Primary Drinking Water Standards
SMCL = Maximum Contaminant Level, Secondary Drinking Water Standards
AL = Action Level, Safe Drinking Water Act
N/A Not available or not applicable

Table 2.5

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

| Exposure Point | CAS Number | Chemical | Minimum [1] Concentration Qualifier | Maximum [1] Concentration Qualifier | Units | Location of Maximum Concentration | Detection Frequency | Range of Detection Limits | Concentration [2] Used for Screening | Background [3] Value | Screening [4] Toxicity Value | Potential ARAR/TBC Value | Potential ARAR/TBC Source | COPC Flag | Rationale for [5] Contaminant Deletion or Selection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bedrock Aquifer-Tap Water | 71-55-6 | 1,1,1-Trichloroethane | 1.3E+00 | 2.0E+00 | UG_L | AS12-12MW09S-0605 | 2/37 | 0.5 - 10 | 2.0E+00 | N/A | 9.1E+02 N | 2.0E+02 | MCL | NO | BSL |
| | 76-13-1 | 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | 3.6E+00 | 3.6E+00 | UG_L | AS12-12MW13S-0505 | 1/37 | 0.5 - 10 | 3.6E+00 | N/A | 5.9E+03 N | N/A | N/A | NO | BSL |
| | 75-34-3 | 1,1-Dichloroethane | 4.5E-01 J | 9.0E+00 | UG_L | AS12-12MW09S-0607 | 6/37 | 0.5 - 10 | 9.0E+00 | N/A | 9.0E+01 N | N/A | N/A | NO | BSL |
| | 75-35-4 | 1,1-Dichloroethene | 4.3E-01 J | 6.1E-01 | UG_L | AS12-12MW09S-0607 | 2/37 | 0.5 - 10 | 6.1E-01 | N/A | 3.5E+01 N | 7.0E+00 | MCL | NO | BSL |
| | 78-93-3 | 2-Butanone | 7.9E+00 J | 7.9E+00 J | UG_L | AS12-12MW20D-1206 | 1/37 | 5 - 10 | 7.9E+00 | N/A | 7.0E+02 N | N/A | N/A | NO | BSL |
| | 591-78-6 | 2-Hexanone | 2.2E+00 J | 3.3E+00 J | UG_L | AS12-12MW09D-0607 | 4/37 | 5 - 10 | 3.3E+00 | N/A | 6.3E+02 N | N/A | N/A | NO | BSL |
| | 67-64-1 | Acetone | 2.2E+00 J | 1.6E+01 L | UG_L | AS12-12MW22D-1206 | 5/37 | 5 - 10 | 1.6E+01 | 9.5E+00 | 5.5E+02 N | N/A | N/A | NO | BSL |
| | 74-97-5 | Bromochloromethane | 1.1E+00 | 1.1E+00 | UG_L | AS12-12MW09S-0605 | 1/26 | 0.5 - 0.5 | 1.1E+00 | N/A | 4.1E+00 C | N/A | N/A | NO | BSL |
| | 75-15-0 | Carbon disulfide | 4.9E-01 J | 1.0E+01 UL | UG_L | AS12-12MW20D-1206, AS12-12MW22D-1206 | 5/37 | 0.5 - 10 | 1.0E+01 | N/A | 1.0E+02 N | N/A | N/A | NO | BSL |
| | 74-87-3 | Chloromethane | 1.4E+00 | 1.4E+00 | UG_L | AS12-12MW09S-0605 | 1/37 | 0.5 - 10 | 1.4E+00 | N/A | 1.9E+01 N | N/A | N/A | NO | BSL |
| | 110-82-7 | Cyclohexane | 5.2E-01 | 2.8E+00 | UG_L | AS12-12MW09S-0607 | 5/37 | 0.5 - 10 | 2.8E+00 | N/A | 1.2E+03 N | N/A | N/A | NO | BSL |
| | 100-41-4 | Ethylbenzene | 4.2E-01 J | 4.2E-01 J | UG_L | AS12-12MW09S-0607 | 1/37 | 0.5 - 10 | 4.2E-01 | N/A | 1.3E+02 N | 7.0E+02 | MCL | NO | BSL |
| | 75-09-2 | Methylene chloride | 8.2E-01 | 4.4E+03 | UG_L | AS12-12MW09S-0605 | 8/37 | 0.5 - 250 | 4.4E+03 | N/A | 4.1E+00 C | 5.0E+00 | MCL | YES | ASL |
| | 127-18-4 | Tetrachloroethene | 1.4E+00 | 1.4E+00 | UG_L | AS12-12MW09S-0605 | 1/37 | 0.5 - 10 | 1.4E+00 | N/A | 1.0E-01 C | 5.0E+00 | MCL | YES | ASL |
| | 108-88-3 | Toluene | 4.5E-01 J | 3.1E+00 | UG_L | AS12-12MW09S-0605 | 4/37 | 0.5 - 10 | 3.1E+00 | 1.0E-01 | 2.3E+02 N | 1.0E+02 | MCL | NO | BSL |
| | 79-01-6 | Trichloroethene | 3.3E-01 J | 8.9E+00 | UG_L | AS12-12MW07S-0505 | 18/37 | 0.5 - 10 | 8.9E+00 | N/A | 2.6E-02 C | 5.0E+00 | MCL | YES | ASL |
| | 1330-20-7 | Xylene, total | 6.2E-01 | 6.2E-01 | UG_L | AS12-12MW09S-0607 | 1/37 | 0.5 - 10 | 6.2E-01 | N/A | 2.1E+01 N | 1.0E+04 | MCL | NO | BSL |
| | 156-59-2 | cis-1,2-Dichloroethene | 1.2E+00 | 1.1E+01 | UG_L | AS12-12MW09S-0607 | 6/37 | 0.5 - 10 | 1.1E+01 | N/A | 6.1E+00 N | 7.0E+01 | MCL | YES | ASL |
| | 156-60-5 | trans-1,2-Dichloroethene | 2.2E+00 J | 3.1E+00 | UG_L | AS12-12MW09S-0607 | 3/37 | 0.5 - 10 | 3.1E+00 | N/A | 1.1E+01 N | 1.0E+02 | MCL | NO | BSL |
| | 105-60-2 | Caprolactam | 1.2E+00 J | 1.9E+00 J | UG_L | AS12-12MW05SP-0505 | 2/26 | 10 - 11 | 1.9E+00 | N/A | 1.8E+03 N | N/A | N/A | NO | BSL |
| | 84-74-2 | Di-n-butylphthalate | 1.4E+00 J | 1.8E+00 J | UG_L | AS12-12MW05SP-0505 | 2/26 | 10 - 11 | 1.8E+00 | N/A | 3.7E+02 N | N/A | N/A | NO | BSL |
| | 117-81-7 | bis(2-Ethylhexyl)phthalate | 1.2E+00 J | 2.1E+01 | UG_L | AS12-12MW09DP-0605 | 3/26 | 10 - 11 | 2.1E+01 | 2.0E+00 | 4.8E+00 C | 6.0E+00 | MCL | YES | ASL |
| | 14797-73-0 | Perchlorate | 4.0E-01 | 4.0E-01 | UG_L | AS12-12MW17S-0607 | 1/26 | 0.2 - 5 | 4.0E-01 | N/A | 2.6E+00 N | N/A | N/A | NO | BSL |
| | 7429-90-5 | Aluminum | 9.0E+01 J | 1.7E+04 J | UG_L | AS12-12MW09D-0607 | 23/26 | 200 - 200 | 1.7E+04 | 7.8E+02 | 3.7E+03 N | 50-200 | SMCL | YES | ASL |
| | 7440-36-0 | Antimony | 3.3E+00 J | 3.3E+00 J | UG_L | AS12-12MW07S-0505 | 1/26 | 60 - 60 | 3.3E+00 | 5.9E+00 | 1.5E+00 N | 6.0E+00 | MCL | YES | ASL |
| | 7440-38-2 | Arsenic | 2.6E+00 K | 1.1E+01 K | UG_L | AS12-12MW09D-0607 | 10/26 | 10 - 10 | 1.1E+01 | 4.9E+00 | 4.5E-02 C | 1.0E+01 | MCL | YES | ASL |
| | 7440-39-3 | Barium | 1.1E+01 J | 1.0E+02 J | UG_L | AS12-12MW09S-0607 | 26/26 | 200 - 200 | 1.0E+02 | 8.7E+01 | 7.3E+02 N | 2.0E+03 | MCL | NO | BSL |
| | 7440-41-7 | Beryllium | 1.2E-01 J | 8.3E-01 J | UG_L | AS12-12MW09D-0607 | 5/26 | 5 - 5 | 8.3E-01 | 8.3E-01 | 7.3E+00 N | 4.0E+00 | MCL | NO | BSL |
| | 7440-43-9 | Cadmium | 4.1E-01 J | 4.1E-01 J | UG_L | AS12-12MW11D-0505 | 1/26 | 5 - 5 | 4.1E-01 | N/A | 1.8E+00 N | 5.0E+00 | MCL | NO | BSL |
| | 7440-70-2 | Calcium | 1.1E+05 | 4.0E+05 | UG_L | AS12-12MW04S-0605 | 26/26 | 5000 - 5000 | 4.0E+05 | 2.3E+05 | N/A | N/A | N/A | NO | NUT |
| | 7440-47-3 | Chromium | 1.3E+00 J | 2.5E+02 | UG_L | AS12-12MW09S-0607 | 15/26 | 10 - 10 | 2.5E+02 | 2.3E+01 | 1.1E+01 N | 1.0E+02 | MCL | YES | ASL |
| | 7440-48-4 | Cobalt | 3.2E+00 J | 1.3E+01 J | UG_L | AS12-12MW09D-0607 | 5/26 | 50 - 50 | 1.3E+01 | N/A | 7.3E+01 N | N/A | N/A | NO | BSL |
| | 7440-50-8 | Copper | 9.6E+00 J | 3.2E+01 | UG_L | AS12-12MW09S-0607 | 3/26 | 25 - 25 | 3.2E+01 | 1.2E+01 | 1.5E+02 N | 1.3E+03 | AL | NO | BSL |
| | 7439-89-6 | Iron | 2.8E+02 | 2.0E+04 | UG_L | AS12-12MW09S-0607 | 25/26 | 100 - 100 | 2.0E+04 | 3.6E+02 | 2.6E+03 N | 3.0E+02 | SMCL | YES | ASL |
| | 7439-92-1 | Lead | 1.8E+00 J | 1.9E+01 K | UG_L | AS12-12MW09D-0607 | 8/26 | 3 - 10 | 1.9E+01 | 1.0E+01 | 1.5E+01 | 1.5E+01 | AL | YES | ASL |
| | 7439-95-4 | Magnesium | 3.1E+04 | 1.4E+05 | UG_L | AS12-12MW04S-0605 | 26/26 | 5000 - 5000 | 1.4E+05 | 4.7E+04 | N/A | N/A | N/A | NO | NUT |
| | 7439-96-5 | Manganese | 7.0E+00 J | 7.4E+02 | UG_L | AS12-12MW09S-0605 | 25/26 | 15 - 15 | 7.4E+02 | 2.1E+01 | 7.3E+01 N | 5.0E+01 | SMCL | YES | ASL |
| | 7439-97-6 | Mercury | 2.3E-02 J | 2.9E-02 J | UG_L | AS12-12MW09S-0607 | 2/26 | 0.2 - 0.2 | 2.9E-02 | 9.0E-02 | 1.1E+00 N | 2.0E+00 | MCL | NO | BSL |

Table 2.5

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

| Exposure Point | CAS Number | Chemical | Minimum [1] Concentration Qualifier | Maximum [1] Concentration Qualifier | Units | Location of Maximum Concentration | Detection Frequency | Range of Detection Limits | Concentration [2] Used for Screening | Background [3] Value | Screening [4] Toxicity Value | Potential ARAR/TBC Value | Potential ARAR/TBC Source | COPC Flag | Rationale for [5] Contaminant Deletion or Selection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7440-02-0 | Nickel | 1.3E+00 J | 1.6E+02 | UG_L | AS12-12MW09S-0607 | 11/26 | 40 - 40 | 1.6E+02 | N/A | 7.3E+01 N | N/A | N/A | YES | ASL |
| | 7440-09-7 | Potassium | 1.9E+03 J | 1.8E+04 | UG_L | AS12-12MW11S-0605 | 26/26 | 5000 - 5000 | 1.8E+04 | 1.4E+04 | N/A | N/A | N/A | NO | NUT |
| | 7782-49-2 | Selenium | 2.9E+00 J | 4.0E+00 J | UG_L | AS12-12MW05S-0505 | 2/26 | 5 - 35 | 4.0E+00 | 3.5E+00 | 1.8E+01 N | 5.0E+01 | MCL | NO | BSL |
| | 7440-23-5 | Sodium | 2.4E+03 J | 7.2E+04 | UG_L | AS12-12MW11S-0607 | 26/26 | 5000 - 5000 | 7.2E+04 | 9.7E+04 | N/A | N/A | N/A | NO | NUT |
| | 7440-28-0 | Thallium | 5.8E+00 J | 6.2E+00 K | UG_L | AS12-12MW07D-0505 AS12-12MW17D-0607 | 3/26 | 10 - 25 | 6.2E+00 | N/A | 2.6E-01 N | 2.0E+00 | MCL | YES | ASL |
| | 7440-62-2 | Vanadium | 5.4E-01 J | 2.8E+01 J | UG_L | AS12-12MW09D-0607 | 12/26 | 50 - 50 | 2.8E+01 | 4.6E+00 | 3.7E+00 N | N/A | N/A | YES | ASL |
| | 7440-66-6 | Zinc | 8.0E+00 J | 2.7E+01 | UG_L | AS12-12MW09S-0605 | 3/26 | 20 - 60 | 2.7E+01 | 2.0E+01 | 1.1E+03 N | 5.0E+02 | SMCL | NO | BSL |

[1] Minimum/Maximum detected concentration. Unfiltered results for metals since in general no significant difference between filtered and unfiltered results.

[2] Maximum concentration is used for screening.

[3] Background values are maximum concentration from background well 11GW10.

[4] Risk-Based Concentration Table, October 11, 2007, U.S. EPA Region III, Jennifer Hubbard.
RBC value for methyl isobutyl ketone used as surrogate for 2-hexanone
RBC value for methylene chloride used as surrogate for bromochloromethane.
RBC value for cadmium-water used for cadmium.
RBC value for hexavalent chromium used for total chromium.
Cobalt was withdrawn from October 2005 RBC Table due to expiration of NCEA provisional toxicity values. Value is from the April 2005 RBC table.
The tap water value of 15 ug/L for lead is the action level provided in the Drinking Water Regulations and Health Advisories.
RBC value for manganese-nonfood used for manganese.
RBC value for mercuric chloride used as surrogate for mercury.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
J = Estimated Value
K = Biased High
L = Biased Low
C = Carcinogenic
N = Noncarcinogenic
MCL = Maximum Contaminant Level, Primary Drinking Water Standards
SMCL = Maximum Contaminant Level, Secondary Drinking Water Standards
AL = Action Level, Safe Drinking Water Act
N/A Not available or not applicable

Table 2.6

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air

| Exposure Point | CAS Number | Chemical | Minimum [1] Concentration Qualifier | Maximum [1] Concentration Qualifier | Units | Location of Maximum Concentration | Detection Frequency | Range of Detection Limits | Concentration [2] Used for Screening | Background [3] Value | Screening [4] Toxicity Value | Potential ARAR/TBC Value | Potential ARAR/TBC Source | COPC Flag | Rationale for [5] Contaminant Deletion or Selection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bedrock Aquifer-Water Vapors at Showerhead | 71-55-6 | 1,1,1-Trichloroethane | 1.3E+00 | 2.0E+00 | UG_L | AS12-12MW09S-0605 | 2/37 | 0.5 - 10 | 2.0E+00 | N/A | 9.1E+02 N | 2.0E+02 | MCL | NO | BSL |
| | 76-13-1 | 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | 3.6E+00 | 3.6E+00 | UG_L | AS12-12MW13S-0505 | 1/37 | 0.5 - 10 | 3.6E+00 | N/A | 5.9E+03 N | N/A | N/A | NO | BSL |
| | 75-34-3 | 1,1-Dichloroethane | 4.5E-01 J | 9.0E+00 | UG_L | AS12-12MW09S-0607 | 6/37 | 0.5 - 10 | 9.0E+00 | N/A | 9.0E+01 N | N/A | N/A | NO | BSL |
| | 75-35-4 | 1,1-Dichloroethene | 4.3E-01 J | 6.1E-01 | UG_L | AS12-12MW09S-0607 | 2/37 | 0.5 - 10 | 6.1E-01 | N/A | 3.5E+01 N | 7.0E+00 | MCL | NO | BSL |
| | 78-93-3 | 2-Butanone | 7.9E+00 J | 7.9E+00 J | UG_L | AS12-12MW20D-1206 | 1/37 | 5 - 10 | 7.9E+00 | N/A | 7.0E+02 N | N/A | N/A | NO | BSL |
| | 591-78-6 | 2-Hexanone | 2.2E+00 J | 3.3E+00 J | UG_L | AS12-12MW09D-0607 | 4/37 | 5 - 10 | 3.3E+00 | N/A | 6.3E+02 N | N/A | N/A | NO | BSL |
| | 67-64-1 | Acetone | 2.2E+00 J | 1.6E+01 L | UG_L | AS12-12MW22D-1206 | 5/37 | 5 - 10 | 1.6E+01 | 9.5E+00 | 5.5E+02 N | N/A | N/A | NO | BSL |
| | 74-97-5 | Bromochloromethane | 1.1E+00 | 1.1E+00 | UG_L | AS12-12MW09S-0605 | 1/26 | 0.5 - 0.5 | 1.1E+00 | N/A | 4.1E+00 C | N/A | N/A | NO | BSL |
| | 75-15-0 | Carbon disulfide | 4.9E-01 J | 1.0E+01 UL | UG_L | AS12-12MW20D-1206, AS12-12MW22D-1206 | 5/37 | 0.5 - 10 | 1.0E+01 | N/A | 1.0E+02 N | N/A | N/A | NO | BSL |
| | 74-87-3 | Chloromethane | 1.4E+00 | 1.4E+00 | UG_L | AS12-12MW09S-0605 | 1/37 | 0.5 - 10 | 1.4E+00 | N/A | 1.9E+01 N | N/A | N/A | NO | BSL |
| | 110-82-7 | Cyclohexane | 5.2E-01 | 2.8E+00 | UG_L | AS12-12MW09S-0607 | 5/37 | 0.5 - 10 | 2.8E+00 | N/A | 1.2E+03 N | N/A | N/A | NO | BSL |
| | 100-41-4 | Ethylbenzene | 4.2E-01 J | 4.2E-01 J | UG_L | AS12-12MW09S-0607 | 1/37 | 0.5 - 10 | 4.2E-01 | N/A | 1.3E+02 N | 7.0E+02 | MCL | NO | BSL |
| | 75-09-2 | Methylene chloride | 8.2E-01 | 4.4E+03 | UG_L | AS12-12MW09S-0605 | 8/37 | 0.5 - 250 | 4.4E+03 | N/A | 4.1E+00 C | 5.0E+00 | MCL | YES | ASL |
| | 127-18-4 | Tetrachloroethene | 1.4E+00 | 1.4E+00 | UG_L | AS12-12MW09S-0605 | 1/37 | 0.5 - 10 | 1.4E+00 | N/A | 1.0E-01 C | 5.0E+00 | MCL | YES | ASL |
| | 108-88-3 | Toluene | 4.5E-01 J | 3.1E+00 | UG_L | AS12-12MW09S-0605 | 4/37 | 0.5 - 10 | 3.1E+00 | 1.0E-01 | 2.3E+02 N | 1.0E+02 | MCL | NO | BSL |
| | 79-01-6 | Trichloroethene | 3.3E-01 J | 8.9E+00 | UG_L | AS12-12MW07S-0505 | 18/37 | 0.5 - 10 | 8.9E+00 | N/A | 2.6E-02 C | 5.0E+00 | MCL | YES | ASL |
| | 1330-20-7 | Xylene, total | 6.2E-01 | 6.2E-01 | UG_L | AS12-12MW09S-0607 | 1/37 | 0.5 - 10 | 6.2E-01 | N/A | 2.1E+01 N | 1.0E+04 | MCL | NO | BSL |
| | 156-59-2 | cis-1,2-Dichloroethene | 1.2E+00 | 1.1E+01 | UG_L | AS12-12MW09S-0607 | 6/37 | 0.5 - 10 | 1.1E+01 | N/A | 6.1E+00 N | 7.0E+01 | MCL | YES | ASL |
| | 156-60-5 | trans-1,2-Dichloroethene | 2.2E+00 J | 3.1E+00 | UG_L | AS12-12MW09S-0607 | 3/37 | 0.5 - 10 | 3.1E+00 | N/A | 1.1E+01 N | 1.0E+02 | MCL | NO | BSL |

[1] Minimum/Maximum detected concentration. Unfiltered results for metals since in general no significant difference between filtered and unfiltered results.

[2] Maximum concentration is used for screening.

[3] Background values are maximum concentration from background well 11GW10.

[4] Risk-Based Concentration Table, October 11, 2007, U.S. EPA Region III, Jennifer Hubbard.
RBC value for methyl isobutyl ketone used as surrogate for 2-hexanone
RBC value for methylene chloride used as surrogate for bromochloromethane.
RBC value for cadmium-water used for cadmium.
RBC value for hexavalent chromium used for total chromium.
Cobalt was withdrawn from October 2005 RBC Table due to expiration of NCEA provisional toxicity values. Value is from the April 2005 RBC table.
The tap water value of 15 ug/L for lead is the action level provided in the Drinking Water Regulations and Health Advisories.
RBC value for manganese-nonfood used for manganese.
RBC value for mercuric chloride used as surrogate for mercury.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
J = Estimated Value
K = Biased High
L = Biased Low
C = Carcinogenic
N = Noncarcinogenic
MCL = Maximum Contaminant Level, Primary Drinking Water Standards
SMCL = Maximum Contaminant Level, Secondary Drinking Water Standards
AL = Action Level, Safe Drinking Water Act
N/A Not available or not applicable

Table 3.1.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

| Exposure Point | Chemical of Potential Concern | Units | Arithmetic Mean | 95% UCL (Distribution) | | Maximum Concentration (Qualifier) | | Exposure Point Concentration | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Value | Units | Statistic | Rationale |
| Alluvial Aquifer - Tap Water | 1,1,2,2-Tetrachloroethane | UG/L | 1.5E+00 | 5.9E+00 | (NP) | 3.2E+00 | J | 3.2E+00 | UG/L | Max | (5,6) |
| | 1,1,2-Trichloroethane | UG/L | 1.5E+00 | 5.9E+00 | (NP) | 3.4E+00 | J | 3.4E+00 | UG/L | Max | (5,6) |
| | 1,2-Dibromo-3-chloropropane | UG/L | 1.2E+00 | 5.3E+00 | (NP) | 3.8E+00 | J | 3.8E+00 | UG/L | Max | (5,6) |
| | 1,2-Dichlorobenzene | UG/L | 8.9E+00 | 6.2E+01 | (T) | 8.7E+01 | J | 6.2E+01 | UG/L | 99% KM | (1) |
| | 1,2-Dichloropropane | UG/L | 1.7E+00 | 6.3E+00 | (NP) | 9.6E-01 | | 9.6E-01 | UG/L | Max | (5,6) |
| | 1,4-Dichlorobenzene | UG/L | 1.6E+00 | 1.9E+00 | (NP) | 2.1E+00 | | 1.9E+00 | UG/L | 95% KM-t | (5) |
| | Benzene | UG/L | 1.5E+00 | 1.5E+00 | (NP) | 1.8E+00 | J | 1.5E+00 | UG/L | 95% KM-t | (5) |
| | Bromodichloromethane | UG/L | 1.7E+00 | 6.3E+00 | (NP) | 6.1E-01 | | 6.1E-01 | UG/L | Max | (5,6) |
| | Chlorobenzene | UG/L | 5.9E+00 | 3.6E+01 | (NP) | 9.4E+01 | J | 3.6E+01 | UG/L | 97.5% KM | (5) |
| | Chloroform | UG/L | 1.7E+00 | 6.3E+00 | (NP) | 2.2E+00 | | 2.2E+00 | UG/L | Max | (5,6) |
| | Methylene chloride | UG/L | 2.2E+00 | 6.8E+00 | (NP) | 4.4E+00 | | 4.4E+00 | UG/L | Max | (5,6) |
| | Tetrachloroethene | UG/L | 1.4E+00 | 1.5E+00 | (NP) | 1.9E+00 | L | 1.5E+00 | UG/L | 95% KM-t | (5) |
| | Trichloroethene | UG/L | 2.4E+00 | 3.0E+00 | (NP) | 9.4E+00 | | 3.0E+00 | UG/L | 95% KM-t | (1,3,4) |
| | Vinyl chloride | UG/L | 2.2E+00 | 2.0E+00 | (NP) | 7.6E+00 | | 2.0E+00 | UG/L | 95% KM-t | (1,3,4) |
| | cis-1,2-Dichloroethene | UG/L | 4.0E+00 | 5.4E+00 | (NP) | 2.2E+01 | | 5.4E+00 | UG/L | 95% KM-t | (1,3,4) |
| | Arsenic-dissolved | UG/L | 3.6E+00 | 4.8E+00 | (NP) | 8.5E+00 | J | 4.8E+00 | UG/L | 95% KM-t | (1,2,3,4) |
| | Chromium (hexavalent)-dissolved | UG/L | 4.6E+00 | 6.3E+00 | (NP) | 1.1E+01 | | 6.3E+00 | UG/L | 95% Cheb-m | (5) |
| | Iron-dissolved | UG/L | 4.8E+03 | 9.4E+03 | (NP) | 3.3E+04 | | 9.4E+03 | UG/L | 95% KM-t | (1,2,3,4) |
| | Manganese-dissolved | UG/L | 9.0E+02 | 2.5E+03 | (G) | 5.1E+03 | | 2.5E+03 | UG/L | Adj. Gamma | (1,3,4) |
| | Nickel-dissolved | UG/L | 4.2E+01 | 1.7E+02 | (NP) | 3.2E+02 | | 1.7E+02 | UG/L | 97.5% KM | (5) |
| | Thallium-dissolved | UG/L | 5.4E+00 | 1.1E+01 | (NP) | 6.2E+00 | K | 6.2E+00 | UG/L | Max | (5,6) |

ProUCL, Version 4.0 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate RME EPC, following recommendations based on distribution and standard deviation in users guide (USEPA. April 2007. ProUCL, Version 4.0. Prepared by Lockheed Martin Environmental Services).
Options: 99% Kaplan-Meier Chebyshev (99% KM); 97.5% Kaplan-Meier Chebyshev (97.5% KM); 95% Kaplan-Meier (t) UCL (95% KM-t); 95% Adjusted Gamma (Adj. Gamma); Maximum Detected Value (Max); 95% Chebyshev (mean, std) UCL (95% Cheb-m)

(1) Shapiro-Wilk W Test/Lilliefors test indicates data are log-normally distributed.
(2) Shapiro-Wilk W Test/Lilliefors indicates data are normally distributed.
(3) Anderson-Darling Test indicates data are gamma distributed.
(4) Kolmogorov-Smirnov Test indicates data are gamma distributed.
(5) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).
(6) Max value used because 95% UCL greater than max.

N = Normal
T = Log-Transformed
NP = Non-Parametric
G = Gamma

UG/L = micrograms liter
L = Biased Low
J = Estimated Value
K = Biased High

Table 3.2.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

| Exposure Point | Chemical of Potential Concern | Units | Arithmetic Mean | 95% UCL (Distribution) | | Maximum Concentration (Qualifier) | | Exposure Point Concentration | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Value | Units | Statistic | Rationale |
| Alluvial Aquifer - Water in Excavation Pit | 1,1,2,2-Tetrachloroethane | UG/L | 1.5E+00 | 5.9E+00 | (NP) | 3.2E+00 | J | 3.2E+00 | UG/L | Max | (5,6) |
| | 1,1,2-Trichloroethane | UG/L | 1.5E+00 | 5.9E+00 | (NP) | 3.4E+00 | J | 3.4E+00 | UG/L | Max | (5,6) |
| | 1,2-Dibromo-3-chloropropane | UG/L | 1.2E+00 | 5.3E+00 | (NP) | 3.8E+00 | J | 3.8E+00 | UG/L | Max | (5,6) |
| | 1,2-Dichlorobenzene | UG/L | 8.9E+00 | 6.2E+01 | (T) | 8.7E+01 | J | 6.2E+01 | UG/L | 99% KM | (1) |
| | 1,2-Dichloropropane | UG/L | 1.7E+00 | 6.3E+00 | (NP) | 9.6E-01 | | 9.6E-01 | UG/L | Max | (5,6) |
| | 1,4-Dichlorobenzene | UG/L | 1.6E+00 | 1.9E+00 | (NP) | 2.1E+00 | | 1.9E+00 | UG/L | 95% KM-t | (5) |
| | Benzene | UG/L | 1.5E+00 | 1.5E+00 | (NP) | 1.8E+00 | J | 1.5E+00 | UG/L | 95% KM-t | (5) |
| | Bromodichloromethane | UG/L | 1.7E+00 | 6.3E+00 | (NP) | 6.1E-01 | | 6.1E-01 | UG/L | Max | (5,6) |
| | Chlorobenzene | UG/L | 5.9E+00 | 3.6E+01 | (NP) | 9.4E+01 | J | 3.6E+01 | UG/L | 97.5% KM | (5) |
| | Chloroform | UG/L | 1.7E+00 | 6.3E+00 | (NP) | 2.2E+00 | | 2.2E+00 | UG/L | Max | (5,6) |
| | Methylene chloride | UG/L | 2.2E+00 | 6.8E+00 | (NP) | 4.4E+00 | | 4.4E+00 | UG/L | Max | (5,6) |
| | Tetrachloroethene | UG/L | 1.4E+00 | 1.5E+00 | (NP) | 1.9E+00 | L | 1.5E+00 | UG/L | 95% KM-t | (5) |
| | Trichloroethene | UG/L | 2.4E+00 | 3.0E+00 | (NP) | 9.4E+00 | | 3.0E+00 | UG/L | 95% KM-t | (1,3,4) |
| | Vinyl chloride | UG/L | 2.2E+00 | 2.0E+00 | (NP) | 7.6E+00 | | 2.0E+00 | UG/L | 95% KM-t | (1,3,4) |
| | cis-1,2-Dichloroethene | UG/L | 4.0E+00 | 5.4E+00 | (NP) | 2.2E+01 | | 5.4E+00 | UG/L | 95% KM-t | (1,3,4) |
| | Aluminum | UG/L | 3.4E+03 | 8.3E+03 | (NP) | 1.7E+04 | | 8.3E+03 | UG/L | 95% KM | (1,3,4) |
| | Arsenic | UG/L | 5.9E+00 | 8.4E+00 | (NP) | 1.2E+01 | | 8.4E+00 | UG/L | 95% KM-t | (1,2,3,4) |
| | Chromium | UG/L | 6.8E+00 | 1.1E+01 | (NP) | 3.7E+01 | | 1.1E+01 | UG/L | 95% KM-t | (1,3,4) |
| | Chromium (hexavalent) | UG/L | 2.6E+01 | 4.6E+01 | (NP) | 6.8E+01 | | 4.6E+01 | UG/L | 95% KM-t | (1,2) |
| | Iron | UG/L | 1.1E+04 | 2.3E+04 | (NP) | 3.6E+04 | | 2.3E+04 | UG/L | 95% KM | (1,3,4) |
| | Manganese | UG/L | 1.1E+03 | 2.1E+03 | (G) | 5.1E+03 | | 2.1E+03 | UG/L | App. Gamma | (3,4) |
| | Nickel | UG/L | 4.7E+01 | 9.5E+01 | (NP) | 3.4E+02 | | 9.5E+01 | UG/L | 95% KM-BCA | (1,3,4) |
| | Vanadium | UG/L | 5.6E+00 | 1.4E+01 | (NP) | 3.0E+01 | J | 1.4E+01 | UG/L | 95% KM | (1,3,4) |

ProUCL, Version 4.0 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate RME EPC, following recommendations based on distribution and standard deviation in users guide (USEPA. April 2007. ProUCL, Version 4.0. Prepared by Lockheed Martin Environmental Services).
Options: 99% Kaplan-Meier Chebyshev (99% KM); 97.5% Kaplan-Meier Chebyshev (97.5% KM); 95% Kaplan-Meier Chebyshev (95% KM); 95% Kaplan-Meier (t) UCL (95% KM-t); 95% Kaplan-Meier (BCA) UCL (95% KM-BCA); 95% Approximate Gamma (App. Gamma); Maximum Detected Value (Max)

(1) Shapiro-Wilk W Test/Lilliefors test indicates data are log-normally distributed.
(2) Shapiro-Wilk W Test/Lilliefors indicates data are normally distributed.
(3) Anderson-Darling Test indicates data are gamma distributed.
(4) Kolmogorov-Smirnov Test indicates data are gamma distributed.
(5) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).
(6) Max value used because 95% UCL greater than max.

N = Normal
T = Log-Transformed
NP = Non-Parametric
G = Gamma

UG/L = micrograms liter
L = Biased Low
J = Estimated Value
K = Biased High

Table 3.3.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air

| Exposure Point | Chemical of Potential Concern | Units | Arithmetic Mean | 95% UCL (Distribution) | | Maximum Concentration (Qualifier) | | Exposure Point Concentration | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Value | Units | Statistic | Rationale |
| Alluvial Aquifer - Water Vapors at Showerhead | 1,1,2,2-Tetrachloroethane | UG/L | 1.5E+00 | 5.9E+00 | (NP) | 3.2E+00 | J | 3.2E+00 | UG/L | Max | (5,6) |
| | 1,1,2-Trichloroethane | UG/L | 1.5E+00 | 5.9E+00 | (NP) | 3.4E+00 | J | 3.4E+00 | UG/L | Max | (5,6) |
| | 1,2-Dibromo-3-chloropropane | UG/L | 1.2E+00 | 5.3E+00 | (NP) | 3.8E+00 | J | 3.8E+00 | UG/L | Max | (5,6) |
| | 1,2-Dichlorobenzene | UG/L | 8.9E+00 | 6.2E+01 | (T) | 8.7E+01 | J | 6.2E+01 | UG/L | 99% KM | (1) |
| | 1,2-Dichloropropane | UG/L | 1.7E+00 | 6.3E+00 | (NP) | 9.6E-01 | | 9.6E-01 | UG/L | Max | (5,6) |
| | 1,4-Dichlorobenzene | UG/L | 1.6E+00 | 1.9E+00 | (NP) | 2.1E+00 | | 1.9E+00 | UG/L | 95% KM-t | (5) |
| | Benzene | UG/L | 1.5E+00 | 1.5E+00 | (NP) | 1.8E+00 | J | 1.5E+00 | UG/L | 95% KM-t | (5) |
| | Bromodichloromethane | UG/L | 1.7E+00 | 6.3E+00 | (NP) | 6.1E-01 | | 6.1E-01 | UG/L | Max | (5,6) |
| | Chlorobenzene | UG/L | 5.9E+00 | 3.6E+01 | (NP) | 9.4E+01 | J | 3.6E+01 | UG/L | 97.5% KM | (5) |
| | Chloroform | UG/L | 1.7E+00 | 6.3E+00 | (NP) | 2.2E+00 | | 2.2E+00 | UG/L | Max | (5,6) |
| | Methylene chloride | UG/L | 2.2E+00 | 6.8E+00 | (NP) | 4.4E+00 | | 4.4E+00 | UG/L | Max | (5,6) |
| | Tetrachloroethene | UG/L | 1.4E+00 | 1.5E+00 | (NP) | 1.9E+00 | L | 1.5E+00 | UG/L | 95% KM-t | (5) |
| | Trichloroethene | UG/L | 2.4E+00 | 3.0E+00 | (NP) | 9.4E+00 | | 3.0E+00 | UG/L | 95% KM-t | (1,3,4) |
| | Vinyl chloride | UG/L | 2.2E+00 | 2.0E+00 | (NP) | 7.6E+00 | | 2.0E+00 | UG/L | 95% KM-t | (1,3,4) |
| | cis-1,2-Dichloroethene | UG/L | 4.0E+00 | 5.4E+00 | (NP) | 2.2E+01 | | 5.4E+00 | UG/L | 95% KM-t | (1,3,4) |

ProUCL, Version 4.0 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate RME EPC, following recommendations based on distribution and standard deviation in users guide (USEPA. April 2007. ProUCL, Version 4.0. Prepared by Lockheed Martin Environmental Services).
Options: 99% Kaplan-Meier Chebyshev (99% KM); 97.5% Kaplan-Meier Chebyshev (97.5% KM); 95% Kaplan-Meier (t) UCL (95% KM-t); Maximum Detected Value (Max)

(1) Shapiro-Wilk W Test/Lilliefors test indicates data are log-normally distributed.
(2) Shapiro-Wilk W Test/Lilliefors indicates data are normally distributed.
(3) Anderson-Darling Test indicates data are gamma distributed.
(4) Kolmogorov-Smirnov Test indicates data are gamma distributed.
(5) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).
(6) Max value used because 95% UCL greater than max.

N = Normal
T = Log-Transformed
NP = Non-Parametric
G = Gamma

UG/L = micrograms liter
L = Biased Low
J = Estimated Value
K = Biased High

Table 3.4.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air

| Exposure Point | Chemical of Potential Concern | Units | Arithmetic Mean | 95% UCL (Distribution) | | Maximum Concentration (Qualifier) | | Exposure Point Concentration | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Value | Units | Statistic | Rationale |
| Alluvial Aquifer - Volatilization from Water in Excavation Pit | 1,1,2,2-Tetrachloroethane | UG/L | 1.5E+00 | 5.9E+00 | (NP) | 3.2E+00 | J | 3.2E+00 | UG/L | Max | (5,6) |
| | 1,1,2-Trichloroethane | UG/L | 1.5E+00 | 5.9E+00 | (NP) | 3.4E+00 | J | 3.4E+00 | UG/L | Max | (5,6) |
| | 1,2-Dibromo-3-chloropropane | UG/L | 1.2E+00 | 5.3E+00 | (NP) | 3.8E+00 | J | 3.8E+00 | UG/L | Max | (5,6) |
| | 1,2-Dichlorobenzene | UG/L | 8.9E+00 | 6.2E+01 | (T) | 8.7E+01 | J | 6.2E+01 | UG/L | 99% KM | (1) |
| | 1,2-Dichloropropane | UG/L | 1.7E+00 | 6.3E+00 | (NP) | 9.6E-01 | | 9.6E-01 | UG/L | Max | (5,6) |
| | 1,4-Dichlorobenzene | UG/L | 1.6E+00 | 1.9E+00 | (NP) | 2.1E+00 | | 1.9E+00 | UG/L | 95% KM-t | (5) |
| | Benzene | UG/L | 1.5E+00 | 1.5E+00 | (NP) | 1.8E+00 | J | 1.5E+00 | UG/L | 95% KM-t | (5) |
| | Bromodichloromethane | UG/L | 1.7E+00 | 6.3E+00 | (NP) | 6.1E-01 | | 6.1E-01 | UG/L | Max | (5,6) |
| | Chlorobenzene | UG/L | 5.9E+00 | 3.6E+01 | (NP) | 9.4E+01 | J | 3.6E+01 | UG/L | 97.5% KM | (5) |
| | Chloroform | UG/L | 1.7E+00 | 6.3E+00 | (NP) | 2.2E+00 | | 2.2E+00 | UG/L | Max | (5,6) |
| | Methylene chloride | UG/L | 2.2E+00 | 6.8E+00 | (NP) | 4.4E+00 | | 4.4E+00 | UG/L | Max | (5,6) |
| | Tetrachloroethene | UG/L | 1.4E+00 | 1.5E+00 | (NP) | 1.9E+00 | L | 1.5E+00 | UG/L | 95% KM-t | (5) |
| | Trichloroethene | UG/L | 2.4E+00 | 3.0E+00 | (NP) | 9.4E+00 | | 3.0E+00 | UG/L | 95% KM-t | (1,3,4) |
| | Vinyl chloride | UG/L | 2.2E+00 | 2.0E+00 | (NP) | 7.6E+00 | | 2.0E+00 | UG/L | 95% KM-t | (1,3,4) |
| | cis-1,2-Dichloroethene | UG/L | 4.0E+00 | 5.4E+00 | (NP) | 2.2E+01 | | 5.4E+00 | UG/L | 95% KM-t | (1,3,4) |

ProUCL, Version 4.0 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate RME EPC, following recommendations based on distribution and standard deviation in users guide (USEPA. April 2007. ProUCL, Version 4.0. Prepared by Lockheed Martin Environmental Services).
Options: 99% Kaplan-Meier Chebyshev (99% KM); 97.5% Kaplan-Meier Chebyshev (97.5% KM); 95% Kaplan-Meier (t) UCL (95% KM-t); Maximum Detected Value (Max)

(1) Shapiro-Wilk W Test/Lilliefors test indicates data are log-normally distributed.
(2) Shapiro-Wilk W Test/Lilliefors indicates data are normally distributed.
(3) Anderson-Darling Test indicates data are gamma distributed.
(4) Kolmogorov-Smirnov Test indicates data are gamma distributed.
(5) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).
(6) Max value used because 95% UCL greater than max.

N = Normal
T = Log-Transformed
NP = Non-Parametric
G = Gamma

UG/L = micrograms liter
L = Biased Low
J = Estimated Value
K = Biased High

Table 3.5.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

| Exposure Point | Chemical of Potential Concern | Units | Arithmetic Mean | 95% UCL (Distribution) | | Maximum Concentration (Qualifier) | | Exposure Point Concentration | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Value | Units | Statistic | Rationale |
| Bedrock Aquifer - Tap Water | Methylene chloride | UG_L | 1.5E+02 | 3.6E+02 | (NP) | 4.4E+03 | | 3.6E+02 | UG_L | 95% KM-t | (1,3,4) |
| | Tetrachloroethene | UG_L | 1.7E+00 | 5.3E+00 | (NP) | 1.4E+00 | | 1.4E+00 | UG_L | Max | (5,6) |
| | Trichloroethene | UG_L | 2.1E+00 | 2.0E+00 | (NP) | 8.9E+00 | | 2.0E+00 | UG_L | 95% KM-t | (1,3,4) |
| | cis-1,2-Dichloroethene | UG_L | 2.1E+00 | 2.2E+00 | (NP) | 1.1E+01 | | 2.2E+00 | UG_L | 95% KM-t | (1,3,4) |
| | bis(2-Ethylhexyl)phthalate | UG_L | 3.7E+00 | 3.7E+00 | (NP) | 2.1E+01 | | 3.7E+00 | UG_L | 95% KM-t | (1,2) |
| | Aluminum | UG_L | 1.6E+03 | 6.3E+03 | (NP) | 1.7E+04 | J | 6.3E+03 | UG_L | 97.5% KM | (5) |
| | Antimony | UG_L | 1.7E+01 | 4.5E+01 | (NP) | 3.3E+00 | J | 3.3E+00 | UG_L | Max | (5,6) |
| | Arsenic | UG_L | 4.0E+00 | 4.9E+00 | (NP) | 1.1E+01 | K | 4.9E+00 | UG_L | 95% KM-t | (1,2,3,4) |
| | Chromium | UG_L | 1.6E+01 | 3.6E+01 | (NP) | 2.5E+02 | | 3.6E+01 | UG_L | 95% KM-BCA | (1,3,4) |
| | Iron | UG_L | 3.0E+03 | 9.3E+03 | (NP) | 2.0E+04 | | 9.3E+03 | UG_L | 97.5% KM | (5) |
| | Lead | UG_L | 3.9E+00 | 4.6E+00 | (NP) | 1.9E+01 | K | 3.9E+00 | UG_L | Mean-N | (7) |
| | Manganese | UG_L | 1.3E+02 | 4.2E+02 | (NP) | 7.4E+02 | | 4.2E+02 | UG_L | 97.5% KM | (5) |
| | Nickel | UG_L | 1.4E+01 | 2.4E+01 | (NP) | 1.6E+02 | | 2.4E+01 | UG_L | 95% KM-t | (1,3,4) |
| | Thallium | UG_L | 7.8E+00 | 5.9E+00 | (NP) | 6.2E+00 | K | 5.9E+00 | UG_L | 95% KM-t | (5) |
| | Vanadium | UG_L | 8.6E+00 | 6.5E+00 | (NP) | 2.8E+01 | J | 6.5E+00 | UG_L | 95% KM-t | (1,3,4) |

ProUCL, Version 4.0 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate RME EPC, following recommendations based on distribution and standard deviation in users guide (USEPA. April 2007. ProUCL, Version 4.0. Prepared by Lockheed Martin Environmental Services).
Options: 99% Kaplan-Meier Chebyshev (99% KM); 97.5% Kaplan-Meier Chebyshev (97.5% KM); 95% Kaplan-Meier (t) UCL (95% KM-t); 95% Adjusted Gamma (Adj. Gamma); 95% KM (BCA) UCL (95% KM-BCA); Maximum Detected Value (Max); Mean Detected Value (Mean-N); 99% Chebyshev (mean, std) UCL (99% Cheb-m)

(1) Shapiro-Wilk W Test/Lilliefors test indicates data are log-normally distributed.
(2) Shapiro-Wilk W Test/Lilliefors indicates data are normally distributed.
(3) Anderson-Darling Test indicates data are gamma distributed.
(4) Kolmogorov-Smirnov Test indicates data are gamma distributed.
(5) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).
(6) Max value used because 95% UCL greater than max.
(7) Mean value used for lead model

N = Normal
T = Log-Transformed
NP = Non-Parametric
G = Gamma

UG/L = micrograms liter
L = Biased Low
J = Estimated Value
K = Biased High

Table 3.6.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air

| Exposure Point | Chemical of Potential Concern | Units | Arithmetic Mean | 95% UCL (Distribution) | | Maximum Concentration (Qualifier) | Exposure Point Concentration | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Value | Units | Statistic | Rationale |
| Bedrock Aquifer - Water Vapors at Showerhead | Methylene chloride | UG_L | 1.5E+02 | 3.6E+02 | (NP) | 4.4E+03 | 3.6E+02 | UG_L | 95% KM-t | (1,3,4) |
| | Tetrachloroethene | UG_L | 1.7E+00 | 5.3E+00 | (NP) | 1.4E+00 | 1.4E+00 | UG_L | Max | (5,6) |
| | Trichloroethene | UG_L | 2.1E+00 | 2.0E+00 | (NP) | 8.9E+00 | 2.0E+00 | UG_L | 95% KM-t | (1,3,4) |
| | cis-1,2-Dichloroethene | UG_L | 2.1E+00 | 2.2E+00 | (NP) | 1.1E+01 | 2.2E+00 | UG_L | 95% KM-t | (1,3,4) |

ProUCL, Version 4.0 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate RME EPC, following recommendations based on distribution and standard deviation in users guide (USEPA. April 2007. ProUCL, Version 4.0. Prepared by Lockheed Martin Environmental Services).
Options: 95% Kaplan-Meier (t) UCL (95% KM-t); Maximum Detected Value (Max)

(1) Shapiro-Wilk W Test/Lilliefors test indicates data are log-normally distributed.
(2) Shapiro-Wilk W Test/Lilliefors indicates data are normally distributed.
(3) Anderson-Darling Test indicates data are gamma distributed.
(4) Kolmogorov-Smirnov Test indicates data are gamma distributed.
(5) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).
(6) Max value used because 95% UCL greater than max.

N = Normal
T = Log-Transformed
NP = Non-Parametric
G = Gamma

UG/L = micrograms liter
L = Biased Low
J = Estimated Value
K = Biased High

Table 3.6.CTE
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
CENTRAL TENDENCY EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air

| Exposure Point | Chemical of Potential Concern | Units | Arithmetic Mean | 95% UCL (Distribution) | | Maximum Concentration (Qualifier) | Exposure Point Concentration | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Value | Units | Statistic | Rationale |
| Bedrock Aquifer - Water Vapors at Showerhead | Methylene chloride | UG_L | 1.5E+02 | 3.6E+02 | (NP) | 4.4E+03 | 1.4E+02 | UG_L | Mean-N | (1,3,4) |
| | Tetrachloroethene | UG_L | 1.7E+00 | 5.3E+00 | (NP) | 1.4E+00 | 1.4E+00 | UG_L | Max | (5,6) |
| | Trichloroethene | UG_L | 2.1E+00 | 2.0E+00 | (NP) | 8.9E+00 | 1.4E+00 | UG_L | Mean-N | (1,3,4) |
| | cis-1,2-Dichloroethene | UG_L | 2.1E+00 | 2.2E+00 | (NP) | 1.1E+01 | 1.7E+00 | UG_L | Mean-N | (1,3,4) |

ProUCL, Version 4.0 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate RME EPC, following recommendations based on distribution and standard deviation in users guide (USEPA. April 2007. ProUCL, Version 4.0. Prepared by Lockheed Martin Environmental Services).
Statistics: Mean of data assuming normal distribution (Mean-N); MVUE estimate of the mean for assuming lognormal distribution (Mean-T)
Maximum Detected Value (Max)

(1) Shapiro-Wilk W Test/Lilliefors test indicates data are log-normally distributed.
(2) Shapiro-Wilk W Test/Lilliefors indicates data are normally distributed.
(3) Anderson-Darling Test indicates data are gamma distributed.
(4) Kolmogorov-Smirnov Test indicates data are gamma distributed.
(5) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).
(6) Max value used because mean greater than max.

N = Normal
T = Log-Transformed
NP = Non-Parametric
G = Gamma

UG/L = micrograms liter
L = Biased Low
J = Estimated Value
K = Biased High

Table 3.1.CTE
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
CENTRAL TENDENCY EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

| Exposure Point | Chemical of Potential Concern | Units | Arithmetic Mean | 95% UCL (Distribution) | | Maximum Concentration (Qualifier) | | Exposure Point Concentration | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Value | Units | Statistic | Rationale |
| Alluvial Aquifer - Tap Water | 1,1,2,2-Tetrachloroethane | UG/L | 1.5E+00 | 5.9E+00 | (NP) | 3.2E+00 | J | 1.5E+00 | UG/L | Mean-N | (5) |
| | 1,1,2-Trichloroethane | UG/L | 1.5E+00 | 5.9E+00 | (NP) | 3.4E+00 | J | 1.5E+00 | UG/L | Mean-N | (5) |
| | 1,2-Dibromo-3-chloropropane | UG/L | 1.2E+00 | 5.3E+00 | (NP) | 3.8E+00 | J | 1.2E+00 | UG/L | Mean-N | (5) |
| | 1,2-Dichlorobenzene | UG/L | 8.9E+00 | 6.2E+01 | (T) | 8.7E+01 | J | 8.1E+00 | UG/L | Mean-T | (1) |
| | 1,2-Dichloropropane | UG/L | 1.7E+00 | 6.3E+00 | (NP) | 9.6E-01 | | 9.6E-01 | UG/L | Max | (5,6) |
| | 1,4-Dichlorobenzene | UG/L | 1.6E+00 | 1.9E+00 | (NP) | 2.1E+00 | | 1.8E+00 | UG/L | Mean-N | (5) |
| | Benzene | UG/L | 1.5E+00 | 1.5E+00 | (NP) | 1.8E+00 | J | 1.4E+00 | UG/L | Mean-N | (5) |
| | Bromodichloromethane | UG/L | 1.7E+00 | 6.3E+00 | (NP) | 6.1E-01 | | 6.1E-01 | UG/L | Max | (5,6) |
| | Chlorobenzene | UG/L | 5.9E+00 | 3.6E+01 | (NP) | 9.4E+01 | J | 6.6E+00 | UG/L | Mean-N | (5) |
| | Chloroform | UG/L | 1.7E+00 | 6.3E+00 | (NP) | 2.2E+00 | | 1.7E+00 | UG/L | Mean-N | (5) |
| | Methylene chloride | UG/L | 2.2E+00 | 6.8E+00 | (NP) | 4.4E+00 | | 2.2E+00 | UG/L | Mean-N | (5) |
| | Tetrachloroethene | UG/L | 1.4E+00 | 1.5E+00 | (NP) | 1.9E+00 | L | 1.4E+00 | UG/L | Mean-N | (5) |
| | Trichloroethene | UG/L | 2.4E+00 | 3.0E+00 | (NP) | 9.4E+00 | | 1.9E+00 | UG/L | Mean-N | (1,3,4) |
| | Vinyl chloride | UG/L | 2.2E+00 | 2.0E+00 | (NP) | 7.6E+00 | | 1.1E+00 | UG/L | Mean-N | (1,3,4) |
| | cis-1,2-Dichloroethene | UG/L | 4.0E+00 | 5.4E+00 | (NP) | 2.2E+01 | | 3.3E+00 | UG/L | Mean-N | (1,3,4) |
| | Arsenic-dissolved | UG/L | 3.6E+00 | 4.8E+00 | (NP) | 8.5E+00 | J | 3.6E+00 | UG/L | Mean-N | (1,2,3,4) |
| | Chromium (hexavalent)-dissolved | UG/L | 4.6E+00 | 6.3E+00 | (NP) | 1.1E+01 | | 4.6E+00 | UG/L | Mean-N | (5) |
| | Iron-dissolved | UG/L | 4.8E+03 | 9.4E+03 | (NP) | 3.3E+04 | | 4.8E+03 | UG/L | Mean-N | (1,2,3,4) |
| | Manganese-dissolved | UG/L | 9.0E+02 | 2.5E+03 | (G) | 5.1E+03 | | 9.0E+02 | UG/L | Mean-N | (1,3,4) |
| | Nickel-dissolved | UG/L | 4.2E+01 | 1.7E+02 | (NP) | 3.2E+02 | | 4.2E+01 | UG/L | Mean-N | (5) |
| | Thallium-dissolved | UG/L | 5.4E+00 | 1.1E+01 | (NP) | 6.2E+00 | K | 5.4E+00 | UG/L | Mean-N | (5) |

ProUCL, Version 4.0 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate RME EPC, following recommendations based on distribution and standard deviation in users guide (USEPA. April 2007. ProUCL, Version 4.0. Prepared by Lockheed Martin Environmental Services).
Statistics: Mean of data assuming normal distribution (Mean-N); Mean of data assuming lognormal distribution (Mean-T); Maximum Detected Value (Max)

(1) Shapiro-Wilk W Test/Lilliefors test indicates data are log-normally distributed.
(2) Shapiro-Wilk W Test/Lilliefors indicates data are normally distributed.
(3) Anderson-Darling Test indicates data are gamma distributed.
(4) Kolmogorov-Smirnov Test indicates data are gamma distributed.
(5) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).
(6) Max value used because mean greater than max.

N = Normal
T = Log-Transformed
NP = Non-Parametric
G = Gamma

UG/L = micrograms liter
L = Biased Low
J = Estimated Value
K = Biased High

Table 3.2.CTE
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
CENTRAL TENDENCY EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

| Exposure Point | Chemical of Potential Concern | Units | Arithmetic Mean | 95% UCL (Distribution) | | Maximum Concentration (Qualifier) | | Exposure Point Concentration | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Value | Units | Statistic | Rationale |
| Alluvial Aquifer - Water in Excavation Pit | 1,1,2,2-Tetrachloroethane | UG/L | 1.5E+00 | 5.9E+00 | (NP) | 3.2E+00 | J | 1.5E+00 | UG/L | Mean-N | (5) |
| | 1,1,2-Trichloroethane | UG/L | 1.5E+00 | 5.9E+00 | (NP) | 3.4E+00 | J | 1.5E+00 | UG/L | Mean-N | (5) |
| | 1,2-Dibromo-3-chloropropane | UG/L | 1.2E+00 | 5.3E+00 | (NP) | 3.8E+00 | J | 1.2E+00 | UG/L | Mean-N | (5) |
| | 1,2-Dichlorobenzene | UG/L | 8.9E+00 | 6.2E+01 | (T) | 8.7E+01 | J | 8.1E+00 | UG/L | Mean-T | (1) |
| | 1,2-Dichloropropane | UG/L | 1.7E+00 | 6.3E+00 | (NP) | 9.6E-01 | | 9.6E-01 | UG/L | Max | (5,6) |
| | 1,4-Dichlorobenzene | UG/L | 1.6E+00 | 1.9E+00 | (NP) | 2.1E+00 | | 1.8E+00 | UG/L | Mean-N | (5) |
| | Benzene | UG/L | 1.5E+00 | 1.5E+00 | (NP) | 1.8E+00 | J | 1.4E+00 | UG/L | Mean-N | (5) |
| | Bromodichloromethane | UG/L | 1.7E+00 | 6.3E+00 | (NP) | 6.1E-01 | | 6.1E-01 | UG/L | Max | (5,6) |
| | Chlorobenzene | UG/L | 5.9E+00 | 3.6E+01 | (NP) | 9.4E+01 | J | 6.6E+00 | UG/L | Mean-N | (5) |
| | Chloroform | UG/L | 1.7E+00 | 6.3E+00 | (NP) | 2.2E+00 | | 1.7E+00 | UG/L | Mean-N | (5) |
| | Methylene chloride | UG/L | 2.2E+00 | 6.8E+00 | (NP) | 4.4E+00 | | 2.2E+00 | UG/L | Mean-N | (5) |
| | Tetrachloroethene | UG/L | 1.4E+00 | 1.5E+00 | (NP) | 1.9E+00 | L | 1.4E+00 | UG/L | Mean-N | (5) |
| | Trichloroethene | UG/L | 2.4E+00 | 3.0E+00 | (NP) | 9.4E+00 | | 1.9E+00 | UG/L | Mean-N | (1,3,4) |
| | Vinyl chloride | UG/L | 2.2E+00 | 2.0E+00 | (NP) | 7.6E+00 | | 1.1E+00 | UG/L | Mean-N | (1,3,4) |
| | cis-1,2-Dichloroethene | UG/L | 4.0E+00 | 5.4E+00 | (NP) | 2.2E+01 | | 3.3E+00 | UG/L | Mean-N | (1,3,4) |
| | Aluminum | UG/L | 3.4E+03 | 8.3E+03 | (NP) | 1.7E+04 | | 3.4E+03 | UG/L | Mean-N | (1,3,4) |
| | Arsenic | UG/L | 5.9E+00 | 8.4E+00 | (NP) | 1.2E+01 | | 6.5E+00 | UG/L | Mean-N | (1,2,3,4) |
| | Chromium | UG/L | 6.8E+00 | 1.1E+01 | (NP) | 3.7E+01 | | 6.9E+00 | UG/L | Mean-N | (1,3,4) |
| | Chromium (hexavalent) | UG/L | 2.6E+01 | 4.6E+01 | (NP) | 6.8E+01 | | 3.2E+01 | UG/L | Mean-N | (1,2) |
| | Iron | UG/L | 1.1E+04 | 2.3E+04 | (NP) | 3.6E+04 | | 1.1E+04 | UG/L | Mean-N | (1,3,4) |
| | Manganese | UG/L | 1.1E+03 | 2.1E+03 | (G) | 5.1E+03 | | 1.1E+03 | UG/L | Mean-N | (3,4) |
| | Nickel | UG/L | 4.7E+01 | 9.5E+01 | (NP) | 3.4E+02 | | 4.8E+01 | UG/L | Mean-N | (1,3,4) |
| | Vanadium | UG/L | 5.6E+00 | 1.4E+01 | (NP) | 3.0E+01 | J | 5.4E+00 | UG/L | Mean-N | (1,3,4) |

ProUCL, Version 4.0 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate RME EPC, following recommendations based on distribution and standard deviation in users guide (USEPA. April 2007. ProUCL, Version 4.0. Prepared by Lockheed Martin Environmental Services).
Statistics: Mean of data assuming normal distribution (Mean-N); Mean of data assuming lognormal distribution (Mean-T); Maximum Detected Value (Max)

(1) Shapiro-Wilk W Test/Lilliefors test indicates data are log-normally distributed.
(2) Shapiro-Wilk W Test/Lilliefors indicates data are normally distributed.
(3) Anderson-Darling Test indicates data are gamma distributed.
(4) Kolmogorov-Smirnov Test indicates data are gamma distributed.
(5) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).
(6) Max value used because mean greater than max.

N = Normal
T = Log-Transformed
NP = Non-Parametric
G = Gamma

UG/L = micrograms liter
L = Biased Low
J = Estimated Value
K = Biased High

Table 3.3.CTE
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
CENTRAL TENDENCY EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air

| Exposure Point | Chemical of Potential Concern | Units | Arithmetic Mean | 95% UCL (Distribution) | | Maximum Concentration (Qualifier) | | Exposure Point Concentration | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Value | Units | Statistic | Rationale |
| Alluvial Aquifer - Water Vapors at Showerhead | 1,1,2,2-Tetrachloroethane | UG/L | 1.5E+00 | 5.9E+00 | (NP) | 3.2E+00 | J | 1.5E+00 | UG/L | Mean-N | (5) |
| | 1,1,2-Trichloroethane | UG/L | 1.5E+00 | 5.9E+00 | (NP) | 3.4E+00 | J | 1.5E+00 | UG/L | Mean-N | (5) |
| | 1,2-Dibromo-3-chloropropane | UG/L | 1.2E+00 | 5.3E+00 | (NP) | 3.8E+00 | J | 1.2E+00 | UG/L | Mean-N | (5) |
| | 1,2-Dichlorobenzene | UG/L | 8.9E+00 | 6.2E+01 | (T) | 8.7E+01 | J | 8.1E+00 | UG/L | Mean-T | (1) |
| | 1,2-Dichloropropane | UG/L | 1.7E+00 | 6.3E+00 | (NP) | 9.6E-01 | | 9.6E-01 | UG/L | Max | (5,6) |
| | 1,4-Dichlorobenzene | UG/L | 1.6E+00 | 1.9E+00 | (NP) | 2.1E+00 | | 1.8E+00 | UG/L | Mean-N | (5) |
| | Benzene | UG/L | 1.5E+00 | 1.5E+00 | (NP) | 1.8E+00 | J | 1.4E+00 | UG/L | Mean-N | (5) |
| | Bromodichloromethane | UG/L | 1.7E+00 | 6.3E+00 | (NP) | 6.1E-01 | | 6.1E-01 | UG/L | Max | (5,6) |
| | Chlorobenzene | UG/L | 5.9E+00 | 3.6E+01 | (NP) | 9.4E+01 | J | 6.6E+00 | UG/L | Mean-N | (5) |
| | Chloroform | UG/L | 1.7E+00 | 6.3E+00 | (NP) | 2.2E+00 | | 1.7E+00 | UG/L | Mean-N | (5) |
| | Methylene chloride | UG/L | 2.2E+00 | 6.8E+00 | (NP) | 4.4E+00 | | 2.2E+00 | UG/L | Mean-N | (5) |
| | Tetrachloroethene | UG/L | 1.4E+00 | 1.5E+00 | (NP) | 1.9E+00 | L | 1.4E+00 | UG/L | Mean-N | (5) |
| | Trichloroethene | UG/L | 2.4E+00 | 3.0E+00 | (NP) | 9.4E+00 | | 1.9E+00 | UG/L | Mean-N | (1,3,4) |
| | Vinyl chloride | UG/L | 2.2E+00 | 2.0E+00 | (NP) | 7.6E+00 | | 1.1E+00 | UG/L | Mean-N | (1,3,4) |
| | cis-1,2-Dichloroethene | UG/L | 4.0E+00 | 5.4E+00 | (NP) | 2.2E+01 | | 3.3E+00 | UG/L | Mean-N | (1,3,4) |

ProUCL, Version 4.0 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate RME EPC, following recommendations based on distribution and standard deviation in users guide (USEPA. April 2007. ProUCL, Version 4.0. Prepared by Lockheed Martin Environmental Services).
Statistics: Mean of data assuming normal distribution (Mean-N); Mean of data assuming lognormal distribution (Mean-T); Maximum Detected Value (Max)

(1) Shapiro-Wilk W Test/Lilliefors test indicates data are log-normally distributed.
(2) Shapiro-Wilk W Test/Lilliefors indicates data are normally distributed.
(3) Anderson-Darling Test indicates data are gamma distributed.
(4) Kolmogorov-Smirnov Test indicates data are gamma distributed.
(5) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).
(6) Max value used because mean greater than max.

N = Normal
T = Log-Transformed
NP = Non-Parametric
G = Gamma

UG/L = micrograms liter
L = Biased Low
J = Estimated Value
K = Biased High

Table 3.5.CTE
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
CENTRAL TENDENCY EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

| Exposure Point | Chemical of Potential Concern | Units | Arithmetic Mean | 95% UCL (Distribution) | | Maximum Concentration (Qualifier) | | Exposure Point Concentration | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Value | Units | Statistic | Rationale |
| Bedrock Aquifer - Tap Water | Methylene chloride | UG_L | 1.5E+02 | 3.6E+02 | (NP) | 4.4E+03 | | 1.4E+02 | UG_L | Mean-N | (1,3,4) |
| | Tetrachloroethene | UG_L | 1.7E+00 | 5.3E+00 | (NP) | 1.4E+00 | | 1.4E+00 | UG_L | Max | (5,6) |
| | Trichloroethene | UG_L | 2.1E+00 | 2.0E+00 | (NP) | 8.9E+00 | | 1.4E+00 | UG_L | Mean-N | (1,3,4) |
| | cis-1,2-Dichloroethene | UG_L | 2.1E+00 | 2.2E+00 | (NP) | 1.1E+01 | | 1.7E+00 | UG_L | Mean-N | (1,3,4) |
| | bis(2-Ethylhexyl)phthalate | UG_L | 3.7E+00 | 3.7E+00 | (NP) | 2.1E+01 | | 2.1E+00 | UG_L | Mean-N | (1,2) |
| | Aluminum | UG_L | 1.6E+03 | 6.3E+03 | (NP) | 1.7E+04 | J | 1.6E+03 | UG_L | Mean-N | (5) |
| | Antimony | UG_L | 1.7E+01 | 4.5E+01 | (NP) | 3.3E+00 | J | 3.3E+00 | UG_L | Max | (5,6) |
| | Arsenic | UG_L | 4.0E+00 | 4.9E+00 | (NP) | 1.1E+01 | K | 4.1E+00 | UG_L | Mean-N | (1,2,3,4) |
| | Chromium | UG_L | 1.6E+01 | 3.6E+01 | (NP) | 2.5E+02 | | 1.6E+01 | UG_L | Mean-N | (1,3,4) |
| | Iron | UG_L | 3.0E+03 | 9.3E+03 | (NP) | 2.0E+04 | | 3.0E+03 | UG_L | Mean-N | (5) |
| | Lead | UG_L | 3.9E+00 | 4.6E+00 | (NP) | 1.9E+01 | K | 3.2E+00 | UG_L | Mean-N | (7) |
| | Manganese | UG_L | 1.3E+02 | 4.2E+02 | (NP) | 7.4E+02 | | 1.3E+02 | UG_L | Mean-N | (5) |
| | Nickel | UG_L | 1.4E+01 | 2.4E+01 | (NP) | 1.6E+02 | | 1.3E+01 | UG_L | Mean-N | (1,3,4) |
| | Thallium | UG_L | 7.8E+00 | 5.9E+00 | (NP) | 6.2E+00 | K | 5.9E+00 | UG_L | Mean-N | (5) |
| | Vanadium | UG_L | 8.6E+00 | 6.5E+00 | (NP) | 2.8E+01 | J | 3.7E+00 | UG_L | Mean-N | (1,3,4) |

ProUCL, Version 4.0 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate RME EPC, following recommendations based on distribution and standard deviation in users guide (USEPA. April 2007. ProUCL, Version 4.0. Prepared by Lockheed Martin Environmental Services).
Options: 99% Kaplan-Meier Chebyshev (99% KM); 97.5% Kaplan-Meier Chebyshev (97.5% KM); 95% Kaplan-Meier (t) UCL (95% KM-t); 95% Adjusted Gamma (Adj. Gamma); 95% KM (BCA) UCL (95% KM-BCA); Maximum Detected Value (Max); Mean Detected Value (Mean-N); 99% Chebyshev (mean, std) UCL (99% Cheb-m)

(1) Shapiro-Wilk W Test/Lilliefors test indicates data are log-normally distributed.
(2) Shapiro-Wilk W Test/Lilliefors indicates data are normally distributed.
(3) Anderson-Darling Test indicates data are gamma distributed.
(4) Kolmogorov-Smirnov Test indicates data are gamma distributed.
(5) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).
(6) Max value used because 95% UCL greater than max.
(7) Mean value used for lead model

UG/L = micrograms liter
N = Normal
L = Biased Low
T = Log-Transformed
J = Estimated Value
NP = Non-Parametric
K = Biased High
G = Gamma

TABLE 4.1.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Ingestion | Resident | Adult | Alluvial Aquifer - Tap Water | CW | Chemical Concentration in Water | See Table 3.1.RME | µg/l | See Table 3.1.RME | Chronic Daily Intake (CDI) (mg/kg-day) = |
| | | | | IR-W | Ingestion Rate of Water | 2 | liters/day | EPA, 1997 | CW x IR-W x EF x ED x CF2 x 1/BW x 1/AT |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 1991 | |
| | | | | ED | Exposure Duration | 24 | years | EPA, 1991 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | BW | Body Weight | 70 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 8,760 | days | EPA, 1989 | |
| | | Child | Alluvial Aquifer - Tap Water | CW | Chemical Concentration in Water | See Table 3.1.RME | µg/l | See Table 3.1.RME | CDI (mg/kg-day) = |
| | | | | IR-W | Ingestion Rate of Water | 1 | liters/day | EPA, 1997 | CW x IR-W x EF x ED x CF2 x 1/BW x 1/AT |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 1991 | |
| | | | | ED | Exposure Duration | 6 | years | EPA, 1991 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | BW | Body Weight | 15 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 2,190 | days | EPA, 1989 | |
| | | Child/Adult | Alluvial Aquifer - Tap Water | CW | Chemical Concentration in Water | See Table 3.1.RME | µg/l | See Table 3.1.RME | CDI (mg/kg-day) = |
| | | | | IR-W-A | Ingestion Rate of Water, Adult | 2 | liters/day | EPA, 1997 | CW x IR-W-Adj x EF x CF2 x 1/AT |
| | | | | IR-W-C | Ingestion Rate of Water, Child | 1 | liters/day | EPA, 1997 | |
| | | | | IR-W-Adj | Ingestion Rate of Water, Age-adjusted | 1.09 | liter-year/kg-day | calculated | IR-W-Adj (liter-year/kd-day) = |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 1991 | (ED-C x IR-W-C / BW-C) + |
| | | | | ED-A | Exposure Duration, Adult | 24 | years | EPA, 1991 | (ED-A x IR-W-A / BW-A) |
| | | | | ED-C | Exposure Duration, Child | 6 | years | EPA, 1991 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | BW-A | Body Weight , Adult | 70 | kg | EPA, 1991 | |
| | | | | BW-C | Body Weight, Child | 15 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |

TABLE 4.1.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Dermal | Resident | Adult | Alluvial Aquifer - Tap Water | CW | Chemical Concentration in Water | See Table 3.1.RME | µg/l | See Table 3.1.RME | CDI (mg/kg-day) = |
| | | | | DAevent | Dermally Absorbed Dose per Event | calculated | $mg/cm^2$-event | calculated | DAevent x SA x EV x EF x ED x 1/BW x 1/AT |
| | | | | FA | Fraction absorbed water | chemical specific | dimensionless | EPA, 2004 | |
| | | | | $K_p$ | Permeability Coefficient | chemical specific | cm/hr | EPA, 2004 | Inorganics: DAevent ($mg/cm^2$-event) = |
| | | | | $\tau$ | Lag Time | chemical specific | hr/event | EPA, 2004 | Kp x CW x $t_{event}$ x CF2 x CF3 |
| | | | | t* | Time to Reach Steady-state | chemical specific | hours | EPA, 2004 | |
| | | | | B | Ratio of Permeability of Stratum Corneum to Epidermis | chemical specific | dimensionless | EPA, 2004 | Organics : |
| | | | | $t_{event}$ | Event Time | 0.58 | hr/event | EPA, 2004 | $t_{event} \leq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | SA | Skin Surface Area Available for Contact | 18,000 | $cm^2$ | EPA, 2004 | 2 x FA x Kp x CW x (sqrt((6 x $\tau$ x $t_{event}$)/$\pi$)) |
| | | | | EV | Event Frequency | 1 | events/day | EPA, 2004 | x CF2 x CF3 |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 2004 | |
| | | | | ED | Exposure Duration | 24 | years | EPA, 2004 | $t_{event} \geq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | BW | Body Weight | 70 | kg | EPA, 1991 | FA x Kp x CW x ( $t_{event}$/(1+B) + 2 x $\tau$ x |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | ((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF2 x CF3 |
| | | | | AT-N | Averaging Time (Non-Cancer) | 8,760 | days | EPA, 1989 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | CF2 | Conversion Factor 2 | 0.001 | $l/cm^3$ | - - | |
| | | Child | Alluvial Aquifer - Tap Water | CW | Chemical Concentration in Water | See Table 3.1.RME | µg/l | See Table 3.1.RME | CDI (mg/kg-day) = |
| | | | | DAevent | Dermally Absorbed Dose per Event | calculated | $mg/cm^2$-event | calculated | DAevent x SA x EV x EF x ED x 1/BW x 1/AT |
| | | | | FA | Fraction absorbed water | chemical specific | dimensionless | EPA, 2004 | |
| | | | | $K_p$ | Permeability Coefficient | chemical specific | cm/hr | EPA, 2004 | Inorganics: DAevent ($mg/cm^2$-event) = |
| | | | | $\tau$ | Lag Time | chemical specific | hr/event | EPA, 2004 | Kp x CW x $t_{event}$ x CF2 x CF3 |
| | | | | t* | Time to Reach Steady-state | chemical specific | hours | EPA, 2004 | |
| | | | | B | Ratio of Permeability of Stratum Corneum to Epidermis | chemical specific | dimensionless | EPA, 2004 | Organics : |
| | | | | $t_{event}$ | Event Time | 1.0 | hr/event | EPA, 2004 | $t_{event} \leq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | SA | Skin Surface Area Available for Contact | 6,600 | $cm^2$ | EPA, 2004 | 2 x FA x Kp x CW x (sqrt((6 x $\tau$ x $t_{event}$)/$\pi$)) |
| | | | | EV | Event Frequency | 1 | events/day | EPA, 2004 | x CF2 x CF3 |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 2004 | |
| | | | | ED | Exposure Duration | 6 | years | EPA, 2004 | $t_{event} \geq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | BW | Body Weight | 15 | kg | EPA, 1991 | FA x Kp x CW x ( $t_{event}$/(1+B) + 2 x $\tau$ x |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | ((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF2 x CF3 |
| | | | | AT-N | Averaging Time (Non-Cancer) | 2,190 | days | EPA, 1989 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | CF2 | Conversion Factor 2 | 0.001 | $l/cm^3$ | - - | |

TABLE 4.1.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Dermal | Resident | Child/Adult | Alluvial Aquifer - Tap Water | CW | Chemical Concentration in Water | See Table 3.1.RME | µg/l | See Table 3.1.RME | CDI (mg/kg-day) = DA-Adj x EF x 1/AT |
| | | | | DAevent-A | Dermally Absorbed Dose per Event, Adult | calculated | $mg/cm^2$-event | calculated | |
| | | | | DAevent-C | Dermally Absorbed Dose per Event, Child | calculated | $mg/cm^2$-event | calculated | DA-Adj = (Daevent-A x SA-A x ED-A x 1/BW-A) |
| | | | | DA-Adj | Dermally Absorbed Dose, Age-adjusted | calculated | mg-year/event-kg | calculated | + (Daevent-C x SA-C x ED-C x 1/BW-C) |
| | | | | FA | Fraction absorbed water | chemical specific | dimensionless | EPA, 2004 | |
| | | | | $K_p$ | Permeability Coefficient | chemical specific | cm/hr | EPA, 2004 | Inorganics: DAevent ($mg/cm^2$-event) = |
| | | | | $\tau$ | Lag Time | chemical specific | hr/event | EPA, 2004 | Kp x CW x $t_{event}$ x CF2 x CF3 |
| | | | | t* | Time to Reach Steady-state | chemical specific | hours | EPA, 2004 | |
| | | | | B | Ratio of Permeability of Stratum Corneum to Epidermis | chemical specific | dimensionless | EPA, 2004 | Organics : |
| | | | | $t_{event}$-A | Event Time, Adult | 0.58 | hr/event | EPA, 2004 | $t_{event} \leq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | $t_{event}$-C | Event Time, Child | 1.0 | hr/event | EPA, 2004 | 2 x FA x Kp x CW x (sqrt((6 x $\tau$ x $t_{event}$)/$\pi$)) |
| | | | | SA-A | Skin Surface Area, Adult | 18,000 | $cm^2$ | EPA, 2004 | x CF2 x CF3 |
| | | | | SA-C | Skin Surface Area, Child | 6,600 | $cm^2$ | EPA, 2004 | |
| | | | | EV | Event Frequency | 1 | events/day | EPA, 2004 | $t_{event} \geq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 2004 | FA x Kp x CW x ( $t_{event}$/(1+B) + 2 x $\tau$ x |
| | | | | ED-A | Exposure Duration, Adult | 24 | years | EPA, 2004 | ((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF2 x CF3 |
| | | | | ED-C | Exposure Duration, Child | 6 | years | EPA, 2004 | |
| | | | | BW-A | Body Weight, Adult | 70 | kg | EPA, 1991 | |
| | | | | BW-C | Body Weight, Child | 15 | ke | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | CF2 | Conversion Factor 2 | 0.001 | $l/cm^3$ | - - | |
| | Construction Worker | Adult | Alluvial Aquifer - Water in Excavation Pit | CW | Chemical Concentration in Water | See Table 3.2.RME | µg/l | See Table 3.2.RME | CDI (mg/kg-day) = |
| | | | | DAevent | Dermally Absorbed Dose per Event | calculated | $mg/cm^2$-event | calculated | DAevent x SA x EV x EF x ED x 1/BW x 1/AT |
| | | | | FA | Fraction absorbed water | chemical specific | dimensionless | EPA, 2004 | |
| | | | | $K_p$ | Permeability Coefficient | chemical specific | cm/hr | EPA, 2004 | Inorganics: DAevent ($mg/cm^2$-event) = |
| | | | | $\tau$ | Lag Time | chemical specific | hr/event | EPA, 2004 | Kp x CW x $t_{event}$ x CF2 x CF3 |
| | | | | t* | Time to Reach Steady-state | chemical specific | hours | EPA, 2004 | |
| | | | | B | Ratio of Permeability of Stratum Corneum to Epidermis | chemical specific | dimensionless | EPA, 2004 | Organics : |
| | | | | $t_{event}$ | Event Time | 8 | hr/day | (1) | $t_{event} \leq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | SA | Skin Surface Area Available for Contact | 5,700 | $cm^2$ | EPA, 2004, (3) | 2 x FA x Kp x CW x (sqrt((6 x $\tau$ x $t_{event}$)/$\pi$)) |
| | | | | EV | Event Frequency | 1 | events/day | EPA, 2004 | x CF2 x CF3 |
| | | | | EF | Exposure Frequency | 125 | days/year | (2) | |
| | | | | ED | Exposure Duration | 0.5 | years | EPA, 1991 | $t_{event} \geq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | BW | Body Weight | 70 | kg | EPA, 1991 | FA x Kp x CW x ( $t_{event}$/(1+B) + 2 x $\tau$ x |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | ((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF2 x CF3 |

TABLE 4.1.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Dermal (cont.) | Construction Worker (cont.) | Adult | Alluvial Aquifer - Water in Excavation Pit | AT-N | Averaging Time (Non-Cancer) | 182.5 | days | EPA, 1989 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | CF2 | Conversion Factor 2 | 0.001 | $l/cm^3$ | - - | |

(1) Professional Judgement based on construction activities that would occur 8 hrs per day for the RME.
(2) Assumed duration of construction project may be 1/2 a year.
(3) Skin surface area in contact with groundwater assumed to be hands, forearms, lower legs, and feet.

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.
EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.
EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa.
EPA, 2004 . Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment (Final). EPA/540/R/99/005. July 2004.

TABLE 4.2.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Inhalation | Resident | Adult | Alluvial Aquifer - Water Vapors at Showerhead | CW | Chemical Concentration in Water | See Table 3.3.RME | µg/l | See Table 3.3.RME | Chronic Daily Intake (CDI) (mg/kg-day) = |
| | | | | InhExp | Inhalation Exposure per Shower | calculated | mg/kg-shower | | InhExp x EF x ED x 1/AT |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 1991 | Foster & Chrostowski Shower Inhalation Model for InhExp |
| | | | | ED | Exposure Duration | 24 | years | EPA, 1991 | see Table 7.1.RME Supplement B for InhExp calculation |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 8,760 | days | EPA, 1989 | |
| | Construction Worker | Adult | Alluvial Aquifer - Volatilization from | CW | Chemical Concentration in Water | See Table 3.4.RME | µg/l | See Table 3.4.RME | Chronic Daily Intake (CDI) (mg/kg-day) = |
| | | | Water in Excavation Pit | CA | Chemical Concentration in Air | calculated | $mg/m^3$ | | CA x IN x ET x EF x ED x 1/BW x 1/AT |
| | | | | IN | Inhalation Rate | 2.5 | $m^3$/hour | EPA, 1997 (1) | |
| | | | | ET | Exposure Time | 8 | hr/day | (2) | CA calculated using two-film model |
| | | | | EF | Exposure Frequency | 125 | days/year | (3) | |
| | | | | ED | Exposure Duration | 0.5 | years | EPA, 1991 | |
| | | | | BW | Body Weight | 70 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 182.5 | days | EPA, 1989 | |

Notes:

(1) Inhalation rate is for adults working outdoors performing heavy activities.

(2) Professional Judgement based on construction activities that would occur 8 hrs per day for the RME.

(3) Assumed duration of construction project may be 1/2 a year.

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa.

TABLE 4.3.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Ingestion | Resident | Adult | Bedrock Aquifer - Tap Water | CW | Chemical Concentration in Water | See Table 3.5.RME | µg/l | See Table 3.5.RME | Chronic Daily Intake (CDI) (mg/kg-day) = |
| | | | | IR-W | Ingestion Rate of Water | 2 | liters/day | EPA, 1997 | CW x IR-W x EF x ED x CF2 x 1/BW x 1/AT |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 1991 | |
| | | | | ED | Exposure Duration | 24 | years | EPA, 1991 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | BW | Body Weight | 70 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 8,760 | days | EPA, 1989 | |
| | | Child | Bedrock Aquifer - Tap Water | CW | Chemical Concentration in Water | See Table 3.5.RME | µg/l | See Table 3.5.RME | CDI (mg/kg-day) = |
| | | | | IR-W | Ingestion Rate of Water | 1 | liters/day | EPA, 1997 | CW x IR-W x EF x ED x CF2 x 1/BW x 1/AT |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 1991 | |
| | | | | ED | Exposure Duration | 6 | years | EPA, 1991 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | BW | Body Weight | 15 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 2,190 | days | EPA, 1989 | |
| | | Child/Adult | Bedrock Aquifer - Tap Water | CW | Chemical Concentration in Water | See Table 3.5.RME | µg/l | See Table 3.5.RME | CDI (mg/kg-day) = |
| | | | | IR-W-A | Ingestion Rate of Water, Adult | 2 | liters/day | EPA, 1997 | CW x IR-W-Adj x EF x CF2 x 1/AT |
| | | | | IR-W-C | Ingestion Rate of Water, Child | 1 | liters/day | EPA, 1997 | |
| | | | | IR-W-Adj | Ingestion Rate of Water, Age-adjusted | 1.09 | liter-year/kg-day | calculated | IR-W-Adj (liter-year/kd-day) = |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 1991 | (ED-C x IR-W-C / BW-C) + |
| | | | | ED-A | Exposure Duration, Adult | 24 | years | EPA, 1991 | (ED-A x IR-W-A / BW-A) |
| | | | | ED-C | Exposure Duration, Child | 6 | years | EPA, 1991 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | BW-A | Body Weight , Adult | 70 | kg | EPA, 1991 | |
| | | | | BW-C | Body Weight, Child | 15 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |

TABLE 4.3.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Dermal | Resident | Adult | Bedrock Aquifer - Tap Water | CW | Chemical Concentration in Water | See Table 3.5.RME | µg/l | See Table 3.5.RME | CDI (mg/kg-day) = |
| | | | | DAevent | Dermally Absorbed Dose per Event | calculated | $mg/cm^2$-event | calculated | DAevent x SA x EV x EF x ED x 1/BW x 1/AT |
| | | | | FA | Fraction absorbed water | chemical specific | dimensionless | EPA, 2004 | |
| | | | | $K_p$ | Permeability Coefficient | chemical specific | cm/hr | EPA, 2004 | Inorganics: DAevent ($mg/cm^2$-event) = |
| | | | | $\tau$ | Lag Time | chemical specific | hr/event | EPA, 2004 | Kp x CW x $t_{event}$ x CF2 x CF3 |
| | | | | t* | Time to Reach Steady-state | chemical specific | hours | EPA, 2004 | |
| | | | | B | Ratio of Permeability of Stratum Corneum to Epidermis | chemical specific | dimensionless | EPA, 2004 | Organics : |
| | | | | $t_{event}$ | Event Time | 0.58 | hr/event | EPA, 2004 | $t_{event} \leq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | SA | Skin Surface Area Available for Contact | 18,000 | $cm^2$ | EPA, 2004 | 2 x FA x Kp x CW x (sqrt((6 x $\tau$ x $t_{event}$)/$\pi$)) |
| | | | | EV | Event Frequency | 1 | events/day | EPA, 2004 | x CF2 x CF3 |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 2004 | |
| | | | | ED | Exposure Duration | 24 | years | EPA, 2004 | $t_{event} \geq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | BW | Body Weight | 70 | kg | EPA, 1991 | FA x Kp x CW x ( $t_{event}$/(1+B) + 2 x $\tau$ x |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | ((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF2 x CF3 |
| | | | | AT-N | Averaging Time (Non-Cancer) | 8,760 | days | EPA, 1989 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | CF2 | Conversion Factor 2 | 0.001 | $l/cm^3$ | - - | |
| | | Child | Bedrock Aquifer - Tap Water | CW | Chemical Concentration in Water | See Table 3.5.RME | µg/l | See Table 3.5.RME | CDI (mg/kg-day) = |
| | | | | DAevent | Dermally Absorbed Dose per Event | calculated | $mg/cm^2$-event | calculated | DAevent x SA x EV x EF x ED x 1/BW x 1/AT |
| | | | | FA | Fraction absorbed water | chemical specific | dimensionless | EPA, 2004 | |
| | | | | $K_p$ | Permeability Coefficient | chemical specific | cm/hr | EPA, 2004 | Inorganics: DAevent ($mg/cm^2$-event) = |
| | | | | $\tau$ | Lag Time | chemical specific | hr/event | EPA, 2004 | Kp x CW x $t_{event}$ x CF2 x CF3 |
| | | | | t* | Time to Reach Steady-state | chemical specific | hours | EPA, 2004 | |
| | | | | B | Ratio of Permeability of Stratum Corneum to Epidermis | chemical specific | dimensionless | EPA, 2004 | Organics : |
| | | | | $t_{event}$ | Event Time | 1.0 | hr/event | EPA, 2004 | $t_{event} \leq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | SA | Skin Surface Area Available for Contact | 6,600 | $cm^2$ | EPA, 2004 | 2 x FA x Kp x CW x (sqrt((6 x $\tau$ x $t_{event}$)/$\pi$)) |
| | | | | EV | Event Frequency | 1 | events/day | EPA, 2004 | x CF2 x CF3 |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 2004 | |
| | | | | ED | Exposure Duration | 6 | years | EPA, 2004 | $t_{event} \geq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | BW | Body Weight | 15 | kg | EPA, 1991 | FA x Kp x CW x ( $t_{event}$/(1+B) + 2 x $\tau$ x |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | ((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF2 x CF3 |
| | | | | AT-N | Averaging Time (Non-Cancer) | 2,190 | days | EPA, 1989 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | CF2 | Conversion Factor 2 | 0.001 | $l/cm^3$ | - - | |

TABLE 4.3.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Dermal | Resident | Child/Adult | Bedrock Aquifer - Tap Water | CW | Chemical Concentration in Water | See Table 3.5.RME | µg/l | See Table 3.5.RME | CDI (mg/kg-day) = DA-Adj x EF x 1/AT |
| | | | | DAevent-A | Dermally Absorbed Dose per Event, Adult | calculated | $mg/cm^2$-event | calculated | |
| | | | | DAevent-C | Dermally Absorbed Dose per Event, Child | calculated | $mg/cm^2$-event | calculated | DA-Adj = (Daevent-A x SA-A x ED-A x 1/BW-A) |
| | | | | DA-Adj | Dermally Absorbed Dose, Age-adjusted | calculated | mg-year/event-kg | calculated | + (Daevent-C x SA-C x ED-C x 1/BW-C) |
| | | | | FA | Fraction absorbed water | chemical specific | dimensionless | EPA, 2004 | |
| | | | | $K_p$ | Permeability Coefficient | chemical specific | cm/hr | EPA, 2004 | Inorganics: DAevent ($mg/cm^2$-event) = |
| | | | | $\tau$ | Lag Time | chemical specific | hr/event | EPA, 2004 | Kp x CW x $t_{event}$ x CF2 x CF3 |
| | | | | t* | Time to Reach Steady-state | chemical specific | hours | EPA, 2004 | |
| | | | | B | Ratio of Permeability of Stratum Corneum to Epidermis | chemical specific | dimensionless | EPA, 2004 | Organics : |
| | | | | $t_{event}$-A | Event Time, Adult | 0.58 | hr/event | EPA, 2004 | $t_{event} \leq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | $t_{event}$-C | Event Time, Child | 1.0 | hr/event | EPA, 2004 | 2 x FA x Kp x CW x (sqrt((6 x $\tau$ x $t_{event}$)/$\pi$)) |
| | | | | SA-A | Skin Surface Area, Adult | 18,000 | $cm^2$ | EPA, 2004 | x CF2 x CF3 |
| | | | | SA-C | Skin Surface Area, Child | 6,600 | $cm^2$ | EPA, 2004 | |
| | | | | EV | Event Frequency | 1 | events/day | EPA, 2004 | $t_{event} \geq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 2004 | FA x Kp x CW x ( $t_{event}$/(1+B) + 2 x $\tau$ x |
| | | | | ED-A | Exposure Duration, Adult | 24 | years | EPA, 2004 | ((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF2 x CF3 |
| | | | | ED-C | Exposure Duration, Child | 6 | years | EPA, 2004 | |
| | | | | BW-A | Body Weight, Adult | 70 | kg | EPA, 1991 | |
| | | | | BW-C | Body Weight, Child | 15 | ke | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | CF2 | Conversion Factor 2 | 0.001 | $l/cm^3$ | - - | |

Sources:


EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa.

EPA, 2004 . Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment (Final). EPA/540/R/99/005. July 2004.

TABLE 4.4.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Inhalation | Resident | Adult | Bedrock Aquifer - Water Vapors at Showerhead | CW | Chemical Concentration in Water | See Table 3.6.RME | µg/l | See Table 3.6.RME | Chronic Daily Intake (CDI) (mg/kg-day) = |
| | | | | InhExp | Inhalation Exposure per Shower | calculated | mg/kg-shower | | InhExp x EF x ED x 1/AT |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 1991 | Foster & Chrostowski Shower Inhalation Model for InhExp |
| | | | | ED | Exposure Duration | 24 | years | EPA, 1991 | see Table 7.5.RME Supplement B for InhExp calculation |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 8,760 | days | EPA, 1989 | |

Notes:

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa.

TABLE 4.1.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Ingestion | Resident | Adult | Alluvial Aquifer - Tap Water | CW | Chemical Concentration in Water | See Table 3.1.CTE | µg/l | See Table 3.1.CTE | Chronic Daily Intake (CDI) (mg/kg-day) = |
| | | | | IR-W | Ingestion Rate of Water | 1.4 | liters/day | EPA, 1993 | CW x IR-W x EF x ED x CF2 x 1/BW x 1/AT |
| | | | | EF | Exposure Frequency | 234 | days/year | EPA, 1993 | |
| | | | | ED | Exposure Duration | 9 | years | EPA, 1993 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | BW | Body Weight | 70 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 3,285 | days | EPA, 1989 | |
| | | Child | Alluvial Aquifer - Tap Water | CW | Chemical Concentration in Water | See Table 3.1.CTE | µg/l | See Table 3.1.CTE | CDI (mg/kg-day) = |
| | | | | IR-W | Ingestion Rate of Water | 1 | liters/day | EPA, 1997 | CW x IR-W x EF x ED x CF2 x 1/BW x 1/AT |
| | | | | EF | Exposure Frequency | 234 | days/year | EPA, 1993 | |
| | | | | ED | Exposure Duration | 6 | years | EPA, 1991 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | BW | Body Weight | 15 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 2,190 | days | EPA, 1989 | |
| | | Child/Adult | Alluvial Aquifer - Tap Water | CW | Chemical Concentration in Water | See Table 3.1.CTE | µg/l | See Table 3.1.CTE | CDI (mg/kg-day) = |
| | | | | IR-W-A | Ingestion Rate of Water, Adult | 1.4 | liters/day | EPA, 1993 | CW x IR-W-Adj x EF x CF2 x 1/AT |
| | | | | IR-W-C | Ingestion Rate of Water, Child | 1 | liters/day | EPA, 1997 | |
| | | | | IR-W-Adj | Ingestion Rate of Water, Age-adjusted | 0.58 | liter-year/kg-day | calculated | IR-W-Adj (liter-year/kd-day) = |
| | | | | EF | Exposure Frequency | 234 | days/year | EPA, 1993 | (ED-C x IR-W-C / BW-C) + |
| | | | | ED-A | Exposure Duration, Adult | 9 | years | EPA, 1993 | (ED-A x IR-W-A / BW-A) |
| | | | | ED-C | Exposure Duration, Child | 6 | years | EPA, 1991 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | BW-A | Body Weight , Adult | 70 | kg | EPA, 1991 | |
| | | | | BW-C | Body Weight, Child | 15 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |

TABLE 4.1.CTE

VALUES USED FOR DAILY INTAKE CALCULATIONS

CENTRAL TENDENCY EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Dermal | Resident | Adult | Alluvial Aquifer - Tap Water | CW | Chemical Concentration in Water | See Table 3.1.CTE | µg/l | See Table 3.1.CTE | CDI (mg/kg-day) = |
| | | | | DAevent | Dermally Absorbed Dose per Event | Calculated | $mg/cm^2$-event | calculated | DAevent x SA x EV x EF x ED x 1/BW x 1/AT |
| | | | | FA | Fraction absorbed water | Chemical specific | dimensionless | EPA, 2004 | |
| | | | | $K_p$ | Permeability Coefficient | Chemical specific | cm/hr | EPA, 2004 | Inorganics: DAevent ($mg/cm^2$-event) = |
| | | | | $\tau$ | Lag Time | Chemical specific | hr/event | EPA, 2004 | Kp x CW x $t_{event}$ x CF2 x CF3 |
| | | | | t* | Time to Reach Steady-state | Chemical specific | hours | EPA, 2004 | |
| | | | | B | Ratio of Permeability of Stratum Corneum to Epidermis | Chemical specific | dimensionless | EPA, 2004 | Organics : |
| | | | | $t_{event}$ | Event Time | 0.25 | hr/event | EPA, 2004 | $t_{event} \leq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | SA | Skin Surface Area Available for Contact | 18,000 | $cm^2$ | EPA, 2004 | 2 x FA x Kp x CW x (sqrt((6 x $\tau$ x $t_{event}$)/$\pi$)) |
| | | | | EV | Event Frequency | 1 | events/day | EPA, 2004 | x CF2 x CF3 |
| | | | | EF | Exposure Frequency | 234 | days/year | EPA, 1993 | |
| | | | | ED | Exposure Duration | 9 | years | EPA, 2001 | $t_{event} \geq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | BW | Body Weight | 70 | kg | EPA, 1991 | FA x Kp x CW x ( $t_{event}$/(1+B) + 2 x $\tau$ x |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | ((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF2 x CF3 |
| | | | | AT-N | Averaging Time (Non-Cancer) | 3,285 | days | EPA, 1989 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | CF2 | Conversion Factor 2 | 0.001 | $l/cm^3$ | - - | |
| | | Child | Alluvial Aquifer - Tap Water | CW | Chemical Concentration in Water | See Table 3.1.CTE | µg/l | See Table 3.1.CTE | CDI (mg/kg-day) = |
| | | | | DAevent | Dermally Absorbed Dose per Event | Calculated | $mg/cm^2$-event | calculated | DAevent x SA x EV x EF x ED x 1/BW x 1/AT |
| | | | | FA | Fraction absorbed water | Chemical specific | dimensionless | EPA, 2004 | |
| | | | | $K_p$ | Permeability Coefficient | Chemical specific | cm/hr | EPA, 2004 | Inorganics: DAevent ($mg/cm^2$-event) = |
| | | | | $\tau$ | Lag Time | Chemical specific | hr/event | EPA, 2004 | Kp x CW x $t_{event}$ x CF2 x CF3 |
| | | | | t* | Time to Reach Steady-state | Chemical specific | hours | EPA, 2004 | |
| | | | | B | Ratio of Permeability of Stratum Corneum to Epidermis | Chemical specific | dimensionless | EPA, 2004 | Organics : |
| | | | | $t_{event}$ | Event Time | 0.33 | hr/event | EPA, 2004 | $t_{event} \leq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | SA | Skin Surface Area Available for Contact | 6,600 | $cm^2$ | EPA, 2004 | 2 x FA x Kp x CW x (sqrt((6 x $\tau$ x $t_{event}$)/$\pi$)) |
| | | | | EV | Event Frequency | 1 | events/day | EPA, 2004 | x CF2 x CF3 |
| | | | | EF | Exposure Frequency | 234 | days/year | EPA, 1993 | |
| | | | | ED | Exposure Duration | 6 | years | EPA, 2001 | $t_{event} \geq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | BW | Body Weight | 15 | kg | EPA, 1991 | FA x Kp x CW x ( $t_{event}$/(1+B) + 2 x $\tau$ x |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | ((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF2 x CF3 |
| | | | | AT-N | Averaging Time (Non-Cancer) | 2,190 | days | EPA, 1989 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | CF2 | Conversion Factor 2 | 0.001 | $l/cm^3$ | - - | |

TABLE 4.1.CTE

VALUES USED FOR DAILY INTAKE CALCULATIONS

CENTRAL TENDENCY EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Dermal | Resident | Child/Adult | Alluvial Aquifer - Tap Water | CW | Chemical Concentration in Water | See Table 3.1.CTE | µg/l | See Table 3.1.CTE | CDI (mg/kg-day) = DA-Adj x EF x 1/AT |
| | | | | DAevent-A | Dermally Absorbed Dose per Event, Adult | Calculated | $mg/cm^2$-event | calculated | |
| | | | | DAevent-C | Dermally Absorbed Dose per Event, Child | Calculated | $mg/cm^2$-event | calculated | DA-Adj = (Daevent-A x SA-A x ED-A x 1/BW-A) |
| | | | | DA-Adj | Dermally Absorbed Dose, Age-adjusted | Calculated | mg-year/event-kg | calculated | + (Daevent-C x SA-C x ED-C x 1/BW-C) |
| | | | | FA | Fraction absorbed water | Chemical specific | dimensionless | EPA, 2004 | |
| | | | | $K_p$ | Permeability Coefficient | Chemical specific | cm/hr | EPA, 2004 | Inorganics: DAevent ($mg/cm^2$-event) = |
| | | | | $\tau$ | Lag Time | Chemical specific | hr/event | EPA, 2004 | Kp x CW x $t_{event}$ x CF2 x CF3 |
| | | | | t* | Time to Reach Steady-state | Chemical specific | hours | EPA, 2004 | |
| | | | | B | Ratio of Permeability of Stratum Corneum to Epidermis | Chemical specific | dimensionless | EPA, 2004 | Organics : |
| | | | | $t_{event}$-A | Event Time, Adult | 0.25 | hr/event | EPA, 2004 | $t_{event} \leq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | $t_{event}$-C | Event Time, Child | 0.33 | hr/event | EPA, 2004 | 2 x FA x Kp x CW x (sqrt((6 x $\tau$ x $t_{event}$)/$\pi$)) |
| | | | | SA-A | Skin Surface Area, Adult | 18,000 | $cm^2$ | EPA, 2004 | x CF2 x CF3 |
| | | | | SA-C | Skin Surface Area, Child | 6,600 | $cm^2$ | EPA, 2004 | |
| | | | | EV | Event Frequency | 1 | events/day | EPA, 2004 | $t_{event} \geq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | EF | Exposure Frequency | 234 | days/year | EPA, 1993 | FA x Kp x CW x ( $t_{event}$/(1+B) + 2 x $\tau$ x |
| | | | | ED-A | Exposure Duration, Adult | 9 | years | EPA, 2001 | ((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF2 x CF3 |
| | | | | ED-C | Exposure Duration, Child | 6 | years | EPA, 2001 | |
| | | | | BW-A | Body Weight, Adult | 70 | kg | EPA, 1991 | |
| | | | | BW-C | Body Weight, Child | 15 | ke | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | CF2 | Conversion Factor 2 | 0.001 | $l/cm^3$ | - - | |
| | Construction Worker | Adult | Alluvial Aquifer - Water in Excavation Pit | CW | Chemical Concentration in Water | See Table 3.2.CTE | µg/l | See Table 3.2.CTE | CDI (mg/kg-day) = |
| | | | | DAevent | Dermally Absorbed Dose per Event | Calculated | $mg/cm^2$-event | calculated | DAevent x SA x EV x EF x ED x 1/BW x 1/AT |
| | | | | FA | Fraction absorbed water | Chemical specific | dimensionless | EPA, 2004 | |
| | | | | $K_p$ | Permeability Coefficient | Chemical specific | cm/hr | EPA, 2004 | Inorganics: DAevent ($mg/cm^2$-event) = |
| | | | | $\tau$ | Lag Time | Chemical specific | hr/event | EPA, 2004 | Kp x CW x $t_{event}$ x CF2 x CF3 |
| | | | | t* | Time to Reach Steady-state | Chemical specific | hours | EPA, 2004 | |
| | | | | B | Ratio of Permeability of Stratum Corneum to Epidermis | Chemical specific | dimensionless | EPA, 2004 | Organics : |
| | | | | $t_{event}$ | Event Time | 4 | hr/day | (1) | $t_{event} \leq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | SA | Skin Surface Area Available for Contact | 5,700 | $cm^2$ | EPA, 2001, (3) | 2 x FA x Kp x CW x (sqrt((6 x $\tau$ x $t_{event}$)/$\pi$)) |
| | | | | EV | Event Frequency | 1 | events/day | EPA, 2001 | x CF2 x CF3 |
| | | | | EF | Exposure Frequency | 125 | days/year | (2) | |
| | | | | ED | Exposure Duration | 0.5 | years | EPA, 1991 | $t_{event} \geq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | BW | Body Weight | 70 | kg | EPA, 1991 | FA x Kp x CW x ( $t_{event}$/(1+B) + 2 x $\tau$ x |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | ((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF2 x CF3 |

TABLE 4.1.CTE

VALUES USED FOR DAILY INTAKE CALCULATIONS

CENTRAL TENDENCY EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Dermal (cont.) | Construction Worker (cont.) | Adult | Alluvial Aquifer - Water in Excavation Pit | AT-N | Averaging Time (Non-Cancer) | 182.5 | days | EPA, 1989 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | CF2 | Conversion Factor 2 | 0.001 | $l/cm^3$ | - - | |

(1) Professional judgement assuming 1/2 RME value for CT.

(2) Assumed duration of construction project may be 1/2 a year.

(3) Skin surface area in contact with groundwater assumed to be hands, forearms, lower legs, and feet.

Sources:


EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1993: Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa.

EPA, 2001: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. EPA/540/R/99/005.

EPA, 2004 . Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment (Final). EPA/540/R/99/005. July 2004.

TABLE 4.2.CTE

VALUES USED FOR DAILY INTAKE CALCULATIONS

CENTRAL TENDENCY EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Inhalation | Resident | Adult | Alluvial Aquifer - Water Vapors at Showerhead | CW | Chemical Concentration in Water | See Table 3.3.CTE | µg/l | See Table 3.3.CTE | Chronic Daily Intake (CDI) (mg/kg-day) = |
| | | | | InhExp | Inhalation Exposure per Shower | Calculated | mg/kg-shower | | InhExp x EF x ED x 1/AT |
| | | | | EF | Exposure Frequency | 234 | days/year | EPA, 1993 | Foster & Chrostowski Shower Inhalation Model for InhExp |
| | | | | ED | Exposure Duration | 9 | years | EPA, 2001 | see Table 7.1.CTE Supplement B for InhExp calculation |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 3,285 | days | EPA, 1989 | |
| | Construction Worker | Adult | Alluvial Aquifer - Volatilization from | CW | Chemical Concentration in Water | See Table 3.4.CTE | µg/l | See Table 3.4.CTE | Chronic Daily Intake (CDI) (mg/kg-day) = |
| | | | Water in Excavation Pit | CA | Chemical Concentration in Air | Calculated | $mg/m^3$ | | CA x IN x ET x EF x ED x 1/BW x 1/AT |
| | | | | IN | Inhalation Rate | 1.2 | m3/hour | EPA, 1997 (1) | |
| | | | | ET | Exposure Time | 4 | hr/day | (2) | CA calculated using two-film model |
| | | | | EF | Exposure Frequency | 125 | days/year | (3) | |
| | | | | ED | Exposure Duration | 0.5 | years | EPA, 1991 | |
| | | | | BW | Body Weight | 70 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 182.5 | days | EPA, 1989 | |

Notes:

(1) Inhalation rate is for adult outdoor workers performing moderate activities.

(2) Assumed construction workers could spend 4 hours/day near the excavation trench.

(3) Assumed duration of construction project may be 1/2 a year.

Sources:


EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1993: Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa.

EPA, 2001: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. EPA/540/R/99/005.

TABLE 4.3.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Ingestion | Resident | Adult | Bedrock Aquifer - Tap Water | CW | Chemical Concentration in Water | See Table 3.5.CTE | µg/l | See Table 3.5.CTE | Chronic Daily Intake (CDI) (mg/kg-day) = |
| | | | | IR-W | Ingestion Rate of Water | 1.4 | liters/day | EPA, 1993 | CW x IR-W x EF x ED x CF2 x 1/BW x 1/AT |
| | | | | EF | Exposure Frequency | 234 | days/year | EPA, 1993 | |
| | | | | ED | Exposure Duration | 9 | years | EPA, 1993 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | BW | Body Weight | 70 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 3,285 | days | EPA, 1989 | |
| | | Child | Bedrock Aquifer - Tap Water | CW | Chemical Concentration in Water | See Table 3.5.CTE | µg/l | See Table 3.5.CTE | CDI (mg/kg-day) = |
| | | | | IR-W | Ingestion Rate of Water | 1 | liters/day | EPA, 1997 | CW x IR-W x EF x ED x CF2 x 1/BW x 1/AT |
| | | | | EF | Exposure Frequency | 234 | days/year | EPA, 1993 | |
| | | | | ED | Exposure Duration | 6 | years | EPA, 1991 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | BW | Body Weight | 15 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 2,190 | days | EPA, 1989 | |
| | | Child/Adult | Bedrock Aquifer - Tap Water | CW | Chemical Concentration in Water | See Table 3.5.CTE | µg/l | See Table 3.5.CTE | CDI (mg/kg-day) = |
| | | | | IR-W-A | Ingestion Rate of Water, Adult | 1.4 | liters/day | EPA, 1993 | CW x IR-W-Adj x EF x CF2 x 1/AT |
| | | | | IR-W-C | Ingestion Rate of Water, Child | 1 | liters/day | EPA, 1997 | |
| | | | | IR-W-Adj | Ingestion Rate of Water, Age-adjusted | 0.58 | liter-year/kg-day | calculated | IR-W-Adj (liter-year/kd-day) = |
| | | | | EF | Exposure Frequency | 234 | days/year | EPA, 1993 | (ED-C x IR-W-C / BW-C) + |
| | | | | ED-A | Exposure Duration, Adult | 9 | years | EPA, 1993 | (ED-A x IR-W-A / BW-A) |
| | | | | ED-C | Exposure Duration, Child | 6 | years | EPA, 1991 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | BW-A | Body Weight , Adult | 70 | kg | EPA, 1991 | |
| | | | | BW-C | Body Weight, Child | 15 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |

TABLE 4.3.CTE

VALUES USED FOR DAILY INTAKE CALCULATIONS

CENTRAL TENDENCY EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Dermal | Resident | Adult | Bedrock Aquifer - Tap Water | CW | Chemical Concentration in Water | See Table 3.5.CTE | µg/l | See Table 3.5.CTE | CDI (mg/kg-day) = |
| | | | | DAevent | Dermally Absorbed Dose per Event | Calculated | $mg/cm^2$-event | calculated | DAevent x SA x EV x EF x ED x 1/BW x 1/AT |
| | | | | FA | Fraction absorbed water | Chemical specific | dimensionless | EPA, 2004 | |
| | | | | $K_p$ | Permeability Coefficient | Chemical specific | cm/hr | EPA, 2004 | Inorganics: DAevent ($mg/cm^2$-event) = |
| | | | | $\tau$ | Lag Time | Chemical specific | hr/event | EPA, 2004 | Kp x CW x $t_{event}$ x CF2 x CF3 |
| | | | | t* | Time to Reach Steady-state | Chemical specific | hours | EPA, 2004 | |
| | | | | B | Ratio of Permeability of Stratum Corneum to Epidermis | Chemical specific | dimensionless | EPA, 2004 | Organics : |
| | | | | $t_{event}$ | Event Time | 0.25 | hr/event | EPA, 2004 | $t_{event} \leq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | SA | Skin Surface Area Available for Contact | 18,000 | $cm^2$ | EPA, 2004 | 2 x FA x Kp x CW x (sqrt((6 x $\tau$ x $t_{event}$)/$\pi$)) |
| | | | | EV | Event Frequency | 1 | events/day | EPA, 2004 | x CF2 x CF3 |
| | | | | EF | Exposure Frequency | 234 | days/year | EPA, 1993 | |
| | | | | ED | Exposure Duration | 9 | years | EPA, 2001 | $t_{event} \geq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | BW | Body Weight | 70 | kg | EPA, 1991 | FA x Kp x CW x ( $t_{event}$/(1+B) + 2 x $\tau$ x |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | ((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF2 x CF3 |
| | | | | AT-N | Averaging Time (Non-Cancer) | 3,285 | days | EPA, 1989 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | CF2 | Conversion Factor 2 | 0.001 | $l/cm^3$ | - - | |
| | | Child | Bedrock Aquifer - Tap Water | CW | Chemical Concentration in Water | See Table 3.5.CTE | µg/l | See Table 3.5.CTE | CDI (mg/kg-day) = |
| | | | | DAevent | Dermally Absorbed Dose per Event | Calculated | $mg/cm^2$-event | calculated | DAevent x SA x EV x EF x ED x 1/BW x 1/AT |
| | | | | FA | Fraction absorbed water | Chemical specific | dimensionless | EPA, 2004 | |
| | | | | $K_p$ | Permeability Coefficient | Chemical specific | cm/hr | EPA, 2004 | Inorganics: DAevent ($mg/cm^2$-event) = |
| | | | | $\tau$ | Lag Time | Chemical specific | hr/event | EPA, 2004 | Kp x CW x $t_{event}$ x CF2 x CF3 |
| | | | | t* | Time to Reach Steady-state | Chemical specific | hours | EPA, 2004 | |
| | | | | B | Ratio of Permeability of Stratum Corneum to Epidermis | Chemical specific | dimensionless | EPA, 2004 | Organics : |
| | | | | $t_{event}$ | Event Time | 0.33 | hr/event | EPA, 2004 | $t_{event} \leq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | SA | Skin Surface Area Available for Contact | 6,600 | $cm^2$ | EPA, 2004 | 2 x FA x Kp x CW x (sqrt((6 x $\tau$ x $t_{event}$)/$\pi$)) |
| | | | | EV | Event Frequency | 1 | events/day | EPA, 2004 | x CF2 x CF3 |
| | | | | EF | Exposure Frequency | 234 | days/year | EPA, 1993 | |
| | | | | ED | Exposure Duration | 6 | years | EPA, 2001 | $t_{event} \geq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | BW | Body Weight | 15 | kg | EPA, 1991 | FA x Kp x CW x ( $t_{event}$/(1+B) + 2 x $\tau$ x |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | ((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF2 x CF3 |
| | | | | AT-N | Averaging Time (Non-Cancer) | 2,190 | days | EPA, 1989 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | CF2 | Conversion Factor 2 | 0.001 | $l/cm^3$ | - - | |

TABLE 4.3.CTE

VALUES USED FOR DAILY INTAKE CALCULATIONS

CENTRAL TENDENCY EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Dermal | Resident | Child/Adult | Bedrock Aquifer - Tap Water | CW | Chemical Concentration in Water | See Table 3.5.CTE | µg/l | See Table 3.5.CTE | CDI (mg/kg-day) = DA-Adj x EF x 1/AT |
| | | | | DAevent-A | Dermally Absorbed Dose per Event, Adult | Calculated | $mg/cm^2$-event | calculated | |
| | | | | DAevent-C | Dermally Absorbed Dose per Event, Child | Calculated | $mg/cm^2$-event | calculated | DA-Adj = (Daevent-A x SA-A x ED-A x 1/BW-A) |
| | | | | DA-Adj | Dermally Absorbed Dose, Age-adjusted | Calculated | mg-year/event-kg | calculated | + (Daevent-C x SA-C x ED-C x 1/BW-C) |
| | | | | FA | Fraction absorbed water | Chemical specific | dimensionless | EPA, 2004 | |
| | | | | $K_p$ | Permeability Coefficient | Chemical specific | cm/hr | EPA, 2004 | Inorganics: DAevent ($mg/cm^2$-event) = |
| | | | | $\tau$ | Lag Time | Chemical specific | hr/event | EPA, 2004 | Kp x CW x $t_{event}$ x CF2 x CF3 |
| | | | | t* | Time to Reach Steady-state | Chemical specific | hours | EPA, 2004 | |
| | | | | B | Ratio of Permeability of Stratum Corneum to Epidermis | Chemical specific | dimensionless | EPA, 2004 | Organics : |
| | | | | $t_{event}$-A | Event Time, Adult | 0.25 | hr/event | EPA, 2004 | $t_{event} \leq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | $t_{event}$-C | Event Time, Child | 0.33 | hr/event | EPA, 2004 | 2 x FA x Kp x CW x (sqrt((6 x $\tau$ x $t_{event}$)/$\pi$)) |
| | | | | SA-A | Skin Surface Area, Adult | 18,000 | $cm^2$ | EPA, 2004 | x CF2 x CF3 |
| | | | | SA-C | Skin Surface Area, Child | 6,600 | $cm^2$ | EPA, 2004 | |
| | | | | EV | Event Frequency | 1 | events/day | EPA, 2004 | $t_{event} \geq t^*$: DAevent ($mg/cm^2$-event) = |
| | | | | EF | Exposure Frequency | 234 | days/year | EPA, 1993 | FA x Kp x CW x ( $t_{event}$/(1+B) + 2 x $\tau$ x |
| | | | | ED-A | Exposure Duration, Adult | 9 | years | EPA, 2001 | ((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF2 x CF3 |
| | | | | ED-C | Exposure Duration, Child | 6 | years | EPA, 2001 | |
| | | | | BW-A | Body Weight, Adult | 70 | kg | EPA, 1991 | |
| | | | | BW-C | Body Weight, Child | 15 | ke | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | CF2 | Conversion Factor 2 | 0.001 | $l/cm^3$ | - - | |

Sources:


EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1993: Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa.

EPA, 2001: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. EPA/540/R/99/005.

EPA, 2004 . Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment (Final). EPA/540/R/99/005. July 2004.

TABLE 4.4.CTE

VALUES USED FOR DAILY INTAKE CALCULATIONS

CENTRAL TENDENCY EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Inhalation | Resident | Adult | Bedrock Aquifer - Water Vapors at Showerhead | CW | Chemical Concentration in Water | See Table 3.6.CTE | µg/l | See Table 3.6.CTE | Chronic Daily Intake (CDI) (mg/kg-day) = |
| | | | | InhExp | Inhalation Exposure per Shower | Calculated | mg/kg-shower | | InhExp x EF x ED x 1/AT |
| | | | | EF | Exposure Frequency | 234 | days/year | EPA, 1993 | Foster & Chrostowski Shower Inhalation Model for InhExp |
| | | | | ED | Exposure Duration | 9 | years | EPA, 2001 | see Table 7.4.CTE Supplement B for InhExp calculation |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 3,285 | days | EPA, 1989 | |

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1993: Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

TABLE 5.1

NON-CANCER TOXICITY DATA -- ORAL/DERMAL

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

| Chemical of Potential Concern | Chronic/ Subchronic | Oral RfD Value | Oral RfD Units | Oral to Dermal Adjustment Factor (1) | Adjusted Dermal RfD (2) | Units | Primary Target Organ | Combined Uncertainty/Modifying Factors | Sources of RfD: Target Organ | Dates of RfD: Target Organ (3) (MM/DD/YY) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1,1,2,2-Tetrachloroethane | Chronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| | Subchronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1,1,2-Trichloroethane | Chronic | 4.0E-03 | mg/kg-day | N/A | 4.0E-03 | mg/kg-day | Blood | 1000/1 | IRIS | 09/24/07 |
| | Subchronic | 4.0E-02 | mg/kg-day | N/A | 4.0E-02 | mg/kg-day | Blood | 100 | HEAST | 07/01/97 |
| 1,2-Dibromo-3-chloropropane | Chronic | 2.0E-04 | mg/kg-day | N/A | 2.0E-04 | mg/kg-day | Testis | 1000/1 | PPRTV | 8/2/2006 |
| | Subchronic | 2.0E-04 | mg/kg-day | N/A | 2.0E-04 | mg/kg-day | Testis | 1000/1 | PPRTV | 8/2/2006 |
| 1,2-Dichlorobenzene | Chronic | 9.0E-02 | mg/kg-day | N/A | 9.0E-02 | mg/kg-day | NOAEL | 1000/1 | IRIS | 9/21/2007 |
| | Subchronic | 9.0E-02 | mg/kg-day | N/A | 9.0E-02 | mg/kg-day | NOAEL | 1000/1 | IRIS | 9/21/2007 |
| 1,2-Dichloropropane | Chronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| | Subchronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1,4-Dichlorobenzene | Chronic | 3.0E-02 | mg/kg/day | N/A | 3.0E-02 | mg/kg/day | Liver, Developmental | 1000 | NCEA | 04/29/97 |
| | Subchronic | 3.0E-02 | mg/kg/day | N/A | 3.0E-02 | mg/kg/day | Liver, Developmental | 1000 | NCEA | 04/29/97 |
| Benzene | Chronic | 4.0E-03 | mg/kg-day | N/A | 4.0E-03 | mg/kg-day | Blood, Immune | 300/1 | IRIS | 9/21/2007 |
| | Subchronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| bis(2-Ethylhexyl)phthalate) | Chronic | 2.0E-02 | mg/kg-day | N/A | 2.0E-02 | mg/kg-day | Liver | 1000/1 | IRIS | 09/21/07 |
| | Subchronic | 2.0E-02 | mg/kg-day | N/A | 2.0E-02 | mg/kg-day | Reproductive | 3000 | NCEA | 03/28/96 |
| Bromodichloromethane | Chronic | 2.0E-02 | mg/kg-day | N/A | 2.0E-02 | mg/kg-day | Kidney | 1000/1 | IRIS | 09/21/07 |
| | Subchronic | 2.0E-02 | mg/kg-day | N/A | 2.0E-02 | mg/kg-day | Kidney | 1000 | HEAST | 07/01/97 |
| Chlorobenzene | Chronic | 2.0E-02 | mg/kg-day | N/A | 2.0E-02 | mg/kg-day | Liver | 1000/1 | IRIS | 09/21/07 |
| | Subchronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Chloroform | Chronic | 1.0E-02 | mg/kg-day | N/A | 1.0E-02 | mg/kg-day | Liver | 1000/1 | IRIS | 9/21/2007 |
| | Subchronic | 1.0E-02 | mg/kg-day | N/A | 1.0E-02 | mg/kg-day | Liver | 1000 | HEAST | 7/1/1997 |
| Methylene chloride | Chronic | 6.0E-02 | mg/kg-day | N/A | 6.0E-02 | mg/kg-day | Liver | 100/1 | IRIS | 09/21/07 |
| | Subchronic | 6.0E-02 | mg/kg-day | N/A | 6.0E-02 | mg/kg-day | Liver | 100 | HEAST | 07/01/97 |
| Tetrachloroethene | Chronic | 1.0E-02 | mg/kg-day | N/A | 1.0E-02 | mg/kg-day | Liver, Whole body | 1000/1 | IRIS | 9/21/2007 |
| | Subchronic | 1.0E-01 | mg/kg-day | N/A | 1.0E-01 | mg/kg-day | Liver, Whole body | 100 | HEAST | 7/1/1997 |
| Trichloroethene (older NCEA | Chronic | 6.0E-03 | mg/kg-day | N/A | 6.0E-03 | mg/kg-day | Liver | 3000 | NCEA | 3/5/1992 |
| value, used in HHRA calculations) | Subchronic | 6.0E-03 | mg/kg-day | N/A | 6.0E-03 | mg/kg-day | Liver | 3000 | NCEA | 3/5/1992 |
| Trichloroethene (draft 2001 value, | Chronic | 3.0E-04 | mg/kg-day | N/A | 3.0E-04 | mg/kg-day | Liver, Kidney, Fetus | 3000 | NCEA | 8/1/2001 |
| used for uncertainty evaluation) | Subchronic | 3.0E-04 | mg/kg-day | N/A | 3.0E-04 | mg/kg-day | Liver, Kidney, Fetus | 3000 | NCEA | 8/1/2001 |
| Vinyl chloride | Chronic | 3.0E-03 | mg/kg-day | N/A | 3.0E-03 | mg/kg-day | Liver | 30/1 | IRIS | 9/21/2007 |
| | Subchronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| cis-1,2-Dichloroethene | Chronic | 1.0E-02 | mg/kg/day | N/A | 1.0E-02 | mg/kg/day | Blood | 3000 | PPRTV | 3/1/2006 |
| | Subchronic | 1.0E-01 | mg/kg/day | N/A | 1.0E-01 | mg/kg/day | Blood | 300 | PPRTV | 3/1/2006 |
| Aluminum | Chronic | 1.0E+00 | mg/kg-day | N/A | 1.0E+00 | mg/kg-day | Neurological | 100 | PPRTV | 10/23/06 |
| | Subchronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Antimony | Chronic | 4.0E-04 | mg/kg-day | 15% | 6.0E-05 | mg/kg-day | Blood | 1000/1 | IRIS | 12/22/03 |
| | Subchronic | 4.0E-04 | mg/kg-day | 15% | 6.0E-05 | mg/kg-day | Blood | 1000/1 | HEAST | 07/01/97 |
| Arsenic | Chronic | 3.0E-04 | mg/kg-day | 95% | 3.0E-04 | mg/kg-day | Skin, Vascular | 3/1 | IRIS | 09/21/07 |
| | Subchronic | 3.0E-04 | mg/kg-day | 95% | 3.0E-04 | mg/kg-day | Skin, Vascular | 3 | HEAST | 07/01/97 |
| Chromium (hexavalent) | Chronic | 3.0E-03 | mg/kg-day | 2.5% | 7.5E-05 | mg/kg-day | Not identified | 300/3 | IRIS | 9/21/2007 |
| | Subchronic | 2.0E-02 | mg/kg-day | 2.5% | 5.0E-04 | mg/kg-day | Not identified | 100 | HEAST | 7/1/1997 |
| Iron | Chronic | 7.0E-01 | mg/kg/day | N/A | 7.0E-01 | mg/kg/day | Gastrointestinal | 1 | PPRTV | 07/29/05 |
| | Subchronic | 7.0E-01 | mg/kg/day | N/A | 7.0E-01 | mg/kg/day | Gastrointestinal | 1 | PPRTV | 07/29/05 |
| Lead | Chronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 09/24/07 |
| | Subchronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Manganese (nonfood) | Chronic | 2.0E-02 | mg/kg-day | 4% | 8.0E-04 | mg/kg-day | CNS | 1/1 | IRIS | 09/21/07 |
| | Subchronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Manganese (food) | Chronic | 1.4E-01 | mg/kg-day | 4% | 5.6E-03 | mg/kg-day | CNS | 1/1 | IRIS | 09/21/07 |
| | Subchronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Nickel | Chronic | 2.0E-02 | mg/kg-day | 4% | 8.0E-04 | mg/kg-day | Decreased Body Weight | 300/1 | IRIS | 09/21/07 |
| | Subchronic | 2.0E-02 | mg/kg-day | 4% | 8.0E-04 | mg/kg-day | Whole Body | 300 | HEAST | 07/01/97 |
| Thallium | Chronic | 7.0E-05 | mg/kg-day | N/A | 7.0E-05 | mg/kg-day | Liver, Blood, Hair | N/A | RBC | 10/15/03 |
| | Subchronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Vanadium | Chronic | 1.0E-03 | mg/kg-day | 2.6% | 2.6E-05 | mg/kg-day | Kidney | 300 | NCEA | 05/01/00 |
| | Subchronic | 7.0E-03 | mg/kg-day | 2.6% | 1.8E-04 | mg/kg-day | Lifetime | 100 | HEAST | 07/01/97 |

(1) Source: Risk Assessment Guidance for Superfund. Volume 1: Human Health Evaluation Manual, Part E, Supplemental Guidance for Dermal Risk Assessment (Final).

Section 4.2 and Exhibit 4-1. USEPA recommends that the oral RfD should not be adjusted to estimate the absorbed dose for compounds when the absorption efficiency is greater than 50%.

Constituents that do not have oral absorption efficiencies reported on this table were assumed to have an oral absorption efficiency of 100%.

(2) Adjusted Dermal RfD = RfD (oral) x Absorption Efficiency or $ABS_{GI}$

(3) For IRIS values, the date IRIS was searched.

For NCEA values, the date of the NCEA article.

For HEAST values, the date of HEAST document.

NOAEL = No adverse effect level

CNS = Central Nervous System

IRIS = Integrated Risk Information System

HEAST= Health Effects Assessment Summary Tables

NA = Not Applicable

NCEA = National Center for Environmental Assessment

PPRTV = Provisional Peer-Reviewed Toxicity Assessment

TABLE 5.2

NON-CANCER TOXICITY DATA -- INHALATION

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

| Chemical of Potential Concern | Chronic/ Subchronic | Value Inhalation RfC | Units | Adjusted Inhalation RfD (1) | Units | Primary Target Organ | Combined Uncertainty/Modifying Factors | Sources of RfC:RfD: Target Organ (2) | Dates (3) (MM/DD/YY) |
|---|---|---|---|---|---|---|---|---|---|
| 1,1,2,2-Tetrachloroethane | Chronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| | Subchronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1,1,2-Trichloroethane | Chronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| | Subchronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1,2-Dibromo-3-chloropropane | Chronic | 2.0E-04 | $mg/m^3$ | 5.7E-05 | mg/kg-day | Testis | 1000 | IRIS | 09/24/07 |
| | Subchronic | 2.0E-04 | $mg/m^3$ | 5.7E-05 | mg/kg-day | Testis | 100 | PPRTV | 08/03/06 |
| 1,2-Dichlorobenzene | Chronic | 2.0E-01 | $mg/m^3$ | 4.0E-02 | mg/kg-day | Decreased Weight Gain | 1000 | HEAST-Alt | 7/1/1997 |
| | Subchronic | 2.0E+00 | $mg/m^3$ | 5.7E-01 | mg/kg-day | Decreased Weight Gain | 100 | HEAST-Alt | 7/1/1997 |
| 1,2-Dichloropropane | Chronic | 4.0E-03 | $mg/m^3$ | 1.1E-03 | mg/kg-day | Nasal Mucosa | 300/1 | IRIS | 09/24/07 |
| | Subchronic | 1.3E-02 | $mg/m^3$ | 3.7E-03 | mg/kg-day | Nasal Mucosa | 100 | HEAST | 07/01/97 |
| 1,4-Dichlorobenzene | Chronic | 8.0E-01 | $mg/m^3$ | 2.3E-01 | mg/kg-day | Liver | 100 | IRIS | 09/24/07 |
| | Subchronic | 2.5E+00 | $mg/m^3$ | 7.1E-01 | mg/kg-day | Liver | 30 | HEAST | 07/01/97 |
| Benzene | Chronic | 3.0E-02 | $mg/m^3$ | 8.6E-03 | mg/kg-day | Blood, Immune | 300/1 | IRIS | 09/24/07 |
| | Subchronic | 6.0E-02 | $mg/m^3$ | 1.7E-02 | mg/kg-day | Blood | 100 | NCEA | 07/02/96 |
| bis(2-Ethylhexyl)phthalate | Chronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| | Subchronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Bromodichloromethane | Chronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| | Subchronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Chlorobenzene | Chronic | 4.9E-02 | $mg/m^3$ | 1.4E-02 | mg/kg-day | Liver | 1000 | PPRTV | 10/12/06 |
| | Subchronic | 4.9E-02 | $mg/m^3$ | 1.4E-02 | mg/kg-day | Liver | 1000 | PPRTV | 10/12/06 |
| Chloroform | Chronic | 4.9E-02 | $mg/m^3$ | 1.4E-02 | mg/kg-day | Liver | NA | NCEA | 01/22/03 |
| | Subchronic | 4.9E-02 | $mg/m^3$ | 1.4E-02 | mg/kg-day | Liver | NA | NCEA | 01/22/03 |
| Methylene chloride | Chronic | 1.1E+00 | $mg/m^3$ | 3.0E-01 | mg/kg-day | Liver | 100/1 | ATSDR | 09/01/00 |
| | Subchronic | 3.0E+00 | $mg/m^3$ | 8.6E-01 | mg/kg-day | Liver | 100/1 | HEAST | 07/01/97 |
| Tetrachloroethene | Chronic | 2.8E-01 | $mg/m^3$ | 8.0E-02 | mg/kg-day | Kidney, Liver | NA | ATSDR | 09/01/97 |
| | Subchronic | 2.80E-01 | $mg/m^3$ | 8.0E-02 | mg/kg-day | Kidney, Liver | NA | ATSDR | 09/01/97 |
| Trichloroethene (older NCEA | Chronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| assessment, used in HHRA calcs) | Subchronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Trichloroethene (draft 2001 value, | Chronic | 3.5E-02 | $mg/m^3$ | 1.0E-02 | mg/kg-day | CNS, Liver, Endocrine system | 1000 | NCEA | 08/01/01 |
| used for uncertainty evaluation) | Subchronic | 3.5E-02 | $mg/m^3$ | 1.0E-02 | mg/kg-day | CNS, Liver, Endocrine system | 1000 | NCEA | 08/01/01 |
| Vinyl chloride | Chronic | 9.8E-02 | $mg/m^3$ | 2.8E-02 | mg/kg-day | Liver | 30/1 | IRIS | 09/24/07 |
| | Subchronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| cis-1,2-Dichloroethene | Chronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| | Subchronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Aluminum | Chronic | 3.5E-03 | $mg/m^3$ | 1.0E-03 | mg/kg-day | Neurological | 300 | PPRTV | 10/23/06 |
| | Subchronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Antimony | Chronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| | Subchronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Arsenic | Chronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| | Subchronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Chromium (hexavalent) | Chronic | 1.1E-04 | $mg/m^3$ | 3.0E-05 | mg/kg-day | Respiratory System | 300/1 | IRIS | 09/24/07 |
| | Subchronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Iron | Chronic | N/A | N/A | N/A | N/A | N/A | N/A | IRIS | 09/24/07 |
| | Subchronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Lead | Chronic | N/A | N/A | N/A | N/A | N/A | N/A | IRIS | 09/24/07 |
| | Subchronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Manganese | Chronic | 5.0E-05 | $mg/m^3$ | 1.4E-05 | mg/kg-day | CNS | 1000/1 | IRIS | 09/24/07 |
| | Subchronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Nickel | Chronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| | Subchronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Thallium | Chronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| | Subchronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Vanadium | Chronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| | Subchronic | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

N/A = Not Applicable

(1) Provide equation used for derivation in text.

(2) HEAST, Alternative Methods used as source of barium values.

Chromium and cadmium values were withdrawn from HEAST, but available in Region III RBC Table.

(3) For IRIS values, provide the date IRIS was searched.

For HEAST values, provide the date of HEAST.

For NCEA values, provide the date of the article provided by NCEA.

ATSDR = Agency for Toxic Substances and Disease Registry

IRIS = Integrated Risk Information System

HEAST= Health Effects Assessment Summary Tables

HEAST Table 2 = Health Effects Assessment Summary Tables, Alternate Methods

HEAST Table 3 = Health Effects Assessment Summary Tables, Carcinogenicity

HEAST(4)= Health Effects Assessment Summary Tables, Withdrawn

NCEA = National Center for Environmental Assessment

PPRTV = Provisional Peer-Reviewed Toxicity Value

TABLE 6.1

CANCER TOXICITY DATA -- ORAL/DERMAL

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

| Chemical of Potential Concern | Oral Cancer Slope Factor | Oral to Dermal Adjustment Factor | Adjusted Dermal Cancer Slope Factor (1) | Units | EPA Carcinogen Group | Source | Date (2) (MM/DD/YY) |
|---|---|---|---|---|---|---|---|
| 1,1,2,2-Tetrachloroethane | 2.0E-01 | Generally > 50% | 2.0E-01 | (mg/kg-day) -1 | C | IRIS | 9/24/2007 |
| 1,1,2-Trichloroethane | 5.7E-02 | Generally > 50% | 5.7E-02 | (mg/kg-day) -1 | C | IRIS | 9/24/2007 |
| 1,2-Dibromo-3-chloropropane (4) | 8.0E-01 | Generally > 50% | 8.0E-01 | (mg/kg-day) -1 | B2 | PPRTV | 8/2/2006 |
| 1,2-Dichlorobenzene | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1,2-Dichloropropane | 6.8E-02 | Generally > 50% | 6.8E-02 | (mg/kg-day) -1 | B2 | HEAST | 7/1/1997 |
| 1,4-Dichlorobenzene | 2.4E-02 | Generally > 50% | 2.4E-02 | (mg/kg-day) -1 | C | HEAST | 7/1/1997 |
| Benzene | 5.5E-02 | Generally > 50% | 5.5E-02 | (mg/kg-day) -1 | A | IRIS | 9/24/2007 |
| Bromodichloromethane | 6.2E-02 | Generally > 50% | 6.2E-02 | (mg/kg-day) -1 | B2 | IRIS | 9/24/2007 |
| Chlorobenzene | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Chloroform | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Methylene chloride | 7.5E-03 | Generally > 50% | 7.5E-03 | (mg/kg-day) -1 | B2 | IRIS | 09/24/07 |
| Tetrachloroethene | 5.4E-01 | Generally > 50% | 5.4E-01 | (mg/kg-day) -1 | N/A | CalEPA | 04/26/04 |
| Trichloroethene (used in risk calculations) | 1.1E-02 | Generally > 50% | 1.1E-02 | (mg/kg-day) -1 | B2 - C | NCEA | 1997 |
| Trichloroethene (used in uncertainty evaluation) | 4.0E-01 | Generally > 50% | 4.0E-01 | (mg/kg-day) -1 | B2 - C | NCEA | 8/1/2001 |
| Vinyl chloride (lifetime from adult) | 7.2E-01 | Generally > 50% | 7.2E-01 | (mg/kg-day) -1 | A | IRIS | 9/24/2007 |
| Vinyl chloride (lifetime from birth) | 1.4E+00 | Generally > 50% | 1.4E+00 | (mg/kg-day) -1 | A | IRIS | 4/26/2004 |
| cis-1,2-Dichloroethene | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| bis(2-Ethylhexyl)phthalate | 1.4E-02 | Generally > 50% | 1.4E-02 | (mg/kg-day) -1 | B2 | IRIS | 9/24/2007 |
| Aluminum | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Antimony | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Arsenic | 1.5E+00 | 95% | 1.5E+00 | (mg/kg-day) -1 | A | IRIS | 9/24/2007 |
| Chromium (hexavalent) | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Iron | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Lead | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Manganese (nonfood) | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Nickel | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Thallium | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Vanadium | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

N/A-Not available

IRIS = Integrated Risk Information System

HEAST= Health Effects Assessment Summary Tables

NCEA = National Center for Environmental Assessment

PPRTV = Provisional Peer-Reviewed Toxicity Value

EPA Carcinogen Group:

A - Human carcinogen

B1 - Probable human carcinogen - indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen

E - Evidence of noncarcinogenicity

(1) Refer to RAGS, Part E. July 2004.

(2) For IRIS values, provide the date IRIS was searched.
For HEAST values, provide the date of HEAST.
For NCEA values, provide article date provided by NCEA.
For RBC values, provide the date of last change in the Tables.

(4) This chemical operates with a mutagenic mode of action (USEPA 2005). Chemical-specific data are not available, thus, USEPA (2005) default age-dependant adjustment factors (ADAF) will be applied to the slope factor as follows

| AGE | AGE ADAF |
|---|---|
| 0-<2 | 10 |
| 2-<16 | 3 |
| 16-<30 | 1 |

TABLE 6.2

CANCER TOXICITY DATA -- INHALATION

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

| Chemical of Potential Concern | Unit Risk | Units | Adjustment (1) | Inhalation Cancer Slope Factor | Units | Weight of Evidence/ Cancer Guidance Description | Source | Date (2) (MM/DD/YY) |
|---|---|---|---|---|---|---|---|---|
| 1,1,2,2-Tetrachloroethane | 5.7E-05 | $(ug/m3)^{-1}$ | 3500 | 2.0E-01 | $(mg/kg\text{-}day)^{-1}$ | C | IRIS | 9/24/2007 |
| 1,1,2-Trichloroethane | 1.6E-05 | $(ug/m3)^{-1}$ | 3500 | 5.6E-02 | $(mg/kg\text{-}day)^{-1}$ | C | IRIS | 9/24/2007 |
| 1,2-Dibromo-3-chloropropane (4) | 6.0E-03 | $(ug/m3)^{-1}$ | 3500 | 2.1E+01 | $(mg/kg\text{-}day)^{-1}$ | B2 | PPRTV | 8/2/2006 |
| 1,2-Dichlorobenzene | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1,2-Dichloropropane | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1,4-Dichlorobenzene | 6.3E-06 | $(ug/m3)^{-1}$ | 3500 | 2.2E-02 | $(mg/kg\text{-}day)^{-1}$ | C | NCEA | 1997 |
| Benzene | 7.7E-06 | $(ug/m3)^{-1}$ | 3500 | 2.7E-02 | $(mg/kg\text{-}day)^{-1}$ | A | IRIS | 9/24/2007 |
| Bromodichloromethane | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Chlorobenzene | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Chloroform | 2.3E-05 | $(ug/m3)^{-1}$ | 3500 | 8.1E-02 | $(mg/kg\text{-}day)^{-1}$ | B2 | IRIS | 9/24/2007 |
| Methylene chloride | 4.7E-07 | $(ug/m3)^{-1}$ | 3500 | 1.7E-03 | $(mg/kg\text{-}day)^{-1}$ | B2 | IRIS | 9/24/2007 |
| Tetrachloroethene | 5.7E-06 | $(ug/m3)^{-1}$ | 3500 | 2.0E-02 | $(mg/kg\text{-}day)^{-1}$ | N/A | CalEPA | 4/26/2004 |
| Trichloroethene (used in risk calculations) | 1.7E-06 | $(ug/m3)^{-1}$ | 3500 | 6.0E-03 | $(mg/kg\text{-}day)^{-1}$ | B2 -C | NCEA | 1997 |
| Trichloroethene (used in uncertainty evaluation) (5) | 1.1E-04 | $(ug/m3)^{-1}$ | 3500 | 4.0E-01 | $(mg/kg\text{-}day)^{-1}$ | B2 -C | NCEA | 8/1/2001 |
| Vinyl chloride (lifetime from adult) | 4.4E-06 | $(ug/m3)^{-1}$ | 3500 | 1.5E-02 | $(mg/kg\text{-}day)^{-1}$ | A | IRIS | 9/24/2007 |
| Vinyl chloride (lifetime from birth) | 8.8E-06 | $(ug/m3)^{-1}$ | 3500 | 3.1E-02 | $(mg/kg\text{-}day)^{-1}$ | A | IRIS | 9/24/2007 |
| cis-1,2-Dichloroethene | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| bis(2-Ethylhexyl)phthalate) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Aluminum | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Antimony | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Arsenic | 4.0E-03 | $(ug/m3)^{-1}$ | 3500 | 1.5E+01 | $(mg/kg\text{-}day)^{-1}$ | A | IRIS | 9/24/2007 |
| Chromium (hexavalent) | 1.2E-02 | $(ug/m3)^{-1}$ | 3500 | 4.1E+01 | $(mg/kg\text{-}day)^{-1}$ | A | IRIS | 9/24/2007 |
| Iron | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Lead | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Manganese | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Nickel | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Thallium | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Vanadium | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

IRIS = Integrated Risk Information System
HEAST= Health Effects Assessment Summary Tables
NCEA = National Center for Environmental Assessment
PPRTV = Provisional Peer-Reviewed Toxicity Value
N/A = Not Available

EPA Group:
A - Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

(1) Adjustment Factor applied to Unit Risk to calculate Inhalation Slope Factor = 70kg x 1/20m3/day x 1000ug/mg

(2) For IRIS values, provide the date IRIS was searched.
For HEAST values, provide the date of HEAST.
For NCEA values, provide the date of the article provided by NCEA.
For RBC values, provide the date of last change in the Tables.

(4) This chemical operates with a mutagenic mode of action (USEPA 2005). Chemical-specific data are not available, thus, USEPA (2005) default age-dependant adjustment factors (ADAF) will be applied to the slope factor as follows:

| AGE | AGE ADAF |
|---|---|
| 0-<2 | 10 |
| 2-<16 | 3 |
| 16-<30 | 1 |

(5) Trichloroethene slope factor is a range from 0.02 to 0.4 kg-d/mg. The median of 0.21 may be used for general populations, 0.4 for sensitive populations.

TABLE 7.1.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Groundwater | Groundwater | Alluvial Aquifer - Tap Water | Ingestion | | | | | | | | | | | | | |
| | | | | 1,1,2,2-Tetrachloroethane | 3.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 8.8E-05 | mg/kg/day | N/A | | N/A |
| | | | | 1,1,2-Trichloroethane | 3.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 9.3E-05 | mg/kg/day | 4.0E-03 | mg/kg/day | 2.3E-02 |
| | | | | 1,2-Dibromo-3-chloropropane | 3.8E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.0E-04 | mg/kg/day | 2.0E-04 | mg/kg/day | 5.2E-01 |
| | | | | 1,2-Dichlorobenzene | 6.2E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.7E-03 | mg/kg/day | 9.0E-02 | mg/kg/day | 1.9E-02 |
| | | | | 1,2-Dichloropropane | 9.6E-01 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.6E-05 | mg/kg/day | N/A | | N/A |
| | | | | 1,4-Dichlorobenzene | 1.9E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 5.1E-05 | mg/kg/day | 3.0E-02 | mg/kg/day | 1.7E-03 |
| | | | | Benzene | 1.5E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 4.1E-05 | mg/kg/day | 4.0E-03 | mg/kg/day | 1.0E-02 |
| | | | | Bromodichloromethane | 6.1E-01 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.7E-05 | mg/kg/day | 2.0E-02 | mg/kg/day | 8.4E-04 |
| | | | | Chlorobenzene | 3.6E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 9.9E-04 | mg/kg/day | 2.0E-02 | mg/kg/day | 4.9E-02 |
| | | | | Chloroform | 2.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 6.0E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 6.0E-03 |
| | | | | Methylene chloride | 4.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.2E-04 | mg/kg/day | 6.0E-02 | mg/kg/day | 2.0E-03 |
| | | | | Tetrachloroethene | 1.5E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 4.1E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 4.1E-03 |
| | | | | Trichloroethene | 3.0E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 8.2E-05 | mg/kg/day | 6.0E-03 | mg/kg/day | 1.4E-02 |
| | | | | Vinyl chloride | 2.0E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 5.4E-05 | mg/kg/day | 3.0E-03 | mg/kg/day | 1.8E-02 |
| | | | | cis-1,2-Dichloroethene | 5.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.5E-04 | mg/kg/day | 1.0E-02 | mg/kg/day | 1.5E-02 |
| | | | | Arsenic-dissolved | 4.8E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.3E-04 | mg/kg/day | 3.0E-04 | mg/kg/day | 4.4E-01 |
| | | | | Chromium (hexavalent)-dissolved | 6.3E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.7E-04 | mg/kg/day | 3.0E-03 | mg/kg/day | 5.8E-02 |
| | | | | Iron-dissolved | 9.4E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.6E-01 | mg/kg/day | 7.0E-01 | mg/kg/day | 3.7E-01 |
| | | | | Manganese-dissolved | 2.5E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 6.9E-02 | mg/kg/day | 2.0E-02 | mg/kg/day | 3.5E+00 |
| | | | | Nickel-dissolved | 1.7E+02 | ug/L | N/A | N/A | N/A | N/A | N/A | 4.6E-03 | mg/kg/day | 2.0E-02 | mg/kg/day | 2.3E-01 |
| | | | | Thallium-dissolved | 6.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.7E-04 | mg/kg/day | 7.0E-05 | mg/kg/day | 2.4E+00 |
| | | | Exp. Route Total | | | | | | | | N/A | | | | | 7.7E+00 |
| | | | Dermal Absorption | 1,1,2,2-Tetrachloroethane | 3.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.1E-05 | mg/kg/day | N/A | | N/A |
| | | | | 1,1,2-Trichloroethane | 3.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 8.8E-06 | mg/kg/day | 4.0E-03 | mg/kg/day | 2.2E-03 |
| | | | | 1,2-Dibromo-3-chloropropane | 3.8E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 6.7E-06 | mg/kg/day | 2.0E-04 | mg/kg/day | 3.4E-02 |
| | | | | 1,2-Dichlorobenzene | 6.2E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.1E-03 | mg/kg/day | 9.0E-02 | mg/kg/day | 1.2E-02 |
| | | | | 1,2-Dichloropropane | 9.6E-01 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.6E-06 | mg/kg/day | N/A | | N/A |
| | | | | 1,4-Dichlorobenzene | 1.9E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.4E-05 | mg/kg/day | 3.0E-02 | mg/kg/day | 1.1E-03 |
| | | | | Benzene | 1.5E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 6.3E-06 | mg/kg/day | 4.0E-03 | mg/kg/day | 1.6E-03 |
| | | | | Bromodichloromethane | 6.1E-01 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.4E-06 | mg/kg/day | 2.0E-02 | mg/kg/day | 6.9E-05 |
| | | | | Chlorobenzene | 3.6E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.6E-04 | mg/kg/day | 2.0E-02 | mg/kg/day | 1.8E-02 |
| | | | | Chloroform | 2.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 5.5E-06 | mg/kg/day | 1.0E-02 | mg/kg/day | 5.5E-04 |
| | | | | Methylene chloride | 4.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 4.6E-06 | mg/kg/day | 6.0E-02 | mg/kg/day | 7.6E-05 |
| | | | | Tetrachloroethene | 1.5E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.5E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 2.5E-03 |
| | | | | Trichloroethene | 3.0E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.4E-05 | mg/kg/day | 6.0E-03 | mg/kg/day | 2.3E-03 |
| | | | | Vinyl chloride | 2.0E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.9E-06 | mg/kg/day | 3.0E-03 | mg/kg/day | 9.5E-04 |
| | | | | cis-1,2-Dichloroethene | 5.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.3E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 1.3E-03 |
| | | | | Arsenic-dissolved | 4.8E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 6.9E-07 | mg/kg/day | 3.0E-04 | mg/kg/day | 2.3E-03 |
| | | | | Chromium (hexavalent)-dissolved | 6.3E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.8E-06 | mg/kg/day | 7.5E-05 | mg/kg/day | 2.4E-02 |

TABLE 7.1.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Groundwater | Groundwater | Alluvial Aquifer - Tap Water | Dermal Absorption | Iron-dissolved | 9.4E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.3E-03 | mg/kg/day | 7.0E-01 | mg/kg/day | 1.9E-03 |
| | | | | Manganese-dissolved | 2.5E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.6E-04 | mg/kg/day | 8.0E-04 | mg/kg/day | 4.5E-01 |
| | | | | Nickel-dissolved | 1.7E+02 | ug/L | N/A | N/A | N/A | N/A | N/A | 4.8E-06 | mg/kg/day | 8.0E-04 | mg/kg/day | 6.0E-03 |
| | | | | Thallium-dissolved | 6.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 8.9E-07 | mg/kg/day | 7.0E-05 | mg/kg/day | 1.3E-02 |
| | | | Exp. Route Total | | | | | | | | N/A | | | | | 5.7E-01 |
| | | Exposure Point Total | | | | | | | | | N/A | | | | | 8.2E+00 |
| | Exposure Medium Total | | | | | | | | | | N/A | | | | | 8.2E+00 |
| Groundwater | Air | Alluvial Aquifer - Water Vapors at Showerhead | Inhalation | 1,1,2,2-Tetrachloroethane | 3.2E+00 | ug/L | 1.3E-05 | mg/kg/day | 2.0E-01 | 1/mg/kg/day | 2.5E-06 | 3.6E-05 | mg/kg/day | N/A | | N/A |
| | | | | 1,1,2-Trichloroethane | 3.4E+00 | ug/L | 2.0E-05 | mg/kg/day | 5.6E-02 | 1/mg/kg/day | 1.1E-06 | 5.8E-05 | mg/kg/day | N/A | | N/A |
| | | | | 1,2-Dibromo-3-chloropropane | 3.8E+00 | ug/L | 8.1E-06 | mg/kg/day | 2.1E+01 | 1/mg/kg/day | 1.7E-04 | 2.4E-05 | mg/kg/day | 5.7E-05 | mg/kg/day | 4.2E-01 |
| | | | | 1,2-Dichlorobenzene | 6.2E+01 | ug/L | 3.9E-04 | mg/kg/day | N/A | | N/A | 1.1E-03 | mg/kg/day | 4.0E-02 | mg/kg/day | 2.8E-02 |
| | | | | 1,2-Dichloropropane | 9.6E-01 | ug/L | 6.2E-06 | mg/kg/day | N/A | | N/A | 1.8E-05 | mg/kg/day | 1.1E-03 | mg/kg/day | 1.6E-02 |
| | | | | 1,4-Dichlorobenzene | 1.9E+00 | ug/L | 1.2E-05 | mg/kg/day | 2.2E-02 | 1/mg/kg/day | 2.6E-07 | 3.5E-05 | mg/kg/day | 2.3E-01 | mg/kg/day | 1.5E-04 |
| | | | | Benzene | 1.5E+00 | ug/L | 1.4E-05 | mg/kg/day | 2.7E-02 | 1/mg/kg/day | 3.7E-07 | 4.0E-05 | mg/kg/day | 8.6E-03 | mg/kg/day | 4.6E-03 |
| | | | | Bromodichloromethane | 6.1E-01 | ug/L | 3.5E-06 | mg/kg/day | N/A | | N/A | 1.0E-05 | mg/kg/day | N/A | | N/A |
| | | | | Chlorobenzene | 3.6E+01 | ug/L | 2.7E-04 | mg/kg/day | N/A | | N/A | 7.8E-04 | mg/kg/day | 1.4E-02 | mg/kg/day | 5.6E-02 |
| | | | | Chloroform | 2.2E+00 | ug/L | 1.6E-05 | mg/kg/day | 8.1E-02 | 1/mg/kg/day | 1.3E-06 | 4.7E-05 | mg/kg/day | 1.4E-02 | mg/kg/day | 3.3E-03 |
| | | | | Methylene chloride | 4.4E+00 | ug/L | 3.6E-05 | mg/kg/day | 1.7E-03 | 1/mg/kg/day | 5.9E-08 | 1.1E-04 | mg/kg/day | 3.0E-01 | mg/kg/day | 3.5E-04 |
| | | | | Tetrachloroethene | 1.5E+00 | ug/L | 9.8E-06 | mg/kg/day | 2.0E-02 | 1/mg/kg/day | 2.0E-07 | 2.8E-05 | mg/kg/day | 8.0E-02 | mg/kg/day | 3.6E-04 |
| | | | | Trichloroethene | 3.0E+00 | ug/L | 2.2E-05 | mg/kg/day | 6.0E-03 | 1/mg/kg/day | 1.3E-07 | 6.4E-05 | mg/kg/day | N/A | | N/A |
| | | | | Vinyl chloride | 2.0E+00 | ug/L | 2.0E-05 | mg/kg/day | 1.5E-02 | 1/mg/kg/day | 3.1E-07 | 5.9E-05 | mg/kg/day | 2.8E-02 | mg/kg/day | 2.1E-03 |
| | | | | cis-1,2-Dichloroethene | 5.4E+00 | ug/L | 4.4E-05 | mg/kg/day | N/A | | N/A | 1.3E-04 | mg/kg/day | N/A | | N/A |
| | | | Exp. Route Total | | | | | | | | 1.8E-04 | | | | | 5.3E-01 |
| | | Exposure Point Total | | | | | | | | | 1.8E-04 | | | | | 5.3E-01 |
| | Exposure Medium Total | | | | | | | | | | 1.8E-04 | | | | | 5.3E-01 |
| Medium Total | | | | | | | | | | | 1.8E-04 | | | | | 8.8E+00 |
| | | | | | | | | | Total of Receptor Risks Across All Media | | 1.8E-04 | | | Total of Receptor Hazards Across All Media | | 8.8E+00 |

Notes-
NA = Not applicable.
DAevent for exposure to groundwater while showering is calculated on Table 7.1.RME Supplement A.
Shower exposure calculated on Table 7.1.RME Supplement B.

Table 7.1.RME Supplement A
Calculation of DAevent
Resident Adult Ground Water
Site 12 Remedial investigation, Allegany Ballistics Laboratory

| Chemical of Potential Concern | Water Concentration (CW) (μg/L) | Permeability Coefficient[1] (Kp) (cm/hr) | B[1] (dimensionless) | Lag Time[1] ($\tau_{event}$) (hr) | t*[1] (hr) | Fraction Absorbed Water[1] (FA) (dimensionless) | Duration of Event (tevent) (hr) | DAevent ($mg/cm^2$-event) | Eq |
|---|---|---|---|---|---|---|---|---|---|
| 1,1,2,2-Tetrachloroethane | 3.2E+00 | 6.9E-03 | 3.5E-02 | 9.3E-01 | 2.2E+00 | 1.0E+00 | 0.58 | 4.5E-08 | 2 |
| 1,1,2-Trichloroethane | 3.4E+00 | 6.4E-03 | 2.9E-02 | 6.0E-01 | 1.4E+00 | 1.0E+00 | 0.58 | 3.6E-08 | 2 |
| 1,2-Dibromo-3-chloropropane[2] | 3.8E+00 | 2.3E-03 | 1.4E-02 | 2.2E+00 | 5.3E+00 | 1.0E+00 | 0.58 | 2.7E-08 | 2 |
| 1,2-Dichlorobenzene | 6.2E+01 | 4.1E-02 | 1.9E-01 | 7.1E-01 | 1.7E+00 | 1.0E+00 | 0.58 | 4.5E-06 | 2 |
| 1,2-Dichloropropane | 9.6E-01 | 7.8E-03 | 3.2E-02 | 4.6E-01 | 1.1E+00 | 1.0E+00 | 0.58 | 1.1E-08 | 2 |
| 1,4-Dichlorobenzene | 1.9E+00 | 4.2E-02 | 2.0E-01 | 7.1E-01 | 1.7E+00 | 1.0E+00 | 0.58 | 1.4E-07 | 2 |
| Benzene | 1.5E+00 | 1.5E-02 | 5.1E-02 | 2.9E-01 | 7.0E-01 | 1.0E+00 | 0.58 | 2.5E-08 | 2 |
| Bromodichloromethane | 6.1E-01 | 4.6E-03 | 2.3E-02 | 8.8E-01 | 2.1E+00 | 1.0E+00 | 0.58 | 5.6E-09 | 2 |
| Chlorobenzene | 3.6E+01 | 2.8E-02 | 1.2E-01 | 4.6E-01 | 1.1E+00 | 1.0E+00 | 0.58 | 1.4E-06 | 2 |
| Chloroform | 2.2E+00 | 6.8E-03 | 2.9E-02 | 5.0E-01 | 1.2E+00 | 1.0E+00 | 0.58 | 2.2E-08 | 2 |
| Methylene chloride | 4.4E+00 | 3.5E-03 | 1.3E-02 | 3.2E-01 | 7.6E-01 | 1.0E+00 | 0.58 | 1.9E-08 | 2 |
| Tetrachloroethene | 1.5E+00 | 3.3E-02 | 1.7E-01 | 9.1E-01 | 2.2E+00 | 1.0E+00 | 0.58 | 1.0E-07 | 2 |
| Trichloroethene | 3.0E+00 | 1.2E-02 | 5.1E-02 | 5.8E-01 | 1.4E+00 | 1.0E+00 | 0.58 | 5.6E-08 | 2 |
| Vinyl chloride | 2.0E+00 | 5.6E-03 | 1.7E-02 | 2.4E-01 | 5.7E-01 | 1.0E+00 | 0.58 | 1.2E-08 | 3 |
| cis-1,2-Dichloroethene | 5.4E+00 | 7.7E-03 | 2.9E-02 | 3.7E-01 | 8.8E-01 | 1.0E+00 | 0.58 | 5.3E-08 | 2 |
| Arsenic-dissolved | 4.8E+00 | 1.0E-03 | NA | NA | NA | NA | 0.58 | 2.8E-09 | 1 |
| Chromium (hexavalent)-dissolved | 6.3E+00 | 2.0E-03 | NA | NA | NA | NA | 0.58 | 7.4E-09 | 1 |
| Iron-dissolved | 9.4E+03 | 1.0E-03 | NA | NA | NA | NA | 0.58 | 5.4E-06 | 1 |
| Manganese-dissolved | 2.5E+03 | 1.0E-03 | NA | NA | NA | NA | 0.58 | 1.5E-06 | 1 |
| Nickel-dissolved | 1.7E+02 | 2.0E-04 | NA | NA | NA | NA | 0.58 | 2.0E-08 | 1 |
| Thallium-dissolved | 6.2E+00 | 1.0E-03 | NA | NA | NA | NA | 0.58 | 3.6E-09 | 1 |

**Inorganics: DAevent (mg/cm2-event) =**
Kp x CW x tevent x 0.001 mg/ug x 0.001 $l/cm^3$ (eq 1)

**Organics: DAevent (mg/cm2-event) =**
If $t_{event} \leq t^*$ then

$$DA_{event} = 2 \times FA \times K_p \times C_w \times 0.001 \quad mg/ug \times 0.001 \quad l/cm^3 \sqrt{\frac{6 \times \tau_{event} \times t_{event}}{\pi}} \qquad \text{(eq 2)}$$

If $t_{event} \geq t^*$ then

$$DA_{event} = FA \times K_p \times C_w \times 0.001 \quad mg/ug \times 0.001 \quad l/cm^3 \left[ \frac{t_{event}}{1+B} + 2 \times \tau_{event} \left( \frac{1+3B+3B^2}{(1+B)^2} \right) \right] \qquad \text{(eq 3)}$$

Notes:
[1] Values from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.

[2] Values from Virginia Remediation Program, Risk Assessment Guidance, gwcalcs.xls, revised 6/7/07
NA - not applicable.

Table 7.1.RME Supplement B
Inhalation Exposure Concentrations from Foster and Chrostowski Shower Model
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

| Chemical | Exposure Point Concentration Cwo (µg/l) | Molecular weight (HH) (g/mole) | Henry's Law Constant (H) (atm-$m^3$/mole) | Kg (VOC) (cm/hr) | Kl(VOC) (cm/hr) | KL (cm/hr) | Kal (cm/hr) | Cwd (µg/l) | S (µg/$m^3$ - min) | Calculated Inhalation Exposure (Einh) (mg/kg/shower) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1,1,2,2-Tetrachloroethane | 3.2E+00 | 1.7E+02 | 3.5E-04 | 9.8E+02 | 1.0E+01 | 5.9E+00 | 8.0E+00 | 2.1E-01 | 1.7E-01 | 3.8E-05 |
| 1,1,2-Trichloroethane | 3.4E+00 | 1.3E+02 | 9.1E-04 | 1.1E+03 | 1.1E+01 | 9.0E+00 | 1.2E+01 | 3.3E-01 | 2.7E-01 | 6.0E-05 |
| 1,2-Dibromo-3-chloropropane | 3.8E+00 | 2.4E+02 | 1.5E-04 | 8.3E+02 | 8.6E+00 | 3.2E+00 | 4.3E+00 | 1.3E-01 | 1.1E-01 | 2.5E-05 |
| 1,2-Dichlorobenzene | 6.2E+01 | 1.5E+02 | 1.9E-03 | 1.0E+03 | 1.1E+01 | 9.7E+00 | 1.3E+01 | 6.4E+00 | 5.3E+00 | 1.2E-03 |
| 1,2-Dichloropropane | 9.6E-01 | 1.5E+02 | 2.8E-03 | 1.0E+03 | 1.1E+01 | 1.0E+01 | 1.4E+01 | 1.0E-01 | 8.6E-02 | 1.9E-05 |
| 1,4-Dichlorobenzene | 1.9E+00 | 1.5E+02 | 2.4E-03 | 1.0E+03 | 1.1E+01 | 9.9E+00 | 1.3E+01 | 2.0E-01 | 1.6E-01 | 3.6E-05 |
| Benzene | 1.5E+00 | 7.8E+01 | 5.6E-03 | 1.4E+03 | 1.5E+01 | 1.4E+01 | 1.9E+01 | 2.2E-01 | 1.9E-01 | 4.1E-05 |
| Bromodichloromethane | 6.1E-01 | 1.6E+02 | 1.6E-03 | 9.9E+02 | 1.0E+01 | 9.0E+00 | 1.2E+01 | 5.9E-02 | 4.9E-02 | 1.1E-05 |
| Chlorobenzene | 3.6E+01 | 1.1E+02 | 3.7E-03 | 1.2E+03 | 1.3E+01 | 1.2E+01 | 1.6E+01 | 4.4E+00 | 3.7E+00 | 8.2E-04 |
| Chloroform | 2.2E+00 | 1.2E+02 | 3.7E-03 | 1.2E+03 | 1.2E+01 | 1.1E+01 | 1.5E+01 | 2.6E-01 | 2.2E-01 | 4.9E-05 |
| Methylene chloride | 4.4E+00 | 8.5E+01 | 2.2E-03 | 1.4E+03 | 1.4E+01 | 1.3E+01 | 1.7E+01 | 6.0E-01 | 5.0E-01 | 1.1E-04 |
| Tetrachloroethene | 1.5E+00 | 1.7E+02 | 1.8E-02 | 9.9E+02 | 1.0E+01 | 1.0E+01 | 1.4E+01 | 1.6E-01 | 1.3E-01 | 3.0E-05 |
| Trichloroethene | 3.0E+00 | 1.3E+02 | 4.0E-01 | 1.1E+03 | 1.2E+01 | 1.2E+01 | 1.6E+01 | 3.6E-01 | 3.0E-01 | 6.7E-05 |
| Vinyl chloride | 2.0E+00 | 6.3E+01 | 2.7E-02 | 1.6E+03 | 1.7E+01 | 1.7E+01 | 2.2E+01 | 3.4E-01 | 2.8E-01 | 6.2E-05 |
| cis-1,2-Dichloroethene | 5.4E+00 | 9.7E+01 | 4.1E-03 | 1.3E+03 | 1.3E+01 | 1.3E+01 | 1.7E+01 | 7.2E-01 | 6.0E-01 | 1.3E-04 |

| Variables | Units | Exposure Assumptions |
|---|---|---|
| Kg(VOC) = gas-film mass transfer coefficient | cm/hr | Solved by Eq 1 |
| Kl(VOC) = liquid-film mass transfer coefficient | cm/hr | Solved by Eq 2 |
| KL = overall mass transfer coefficient | cm/hr | Solved by Eq 3 |
| Kal = adjusted overall mass transfer coeff. | cm/hr | Solved by Eq 4 |
| Tl = Calibration temp. of water | K (20C +273) | 293 |
| Ts = Shower water temperature | k (45C) | 318 |
| Us = water viscosity at Ts | centipoise | 0.596 |
| Ul = water viscosity at Tl | cp | 1.002 |
| Cwd = conc. leaving droplets after time sdt | µg/l | Solved by Eq 5 |
| sdt = shower droplet drop time | sec | 0.5 |
| d = shower droplet diameter | mm | 1 |
| FR = shower water flow rate | l/min | 10 |
| SV = shower room air volume | $m^3$ | 12 |
| S = indoor VOC generation rate | µg/$m^3$-min | Solved by Eq 6 |
| VR = ventilation rate | l/min | 13.8 |
| **Variables** | **Units** | **Exposure Assumptions** |
| BW = body weight | kg | 70 |
| Ds = duration of shower | min | 30 |
| Dt = total duration in shower room | min | 60 |
| R = air exchange rate | $min^{-1}$ | 0.0083 |
| Ca = indoor air concentration of VOCs | µg/$m^3$ | Solved by Eq 7 |
| Einh = inhalation exposure per shower | mg/kg/shower | Solved by Eq 8 |

Equation 1: Kg(VOC) = $3000 * (18 / HH)^{0.5}$

Equation 2: Kl(VOC) = $20 * (44 / HH)^{0.5}$

Equation 3: KL = $((1 / Kl(VOC)) + (0.024 / (Kg (VOC) * H)))^{-1}$

Equation 4: Kal = $(KL * (((Tl * Us) / (Ts * Ul))^{-0.5}))$

Equation 5: Cwd = (Cwo * (1-EXP((-1 * Kal * sdt)/(60 * d))))

Equation 6: S = (Cwd * FR / SV)

Equation 7: see time series example on Table I-GW-5

Equation 8: Einh = If t>Ds (((VR * S) / (BW * R * 1000000)) * ((Ds + (EXP(-R * Dt) / R)-(EXP(R * (Ds - Dt))) / R)))

TABLE 7.2.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Groundwater | Groundwater | Alluvial Aquifer - Tap Water | Ingestion | | | | | | | | | | | | | |
| | | | | 1,1,2,2-Tetrachloroethane | 3.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.0E-04 | mg/kg/day | N/A | | N/A |
| | | | | 1,1,2-Trichloroethane | 3.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.2E-04 | mg/kg/day | 4.0E-03 | mg/kg/day | 5.4E-02 |
| | | | | 1,2-Dibromo-3-chloropropane | 3.8E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.4E-04 | mg/kg/day | 2.0E-04 | mg/kg/day | 1.2E+00 |
| | | | | 1,2-Dichlorobenzene | 6.2E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.9E-03 | mg/kg/day | 9.0E-02 | mg/kg/day | 4.4E-02 |
| | | | | 1,2-Dichloropropane | 9.6E-01 | ug/L | N/A | N/A | N/A | N/A | N/A | 6.1E-05 | mg/kg/day | N/A | | N/A |
| | | | | 1,4-Dichlorobenzene | 1.9E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.2E-04 | mg/kg/day | 3.0E-02 | mg/kg/day | 4.0E-03 |
| | | | | Benzene | 1.5E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 9.6E-05 | mg/kg/day | 4.0E-03 | mg/kg/day | 2.4E-02 |
| | | | | Bromodichloromethane | 6.1E-01 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.9E-05 | mg/kg/day | 2.0E-02 | mg/kg/day | 1.9E-03 |
| | | | | Chlorobenzene | 3.6E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.3E-03 | mg/kg/day | 2.0E-02 | mg/kg/day | 1.1E-01 |
| | | | | Chloroform | 2.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.4E-04 | mg/kg/day | 1.0E-02 | mg/kg/day | 1.4E-02 |
| | | | | Methylene chloride | 4.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.8E-04 | mg/kg/day | 6.0E-02 | mg/kg/day | 4.7E-03 |
| | | | | Tetrachloroethene | 1.5E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 9.5E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 9.5E-03 |
| | | | | Trichloroethene | 3.0E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.9E-04 | mg/kg/day | 6.0E-03 | mg/kg/day | 3.2E-02 |
| | | | | Vinyl chloride | 2.0E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.3E-04 | mg/kg/day | 3.0E-03 | mg/kg/day | 4.2E-02 |
| | | | | cis-1,2-Dichloroethene | 5.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.5E-04 | mg/kg/day | 1.0E-02 | mg/kg/day | 3.5E-02 |
| | | | | Arsenic-dissolved | 4.8E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.1E-04 | mg/kg/day | 3.0E-04 | mg/kg/day | 1.0E+00 |
| | | | | Chromium (hexavalent)-dissolved | 6.3E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 4.1E-04 | mg/kg/day | 3.0E-03 | mg/kg/day | 1.4E-01 |
| | | | | Iron-dissolved | 9.4E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 6.0E-01 | mg/kg/day | 7.0E-01 | mg/kg/day | 8.6E-01 |
| | | | | Manganese-dissolved | 2.5E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.6E-01 | mg/kg/day | 2.0E-02 | mg/kg/day | 8.1E+00 |
| | | | | Nickel-dissolved | 1.7E+02 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.1E-02 | mg/kg/day | 2.0E-02 | mg/kg/day | 5.4E-01 |
| | | | | Thallium-dissolved | 6.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 4.0E-04 | mg/kg/day | 7.0E-05 | mg/kg/day | 5.7E+00 |
| | | | Exp. Route Total | | | | | | | | N/A | | | | | 1.8E+01 |
| | | | Dermal Absorption | 1,1,2,2-Tetrachloroethane | 3.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.5E-05 | mg/kg/day | N/A | | N/A |
| | | | | 1,1,2-Trichloroethane | 3.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.0E-05 | mg/kg/day | 4.0E-03 | mg/kg/day | 4.9E-03 |
| | | | | 1,2-Dibromo-3-chloropropane | 3.8E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.5E-05 | mg/kg/day | 2.0E-04 | mg/kg/day | 7.6E-02 |
| | | | | 1,2-Dichlorobenzene | 6.2E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.5E-03 | mg/kg/day | 9.0E-02 | mg/kg/day | 2.8E-02 |
| | | | | 1,2-Dichloropropane | 9.6E-01 | ug/L | N/A | N/A | N/A | N/A | N/A | 5.9E-06 | mg/kg/day | N/A | | N/A |
| | | | | 1,4-Dichlorobenzene | 1.9E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 7.7E-05 | mg/kg/day | 3.0E-02 | mg/kg/day | 2.6E-03 |
| | | | | Benzene | 1.5E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.5E-05 | mg/kg/day | 4.0E-03 | mg/kg/day | 3.7E-03 |
| | | | | Bromodichloromethane | 6.1E-01 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.1E-06 | mg/kg/day | 2.0E-02 | mg/kg/day | 1.5E-04 |
| | | | | Chlorobenzene | 3.6E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 8.0E-04 | mg/kg/day | 2.0E-02 | mg/kg/day | 4.0E-02 |
| | | | | Chloroform | 2.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.2E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 1.2E-03 |
| | | | | Methylene chloride | 4.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.1E-05 | mg/kg/day | 6.0E-02 | mg/kg/day | 1.8E-04 |
| | | | | Tetrachloroethene | 1.5E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 5.5E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 5.5E-03 |
| | | | | Trichloroethene | 3.0E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.1E-05 | mg/kg/day | 6.0E-03 | mg/kg/day | 5.1E-03 |
| | | | | Vinyl chloride | 2.0E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 6.8E-06 | mg/kg/day | 3.0E-03 | mg/kg/day | 2.3E-03 |
| | | | | cis-1,2-Dichloroethene | 5.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.0E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 3.0E-03 |
| | | | | Arsenic-dissolved | 4.8E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.0E-06 | mg/kg/day | 3.0E-04 | mg/kg/day | 6.8E-03 |
| | | | | Chromium (hexavalent)-dissolved | 6.3E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 5.4E-06 | mg/kg/day | 7.5E-05 | mg/kg/day | 7.1E-02 |

TABLE 7.2.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Groundwater | Groundwater | Alluvial Aquifer - Tap Water | Dermal Absorption | Iron-dissolved | 9.4E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 4.0E-03 | mg/kg/day | 7.0E-01 | mg/kg/day | 5.6E-03 |
| | | | | Manganese-dissolved | 2.5E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.1E-03 | mg/kg/day | 8.0E-04 | mg/kg/day | 1.3E+00 |
| | | | | Nickel-dissolved | 1.7E+02 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.4E-05 | mg/kg/day | 8.0E-04 | mg/kg/day | 1.8E-02 |
| | | | | Thallium-dissolved | 6.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.6E-06 | mg/kg/day | 7.0E-05 | mg/kg/day | 3.7E-02 |
| | | | Exp. Route Total | | | | | | | | N/A | | | | | 1.6E+00 |
| | | Exposure Point Total | | | | | | | | | N/A | | | | | 2.0E+01 |
| | Exposure Medium Total | | | | | | | | | | N/A | | | | | 2.0E+01 |
| Medium Total | | | | | | | | | | | N/A | | | | | 2.0E+01 |
| | | | | | | | | | | Total of Receptor Risks Across All Media | N/A | | | Total of Receptor Hazards Across All Media | | 2.0E+01 |

Notes-
NA = Not applicable.
DAevent for exposure to groundwater while bathing is calculated on Table 7.2.RME Supplement A.

Table 7.2.RME Supplement A
Calculation of DAevent
Resident Child Ground Water
Site 12 Remedial investigation, Allegany Ballistics Laboratory

| Chemical of Potential Concern | Water Concentration (CW) (µg/L) | Permeability Coefficient[1] (Kp) (cm/hr) | B[1] (dimensionless) | Lag Time[1] ($\tau_{event}$) (hr) | t*[1] (hr) | Fraction Absorbed Water[1] (FA) (dimensionless) | Duration of Event (tevent) (hr) | DAevent ($mg/cm^2$-event) | Eq |
|---|---|---|---|---|---|---|---|---|---|
| 1,1,2,2-Tetrachloroethane | 3.2E+00 | 6.9E-03 | 3.5E-02 | 9.3E-01 | 2.2E+00 | 1.0E+00 | 1.0 | 5.9E-08 | 2 |
| 1,1,2-Trichloroethane | 3.4E+00 | 6.4E-03 | 2.9E-02 | 6.0E-01 | 1.4E+00 | 1.0E+00 | 1.0 | 4.7E-08 | 2 |
| 1,2-Dibromo-3-chloropropane[1] | 3.8E+00 | 2.3E-03 | 1.4E-02 | 2.2E+00 | 5.3E+00 | 1.0E+00 | 1.0 | 3.6E-08 | 2 |
| 1,2-Dichlorobenzene | 6.2E+01 | 4.1E-02 | 1.9E-01 | 7.1E-01 | 1.7E+00 | 1.0E+00 | 1.0 | 5.9E-06 | 2 |
| 1,2-Dichloropropane | 9.6E-01 | 7.8E-03 | 3.2E-02 | 4.6E-01 | 1.1E+00 | 1.0E+00 | 1.0 | 1.4E-08 | 2 |
| 1,4-Dichlorobenzene | 1.9E+00 | 4.2E-02 | 2.0E-01 | 7.1E-01 | 1.7E+00 | 1.0E+00 | 1.0 | 1.8E-07 | 2 |
| Benzene | 1.5E+00 | 1.5E-02 | 5.1E-02 | 2.9E-01 | 7.0E-01 | 1.0E+00 | 1.0 | 3.5E-08 | 3 |
| Bromodichloromethane | 6.1E-01 | 4.6E-03 | 2.3E-02 | 8.8E-01 | 2.1E+00 | 1.0E+00 | 1.0 | 7.3E-09 | 2 |
| Chlorobenzene | 3.6E+01 | 2.8E-02 | 1.2E-01 | 4.6E-01 | 1.1E+00 | 1.0E+00 | 1.0 | 1.9E-06 | 2 |
| Chloroform | 2.2E+00 | 6.8E-03 | 2.9E-02 | 5.0E-01 | 1.2E+00 | 1.0E+00 | 1.0 | 2.9E-08 | 2 |
| Methylene chloride | 4.4E+00 | 3.5E-03 | 1.3E-02 | 3.2E-01 | 7.6E-01 | 1.0E+00 | 1.0 | 2.5E-08 | 3 |
| Tetrachloroethene | 1.5E+00 | 3.3E-02 | 1.7E-01 | 9.1E-01 | 2.2E+00 | 1.0E+00 | 1.0 | 1.3E-07 | 2 |
| Trichloroethene | 3.0E+00 | 1.2E-02 | 5.1E-02 | 5.8E-01 | 1.4E+00 | 1.0E+00 | 1.0 | 7.3E-08 | 2 |
| Vinyl chloride | 2.0E+00 | 5.6E-03 | 1.7E-02 | 2.4E-01 | 5.7E-01 | 1.0E+00 | 1.0 | 1.6E-08 | 3 |
| cis-1,2-Dichloroethene | 5.4E+00 | 7.7E-03 | 2.9E-02 | 3.7E-01 | 8.8E-01 | 1.0E+00 | 1.0 | 7.2E-08 | 3 |
| Arsenic-dissolved | 4.8E+00 | 1.0E-03 | NA | NA | NA | NA | 1.0 | 4.8E-09 | 1 |
| Chromium (hexavalent)-dissolved | 6.3E+00 | 2.0E-03 | NA | NA | NA | NA | 1.0 | 1.3E-08 | 1 |
| Iron-dissolved | 9.4E+03 | 1.0E-03 | NA | NA | NA | NA | 1.0 | 9.4E-06 | 1 |
| Manganese-dissolved | 2.5E+03 | 1.0E-03 | NA | NA | NA | NA | 1.0 | 2.5E-06 | 1 |
| Nickel-dissolved | 1.7E+02 | 2.0E-04 | NA | NA | NA | NA | 1.0 | 3.4E-08 | 1 |
| Thallium-dissolved | 6.2E+00 | 1.0E-03 | NA | NA | NA | NA | 1.0 | 6.2E-09 | 1 |

**Inorganics: DAevent (mg/cm2-event) =**
Kp x CW x tevent x 0.001 mg/ug x 0.001 l/$cm^3$ (eq 1)

**Organics: DAevent (mg/cm2-event) =**
If $t_{event} \leq t^*$ then

$$DA_{event} = 2 \times FA \times K_p \times C_w \times 0.001 \quad mg/ug \times 0.001 \quad l/cm^3 \sqrt{\frac{6 \times \tau_{event} \times t_{event}}{\pi}} \qquad \text{(eq 2)}$$

If $t_{event} \geq t^*$ then

$$DA_{event} = FA \times K_p \times C_w \times 0.001 \quad mg/ug \times 0.001 \quad l/cm^3 \left[ \frac{t_{event}}{1+B} + 2 \times \tau_{event} \left( \frac{1+3B+3B^2}{(1+B)^2} \right) \right] \qquad \text{(eq 3)}$$

Notes:
[1] Values from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.
[2] Values from Virginia Remediation Program, Risk Assessment Guidance, gwcalcs.xls, revised 6/7/07
NA - not applicable.

TABLE 7.3.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult/Child

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Groundwater | Groundwater | Alluvial Aquifer - Tap Water | Ingestion | | | | | | | | | | | | | |
| | | | | 1,1,2,2-Tetrachloroethane | 3.2E+00 | ug/L | 4.8E-05 | mg/kg/day | 2.0E-01 | 1/mg/kg/day | 9.6E-06 | N/A | N/A | N/A | N/A | N/A |
| | | | | 1,1,2-Trichloroethane | 3.4E+00 | ug/L | 5.1E-05 | mg/kg/day | 5.7E-02 | 1/mg/kg/day | 2.9E-06 | N/A | N/A | N/A | N/A | N/A |
| | | | | 1,2-Dibromo-3-chloropropane [1] | 3.8E+00 | ug/L | | mg/kg/day | 8.0E-01 | 1/mg/kg/day | 1.4E-04 | N/A | N/A | N/A | N/A | N/A |
| | | | | 1,2-Dichlorobenzene | 6.2E+01 | ug/L | 9.2E-04 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | 1,2-Dichloropropane | 9.6E-01 | ug/L | 1.4E-05 | mg/kg/day | 6.8E-02 | 1/mg/kg/day | 9.7E-07 | N/A | N/A | N/A | N/A | N/A |
| | | | | 1,4-Dichlorobenzene | 1.9E+00 | ug/L | 2.8E-05 | mg/kg/day | 2.4E-02 | 1/mg/kg/day | 6.7E-07 | N/A | N/A | N/A | N/A | N/A |
| | | | | Benzene | 1.5E+00 | ug/L | 2.3E-05 | mg/kg/day | 5.5E-02 | 1/mg/kg/day | 1.2E-06 | N/A | N/A | N/A | N/A | N/A |
| | | | | Bromodichloromethane | 6.1E-01 | ug/L | 9.1E-06 | mg/kg/day | 6.2E-02 | 1/mg/kg/day | 5.6E-07 | N/A | N/A | N/A | N/A | N/A |
| | | | | Chlorobenzene | 3.6E+01 | ug/L | 5.4E-04 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Chloroform | 2.2E+00 | ug/L | 3.3E-05 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Methylene chloride | 4.4E+00 | ug/L | 6.6E-05 | mg/kg/day | 7.5E-03 | 1/mg/kg/day | 4.9E-07 | N/A | N/A | N/A | N/A | N/A |
| | | | | Tetrachloroethene | 1.5E+00 | ug/L | 2.2E-05 | mg/kg/day | 5.4E-01 | 1/mg/kg/day | 1.2E-05 | N/A | N/A | N/A | N/A | N/A |
| | | | | Trichloroethene | 3.0E+00 | ug/L | 4.5E-05 | mg/kg/day | 1.1E-02 | 1/mg/kg/day | 4.9E-07 | N/A | N/A | N/A | N/A | N/A |
| | | | | Vinyl chloride | 2.0E+00 | ug/L | 9.0E-04 | mg/kg/day | 7.2E-01 | 1/mg/kg/day | 1.2E-04 | N/A | N/A | N/A | N/A | N/A |
| | | | | cis-1,2-Dichloroethene | 5.4E+00 | ug/L | 8.1E-05 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Arsenic-dissolved | 4.8E+00 | ug/L | 7.2E-05 | mg/kg/day | 1.5E+00 | 1/mg/kg/day | 1.1E-04 | N/A | N/A | N/A | N/A | N/A |
| | | | | Chromium (hexavalent)-dissolved | 6.3E+00 | ug/L | 9.5E-05 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Iron-dissolved | 9.4E+03 | ug/L | 1.4E-01 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Manganese-dissolved | 2.5E+03 | ug/L | 3.8E-02 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Nickel-dissolved | 1.7E+02 | ug/L | 2.5E-03 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Thallium-dissolved | 6.2E+00 | ug/L | 9.3E-05 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | Exp. Route Total | | | | | | | | 3.9E-04 | | | | | N/A |
| | | | Dermal Absorption | 1,1,2,2-Tetrachloroethane | 3.2E+00 | ug/L | 6.0E-06 | mg/kg/day | 2.0E-01 | 1/mg/kg/day | 1.2E-06 | N/A | N/A | N/A | N/A | N/A |
| | | | | 1,1,2-Trichloroethane | 3.4E+00 | ug/L | 4.7E-06 | mg/kg/day | 5.7E-02 | 1/mg/kg/day | 2.7E-07 | N/A | N/A | N/A | N/A | N/A |
| | | | | 1,2-Dibromo-3-chloropropane [1] | 3.8E+00 | ug/L | | mg/kg/day | 8.0E-01 | 1/mg/kg/day | 1.2E-05 | N/A | N/A | N/A | N/A | N/A |
| | | | | 1,2-Dichlorobenzene | 6.2E+01 | ug/L | 6.0E-04 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | 1,2-Dichloropropane | 9.6E-01 | ug/L | 1.4E-06 | mg/kg/day | 6.8E-02 | 1/mg/kg/day | 9.5E-08 | N/A | N/A | N/A | N/A | N/A |
| | | | | 1,4-Dichlorobenzene | 1.9E+00 | ug/L | 1.8E-05 | mg/kg/day | 2.4E-02 | 1/mg/kg/day | 4.4E-07 | N/A | N/A | N/A | N/A | N/A |
| | | | | Benzene | 1.5E+00 | ug/L | 3.4E-06 | mg/kg/day | 5.5E-02 | 1/mg/kg/day | 1.9E-07 | N/A | N/A | N/A | N/A | N/A |
| | | | | Bromodichloromethane | 6.1E-01 | ug/L | 7.4E-07 | mg/kg/day | 6.2E-02 | 1/mg/kg/day | 4.6E-08 | N/A | N/A | N/A | N/A | N/A |
| | | | | Chlorobenzene | 3.6E+01 | ug/L | 1.9E-04 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Chloroform | 2.2E+00 | ug/L | 2.9E-06 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Methylene chloride | 4.4E+00 | ug/L | 2.5E-06 | mg/kg/day | 7.5E-03 | 1/mg/kg/day | 1.9E-08 | N/A | N/A | N/A | N/A | N/A |
| | | | | Tetrachloroethene | 1.5E+00 | ug/L | 1.3E-05 | mg/kg/day | 5.4E-01 | 1/mg/kg/day | 7.1E-06 | N/A | N/A | N/A | N/A | N/A |
| | | | | Trichloroethene | 3.0E+00 | ug/L | 7.4E-06 | mg/kg/day | 1.1E-02 | 1/mg/kg/day | 8.1E-08 | N/A | N/A | N/A | N/A | N/A |
| | | | | Vinyl chloride | 2.0E+00 | ug/L | 1.2E-05 | mg/kg/day | 7.2E-01 | 1/mg/kg/day | 8.9E-06 | N/A | N/A | N/A | N/A | N/A |
| | | | | cis-1,2-Dichloroethene | 5.4E+00 | ug/L | 7.1E-06 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Arsenic-dissolved | 4.8E+00 | ug/L | 4.1E-07 | mg/kg/day | 1.5E+00 | 1/mg/kg/day | 6.1E-07 | N/A | N/A | N/A | N/A | N/A |
| | | | | Chromium (hexavalent)-dissolved | 6.3E+00 | ug/L | 1.1E-06 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |

TABLE 7.3.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult/Child

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Groundwater | Groundwater | Alluvial Aquifer - Tap Water | Dermal Absorption | Iron-dissolved | 9.4E+03 | ug/L | 8.0E-04 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Manganese-dissolved | 2.5E+03 | ug/L | 2.1E-04 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Nickel-dissolved | 1.7E+02 | ug/L | 2.9E-06 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Thallium-dissolved | 6.2E+00 | ug/L | 5.3E-07 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | Exp. Route Total | | | | | | | | 3.1E-05 | | | | | N/A |
| | | Exposure Point Total | | | | | | | | | 4.2E-04 | | | | | N/A |
| | Exposure Medium Total | | | | | | | | | | 4.2E-04 | | | | | N/A |
| Medium Total | | | | | | | | | | | 4.2E-04 | | | | | N/A |
| | | | | | | | | | | Total of Receptor Risks Across All Media | 4.2E-04 | | | | Total of Receptor Hazards Across All Media | N/A |

Notes-

1. See Table 7.3.RME Supplement A for calculation of 1,2-Dibromo-3-chloropropane intake and cancer risk following MMOA method.

NA = Not applicable.

DAevent for exposure to groundwater while showering is calculated on Table 7.1.RME Supplement A and 7.2.RME Supplement A.

TABLE 7.3.RME Supplement A

CALCULATION OF CHEMICAL CANCER RISKS FOR COPC WITH MUTAGENIC MODE OF ACTION

REASONABLE MAXIMUM EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult/Child

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Intake | | | | | CSF/Unit Risk | | | | | Cancer Risk |
| | | | | | Value | Units | Value | | | | Units | Value | | | | Units | |
| | | | | | | | 0-2 yrs | 2-6 yrs | 6-16 years | 16-30 yrs | | 0-2 yrs (ADAF=10) | 2-6 yrs (ADAF=3) | 6-16 yrs (ADAF=3) | 16-30 yrs (ADAF=1) | Units | |
| Groundwater | Groundwater | Alluvial Aquifer - Tap Water | Ingestion | 1,2-Dibromo-3-chloropropane | 3.8E+00 | mg/kg | 6.9E-06 | 1.4E-05 | 1.5E-05 | 2.1E-05 | mg/kg/day | 8.0E+00 | 2.4E+00 | 2.4E+00 | 8.0E-01 | 1/(mg/kg-day) | 1.4E-04 |
| | | | Dermal | 1,2-Dibromo-3-chloropropane | 3.8E+00 | mg/kg | 5.6E-07 | 1.1E-06 | 1.3E-06 | 1.8E-06 | mg/kg/day | 8.0E+00 | 2.4E+00 | 2.4E+00 | 8.0E-01 | 1/(mg/kg-day) | 1.2E-05 |

TABLE 7.4.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Groundwater | Groundwater | Alluvial Aqiuifer - Water in Excavation Pit | Dermal | 1,1,2,2-Tetrachloroethane | 3.2E+00 | µg/L | 8.5E-08 | mg/kg/day | 2.0E-01 | 1/mg/kg-day | 1.7E-08 | 6.0E-06 | mg/kg/day | N/A | | N/A |
| | | | | 1,1,2-Trichloroethane | 3.4E+00 | µg/L | 7.9E-08 | mg/kg/day | 5.7E-02 | 1/mg/kg-day | 4.5E-09 | 5.5E-06 | mg/kg/day | 4.0E-02 | mg/kg/day | 1.4E-04 |
| | | | | 1,2-Dibromo-3-chloropropane | 3.8E+00 | µg/L | 4.3E-08 | mg/kg/day | 8.0E-01 | | 3.4E-08 | 3.0E-06 | mg/kg/day | 2.0E-04 | mg/kg/day | 1.5E-02 |
| | | | | 1,2-Dichlorobenzene | 6.2E+01 | µg/L | 8.5E-06 | mg/kg/day | N/A | | N/A | 6.0E-04 | mg/kg/day | 9.0E-02 | mg/kg/day | 6.6E-03 |
| | | | | 1,2-Dichloropropane | 9.6E-01 | µg/L | 2.6E-08 | mg/kg/day | 6.8E-02 | 1/mg/kg-day | 1.8E-09 | 1.8E-06 | mg/kg/day | N/A | | N/A |
| | | | | 1,4-Dichlorobenzene | 1.9E+00 | µg/L | 2.6E-07 | mg/kg/day | 2.4E-02 | 1/mg/kg-day | 6.3E-09 | 1.8E-05 | mg/kg/day | 3.0E-02 | mg/kg/day | 6.1E-04 |
| | | | | Benzene | 1.5E+00 | µg/L | 7.3E-08 | mg/kg/day | 5.5E-02 | 1/mg/kg-day | 4.0E-09 | 5.1E-06 | mg/kg/day | 4.0E-03 | mg/kg/day | 1.3E-03 |
| | | | | Bromodichloromethane | 6.1E-01 | µg/L | 1.1E-08 | mg/kg/day | 6.2E-02 | 1/mg/kg-day | 6.7E-10 | 7.6E-07 | mg/kg/day | 2.0E-02 | mg/kg/day | 3.8E-05 |
| | | | | Chlorobenzene | 3.6E+01 | µg/L | 3.3E-06 | mg/kg/day | N/A | | N/A | 2.3E-04 | mg/kg/day | 2.0E-02 | mg/kg/day | 1.2E-02 |
| | | | | Chloroform | 2.2E+00 | µg/L | 5.2E-08 | mg/kg/day | N/A | | N/A | 3.7E-06 | mg/kg/day | 1.0E-02 | mg/kg/day | 3.7E-04 |
| | | | | Methylene chloride | 4.4E+00 | µg/L | 5.3E-08 | mg/kg/day | 7.5E-03 | | 4.0E-10 | 3.7E-06 | mg/kg/day | 6.0E-02 | mg/kg/day | 6.2E-05 |
| | | | | Tetrachloroethene | 1.5E+00 | µg/L | 1.8E-07 | mg/kg/day | 5.4E-01 | 1/mg/kg-day | 9.6E-08 | 1.2E-05 | mg/kg/day | 1.0E-01 | mg/kg/day | 1.2E-04 |
| | | | | Trichloroethene | 3.0E+00 | µg/L | 1.2E-07 | mg/kg/day | 1.1E-02 | 1/mg/kg-day | 1.3E-09 | 8.6E-06 | mg/kg/day | 6.0E-03 | mg/kg/day | 1.4E-03 |
| | | | | Vinyl chloride | 2.0E+00 | µg/L | 3.7E-08 | mg/kg/day | 7.2E-01 | 1/mg/kg-day | 2.6E-08 | 2.6E-06 | mg/kg/day | 3.0E-03 | mg/kg/day | 8.5E-04 |
| | | | | cis-1,2-Dichloroethene | 5.4E+00 | µg/L | 1.4E-07 | mg/kg/day | N/A | | N/A | 9.9E-06 | mg/kg/day | 1.0E-01 | mg/kg/day | 9.9E-05 |
| | | | | Aluminum | 8.3E+03 | µg/L | 2.6E-05 | mg/kg/day | N/A | | N/A | 1.9E-03 | mg/kg/day | 1.0E+00 | mg/kg/day | 1.9E-03 |
| | | | | Arsenic | 8.4E+00 | µg/L | 2.7E-08 | mg/kg/day | 1.5E+00 | 1/mg/kg-day | 4.0E-08 | 1.9E-06 | mg/kg/day | 3.0E-04 | mg/kg/day | 6.3E-03 |
| | | | | Chromium | 1.1E+01 | µg/L | 7.0E-08 | mg/kg/day | N/A | | N/A | 4.9E-06 | mg/kg/day | 5.0E-04 | mg/kg/day | 9.8E-03 |
| | | | | Chromium (hexavalent) | 4.6E+01 | µg/L | 2.9E-07 | mg/kg/day | N/A | | N/A | 2.1E-05 | mg/kg/day | 5.0E-04 | mg/kg/day | 4.1E-02 |
| | | | | Iron | 2.3E+04 | µg/L | 7.4E-05 | mg/kg/day | N/A | | N/A | 5.2E-03 | mg/kg/day | 7.0E-01 | mg/kg/day | 7.4E-03 |
| | | | | Manganese | 2.1E+03 | µg/L | 6.7E-06 | mg/kg/day | N/A | | N/A | 4.7E-04 | mg/kg/day | 8.0E-04 | mg/kg/day | 5.9E-01 |
| | | | | Nickel | 9.5E+01 | µg/L | 6.0E-08 | mg/kg/day | N/A | | N/A | 4.2E-06 | mg/kg/day | 8.0E-04 | mg/kg/day | 5.3E-03 |
| | | | | Vanadium | 1.4E+01 | µg/L | 4.4E-08 | mg/kg/day | N/A | | N/A | 3.1E-06 | mg/kg/day | 1.8E-04 | mg/kg/day | 1.7E-02 |
| | | | Exp. Route Total | | | | | | | | 2.3E-07 | | | | | 7.1E-01 |
| | | Exposure Point Total | | | | | | | | | 2.3E-07 | | | | | 7.1E-01 |
| | Exposure Medium Total | | | | | | | | | | 2.3E-07 | | | | | 7.1E-01 |
| Groundwater | Air | Alluvial Aquifer - Volatilization from Water in Excavation Pit | Inhalation | 1,1,2,2-Tetrachloroethane | 3.2E+00 | µg/L | 6.6E-09 | mg/kg/day | 2.0E-01 | 1/mg/kg-day | 1.3E-09 | 4.6E-07 | mg/kg/day | N/A | | N/A |
| | | | | 1,1,2-Trichloroethane | 3.4E+00 | µg/L | 1.5E-08 | mg/kg/day | 5.6E-02 | 1/mg/kg-day | 8.5E-10 | 1.1E-06 | mg/kg/day | N/A | | N/A |
| | | | | 1,2-Dibromo-3-chloropropane | 3.8E+00 | µg/L | 3.4E-09 | mg/kg/day | 2.1E+01 | 1/mg/kg-day | 7.1E-08 | 2.4E-07 | mg/kg/day | 5.7E-05 | mg/kg/day | 4.2E-03 |
| | | | | 1,2-Dichlorobenzene | 6.2E+01 | µg/L | 4.1E-07 | mg/kg/day | N/A | | N/A | 2.8E-05 | mg/kg/day | 5.7E-01 | mg/kg/day | 5.0E-05 |
| | | | | 1,2-Dichloropropane | 9.6E-01 | µg/L | 7.4E-09 | mg/kg/day | N/A | | N/A | 5.2E-07 | mg/kg/day | 3.7E-03 | mg/kg/day | 1.4E-04 |
| | | | | 1,4-Dichlorobenzene | 1.9E+00 | µg/L | 1.4E-08 | mg/kg/day | 2.2E-02 | 1/mg/kg-day | 3.0E-10 | 9.5E-07 | mg/kg/day | 7.1E-01 | mg/kg/day | 1.3E-06 |
| | | | | Benzene | 1.5E+00 | µg/L | 1.7E-08 | mg/kg/day | 2.7E-02 | 1/mg/kg-day | 4.5E-10 | 1.2E-06 | mg/kg/day | 1.7E-02 | mg/kg/day | 6.9E-05 |
| | | | | Bromodichloromethane | 6.1E-01 | µg/L | 3.6E-09 | mg/kg/day | N/A | | N/A | 2.5E-07 | mg/kg/day | N/A | | N/A |
| | | | | Chlorobenzene | 3.6E+01 | µg/L | 3.3E-07 | mg/kg/day | N/A | | N/A | 2.3E-05 | mg/kg/day | 1.4E-02 | mg/kg/day | 1.6E-03 |
| | | | | Chloroform | 2.2E+00 | µg/L | 2.0E-08 | mg/kg/day | 8.1E-02 | 1/mg/kg-day | 1.6E-09 | 1.4E-06 | mg/kg/day | 1.4E-02 | mg/kg/day | 9.8E-05 |
| | | | | Methylene chloride | 4.4E+00 | µg/L | 3.5E-08 | mg/kg/day | 1.7E-03 | 1/mg/kg-day | 5.8E-11 | 2.5E-06 | mg/kg/day | 8.6E-01 | mg/kg/day | 2.9E-06 |

TABLE 7.4.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Groundwater | Air | Alluvial Aquifer - Volatilization from Water in Excavation Pit | Inhalation | Tetrachloroethene | 1.5E+00 | µg/L | 1.6E-08 | mg/kg/day | 2.0E-02 | 1/mg/kg-day | 3.3E-10 | 1.1E-06 | mg/kg/day | 8.0E-02 | mg/kg/day | 1.4E-05 |
| | | | | Trichloroethene | 3.0E+00 | µg/L | 3.8E-08 | mg/kg/day | 6.0E-03 | 1/mg/kg-day | 2.3E-10 | 2.6E-06 | mg/kg/day | N/A | | N/A |
| | | | | Vinyl chloride | 2.0E+00 | µg/L | 2.8E-08 | mg/kg/day | 1.5E-02 | 1/mg/kg-day | 4.3E-10 | 2.0E-06 | mg/kg/day | 2.8E-02 | mg/kg/day | 7.0E-05 |
| | | | | cis-1,2-Dichloroethene | 5.4E+00 | µg/L | 5.3E-08 | mg/kg/day | N/A | | N/A | 3.7E-06 | mg/kg/day | N/A | | N/A |
| | | | Exp. Route Total | | | | | | | | 7.7E-08 | | | | | 6.2E-03 |
| | | Exposure Point Total | | | | | | | | | 7.7E-08 | | | | | 6.2E-03 |
| | Exposure Medium Total | | | | | | | | | | 7.7E-08 | | | | | 6.2E-03 |
| Groundwater - Shallow Groundwater in Excavation Total | | | | | | | | | | | 3.1E-07 | | | | | 7.2E-01 |
| | | | | | | | Total of Receptor Risks Across All Media | | | | 3.1E-07 | Total of Receptor Hazards Across All Media | | | | 7.2E-01 |

Notes-
NA = Not applicable.
Subcronic RfD values used when available

DAevent for exposure to shallow aquifer groundwater during excavation activities calculated on Table 7.4.RME Supplement A.
EPC for inhalation of volatiles from shallow aquifer groundwater from excavation pit calculated on Table 7.4.RME Supplement B.

Table 7.4.RME Supplement A
Calculation of DAevent
Construction Worker
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

| Chemical of Potential Concern | Water Concentration (CW) (μg/L) | Permeability Coefficient[1] (Kp) (cm/hr) | B[1] (dimensionless) | Lag Time[1] ($\tau_{event}$) (hr) | t*[1] (hr) | Fraction Absorbed Water[1] (FA) (dimensionless) | Duration of Event (tevent) (hr) | DAevent (mg/cm$^2$-event) | Eq |
|---|---|---|---|---|---|---|---|---|---|
| 1,1,2,2-Tetrachloroethane | 3.2E+00 | 6.9E-03 | 3.5E-02 | 9.3E-01 | 2.2E+00 | 1.0E+00 | 8 | 2.1E-07 | 3 |
| 1,1,2-Trichloroethane | 3.4E+00 | 6.4E-03 | 2.9E-02 | 6.0E-01 | 1.4E+00 | 1.0E+00 | 8 | 2.0E-07 | 3 |
| 1,2-Dibromo-3-chloropropane | 3.8E+00 | 2.3E-03 | 1.4E-02 | 2.2E+00 | 5.3E+00 | 1.0E+00 | 8 | 1.1E-07 | 3 |
| 1,2-Dichlorobenzene | 6.2E+01 | 4.1E-02 | 1.9E-01 | 7.1E-01 | 1.7E+00 | 1.0E+00 | 8 | 2.1E-05 | 3 |
| 1,2-Dichloropropane | 9.6E-01 | 7.8E-03 | 3.2E-02 | 4.6E-01 | 1.1E+00 | 1.0E+00 | 8 | 6.5E-08 | 3 |
| 1,4-Dichlorobenzene | 1.9E+00 | 4.2E-02 | 2.0E-01 | 7.1E-01 | 1.7E+00 | 1.0E+00 | 8 | 6.5E-07 | 3 |
| Benzene | 1.5E+00 | 1.5E-02 | 5.1E-02 | 2.9E-01 | 7.0E-01 | 1.0E+00 | 8 | 1.8E-07 | 3 |
| Bromodichloromethane | 6.1E-01 | 4.6E-03 | 2.3E-02 | 8.8E-01 | 2.1E+00 | 1.0E+00 | 8 | 2.7E-08 | 3 |
| Chlorobenzene | 3.6E+01 | 2.8E-02 | 1.2E-01 | 4.6E-01 | 1.1E+00 | 1.0E+00 | 8 | 8.3E-06 | 3 |
| Chloroform | 2.2E+00 | 6.8E-03 | 2.9E-02 | 5.0E-01 | 1.2E+00 | 1.0E+00 | 8 | 1.3E-07 | 3 |
| Methylene chloride | 4.4E+00 | 3.5E-03 | 1.3E-02 | 3.2E-01 | 7.6E-01 | 1.0E+00 | 8 | 1.3E-07 | 3 |
| Tetrachloroethene | 1.5E+00 | 3.3E-02 | 1.7E-01 | 9.1E-01 | 2.2E+00 | 1.0E+00 | 8 | 4.5E-07 | 3 |
| Trichloroethene | 3.0E+00 | 1.2E-02 | 5.1E-02 | 5.8E-01 | 1.4E+00 | 1.0E+00 | 8 | 3.1E-07 | 3 |
| Vinyl chloride | 2.0E+00 | 5.6E-03 | 1.7E-02 | 2.4E-01 | 5.7E-01 | 1.0E+00 | 8 | 9.2E-08 | 3 |
| cis-1,2-Dichloroethene | 5.4E+00 | 7.7E-03 | 2.9E-02 | 3.7E-01 | 8.8E-01 | 1.0E+00 | 8 | 3.5E-07 | 3 |
| Aluminum | 8.3E+03 | 1.0E-03 | NA | NA | NA | NA | 8 | 6.6E-05 | 1 |
| Arsenic | 8.4E+00 | 1.0E-03 | NA | NA | NA | NA | 8 | 6.7E-08 | 1 |
| Chromium | 1.1E+01 | 2.0E-03 | NA | NA | NA | NA | 8 | 1.8E-07 | 1 |
| Chromium (hexavalent) | 4.6E+01 | 2.0E-03 | NA | NA | NA | NA | 8 | 7.4E-07 | 1 |
| Iron | 2.3E+04 | 1.0E-03 | NA | NA | NA | NA | 8 | 1.9E-04 | 1 |
| Manganese | 2.1E+03 | 1.0E-03 | NA | NA | NA | NA | 8 | 1.7E-05 | 1 |
| Nickel | 9.5E+01 | 2.0E-04 | NA | NA | NA | NA | 8 | 1.5E-07 | 1 |
| Vanadium | 1.4E+01 | 1.0E-03 | NA | NA | NA | NA | 8 | 1.1E-07 | 1 |

**Inorganics: DAevent (mg/cm2-event) =**
Kp x CW x tevent x 0.001 mg/ug x 0.001 l/cm$^3$ (eq 1)

**Organics: DAevent (mg/cm2-event) =**
If tevent≤t*, then DAevent =
2 x FA x Kp x CW x (sqrt((6 x $\tau_{event}$ x $t_{event}$)/$\pi$)) x 0.001 mg/ug x 0.001 l/cm$^3$ (eq 2)

If tevent≥t*, then DAevent =
FA x Kp x CW x ( $t_{event}$/(1+B) + 2 x $\tau_{event}$ x ((1 + 3xB + 3x$B^2$)/(1+B)$^2$) x 0.001 mg/ug x 0.001 l/cm$^3$ (eq 3)

Notes:
[1] Values from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.
[2] Values from Virginia Remediation Program, Risk Assessment Guidance, gwcalcs.xls, revised 6/7/07
NA - not applicable.

Table 7.4.RME Supplement B
Inhalation of Volatiles from Wter in Excavation Pit
Inhalation Exposure Concentrations Calculated Using a Two-Film Volatilization Model
Future Construction Worker Senario
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

| Chemical | Cw (μg/L) | MW (mol/gram) | KH (unitless) | kl (cm/hr) | kg (cm/hr) | Kv (cm/hr) | ER (mg/hr) | ERa (g/sec-m2) | Ca (mg/m3) |
|---|---|---|---|---|---|---|---|---|---|
| 1,1,2,2-Tetrachloroethane | 3.2E+00 | 1.7E+02 | 3.5E-04 | 2.9E+00 | 1.8E+03 | 5.0E-01 | 1.6E+00 | 1.7E-10 | 4.7E-06 |
| 1,1,2-Trichloroethane | 3.4E+00 | 1.3E+02 | 9.1E-04 | 3.1E+00 | 1.9E+03 | 1.1E+00 | 3.7E+00 | 3.8E-10 | 1.1E-05 |
| 1,2-Dibromo-3-chloropropane | 3.8E+00 | 2.4E+02 | 1.5E-04 | 2.7E+00 | 1.6E+03 | 2.2E-01 | 8.3E-01 | 8.5E-11 | 2.4E-06 |
| 1,2-Dichlorobenzene | 6.2E+01 | 1.5E+02 | 1.9E-03 | 3.0E+00 | 1.8E+03 | 1.6E+00 | 9.9E+01 | 1.0E-08 | 2.9E-04 |
| 1,2-Dichloropropane | 9.6E-01 | 1.5E+02 | 2.8E-03 | 3.0E+00 | 1.8E+03 | 1.9E+00 | 1.8E+00 | 1.9E-10 | 5.3E-06 |
| 1,4-Dichlorobenzene | 1.9E+00 | 1.5E+02 | 2.4E-03 | 3.0E+00 | 1.8E+03 | 1.8E+00 | 3.3E+00 | 3.4E-10 | 9.7E-06 |
| Benzene | 1.5E+00 | 7.8E+01 | 5.6E-03 | 3.5E+00 | 2.1E+03 | 2.7E+00 | 4.1E+00 | 4.2E-10 | 1.2E-05 |
| Bromodichloromethane | 6.1E-01 | 1.6E+02 | 1.6E-03 | 2.9E+00 | 1.8E+03 | 1.4E+00 | 8.8E-01 | 9.0E-11 | 2.6E-06 |
| Chlorobenzene | 3.6E+01 | 1.1E+02 | 3.7E-03 | 3.2E+00 | 1.9E+03 | 2.2E+00 | 8.0E+01 | 8.2E-09 | 2.3E-04 |
| Chloroform | 2.2E+00 | 1.2E+02 | 3.7E-03 | 3.2E+00 | 1.9E+03 | 2.2E+00 | 4.8E+00 | 4.9E-10 | 1.4E-05 |
| Methylene chloride | 4.4E+00 | 8.5E+01 | 2.2E-03 | 3.4E+00 | 2.1E+03 | 2.0E+00 | 8.7E+00 | 8.9E-10 | 2.5E-05 |
| Tetrachloroethene | 1.5E+00 | 1.7E+02 | 1.8E-02 | 2.9E+00 | 1.8E+03 | 2.7E+00 | 4.0E+00 | 4.1E-10 | 1.2E-05 |
| Trichloroethene | 3.0E+00 | 1.3E+02 | 4.0E-01 | 3.1E+00 | 1.9E+03 | 3.1E+00 | 9.2E+00 | 9.5E-10 | 2.7E-05 |
| Vinyl chloride | 2.0E+00 | 6.3E+01 | 2.7E-02 | 3.7E+00 | 2.3E+03 | 3.5E+00 | 6.9E+00 | 7.1E-10 | 2.0E-05 |
| cis-1,2-Dichloroethene | 5.4E+00 | 9.7E+01 | 4.1E-03 | 3.3E+00 | 2.0E+03 | 2.4E+00 | 1.3E+01 | 1.3E-09 | 3.8E-05 |

Equations

| | | |
|---|---|---|
| Equation 1 | Kv= | $1/(1/k_l + 1/K_H{*}K_g)$ |
| Equation 2 | $k_g$ = | $700(18/MW)^{1/4}V$ |
| Equation 3 | $k_l$ = | $(32/MW)^{1/4}Ka'$ |
| Equation 4 | ER = | Kv * Cw * L/1000 $cm^3$ * mg/1000 μg |
| Equation 5 | ERa = | ER * g/1000 mg * hr/60 min * min/60 sec * 1/A |

| Variables | Units | Exposure Assumptions |
|---|---|---|
| Cw = groundwater concentration | (μg/L) | chem-specific |
| MW = molecular weight | (mol/gram) | chem-specific |
| $K_H$ - Henry's Law Constant | (unitless) | chem-specific |
| Kv = volatilization rate | (cm/hr) | Solved by Eq 1 |
| $k_g$ = gas phase transfer coefficient | (cm/hr) | Solved by Eq 2 |
| $k_l$ = liquid phase transfer coefficient | (cm/hr) | Solved by Eq 3 |
| V = wind speed | (m/s) | 4.4 |
| Ka' = aeration rate | (cm/hr) | 0.0633 |
| ER = emission rate | (mg/hr) | Solved by Eq 4 |
| A = area of excavation (utility ditch) | ($m^2$) | 2,700 |
| Era = area emission rate | (g/sec-$m^2$) | Solved by Eq 5 |
| Ca = air concentration | (mg/$m^3$) | Solved using SCREEN3 model |

Note: aeration rate based on aeration rate for small pond (0.1/day) multiplied by depth of water in excavation (1/2 ft)

TABLE 7.5.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Groundwater | Groundwater | Bedrock Aquifer - Tap Water | Ingestion | | | | | | | | | | | | | |
| | | | | Methylene chloride | 3.6E+02 | ug/L | N/A | N/A | N/A | N/A | N/A | 9.8E-03 | mg/kg/day | 6.0E-02 | mg/kg/day | 1.6E-01 |
| | | | | Tetrachloroethene | 1.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.8E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 3.8E-03 |
| | | | | Trichloroethene | 2.0E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 5.4E-05 | mg/kg/day | 6.0E-03 | mg/kg/day | 9.0E-03 |
| | | | | cis-1,2-Dichloroethene | 2.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 6.0E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 6.0E-03 |
| | | | | bis(2-Ethylhexyl)phthalate | 3.7E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.0E-04 | mg/kg/day | 2.0E-02 | mg/kg/day | 5.1E-03 |
| | | | | Aluminum | 6.3E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.7E-01 | mg/kg/day | 1.0E+00 | mg/kg/day | 1.7E-01 |
| | | | | Antimony | 3.3E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 9.0E-05 | mg/kg/day | 4.0E-04 | mg/kg/day | 2.3E-01 |
| | | | | Arsenic | 4.9E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.4E-04 | mg/kg/day | 3.0E-04 | mg/kg/day | 4.5E-01 |
| | | | | Chromium | 3.6E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 9.9E-04 | mg/kg/day | 3.0E-03 | mg/kg/day | 3.3E-01 |
| | | | | Iron | 9.3E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.5E-01 | mg/kg/day | 7.0E-01 | mg/kg/day | 3.6E-01 |
| | | | | Lead | 3.9E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.1E-04 | mg/kg/day | N/A | | N/A |
| | | | | Manganese | 4.2E+02 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.1E-02 | mg/kg/day | 2.0E-02 | mg/kg/day | 5.7E-01 |
| | | | | Nickel | 2.4E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 6.5E-04 | mg/kg/day | 2.0E-02 | mg/kg/day | 3.3E-02 |
| | | | | Thallium | 5.9E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.6E-04 | mg/kg/day | 7.0E-05 | mg/kg/day | 2.3E+00 |
| | | | | Vanadium | 6.5E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.8E-04 | mg/kg/day | 1.0E-03 | mg/kg/day | 1.8E-01 |
| | | | Exp. Route Total | | | | | | | | N/A | | | | | 4.8E+00 |
| | | | Dermal Absorption | | | | | | | | | | | | | |
| | | | | Methylene chloride | 3.6E+02 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.7E-04 | mg/kg/day | 6.0E-02 | mg/kg/day | 6.2E-03 |
| | | | | Tetrachloroethene | 1.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.3E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 2.3E-03 |
| | | | | Trichloroethene | 2.0E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 9.1E-06 | mg/kg/day | 6.0E-03 | mg/kg/day | 1.5E-03 |
| | | | | cis-1,2-Dichloroethene | 2.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 5.3E-06 | mg/kg/day | 1.0E-02 | mg/kg/day | 5.3E-04 |
| | | | | bis(2-Ethylhexyl)phthalate | 3.7E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 8.8E-03 | mg/kg/day | 2.0E-02 | mg/kg/day | 4.4E-01 |
| | | | | Aluminum | 6.3E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 9.0E-04 | mg/kg/day | 1.0E+00 | mg/kg/day | 9.0E-04 |
| | | | | Antimony | 3.3E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 4.7E-07 | mg/kg/day | 6.0E-05 | mg/kg/day | 7.9E-03 |
| | | | | Arsenic | 4.9E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 7.1E-07 | mg/kg/day | 3.0E-04 | mg/kg/day | 2.4E-03 |
| | | | | Chromium | 3.6E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.0E-05 | mg/kg/day | 7.5E-05 | mg/kg/day | 1.4E-01 |
| Groundwater | Groundwater | Bedrock Aquifer - Tap Water | Dermal Absorption | Iron | 9.3E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.3E-03 | mg/kg/day | 7.0E-01 | mg/kg/day | 1.9E-03 |
| | | | | Lead | 3.9E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 5.6E-07 | mg/kg/day | N/A | | N/A |
| | | | | Manganese | 4.2E+02 | ug/L | N/A | N/A | N/A | N/A | N/A | 6.0E-05 | mg/kg/day | 8.0E-04 | mg/kg/day | 7.5E-02 |
| | | | | Nickel | 2.4E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 6.8E-07 | mg/kg/day | 8.0E-04 | mg/kg/day | 8.5E-04 |
| | | | | Thallium | 5.9E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 8.5E-07 | mg/kg/day | 7.0E-05 | mg/kg/day | 1.2E-02 |
| | | | | Vanadium | 6.5E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 9.3E-07 | mg/kg/day | 2.6E-05 | mg/kg/day | 3.6E-02 |
| | | | Exp. Route Total | | | | | | | | N/A | | | | | 7.2E-01 |
| | | Exposure Point Total | | | | | | | | | N/A | | | | | 5.6E+00 |
| | Exposure Medium Total | | | | | | | | | | N/A | | | | | 5.6E+00 |

TABLE 7.5.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Groundwater | Air | Bedrock Aquifer Water Vapors at Showerhead | Inhalation | Methylene chloride | 3.6E+02 | ug/L | 2.9E-03 | mg/kg/day | 1.7E-03 | 1/mg/kg/day | 4.8E-06 | 8.5E-03 | mg/kg/day | 3.0E-01 | mg/kg/day | 2.8E-02 |
| | | | | Tetrachloroethene | 1.4E+00 | ug/L | 9.2E-06 | mg/kg/day | 2.0E-02 | 1/mg/kg/day | 1.8E-07 | 2.7E-05 | mg/kg/day | 8.0E-02 | mg/kg/day | 3.3E-04 |
| | | | | Trichloroethene | 2.0E+00 | ug/L | 1.4E-05 | mg/kg/day | 6.0E-03 | 1/mg/kg/day | 8.6E-08 | 4.2E-05 | mg/kg/day | N/A | N/A | N/A |
| | | | | cis-1,2-Dichloroethene | 2.2E+00 | ug/L | 1.8E-05 | mg/kg/day | N/A | | N/A | 5.1E-05 | mg/kg/day | N/A | N/A | N/A |
| | | | Exp. Route Total | | | | | | | | 5.1E-06 | | | | | 2.9E-02 |
| | | Exposure Point Total | | | | | | | | | 5.1E-06 | | | | | 2.9E-02 |
| | Exposure Medium Total | | | | | | | | | | 5.1E-06 | | | | | 2.9E-02 |
| Medium Total | | | | | | | | | | | 5.1E-06 | | | | | 5.6E+00 |
| Total of Receptor Risks Across All Media | | | | | | | | | | | 5.1E-06 | Total of Receptor Hazards Across All Media | | | | 5.6E+00 |

Notes-
NA = Not applicable.
DAevent for exposure to groundwater while showering is calculated on Table 7.5.RME Supplement A.
Shower exposure calculated on Table 7.5.RME Supplement B.

Table 7.5.RME Supplement A
Calculation of DAevent
Resident Adult Ground Water
Site 12 Remedial investigation, Allegany Ballistics Laboratory

| Chemical of Potential Concern | Water Concentration (CW) (µg/L) | Permeability Coefficient[1] (Kp) (cm/hr) | B[1] (dimensionless) | Lag Time[1] ($\tau_{event}$) (hr) | t*[1] (hr) | Fraction Absorbed Water[1] (FA) (dimensionless) | Duration of Event (tevent) (hr) | DAevent (mg/cm$^2$-event) | Eq |
|---|---|---|---|---|---|---|---|---|---|
| Methylene chloride | 3.6E+02 | 3.5E-03 | 1.3E-02 | 3.2E-01 | 7.6E-01 | 1.0E+00 | 0.58 | 1.5E-06 | 2 |
| Tetrachloroethene | 1.4E+00 | 3.3E-02 | 1.7E-01 | 9.1E-01 | 2.2E+00 | 1.0E+00 | 0.58 | 9.4E-08 | 2 |
| Trichloroethene | 2.0E+00 | 1.2E-02 | 5.1E-02 | 5.8E-01 | 1.4E+00 | 1.0E+00 | 0.58 | 3.7E-08 | 2 |
| cis-1,2-Dichloroethene | 2.2E+00 | 7.7E-03 | 2.9E-02 | 3.7E-01 | 8.8E-01 | 1.0E+00 | 0.58 | 2.1E-08 | 2 |
| bis(2-Ethylhexyl)phthalate | 3.7E+00 | 1.1E+00 | 8.6E+00 | 1.7E+01 | 7.5E+01 | 1.0E+00 | 0.58 | 3.6E-05 | 2 |
| Aluminum | 6.3E+03 | 1.0E-03 | NA | NA | NA | NA | 0.58 | 3.7E-06 | 1 |
| Antimony | 3.3E+00 | 1.0E-03 | NA | NA | NA | NA | 0.58 | 1.9E-09 | 1 |
| Arsenic | 4.9E+00 | 1.0E-03 | NA | NA | NA | NA | 0.58 | 2.9E-09 | 1 |
| Chromium | 3.6E+01 | 2.0E-03 | NA | NA | NA | NA | 0.58 | 4.2E-08 | 1 |
| Iron | 9.3E+03 | 1.0E-03 | NA | NA | NA | NA | 0.58 | 5.4E-06 | 1 |
| Lead | 3.9E+00 | 1.0E-03 | NA | NA | NA | NA | 0.58 | 2.3E-09 | 1 |
| Manganese | 4.2E+02 | 1.0E-03 | NA | NA | NA | NA | 0.58 | 2.4E-07 | 1 |
| Nickel | 2.4E+01 | 2.0E-04 | NA | NA | NA | NA | 0.58 | 2.8E-09 | 1 |
| Thallium | 5.9E+00 | 1.0E-03 | NA | NA | NA | NA | 0.58 | 3.4E-09 | 1 |
| Vanadium | 6.5E+00 | 1.0E-03 | NA | NA | NA | NA | 0.58 | 3.8E-09 | 1 |

**Inorganics: DAevent (mg/cm2-event) =**
Kp x CW x tevent x 0.001 mg/ug x 0.001 l/cm$^3$ (eq 1)

**Organics: DAevent (mg/cm2-event) =**
If $t_{event} \leq t^*$ then

$$DA_{event} = 2 \times FA \times K_p \times C_w \times 0.001 \quad mg/ug \times 0.001 \quad l/cm^3 \sqrt{\frac{6 \times \tau_{event} \times t_{event}}{\pi}} \qquad \text{(eq 2)}$$

If $t_{event} \geq t^*$ then

$$DA_{event} = FA \times K_p \times C_w \times 0.001 \quad mg/ug \times 0.001 \quad l/cm^3 \left[ \frac{t_{event}}{1+B} + 2 \times \tau_{event} \left( \frac{1+3B+3B^2}{(1+B)^2} \right) \right] \qquad \text{(eq 3)}$$

Notes:
[1] Values from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.
[2] Values from Virginia Remediation Program, Risk Assessment Guidance, gwcalcs.xls, revised 6/7/07
NA - not applicable.

Table 7.5.RME Supplement B
Inhalation Exposure Concentrations from Foster and Chrostowski Shower Model
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

| Chemical | Exposure Point Concentration Cwo (µg/l) | Molecular weight (HH) (g/mole) | Henry's Law Constant (H) (atm-m$^3$/mole) | Kg (VOC) (cm/hr) | Kl(VOC) (cm/hr) | KL (cm/hr) | Kal (cm/hr) | Cwd (µg/l) | S (µg/m$^3$ -min) | Calculated Inhalation Exposure (Einh) (mg/kg/shower) |
|---|---|---|---|---|---|---|---|---|---|---|
| Methylene chloride | 3.6E+02 | 8.5E+01 | 2.2E-03 | 1.4E+03 | 1.4E+01 | 1.3E+01 | 1.7E+01 | 4.8E+01 | 4.0E+01 | 8.9E-03 |
| Tetrachloroethene | 1.4E+00 | 1.7E+02 | 1.8E-02 | 9.9E+02 | 1.0E+01 | 1.0E+01 | 1.4E+01 | 1.5E-01 | 1.3E-01 | 2.8E-05 |
| Trichloroethene | 2.0E+00 | 1.3E+02 | 1.0E-02 | 1.1E+03 | 1.2E+01 | 1.1E+01 | 1.5E+01 | 2.4E-01 | 2.0E-01 | 4.4E-05 |
| cis-1,2-Dichloroethene | 2.2E+00 | 9.7E+01 | 4.1E-03 | 1.3E+03 | 1.3E+01 | 1.3E+01 | 1.7E+01 | 2.9E-01 | 2.4E-01 | 5.4E-05 |

| Variables | Units | Exposure Assumptions |
|---|---|---|
| Kg(VOC) = gas-film mass transfer coefficient | cm/hr | Solved by Eq 1 |
| Kl(VOC) = liquid-film mass transfer coefficient | cm/hr | Solved by Eq 2 |
| KL = overall mass transfer coefficient | cm/hr | Solved by Eq 3 |
| Kal = adjusted overall mass transfer coeff. | cm/hr | Solved by Eq 4 |
| Tl = Calibration temp. of water | K (20C +273) | 293 |
| Ts = Shower water temperature | k (45C) | 318 |
| Us = water viscosity at Ts | centipoise | 0.596 |
| Ul = water viscosity at Tl | cp | 1.002 |
| Cwd = conc. leaving droplets after time sdt | µg/l | Solved by Eq 5 |
| sdt = shower droplet drop time | sec | 0.5 |
| d = shower droplet diameter | mm | 1 |
| FR = shower water flow rate | l/min | 10 |
| SV = shower room air volume | m$^3$ | 12 |
| S = indoor VOC generation rate | µg/m$^3$-min | Solved by Eq 6 |
| VR = ventilation rate | l/min | 13.8 |
| **Variables** | **Units** | **Exposure Assumptions** |
| BW = body weight | kg | 70 |
| Ds = duration of shower | min | 30 |
| Dt = total duration in shower room | min | 60 |
| R = air exchange rate | min$^{-1}$ | 0.0083 |
| Ca = indoor air concentration of VOCs | µg/m$^3$ | Solved by Eq 7 |
| Einh = inhalation exposure per shower | mg/kg/shower | Solved by Eq 8 |

| | | | |
|---|---|---|---|
| Equation 1: | Kg(VOC) = | 3000 * (18 / HH)$^{0.5}$ | |
| Equation 2: | Kl(VOC) = | 20 * (44 / HH)$^{0.5}$ | |
| Equation 3: | KL = | ((1 / Kl(VOC)) + (0.024 / (Kg (VOC) * H)))$^{-1}$ | |
| Equation 4: | Kal = | (KL * (((Tl * Us) / (Ts * Ul))$^{-0.5}$)) | |
| Equation 5: | Cwd = | (Cwo * (1-EXP((-1 * Kal * sdt)/(60 * d)))) | |
| Equation 6: | S = | (Cwd * FR / SV) | |
| Equation 7: | see time series example on Table I-GW-5 | | |
| Equation 8: | Einh = | If t>Ds | (((VR * S) / (BW * R * 1000000)) * ((Ds + (EXP(-R * Dt) / R)-(EXP(R * (Ds - Dt))) / R))) |

TABLE 7.6.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Groundwater | Groundwater | Bedrock Aquifer - Tap Water | Ingestion | | | | | | | | | | | | | |
| | | | | Methylene chloride | 3.6E+02 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.3E-02 | mg/kg/day | 6.0E-02 | mg/kg/day | 3.8E-01 |
| | | | | Tetrachloroethene | 1.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 8.9E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 8.9E-03 |
| | | | | Trichloroethene | 2.0E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.3E-04 | mg/kg/day | 6.0E-03 | mg/kg/day | 2.1E-02 |
| | | | | cis-1,2-Dichloroethene | 2.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.4E-04 | mg/kg/day | 1.0E-02 | mg/kg/day | 1.4E-02 |
| | | | | bis(2-Ethylhexyl)phthalate | 3.7E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.4E-04 | mg/kg/day | 2.0E-02 | mg/kg/day | 1.2E-02 |
| | | | | Aluminum | 6.3E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 4.0E-01 | mg/kg/day | 1.0E+00 | mg/kg/day | 4.0E-01 |
| | | | | Antimony | 3.3E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.1E-04 | mg/kg/day | 4.0E-04 | mg/kg/day | 5.3E-01 |
| | | | | Arsenic | 4.9E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.2E-04 | mg/kg/day | 3.0E-04 | mg/kg/day | 1.1E+00 |
| | | | | Chromium | 3.6E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.3E-03 | mg/kg/day | 3.0E-03 | mg/kg/day | 7.7E-01 |
| | | | | Iron | 9.3E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 5.9E-01 | mg/kg/day | 7.0E-01 | mg/kg/day | 8.5E-01 |
| | | | | Lead | 3.9E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.5E-04 | mg/kg/day | N/A | | N/A |
| | | | | Manganese | 4.2E+02 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.7E-02 | mg/kg/day | 2.0E-02 | mg/kg/day | 1.3E+00 |
| | | | | Nickel | 2.4E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.5E-03 | mg/kg/day | 2.0E-02 | mg/kg/day | 7.6E-02 |
| | | | | Thallium | 5.9E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.8E-04 | mg/kg/day | 7.0E-05 | mg/kg/day | 5.4E+00 |
| | | | | Vanadium | 6.5E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 4.1E-04 | mg/kg/day | 1.0E-03 | mg/kg/day | 4.1E-01 |
| | | | Exp. Route Total | | | | | | | | N/A | | | | | 1.1E+01 |
| | | | Dermal Absorption | | | | | | | | | | | | | |
| | | | | Methylene chloride | 3.6E+02 | ug/L | N/A | N/A | N/A | N/A | N/A | 8.7E-04 | mg/kg/day | 6.0E-02 | mg/kg/day | 1.4E-02 |
| | | | | Tetrachloroethene | 1.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 5.2E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 5.2E-03 |
| | | | | Trichloroethene | 2.0E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.0E-05 | mg/kg/day | 6.0E-03 | mg/kg/day | 3.4E-03 |
| | | | | cis-1,2-Dichloroethene | 2.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.2E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 1.2E-03 |
| | | | | bis(2-Ethylhexyl)phthalate | 3.7E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.0E-02 | mg/kg/day | 2.0E-02 | mg/kg/day | 9.9E-01 |
| | | | | Aluminum | 6.3E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.7E-03 | mg/kg/day | 1.0E+00 | mg/kg/day | 2.7E-03 |
| | | | | Antimony | 3.3E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.4E-06 | mg/kg/day | 6.0E-05 | mg/kg/day | 2.3E-02 |
| | | | | Arsenic | 4.9E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.1E-06 | mg/kg/day | 3.0E-04 | mg/kg/day | 7.0E-03 |
| | | | | Chromium | 3.6E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.0E-05 | mg/kg/day | 7.5E-05 | mg/kg/day | 4.0E-01 |
| Groundwater | Groundwater | Bedrock Aquifer - Tap Water | Dermal Absorption | Iron | 9.3E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.9E-03 | mg/kg/day | 7.0E-01 | mg/kg/day | 5.6E-03 |
| | | | | Lead | 3.9E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.6E-06 | mg/kg/day | N/A | | N/A |
| | | | | Manganese | 4.2E+02 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.8E-04 | mg/kg/day | 8.0E-04 | mg/kg/day | 2.2E-01 |
| | | | | Nickel | 2.4E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.0E-06 | mg/kg/day | 8.0E-04 | mg/kg/day | 2.5E-03 |
| | | | | Thallium | 5.9E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.5E-06 | mg/kg/day | 7.0E-05 | mg/kg/day | 3.6E-02 |
| | | | | Vanadium | 6.5E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.7E-06 | mg/kg/day | 2.6E-05 | mg/kg/day | 1.1E-01 |
| | | | Exp. Route Total | | | | | | | | N/A | | | | | 1.8E+00 |
| | | Exposure Point Total | | | | | | | | | N/A | | | | | 1.3E+01 |
| | Exposure Medium Total | | | | | | | | | | N/A | | | | | 1.3E+01 |
| Medium Total | | | | | | | | | | | N/A | | | | | 1.3E+01 |
| | | | | | | | | | Total of Receptor Risks Across All Media | | N/A | Total of Receptor Hazards Across All Media | | | | 1.3E+01 |

Notes-
NA = Not applicable.
DAevent for exposure to groundwater while showering is calculated on Table 7.6.RME Supplement A.

Table 7.6.RME Supplement A
Calculation of DAevent
Resident Child Ground Water
Site 12 Remedial investigation, Allegany Ballistics Laboratory

| Chemical of Potential Concern | Water Concentration (CW) (µg/L) | Permeability Coefficient[1] (Kp) (cm/hr) | B[1] (dimensionless) | Lag Time[1] ($\tau_{event}$) (hr) | t*[1] (hr) | Fraction Absorbed Water[1] (FA) (dimensionless) | Duration of Event (tevent) (hr) | DAevent ($mg/cm^2$-event) | Eq |
|---|---|---|---|---|---|---|---|---|---|
| Methylene chloride | 3.6E+02 | 3.5E-03 | 1.3E-02 | 3.2E-01 | 7.6E-01 | 1.0E+00 | 1.0 | 2.1E-06 | 3 |
| Tetrachloroethene | 1.4E+00 | 3.3E-02 | 1.7E-01 | 9.1E-01 | 2.2E+00 | 1.0E+00 | 1.0 | 1.2E-07 | 2 |
| Trichloroethene | 2.0E+00 | 1.2E-02 | 5.1E-02 | 5.8E-01 | 1.4E+00 | 1.0E+00 | 1.0 | 4.9E-08 | 2 |
| cis-1,2-Dichloroethene | 2.2E+00 | 7.7E-03 | 2.9E-02 | 3.7E-01 | 8.8E-01 | 1.0E+00 | 1.0 | 2.9E-08 | 3 |
| bis(2-Ethylhexyl)phthalate | 3.7E+00 | 1.1E+00 | 8.6E+00 | 1.7E+01 | 7.5E+01 | 1.0E+00 | 1.0 | 4.7E-05 | 2 |
| Aluminum | 6.3E+03 | 1.0E-03 | NA | NA | NA | NA | 1.0 | 6.3E-06 | 1 |
| Antimony | 3.3E+00 | 1.0E-03 | NA | NA | NA | NA | 1.0 | 3.3E-09 | 1 |
| Arsenic | 4.9E+00 | 1.0E-03 | NA | NA | NA | NA | 1.0 | 4.9E-09 | 1 |
| Chromium | 3.6E+01 | 2.0E-03 | NA | NA | NA | NA | 1.0 | 7.2E-08 | 1 |
| Iron | 9.3E+03 | 1.0E-03 | NA | NA | NA | NA | 1.0 | 9.3E-06 | 1 |
| Lead | 3.9E+00 | 1.0E-03 | NA | NA | NA | NA | 1.0 | 3.9E-09 | 1 |
| Manganese | 4.2E+02 | 1.0E-03 | NA | NA | NA | NA | 1.0 | 4.2E-07 | 1 |
| Nickel | 2.4E+01 | 2.0E-04 | NA | NA | NA | NA | 1.0 | 4.8E-09 | 1 |
| Thallium | 5.9E+00 | 1.0E-03 | NA | NA | NA | NA | 1.0 | 5.9E-09 | 1 |
| Vanadium | 6.5E+00 | 1.0E-03 | NA | NA | NA | NA | 1.0 | 6.5E-09 | 1 |

**Inorganics: DAevent (mg/cm2-event) =**
Kp x CW x tevent x 0.001 mg/ug x 0.001 $l/cm^3$ (eq 1)

**Organics: DAevent (mg/cm2-event) =**
If $t_{event} \leq t^*$ then

$$DA_{event} = 2 \times FA \times K_p \times C_w \times 0.001 \quad mg/ug \times 0.001 \quad l/cm^3 \sqrt{\frac{6 \times \tau_{event} \times t_{event}}{\pi}} \qquad \text{(eq 2)}$$

If $t_{event} \geq t^*$ then

$$DA_{event} = FA \times K_p \times C_w \times 0.001 \quad mg/ug \times 0.001 \quad l/cm^3 \left[ \frac{t_{event}}{1+B} + 2 \times \tau_{event} \left( \frac{1+3B+3B^2}{(1+B)^2} \right) \right] \qquad \text{(eq 3)}$$

Notes:
[1] Values from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.
[2] Values from Virginia Remediation Program, Risk Assessment Guidance, gwcalcs.xls, revised 6/7/07
NA - not applicable.

TABLE 7.6.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult/Child

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Groundwater | Groundwater | Bedrock Aquifer - Tap Water | Ingestion | | | | | | | | | | | | | |
| | | | | Methylene chloride | 3.6E+02 | ug/L | 5.3E-03 | mg/kg/day | 7.5E-03 | 1/mg/kg/day | 4.0E-05 | N/A | N/A | N/A | N/A | N/A |
| | | | | Tetrachloroethene | 1.4E+00 | ug/L | 2.1E-05 | mg/kg/day | 5.4E-01 | 1/mg/kg/day | 1.1E-05 | N/A | N/A | N/A | N/A | N/A |
| | | | | Trichloroethene | 2.0E+00 | ug/L | 3.0E-05 | mg/kg/day | 1.1E-02 | 1/mg/kg/day | 3.3E-07 | N/A | N/A | N/A | N/A | N/A |
| | | | | cis-1,2-Dichloroethene | 2.2E+00 | ug/L | 3.3E-05 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | bis(2-Ethylhexyl)phthalate | 3.7E+00 | ug/L | 5.5E-05 | mg/kg/day | 1.4E-02 | 1/mg/kg/day | 7.7E-07 | N/A | N/A | N/A | N/A | N/A |
| | | | | Aluminum | 6.3E+03 | ug/L | 9.4E-02 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Antimony | 3.3E+00 | ug/L | 4.9E-05 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Arsenic | 4.9E+00 | ug/L | 7.4E-05 | mg/kg/day | 1.5E+00 | 1/mg/kg/day | 1.1E-04 | N/A | N/A | N/A | N/A | N/A |
| | | | | Chromium | 3.6E+01 | ug/L | 5.4E-04 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Iron | 9.3E+03 | ug/L | 1.4E-01 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Lead | 3.9E+00 | ug/L | 5.8E-05 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Manganese | 4.2E+02 | ug/L | 6.2E-03 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Nickel | 2.4E+01 | ug/L | 3.6E-04 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Thallium | 5.9E+00 | ug/L | 8.9E-05 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Vanadium | 6.5E+00 | ug/L | 9.7E-05 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | Exp. Route Total | | | | | | | | 1.6E-04 | | | | | N/A |
| | | | Dermal Absorption | | | | | | | | | | | | | |
| | | | | Methylene chloride | 3.6E+02 | ug/L | 2.0E-04 | mg/kg/day | 7.5E-03 | 1/mg/kg/day | 1.5E-06 | N/A | N/A | N/A | N/A | N/A |
| | | | | Tetrachloroethene | 1.4E+00 | ug/L | 1.2E-05 | mg/kg/day | 5.4E-01 | 1/mg/kg/day | 6.7E-06 | N/A | N/A | N/A | N/A | N/A |
| | | | | Trichloroethene | 2.0E+00 | ug/L | 4.9E-06 | mg/kg/day | 1.1E-02 | 1/mg/kg/day | 5.4E-08 | N/A | N/A | N/A | N/A | N/A |
| | | | | cis-1,2-Dichloroethene | 2.2E+00 | ug/L | 2.8E-06 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | bis(2-Ethylhexyl)phthalate | 3.7E+00 | ug/L | 4.7E-03 | mg/kg/day | 1.4E-02 | 1/mg/kg/day | 6.6E-05 | N/A | N/A | N/A | N/A | N/A |
| | | | | Aluminum | 6.3E+03 | ug/L | 5.4E-04 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Antimony | 3.3E+00 | ug/L | 2.8E-07 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Arsenic | 4.9E+00 | ug/L | 4.2E-07 | mg/kg/day | 1.5E+00 | 1/mg/kg/day | 6.3E-07 | N/A | N/A | N/A | N/A | N/A |
| | | | | Chromium | 3.6E+01 | ug/L | 6.1E-06 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| Groundwater | Groundwater | Bedrock Aquifer - Tap Water | Dermal Absorption | Iron | 9.3E+03 | ug/L | 7.9E-04 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Lead | 3.9E+00 | ug/L | 3.3E-07 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Manganese | 4.2E+02 | ug/L | 3.6E-05 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Nickel | 2.4E+01 | ug/L | 4.1E-07 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Thallium | 5.9E+00 | ug/L | 5.1E-07 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Vanadium | 6.5E+00 | ug/L | 5.5E-07 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | Exp. Route Total | | | | | | | | 7.5E-05 | | | | | N/A |
| | | Exposure Point Total | | | | | | | | | 2.4E-04 | | | | | N/A |
| | Exposure Medium Total | | | | | | | | | | 2.4E-04 | | | | | N/A |
| Medium Total | | | | | | | | | | | 2.4E-04 | | | | | N/A |
| | | | | | | | | | Total of Receptor Risks Across All Media | | 2.4E-04 | Total of Receptor Hazards Across All Media | | | | N/A |

Notes-

NA = Not applicable.

DAevent for exposure to groundwater while showering and bathing is calculated on Tables 7.5.RME Supplement A and 7.6.RME Supplement A.

TABLE 7.1.CTE

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

CENTRAL TENDENCY EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Groundwater | Groundwater | Alluvial Aquifer - Tap Water | Ingestion | | | | | | | | | | | | | |
| | | | | 1,1,2,2-Tetrachloroethane | 1.5E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.0E-05 | mg/kg/day | N/A | | N/A |
| | | | | 1,1,2-Trichloroethane | 1.5E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.0E-05 | mg/kg/day | 4.0E-03 | mg/kg/day | 4.9E-03 |
| | | | | 1,2-Dibromo-3-chloropropane | 1.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.5E-05 | mg/kg/day | 2.0E-04 | mg/kg/day | 7.6E-02 |
| | | | | 1,2-Dichlorobenzene | 8.1E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.0E-04 | mg/kg/day | 9.0E-02 | mg/kg/day | 1.2E-03 |
| | | | | 1,2-Dichloropropane | 9.6E-01 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.2E-05 | mg/kg/day | N/A | | N/A |
| | | | | 1,4-Dichlorobenzene | 1.8E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.3E-05 | mg/kg/day | 3.0E-02 | mg/kg/day | 7.8E-04 |
| | | | | Benzene | 1.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.9E-05 | mg/kg/day | 4.0E-03 | mg/kg/day | 4.6E-03 |
| | | | | Bromodichloromethane | 6.1E-01 | ug/L | N/A | N/A | N/A | N/A | N/A | 7.8E-06 | mg/kg/day | 2.0E-02 | mg/kg/day | 3.9E-04 |
| | | | | Chlorobenzene | 6.6E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 8.5E-05 | mg/kg/day | 2.0E-02 | mg/kg/day | 4.3E-03 |
| | | | | Chloroform | 1.7E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.2E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 2.2E-03 |
| | | | | Methylene chloride | 2.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.8E-05 | mg/kg/day | 6.0E-02 | mg/kg/day | 4.7E-04 |
| | | | | Tetrachloroethene | 1.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.8E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 1.8E-03 |
| | | | | Trichloroethene | 1.9E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.4E-05 | mg/kg/day | 6.0E-03 | mg/kg/day | 4.1E-03 |
| | | | | Vinyl chloride | 1.1E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.4E-05 | mg/kg/day | 3.0E-03 | mg/kg/day | 4.7E-03 |
| | | | | cis-1,2-Dichloroethene | 3.3E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 4.2E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 4.2E-03 |
| | | | | Arsenic-dissolved | 3.6E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 4.6E-05 | mg/kg/day | 3.0E-04 | mg/kg/day | 1.5E-01 |
| | | | | Chromium (hexavalent)-dissolved | 4.6E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 5.9E-05 | mg/kg/day | 3.0E-03 | mg/kg/day | 2.0E-02 |
| | | | | Iron-dissolved | 4.8E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 6.2E-02 | mg/kg/day | 7.0E-01 | mg/kg/day | 8.9E-02 |
| | | | | Manganese-dissolved | 9.0E+02 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.2E-02 | mg/kg/day | 2.0E-02 | mg/kg/day | 5.8E-01 |
| | | | | Nickel-dissolved | 4.2E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 5.4E-04 | mg/kg/day | 2.0E-02 | mg/kg/day | 2.7E-02 |
| | | | | Thallium-dissolved | 5.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 7.0E-05 | mg/kg/day | 7.0E-05 | mg/kg/day | 9.9E-01 |
| | | | Exp. Route Total | | | | | | | | N/A | | | | | 2.0E+00 |
| | | | Dermal Absorption | 1,1,2,2-Tetrachloroethane | 1.5E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.3E-06 | mg/kg/day | N/A | | N/A |
| | | | | 1,1,2-Trichloroethane | 1.5E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.7E-06 | mg/kg/day | 4.0E-03 | mg/kg/day | 4.3E-04 |
| | | | | 1,2-Dibromo-3-chloropropane | 1.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 9.3E-07 | mg/kg/day | 2.0E-04 | mg/kg/day | 4.6E-03 |
| | | | | 1,2-Dichlorobenzene | 8.1E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 6.5E-05 | mg/kg/day | 9.0E-02 | mg/kg/day | 7.2E-04 |
| | | | | 1,2-Dichloropropane | 9.6E-01 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.1E-06 | mg/kg/day | N/A | | N/A |
| | | | | 1,4-Dichlorobenzene | 1.8E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.5E-05 | mg/kg/day | 3.0E-02 | mg/kg/day | 4.9E-04 |
| | | | | Benzene | 1.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.6E-06 | mg/kg/day | 4.0E-03 | mg/kg/day | 6.6E-04 |
| | | | | Bromodichloromethane | 6.1E-01 | ug/L | N/A | N/A | N/A | N/A | N/A | 6.0E-07 | mg/kg/day | 2.0E-02 | mg/kg/day | 3.0E-05 |
| | | | | Chlorobenzene | 6.6E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.9E-05 | mg/kg/day | 2.0E-02 | mg/kg/day | 1.4E-03 |
| | | | | Chloroform | 1.7E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.9E-06 | mg/kg/day | 1.0E-02 | mg/kg/day | 1.9E-04 |
| | | | | Methylene chloride | 2.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.0E-06 | mg/kg/day | 6.0E-02 | mg/kg/day | 1.7E-05 |
| | | | | Tetrachloroethene | 1.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.0E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 1.0E-03 |
| | | | | Trichloroethene | 1.9E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.9E-06 | mg/kg/day | 6.0E-03 | mg/kg/day | 6.4E-04 |
| | | | | Vinyl chloride | 1.1E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 7.4E-07 | mg/kg/day | 3.0E-03 | mg/kg/day | 2.5E-04 |
| | | | | cis-1,2-Dichloroethene | 3.3E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.5E-06 | mg/kg/day | 1.0E-02 | mg/kg/day | 3.5E-04 |
| | | | | Arsenic-dissolved | 3.6E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.5E-07 | mg/kg/day | 3.0E-04 | mg/kg/day | 4.9E-04 |
| | | | | Chromium (hexavalent)-dissolved | 4.6E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.8E-07 | mg/kg/day | 7.5E-05 | mg/kg/day | 5.1E-03 |

TABLE 7.1.CTE

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

CENTRAL TENDENCY EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Groundwater | Groundwater | Alluvial Aquifer - Tap Water | Dermal Absorption | Iron-dissolved | 4.8E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.0E-04 | mg/kg/day | 7.0E-01 | mg/kg/day | 2.9E-04 |
| | | | | Manganese-dissolved | 9.0E+02 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.7E-05 | mg/kg/day | 8.0E-04 | mg/kg/day | 4.7E-02 |
| | | | | Nickel-dissolved | 4.2E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.5E-07 | mg/kg/day | 8.0E-04 | mg/kg/day | 4.3E-04 |
| | | | | Thallium-dissolved | 5.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.2E-07 | mg/kg/day | 7.0E-05 | mg/kg/day | 3.2E-03 |
| | | | Exp. Route Total | | | | | | | | N/A | | | | | 6.7E-02 |
| | | Exposure Point Total | | | | | | | | | N/A | | | | | 2.0E+00 |
| | Exposure Medium Total | | | | | | | | | | N/A | | | | | 2.0E+00 |
| Groundwater | Air | Alluvial Aquifer - Water Vapors at Showerhead | Inhalation | 1,1,2,2-Tetrachloroethane | 1.5E+00 | ug/L | 6.4E-07 | mg/kg/day | 2.0E-01 | 1/mg/kg/day | 1.3E-07 | 7.5E-06 | mg/kg/day | N/A | | N/A |
| | | | | 1,1,2-Trichloroethane | 1.5E+00 | ug/L | 9.6E-07 | mg/kg/day | 5.6E-02 | 1/mg/kg/day | 5.4E-08 | 1.1E-05 | mg/kg/day | N/A | | N/A |
| | | | | 1,2-Dibromo-3-chloropropane | 1.2E+00 | ug/L | 2.7E-07 | mg/kg/day | 2.1E+01 | 1/mg/kg/day | 5.8E-06 | 3.2E-06 | mg/kg/day | 5.7E-05 | mg/kg/day | 5.6E-02 |
| | | | | 1,2-Dichlorobenzene | 8.1E+00 | ug/L | 5.5E-06 | mg/kg/day | N/A | | N/A | 6.4E-05 | mg/kg/day | 4.0E-02 | mg/kg/day | 1.6E-03 |
| | | | | 1,2-Dichloropropane | 9.6E-01 | ug/L | 6.7E-07 | mg/kg/day | N/A | | N/A | 7.8E-06 | mg/kg/day | 1.1E-03 | mg/kg/day | 6.9E-03 |
| | | | | 1,4-Dichlorobenzene | 1.8E+00 | ug/L | 1.3E-06 | mg/kg/day | 2.2E-02 | 1/mg/kg/day | 2.8E-08 | 1.5E-05 | mg/kg/day | 2.3E-01 | mg/kg/day | 6.4E-05 |
| | | | | Benzene | 1.4E+00 | ug/L | 1.4E-06 | mg/kg/day | 2.7E-02 | 1/mg/kg/day | 3.8E-08 | 1.6E-05 | mg/kg/day | 8.6E-03 | mg/kg/day | 1.9E-03 |
| | | | | Bromodichloromethane | 6.1E-01 | ug/L | 3.8E-07 | mg/kg/day | N/A | | N/A | 4.5E-06 | mg/kg/day | N/A | | N/A |
| | | | | Chlorobenzene | 6.6E+00 | ug/L | 5.4E-06 | mg/kg/day | N/A | | N/A | 6.3E-05 | mg/kg/day | 1.4E-02 | mg/kg/day | 4.5E-03 |
| | | | | Chloroform | 1.7E+00 | ug/L | 1.4E-06 | mg/kg/day | 8.1E-02 | 1/mg/kg/day | 1.1E-07 | 1.6E-05 | mg/kg/day | 1.4E-02 | mg/kg/day | 1.1E-03 |
| | | | | Methylene chloride | 2.2E+00 | ug/L | 2.0E-06 | mg/kg/day | 1.7E-03 | 1/mg/kg/day | 3.2E-09 | 2.3E-05 | mg/kg/day | 3.0E-01 | mg/kg/day | 7.6E-05 |
| | | | | Tetrachloroethene | 1.4E+00 | ug/L | 1.0E-06 | mg/kg/day | 2.0E-02 | 1/mg/kg/day | 2.0E-08 | 1.2E-05 | mg/kg/day | 8.0E-02 | mg/kg/day | 1.5E-04 |
| | | | | Trichloroethene | 1.9E+00 | ug/L | 1.5E-06 | mg/kg/day | 6.0E-03 | 1/mg/kg/day | 9.1E-09 | 1.8E-05 | mg/kg/day | N/A | | N/A |
| | | | | Vinyl chloride | 1.1E+00 | ug/L | 1.2E-06 | mg/kg/day | 1.5E-02 | 1/mg/kg/day | 1.9E-08 | 1.4E-05 | mg/kg/day | 2.8E-02 | mg/kg/day | 5.1E-04 |
| | | | | cis-1,2-Dichloroethene | 3.3E+00 | ug/L | 2.9E-06 | mg/kg/day | N/A | | N/A | 3.3E-05 | mg/kg/day | N/A | | N/A |
| | | | Exp. Route Total | | | | | | | | 6.2E-06 | | | | | 7.3E-02 |
| | | Exposure Point Total | | | | | | | | | 6.2E-06 | | | | | 7.3E-02 |
| | Exposure Medium Total | | | | | | | | | | 6.2E-06 | | | | | 7.3E-02 |
| Medium Total | | | | | | | | | | | 6.2E-06 | | | | | 2.1E+00 |
| | | | | | | | | | Total of Receptor Risks Across All Media | | 6.2E-06 | | | Total of Receptor Hazards Across All Media | | 2.1E+00 |

Notes-
NA = Not applicable.
DAevent for exposure to groundwater while showering is calculated on Table 7.1.CTE Supplement A.
Shower exposure calculated on Table 7.1.CTE Supplement B.

Table 7.1.CTE Supplement A
Calculation of DAevent
Resident Adult Ground Water
Site 12 Remedial investigation, Allegany Ballistics Laboratory

| Chemical of Potential Concern | Water Concentration (CW) (µg/L) | Permeability Coefficient[1] (Kp) (cm/hr) | B[1] (dimensionless) | Lag Time[1] ($\tau_{event}$) (hr) | t*[1] (hr) | Fraction Absorbed Water[1] (FA) (dimensionless) | Duration of Event (tevent) (hr) | DAevent ($mg/cm^2$-event) | Eq |
|---|---|---|---|---|---|---|---|---|---|
| 1,1,2,2-Tetrachloroethane | 1.5E+00 | 6.9E-03 | 3.5E-02 | 9.3E-01 | 2.2E+00 | 1.0E+00 | 0.25 | 1.4E-08 | 2 |
| 1,1,2-Trichloroethane | 1.5E+00 | 6.4E-03 | 2.9E-02 | 6.0E-01 | 1.4E+00 | 1.0E+00 | 0.25 | 1.0E-08 | 2 |
| 1,2-Dibromo-3-chloropropane[1] | 1.2E+00 | 2.3E-03 | 1.4E-02 | 2.2E+00 | 5.3E+00 | 1.0E+00 | 0.25 | 5.6E-09 | 2 |
| 1,2-Dichlorobenzene | 8.1E+00 | 4.1E-02 | 1.9E-01 | 7.1E-01 | 1.7E+00 | 1.0E+00 | 0.25 | 3.9E-07 | 2 |
| 1,2-Dichloropropane | 9.6E-01 | 7.8E-03 | 3.2E-02 | 4.6E-01 | 1.1E+00 | 1.0E+00 | 0.25 | 7.0E-09 | 2 |
| 1,4-Dichlorobenzene | 1.8E+00 | 4.2E-02 | 2.0E-01 | 7.1E-01 | 1.7E+00 | 1.0E+00 | 0.25 | 8.9E-08 | 2 |
| Benzene | 1.4E+00 | 1.5E-02 | 5.1E-02 | 2.9E-01 | 7.0E-01 | 1.0E+00 | 0.25 | 1.6E-08 | 2 |
| Bromodichloromethane | 6.1E-01 | 4.6E-03 | 2.3E-02 | 8.8E-01 | 2.1E+00 | 1.0E+00 | 0.25 | 3.7E-09 | 2 |
| Chlorobenzene | 6.6E+00 | 2.8E-02 | 1.2E-01 | 4.6E-01 | 1.1E+00 | 1.0E+00 | 0.25 | 1.7E-07 | 2 |
| Chloroform | 1.7E+00 | 6.8E-03 | 2.9E-02 | 5.0E-01 | 1.2E+00 | 1.0E+00 | 0.25 | 1.1E-08 | 2 |
| Methylene chloride | 2.2E+00 | 3.5E-03 | 1.3E-02 | 3.2E-01 | 7.6E-01 | 1.0E+00 | 0.25 | 6.1E-09 | 2 |
| Tetrachloroethene | 1.4E+00 | 3.3E-02 | 1.7E-01 | 9.1E-01 | 2.2E+00 | 1.0E+00 | 0.25 | 6.3E-08 | 2 |
| Trichloroethene | 1.9E+00 | 1.2E-02 | 5.1E-02 | 5.8E-01 | 1.4E+00 | 1.0E+00 | 0.25 | 2.3E-08 | 2 |
| Vinyl chloride | 1.1E+00 | 5.6E-03 | 1.7E-02 | 2.4E-01 | 5.7E-01 | 1.0E+00 | 0.25 | 4.5E-09 | 2 |
| cis-1,2-Dichloroethene | 3.3E+00 | 7.7E-03 | 2.9E-02 | 3.7E-01 | 8.8E-01 | 1.0E+00 | 0.25 | 2.1E-08 | 2 |
| Arsenic-dissolved | 3.6E+00 | 1.0E-03 | NA | NA | NA | NA | 0.25 | 8.9E-10 | 1 |
| Chromium (hexavalent)-dissolved | 4.6E+00 | 2.0E-03 | NA | NA | NA | NA | 0.25 | 2.3E-09 | 1 |
| Iron-dissolved | 4.8E+03 | 1.0E-03 | NA | NA | NA | NA | 0.25 | 1.2E-06 | 1 |
| Manganese-dissolved | 9.0E+02 | 1.0E-03 | NA | NA | NA | NA | 0.25 | 2.3E-07 | 1 |
| Nickel-dissolved | 4.2E+01 | 2.0E-04 | NA | NA | NA | NA | 0.25 | 2.1E-09 | 1 |
| Thallium-dissolved | 5.4E+00 | 1.0E-03 | NA | NA | NA | NA | 0.25 | 1.4E-09 | 1 |

**Inorganics: DAevent (mg/cm2-event) =**
Kp x CW x tevent x 0.001 mg/ug x 0.001 $l/cm^3$ (eq 1)

**Organics: DAevent (mg/cm2-event) =**
If $t_{event} \leq t^*$ then

$$DA_{event} = 2 \times FA \times K_p \times C_w \times 0.001 \quad mg/ug \times 0.001 \quad l/cm^3 \sqrt{\frac{6 \times \tau_{event} \times t_{event}}{\pi}} \qquad \text{(eq 2)}$$

If $t_{event} \geq t^*$ then

$$DA_{event} = FA \times K_p \times C_w \times 0.001 \quad mg/ug \times 0.001 \quad l/cm^3 \left[ \frac{t_{event}}{1+B} + 2 \times \tau_{event} \left( \frac{1+3B+3B^2}{(1+B)^2} \right) \right] \qquad \text{(eq 3)}$$

Notes:
[1] Values from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.
[2] Values from Virginia Remediation Program, Risk Assessment Guidance, gwcalcs.xls, revised 6/7/07
NA - not applicable.

Table 7.1.CTE Supplement B
Inhalation Exposure Concentrations from Foster and Chrostowski Shower Model
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

| Chemical | Exposure Point Concentration Cwo (μg/l) | Molecular weight (HH) (g/mole) | Henry's Law Constant (H) (atm-m$^3$/mole) | Kg (VOC) (cm/hr) | Kl(VOC) (cm/hr) | KL (cm/hr) | Kal (cm/hr) | Cwd (μg/l) | S (μg/m$^3$ -min) |
|---|---|---|---|---|---|---|---|---|---|
| 1,1,2,2-Tetrachloroethane | 1.5E+00 | 1.7E+02 | 3.5E-04 | 9.8E+02 | 1.0E+01 | 5.9E+00 | 8.0E+00 | 9.8E-02 | 8.2E-02 |
| 1,1,2-Trichloroethane | 1.5E+00 | 1.3E+02 | 9.1E-04 | 1.1E+03 | 1.1E+01 | 9.0E+00 | 1.2E+01 | 1.5E-01 | 1.2E-01 |
| 1,2-Dibromo-3-chloropropane | 1.2E+00 | 2.4E+02 | 1.5E-04 | 8.3E+02 | 8.6E+00 | 3.2E+00 | 4.3E+00 | 4.2E-02 | 3.5E-02 |
| 1,2-Dichlorobenzene | 8.1E+00 | 1.5E+02 | 1.9E-03 | 1.0E+03 | 1.1E+01 | 9.7E+00 | 1.3E+01 | 8.4E-01 | 7.0E-01 |
| 1,2-Dichloropropane | 9.6E-01 | 1.5E+02 | 2.8E-03 | 1.0E+03 | 1.1E+01 | 1.0E+01 | 1.4E+01 | 1.0E-01 | 8.6E-02 |
| 1,4-Dichlorobenzene | 1.8E+00 | 1.5E+02 | 2.4E-03 | 1.0E+03 | 1.1E+01 | 9.9E+00 | 1.3E+01 | 1.9E-01 | 1.6E-01 |
| Benzene | 1.4E+00 | 7.8E+01 | 5.6E-03 | 1.4E+03 | 1.5E+01 | 1.4E+01 | 1.9E+01 | 2.2E-01 | 1.8E-01 |
| Bromodichloromethane | 6.1E-01 | 1.6E+02 | 1.6E-03 | 9.9E+02 | 1.0E+01 | 9.0E+00 | 1.2E+01 | 5.9E-02 | 4.9E-02 |
| Chlorobenzene | 6.6E+00 | 1.1E+02 | 3.7E-03 | 1.2E+03 | 1.3E+01 | 1.2E+01 | 1.6E+01 | 8.2E-01 | 6.8E-01 |
| Chloroform | 1.7E+00 | 1.2E+02 | 3.7E-03 | 1.2E+03 | 1.2E+01 | 1.1E+01 | 1.5E+01 | 2.1E-01 | 1.7E-01 |
| Methylene chloride | 2.2E+00 | 8.5E+01 | 2.2E-03 | 1.4E+03 | 1.4E+01 | 1.3E+01 | 1.7E+01 | 3.0E-01 | 2.5E-01 |
| Tetrachloroethene | 1.4E+00 | 1.7E+02 | 1.8E-02 | 9.9E+02 | 1.0E+01 | 1.0E+01 | 1.4E+01 | 1.5E-01 | 1.3E-01 |
| Trichloroethene | 1.9E+00 | 1.3E+02 | 4.0E-01 | 1.1E+03 | 1.2E+01 | 1.2E+01 | 1.6E+01 | 2.3E-01 | 1.9E-01 |
| Vinyl chloride | 1.1E+00 | 6.3E+01 | 2.7E-02 | 1.6E+03 | 1.7E+01 | 1.7E+01 | 2.2E+01 | 1.9E-01 | 1.6E-01 |
| cis-1,2-Dichloroethene | 3.3E+00 | 9.7E+01 | 4.1E-03 | 1.3E+03 | 1.3E+01 | 1.3E+01 | 1.7E+01 | 4.4E-01 | 3.7E-01 |

| Variables | Units | Exposure Assumptions |
|---|---|---|
| Kg(VOC) = gas-film mass transfer coefficient | cm/hr | Solved by Eq 1 |
| Kl(VOC) = liquid-film mass transfer coefficient | cm/hr | Solved by Eq 2 |
| KL = overall mass transfer coefficient | cm/hr | Solved by Eq 3 |
| Kal = adjusted overall mass transfer coeff. | cm/hr | Solved by Eq 4 |
| Tl = Calibration temp. of water | K (20C +273) | 293 |
| Ts = Shower water temperature | k (45C) | 318 |
| Us = water viscosity at Ts | centipoise | 0.596 |
| Ul = water viscosity at Tl | cp | 1.002 |
| Cwd = conc. leaving droplets after time sdt | μg/l | Solved by Eq 5 |
| sdt = shower droplet drop time | sec | 0.5 |
| d = shower droplet diameter | mm | 1 |
| FR = shower water flow rate | l/min | 10 |
| SV = shower room air volume | m$^3$ | 12 |
| S = indoor VOC generation rate | μg/m$^3$-min | Solved by Eq 6 |
| VR = ventilation rate | l/min | 13.8 |
| **Variables** | **Units** | **Exposure Assumptions** |
| BW = body weight | kg | 70 |
| Ds = duration of shower | min | 15 |
| Dt = total duration in shower room | min | 45 |
| R = air exchange rate | min$^{-1}$ | 0.0083 |
| Ca = indoor air concentration of VOCs | μg/m$^3$ | Solved by Eq 7 |
| Einh = inhalation exposure per shower | mg/kg/shower | Solved by Eq 8 |

| | | | |
|---|---|---|---|
| Equation 1: | Kg(VOC) = | 3000 * (18 / HH)$^{0.5}$ | |
| Equation 2: | Kl(VOC) = | 20 * (44 / HH)$^{0.5}$ | |
| Equation 3: | KL = | ((1 / Kl(VOC)) + (0.024 / (Kg (VOC) * H)))$^{-1}$ | |
| Equation 4: | Kal = | (KL * (((Tl * Us) / (Ts * Ul))$^{-0.5}$)) | |
| Equation 5: | Cwd = | (Cwo * (1-EXP((-1 * Kal * sdt)/(60 * d)))) | |
| Equation 6: | S = | (Cwd * FR / SV) | |
| Equation 7: | see time series example on Table I-GW-5 | | |
| Equation 8: | Einh = | If t>Ds | (((VR * S) / (BW * R * 1000000)) * ((Ds + (EXP(-R * Dt) / R)-(EXP(R * (Ds - Dt))) / R))) |

TABLE 7.2.CTE

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

CENTRAL TENDENCY EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Groundwater | Groundwater | Alluvial Aquifer - Tap Water | Ingestion | | | | | | | | | | | | | |
| | | | | 1,1,2,2-Tetrachloroethane | 1.5E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 6.5E-05 | mg/kg/day | N/A | | N/A |
| | | | | 1,1,2-Trichloroethane | 1.5E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 6.5E-05 | mg/kg/day | 4.0E-03 | mg/kg/day | 1.6E-02 |
| | | | | 1,2-Dibromo-3-chloropropane | 1.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 5.1E-05 | mg/kg/day | 2.0E-04 | mg/kg/day | 2.5E-01 |
| | | | | 1,2-Dichlorobenzene | 8.1E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.5E-04 | mg/kg/day | 9.0E-02 | mg/kg/day | 3.9E-03 |
| | | | | 1,2-Dichloropropane | 9.6E-01 | ug/L | N/A | N/A | N/A | N/A | N/A | 4.1E-05 | mg/kg/day | N/A | | N/A |
| | | | | 1,4-Dichlorobenzene | 1.8E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 7.8E-05 | mg/kg/day | 3.0E-02 | mg/kg/day | 2.6E-03 |
| | | | | Benzene | 1.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 6.2E-05 | mg/kg/day | 4.0E-03 | mg/kg/day | 1.5E-02 |
| | | | | Bromodichloromethane | 6.1E-01 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.6E-05 | mg/kg/day | 2.0E-02 | mg/kg/day | 1.3E-03 |
| | | | | Chlorobenzene | 6.6E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.8E-04 | mg/kg/day | 2.0E-02 | mg/kg/day | 1.4E-02 |
| | | | | Chloroform | 1.7E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 7.4E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 7.4E-03 |
| | | | | Methylene chloride | 2.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 9.5E-05 | mg/kg/day | 6.0E-02 | mg/kg/day | 1.6E-03 |
| | | | | Tetrachloroethene | 1.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 6.1E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 6.1E-03 |
| | | | | Trichloroethene | 1.9E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 8.2E-05 | mg/kg/day | 6.0E-03 | mg/kg/day | 1.4E-02 |
| | | | | Vinyl chloride | 1.1E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 4.7E-05 | mg/kg/day | 3.0E-03 | mg/kg/day | 1.6E-02 |
| | | | | cis-1,2-Dichloroethene | 3.3E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.4E-04 | mg/kg/day | 1.0E-02 | mg/kg/day | 1.4E-02 |
| | | | | Arsenic-dissolved | 3.6E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.5E-04 | mg/kg/day | 3.0E-04 | mg/kg/day | 5.1E-01 |
| | | | | Chromium (hexavalent)-dissolved | 4.6E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.0E-04 | mg/kg/day | 3.0E-03 | mg/kg/day | 6.6E-02 |
| | | | | Iron-dissolved | 4.8E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.1E-01 | mg/kg/day | 7.0E-01 | mg/kg/day | 3.0E-01 |
| | | | | Manganese-dissolved | 9.0E+02 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.9E-02 | mg/kg/day | 2.0E-02 | mg/kg/day | 1.9E+00 |
| | | | | Nickel-dissolved | 4.2E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.8E-03 | mg/kg/day | 2.0E-02 | mg/kg/day | 9.0E-02 |
| | | | | Thallium-dissolved | 5.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.3E-04 | mg/kg/day | 7.0E-05 | mg/kg/day | 3.3E+00 |
| | | | Exp. Route Total | | | | | | | | N/A | | | | | 6.6E+00 |
| | | | Dermal Absorption | 1,1,2,2-Tetrachloroethane | 1.5E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 6.8E-06 | mg/kg/day | N/A | | N/A |
| | | | | 1,1,2-Trichloroethane | 1.5E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 5.1E-06 | mg/kg/day | 4.0E-03 | mg/kg/day | 1.3E-03 |
| | | | | 1,2-Dibromo-3-chloropropane | 1.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.7E-06 | mg/kg/day | 2.0E-04 | mg/kg/day | 1.4E-02 |
| | | | | 1,2-Dichlorobenzene | 8.1E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.9E-04 | mg/kg/day | 9.0E-02 | mg/kg/day | 2.1E-03 |
| | | | | 1,2-Dichloropropane | 9.6E-01 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.4E-06 | mg/kg/day | N/A | | N/A |
| | | | | 1,4-Dichlorobenzene | 1.8E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 4.3E-05 | mg/kg/day | 3.0E-02 | mg/kg/day | 1.4E-03 |
| | | | | Benzene | 1.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 8.4E-06 | mg/kg/day | 4.0E-03 | mg/kg/day | 2.1E-03 |
| | | | | Bromodichloromethane | 6.1E-01 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.8E-06 | mg/kg/day | 2.0E-02 | mg/kg/day | 8.9E-05 |
| | | | | Chlorobenzene | 6.6E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 8.5E-05 | mg/kg/day | 2.0E-02 | mg/kg/day | 4.2E-03 |
| | | | | Chloroform | 1.7E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 5.6E-06 | mg/kg/day | 1.0E-02 | mg/kg/day | 5.6E-04 |
| | | | | Methylene chloride | 2.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.0E-06 | mg/kg/day | 6.0E-02 | mg/kg/day | 4.9E-05 |
| | | | | Tetrachloroethene | 1.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.0E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 3.0E-03 |
| | | | | Trichloroethene | 1.9E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.1E-05 | mg/kg/day | 6.0E-03 | mg/kg/day | 1.9E-03 |
| | | | | Vinyl chloride | 1.1E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.0E-06 | mg/kg/day | 3.0E-03 | mg/kg/day | 6.7E-04 |
| | | | | cis-1,2-Dichloroethene | 3.3E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.0E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 1.0E-03 |
| | | | | Arsenic-dissolved | 3.6E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 5.0E-07 | mg/kg/day | 3.0E-04 | mg/kg/day | 1.7E-03 |
| | | | | Chromium (hexavalent)-dissolved | 4.6E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.3E-06 | mg/kg/day | 7.5E-05 | mg/kg/day | 1.7E-02 |

TABLE 7.2.CTE

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

CENTRAL TENDENCY EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Groundwater | Groundwater | Alluvial Aquifer - Tap Water | Dermal Absorption | Iron-dissolved | 4.8E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 6.7E-04 | mg/kg/day | 7.0E-01 | mg/kg/day | 9.6E-04 |
| | | | | Manganese-dissolved | 9.0E+02 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.3E-04 | mg/kg/day | 8.0E-04 | mg/kg/day | 1.6E-01 |
| | | | | Nickel-dissolved | 4.2E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.2E-06 | mg/kg/day | 8.0E-04 | mg/kg/day | 1.5E-03 |
| | | | | Thallium-dissolved | 5.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 7.6E-07 | mg/kg/day | 7.0E-05 | mg/kg/day | 1.1E-02 |
| | | | Exp. Route Total | | | | | | | | N/A | | | | | 2.2E-01 |
| | | Exposure Point Total | | | | | | | | | N/A | | | | | 6.8E+00 |
| | Exposure Medium Total | | | | | | | | | | N/A | | | | | 6.8E+00 |
| Medium Total | | | | | | | | | | | N/A | | | | | 6.8E+00 |
| | | | | | | | | | Total of Receptor Risks Across All Media | | N/A | | | Total of Receptor Hazards Across All Media | | 6.8E+00 |

Notes-
NA = Not applicable.
DAevent for exposure to groundwater while bathing is calculated on Table 7.2.CTE Supplement A.

Table 7.2.CTE Supplement A
Calculation of DAevent
Resident Child Ground Water
Site 12 Remedial investigation, Allegany Ballistics Laboratory

| Chemical of Potential Concern | Water Concentration (CW) (μg/L) | Permeability Coefficient[1] (Kp) (cm/hr) | B[1] (dimensionless) | Lag Time[1] ($\tau_{event}$) (hr) | t*[1] (hr) | Fraction Absorbed Water[1] (FA) (dimensionless) | Duration of Event (tevent) (hr) | DAevent ($mg/cm^2$-event) | Eq |
|---|---|---|---|---|---|---|---|---|---|
| 1,1,2,2-Tetrachloroethane | 1.5E+00 | 6.9E-03 | 3.5E-02 | 9.3E-01 | 2.2E+00 | 1.0E+00 | 0.33 | 1.6E-08 | 2 |
| 1,1,2-Trichloroethane | 1.5E+00 | 6.4E-03 | 2.9E-02 | 6.0E-01 | 1.4E+00 | 1.0E+00 | 0.33 | 1.2E-08 | 2 |
| 1,2-Dibromo-3-chloropropane[1] | 1.2E+00 | 2.3E-03 | 1.4E-02 | 2.2E+00 | 5.3E+00 | 1.0E+00 | 0.33 | 6.5E-09 | 2 |
| 1,2-Dichlorobenzene | 8.1E+00 | 4.1E-02 | 1.9E-01 | 7.1E-01 | 1.7E+00 | 1.0E+00 | 0.33 | 4.5E-07 | 2 |
| 1,2-Dichloropropane | 9.6E-01 | 7.8E-03 | 3.2E-02 | 4.6E-01 | 1.1E+00 | 1.0E+00 | 0.33 | 8.0E-09 | 2 |
| 1,4-Dichlorobenzene | 1.8E+00 | 4.2E-02 | 2.0E-01 | 7.1E-01 | 1.7E+00 | 1.0E+00 | 0.33 | 1.0E-07 | 2 |
| Benzene | 1.4E+00 | 1.5E-02 | 5.1E-02 | 2.9E-01 | 7.0E-01 | 1.0E+00 | 0.33 | 2.0E-08 | 2 |
| Bromodichloromethane | 6.1E-01 | 4.6E-03 | 2.3E-02 | 8.8E-01 | 2.1E+00 | 1.0E+00 | 0.33 | 4.2E-09 | 2 |
| Chlorobenzene | 6.6E+00 | 2.8E-02 | 1.2E-01 | 4.6E-01 | 1.1E+00 | 1.0E+00 | 0.33 | 2.0E-07 | 2 |
| Chloroform | 1.7E+00 | 6.8E-03 | 2.9E-02 | 5.0E-01 | 1.2E+00 | 1.0E+00 | 0.33 | 1.3E-08 | 2 |
| Methylene chloride | 2.2E+00 | 3.5E-03 | 1.3E-02 | 3.2E-01 | 7.6E-01 | 1.0E+00 | 0.33 | 7.0E-09 | 2 |
| Tetrachloroethene | 1.4E+00 | 3.3E-02 | 1.7E-01 | 9.1E-01 | 2.2E+00 | 1.0E+00 | 0.33 | 7.2E-08 | 2 |
| Trichloroethene | 1.9E+00 | 1.2E-02 | 5.1E-02 | 5.8E-01 | 1.4E+00 | 1.0E+00 | 0.33 | 2.7E-08 | 2 |
| Vinyl chloride | 1.1E+00 | 5.6E-03 | 1.7E-02 | 2.4E-01 | 5.7E-01 | 1.0E+00 | 0.33 | 4.8E-09 | 2 |
| cis-1,2-Dichloroethene | 3.3E+00 | 7.7E-03 | 2.9E-02 | 3.7E-01 | 8.8E-01 | 1.0E+00 | 0.33 | 2.4E-08 | 2 |
| Arsenic-dissolved | 3.6E+00 | 1.0E-03 | NA | NA | NA | NA | 0.33 | 1.2E-09 | 1 |
| Chromium (hexavalent)-dissolved | 4.6E+00 | 2.0E-03 | NA | NA | NA | NA | 0.33 | 3.0E-09 | 1 |
| Iron-dissolved | 4.8E+03 | 1.0E-03 | NA | NA | NA | NA | 0.33 | 1.6E-06 | 1 |
| Manganese-dissolved | 9.0E+02 | 1.0E-03 | NA | NA | NA | NA | 0.33 | 3.0E-07 | 1 |
| Nickel-dissolved | 4.2E+01 | 2.0E-04 | NA | NA | NA | NA | 0.33 | 2.8E-09 | 1 |
| Thallium-dissolved | 5.4E+00 | 1.0E-03 | NA | NA | NA | NA | 0.33 | 1.8E-09 | 1 |

**Inorganics: DAevent (mg/cm2-event) =**
Kp x CW x tevent x 0.001 mg/ug x 0.001 $l/cm^3$ (eq 1)

**Organics: DAevent (mg/cm2-event) =**
If $t_{event} \leq t^*$ then

$$DA_{event} = 2 \times FA \times K_p \times C_w \times 0.001 \quad mg/ug \times 0.001 \quad l/cm^3 \sqrt{\frac{6 \times \tau_{event} \times t_{event}}{\pi}} \qquad \text{(eq 2)}$$

If $t_{event} \geq t^*$ then

$$DA_{event} = FA \times K_p \times C_w \times 0.001 \quad mg/ug \times 0.001 \quad l/cm^3 \left[ \frac{t_{event}}{1+B} + 2 \times \tau_{event} \left( \frac{1+3B+3B^2}{(1+B)^2} \right) \right] \qquad \text{(eq 3)}$$

Notes:
[1] Values from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.
[2] Values from Virginia Remediation Program, Risk Assessment Guidance, gwcalcs.xls, revised 6/7/07
NA - not applicable.

TABLE 7.3.CTE

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

CENTRAL TENDENCY EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult/Child

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Groundwater | Groundwater | Alluvial Aquifer - Tap Water | Ingestion | | | | | | | | | | | | | |
| | | | | 1,1,2,2-Tetrachloroethane | 1.5E+00 | ug/L | 8.1E-06 | mg/kg/day | 2.0E-01 | 1/mg/kg/day | 1.6E-06 | N/A | N/A | N/A | N/A | N/A |
| | | | | 1,1,2-Trichloroethane | 1.5E+00 | ug/L | 8.1E-06 | mg/kg/day | 5.7E-02 | 1/mg/kg/day | 4.6E-07 | N/A | N/A | N/A | N/A | N/A |
| | | | | 1,2-Dibromo-3-chloropropane[1] | 1.2E+00 | ug/L | | mg/kg/day | 8.0E-01 | 1/mg/kg/day | 2.6E-05 | N/A | N/A | N/A | N/A | N/A |
| | | | | 1,2-Dichlorobenzene | 8.1E+00 | ug/L | 4.3E-05 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | 1,2-Dichloropropane | 9.6E-01 | ug/L | 5.1E-06 | mg/kg/day | 6.8E-02 | 1/mg/kg/day | 3.5E-07 | N/A | N/A | N/A | N/A | N/A |
| | | | | 1,4-Dichlorobenzene | 1.8E+00 | ug/L | 9.7E-06 | mg/kg/day | 2.4E-02 | 1/mg/kg/day | 2.3E-07 | N/A | N/A | N/A | N/A | N/A |
| | | | | Benzene | 1.4E+00 | ug/L | 7.7E-06 | mg/kg/day | 5.5E-02 | 1/mg/kg/day | 4.2E-07 | N/A | N/A | N/A | N/A | N/A |
| | | | | Bromodichloromethane | 6.1E-01 | ug/L | 3.2E-06 | mg/kg/day | 6.2E-02 | 1/mg/kg/day | 2.0E-07 | N/A | N/A | N/A | N/A | N/A |
| | | | | Chlorobenzene | 6.6E+00 | ug/L | 3.5E-05 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Chloroform | 1.7E+00 | ug/L | 9.2E-06 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Methylene chloride | 2.2E+00 | ug/L | 1.2E-05 | mg/kg/day | 7.5E-03 | 1/mg/kg/day | 8.8E-08 | N/A | N/A | N/A | N/A | N/A |
| | | | | Tetrachloroethene | 1.4E+00 | ug/L | 7.6E-06 | mg/kg/day | 5.4E-01 | 1/mg/kg/day | 4.1E-06 | N/A | N/A | N/A | N/A | N/A |
| | | | | Trichloroethene | 1.9E+00 | ug/L | 1.0E-05 | mg/kg/day | 1.1E-02 | 1/mg/kg/day | 1.1E-07 | N/A | N/A | N/A | N/A | N/A |
| | | | | Vinyl chloride | 1.1E+00 | ug/L | 3.6E-04 | mg/kg/day | 7.2E-01 | 1/mg/kg/day | 5.7E-05 | N/A | N/A | N/A | N/A | N/A |
| | | | | cis-1,2-Dichloroethene | 3.3E+00 | ug/L | 1.8E-05 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Arsenic-dissolved | 3.6E+00 | ug/L | 1.9E-05 | mg/kg/day | 1.5E+00 | 1/mg/kg/day | 2.8E-05 | N/A | N/A | N/A | N/A | N/A |
| | | | | Chromium (hexavalent)-dissolved | 4.6E+00 | ug/L | 2.4E-05 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Iron-dissolved | 4.8E+03 | ug/L | 2.6E-02 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Manganese-dissolved | 9.0E+02 | ug/L | 4.8E-03 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Nickel-dissolved | 4.2E+01 | ug/L | 2.2E-04 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Thallium-dissolved | 5.4E+00 | ug/L | 2.9E-05 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | Exp. Route Total | | | | | | | | 1.2E-04 | | | | | N/A |
| | | | Dermal Absorption | 1,1,2,2-Tetrachloroethane | 1.5E+00 | ug/L | 6.9E-07 | mg/kg/day | 2.0E-01 | 1/mg/kg/day | 1.4E-07 | N/A | N/A | N/A | N/A | N/A |
| | | | | 1,1,2-Trichloroethane | 1.5E+00 | ug/L | 5.1E-07 | mg/kg/day | 5.7E-02 | 1/mg/kg/day | 2.9E-08 | N/A | N/A | N/A | N/A | N/A |
| | | | | 1,2-Dibromo-3-chloropropane[1] | 1.2E+00 | ug/L | 4.5E-07 | mg/kg/day | 8.0E-01 | 1/mg/kg/day | 1.7E-06 | N/A | N/A | N/A | N/A | N/A |
| | | | | 1,2-Dichlorobenzene | 8.1E+00 | ug/L | 1.9E-05 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | 1,2-Dichloropropane | 9.6E-01 | ug/L | 3.4E-07 | mg/kg/day | 6.8E-02 | 1/mg/kg/day | 2.3E-08 | N/A | N/A | N/A | N/A | N/A |
| | | | | 1,4-Dichlorobenzene | 1.8E+00 | ug/L | 4.4E-06 | mg/kg/day | 2.4E-02 | 1/mg/kg/day | 1.0E-07 | N/A | N/A | N/A | N/A | N/A |
| | | | | Benzene | 1.4E+00 | ug/L | 8.2E-07 | mg/kg/day | 5.5E-02 | 1/mg/kg/day | 4.5E-08 | N/A | N/A | N/A | N/A | N/A |
| | | | | Bromodichloromethane | 6.1E-01 | ug/L | 1.8E-07 | mg/kg/day | 6.2E-02 | 1/mg/kg/day | 1.1E-08 | N/A | N/A | N/A | N/A | N/A |
| | | | | Chlorobenzene | 6.6E+00 | ug/L | 8.6E-06 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Chloroform | 1.7E+00 | ug/L | 5.6E-07 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Methylene chloride | 2.2E+00 | ug/L | 3.0E-07 | mg/kg/day | 7.5E-03 | 1/mg/kg/day | 2.2E-09 | N/A | N/A | N/A | N/A | N/A |
| | | | | Tetrachloroethene | 1.4E+00 | ug/L | 3.1E-06 | mg/kg/day | 5.4E-01 | 1/mg/kg/day | 1.7E-06 | N/A | N/A | N/A | N/A | N/A |
| | | | | Trichloroethene | 1.9E+00 | ug/L | 1.1E-06 | mg/kg/day | 1.1E-02 | 1/mg/kg/day | 1.3E-08 | N/A | N/A | N/A | N/A | N/A |
| | | | | Vinyl chloride | 1.1E+00 | ug/L | 2.2E-06 | mg/kg/day | 7.2E-01 | 1/mg/kg/day | 1.7E-06 | N/A | N/A | N/A | N/A | N/A |
| | | | | cis-1,2-Dichloroethene | 3.3E+00 | ug/L | 1.0E-06 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Arsenic-dissolved | 3.6E+00 | ug/L | 4.7E-08 | mg/kg/day | 1.5E+00 | 1/mg/kg/day | 7.1E-08 | N/A | N/A | N/A | N/A | N/A |
| | | | | Chromium (hexavalent)-dissolved | 4.6E+00 | ug/L | 1.2E-07 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |

TABLE 7.3.CTE

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

CENTRAL TENDENCY EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult/Child

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Groundwater | Groundwater | Alluvial Aquifer - Tap Water | Dermal Absorption | Iron-dissolved | 4.8E+03 | ug/L | 6.4E-05 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Manganese-dissolved | 9.0E+02 | ug/L | 1.2E-05 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Nickel-dissolved | 4.2E+01 | ug/L | 1.1E-07 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Thallium-dissolved | 5.4E+00 | ug/L | 7.2E-08 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | Exp. Route Total | | | | | | | | 5.5E-06 | | | | | N/A |
| | | Exposure Point Total | | | | | | | | | 1.2E-04 | | | | | N/A |
| | Exposure Medium Total | | | | | | | | | | 1.2E-04 | | | | | N/A |
| Medium Total | | | | | | | | | | | 1.2E-04 | | | | | N/A |
| | | | | | | | | | Total of Receptor Risks Across All Media | | 1.2E-04 | | | Total of Receptor Hazards Across All Media | | N/A |

Notes-

1. See Table 7.3.CTE Supplement A for calculation of 1,2-Dibromo-3-chloropropane intake and cancer risk following MMOA method.

NA = Not applicable.

DAevent for exposure to groundwater while showering and bathing is calculated on Tables 7.1.CTE Supplement A and 7.2.CTE Supplement A.

TABLE 7.3.CTE Supplement A

CALCULATION OF CHEMICAL CANCER RISKS FOR COPC WITH MUTAGENIC MODE OF ACTION

CENTRAL TENDENCY EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult/Child

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Intake | | | | | CSF/Unit Risk | | | | | Cancer Risk |
| | | | | | Value | Units | Value | | | | Units | Value | | | | Units | |
| | | | | | | | 0-2 yrs | 2-6 yrs | 6-16 yrs | 16-30 yrs | | 0-2 yrs (ADAF=10) | 2-6 yrs (ADAF=3) | 6-16 yrs (ADAF=3) | 16-30 yrs (ADAF=1) | Units | |
| Soil | Soil | Alluvial Aquifer - Tap Water | Ingestion | 1,2-Dibromo-3-chloropropane | 1.2E+00 | mg/kg | 1.5E-06 | 2.9E-06 | 2.2E-06 | 3.1E-06 | mg/kg/day | 8.0E+00 | 2.4E+00 | 2.4E+00 | 8.0E-01 | 1/(mg/kg-day) | 2.6E-05 |
| | | | Dermal | 1,2-Dibromo-3-chloropropane | 1.2E+00 | mg/kg | 7.8E-08 | 1.6E-07 | 2.0E-07 | 2.8E-07 | mg/kg/day | 8.0E+00 | 2.4E+00 | 2.4E+00 | 8.0E-01 | 1/(mg/kg-day) | 1.7E-06 |

Table 7.3.CTE Supplement B
Calculation of DAevent For COPCs with Mutagenic Mode of Action
Resident Adult/Child Ground Water
Site 12 Remedial investigation, Allegany Ballistics Laboratory

| Chemical of Potential Concern | Water Concentration (CW) (µg/L) | Permeability Coefficient[1] (Kp) (cm/hr) | B[1] (dimensionless) | Lag Time[1] ($\tau_{event}$) (hr) | t*[1] (hr) | Fraction Absorbed Water[1] (FA) (dimensionless) | Duration of Event (tevent) (hr) | DAevent (mg/cm$^2$-event) | Eq |
|---|---|---|---|---|---|---|---|---|---|
| 1,2-Dibromo-3-chloropropane[2] (0<2yrs, 2-6yrs) | 1.2E+00 | 2.3E-03 | 1.4E-02 | 2.2E+00 | 5.3E+00 | 1.0E+00 | 0.33 | 6.5E-09 | 2 |
| 1,2-Dibromo-3-chloropropane[2] (6-16 yrs, 16-30 yrs) | 1.2E+00 | 2.3E-03 | 1.4E-02 | 2.2E+00 | 5.3E+00 | 1.0E+00 | 0.25 | 5.6E-09 | 2 |

**Inorganics: DAevent (mg/cm2-event) =**
Kp x CW x tevent x 0.001 mg/ug x 0.001 l/cm$^3$ (eq 1)

**Organics: DAevent (mg/cm2-event) =**
If $t_{event} \leq t^*$ then

$$DA_{event} = 2 \times FA \times K_p \times C_w \times 0.001 \quad mg/ug \times 0.001 \quad l/cm^3 \sqrt{\frac{6 \times \tau_{event} \times t_{event}}{\pi}} \qquad \text{(eq 2)}$$

If $t_{event} \geq t^*$ then

$$DA_{event} = FA \times K_p \times C_w \times 0.001 \quad mg/ug \times 0.001 \quad l/cm^3 \left[ \frac{t_{event}}{1+B} + 2 \times \tau_{event} \left( \frac{1+3B+3B^2}{(1+B)^2} \right) \right] \qquad \text{(eq 3)}$$

Notes:
[1] Values from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.
[2] Values from Virginia Remediation Program, Risk Assessment Guidance, gwcalcs.xls, revised 6/7/07
NA - not applicable.

TABLE 7.4.CTE

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

CENTRAL TENDENCY EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Groundwater | Groundwater | Bedrock Aquifer - Tap Water | Ingestion | Methylene chloride | 1.4E+02 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.8E-03 | mg/kg/day | 6.0E-02 | mg/kg/day | 3.1E-02 |
| | | | | Tetrachloroethene | 1.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.8E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 1.8E-03 |
| | | | | Trichloroethene | 1.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.8E-05 | mg/kg/day | 6.0E-03 | mg/kg/day | 3.0E-03 |
| | | | | cis-1,2-Dichloroethene | 1.7E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.1E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 2.1E-03 |
| | | | | bis(2-Ethylhexyl)phthalate | 2.1E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.7E-05 | mg/kg/day | 2.0E-02 | mg/kg/day | 1.4E-03 |
| | | | | Aluminum | 1.6E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.1E-02 | mg/kg/day | 1.0E+00 | mg/kg/day | 2.1E-02 |
| | | | | Antimony | 3.3E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 4.2E-05 | mg/kg/day | 4.0E-04 | mg/kg/day | 1.1E-01 |
| | | | | Arsenic | 4.1E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 5.2E-05 | mg/kg/day | 3.0E-04 | mg/kg/day | 1.7E-01 |
| | | | | Chromium | 1.6E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.1E-04 | mg/kg/day | 3.0E-03 | mg/kg/day | 7.0E-02 |
| | | | | Iron | 3.0E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.8E-02 | mg/kg/day | 7.0E-01 | mg/kg/day | 5.5E-02 |
| | | | | Lead | 3.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 4.1E-05 | mg/kg/day | N/A | | N/A |
| | | | | Manganese | 1.3E+02 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.7E-03 | mg/kg/day | 2.0E-02 | mg/kg/day | 8.5E-02 |
| | | | | Nickel | 1.3E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.6E-04 | mg/kg/day | 2.0E-02 | mg/kg/day | 8.2E-03 |
| | | | | Thallium | 5.9E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 7.5E-05 | mg/kg/day | 7.0E-05 | mg/kg/day | 1.1E+00 |
| | | | | Vanadium | 3.7E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 4.7E-05 | mg/kg/day | 1.0E-03 | mg/kg/day | 4.7E-02 |
| | | | Exp. Route Total | | | | | | | | N/A | | | | | 1.7E+00 |
| | | | Dermal Absorption | Methylene chloride | 1.4E+02 | ug/L | N/A | N/A | N/A | N/A | N/A | 6.6E-05 | mg/kg/day | 6.0E-02 | mg/kg/day | 1.1E-03 |
| | | | | Tetrachloroethene | 1.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.0E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 1.0E-03 |
| | | | | Trichloroethene | 1.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.9E-06 | mg/kg/day | 6.0E-03 | mg/kg/day | 4.8E-04 |
| | | | | cis-1,2-Dichloroethene | 1.7E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.7E-06 | mg/kg/day | 1.0E-02 | mg/kg/day | 1.7E-04 |
| | | | | bis(2-Ethylhexyl)phthalate | 2.1E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.2E-03 | mg/kg/day | 2.0E-02 | mg/kg/day | 1.1E-01 |
| | | | | Aluminum | 1.6E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 6.7E-05 | mg/kg/day | 1.0E+00 | mg/kg/day | 6.7E-05 |
| | | | | Antimony | 3.3E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.4E-07 | mg/kg/day | 6.0E-05 | mg/kg/day | 2.3E-03 |
| | | | | Arsenic | 4.1E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.7E-07 | mg/kg/day | 3.0E-04 | mg/kg/day | 5.6E-04 |
| | | | | Chromium | 1.6E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.3E-06 | mg/kg/day | 7.5E-05 | mg/kg/day | 1.8E-02 |
| Groundwater | Groundwater | Bedrock Aquifer - Tap Water | Dermal Absorption | Iron | 3.0E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.2E-04 | mg/kg/day | 7.0E-01 | mg/kg/day | 1.8E-04 |
| | | | | Lead | 3.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.3E-07 | mg/kg/day | N/A | | N/A |
| | | | | Manganese | 1.3E+02 | ug/L | N/A | N/A | N/A | N/A | N/A | 5.5E-06 | mg/kg/day | 8.0E-04 | mg/kg/day | 6.8E-03 |
| | | | | Nickel | 1.3E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.0E-07 | mg/kg/day | 8.0E-04 | mg/kg/day | 1.3E-04 |
| | | | | Thallium | 5.9E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.4E-07 | mg/kg/day | 7.0E-05 | mg/kg/day | 3.5E-03 |
| | | | | Vanadium | 3.7E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.5E-07 | mg/kg/day | 2.6E-05 | mg/kg/day | 5.9E-03 |
| | | | Exp. Route Total | | | | | | | | N/A | | | | | 1.5E-01 |
| | | Exposure Point Total | | | | | | | | | N/A | | | | | 1.8E+00 |
| | Exposure Medium Total | | | | | | | | | | N/A | | | | | 1.8E+00 |

TABLE 7.4.CTE

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

CENTRAL TENDENCY EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Groundwater | Air | Bedrock Aquifer Water Vapors at Showerhead | Inhalation | | | | | | | | | | | | | |
| | | | | Methylene chloride | 1.4E+02 | ug/L | 1.3E-04 | mg/kg/day | 1.7E-03 | 1/mg/kg/day | 2.1E-07 | 9.9E-04 | mg/kg/day | 3.0E-01 | mg/kg/day | 3.3E-03 |
| | | | | Tetrachloroethene | 1.4E+00 | ug/L | 9.9E-07 | mg/kg/day | 2.0E-02 | 1/mg/kg/day | 2.0E-08 | 7.7E-06 | mg/kg/day | 8.0E-02 | mg/kg/day | 9.6E-05 |
| | | | | Trichloroethene | 1.4E+00 | ug/L | 1.1E-06 | mg/kg/day | 6.0E-03 | 1/mg/kg/day | 6.7E-09 | 8.6E-06 | mg/kg/day | N/A | N/A | N/A |
| | | | | cis-1,2-Dichloroethene | 1.7E+00 | ug/L | 1.4E-06 | mg/kg/day | N/A | | N/A | 1.1E-05 | mg/kg/day | N/A | N/A | N/A |
| | | | Exp. Route Total | | | | | | | | 2.4E-07 | | | | | 3.4E-03 |
| | | Exposure Point Total | | | | | | | | | 2.4E-07 | | | | | 3.4E-03 |
| | Exposure Medium Total | | | | | | | | | | 2.4E-07 | | | | | 3.4E-03 |
| Medium Total | | | | | | | | | | | 2.4E-07 | | | | | 1.8E+00 |
| | | | | | | | | | | Total of Receptor Risks Across All Media | 2.4E-07 | Total of Receptor Hazards Across All Media | | | | 1.8E+00 |

Notes-
NA = Not applicable.
DAevent for exposure to groundwater while showering is calculated on Table 7.4.CTE Supplement A.
Shower exposure calculated on Table 7.4.CTE Supplement B.

Table 7.4.CTE Supplement A
Calculation of DAevent
Resident Adult Ground Water
Site 12 Remedial investigation, Allegany Ballistics Laboratory

| Chemical of Potential Concern | Water Concentration (CW) (μg/L) | Permeability Coefficient[1] (Kp) (cm/hr) | B[1] (dimensionless) | Lag Time[1] ($\tau_{event}$) (hr) | t*[1] (hr) | Fraction Absorbed Water[1] (FA) (dimensionless) | Duration of Event (tevent) (hr) | DAevent ($mg/cm^2$-event) | Eq |
|---|---|---|---|---|---|---|---|---|---|
| Methylene chloride | 1.4E+02 | 3.5E-03 | 1.3E-02 | 3.2E-01 | 7.6E-01 | 1.0E+00 | 0.25 | 4.0E-07 | 2 |
| Tetrachloroethene | 1.4E+00 | 3.3E-02 | 1.7E-01 | 9.1E-01 | 2.2E+00 | 1.0E+00 | 0.25 | 6.2E-08 | 2 |
| Trichloroethene | 1.4E+00 | 1.2E-02 | 5.1E-02 | 5.8E-01 | 1.4E+00 | 1.0E+00 | 0.25 | 1.7E-08 | 2 |
| cis-1,2-Dichloroethene | 1.7E+00 | 7.7E-03 | 2.9E-02 | 3.7E-01 | 8.8E-01 | 1.0E+00 | 0.25 | 1.1E-08 | 2 |
| bis(2-Ethylhexyl)phthalate | 2.1E+00 | 1.1E+00 | 8.6E+00 | 1.7E+01 | 7.5E+01 | 1.0E+00 | 0.25 | 1.3E-05 | 2 |
| Aluminum | 1.6E+03 | 1.0E-03 | NA | NA | NA | NA | 0.25 | 4.1E-07 | 1 |
| Antimony | 3.3E+00 | 1.0E-03 | NA | NA | NA | NA | 0.25 | 8.3E-10 | 1 |
| Arsenic | 4.1E+00 | 1.0E-03 | NA | NA | NA | NA | 0.25 | 1.0E-09 | 1 |
| Chromium | 1.6E+01 | 2.0E-03 | NA | NA | NA | NA | 0.25 | 8.2E-09 | 1 |
| Iron | 3.0E+03 | 1.0E-03 | NA | NA | NA | NA | 0.25 | 7.5E-07 | 1 |
| Lead | 3.2E+00 | 1.0E-03 | NA | NA | NA | NA | 0.25 | 8.0E-10 | 1 |
| Manganese | 1.3E+02 | 1.0E-03 | NA | NA | NA | NA | 0.25 | 3.3E-08 | 1 |
| Nickel | 1.3E+01 | 2.0E-04 | NA | NA | NA | NA | 0.25 | 6.4E-10 | 1 |
| Thallium | 5.9E+00 | 1.0E-03 | NA | NA | NA | NA | 0.25 | 1.5E-09 | 1 |
| Vanadium | 3.7E+00 | 1.0E-03 | NA | NA | NA | NA | 0.25 | 9.3E-10 | 1 |

**Inorganics: DAevent (mg/cm2-event) =**
Kp x CW x tevent x 0.001 mg/ug x 0.001 $l/cm^3$ (eq 1)

**Organics: DAevent (mg/cm2-event) =**
If $t_{event} \leq t^*$ then

$$DA_{event} = 2 \times FA \times K_p \times C_w \times 0.001 \quad mg/ug \times 0.001 \quad l/cm^3 \sqrt{\frac{6 \times \tau_{event} \times t_{event}}{\pi}} \qquad \text{(eq 2)}$$

If $t_{event} \geq t^*$ then

$$DA_{event} = FA \times K_p \times C_w \times 0.001 \quad mg/ug \times 0.001 \quad l/cm^3 \left[ \frac{t_{event}}{1+B} + 2 \times \tau_{event} \left( \frac{1+3B+3B^2}{(1+B)^2} \right) \right] \qquad \text{(eq 3)}$$

Notes:
[1] Values from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.
[2] Values from Virginia Remediation Program, Risk Assessment Guidance, gwcalcs.xls, revised 6/7/07
NA - not applicable.

Table 7.4.CTE Supplement B
Inhalation Exposure Concentrations from Foster and Chrostowski Shower Model
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

| Chemical | Exposure Point Concentration Cwo (μg/l) | Molecular weight (HH) (g/mole) | Henry's Law Constant (H) (atm-m$^3$/mole) | Kg (VOC) (cm/hr) | Kl(VOC) (cm/hr) | KL (cm/hr) | Kal (cm/hr) | Cwd (μg/l) | S (μg/m$^3$ -min) | Calculated Inhalation Exposure (Einh) (mg/kg/shower) |
|---|---|---|---|---|---|---|---|---|---|---|
| Methylene chloride | 1.4E+02 | 8.5E+01 | 2.2E-03 | 1.4E+03 | 1.4E+01 | 1.3E+01 | 1.7E+01 | 1.9E+01 | 1.6E+01 | 1.5E-03 |
| Tetrachloroethene | 1.4E+00 | 1.7E+02 | 1.8E-02 | 9.9E+02 | 1.0E+01 | 1.0E+01 | 1.4E+01 | 1.5E-01 | 1.3E-01 | 1.2E-05 |
| Trichloroethene | 1.4E+00 | 1.3E+02 | 1.0E-02 | 1.1E+03 | 1.2E+01 | 1.1E+01 | 1.5E+01 | 1.7E-01 | 1.4E-01 | 1.3E-05 |
| cis-1,2-Dichloroethene | 1.7E+00 | 9.7E+01 | 4.1E-03 | 1.3E+03 | 1.3E+01 | 1.3E+01 | 1.7E+01 | 2.2E-01 | 1.8E-01 | 1.7E-05 |

| Variables | Units | Exposure Assumptions |
|---|---|---|
| Kg(VOC) = gas-film mass transfer coefficient | cm/hr | Solved by Eq 1 |
| Kl(VOC) = liquid-film mass transfer coefficient | cm/hr | Solved by Eq 2 |
| KL = overall mass transfer coefficient | cm/hr | Solved by Eq 3 |
| Kal = adjusted overall mass transfer coeff. | cm/hr | Solved by Eq 4 |
| Tl = Calibration temp. of water | K (20C +273) | 293 |
| Ts = Shower water temperature | k (45C) | 318 |
| Us = water viscosity at Ts | centipoise | 0.596 |
| Ul = water viscosity at Tl | cp | 1.002 |
| Cwd = conc. leaving droplets after time sdt | μg/l | Solved by Eq 5 |
| sdt = shower droplet drop time | sec | 0.5 |
| d = shower droplet diameter | mm | 1 |
| FR = shower water flow rate | l/min | 10 |
| SV = shower room air volume | m$^3$ | 12 |
| S = indoor VOC generation rate | μg/m$^3$-min | Solved by Eq 6 |
| VR = ventilation rate | l/min | 13.8 |
| **Variables** | **Units** | **Exposure Assumptions** |
| BW = body weight | kg | 70 |
| Ds = duration of shower | min | 15 |
| Dt = total duration in shower room | min | 45 |
| R = air exchange rate | min$^{-1}$ | 0.0083 |
| Ca = indoor air concentration of VOCs | μg/m$^3$ | Solved by Eq 7 |
| Einh = inhalation exposure per shower | mg/kg/shower | Solved by Eq 8 |

| | | | |
|---|---|---|---|
| Equation 1: | Kg(VOC) = | 3000 * (18 / HH)$^{0.5}$ | |
| Equation 2: | Kl(VOC) = | 20 * (44 / HH)$^{0.5}$ | |
| Equation 3: | KL = | ((1 / Kl(VOC)) + (0.024 / (Kg (VOC) * H)))$^{-1}$ | |
| Equation 4: | Kal = | (KL * (((Tl * Us) / (Ts * Ul))$^{-0.5}$)) | |
| Equation 5: | Cwd = | (Cwo * (1-EXP((-1 * Kal * sdt)/(60 * d)))) | |
| Equation 6: | S = | (Cwd * FR / SV) | |
| Equation 7: | see time series example on Table I-GW-5 | | |
| Equation 8: | Einh = | If t>Ds | (((VR * S) / (BW * R * 1000000)) * ((Ds + (EXP(-R * Dt) / R)-(EXP(R * (Ds - Dt))) / R))) |

TABLE 7.5.CTE
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
CENTRAL TENDENCY EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Groundwater | Groundwater | Bedrock Aquifer - Tap Water | Ingestion | | | | | | | | | | | | | |
| | | | | Methylene chloride | 1.4E+02 | ug/L | N/A | N/A | N/A | N/A | N/A | 6.1E-03 | mg/kg/day | 6.0E-02 | mg/kg/day | 1.0E-01 |
| | | | | Tetrachloroethene | 1.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 6.0E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 6.0E-03 |
| | | | | Trichloroethene | 1.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 6.1E-05 | mg/kg/day | 6.0E-03 | mg/kg/day | 1.0E-02 |
| | | | | cis-1,2-Dichloroethene | 1.7E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 7.1E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 7.1E-03 |
| | | | | bis(2-Ethylhexyl)phthalate | 2.1E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 9.0E-05 | mg/kg/day | 2.0E-02 | mg/kg/day | 4.5E-03 |
| | | | | Aluminum | 1.6E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 6.9E-02 | mg/kg/day | 1.0E+00 | mg/kg/day | 6.9E-02 |
| | | | | Antimony | 3.3E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.4E-04 | mg/kg/day | 4.0E-04 | mg/kg/day | 3.5E-01 |
| | | | | Arsenic | 4.1E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.7E-04 | mg/kg/day | 3.0E-04 | mg/kg/day | 5.8E-01 |
| | | | | Chromium | 1.6E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 7.0E-04 | mg/kg/day | 3.0E-03 | mg/kg/day | 2.3E-01 |
| | | | | Iron | 3.0E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.3E-01 | mg/kg/day | 7.0E-01 | mg/kg/day | 1.8E-01 |
| | | | | Lead | 3.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.4E-04 | mg/kg/day | N/A | | N/A |
| | | | | Manganese | 1.3E+02 | ug/L | N/A | N/A | N/A | N/A | N/A | 5.7E-03 | mg/kg/day | 2.0E-02 | mg/kg/day | 2.8E-01 |
| | | | | Nickel | 1.3E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 5.4E-04 | mg/kg/day | 2.0E-02 | mg/kg/day | 2.7E-02 |
| | | | | Thallium | 5.9E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.5E-04 | mg/kg/day | 7.0E-05 | mg/kg/day | 3.6E+00 |
| | | | | Vanadium | 3.7E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.6E-04 | mg/kg/day | 1.0E-03 | mg/kg/day | 1.6E-01 |
| | | | Exp. Route Total | | | | | | | | N/A | | | | | 5.6E+00 |
| | | | Dermal Absorption | | | | | | | | | | | | | |
| | | | | Methylene chloride | 1.4E+02 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.3E-04 | mg/kg/day | 6.0E-02 | mg/kg/day | 2.1E-03 |
| | | | | Tetrachloroethene | 1.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.0E-05 | mg/kg/day | 1.0E-02 | mg/kg/day | 2.0E-03 |
| | | | | Trichloroethene | 1.4E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 5.7E-06 | mg/kg/day | 6.0E-03 | mg/kg/day | 9.4E-04 |
| | | | | cis-1,2-Dichloroethene | 1.7E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.4E-06 | mg/kg/day | 1.0E-02 | mg/kg/day | 3.4E-04 |
| | | | | bis(2-Ethylhexyl)phthalate | 2.1E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 4.4E-03 | mg/kg/day | 2.0E-02 | mg/kg/day | 2.2E-01 |
| | | | | Aluminum | 1.6E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.5E-04 | mg/kg/day | 1.0E+00 | mg/kg/day | 1.5E-04 |
| | | | | Antimony | 3.3E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.1E-07 | mg/kg/day | 6.0E-05 | mg/kg/day | 5.1E-03 |
| | | | | Arsenic | 4.1E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.8E-07 | mg/kg/day | 3.0E-04 | mg/kg/day | 1.3E-03 |
| | | | | Chromium | 1.6E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.0E-06 | mg/kg/day | 7.5E-05 | mg/kg/day | 4.1E-02 |
| Groundwater | Groundwater | Bedrock Aquifer - Tap Water | Dermal Absorption | Iron | 3.0E+03 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.8E-04 | mg/kg/day | 7.0E-01 | mg/kg/day | 4.0E-04 |
| | | | | Lead | 3.2E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.0E-07 | mg/kg/day | N/A | | N/A |
| | | | | Manganese | 1.3E+02 | ug/L | N/A | N/A | N/A | N/A | N/A | 1.2E-05 | mg/kg/day | 8.0E-04 | mg/kg/day | 1.5E-02 |
| | | | | Nickel | 1.3E+01 | ug/L | N/A | N/A | N/A | N/A | N/A | 2.4E-07 | mg/kg/day | 8.0E-04 | mg/kg/day | 3.0E-04 |
| | | | | Thallium | 5.9E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 5.5E-07 | mg/kg/day | 7.0E-05 | mg/kg/day | 7.8E-03 |
| | | | | Vanadium | 3.7E+00 | ug/L | N/A | N/A | N/A | N/A | N/A | 3.4E-07 | mg/kg/day | 2.6E-05 | mg/kg/day | 1.3E-02 |
| | | | Exp. Route Total | | | | | | | | N/A | | | | | 3.1E-01 |
| | | Exposure Point Total | | | | | | | | | N/A | | | | | 5.9E+00 |
| | Exposure Medium Total | | | | | | | | | | N/A | | | | | 5.9E+00 |
| Medium Total | | | | | | | | | | | N/A | | | | | 5.9E+00 |
| | | | | | | | | | Total of Receptor Risks Across All Media | | N/A | Total of Receptor Hazards Across All Media | | | | 5.9E+00 |

Notes-
NA = Not applicable.
DAevent for exposure to groundwater while showering is calculated on Table 7.5.CTE Supplement A.

Table 7.5.CTE Supplement A
Calculation of DAevent
Resident Child Ground Water
Site 12 Remedial investigation, Allegany Ballistics Laboratory

| Chemical of Potential Concern | Water Concentration (CW) (μg/L) | Permeability Coefficient[1] (Kp) (cm/hr) | B[1] (dimensionless) | Lag Time[1] ($\tau_{event}$) (hr) | t*[1] (hr) | Fraction Absorbed Water[1] (FA) (dimensionless) | Duration of Event (tevent) (hr) | DAevent ($mg/cm^2$-event) | Eq |
|---|---|---|---|---|---|---|---|---|---|
| Methylene chloride | 1.4E+02 | 3.5E-03 | 1.3E-02 | 3.2E-01 | 7.6E-01 | 1.0E+00 | 0.33 | 4.6E-07 | 2 |
| Tetrachloroethene | 1.4E+00 | 3.3E-02 | 1.7E-01 | 9.1E-01 | 2.2E+00 | 1.0E+00 | 0.33 | 7.1E-08 | 2 |
| Trichloroethene | 1.4E+00 | 1.2E-02 | 5.1E-02 | 5.8E-01 | 1.4E+00 | 1.0E+00 | 0.33 | 2.0E-08 | 2 |
| cis-1,2-Dichloroethene | 1.7E+00 | 7.7E-03 | 2.9E-02 | 3.7E-01 | 8.8E-01 | 1.0E+00 | 0.33 | 1.2E-08 | 2 |
| bis(2-Ethylhexyl)phthalate | 2.1E+00 | 1.1E+00 | 8.6E+00 | 1.7E+01 | 7.5E+01 | 1.0E+00 | 0.33 | 1.5E-05 | 2 |
| Aluminum | 1.6E+03 | 1.0E-03 | NA | NA | NA | NA | 0.33 | 5.4E-07 | 1 |
| Antimony | 3.3E+00 | 1.0E-03 | NA | NA | NA | NA | 0.33 | 1.1E-09 | 1 |
| Arsenic | 4.1E+00 | 1.0E-03 | NA | NA | NA | NA | 0.33 | 1.3E-09 | 1 |
| Chromium | 1.6E+01 | 2.0E-03 | NA | NA | NA | NA | 0.33 | 1.1E-08 | 1 |
| Iron | 3.0E+03 | 1.0E-03 | NA | NA | NA | NA | 0.33 | 9.8E-07 | 1 |
| Lead | 3.2E+00 | 1.0E-03 | NA | NA | NA | NA | 0.33 | 1.1E-09 | 1 |
| Manganese | 1.3E+02 | 1.0E-03 | NA | NA | NA | NA | 0.33 | 4.4E-08 | 1 |
| Nickel | 1.3E+01 | 2.0E-04 | NA | NA | NA | NA | 0.33 | 8.4E-10 | 1 |
| Thallium | 5.9E+00 | 1.0E-03 | NA | NA | NA | NA | 0.33 | 1.9E-09 | 1 |
| Vanadium | 3.7E+00 | 1.0E-03 | NA | NA | NA | NA | 0.33 | 1.2E-09 | 1 |

**Inorganics: DAevent (mg/cm2-event) =**
Kp x CW x tevent x 0.001 mg/ug x 0.001 $l/cm^3$ (eq 1)

**Organics: DAevent (mg/cm2-event) =**
If $t_{event} \leq t^*$ then

$$DA_{event} = 2 \times FA \times K_p \times C_w \times 0.001 \quad mg/ug \times 0.001 \quad l/cm^3 \sqrt{\frac{6 \times \tau_{event} \times t_{event}}{\pi}} \qquad \text{(eq 2)}$$

If $t_{event} \geq t^*$ then

$$DA_{event} = FA \times K_p \times C_w \times 0.001 \quad mg/ug \times 0.001 \quad l/cm^3 \left[ \frac{t_{event}}{1+B} + 2 \times \tau_{event} \left( \frac{1+3B+3B^2}{(1+B)^2} \right) \right] \qquad \text{(eq 3)}$$

Notes:
[1] Values from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.
[2] Values from Virginia Remediation Program, Risk Assessment Guidance, gwcalcs.xls, revised 6/7/07
NA - not applicable.

TABLE 7.6.CTE

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

CENTRAL TENDENCY EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult/Child

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Groundwater | Groundwater | Bedrock Aquifer - Tap Water | Ingestion | | | | | | | | | | | | | |
| | | | | Methylene chloride | 1.4E+02 | ug/L | 7.6E-04 | mg/kg/day | 7.5E-03 | 1/mg/kg/day | 5.7E-06 | N/A | N/A | N/A | N/A | N/A |
| | | | | Tetrachloroethene | 1.4E+00 | ug/L | 7.4E-06 | mg/kg/day | 5.4E-01 | 1/mg/kg/day | 4.0E-06 | N/A | N/A | N/A | N/A | N/A |
| | | | | Trichloroethene | 1.4E+00 | ug/L | 7.6E-06 | mg/kg/day | 1.1E-02 | 1/mg/kg/day | 8.3E-08 | N/A | N/A | N/A | N/A | N/A |
| | | | | cis-1,2-Dichloroethene | 1.7E+00 | ug/L | 8.8E-06 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | bis(2-Ethylhexyl)phthalate | 2.1E+00 | ug/L | 1.1E-05 | mg/kg/day | 1.4E-02 | 1/mg/kg/day | 1.6E-07 | N/A | N/A | N/A | N/A | N/A |
| | | | | Aluminum | 1.6E+03 | ug/L | 8.6E-03 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Antimony | 3.3E+00 | ug/L | 1.8E-05 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Arsenic | 4.1E+00 | ug/L | 2.2E-05 | mg/kg/day | 1.5E+00 | 1/mg/kg/day | 3.3E-05 | N/A | N/A | N/A | N/A | N/A |
| | | | | Chromium | 1.6E+01 | ug/L | 8.7E-05 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Iron | 3.0E+03 | ug/L | 1.6E-02 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Lead | 3.2E+00 | ug/L | 1.7E-05 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Manganese | 1.3E+02 | ug/L | 7.0E-04 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Nickel | 1.3E+01 | ug/L | 6.8E-05 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Thallium | 5.9E+00 | ug/L | 3.1E-05 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Vanadium | 3.7E+00 | ug/L | 2.0E-05 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | Exp. Route Total | | | | | | | | 4.3E-05 | | | | | N/A |
| | | | Dermal Absorption | | | | | | | | | | | | | |
| | | | | Methylene chloride | 1.4E+02 | ug/L | 6.9E-07 | mg/kg/day | 7.5E-03 | 1/mg/kg/day | 5.2E-09 | N/A | N/A | N/A | N/A | N/A |
| | | | | Tetrachloroethene | 1.4E+00 | ug/L | 5.1E-07 | mg/kg/day | 5.4E-01 | 1/mg/kg/day | 2.8E-07 | N/A | N/A | N/A | N/A | N/A |
| | | | | Trichloroethene | 1.4E+00 | ug/L | 2.8E-07 | mg/kg/day | 1.1E-02 | 1/mg/kg/day | 3.0E-09 | N/A | N/A | N/A | N/A | N/A |
| | | | | cis-1,2-Dichloroethene | 1.7E+00 | ug/L | 1.9E-05 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | bis(2-Ethylhexyl)phthalate | 2.1E+00 | ug/L | 3.4E-07 | mg/kg/day | 1.4E-02 | 1/mg/kg/day | 4.8E-09 | N/A | N/A | N/A | N/A | N/A |
| | | | | Aluminum | 1.6E+03 | ug/L | 4.4E-06 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Antimony | 3.3E+00 | ug/L | 8.2E-07 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Arsenic | 4.1E+00 | ug/L | 1.8E-07 | mg/kg/day | 1.5E+00 | 1/mg/kg/day | 2.7E-07 | N/A | N/A | N/A | N/A | N/A |
| | | | | Chromium | 1.6E+01 | ug/L | 8.6E-06 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| Groundwater | Groundwater | Bedrock Aquifer - Tap Water | Dermal Absorption | Iron | 3.0E+03 | ug/L | 5.6E-07 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Lead | 3.2E+00 | ug/L | 3.0E-07 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Manganese | 1.3E+02 | ug/L | 3.1E-06 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Nickel | 1.3E+01 | ug/L | 1.1E-06 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Thallium | 5.9E+00 | ug/L | 2.1E-07 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | Vanadium | 3.7E+00 | ug/L | 1.0E-06 | mg/kg/day | N/A | | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | Exp. Route Total | | | | | | | | 5.6E-07 | | | | | N/A |
| | | Exposure Point Total | | | | | | | | | 4.3E-05 | | | | | N/A |
| | Exposure Medium Total | | | | | | | | | | 4.3E-05 | | | | | N/A |
| Medium Total | | | | | | | | | | | 4.3E-05 | | | | | N/A |
| | | | | | | | | | Total of Receptor Risks Across All Media | | 4.3E-05 | Total of Receptor Hazards Across All Media | | | | N/A |

Notes-

NA = Not applicable.

DAevent for exposure to groundwater while showering and bathing is calculated on Tables 7.4.CTE Supplement A and 7.5.CTE Supplement A.

Table 3.4.CTE
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
CENTRAL TENDENCY EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air

| Exposure Point | Chemical of Potential Concern | Units | Arithmetic Mean | 95% UCL (Distribution) | | Maximum Concentration (Qualifier) | | Exposure Point Concentration | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Value | Units | Statistic | Rationale |
| Alluvial Aquifer - Volatilization from Water in Excavation Pit | 1,1,2,2-Tetrachloroethane | UG/L | 1.5E+00 | 5.9E+00 | (NP) | 3.2E+00 | J | 1.5E+00 | UG/L | Mean-N | (5) |
| | 1,1,2-Trichloroethane | UG/L | 1.5E+00 | 5.9E+00 | (NP) | 3.4E+00 | J | 1.5E+00 | UG/L | Mean-N | (5) |
| | 1,2-Dibromo-3-chloropropane | UG/L | 1.2E+00 | 5.3E+00 | (NP) | 3.8E+00 | J | 1.2E+00 | UG/L | Mean-N | (5) |
| | 1,2-Dichlorobenzene | UG/L | 8.9E+00 | 6.2E+01 | (T) | 8.7E+01 | J | 8.1E+00 | UG/L | Mean-T | (1) |
| | 1,2-Dichloropropane | UG/L | 1.7E+00 | 6.3E+00 | (NP) | 9.6E-01 | | 9.6E-01 | UG/L | Max | (5,6) |
| | 1,4-Dichlorobenzene | UG/L | 1.6E+00 | 1.9E+00 | (NP) | 2.1E+00 | | 1.8E+00 | UG/L | Mean-N | (5) |
| | Benzene | UG/L | 1.5E+00 | 1.5E+00 | (NP) | 1.8E+00 | J | 1.4E+00 | UG/L | Mean-N | (5) |
| | Bromodichloromethane | UG/L | 1.7E+00 | 6.3E+00 | (NP) | 6.1E-01 | | 6.1E-01 | UG/L | Max | (5,6) |
| | Chlorobenzene | UG/L | 5.9E+00 | 3.6E+01 | (NP) | 9.4E+01 | J | 6.6E+00 | UG/L | Mean-N | (5) |
| | Chloroform | UG/L | 1.7E+00 | 6.3E+00 | (NP) | 2.2E+00 | | 1.7E+00 | UG/L | Mean-N | (5) |
| | Methylene chloride | UG/L | 2.2E+00 | 6.8E+00 | (NP) | 4.4E+00 | | 2.2E+00 | UG/L | Mean-N | (5) |
| | Tetrachloroethene | UG/L | 1.4E+00 | 1.5E+00 | (NP) | 1.9E+00 | L | 1.4E+00 | UG/L | Mean-N | (5) |
| | Trichloroethene | UG/L | 2.4E+00 | 3.0E+00 | (NP) | 9.4E+00 | | 1.9E+00 | UG/L | Mean-N | (1,3,4) |
| | Vinyl chloride | UG/L | 2.2E+00 | 2.0E+00 | (NP) | 7.6E+00 | | 1.1E+00 | UG/L | Mean-N | (1,3,4) |
| | cis-1,2-Dichloroethene | UG/L | 4.0E+00 | 5.4E+00 | (NP) | 2.2E+01 | | 3.3E+00 | UG/L | Mean-N | (1,3,4) |

ProUCL, Version 4.0 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate RME EPC, following recommendations based on distribution and standard deviation in users guide (USEPA. April 2007. ProUCL, Version 4.0. Prepared by Lockheed Martin Environmental Services).
Statistics: Mean of data assuming normal distribution (Mean-N); Mean of data assuming lognormal distribution (Mean-T); Maximum Detected Value (Max)

(1) Shapiro-Wilk W Test/Lilliefors test indicates data are log-normally distributed.
(2) Shapiro-Wilk W Test/Lilliefors indicates data are normally distributed.
(3) Anderson-Darling Test indicates data are gamma distributed.
(4) Kolmogorov-Smirnov Test indicates data are gamma distributed.
(5) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).
(6) Max value used because mean greater than max.

N = Normal
T = Log-Transformed
NP = Non-Parametric
G = Gamma

UG/L = micrograms liter
L = Biased Low
J = Estimated Value
K = Biased High

TABLE 9.1.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Groundwater | Alluvial Aquifer - Tap Water | 1,1,2,2-Tetrachloroethane | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,1,2-Trichloroethane | N/A | N/A | N/A | 0.0E+00 | Blood | 2.3E-02 | N/A | 2.2E-03 | 2.5E-02 |
| | | | 1,2-Dibromo-3-chloropropane | N/A | N/A | N/A | 0.0E+00 | Testis | 5.2E-01 | N/A | 3.4E-02 | 5.5E-01 |
| | | | 1,2-Dichlorobenzene | N/A | N/A | N/A | 0.0E+00 | NOAEL | 1.9E-02 | N/A | 1.2E-02 | 3.1E-02 |
| | | | 1,2-Dichloropropane | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,4-Dichlorobenzene | N/A | N/A | N/A | 0.0E+00 | Liver, Developmental | 1.7E-03 | N/A | 1.1E-03 | 2.8E-03 |
| | | | Benzene | N/A | N/A | N/A | 0.0E+00 | Blood, Immune | 1.0E-02 | N/A | 1.6E-03 | 1.2E-02 |
| | | | Bromodichloromethane | N/A | N/A | N/A | 0.0E+00 | Kidney | 8.4E-04 | N/A | 6.9E-05 | 9.0E-04 |
| | | | Chlorobenzene | N/A | N/A | N/A | 0.0E+00 | Liver | 4.9E-02 | N/A | 1.8E-02 | 6.7E-02 |
| | | | Chloroform | N/A | N/A | N/A | 0.0E+00 | Liver | 6.0E-03 | N/A | 5.5E-04 | 6.6E-03 |
| | | | Methylene chloride | N/A | N/A | N/A | 0.0E+00 | Liver | 2.0E-03 | N/A | 7.6E-05 | 2.1E-03 |
| | | | Tetrachloroethene | N/A | N/A | N/A | 0.0E+00 | Liver, Whole body | 4.1E-03 | N/A | 2.5E-03 | 6.6E-03 |
| | | | Trichloroethene | N/A | N/A | N/A | 0.0E+00 | Liver | 1.4E-02 | N/A | 2.3E-03 | 1.6E-02 |
| | | | Vinyl chloride | N/A | N/A | N/A | 0.0E+00 | Liver | 1.8E-02 | N/A | 9.5E-04 | 1.9E-02 |
| | | | cis-1,2-Dichloroethene | N/A | N/A | N/A | 0.0E+00 | Blood | 1.5E-02 | N/A | 1.3E-03 | 1.6E-02 |
| | | | Arsenic-dissolved | N/A | N/A | N/A | 0.0E+00 | Skin, Vascular | 4.4E-01 | N/A | 2.3E-03 | 4.4E-01 |
| | | | Chromium (hexavalent)-dissolved | N/A | N/A | N/A | 0.0E+00 | Not identified | 5.8E-02 | N/A | 2.4E-02 | 8.2E-02 |
| | | | Iron-dissolved | N/A | N/A | N/A | 0.0E+00 | Gastrointestinal | 3.7E-01 | N/A | 1.9E-03 | 3.7E-01 |
| | | | Manganese-dissolved | N/A | N/A | N/A | 0.0E+00 | CNS | 3.5E+00 | N/A | 4.5E-01 | 3.9E+00 |
| | | | Nickel-dissolved | N/A | N/A | N/A | 0.0E+00 | Decreased Body Weight | 2.3E-01 | N/A | 6.0E-03 | 2.4E-01 |
| | | | Thallium-dissolved | N/A | N/A | N/A | 0.0E+00 | Liver, Blood, Hair | 2.4E+00 | N/A | 1.3E-02 | 2.4E+00 |
| | | | Chemical Total | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | | 7.7E+00 | 0.0E+00 | 5.7E-01 | 8.2E+00 |
| | | Exposure Point Total | | | | | 0.0E+00 | | | | | 8.2E+00 |
| | Exposure Medium Total | | | | | | 0.0E+00 | | | | | 8.2E+00 |

TABLE 9.1.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Air | Alluvial Aquifer - Water Vapors at Showerhead | 1,1,2,2-Tetrachloroethane | N/A | 2.5E-06 | N/A | 2.5E-06 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,1,2-Trichloroethane | N/A | 1.1E-06 | N/A | 1.1E-06 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,2-Dibromo-3-chloropropane | N/A | 1.7E-04 | N/A | 1.7E-04 | Testis | N/A | 4.2E-01 | N/A | 4.2E-01 |
| | | | 1,2-Dichlorobenzene | N/A | N/A | N/A | 0.0E+00 | Decreased Weight Gain | N/A | 2.8E-02 | N/A | 2.8E-02 |
| | | | 1,2-Dichloropropane | N/A | N/A | N/A | 0.0E+00 | Nasal Mucosa | N/A | 1.6E-02 | N/A | 1.6E-02 |
| | | | 1,4-Dichlorobenzene | N/A | 2.6E-07 | N/A | 2.6E-07 | Liver | N/A | 1.5E-04 | N/A | 1.5E-04 |
| | | | Benzene | N/A | 3.7E-07 | N/A | 3.7E-07 | Blood, Immune | N/A | 4.6E-03 | N/A | 4.6E-03 |
| | | | Bromodichloromethane | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | Chlorobenzene | N/A | N/A | N/A | 0.0E+00 | Liver | N/A | 5.6E-02 | N/A | 5.6E-02 |
| | | | Chloroform | N/A | 1.3E-06 | N/A | 1.3E-06 | Liver | N/A | 3.3E-03 | N/A | 3.3E-03 |
| | | | Methylene chloride | N/A | 5.9E-08 | N/A | 5.9E-08 | Liver | N/A | 3.5E-04 | N/A | 3.5E-04 |
| | | | Tetrachloroethene | N/A | 2.0E-07 | N/A | 2.0E-07 | Kidney, Liver | N/A | 3.6E-04 | N/A | 3.6E-04 |
| | | | Trichloroethene | N/A | 1.3E-07 | N/A | 1.3E-07 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | Vinyl chloride | N/A | 3.1E-07 | N/A | 3.1E-07 | Liver | N/A | 2.1E-03 | N/A | 2.1E-03 |
| | | | cis-1,2-Dichloroethene | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | Chemical Total | 0.0E+00 | 1.8E-04 | 0.0E+00 | 1.8E-04 | | 0.0E+00 | 5.3E-01 | 0.0E+00 | 5.3E-01 |
| | | Exposure Point Total | | | | | 1.8E-04 | | | | | 5.3E-01 |
| | Exposure Medium Total | | | | | | 1.8E-04 | | | | | 5.3E-01 |
| Medium Total | | | | | | | 1.8E-04 | | | | | 8.8E+00 |
| Receptor Total | | | | | | | 1.8E-04 | | | | Receptor HI Total | 8.8E+00 |

HI - Hazard Index
CNS = Central Nervous System

| | |
|---|---|
| Total Blood HI Across All Media = | 2.5E+00 |
| Total Testis HI Across All Media = | 9.7E-01 |
| Total Liver HI Across All Media = | 2.6E+00 |
| Total Developmental HI Across All Media = | 2.8E-03 |
| Total Immune HI Across All Media = | 1.7E-02 |
| Total Kidney HI Across All Media = | 1.3E-03 |
| Total Whole Body HI Across All Media = | 6.6E-03 |
| Total Skin HI Across All Media = | 4.4E-01 |
| Total Vascular HI Across All Media = | 4.4E-01 |
| Total Gastrointestinal HI Across All Media = | 3.7E-01 |
| Total CNS HI Across All Media = | 3.9E+00 |
| Total Decreased Body Weight HI Across All Media = | 2.7E-01 |
| Total Hair HI Across All Media = | 2.4E+00 |
| Total Nasal Mucosa HI Across All Media = | 1.6E-02 |

TABLE 9.2.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Groundwater | Alluvial Aquifer - Tap Water | 1,1,2,2-Tetrachloroethane | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,1,2-Trichloroethane | N/A | N/A | N/A | 0.0E+00 | Blood | 5.4E-02 | N/A | 4.9E-03 | 5.9E-02 |
| | | | 1,2-Dibromo-3-chloropropane | N/A | N/A | N/A | 0.0E+00 | Testis | 1.2E+00 | N/A | 7.6E-02 | 1.3E+00 |
| | | | 1,2-Dichlorobenzene | N/A | N/A | N/A | 0.0E+00 | NOAEL | 4.4E-02 | N/A | 2.8E-02 | 7.2E-02 |
| | | | 1,2-Dichloropropane | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,4-Dichlorobenzene | N/A | N/A | N/A | 0.0E+00 | Liver, Developmental | 4.0E-03 | N/A | 2.6E-03 | 6.5E-03 |
| | | | Benzene | N/A | N/A | N/A | 0.0E+00 | Blood, Immune | 2.4E-02 | N/A | 3.7E-03 | 2.8E-02 |
| | | | Bromodichloromethane | N/A | N/A | N/A | 0.0E+00 | Kidney | 1.9E-03 | N/A | 1.5E-04 | 2.1E-03 |
| | | | Chlorobenzene | N/A | N/A | N/A | 0.0E+00 | Liver | 1.1E-01 | N/A | 4.0E-02 | 1.5E-01 |
| | | | Chloroform | N/A | N/A | N/A | 0.0E+00 | Liver | 1.4E-02 | N/A | 1.2E-03 | 1.5E-02 |
| | | | Methylene chloride | N/A | N/A | N/A | 0.0E+00 | Liver | 4.7E-03 | N/A | 1.8E-04 | 4.9E-03 |
| | | | Tetrachloroethene | N/A | N/A | N/A | 0.0E+00 | Liver, Whole body | 9.5E-03 | N/A | 5.5E-03 | 1.5E-02 |
| | | | Trichloroethene | N/A | N/A | N/A | 0.0E+00 | Liver | 3.2E-02 | N/A | 5.1E-03 | 3.7E-02 |
| | | | Vinyl chloride | N/A | N/A | N/A | 0.0E+00 | Liver | 4.2E-02 | N/A | 2.3E-03 | 4.4E-02 |
| | | | cis-1,2-Dichloroethene | N/A | N/A | N/A | 0.0E+00 | Blood | 3.5E-02 | N/A | 3.0E-03 | 3.8E-02 |
| | | | Arsenic-dissolved | N/A | N/A | N/A | 0.0E+00 | Skin, Vascular | 1.0E+00 | N/A | 6.8E-03 | 1.0E+00 |
| | | | Chromium (hexavalent)-dissolved | N/A | N/A | N/A | 0.0E+00 | Not identified | 1.4E-01 | N/A | 7.1E-02 | 2.1E-01 |
| | | | Iron-dissolved | N/A | N/A | N/A | 0.0E+00 | Gastrointestinal | 8.6E-01 | N/A | 5.6E-03 | 8.6E-01 |
| | | | Manganese-dissolved | N/A | N/A | N/A | 0.0E+00 | CNS | 8.1E+00 | N/A | 1.3E+00 | 9.4E+00 |
| | | | Nickel-dissolved | N/A | N/A | N/A | 0.0E+00 | Decreased Body Weight | 5.4E-01 | N/A | 1.8E-02 | 5.6E-01 |
| | | | Thallium-dissolved | N/A | N/A | N/A | 0.0E+00 | Liver, Blood, Hair | 5.7E+00 | N/A | 3.7E-02 | 5.7E+00 |
| | | | Chemical Total | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | | 1.8E+01 | 0.0E+00 | 1.6E+00 | 2.0E+01 |
| | | Exposure Point Total | | | | | 0.0E+00 | | | | | 2.0E+01 |
| | Exposure Medium Total | | | | | | 0.0E+00 | | | | | 2.0E+01 |
| Medium Total | | | | | | | 0.0E+00 | | | | | 2.0E+01 |
| Receptor Total | | | | | | | 0.0E+00 | | | | Receptor HI Total | 2.0E+01 |

HI - Hazard Index
CNS = Central Nervous System

| | |
|---|---|
| Total Blood HI Across All Media = | 5.8E+00 |
| Total Testis HI Across All Media = | 1.3E+00 |
| Total Liver HI Across All Media = | 6.0E+00 |
| Total Developmental HI Across All Media = | 6.5E-03 |
| Total Immune HI Across All Media = | 2.8E-02 |
| Total Kidney HI Across All Media = | 2.1E-03 |
| Total Whole Body HI Across All Media = | 1.5E-02 |
| Total Skin HI Across All Media = | 1.0E+00 |
| Total Vascular HI Across All Media = | 1.0E+00 |
| Total Gastrointestinal HI Across All Media = | 8.6E-01 |
| Total CNS HI Across All Media = | 9.4E+00 |
| Total Decreased Body Weight HI Across All Media = | 5.6E-01 |
| Total Hair HI Across All Media = | 5.7E+00 |

TABLE 9.3.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult/Child

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Groundwater | Alluvial Aquifer - Tap Water | 1,1,2,2-Tetrachloroethane | 9.6E-06 | N/A | 1.2E-06 | 1.1E-05 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,1,2-Trichloroethane | 2.9E-06 | N/A | 2.7E-07 | 3.2E-06 | Blood | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,2-Dibromo-3-chloropropane | 1.4E-04 | N/A | 1.2E-05 | 1.5E-04 | Testis | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,2-Dichlorobenzene | N/A | N/A | N/A | 0.0E+00 | NOAEL | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,2-Dichloropropane | 9.7E-07 | N/A | 9.5E-08 | 1.1E-06 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,4-Dichlorobenzene | 6.7E-07 | N/A | 4.4E-07 | 1.1E-06 | Liver, Developmental | N/A | N/A | N/A | 0.0E+00 |
| | | | Benzene | 1.2E-06 | N/A | 1.9E-07 | 1.4E-06 | Blood, Immune | N/A | N/A | N/A | 0.0E+00 |
| | | | Bromodichloromethane | 5.6E-07 | N/A | 4.6E-08 | 6.1E-07 | Kidney | N/A | N/A | N/A | 0.0E+00 |
| | | | Chlorobenzene | N/A | N/A | N/A | 0.0E+00 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Chloroform | N/A | N/A | N/A | 0.0E+00 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Methylene chloride | 4.9E-07 | N/A | 1.9E-08 | 5.1E-07 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Tetrachloroethene | 1.2E-05 | N/A | 7.1E-06 | 1.9E-05 | Liver, Whole body | N/A | N/A | N/A | 0.0E+00 |
| | | | Trichloroethene | 4.9E-07 | N/A | 8.1E-08 | 5.7E-07 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Vinyl chloride | 1.2E-04 | N/A | 8.9E-06 | 1.2E-04 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | cis-1,2-Dichloroethene | N/A | N/A | N/A | 0.0E+00 | Blood | N/A | N/A | N/A | 0.0E+00 |
| | | | Arsenic-dissolved | 1.1E-04 | N/A | 6.1E-07 | 1.1E-04 | Skin, Vascular | N/A | N/A | N/A | 0.0E+00 |
| | | | Chromium (hexavalent)-dissolved | N/A | N/A | N/A | 0.0E+00 | Not identified | N/A | N/A | N/A | 0.0E+00 |
| | | | Iron-dissolved | N/A | N/A | N/A | 0.0E+00 | Gastrointestinal | N/A | N/A | N/A | 0.0E+00 |
| | | | Manganese-dissolved | N/A | N/A | N/A | 0.0E+00 | CNS | N/A | N/A | N/A | 0.0E+00 |
| | | | Nickel-dissolved | N/A | N/A | N/A | 0.0E+00 | Decreased Body Weight | N/A | N/A | N/A | 0.0E+00 |
| | | | Thallium-dissolved | N/A | N/A | N/A | 0.0E+00 | Liver, Blood, Hair | N/A | N/A | N/A | 0.0E+00 |
| | | | Chemical Total | 3.9E-04 | 0.0E+00 | 3.1E-05 | 4.2E-04 | | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | | Exposure Point Total | | | | | 4.2E-04 | | | | | 0.0E+00 |
| | Exposure Medium Total | | | | | | 4.2E-04 | | | | | 0.0E+00 |

TABLE 9.3.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult/Child

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Air[1] | Alluvial Aquifer - Water Vapors at Showerhead | 1,1,2,2-Tetrachloroethane | N/A | 2.5E-06 | N/A | 2.5E-06 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,1,2-Trichloroethane | N/A | 1.1E-06 | N/A | 1.1E-06 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,2-Dibromo-3-chloropropane | N/A | 1.7E-04 | N/A | 1.7E-04 | Testis | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,2-Dichlorobenzene | N/A | N/A | N/A | 0.0E+00 | Decreased Weight Gain | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,2-Dichloropropane | N/A | N/A | N/A | 0.0E+00 | Nasal Mucosa | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,4-Dichlorobenzene | N/A | 2.6E-07 | N/A | 2.6E-07 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Benzene | N/A | 3.7E-07 | N/A | 3.7E-07 | Blood, Immune | N/A | N/A | N/A | 0.0E+00 |
| | | | Bromodichloromethane | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | Chlorobenzene | N/A | N/A | N/A | 0.0E+00 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Chloroform | N/A | 1.3E-06 | N/A | 1.3E-06 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Methylene chloride | N/A | 5.9E-08 | N/A | 5.9E-08 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Tetrachloroethene | N/A | 2.0E-07 | N/A | 2.0E-07 | Kidney, Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Trichloroethene | N/A | 1.5E-07 | N/A | 1.5E-07 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | Vinyl chloride | N/A | 3.1E-07 | N/A | 3.1E-07 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | cis-1,2-Dichloroethene | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | Chemical Total | 0.0E+00 | 1.8E-04 | 0.0E+00 | 1.8E-04 | | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | | Exposure Point Total | | | | | 1.8E-04 | | | | | 0.0E+00 |
| | Exposure Medium Total | | | | | | 1.8E-04 | | | | | 0.0E+00 |
| Medium Total | | | | | | | 6.0E-04 | | | | | 0.0E+00 |
| Receptor Total | | | | | | | 6.0E-04 | | | | Receptor HI Total | 0.0E+00 |

[1] Inhalation calculated for adult only.

HI - Hazard Index

CNS = Central Nervous System

TABLE 9.4.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Groundwater | Alluvial Aquifer - Water in Excavation pit | 1,1,2,2-Tetrachloroethane | N/A | N/A | 1.7E-08 | 1.7E-08 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,1,2-Trichloroethane | N/A | N/A | 4.5E-09 | 4.5E-09 | Blood | N/A | N/A | 1.4E-04 | 1.4E-04 |
| | | | 1,2-Dibromo-3-chloropropane | N/A | N/A | 3.4E-08 | 3.4E-08 | Testis | N/A | N/A | 1.5E-02 | 1.5E-02 |
| | | | 1,2-Dichlorobenzene | N/A | N/A | N/A | 0.0E+00 | NOAEL | N/A | N/A | 6.6E-03 | 6.6E-03 |
| | | | 1,2-Dichloropropane | N/A | N/A | 1.8E-09 | 1.8E-09 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,4-Dichlorobenzene | N/A | N/A | 6.3E-09 | 6.3E-09 | Liver, Developmental | N/A | N/A | 6.1E-04 | 6.1E-04 |
| | | | Benzene | N/A | N/A | 4.0E-09 | 4.0E-09 | Blood, Immune | N/A | N/A | 1.3E-03 | 1.3E-03 |
| | | | Bromodichloromethane | N/A | N/A | 6.7E-10 | 6.7E-10 | Kidney | N/A | N/A | 3.8E-05 | 3.8E-05 |
| | | | Chlorobenzene | N/A | N/A | N/A | 0.0E+00 | Liver | N/A | N/A | 1.2E-02 | 1.2E-02 |
| | | | Chloroform | N/A | N/A | N/A | 0.0E+00 | Liver | N/A | N/A | 3.7E-04 | 3.7E-04 |
| | | | Methylene chloride | N/A | N/A | 4.0E-10 | 4.0E-10 | Liver | N/A | N/A | 6.2E-05 | 6.2E-05 |
| | | | Tetrachloroethene | N/A | N/A | 9.6E-08 | 9.6E-08 | Liver, Whole body | N/A | N/A | 1.2E-04 | 1.2E-04 |
| | | | Trichloroethene | N/A | N/A | 1.3E-09 | 1.3E-09 | Liver | N/A | N/A | 1.4E-03 | 1.4E-03 |
| | | | Vinyl chloride | N/A | N/A | 2.6E-08 | 2.6E-08 | Liver | N/A | N/A | 8.5E-04 | 8.5E-04 |
| | | | cis-1,2-Dichloroethene | N/A | N/A | N/A | 0.0E+00 | Blood | N/A | N/A | 9.9E-05 | 9.9E-05 |
| | | | Aluminum | N/A | N/A | N/A | 0.0E+00 | Neurological | N/A | N/A | 1.9E-03 | 1.9E-03 |
| | | | Arsenic | N/A | N/A | 4.0E-08 | 4.0E-08 | Skin, Vascular | N/A | N/A | 6.3E-03 | 6.3E-03 |
| | | | Chromium | N/A | N/A | N/A | 0.0E+00 | Not identified | N/A | N/A | 9.8E-03 | 9.8E-03 |
| | | | Chromium (hexavalent) | N/A | N/A | N/A | 0.0E+00 | Not identified | N/A | N/A | 4.1E-02 | 4.1E-02 |
| | | | Iron | N/A | N/A | N/A | 0.0E+00 | Gastrointestinal | N/A | N/A | 7.4E-03 | 7.4E-03 |
| | | | Manganese | N/A | N/A | N/A | 0.0E+00 | CNS | N/A | N/A | 5.9E-01 | 5.9E-01 |
| | | | Nickel | N/A | N/A | N/A | 0.0E+00 | Decreased Body Weight | N/A | N/A | 5.3E-03 | 5.3E-03 |
| | | | Vanadium | N/A | N/A | N/A | 0.0E+00 | Lifetime | N/A | N/A | 1.7E-02 | 1.7E-02 |
| | | | Chemical Total | 0.0E+00 | 0.0E+00 | 2.3E-07 | 2.3E-07 | | 0.0E+00 | 0.0E+00 | 7.1E-01 | 7.1E-01 |
| | | Exposure Point Total | | | | | 2.3E-07 | | | | | 7.1E-01 |
| | Exposure Medium Total | | | | | | 2.3E-07 | | | | | 7.1E-01 |

TABLE 9.4.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Air | Alluvial Aquifer - Volatilization from Water in Excavation Pit | 1,1,2,2-Tetrachloroethane | N/A | 1.3E-09 | N/A | 1.3E-09 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,1,2-Trichloroethane | N/A | 8.5E-10 | N/A | 8.5E-10 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,2-Dibromo-3-chloropropane | N/A | 7.1E-08 | N/A | 7.1E-08 | Testis | N/A | 4.2E-03 | N/A | 4.2E-03 |
| | | | 1,2-Dichlorobenzene | N/A | N/A | N/A | 0.0E+00 | Decreased Weight Gain | N/A | 5.0E-05 | N/A | 5.0E-05 |
| | | | 1,2-Dichloropropane | N/A | N/A | N/A | 0.0E+00 | Nasal Mucosa | N/A | 1.4E-04 | N/A | 1.4E-04 |
| | | | 1,4-Dichlorobenzene | N/A | 3.0E-10 | N/A | 3.0E-10 | Liver | N/A | 1.3E-06 | N/A | 1.3E-06 |
| | | | Benzene | N/A | 4.5E-10 | N/A | 4.5E-10 | Blood, Immune | N/A | 6.9E-05 | N/A | 6.9E-05 |
| | | | Bromodichloromethane | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | Chlorobenzene | N/A | N/A | N/A | 0.0E+00 | Liver | N/A | 1.6E-03 | N/A | 1.6E-03 |
| | | | Chloroform | N/A | 1.6E-09 | N/A | 1.6E-09 | Liver | N/A | 9.8E-05 | N/A | 9.8E-05 |
| | | | Methylene chloride | N/A | 5.8E-11 | N/A | 5.8E-11 | Liver | N/A | 2.9E-06 | N/A | 2.9E-06 |
| | | | Tetrachloroethene | N/A | 3.3E-10 | N/A | 3.3E-10 | Kidney, Liver | N/A | 1.4E-05 | N/A | 1.4E-05 |
| | | | Trichloroethene | N/A | 2.3E-10 | N/A | 2.3E-10 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | Vinyl chloride | N/A | 4.3E-10 | N/A | 4.3E-10 | Liver | N/A | 7.0E-05 | N/A | 7.0E-05 |
| | | | cis-1,2-Dichloroethene | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | Chemical Total | 0.0E+00 | 7.7E-08 | 0.0E+00 | 7.7E-08 | | 0.0E+00 | 6.2E-03 | 0.0E+00 | 6.2E-03 |
| | | Exposure Point Total | | | | | 7.7E-08 | | | | | 6.2E-03 |
| | Exposure Medium Total | | | | | | 7.7E-08 | | | | | 6.2E-03 |
| Medium Total | | | | | | | 3.1E-07 | | | | | 7.2E-01 |
| Receptor Total | | | | | | | 3.1E-07 | | | | Receptor HI Total | 7.2E-01 |

HI - Hazard Index
CNS = Central Nervous System

| | |
|---|---|
| Total Blood HI Across All Media = | 1.6E-03 |
| Total Testis HI Across All Media = | 1.9E-02 |
| Total Liver HI Across All Media = | 1.7E-02 |
| Total Developmental HI Across All Media = | 6.1E-04 |
| Total Immune HI Across All Media = | 1.4E-03 |
| Total Kidney HI Across All Media = | 5.2E-05 |
| Total Whole Body HI Across All Media = | 1.2E-04 |
| Total Skin HI Across All Media = | 6.3E-03 |
| Total Vascular HI Across All Media = | 6.3E-03 |
| Total Gastrointestinal HI Across All Media = | 7.4E-03 |
| Total CNS HI Across All Media = | 5.9E-01 |
| Total Decreased Body Weight HI Across All Media = | 5.3E-03 |
| Total Nasal Mucosa HI Across All Media = | 1.4E-04 |
| Total Lifetime HI Across All Media = | 1.7E-02 |

TABLE 9.5.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Groundwater | Bedrock Aquifer - Tap Water | Methylene chloride | N/A | N/A | N/A | 0.0E+00 | Liver | 1.6E-01 | N/A | 6.2E-03 | 1.7E-01 |
| | | | Tetrachloroethene | N/A | N/A | N/A | 0.0E+00 | Liver, Whole body | 3.8E-03 | N/A | 2.3E-03 | 6.1E-03 |
| | | | Trichloroethene | N/A | N/A | N/A | 0.0E+00 | Liver | 9.0E-03 | N/A | 1.5E-03 | 1.1E-02 |
| | | | cis-1,2-Dichloroethene | N/A | N/A | N/A | 0.0E+00 | Blood | 6.0E-03 | N/A | 5.3E-04 | 6.5E-03 |
| | | | bis(2-Ethylhexyl)phthalate | N/A | N/A | N/A | 0.0E+00 | Liver | 5.1E-03 | N/A | 4.4E-01 | 4.5E-01 |
| | | | Aluminum | N/A | N/A | N/A | 0.0E+00 | Neurological | 1.7E-01 | N/A | 9.0E-04 | 1.7E-01 |
| | | | Antimony | N/A | N/A | N/A | 0.0E+00 | Blood | 2.3E-01 | N/A | 7.9E-03 | 2.3E-01 |
| | | | Arsenic | N/A | N/A | N/A | 0.0E+00 | Skin, Vascular | 4.5E-01 | N/A | 2.4E-03 | 4.5E-01 |
| | | | Chromium | N/A | N/A | N/A | 0.0E+00 | Not identified | 3.3E-01 | N/A | 1.4E-01 | 4.7E-01 |
| | | | Iron | N/A | N/A | N/A | 0.0E+00 | Gastrointestinal | 3.6E-01 | N/A | 1.9E-03 | 3.6E-01 |
| | | | Lead | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | Manganese | N/A | N/A | N/A | 0.0E+00 | CNS | 5.7E-01 | N/A | 7.5E-02 | 6.5E-01 |
| | | | Nickel | N/A | N/A | N/A | 0.0E+00 | Decreased Body Weight | 3.3E-02 | N/A | 8.5E-04 | 3.4E-02 |
| | | | Thallium | N/A | N/A | N/A | 0.0E+00 | Liver, Blood, Hair | 2.3E+00 | N/A | 1.2E-02 | 2.3E+00 |
| | | | Vanadium | N/A | N/A | N/A | 0.0E+00 | Kidney | 1.8E-01 | N/A | 3.6E-02 | 2.1E-01 |
| | | | Chemical Total | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | | 4.8E+00 | 0.0E+00 | 7.2E-01 | 5.6E+00 |
| | | Exposure Point Total | | | | | 0.0E+00 | | | | | 5.6E+00 |
| | Exposure Medium Total | | | | | | 0.0E+00 | | | | | 5.6E+00 |
| Groundwater | Air | Bedrock Aquifer - Water Vapors at Showerhead | Methylene chloride | N/A | 4.8E-06 | N/A | 4.8E-06 | Liver | N/A | 2.8E-02 | N/A | 2.8E-02 |
| | | | Tetrachloroethene | N/A | 1.8E-07 | N/A | 1.8E-07 | Kidney, Liver | N/A | 3.3E-04 | N/A | 3.3E-04 |
| | | | Trichloroethene | N/A | 8.6E-08 | N/A | 8.6E-08 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | cis-1,2-Dichloroethene | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | Chemical Total | 0.0E+00 | 5.1E-06 | 0.0E+00 | 5.1E-06 | | 0.0E+00 | 2.9E-02 | 0.0E+00 | 2.9E-02 |
| | | Exposure Point Total | | | | | 5.1E-06 | | | | | 2.9E-02 |
| | Exposure Medium Total | | | | | | 5.1E-06 | | | | | 2.9E-02 |
| Medium Total | | | | | | | 5.1E-06 | | | | | 5.6E+00 |
| Receptor Total | | | | | | | 5.1E-06 | | | | Receptor HI Total | 5.6E+00 |

HI - Hazard Index
CNS = Central Nervous System

| | |
|---|---|
| Total Blood HI Across All Media = | 2.6E+00 |
| Total Liver HI Across All Media = | 3.0E+00 |
| Total Kidney HI Across All Media = | 2.1E-01 |
| Total Whole Body HI Across All Media = | 6.1E-03 |
| Total Skin HI Across All Media = | 4.5E-01 |
| Total Vascular HI Across All Media = | 4.5E-01 |
| Total Gastrointestinal HI Across All Media = | 3.6E-01 |
| Total CNS HI Across All Media = | 8.2E-01 |
| Total Decreased Body Weight HI Across All Media = | 3.4E-02 |
| Total Hair HI Across All Media = | 2.3E+00 |

TABLE 9.6.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Groundwater | Bedrock Aquifer - Tap Water | | | | | | | | | | |
| | | | Methylene chloride | N/A | N/A | N/A | 0.0E+00 | Liver | 3.8E-01 | N/A | 1.4E-02 | 3.9E-01 |
| | | | Tetrachloroethene | N/A | N/A | N/A | 0.0E+00 | Liver, Whole body | 8.9E-03 | N/A | 5.2E-03 | 1.4E-02 |
| | | | Trichloroethene | N/A | N/A | N/A | 0.0E+00 | Liver | 2.1E-02 | N/A | 3.4E-03 | 2.5E-02 |
| | | | cis-1,2-Dichloroethene | N/A | N/A | N/A | 0.0E+00 | Blood | 1.4E-02 | N/A | 1.2E-03 | 1.5E-02 |
| | | | bis(2-Ethylhexyl)phthalate | N/A | N/A | N/A | 0.0E+00 | Liver | 1.2E-02 | N/A | 9.9E-01 | 1.0E+00 |
| | | | Aluminum | N/A | N/A | N/A | 0.0E+00 | Neurological | 4.0E-01 | N/A | 2.7E-03 | 4.1E-01 |
| | | | Antimony | N/A | N/A | N/A | 0.0E+00 | Blood | 5.3E-01 | N/A | 2.3E-02 | 5.5E-01 |
| | | | Arsenic | N/A | N/A | N/A | 0.0E+00 | Skin, Vascular | 1.1E+00 | N/A | 7.0E-03 | 1.1E+00 |
| | | | Chromium | N/A | N/A | N/A | 0.0E+00 | Not identified | 7.7E-01 | N/A | 4.0E-01 | 1.2E+00 |
| | | | Iron | N/A | N/A | N/A | 0.0E+00 | Gastrointestinal | 8.5E-01 | N/A | 5.6E-03 | 8.5E-01 |
| | | | Lead | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | Manganese | N/A | N/A | N/A | 0.0E+00 | CNS | 1.3E+00 | N/A | 2.2E-01 | 1.6E+00 |
| | | | Nickel | N/A | N/A | N/A | 0.0E+00 | Decreased Body Weight | 7.6E-02 | N/A | 2.5E-03 | 7.9E-02 |
| | | | Thallium | N/A | N/A | N/A | 0.0E+00 | Liver, Blood, Hair | 5.4E+00 | N/A | 3.6E-02 | 5.5E+00 |
| | | | Vanadium | N/A | N/A | N/A | 0.0E+00 | Kidney | 4.1E-01 | N/A | 1.1E-01 | 5.2E-01 |
| | | | Chemical Total | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | | 1.1E+01 | 0.0E+00 | 1.8E+00 | 1.3E+01 |
| | | Exposure Point Total | | | | | 0.0E+00 | | | | | 1.3E+01 |
| | Exposure Medium Total | | | | | | 0.0E+00 | | | | | 1.3E+01 |
| Medium Total | | | | | | | 0.0E+00 | | | | | 1.3E+01 |
| Receptor Total | | | | | | | 0.0E+00 | | | | Receptor HI Total | 1.3E+01 |

HI - Hazard Index
CNS = Central Nervous System

| | |
|---|---|
| Total Blood HI Across All Media = | 6.0E+00 |
| Total Liver HI Across All Media = | 6.9E+00 |
| Total Kidney HI Across All Media = | 5.2E-01 |
| Total Whole Body HI Across All Media = | 1.4E-02 |
| Total Skin HI Across All Media = | 1.1E+00 |
| Total Vascular HI Across All Media = | 1.1E+00 |
| Total Gastrointestinal HI Across All Media = | 8.5E-01 |
| Total CNS HI Across All Media = | 2.0E+00 |
| Total Decreased Body Weight HI Across All Media = | 7.9E-02 |
| Total Hair HI Across All Media = | 5.5E+00 |

TABLE 9.7.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult/Child

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Groundwater | Bedrock Aquifer - Tap Water | Methylene chloride | 4.0E-05 | N/A | 1.5E-06 | 4.1E-05 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Tetrachloroethene | 1.1E-05 | N/A | 6.7E-06 | 1.8E-05 | Liver, Whole body | N/A | N/A | N/A | 0.0E+00 |
| | | | Trichloroethene | 3.3E-07 | N/A | 5.4E-08 | 3.8E-07 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | cis-1,2-Dichloroethene | N/A | N/A | N/A | 0.0E+00 | Blood | N/A | N/A | N/A | 0.0E+00 |
| | | | bis(2-Ethylhexyl)phthalate | 7.7E-07 | N/A | 6.6E-05 | 6.7E-05 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Aluminum | N/A | N/A | N/A | 0.0E+00 | Neurological | N/A | N/A | N/A | 0.0E+00 |
| | | | Antimony | N/A | N/A | N/A | 0.0E+00 | Blood | N/A | N/A | N/A | 0.0E+00 |
| | | | Arsenic | 1.1E-04 | N/A | 6.3E-07 | 1.1E-04 | Skin, Vascular | N/A | N/A | N/A | 0.0E+00 |
| | | | Chromium | N/A | N/A | N/A | 0.0E+00 | Not identified | N/A | N/A | N/A | 0.0E+00 |
| | | | Iron | N/A | N/A | N/A | 0.0E+00 | Gastrointestinal | N/A | N/A | N/A | 0.0E+00 |
| | | | Lead | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | Manganese | N/A | N/A | N/A | 0.0E+00 | CNS | N/A | N/A | N/A | 0.0E+00 |
| | | | Nickel | N/A | N/A | N/A | 0.0E+00 | Decreased Body Weight | N/A | N/A | N/A | 0.0E+00 |
| | | | Thallium | N/A | N/A | N/A | 0.0E+00 | Liver, Blood, Hair | N/A | N/A | N/A | 0.0E+00 |
| | | | Vanadium | N/A | N/A | N/A | 0.0E+00 | Kidney | N/A | N/A | N/A | 0.0E+00 |
| | | | Chemical Total | 1.6E-04 | 0.0E+00 | 7.5E-05 | 2.4E-04 | | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | | Exposure Point Total | | | | | 2.4E-04 | | | | | 0.0E+00 |
| | Exposure Medium Total | | | | | | 2.4E-04 | | | | | 0.0E+00 |
| Groundwater | Air[1] | Bedrock Aquifer - Water Vapors at Showerhead | Methylene chloride | N/A | 4.8E-06 | N/A | 4.8E-06 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Tetrachloroethene | N/A | 1.8E-07 | N/A | 1.8E-07 | Kidney, Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Trichloroethene | N/A | 8.6E-08 | N/A | 8.6E-08 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | cis-1,2-Dichloroethene | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | Chemical Total | 0.0E+00 | 5.1E-06 | 0.0E+00 | 5.1E-06 | | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | | Exposure Point Total | | | | | 5.1E-06 | | | | | 0.0E+00 |
| | Exposure Medium Total | | | | | | 5.1E-06 | | | | | 0.0E+00 |
| Medium Total | | | | | | | 2.4E-04 | | | | | 0.0E+00 |
| Receptor Total | | | | | | | 2.4E-04 | | | | Receptor HI Total | 0.0E+00 |

[1] Inhalation calculated for adult only.
HI - Hazard Index
CNS = Central Nervous System

TABLE 9.1.CTE
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
CENTRAL TENDENCY EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Groundwater | Alluvial Aquifer - Tap Water | 1,1,2,2-Tetrachloroethane | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,1,2-Trichloroethane | N/A | N/A | N/A | 0.0E+00 | Blood | 4.9E-03 | N/A | 4.3E-04 | 5.3E-03 |
| | | | 1,2-Dibromo-3-chloropropane | N/A | N/A | N/A | 0.0E+00 | Testis | 7.6E-02 | N/A | 4.6E-03 | 8.1E-02 |
| | | | 1,2-Dichlorobenzene | N/A | N/A | N/A | 0.0E+00 | NOAEL | 1.2E-03 | N/A | 7.2E-04 | 1.9E-03 |
| | | | 1,2-Dichloropropane | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,4-Dichlorobenzene | N/A | N/A | N/A | 0.0E+00 | Liver, Developmental | 7.8E-04 | N/A | 4.9E-04 | 1.3E-03 |
| | | | Benzene | N/A | N/A | N/A | 0.0E+00 | Blood, Immune | 4.6E-03 | N/A | 6.6E-04 | 5.3E-03 |
| | | | Bromodichloromethane | N/A | N/A | N/A | 0.0E+00 | Kidney | 3.9E-04 | N/A | 3.0E-05 | 4.2E-04 |
| | | | Chlorobenzene | N/A | N/A | N/A | 0.0E+00 | Liver | 4.3E-03 | N/A | 1.4E-03 | 5.7E-03 |
| | | | Chloroform | N/A | N/A | N/A | 0.0E+00 | Liver | 2.2E-03 | N/A | 1.9E-04 | 2.4E-03 |
| | | | Methylene chloride | N/A | N/A | N/A | 0.0E+00 | Liver | 4.7E-04 | N/A | 1.7E-05 | 4.9E-04 |
| | | | Tetrachloroethene | N/A | N/A | N/A | 0.0E+00 | Liver, Whole body | 1.8E-03 | N/A | 1.0E-03 | 2.9E-03 |
| | | | Trichloroethene | N/A | N/A | N/A | 0.0E+00 | Liver | 4.1E-03 | N/A | 6.4E-04 | 4.7E-03 |
| | | | Vinyl chloride | N/A | N/A | N/A | 0.0E+00 | Liver | 4.7E-03 | N/A | 2.5E-04 | 5.0E-03 |
| | | | cis-1,2-Dichloroethene | N/A | N/A | N/A | 0.0E+00 | Blood | 4.2E-03 | N/A | 3.5E-04 | 4.6E-03 |
| | | | Arsenic-dissolved | N/A | N/A | N/A | 0.0E+00 | Skin, Vascular | 1.5E-01 | N/A | 4.9E-04 | 1.5E-01 |
| | | | Chromium (hexavalent)-dissolved | N/A | N/A | N/A | 0.0E+00 | Not identified | 2.0E-02 | N/A | 5.1E-03 | 2.5E-02 |
| | | | Iron-dissolved | N/A | N/A | N/A | 0.0E+00 | Gastrointestinal | 8.9E-02 | N/A | 2.9E-04 | 8.9E-02 |
| | | | Manganese-dissolved | N/A | N/A | N/A | 0.0E+00 | CNS | 5.8E-01 | N/A | 4.7E-02 | 6.3E-01 |
| | | | Nickel-dissolved | N/A | N/A | N/A | 0.0E+00 | Decreased Body Weight | 2.7E-02 | N/A | 4.3E-04 | 2.7E-02 |
| | | | Thallium-dissolved | N/A | N/A | N/A | 0.0E+00 | Liver, Blood, Hair | 9.9E-01 | N/A | 3.2E-03 | 1.0E+00 |
| | | | Chemical Total | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | | 2.0E+00 | 0.0E+00 | 6.7E-02 | 2.0E+00 |
| | | Exposure Point Total | | | | | 0.0E+00 | | | | | 2.0E+00 |
| | Exposure Medium Total | | | | | | 0.0E+00 | | | | | 2.0E+00 |

TABLE 9.1.CTE
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
CENTRAL TENDENCY EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Air | Alluvial Aquifer - Water Vapors at Showerhead | 1,1,2,2-Tetrachloroethane | N/A | 1.3E-07 | N/A | 1.3E-07 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,1,2-Trichloroethane | N/A | 5.4E-08 | N/A | 5.4E-08 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,2-Dibromo-3-chloropropane | N/A | 5.8E-06 | N/A | 5.8E-06 | Testis | N/A | 5.6E-02 | N/A | 5.6E-02 |
| | | | 1,2-Dichlorobenzene | N/A | N/A | N/A | 0.0E+00 | Decreased Weight Gain | N/A | 1.6E-03 | N/A | 1.6E-03 |
| | | | 1,2-Dichloropropane | N/A | N/A | N/A | 0.0E+00 | Nasal Mucosa | N/A | 6.9E-03 | N/A | 6.9E-03 |
| | | | 1,4-Dichlorobenzene | N/A | 2.8E-08 | N/A | 2.8E-08 | Liver | N/A | 6.4E-05 | N/A | 6.4E-05 |
| | | | Benzene | N/A | 3.8E-08 | N/A | 3.8E-08 | Blood, Immune | N/A | 1.9E-03 | N/A | 1.9E-03 |
| | | | Bromodichloromethane | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | Chlorobenzene | N/A | N/A | N/A | 0.0E+00 | Liver | N/A | 4.5E-03 | N/A | 4.5E-03 |
| | | | Chloroform | N/A | 1.1E-07 | N/A | 1.1E-07 | Liver | N/A | 1.1E-03 | N/A | 1.1E-03 |
| | | | Methylene chloride | N/A | 3.2E-09 | N/A | 3.2E-09 | Liver | N/A | 7.6E-05 | N/A | 7.6E-05 |
| | | | Tetrachloroethene | N/A | 2.0E-08 | N/A | 2.0E-08 | Kidney, Liver | N/A | 1.5E-04 | N/A | 1.5E-04 |
| | | | Trichloroethene | N/A | 9.1E-09 | N/A | 9.1E-09 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | Vinyl chloride | N/A | 1.9E-08 | N/A | 1.9E-08 | Liver | N/A | 5.1E-04 | N/A | 5.1E-04 |
| | | | cis-1,2-Dichloroethene | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | Chemical Total | 0.0E+00 | 6.2E-06 | 0.0E+00 | 6.2E-06 | | 0.0E+00 | 7.3E-02 | 0.0E+00 | 7.3E-02 |
| | | Exposure Point Total | | | | | 6.2E-06 | | | | | 7.3E-02 |
| | Exposure Medium Total | | | | | | 6.2E-06 | | | | | 7.3E-02 |
| Medium Total | | | | | | | 6.2E-06 | | | | | 2.1E+00 |
| Receptor Total | | | | | | | 6.2E-06 | | | | Receptor HI Total | 2.1E+00 |

HI - Hazard Index
CNS = Central Nervous System

| | |
|---|---|
| Total Blood HI Across All Media = | 1.0E+00 |
| Total Testis HI Across All Media = | 1.4E-01 |
| Total Liver HI Across All Media = | 1.0E+00 |
| Total Developmental HI Across All Media = | 1.3E-03 |
| Total Immune HI Across All Media = | 7.2E-03 |
| Total Kidney HI Across All Media = | 5.7E-04 |
| Total Whole Body HI Across All Media = | 2.9E-03 |
| Total Skin HI Across All Media = | 1.5E-01 |
| Total Vascular HI Across All Media = | 1.5E-01 |
| Total Gastrointestinal HI Across All Media = | 8.9E-02 |
| Total CNS HI Across All Media = | 6.3E-01 |
| Total Decreased Body Weight HI Across All Media = | 2.9E-02 |
| Total Hair HI Across All Media = | 1.0E+00 |
| Total Nasal Mucosa HI Across All Media = | 6.9E-03 |

TABLE 9.2.CTE
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
CENTRAL TENDENCY EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Groundwater | Alluvial Aquifer - Tap Water | 1,1,2,2-Tetrachloroethane | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,1,2-Trichloroethane | N/A | N/A | N/A | 0.0E+00 | Blood | 1.6E-02 | N/A | 1.3E-03 | 1.8E-02 |
| | | | 1,2-Dibromo-3-chloropropane | N/A | N/A | N/A | 0.0E+00 | Testis | 2.5E-01 | N/A | 1.4E-02 | 2.7E-01 |
| | | | 1,2-Dichlorobenzene | N/A | N/A | N/A | 0.0E+00 | NOAEL | 3.9E-03 | N/A | 2.1E-03 | 6.0E-03 |
| | | | 1,2-Dichloropropane | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,4-Dichlorobenzene | N/A | N/A | N/A | 0.0E+00 | Liver, Developmental | 2.6E-03 | N/A | 1.4E-03 | 4.0E-03 |
| | | | Benzene | N/A | N/A | N/A | 0.0E+00 | Blood, Immune | 1.5E-02 | N/A | 2.1E-03 | 1.8E-02 |
| | | | Bromodichloromethane | N/A | N/A | N/A | 0.0E+00 | Kidney | 1.3E-03 | N/A | 8.9E-05 | 1.4E-03 |
| | | | Chlorobenzene | N/A | N/A | N/A | 0.0E+00 | Liver | 1.4E-02 | N/A | 4.2E-03 | 1.8E-02 |
| | | | Chloroform | N/A | N/A | N/A | 0.0E+00 | Liver | 7.4E-03 | N/A | 5.6E-04 | 7.9E-03 |
| | | | Methylene chloride | N/A | N/A | N/A | 0.0E+00 | Liver | 1.6E-03 | N/A | 4.9E-05 | 1.6E-03 |
| | | | Tetrachloroethene | N/A | N/A | N/A | 0.0E+00 | Liver, Whole body | 6.1E-03 | N/A | 3.0E-03 | 9.1E-03 |
| | | | Trichloroethene | N/A | N/A | N/A | 0.0E+00 | Liver | 1.4E-02 | N/A | 1.9E-03 | 1.5E-02 |
| | | | Vinyl chloride | N/A | N/A | N/A | 0.0E+00 | Liver | 1.6E-02 | N/A | 6.7E-04 | 1.6E-02 |
| | | | cis-1,2-Dichloroethene | N/A | N/A | N/A | 0.0E+00 | Blood | 1.4E-02 | N/A | 1.0E-03 | 1.5E-02 |
| | | | Arsenic-dissolved | N/A | N/A | N/A | 0.0E+00 | Skin, Vascular | 5.1E-01 | N/A | 1.7E-03 | 5.1E-01 |
| | | | Chromium (hexavalent)-dissolved | N/A | N/A | N/A | 0.0E+00 | Not identified | 6.6E-02 | N/A | 1.7E-02 | 8.3E-02 |
| | | | Iron-dissolved | N/A | N/A | N/A | 0.0E+00 | Gastrointestinal | 3.0E-01 | N/A | 9.6E-04 | 3.0E-01 |
| | | | Manganese-dissolved | N/A | N/A | N/A | 0.0E+00 | CNS | 1.9E+00 | N/A | 1.6E-01 | 2.1E+00 |
| | | | Nickel-dissolved | N/A | N/A | N/A | 0.0E+00 | Decreased Body Weight | 9.0E-02 | N/A | 1.5E-03 | 9.2E-02 |
| | | | Thallium-dissolved | N/A | N/A | N/A | 0.0E+00 | Liver, Blood, Hair | 3.3E+00 | N/A | 1.1E-02 | 3.3E+00 |
| | | | Chemical Total | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | | 6.6E+00 | 0.0E+00 | 2.2E-01 | 6.8E+00 |
| | | Exposure Point Total | | | | | 0.0E+00 | | | | | 6.8E+00 |
| | Exposure Medium Total | | | | | | 0.0E+00 | | | | | 6.8E+00 |
| Medium Total | | | | | | | 0.0E+00 | | | | | 6.8E+00 |
| Receptor Total | | | | | | | 0.0E+00 | Receptor HI Total | | | | 6.8E+00 |

HI - Hazard Index
CNS = Central Nervous System

| | |
|---|---|
| Total Blood HI Across All Media = | 3.4E+00 |
| Total Testis HI Across All Media = | 2.7E-01 |
| Total Liver HI Across All Media = | 3.4E+00 |
| Total Developmental HI Across All Media = | 4.0E-03 |
| Total Immune HI Across All Media = | 1.8E-02 |
| Total Kidney HI Across All Media = | 1.4E-03 |
| Total Whole Body HI Across All Media = | 9.1E-03 |
| Total Skin HI Across All Media = | 5.1E-01 |
| Total Vascular HI Across All Media = | 5.1E-01 |
| Total Gastrointestinal HI Across All Media = | 3.0E-01 |
| Total CNS HI Across All Media = | 2.1E+00 |
| Total Decreased Body Weight HI Across All Media = | 9.2E-02 |
| Total Hair HI Across All Media = | 3.3E+00 |

TABLE 9.3.CTE

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

CENTRAL TENDENCY EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult/Child

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Groundwater | Alluvial Aquifer - Tap Water | 1,1,2,2-Tetrachloroethane | 1.6E-06 | N/A | 1.4E-07 | 1.8E-06 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,1,2-Trichloroethane | 4.6E-07 | N/A | 2.9E-08 | 4.9E-07 | Blood | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,2-Dibromo-3-chloropropane | 2.6E-05 | N/A | 1.7E-06 | 2.8E-05 | Testis | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,2-Dichlorobenzene | N/A | N/A | N/A | 0.0E+00 | NOAEL | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,2-Dichloropropane | 3.5E-07 | N/A | 2.3E-08 | 3.7E-07 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,4-Dichlorobenzene | 2.3E-07 | N/A | 1.0E-07 | 3.4E-07 | Liver, Developmental | N/A | N/A | N/A | 0.0E+00 |
| | | | Benzene | 4.2E-07 | N/A | 4.5E-08 | 4.7E-07 | Blood, Immune | N/A | N/A | N/A | 0.0E+00 |
| | | | Bromodichloromethane | 2.0E-07 | N/A | 1.1E-08 | 2.1E-07 | Kidney | N/A | N/A | N/A | 0.0E+00 |
| | | | Chlorobenzene | N/A | N/A | N/A | 0.0E+00 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Chloroform | N/A | N/A | N/A | 0.0E+00 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Methylene chloride | 8.8E-08 | N/A | 2.2E-09 | 9.0E-08 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Tetrachloroethene | 4.1E-06 | N/A | 1.7E-06 | 5.8E-06 | Liver, Whole body | N/A | N/A | N/A | 0.0E+00 |
| | | | Trichloroethene | 1.1E-07 | N/A | 1.3E-08 | 1.2E-07 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Vinyl chloride | 5.7E-05 | N/A | 1.7E-06 | 5.9E-05 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | cis-1,2-Dichloroethene | N/A | N/A | N/A | 0.0E+00 | Blood | N/A | N/A | N/A | 0.0E+00 |
| | | | Arsenic-dissolved | 2.8E-05 | N/A | 7.1E-08 | 2.8E-05 | Skin, Vascular | N/A | N/A | N/A | 0.0E+00 |
| | | | Chromium (hexavalent)-dissolved | N/A | N/A | N/A | 0.0E+00 | Not identified | N/A | N/A | N/A | 0.0E+00 |
| | | | Iron-dissolved | N/A | N/A | N/A | 0.0E+00 | Gastrointestinal | N/A | N/A | N/A | 0.0E+00 |
| | | | Manganese-dissolved | N/A | N/A | N/A | 0.0E+00 | CNS | N/A | N/A | N/A | 0.0E+00 |
| | | | Nickel-dissolved | N/A | N/A | N/A | 0.0E+00 | Decreased Body Weight | N/A | N/A | N/A | 0.0E+00 |
| | | | Thallium-dissolved | N/A | N/A | N/A | 0.0E+00 | Liver, Blood, Hair | N/A | N/A | N/A | 0.0E+00 |
| | | | Chemical Total | 1.2E-04 | 0.0E+00 | 5.5E-06 | 1.2E-04 | | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | | Exposure Point Total | | | | | 1.2E-04 | | | | | 0.0E+00 |
| | Exposure Medium Total | | | | | | 1.2E-04 | | | | | 0.0E+00 |

TABLE 9.3.CTE

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

CENTRAL TENDENCY EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult/Child

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Air[1] | Alluvial Aquifer - Water Vapors at Showerhead | 1,1,2,2-Tetrachloroethane | N/A | 1.3E-07 | N/A | 1.3E-07 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,1,2-Trichloroethane | N/A | 5.4E-08 | N/A | 5.4E-08 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,2-Dibromo-3-chloropropane | N/A | 5.8E-06 | N/A | 5.8E-06 | Testis | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,2-Dichlorobenzene | N/A | N/A | N/A | 0.0E+00 | Decreased Weight Gain | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,2-Dichloropropane | N/A | N/A | N/A | 0.0E+00 | Nasal Mucosa | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,4-Dichlorobenzene | N/A | 2.8E-08 | N/A | 2.8E-08 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Benzene | N/A | 3.8E-08 | N/A | 3.8E-08 | Blood, Immune | N/A | N/A | N/A | 0.0E+00 |
| | | | Bromodichloromethane | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | Chlorobenzene | N/A | N/A | N/A | 0.0E+00 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Chloroform | N/A | 1.1E-07 | N/A | 1.1E-07 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Methylene chloride | N/A | 3.2E-09 | N/A | 3.2E-09 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Tetrachloroethene | N/A | 2.0E-08 | N/A | 2.0E-08 | Kidney, Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Trichloroethene | N/A | 1.1E-08 | N/A | 1.1E-08 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | Vinyl chloride | N/A | 1.9E-08 | N/A | 1.9E-08 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | cis-1,2-Dichloroethene | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | Chemical Total | 0.0E+00 | 6.2E-06 | 0.0E+00 | 6.2E-06 | | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | | Exposure Point Total | | | | | 6.2E-06 | | | | | 0.0E+00 |
| | Exposure Medium Total | | | | | | 6.2E-06 | | | | | 0.0E+00 |
| Medium Total | | | | | | | 1.3E-04 | | | | | 0.0E+00 |
| Receptor Total | | | | | | | 1.3E-04 | | | | Receptor HI Total | 0.0E+00 |

[1] Inhalation calculated for adult only.

HI - Hazard Index

CNS = Central Nervous System

TABLE 9.4.CTE
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
CENTRAL TENDENCY EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Groundwater | Bedrock Aquifer - Tap Water | Methylene chloride | N/A | N/A | N/A | 0.0E+00 | Liver | 3.1E-02 | N/A | 1.1E-03 | 3.2E-02 |
| | | | Tetrachloroethene | N/A | N/A | N/A | 0.0E+00 | Liver, Whole body | 1.8E-03 | N/A | 1.0E-03 | 2.8E-03 |
| | | | Trichloroethene | N/A | N/A | N/A | 0.0E+00 | Liver | 3.0E-03 | N/A | 4.8E-04 | 3.5E-03 |
| | | | cis-1,2-Dichloroethene | N/A | N/A | N/A | 0.0E+00 | Blood | 2.1E-03 | N/A | 1.7E-04 | 2.3E-03 |
| | | | bis(2-Ethylhexyl)phthalate | N/A | N/A | N/A | 0.0E+00 | Liver | 1.4E-03 | N/A | 1.1E-01 | 1.1E-01 |
| | | | Aluminum | N/A | N/A | N/A | 0.0E+00 | Neurological | 2.1E-02 | N/A | 6.7E-05 | 2.1E-02 |
| | | | Antimony | N/A | N/A | N/A | 0.0E+00 | Blood | 1.1E-01 | N/A | 2.3E-03 | 1.1E-01 |
| | | | Arsenic | N/A | N/A | N/A | 0.0E+00 | Skin, Vascular | 1.7E-01 | N/A | 5.6E-04 | 1.8E-01 |
| | | | Chromium | N/A | N/A | N/A | 0.0E+00 | Not identified | 7.0E-02 | N/A | 1.8E-02 | 8.8E-02 |
| | | | Iron | N/A | N/A | N/A | 0.0E+00 | Gastrointestinal | 5.5E-02 | N/A | 1.8E-04 | 5.5E-02 |
| | | | Lead | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | Manganese | N/A | N/A | N/A | 0.0E+00 | CNS | 8.5E-02 | N/A | 6.8E-03 | 9.2E-02 |
| | | | Nickel | N/A | N/A | N/A | 0.0E+00 | Decreased Body Weight | 8.2E-03 | N/A | 1.3E-04 | 8.3E-03 |
| | | | Thallium | N/A | N/A | N/A | 0.0E+00 | Liver, Blood, Hair | 1.1E+00 | N/A | 3.5E-03 | 1.1E+00 |
| | | | Vanadium | N/A | N/A | N/A | 0.0E+00 | Kidney | 4.7E-02 | N/A | 5.9E-03 | 5.3E-02 |
| | | | Chemical Total | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | | 1.7E+00 | 0.0E+00 | 1.5E-01 | 1.8E+00 |
| | | Exposure Point Total | | | | | 0.0E+00 | | | | | 1.8E+00 |
| | Exposure Medium Total | | | | | | 0.0E+00 | | | | | 1.8E+00 |
| Groundwater | Air | Bedrock Aquifer - Water Vapors at Showerhead | Methylene chloride | N/A | 2.1E-07 | N/A | 2.1E-07 | Liver | N/A | 3.3E-03 | N/A | 3.3E-03 |
| | | | Tetrachloroethene | N/A | 2.0E-08 | N/A | 2.0E-08 | Kidney, Liver | N/A | 9.6E-05 | N/A | 9.6E-05 |
| | | | Trichloroethene | N/A | 6.7E-09 | N/A | 6.7E-09 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | cis-1,2-Dichloroethene | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | Chemical Total | 0.0E+00 | 2.4E-07 | 0.0E+00 | 2.4E-07 | | 0.0E+00 | 3.4E-03 | 0.0E+00 | 3.4E-03 |
| | | Exposure Point Total | | | | | 2.4E-07 | | | | | 3.4E-03 |
| | Exposure Medium Total | | | | | | 2.4E-07 | | | | | 3.4E-03 |
| Medium Total | | | | | | | 2.4E-07 | | | | | 1.8E+00 |
| Receptor Total | | | | | | | 2.4E-07 | | | | Receptor HI Total | 1.8E+00 |

HI - Hazard Index
CNS = Central Nervous System

| | |
|---|---|
| Total Blood HI Across All Media = | 1.2E+00 |
| Total Liver HI Across All Media = | 1.2E+00 |
| Total Kidney HI Across All Media = | 5.3E-02 |
| Total Whole Body HI Across All Media = | 2.8E-03 |
| Total Skin HI Across All Media = | 1.8E-01 |
| Total Vascular HI Across All Media = | 1.8E-01 |
| Total Gastrointestinal HI Across All Media = | 5.5E-02 |
| Total CNS HI Across All Media = | 1.1E-01 |
| Total Decreased Body Weight HI Across All Media = | 8.3E-03 |
| Total Hair HI Across All Media = | 1.1E+00 |

TABLE 9.5.CTE
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
CENTRAL TENDENCY EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Groundwater | Bedrock Aquifer - Tap Water | Methylene chloride | N/A | N/A | N/A | 0.0E+00 | Liver | 1.0E-01 | N/A | 2.1E-03 | 1.0E-01 |
| | | | Tetrachloroethene | N/A | N/A | N/A | 0.0E+00 | Liver, Whole body | 6.0E-03 | N/A | 2.0E-03 | 8.0E-03 |
| | | | Trichloroethene | N/A | N/A | N/A | 0.0E+00 | Liver | 1.0E-02 | N/A | 9.4E-04 | 1.1E-02 |
| | | | cis-1,2-Dichloroethene | N/A | N/A | N/A | 0.0E+00 | Blood | 7.1E-03 | N/A | 3.4E-04 | 7.4E-03 |
| | | | bis(2-Ethylhexyl)phthalate | N/A | N/A | N/A | 0.0E+00 | Liver | 4.5E-03 | N/A | 2.2E-01 | 2.2E-01 |
| | | | Aluminum | N/A | N/A | N/A | 0.0E+00 | Neurological | 6.9E-02 | N/A | 1.5E-04 | 7.0E-02 |
| | | | Antimony | N/A | N/A | N/A | 0.0E+00 | Blood | 3.5E-01 | N/A | 5.1E-03 | 3.6E-01 |
| | | | Arsenic | N/A | N/A | N/A | 0.0E+00 | Skin, Vascular | 5.8E-01 | N/A | 1.3E-03 | 5.8E-01 |
| | | | Chromium | N/A | N/A | N/A | 0.0E+00 | Not identified | 2.3E-01 | N/A | 4.1E-02 | 2.7E-01 |
| | | | Iron | N/A | N/A | N/A | 0.0E+00 | Gastrointestinal | 1.8E-01 | N/A | 4.0E-04 | 1.8E-01 |
| | | | Lead | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | Manganese | N/A | N/A | N/A | 0.0E+00 | CNS | 2.8E-01 | N/A | 1.5E-02 | 3.0E-01 |
| | | | Nickel | N/A | N/A | N/A | 0.0E+00 | Decreased Body Weight | 2.7E-02 | N/A | 3.0E-04 | 2.7E-02 |
| | | | Thallium | N/A | N/A | N/A | 0.0E+00 | Liver, Blood, Hair | 3.6E+00 | N/A | 7.8E-03 | 3.6E+00 |
| | | | Vanadium | N/A | N/A | N/A | 0.0E+00 | Kidney | 1.6E-01 | N/A | 1.3E-02 | 1.7E-01 |
| | | | Chemical Total | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | | 5.6E+00 | 0.0E+00 | 3.1E-01 | 5.9E+00 |
| | | Exposure Point Total | | | | | 0.0E+00 | | | | | 5.9E+00 |
| | Exposure Medium Total | | | | | | 0.0E+00 | | | | | 5.9E+00 |
| Medium Total | | | | | | | 0.0E+00 | | | | | 5.9E+00 |
| Receptor Total | | | | | | | 0.0E+00 | | | | Receptor HI Total | 5.9E+00 |

HI - Hazard Index
CNS = Central Nervous System

| | |
|---|---|
| Total Blood HI Across All Media = | 4.0E+00 |
| Total Liver HI Across All Media = | 3.9E+00 |
| Total Kidney HI Across All Media = | 1.7E-01 |
| Total Whole Body HI Across All Media = | 8.0E-03 |
| Total Skin HI Across All Media = | 5.8E-01 |
| Total Vascular HI Across All Media = | 5.8E-01 |
| Total Gastrointestinal HI Across All Media = | 1.8E-01 |
| Total CNS HI Across All Media = | 3.7E-01 |
| Total Decreased Body Weight HI Across All Media = | 2.7E-02 |
| Total Hair HI Across All Media = | 3.6E+00 |

TABLE 9.6.CTE
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
CENTRAL TENDENCY EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult/Child

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Groundwater | Bedrock Aquifer - Tap Water | Methylene chloride | 5.7E-06 | N/A | 5.2E-09 | 5.7E-06 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Tetrachloroethene | 4.0E-06 | N/A | 2.8E-07 | 4.3E-06 | Liver, Whole body | N/A | N/A | N/A | 0.0E+00 |
| | | | Trichloroethene | 8.3E-08 | N/A | 3.0E-09 | 8.6E-08 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | cis-1,2-Dichloroethene | N/A | N/A | N/A | 0.0E+00 | Blood | N/A | N/A | N/A | 0.0E+00 |
| | | | bis(2-Ethylhexyl)phthalate | 1.6E-07 | N/A | 4.8E-09 | 1.6E-07 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Aluminum | N/A | N/A | N/A | 0.0E+00 | Neurological | N/A | N/A | N/A | 0.0E+00 |
| | | | Antimony | N/A | N/A | N/A | 0.0E+00 | Blood | N/A | N/A | N/A | 0.0E+00 |
| | | | Arsenic | 3.3E-05 | N/A | 2.7E-07 | 3.3E-05 | Skin, Vascular | N/A | N/A | N/A | 0.0E+00 |
| | | | Chromium | N/A | N/A | N/A | 0.0E+00 | Not identified | N/A | N/A | N/A | 0.0E+00 |
| | | | Iron | N/A | N/A | N/A | 0.0E+00 | Gastrointestinal | N/A | N/A | N/A | 0.0E+00 |
| | | | Lead | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | Manganese | N/A | N/A | N/A | 0.0E+00 | CNS | N/A | N/A | N/A | 0.0E+00 |
| | | | Nickel | N/A | N/A | N/A | 0.0E+00 | Decreased Body Weight | N/A | N/A | N/A | 0.0E+00 |
| | | | Thallium | N/A | N/A | N/A | 0.0E+00 | Liver, Blood, Hair | N/A | N/A | N/A | 0.0E+00 |
| | | | Vanadium | N/A | N/A | N/A | 0.0E+00 | Kidney | N/A | N/A | N/A | 0.0E+00 |
| | | | Chemical Total | 4.3E-05 | 0.0E+00 | 5.6E-07 | 4.3E-05 | | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | | Exposure Point Total | | | | | 4.3E-05 | | | | | 0.0E+00 |
| | Exposure Medium Total | | | | | | 4.3E-05 | | | | | 0.0E+00 |
| Groundwater | Air | Bedrock Aquifer - Water Vapors at Showerhead | Methylene chloride | N/A | 2.1E-07 | N/A | 2.1E-07 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Tetrachloroethene | N/A | 2.0E-08 | N/A | 2.0E-08 | Kidney, Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Trichloroethene | N/A | 6.7E-09 | N/A | 6.7E-09 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | cis-1,2-Dichloroethene | N/A | N/A | N/A | 0.0E+00 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | Chemical Total | 0.0E+00 | 2.4E-07 | 0.0E+00 | 2.4E-07 | | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | | Exposure Point Total | | | | | 2.4E-07 | | | | | 0.0E+00 |
| | Exposure Medium Total | | | | | | 2.4E-07 | | | | | 0.0E+00 |
| Medium Total | | | | | | | 4.3E-05 | | | | | 0.0E+00 |
| Receptor Total | | | | | | | 4.3E-05 | | | | Receptor HI Total | 0.0E+00 |

[1] Inhalation calculated for adult only.
HI - Hazard Index
CNS = Central Nervous System

TABLE 10.1.RME

RISK SUMMARY

REASONABLE MAXIMUM EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Groundwater | Alluvial Aquifer - Tap Water | | | | | | | | | | |
| | | | 1,2-Dibromo-3-chloropropane | N/A | N/A | N/A | 0.0E+00 | Testis | 5.2E-01 | N/A | 3.4E-02 | 5.5E-01 |
| | | | Arsenic-dissolved | N/A | N/A | N/A | 0.0E+00 | Skin, Vascular | 4.4E-01 | N/A | 2.3E-03 | 4.4E-01 |
| | | | Iron-dissolved | N/A | N/A | N/A | 0.0E+00 | Gastrointestinal | 3.7E-01 | N/A | 1.9E-03 | 3.7E-01 |
| | | | Manganese-dissolved | N/A | N/A | N/A | 0.0E+00 | CNS | 3.5E+00 | N/A | 4.5E-01 | 3.9E+00 |
| | | | Nickel-dissolved | N/A | N/A | N/A | 0.0E+00 | Decreased Body Weight | 2.3E-01 | N/A | 6.0E-03 | 2.4E-01 |
| | | | Thallium-dissolved | N/A | N/A | N/A | 0.0E+00 | Liver, Blood, Hair | 2.4E+00 | N/A | 1.3E-02 | 2.4E+00 |
| | | | Chemical Total | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | | 7.4E+00 | 0.0E+00 | 5.1E-01 | 7.9E+00 |
| | | Exposure Point Total | | | | | 0.0E+00 | | | | | 7.9E+00 |
| | Exposure Medium Total | | | | | | 0.0E+00 | | | | | 7.9E+00 |
| Groundwater | Air | Alluvial Aquifer - Water Vapors at Showerhead | 1,1,2,2-Tetrachloroethane | N/A | 2.5E-06 | N/A | 2.5E-06 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,1,2-Trichloroethane | N/A | 1.1E-06 | N/A | 1.1E-06 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,2-Dibromo-3-chloropropane | N/A | 1.7E-04 | N/A | 1.7E-04 | Testis | N/A | 4.2E-01 | N/A | 4.2E-01 |
| | | | Chloroform | N/A | 1.3E-06 | N/A | 1.3E-06 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Chemical Total | 0.0E+00 | 1.8E-04 | 0.0E+00 | 1.8E-04 | | 0.0E+00 | 4.2E-01 | 0.0E+00 | 4.2E-01 |
| | | Exposure Point Total | | | | | 1.8E-04 | | | | | 4.2E-01 |
| | Exposure Medium Total | | | | | | 1.8E-04 | | | | | 4.2E-01 |
| Medium Total | | | | | | | 1.8E-04 | | | | | 8.4E+00 |
| Receptor Total | | | | | | | 1.8E-04 | | | | Receptor HI Total | 8.4E+00 |

HI - Hazard Index

CNS = Central Nervous System

| | |
|---|---|
| Total Blood HI Across All Media = | 2.4E+00 |
| Total Testis HI Across All Media = | 9.7E-01 |
| Total Liver HI Across All Media = | 2.4E+00 |
| Total Skin HI Across All Media = | 4.4E-01 |
| Total Vascular HI Across All Media = | 4.4E-01 |
| Total CNS HI Across All Media = | 3.9E+00 |
| Total Hair HI Across All Media = | 2.4E+00 |
| Total Gastrointestinal HI Across All Media = | 3.7E-01 |
| Total Decreased Body Weight HI Across All Media = | 2.4E-01 |

TABLE 10.2.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Groundwater | Alluvial Aquifer - Tap Water | | | | | | | | | | |
| | | | 1,2-Dibromo-3-chloropropane | N/A | N/A | N/A | 0.0E+00 | Testis | 1.2E+00 | N/A | 7.6E-02 | 1.3E+00 |
| | | | Chlorobenzene | N/A | N/A | N/A | 0.0E+00 | Liver | 1.1E-01 | N/A | 4.0E-02 | 1.5E-01 |
| | | | Arsenic-dissolved | N/A | N/A | N/A | 0.0E+00 | Skin, Vascular | 1.0E+00 | N/A | 6.8E-03 | 1.0E+00 |
| | | | Chromium (hexavalent)-dissolved | N/A | N/A | N/A | 0.0E+00 | Not identified | 1.4E-01 | N/A | 7.1E-02 | 2.1E-01 |
| | | | Iron-dissolved | N/A | N/A | N/A | 0.0E+00 | Gastrointestinal | 8.6E-01 | N/A | 5.6E-03 | 8.6E-01 |
| | | | Manganese-dissolved | N/A | N/A | N/A | 0.0E+00 | CNS | 8.1E+00 | N/A | 1.3E+00 | 9.4E+00 |
| | | | Nickel-dissolved | N/A | N/A | N/A | 0.0E+00 | Decreased Body Weight | 5.4E-01 | N/A | 1.8E-02 | 5.6E-01 |
| | | | Thallium-dissolved | N/A | N/A | N/A | 0.0E+00 | Liver, Blood, Hair | 5.7E+00 | N/A | 3.7E-02 | 5.7E+00 |
| | | | Chemical Total | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | | 1.8E+01 | 0.0E+00 | 1.6E+00 | 1.9E+01 |
| | | Exposure Point Total | | | | | 0.0E+00 | | | | | 1.9E+01 |
| | Exposure Medium Total | | | | | | 0.0E+00 | | | | | 1.9E+01 |
| Medium Total | | | | | | | 0.0E+00 | | | | | 1.9E+01 |
| Receptor Total | | | | | | | 0.0E+00 | | | | Receptor HI Total | 1.9E+01 |

HI - Hazard Index
CNS = Central Nervous System

| | |
|---|---|
| Total Blood HI Across All Media = | 5.7E+00 |
| Total Testis HI Across All Media = | 1.3E+00 |
| Total Liver HI Across All Media = | 5.9E+00 |
| Total Skin HI Across All Media = | 1.0E+00 |
| Total Vascular HI Across All Media = | 1.0E+00 |
| Total Gastrointestinal HI Across All Media = | 8.6E-01 |
| Total CNS HI Across All Media = | 9.4E+00 |
| Total Decreased Body Weight HI Across All Media = | 5.6E-01 |
| Total Hair HI Across All Media = | 5.7E+00 |

TABLE 10.3.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult/Child

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Groundwater | Alluvial Aquifer - Tap Water | 1,1,2,2-Tetrachloroethane | 9.6E-06 | N/A | 1.2E-06 | 1.1E-05 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,1,2-Trichloroethane | 2.9E-06 | N/A | 2.7E-07 | 3.2E-06 | Blood | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,2-Dibromo-3-chloropropane | 1.4E-04 | N/A | 1.2E-05 | 1.5E-04 | Testis | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,2-Dichloropropane | 9.7E-07 | N/A | 9.5E-08 | 1.1E-06 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,4-Dichlorobenzene | 6.7E-07 | N/A | 4.4E-07 | 1.1E-06 | Liver, Developmental | N/A | N/A | N/A | 0.0E+00 |
| | | | Benzene | 1.2E-06 | N/A | 1.9E-07 | 1.4E-06 | Blood, Immune | N/A | N/A | N/A | 0.0E+00 |
| | | | Tetrachloroethene | 1.2E-05 | N/A | 7.1E-06 | 1.9E-05 | Liver, Whole body | N/A | N/A | N/A | 0.0E+00 |
| | | | Vinyl chloride | 1.2E-04 | N/A | 8.9E-06 | 1.2E-04 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Arsenic | 1.1E-04 | N/A | 6.1E-07 | 1.1E-04 | Skin, Vascular | N/A | N/A | N/A | 0.0E+00 |
| | | | Chemical Total | 3.9E-04 | 0.0E+00 | 3.0E-05 | 4.2E-04 | | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | | Exposure Point Total | | | | | 4.2E-04 | | | | | 0.0E+00 |
| | Exposure Medium Total | | | | | | 4.2E-04 | | | | | 0.0E+00 |
| Groundwater | Air[1] | Alluvial Aquifer - Water Vapors at Showerhead | 1,1,2,2-Tetrachloroethane | N/A | 2.5E-06 | N/A | 2.5E-06 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,1,2-Trichloroethane | N/A | 1.1E-06 | N/A | 1.1E-06 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,2-Dibromo-3-chloropropane | N/A | 1.7E-04 | N/A | 1.7E-04 | Testis | N/A | N/A | N/A | 0.0E+00 |
| | | | Chloroform | N/A | 1.3E-06 | N/A | 1.3E-06 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Chemical Total | 0.0E+00 | 1.8E-04 | 0.0E+00 | 1.8E-04 | | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | | Exposure Point Total | | | | | 1.8E-04 | | | | | 0.0E+00 |
| | Exposure Medium Total | | | | | | 1.8E-04 | | | | | 0.0E+00 |
| Medium Total | | | | | | | 6.0E-04 | | | | | 0.0E+00 |
| Receptor Total | | | | | | | 6.0E-04 | | | | Receptor HI Total | 0.0E+00 |

[1] Inhalation calculated for adult only.

HI - Hazard Index

CNS = Central Nervous System

TABLE 10.4.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Groundwater | Bedrock Aquifer - Tap Water | Methylene chloride | N/A | N/A | N/A | 0.0E+00 | Liver | 1.6E-01 | N/A | 6.2E-03 | 1.7E-01 |
| | | | bis(2-Ethylhexyl)phthalate | N/A | N/A | N/A | 0.0E+00 | Liver | 5.1E-03 | N/A | 4.4E-01 | 4.5E-01 |
| | | | Aluminum | N/A | N/A | N/A | 0.0E+00 | Neurological | 1.7E-01 | N/A | 9.0E-04 | 1.7E-01 |
| | | | Antimony | N/A | N/A | N/A | 0.0E+00 | Blood | 2.3E-01 | N/A | 7.9E-03 | 2.3E-01 |
| | | | Arsenic | N/A | N/A | N/A | 0.0E+00 | Skin, Vascular | 4.5E-01 | N/A | 2.4E-03 | 4.5E-01 |
| | | | Chromium | N/A | N/A | N/A | 0.0E+00 | Not identified | 3.3E-01 | N/A | 1.4E-01 | 4.7E-01 |
| | | | Iron | N/A | N/A | N/A | 0.0E+00 | Gastrointestinal | 3.6E-01 | N/A | 1.9E-03 | 3.6E-01 |
| | | | Manganese | N/A | N/A | N/A | 0.0E+00 | CNS | 5.7E-01 | N/A | 7.5E-02 | 6.5E-01 |
| | | | Thallium | N/A | N/A | N/A | 0.0E+00 | Liver, Blood, Hair | 2.3E+00 | N/A | 1.2E-02 | 2.3E+00 |
| | | | Vanadium | N/A | N/A | N/A | 0.0E+00 | Kidney | 1.8E-01 | N/A | 3.6E-02 | 2.1E-01 |
| | | | Chemical Total | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | | 4.8E+00 | 0.0E+00 | 7.2E-01 | 5.5E+00 |
| | | Exposure Point Total | | | | | 0.0E+00 | | | | | 5.5E+00 |
| | Exposure Medium Total | | | | | | 0.0E+00 | | | | | 5.5E+00 |
| Groundwater | Air | Bedrock Aquifer - Water Vapors at Showerhead | Methylene chloride | N/A | 4.8E-06 | N/A | 4.8E-06 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Chemical Total | 0.0E+00 | 4.8E-06 | 0.0E+00 | 4.8E-06 | | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | | Exposure Point Total | | | | | 4.8E-06 | | | | | 0.0E+00 |
| | Exposure Medium Total | | | | | | 4.8E-06 | | | | | 0.0E+00 |
| Medium Total | | | | | | | 4.8E-06 | | | | | 5.5E+00 |
| Receptor Total | | | | | | | 4.8E-06 | | | | Receptor HI Total | 5.5E+00 |

HI - Hazard Index
CNS = Central Nervous System

| | |
|---|---|
| Total Blood HI Across All Media = | 2.6E+00 |
| Total Liver HI Across All Media = | 3.0E+00 |
| Total Kidney HI Across All Media = | 2.1E-01 |
| Total Skin HI Across All Media = | 4.5E-01 |
| Total Vascular HI Across All Media = | 4.5E-01 |
| Total CNS, Neurological HI Across All Media = | 8.2E-01 |
| Total Hair HI Across All Media = | 2.3E+00 |
| Total Gastrointestinal HI Across All Media = | 3.6E-01 |

TABLE 10.5.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Groundwater | Bedrock Aquifer - Tap Water | Methylene chloride | N/A | N/A | N/A | 0.0E+00 | Liver | 3.8E-01 | N/A | 1.4E-02 | 3.9E-01 |
| | | | bis(2-Ethylhexyl)phthalate | N/A | N/A | N/A | 0.0E+00 | Liver | 1.2E-02 | N/A | 9.9E-01 | 1.0E+00 |
| | | | Aluminum | N/A | N/A | N/A | 0.0E+00 | Neurological | 4.0E-01 | N/A | 2.7E-03 | 4.1E-01 |
| | | | Antimony | N/A | N/A | N/A | 0.0E+00 | Blood | 5.3E-01 | N/A | 2.3E-02 | 5.5E-01 |
| | | | Arsenic | N/A | N/A | N/A | 0.0E+00 | Skin, Vascular | 1.1E+00 | N/A | 7.0E-03 | 1.1E+00 |
| | | | Chromium | N/A | N/A | N/A | 0.0E+00 | Not identified | 7.7E-01 | N/A | 4.0E-01 | 1.2E+00 |
| | | | Iron | N/A | N/A | N/A | 0.0E+00 | Gastrointestinal | 8.5E-01 | N/A | 5.6E-03 | 8.5E-01 |
| | | | Manganese | N/A | N/A | N/A | 0.0E+00 | CNS | 1.3E+00 | N/A | 2.2E-01 | 1.6E+00 |
| | | | Thallium | N/A | N/A | N/A | 0.0E+00 | Liver, Blood, Hair | 5.4E+00 | N/A | 3.6E-02 | 5.5E+00 |
| | | | Vanadium | N/A | N/A | N/A | 0.0E+00 | Kidney | 4.1E-01 | N/A | 1.1E-01 | 5.2E-01 |
| | | | Chemical Total | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | | 1.1E+01 | 0.0E+00 | 1.8E+00 | 1.3E+01 |
| | | Exposure Point Total | | | | | 0.0E+00 | | | | | 1.3E+01 |
| | Exposure Medium Total | | | | | | 0.0E+00 | | | | | 1.3E+01 |
| Medium Total | | | | | | | 0.0E+00 | | | | | 1.3E+01 |
| Receptor Total | | | | | | | 0.0E+00 | | | | Receptor HI Total | 1.3E+01 |

HI - Hazard Index
CNS = Central Nervous System

| | |
|---|---|
| Total Blood HI Across All Media = | 6.0E+00 |
| Total Liver HI Across All Media = | 6.9E+00 |
| Total Kidney HI Across All Media = | 5.2E-01 |
| Total Skin HI Across All Media = | 1.1E+00 |
| Total Vascular HI Across All Media = | 1.1E+00 |
| Total Gastrointestinal HI Across All Media = | 8.5E-01 |
| Total CNS HI Across All Media = | 2.0E+00 |
| Total Hair HI Across All Media = | 5.5E+00 |

TABLE 10.6.RME

RISK SUMMARY

REASONABLE MAXIMUM EXPOSURE

Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult/Child

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Groundwater | Bedrock Aquifer - Tap Water | Methylene chloride | 4.0E-05 | N/A | 1.5E-06 | 4.1E-05 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Tetrachloroethene | 1.1E-05 | N/A | 6.7E-06 | 1.8E-05 | Liver, Whole body | N/A | N/A | N/A | 0.0E+00 |
| | | | bis(2-Ethylhexyl)phthalate | 7.7E-07 | N/A | 6.6E-05 | 6.7E-05 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Arsenic | 1.1E-04 | N/A | 6.3E-07 | 1.1E-04 | Skin, Vascular | N/A | N/A | N/A | 0.0E+00 |
| | | | Chemical Total | 1.6E-04 | 0.0E+00 | 7.5E-05 | 2.4E-04 | | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | | Exposure Point Total | | | | | 2.4E-04 | | | | | 0.0E+00 |
| | Exposure Medium Total | | | | | | 2.4E-04 | | | | | 0.0E+00 |
| Medium Total | | | | | | | 2.4E-04 | | | | | 0.0E+00 |
| Receptor Total | | | | | | | 2.4E-04 | Receptor HI Total | | | | 0.0E+00 |

HI - Hazard Index

CNS = Central Nervous System

TABLE 10.1.CTE
RISK SUMMARY
CENTRAL TENDENCY EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Groundwater | Alluvial Aquifer - Tap Water | | | | | | | | | | |
| | | | Arsenic-dissolved | N/A | N/A | N/A | 0.0E+00 | Skin, Vascular | 1.5E-01 | N/A | 4.9E-04 | 1.5E-01 |
| | | | Manganese-dissolved | N/A | N/A | N/A | 0.0E+00 | CNS | 5.8E-01 | N/A | 4.7E-02 | 6.3E-01 |
| | | | Thallium-dissolved | N/A | N/A | N/A | 0.0E+00 | Liver, Blood, Hair | 9.9E-01 | N/A | 3.2E-03 | 1.0E+00 |
| | | | Chemical Total | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | | 1.7E+00 | 0.0E+00 | 5.0E-02 | 1.8E+00 |
| | | Exposure Point Total | | | | | 0.0E+00 | | | | | 1.8E+00 |
| | Exposure Medium Total | | | | | | 0.0E+00 | | | | | 1.8E+00 |
| Medium Total | | | | | | | 0.0E+00 | | | | | 1.8E+00 |
| Receptor Total | | | | | | | 0.0E+00 | | | | Receptor HI Total | 1.8E+00 |

HI - Hazard Index
CNS = Central Nervous System

| | |
|---|---|
| Total Blood HI Across All Media = | 1.0E+00 |
| Total Liver HI Across All Media = | 1.0E+00 |
| Total CNS HI Across All Media = | 6.3E-01 |
| Total Hair HI Across All Media = | 1.0E+00 |
| Total Skin HI Across All Media = | 1.5E-01 |
| Total Vascular HI Across All Media = | 1.5E-01 |

TABLE 10.2.CTE
RISK SUMMARY
CENTRAL TENDENCY EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Groundwater | Alluvial Aquifer - Tap Water | 1,2-Dibromo-3-chloropropane | N/A | N/A | N/A | 0.0E+00 | Testis | 2.5E-01 | N/A | 1.4E-02 | 2.7E-01 |
| | | | Arsenic-dissolved | N/A | N/A | N/A | 0.0E+00 | Skin, Vascular | 5.1E-01 | N/A | 1.7E-03 | 5.1E-01 |
| | | | Iron-dissolved | N/A | N/A | N/A | 0.0E+00 | Gastrointestinal | 3.0E-01 | N/A | 9.6E-04 | 3.0E-01 |
| | | | Manganese-dissolved | N/A | N/A | N/A | 0.0E+00 | CNS | 1.9E+00 | N/A | 1.6E-01 | 2.1E+00 |
| | | | Thallium-dissolved | N/A | N/A | N/A | 0.0E+00 | Liver, Blood, Hair | 3.3E+00 | N/A | 1.1E-02 | 3.3E+00 |
| | | | Chemical Total | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | | 6.3E+00 | 0.0E+00 | 1.8E-01 | 6.5E+00 |
| | | Exposure Point Total | | | | | 0.0E+00 | | | | | 6.5E+00 |
| | Exposure Medium Total | | | | | | 0.0E+00 | | | | | 6.5E+00 |
| Medium Total | | | | | | | 0.0E+00 | | | | | 6.5E+00 |
| Receptor Total | | | | | | | 0.0E+00 | | | | Receptor HI Total | 6.5E+00 |

HI - Hazard Index
CNS = Central Nervous System

| | |
|---|---|
| Total Blood HI Across All Media = | 3.3E+00 |
| Total Liver HI Across All Media = | 3.3E+00 |
| Total Skin HI Across All Media = | 5.1E-01 |
| Total Vascular HI Across All Media = | 5.1E-01 |
| Total CNS HI Across All Media = | 2.1E+00 |
| Total Hair HI Across All Media = | 3.3E+00 |
| Total Testis HI Across All Media = | 2.7E-01 |

TABLE 10.3.CTE
RISK SUMMARY
CENTRAL TENDENCY EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult/Child

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Groundwater | Alluvial Aquifer - Tap Water | 1,1,2,2-Tetrachloroethane | 1.6E-06 | N/A | 1.4E-07 | 1.8E-06 | N/A | N/A | N/A | N/A | 0.0E+00 |
| | | | 1,2-Dibromo-3-chloropropane | 2.6E-05 | N/A | 1.7E-06 | 2.8E-05 | Testis | N/A | N/A | N/A | 0.0E+00 |
| | | | Tetrachloroethene | 4.1E-06 | N/A | 1.7E-06 | 5.8E-06 | Liver, Whole body | N/A | N/A | N/A | 0.0E+00 |
| | | | Vinyl chloride | 5.7E-05 | N/A | 1.7E-06 | 5.9E-05 | Liver | N/A | N/A | N/A | 0.0E+00 |
| | | | Arsenic-dissolved | 2.8E-05 | N/A | 7.1E-08 | 2.8E-05 | Skin, Vascular | N/A | N/A | N/A | 0.0E+00 |
| | | | Chemical Total | 1.2E-04 | 0.0E+00 | 5.2E-06 | 1.2E-04 | | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | | Exposure Point Total | | | | | 1.2E-04 | | | | | 0.0E+00 |
| | Exposure Medium Total | | | | | | 1.2E-04 | | | | | 0.0E+00 |
| Medium Total | | | | | | | 1.2E-04 | | | | | 0.0E+00 |
| Receptor Total | | | | | | | 1.2E-04 | Receptor HI Total | | | | 0.0E+00 |

HI - Hazard Index
CNS = Central Nervous System

TABLE 10.4.CTE
RISK SUMMARY
CENTRAL TENDENCY EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Groundwater | Bedrock Aquifer - Tap Water | bis(2-Ethylhexyl)phthalate | N/A | N/A | N/A | 0.0E+00 | Liver | 1.4E-03 | N/A | 1.1E-01 | 1.1E-01 |
| | | | Antimony | N/A | N/A | N/A | 0.0E+00 | Blood | 1.1E-01 | N/A | 2.3E-03 | 1.1E-01 |
| | | | Arsenic | N/A | N/A | N/A | 0.0E+00 | Skin, Vascular | 1.7E-01 | N/A | 5.6E-04 | 1.8E-01 |
| | | | Thallium | N/A | N/A | N/A | 0.0E+00 | Liver, Blood, Hair | 1.1E+00 | N/A | 3.5E-03 | 1.1E+00 |
| | | | Chemical Total | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | | 1.4E+00 | 0.0E+00 | 1.2E-01 | 1.5E+00 |
| | | Exposure Point Total | | | | | 0.0E+00 | | | | | 1.5E+00 |
| | Exposure Medium Total | | | | | | 0.0E+00 | | | | | 1.5E+00 |
| Medium Total | | | | | | | 0.0E+00 | | | | | 1.5E+00 |
| Receptor Total | | | | | | | 0.0E+00 | Receptor HI Total | | | | 1.5E+00 |

HI - Hazard Index

| | |
|---|---|
| Total Blood HI Across All Media = | 1.1E-01 |
| Total Liver HI Across All Media = | 1.1E-01 |
| Total Skin HI Across All Media = | 1.8E-01 |
| Total Vascular HI Across All Media = | 1.8E-01 |
| Total Hair HI Across All Media = | 1.1E+00 |

TABLE 10.5.CTE
RISK SUMMARY
CENTRAL TENDENCY EXPOSURE
Site 12 Remedial Investigation, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Groundwater | Groundwater | Bedrock Aquifer - Tap Water | | | | | | | | | | |
| | | | Methylene chloride | N/A | N/A | N/A | 0.0E+00 | Liver | 1.0E-01 | N/A | 2.1E-03 | 1.0E-01 |
| | | | bis(2-Ethylhexyl)phthalate | N/A | N/A | N/A | 0.0E+00 | Liver | 6.0E-03 | N/A | 2.2E-01 | 2.2E-01 |
| | | | Antimony | N/A | N/A | N/A | 0.0E+00 | Blood | 3.5E-01 | N/A | 5.1E-03 | 3.6E-01 |
| | | | Arsenic | N/A | N/A | N/A | 0.0E+00 | Skin, Vascular | 5.8E-01 | N/A | 1.3E-03 | 5.8E-01 |
| | | | Chromium | N/A | N/A | N/A | 0.0E+00 | Not identified | 2.3E-01 | N/A | 4.1E-02 | 2.7E-01 |
| | | | Iron | N/A | N/A | N/A | 0.0E+00 | Gastrointestinal | 1.8E-01 | N/A | 4.0E-04 | 1.8E-01 |
| | | | Manganese | N/A | N/A | N/A | 0.0E+00 | CNS | 2.8E-01 | N/A | 1.5E-02 | 3.0E-01 |
| | | | Thallium | N/A | N/A | N/A | 0.0E+00 | Liver, Blood, Hair | 3.6E+00 | N/A | 7.8E-03 | 3.6E+00 |
| | | | Vanadium | N/A | N/A | N/A | 0.0E+00 | Kidney | 1.6E-01 | N/A | 1.3E-02 | 1.7E-01 |
| | | | Chemical Total | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | | 4.9E+00 | 0.0E+00 | 6.5E-02 | 4.9E+00 |
| | | Exposure Point Total | | | | | 0.0E+00 | | | | | 4.9E+00 |
| | Exposure Medium Total | | | | | | 0.0E+00 | | | | | 4.9E+00 |
| Medium Total | | | | | | | 0.0E+00 | | | | | 4.9E+00 |
| Receptor Total | | | | | | | 0.0E+00 | | | | Receptor HI Total | 4.9E+00 |

HI - Hazard Index
CNS = Central Nervous System

| | |
|---|---|
| Total Blood HI Across All Media = | 3.9E+00 |
| Total Liver HI Across All Media = | 3.9E+00 |
| Total Skin HI Across All Media = | 5.8E-01 |
| Total Vascular HI Across All Media = | 5.8E-01 |
| Total Hair HI Across All Media = | 3.6E+00 |
| Total Gastrointestinal HI Across All Media = | 1.8E-01 |
| Total Kidney HI Across All Media = | 1.7E-01 |

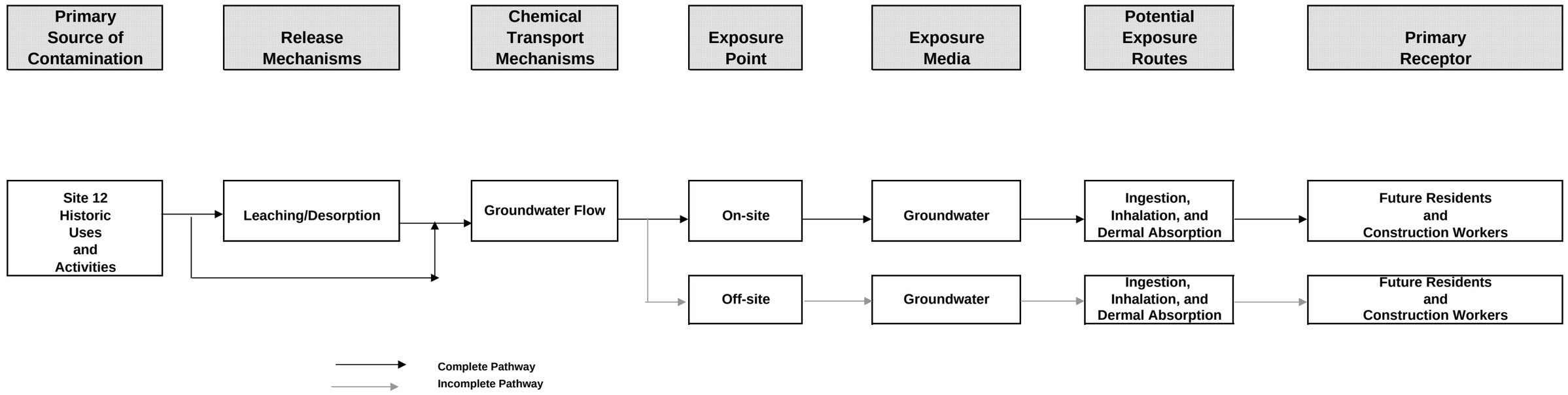
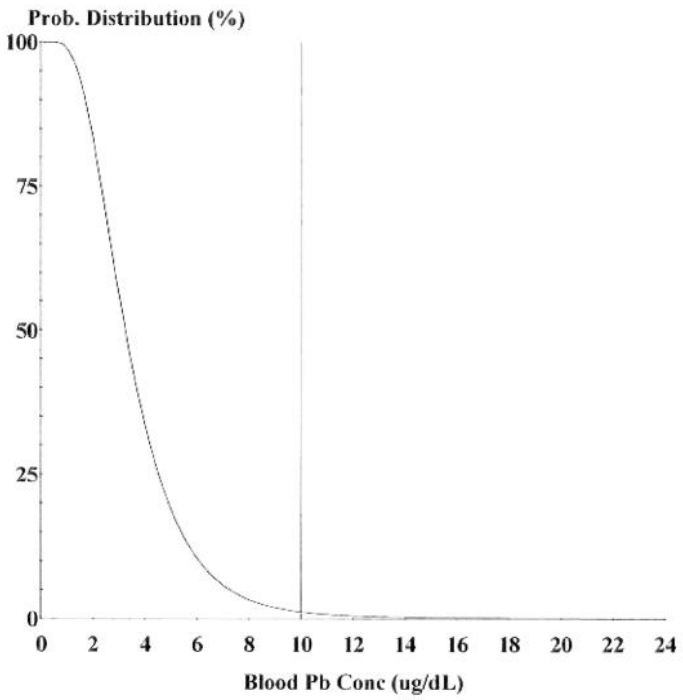



**Figure D-1**
Conceptual Exposure Model, Potential Human Exposures at Site 12
Allegany Ballistics Laboratory




Cutoff = 10.000 ug/dl
Geo Mean = 3.401
GSD = 1.600
% Above = 1.088

Age Range = 0 to 84 months
Time Step = Hourly
Run Mode = Research

**FIGURE D-2**
IEUBK Model Output
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

LEAD MODEL FOR WINDOWS Version 1.0 Build 252

==========
Model Version: 1.0 Build 252
User Name:
Date:
Site Name:
Operable Unit:
Run Mode: Research
==========
The time step used in this model run: 3 - Hourly (24 times a day).

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

| Age | Time Outdoors (hours) | Ventilation Rate (m^3/day) | Lung Absorption (%) | Outdoor Air Pb Conc (ug Pb/m^3) |
|---|---|---|---|---|
| .5-1 | 1.000 | 2.000 | 32.000 | 0.100 |
| 1-2 | 2.000 | 3.000 | 32.000 | 0.100 |
| 2-3 | 3.000 | 5.000 | 32.000 | 0.100 |
| 3-4 | 4.000 | 5.000 | 32.000 | 0.100 |
| 4-5 | 4.000 | 5.000 | 32.000 | 0.100 |
| 5-6 | 4.000 | 7.000 | 32.000 | 0.100 |
| 6-7 | 4.000 | 7.000 | 32.000 | 0.100 |

****** Diet ******

| Age | Diet Intake(ug/day) |
|---|---|
| .5-1 | 5.530 |
| 1-2 | 5.780 |
| 2-3 | 6.490 |
| 3-4 | 6.240 |
| 4-5 | 6.010 |
| 5-6 | 6.340 |
| 6-7 | 7.000 |

****** Drinking Water ******

Water Consumption:

| Age | Water (L/day) |
|---|---|
| .5-1 | 0.200 |
| 1-2 | 0.500 |
| 2-3 | 0.520 |
| 3-4 | 0.530 |
| 4-5 | 0.550 |
| 5-6 | 0.580 |
| 6-7 | 0.590 |

Drinking Water Concentration: 3.900 ug Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used
Average multiple source concentration: 150.000 ug/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

| Age | Soil (ug Pb/g) | House Dust (ug Pb/g) |
|---|---|---|

| | | |
|---|---|---|
| .5-1 | 200.000 | 150.000 |
| 1-2 | 200.000 | 150.000 |
| 2-3 | 200.000 | 150.000 |
| 3-4 | 200.000 | 150.000 |
| 4-5 | 200.000 | 150.000 |
| 5-6 | 200.000 | 150.000 |
| 6-7 | 200.000 | 150.000 |

****** Alternate Intake ******

| Age | Alternate (ug Pb/day) |
|---|---|
| .5-1 | 0.000 |
| 1-2 | 0.000 |
| 2-3 | 0.000 |
| 3-4 | 0.000 |
| 4-5 | 0.000 |
| 5-6 | 0.000 |
| 6-7 | 0.000 |

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 2.500 ug Pb/dL

**********
CALCULATED BLOOD LEAD AND LEAD UPTAKES:
**********

| Year | Air (ug/dL) | Diet (ug/day) | Alternate (ug/day) | Water (ug/day) |
|---|---|---|---|---|
| .5-1 | 0.021 | 2.553 | 0.000 | 0.360 |
| 1-2 | 0.034 | 2.648 | 0.000 | 0.893 |
| 2-3 | 0.062 | 3.002 | 0.000 | 0.938 |
| 3-4 | 0.067 | 2.919 | 0.000 | 0.967 |
| 4-5 | 0.067 | 2.863 | 0.000 | 1.022 |
| 5-6 | 0.093 | 3.040 | 0.000 | 1.085 |
| 6-7 | 0.093 | 3.367 | 0.000 | 1.107 |

| Year | Soil+Dust (ug/day) | Total (ug/day) | Blood (ug/dL) |
|---|---|---|---|
| .5-1 | 4.062 | 6.996 | 3.8 |
| 1-2 | 6.400 | 9.976 | 4.2 |
| 2-3 | 6.464 | 10.466 | 3.9 |
| 3-4 | 6.537 | 10.490 | 3.7 |
| 4-5 | 4.931 | 8.883 | 3.1 |
| 5-6 | 4.467 | 8.686 | 2.7 |
| 6-7 | 4.231 | 8.798 | 2.5 |

# Appendix E
# COC Concentration Trend Lines

**TABLE E-1**
Site 12 TCE Trends in the Alluvial Aquifer
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Well | Concentration (ug/L) | | | | | |
|---|---|---|---|---|---|---|
| | July-00 | July-03 | September-03 | June-05 | December-06 | June-07 |
| 12MW01 | 0.1 | 0.1 | 16 | 0.25 | 5 | 5 |
| 12MW02 | 4.7 | 4.7 | 3.4 | 1.9 | 1.7 | 1.7 |
| 12MW06 | 28 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 |
| 12MW08 | 2 | 2 | 0.76 | 0.25 | 5 | 0.62 |
| 12MW10 | 0.87 | 0.87 | 0.78 | 0.25 | 2.6 | 0.25 |
| 12MW12 | 0.46 | 0.46 | 0.46 | 0.25 | 0.25 | 0.25 |
| 12MW14 | 2.4 | 2.4 | 2.4 | 1.4 | 1.4 | 1.4 |
| 12MW16 | 0.89 | 0.89 | 1.5 | 2.9 | 2.4 | 0.88 |
| 12MW18 | 24 | 24 | 24 | 9.4 | 9.4 | 8.8 |
| 12MW19 | 0.78 | 0.78 | 0.78 | 0.41 | 0.41 | 0.41 |
| Average | 6.42 | 3.8 | 5.188 | 1.881 | 2.996 | 2.111 |

Notes:

1) Trends created using only monitoring wells with detections

2) If well not sampled during sampling event, used previous sampling result to maintain a constant population. If no previous sampling result, used the most recent result.

3) If result was a non-detect value, used half of the detection limit reported

## Figure E-1 TCE Trends in the Alluvial Aquifer

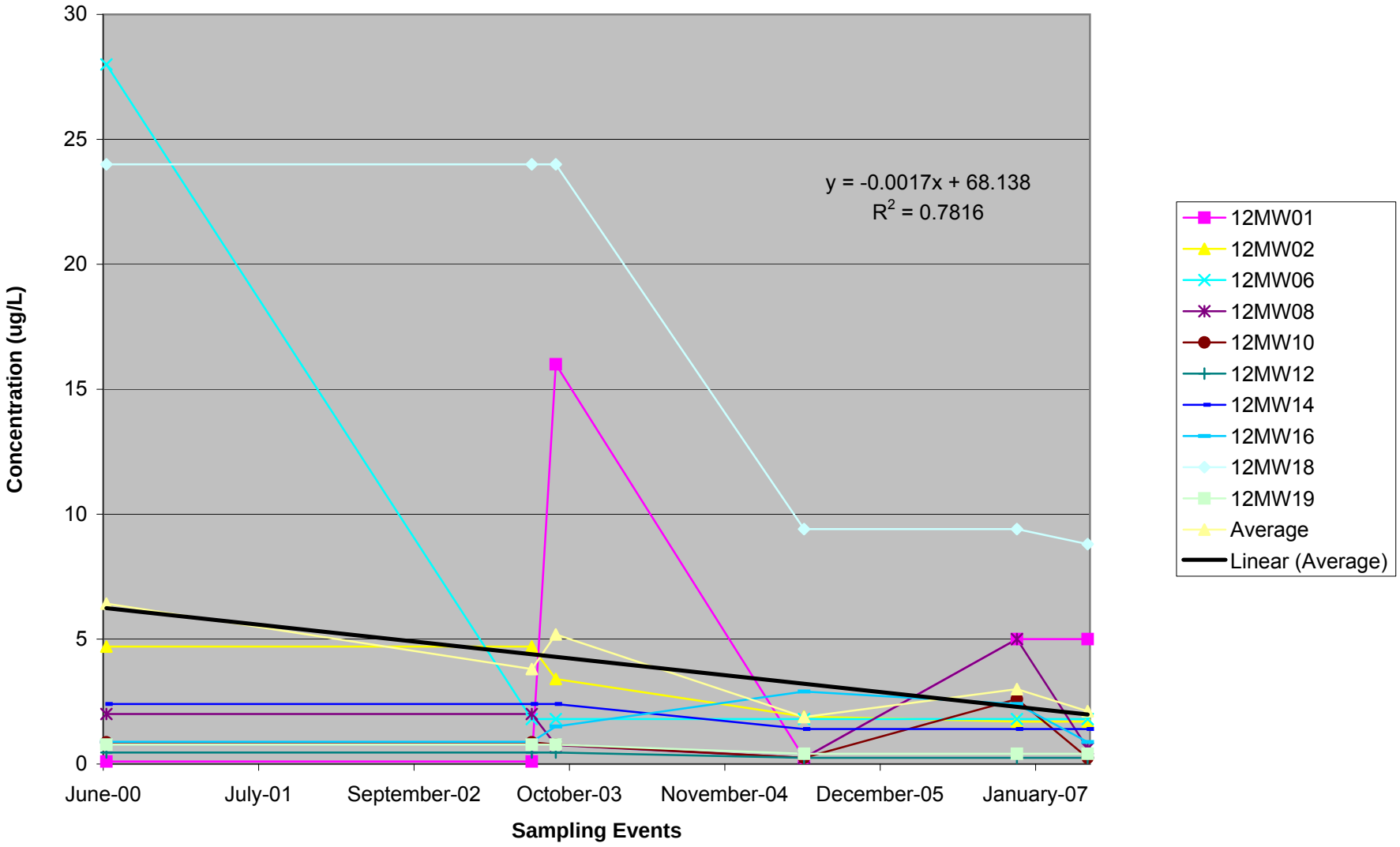


**TABLE E-2**
Site 12 MC Trends in the Alluvial Aquifer
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Well | Concentration (ug/L) | | | | |
|---|---|---|---|---|---|
| | July-03 | September-03 | June-05 | December-06 | June-07 |
| 12MW01 | 2900 | 2900 | 1.45 | 5 | 5 |
| 12MW08 | 1 | 36 | 5.5 | 5 | 0.31 |
| 12MW14 | 0.395 | 0.395 | 4.4 | 4.4 | 4.4 |
| Average | 967.1317 | 978.7983333 | 3.783333 | 4.8 | 3.236666667 |

Notes:

1) Trends created using only monitoring wells with detections

2) If well not sampled during sampling event, used previous sampling result to maintain a constant population. If no previous sampling result, used the most recent result.

3) If result was a non-detect value, used half of the detection limit reported

**Figure E-2 MC Trends in the Alluvial Aquifer**

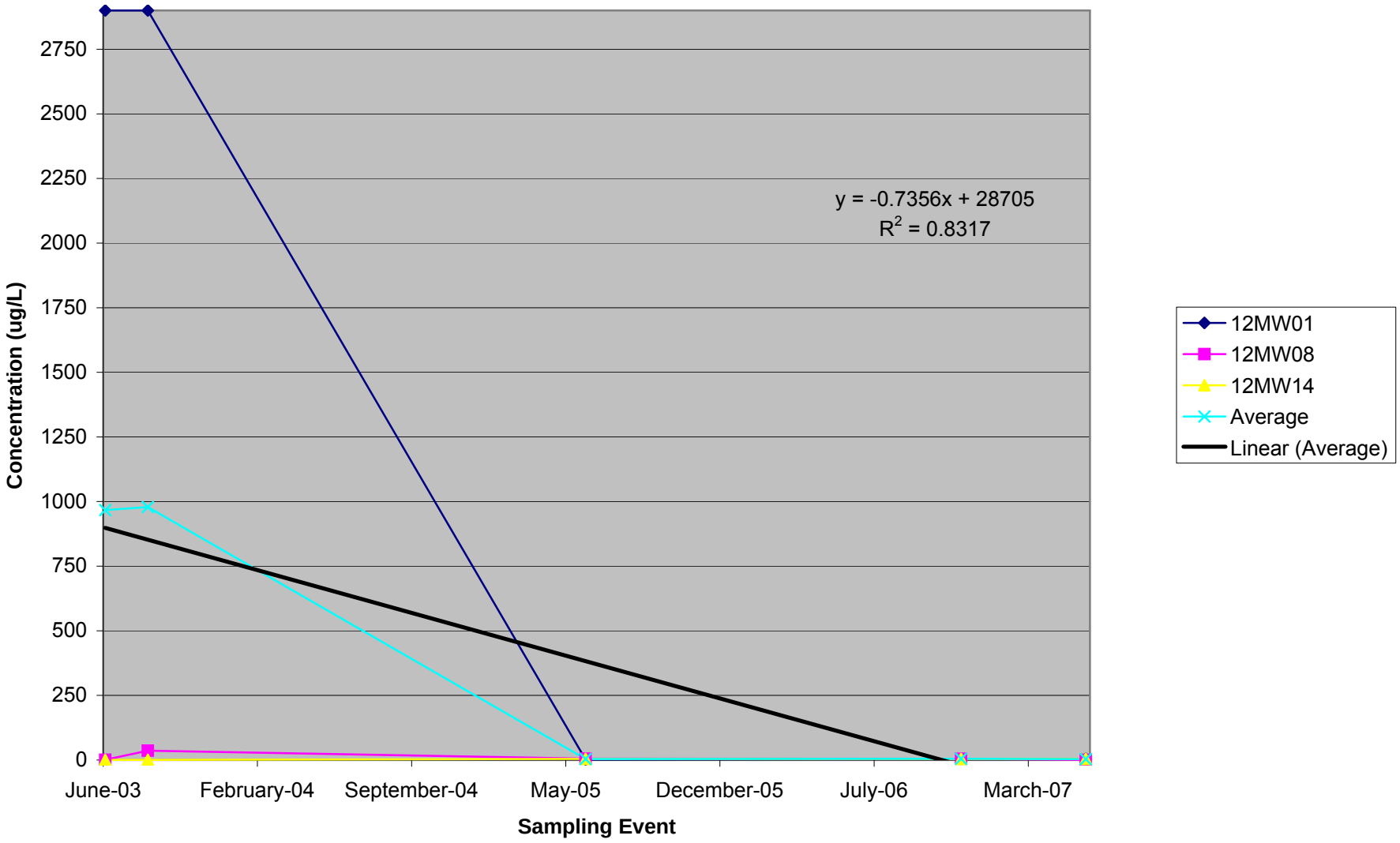


**TABLE E-3**
Site 12 TCE Trends in the Bedrock Aquifer
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Well | Concentration (ug/L) | | |
|---|---|---|---|
| | Jun-05 | Dec-06 | Jun-07 |
| 12MW04S | 1.4 | 2.1 | 2.1 |
| 12MW05D | 1 | 1 | 0.6 |
| 12MW05S | 2.2 | 2.2 | 0.87 |
| 12MW07D | 2.2 | 2.2 | 1.6 |
| 12MW07S | 8.9 | 8.9 | 3.8 |
| 12MW09S | 4.3 | 1.5 | 1.8 |
| 12MW17D | 0.84 | 0.84 | 0.25 |
| 12MW17S | 0.56 | 0.56 | 0.25 |
| 12MW20D | 1.8 | 1.8 | 1.8 |
| 12MW21S | 3 | 3 | 0.33 |
| Average | 2.62 | 2.41 | 1.34 |

Notes:

1) Trends created using only monitoring wells with detections

2) If well not sampled during sampling event, used previous sampling result to maintain a constant population. If no previous sampling result, used the most recent result.

3) If result was a non-detect value, used half of the detection limit reported

## Figure E-3 TCE Trends in the Bedrock Aquifer

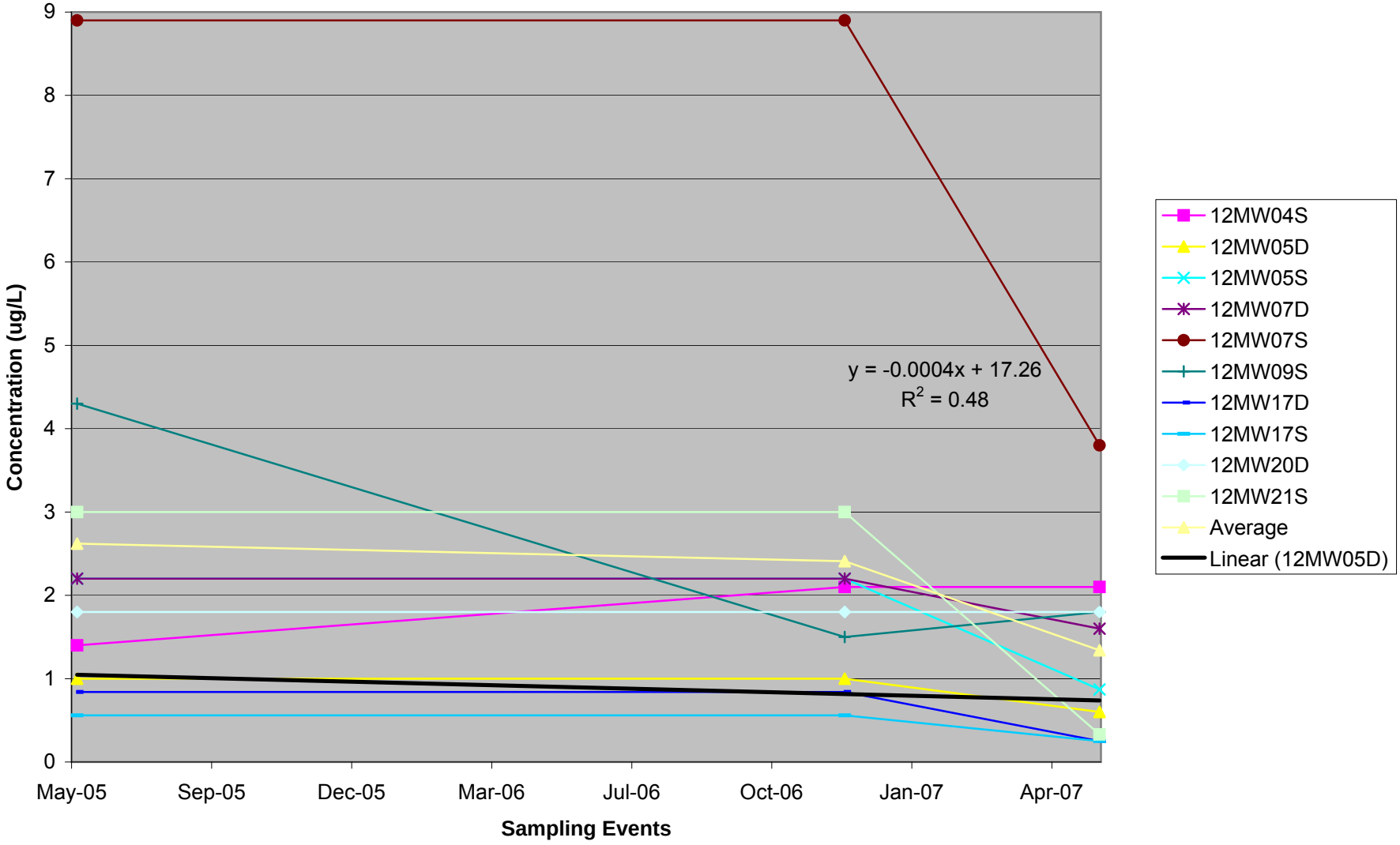


**TABLE E-4**
Site 12 MC Trends in the Bedrock Aquifer
*Site 12 Remedial Investigation Report*
*Allegany Ballistics Laboratory*
*Rocket Center, West Virginia*

| Well | Concentration (ug/L) | | |
|---|---|---|---|
| | Jun-05 | Dec-06 | Jun-07 |
| 12MW09S | 4400 | 5 | 540 |
| 12MW11S | 0.41 | 5 | 0.215 |
| 12MW20D | 3 | 3 | 3 |
| 12MW21D | 300 | 300 | 0.43 |
| 12MW21S | 170 | 170 | 0.25 |
| 12MW22D | 5 | 5 | 0.29 |
| 12MW22S | 6.5 | 6.5 | 0.31 |
| Average | 697.8443 | 70.64286 | 77.785 |

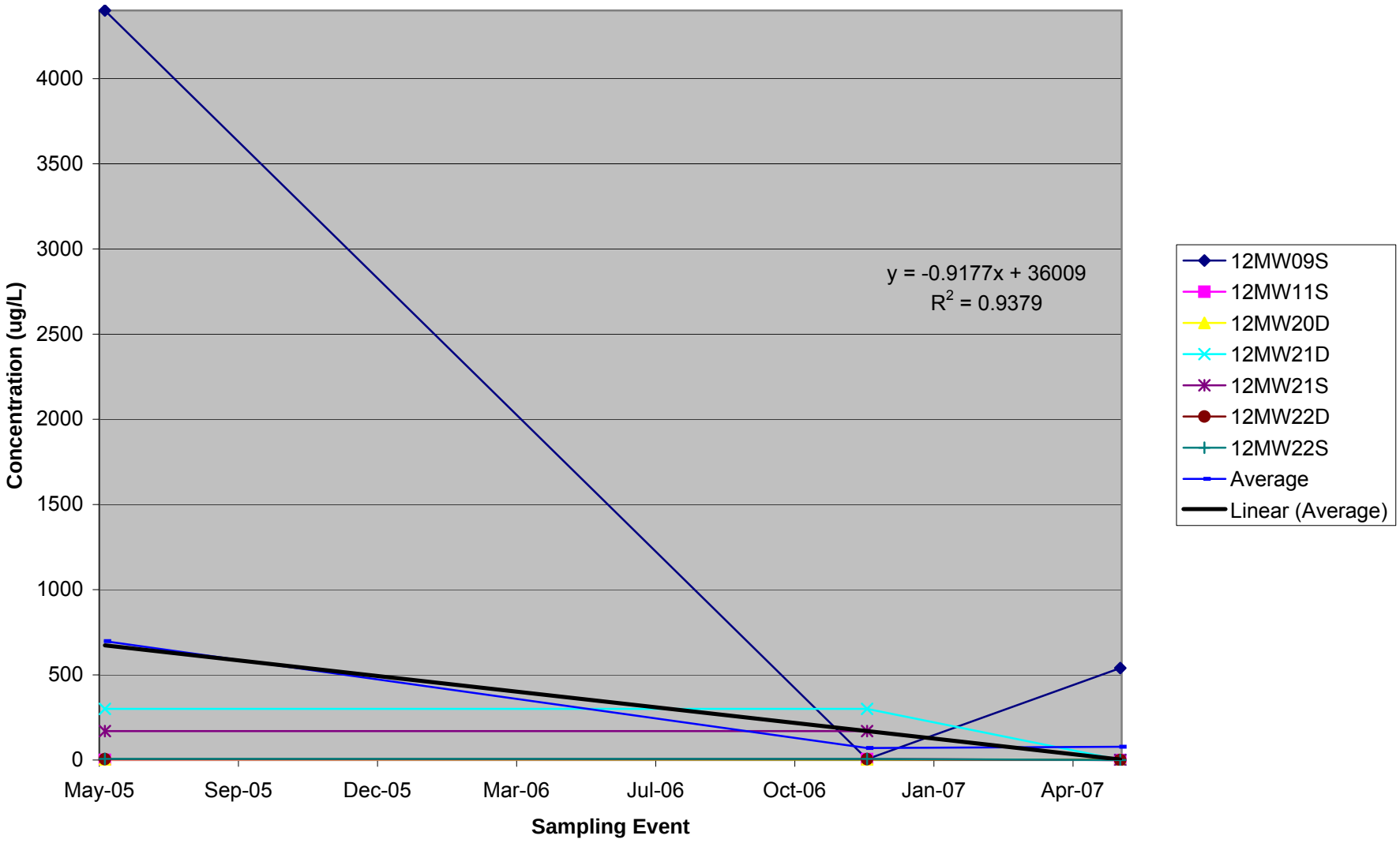
Notes:

1) Trends created using only monitoring wells with detections

2) If well not sampled during sampling event, used previous sampling result to maintain a constant population. If no previous sampling result, used the most recent result.

3) If result was a non-detect value, used half of the detection limit reported

## Figure E-4 MC Trends in the Bedrock Aquifer



# Appendix F
# Analytical Results from Packer Testing

| Sample Date | AS12-12GW11-42-52 1/23/04 | AS12-12GW11-60-70 1/23/04 | AS12-12GW13-36-46 1/20/04 | AS12-12GW13P-36-46 1/20/04 | AS12-12GW17-26-36 1/22/04 | AS12-EB200104 1/20/04 | AS12-EB220104 1/22/04 | AS12-EB230104 1/23/04 | AS12-FB220104 1/22/04 | TRIP BLANK 1/26/04 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical Name** | | | | | | | | | | |
| | | | | | | | | | | |
| **Volatile Organic Compounds (UG/L)** | | | | | | | | | | |
| 1,1,1-TRICHLOROETHANE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,1,2,2-TETRACHLOROETHANE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,1,2-TRICHLOROETHANE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,1-DICHLOROETHANE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,1-DICHLOROETHENE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,2,3-TRICHLOROBENZENE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,2,4-TRICHLOROBENZENE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,2-DIBROMO-3-CHLOROPROPANE | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,2-DICHLOROBENZENE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,2-DICHLOROETHANE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,2-DICHLOROPROPANE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,3-DICHLOROBENZENE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,4-DICHLOROBENZENE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 2-BUTANONE | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 2.2 J | 2 J | 2 J | 5 U |
| 2-HEXANONE | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 4-METHYL-2-PENTANONE | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| ACETONE | 3.5 J | 4.1 J | 6.6 | 5 U | 6.5 | 5.7 | 12 | 10 | 12 | 4.1 J |
| BENZENE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| BROMOCHLOROMETHANE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| BROMODICHLOROMETHANE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| BROMOFORM | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| BROMOMETHANE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| CARBONDISULFIDE | 0.5 U | 0.54 | 0.5 U | 0.5 U | 0.34 J | 0.78 | 0.53 | 0.5 U | 0.5 U | 0.34 J |
| CARBONTETRACHLORIDE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| CHLOROBENZENE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| CHLOROETHANE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| CHLOROFORM | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| CHLOROMETHANE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| CIS-1,2-DICHLOROETHENE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1.1 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| CIS-1,3-DICHLOROPROPENE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| CYCLOHEXANE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| DIBROMOCHLOROMETHANE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| DICHLORODIFLUOROMETHANE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| ETHYLBENZENE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| ETHYLENEDIBROMIDE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| FREON113 | 0.5 U | 0.5 U | 5 | 5 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| ISOPROPYLBENZENE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| METHYLACETATE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| METHYLCYCLOHEXANE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| METHYLENECHLORIDE | 1 B | 1 B | 1 B | 0.94 B | 1.2 B | 2.2 B | 2 B | 2 B | 2.1 B | 1.8 B |
| STYRENE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| TERT-BUTYLMETHYLETHER | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| TETRACHLOROETHYLENE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.38 J | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| TOLUENE | 18 | 9.1 | 0.5 J | 0.48 J | 0.63 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| TOTALXYLENES | 0.57 | 0.46 J | 0.5 U | 0.5 U | 0.57 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| TRANS-1,2-DICHLOROETHENE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| TRANS-1,3-DICHLOROPROPENE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| TRICHLOROETHENE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1.5 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| TRICHLOROFLUOROMETHANE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| VINYLCHLORIDE | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |

NA - Not analyzed

| Sample Date | | | | AS12-EB220104<br>1/22/04 | AS12-EB230104<br>1/23/04 | AS12-FB220104<br>1/22/04 | TRIP BLANK<br>1/26/04 |
|---|---|---|---|---|---|---|---|
| **Chemical Name** | **Frequency** | **Max Value** | **Max Location** | | | | |
| | | | | | | | |
| **Volatile Organic Compounds (UG/L)** | | | | | | | |
| 2-BUTANONE | 3 / 10 | 2.20 J | AS12-EB220104 | 2.2 J | 2 J | 2 J | 5 U |
| ACETONE | 9 / 10 | 12.0 | AS12-EB220104 | 12 | 10 | 12 | 4.1 J |
| CARBONDISULFIDE | 5 / 10 | 0.780 | AS12-EB200104 | 0.53 | 0.5 U | 0.5 U | 0.34 J |
| CIS-1,2-DICHLOROETHENE | 1 / 10 | 1.10 | AS12-12GW17-26-36 | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| FREON113 | 2 / 10 | 5.00 | AS12-12GW13-36-46 | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| TETRACHLOROETHYLENE | 1 / 10 | 0.380 J | AS12-12GW17-26-36 | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| TOLUENE | 5 / 10 | 18.0 | AS12-12GW11-42-52 | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| TOTALXYLENES | 3 / 10 | 0.570 | AS12-12GW11-42-52 | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| TRICHLOROETHENE | 1 / 10 | 1.50 | AS12-12GW17-26-36 | 0.5 U | 0.5 U | 0.5 U | 0.5 U |

NA - Not analyzed

Detected Analytical Data

| Sample Date | | | | AS12-12GW11-42-52<br>1/23/04 | AS12-12GW11-60-70<br>1/23/04 | AS12-12GW13-36-46<br>1/20/04 | AS12-12GW13P-36-46<br>1/20/04 | AS12-12GW17-26-36<br>1/22/04 | AS12-EB200104<br>1/20/04 |
|---|---|---|---|---|---|---|---|---|---|
| **Chemical Name** | **Frequency** | **Max Value** | **Max Location** | | | | | | |
| | | | | | | | | | |
| **Volatile Organic Compounds (UG/L)** | | | | | | | | | |
| 2-BUTANONE | 3 / 10 | 2.20 J | AS12-EB220104 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| ACETONE | 9 / 10 | 12.0 | AS12-EB220104 | 3.5 J | 4.1 J | 6.6 | 5 U | 6.5 | 5.7 |
| CARBONDISULFIDE | 5 / 10 | 0.780 | AS12-EB200104 | 0.5 U | 0.54 | 0.5 U | 0.5 U | 0.34 J | 0.78 |
| CIS-1,2-DICHLOROETHENE | 1 / 10 | 1.10 | AS12-12GW17-26-36 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1.1 | 0.5 U |
| FREON113 | 2 / 10 | 5.00 | AS12-12GW13-36-46 | 0.5 U | 0.5 U | 5 | 5 | 0.5 U | 0.5 U |
| TETRACHLOROETHYLENE | 1 / 10 | 0.380 J | AS12-12GW17-26-36 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.38 J | 0.5 U |
| TOLUENE | 5 / 10 | 18.0 | AS12-12GW11-42-52 | 18 | 9.1 | 0.5 J | 0.48 J | 0.63 | 0.5 U |
| TOTALXYLENES | 3 / 10 | 0.570 | AS12-12GW11-42-52 | 0.57 | 0.46 J | 0.5 U | 0.5 U | 0.57 | 0.5 U |
| TRICHLOROETHENE | 1 / 10 | 1.50 | AS12-12GW17-26-36 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 1.5 | 0.5 U |

NA - Not analyzed