DEPARTMENT OF THE ARMY
US ARMY INSTALLATION MANAGEMENT COMMAND
HEADQUARTERS, UNITED STATES ARMY GARRISON, REDSTONE
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REDSTONE ARSENAL, ALABAMA 35898-5000

Environmental Management Division

February 14, 2022

Mr. Stephen A. Cobb
Chief, Land Division
Alabama Department of Environmental Management
Post Office Box 301463
Montgomery, Alabama 36130-1463

Reference:

a. The Installation Restoration Program at Redstone Arsenal, Alabama, AMIM-REP-ER (EPA ID AL7 210 020 742).

b. Resource Conservation and Recovery Act Corrective Action Program at Redstone Arsenal, Alabama (EPA ID AL7 210 020 742).

c. Redstone Arsenal's Alabama Hazardous Wastes Management and Minimization Act Hazardous Waste Storage Facility/Thermal Treatment/Solid Waste Management Unit Corrective Action (AHWMMA) Permit dated July 19, 2021.

Dear Mr. Cobb:

This letter transmits the submittal of the Corrective Measures Implementation Work Plan, RSA-013, Unlined Inactive Open Burn Pad, Operable Unit 14, US Army Garrison-Redstone, Madison County, Alabama for your review.

Revisions include:
- Main Text: Chapter 3 (pages 3-2 and 3-4)
- Figure 2-1
- RTCs: Addition of responses to ADEM informal comments dated January 10, 2022.

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the

information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Copies of this correspondence are being furnished to Will Montgomery, Alabama Department of Environmental Management; Mr. Robert Pope, Superfund and Emergency Management Division USEPA Region 4, Mr. Cesar Zapata, Land, Chemicals and Redevelopment Division USEPA Region 4.

My point of contact for this request is Mr. Robert Gorman, Environmental Management Division, 256-876-3814 or email robert.p.gorman10.civ@army.mil.

Sincerely,

Clint Howard

Clint Howard
Chief, Environmental Restoration Branch

Enclosure

Corrective Measures Implementation Work Plan
RSA-013, Unlined Inactive Open Burn Pad
Operable Unit 14
U.S. Army Garrison-Redstone
Madison County, Alabama
EPA ID No. AL7 210 020 742

Prepared for:

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Huntsville Engineering and Support Center
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Contract No. W912DY-17-D-0003
APTIM Project Number 501388
Delivery Order W912DY19F1116

November 2021

Corrective Measures Implementation Work Plan
RSA-013, Unlined Inactive Open Burn Pad
Operable Unit 14
U.S. Army Garrison-Redstone
Madison County, Alabama
EPA ID No. AL7 210 020 742

Certification

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Kenneth J Hurley
Kenneth J. Hurley
Alabama PE No. 25249

11/10/2021
Date

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Executive Summary

Aptim Federal Services, LLC, on behalf of the U.S. Army Garrison–Redstone, has prepared this corrective measures implementation work plan for Redstone Arsenal, Madison County, Alabama, under the management of the U.S. Army Environmental Command. The U.S. Army Engineering and Support Center, Huntsville has contracted Aptim Federal Services, LLC under Contract Number W912DY-17-D-0003 to perform environmental remediation and restoration services within the Active Army Installation Restoration Program for Redstone Arsenal. All work will be performed in compliance with the Resource Conservation and Recovery Act Corrective Action program in accordance with Redstone Arsenal's hazardous waste permit (U.S. Environmental Protection Agency ID # AL7 210 020 742). In addition, all work shall comply with the Department of Defense, Department of Army, U.S. Army Corps of Engineers, Redstone Arsenal, and federal and state regulations and guidance, to include Interim Guidance and Data Item Descriptions. This corrective measures implementation work plan has been prepared to provide technical guidance for implementing soil corrective measures selected for Solid Waste Management Unit RSA-013, Unlined Inactive Open Burn Pad, in Operable Unit 14.

RSA-013 is located in the southern portion of Redstone Arsenal, within the RSA-151 groundwater unit. RSA-013 is located east of the Tennessee River and south of an embayment to the Tennessee River. The RSA-013 Resource Conservation and Recovery Act facility investigation report recommended corrective measures for perchlorate- and RDX-contaminated soil that pose a continuing leaching threat to groundwater. Corrective measures for groundwater under RSA-013 were recommended to be conducted with the corrective measures required for groundwater unit RSA-151. Although groundwater contaminants under RSA-013 are site related, there are intermingled contaminant plumes from multiple sources within the RSA-151 groundwater unit, and therefore groundwater contamination for RSA-013 is best addressed on a broader scale of the groundwater unit than the surface media site level.

This corrective measures implementation work plan describes the correct measures necessary to support the removal of contaminated soil that poses a leaching threat to groundwater resulting in concentrations of these constituents in groundwater that pose an unacceptable risk to human health should groundwater be consumed. These soil concentrations are a result of historical releases at RSA-013, and thus corrective measures are recommended to minimize or eliminate ongoing leaching to groundwater of perchlorate and RDX, thereby reducing the unacceptable risk to human health should groundwater be consumed. The selected corrective measures manage the risks by excavation and off-site disposal of perchlorate- and RDX-contaminated soil, which was a result of past Army activities conducted at RSA-013.

This work plan incorporates applicable elements of Redstone Arsenal's Hazardous Wastes Management and Minimization Act Hazardous Waste Storage Facility/Thermal Treatment/Solid Waste Management Unit Corrective Action Permit and the most recent edition of the Alabama Environmental Investigation and Remediation Guidance. This work plan is submitted to fulfill, in part, the requirements listed in Section VI.E of the Permit. As specified in Section VI.E.3 of the Permit, a request for permit modification is included as part of this plan.

The RSA-013 Resource Conservation and Recovery Act facility investigation defined the nature and extent of contamination, evaluated potential risks to current and future receptors, and concluded that corrective measures are required to attain site closure. The Alabama Risk Based Corrective Action Risk Management 2 evaluation concluded that exposure to RSA-013 soils alone does not pose an unacceptable health threat to the commercial worker, construction worker, or hypothetical residential receptor by direct exposure pathways. However, exposure to groundwater poses a health threat to the commercial worker, construction worker, and hypothetical residential receptor by direct exposure pathways if groundwater is developed as a potable source. Based on the soil-to-groundwater migration evaluation, perchlorate and RDX concentrations in soil are considered to be sources of contamination to groundwater from the soil-to-groundwater migration pathway.

The Army has elected to perform corrective measures to remove and dispose of perchlorate- and RDX-contaminated soil at RSA-013 to address this problem. The following cleanup goals have been set to achieve the corrective measure objectives.

Chemical of Concern	Soil Cleanup Goals (milligrams per kilogram)	Basis
Perchlorate	1.7	Leachate-based Soil Screening Level[1]
RDX	0.45	Cleanup goal based on RSA-013-specific Alabama Risk-Based Corrective Action groundwater resource protection modeling [2]

[1] Redstone Arsenal-specific cleanup goal for perchlorate based on leachate-based soil screening level presented in the Final Redstone Arsenal Installation-Wide Groundwater Cleanup Strategy.

[2] Value calculated using the Alabama Risk-Based Corrective Action computational software package, Version 2.1-R (2010), updated based on Alabama risk-based corrective-action guidance (2017) and current physical and toxicological properties for RDX. Model used the Department's groundwater resource protection formulas per Figure B-1 of the state risk guidance.

The established cleanup goals and corrective measure objective will be met if the confirmatory soil samples have perchlorate and RDX concentrations less than or equal to their respective cleanup goals. The corrective measures involve excavation and off-site disposal of perchlorate- and RDX-contaminated soil. Corrective measures activities are summarized in the following bullets:

- The projected excavation area at RSA-013 includes an area of approximately 81,700 square feet where perchlorate concentrations in soil exceed the cleanup goal (1.7 milligrams per kilogram). A smaller area (approximately 400 square feet) within the larger perchlorate-contaminated soil area also contains RDX in soil at concentrations above the cleanup goal (0.45 milligrams per kilogram). The approximate depth of excavation, based on the average depth of groundwater, is 8 feet below ground surface. The approximate volume of contaminated soil to be excavated is 24,200 bank cubic yards.

- All contaminated soils will be excavated, stockpiled, and characterized for waste disposal.

- Confirmation soil samples will be collected after excavation to verify that perchlorate and RDX concentrations collected along the excavation sidewalls are below their respective cleanup goal.

- In situ enhanced bioremediation via placement of a carbon source (emulsified vegetable oil substrate) at the bottom of the excavation to promote biodegradation of perchlorate in the smear zone and possibly into saturated zone soils

- Waste characterization sampling will also be performed to acquire data that will be used to profile the waste for off-site disposal. The excavated soils at RSA-013 are expected to be managed as a nonhazardous waste and disposed in a Subtitle D landfill

- The site will be restored, including application of backfill and topsoil and revegetation with grass mixtures approved by the Army.

This corrective measures implementation work plan presents the specific activities necessary to ensure implementation of the corrective measures. These activities include procurement and subcontracting, mobilization, soil excavation, collection of confirmation and waste characterization samples, transportation and disposal of excavated soil, and site restoration. It is anticipated that the site soils will be restored to unrestricted use in accordance with Alabama Administrative Code r. 335-5-1. In conjunction with the corrective measures implementation report, a site-specific probability assessment will be prepared to reduce the unexploded ordnance probability rating from “Low” to “None.” Lowering the unexploded ordnance rating also supports that no land-use controls need to be maintained for surface media at this site.

The following plans and supporting documentation are included as appendices to this corrective measures implementation work plan:

- Alabama Department of Environmental Management Concurrence Letter for RSA-013, RSA-132, and RSA-133 Resource Conservation and Recovery Act Facility Investigation Report

- Request for Redstone Resource Conservation and Recovery Act Permit Modification

- Corrective Measures Implementation Schedule
- Quality Assurance Project Plan
- Site-Specific Safety and Health Plan
- Remedial-Derived Waste Management Plan
- Alabama Best Management Practices and Notice of Intent
- Construction Quality Assurance Plan
- Derivation of Cleanup Goal for RDX
- Underground Injection Control Permit Application.

1.0 Introduction

Aptim Federal Services, LLC (APTIM), on behalf of the U.S. Army Garrison–Redstone (hereinafter referred to as the Army), has prepared this corrective measures implementation (CMI) work plan for Redstone Arsenal (RSA), Madison County, Alabama, under the management of the U.S. Army Environmental Command. The U.S. Army Engineering and Support Center, Huntsville (CEHNC) has contracted APTIM under Contract Number W912DY-17-D-0003 to perform CMI at multiple (nine) sites at RSA under the Resource Conservation and Recovery Act (RCRA) Corrective Action program in accordance with RSA's Alabama Hazardous Wastes Management and Minimization Act (AHWMMA) Hazardous Waste Storage Facility/Thermal Treatment/Solid Waste Management Unit (SWMU) Corrective Action Permit, dated July 19, 2021 (hereinafter referred to as the Permit) (U.S. Environmental Protection Agency [EPA] ID # AL7 210 020 742) (Alabama Department of Environmental Management [ADEM], 2021). This CMI work plan has been developed to provide technical guidance for implementing the soil corrective measures selected for SWMU RSA-013, Unlined Inactive Open Burn Pad, in Operable Unit (OU) 14.

This CMI work plan incorporates applicable elements of the Permit (ADEM, 2021) and the most recent edition of the Alabama Environmental Investigation and Remediation Guidance (AEIRG) (ADEM, 2017a). This CMI work plan is submitted to fulfill in part the requirements listed in Section VI.E of the Permit. As specified in Permit Section VI.E.3, the request for permit modification is included as part of this plan (Appendix B).

1.1 Purpose

The purpose of this CMI work plan is to describe the corrective measures selected for use at RSA-013 to address perchlorate and RDX contamination in soil posing a leaching threat to groundwater resulting in an unacceptable risk to human health if the groundwater is consumed. The Army derived a cleanup goal (CG) of 1.7 milligrams per kilogram (mg/kg) for perchlorate in soils using the EPA Interim Drinking Water Health Advisory Level (HAL) of 15 micrograms per liter (µg/L). A site-specific leachate-based CG was developed for RDX to determine a soil concentration of RDX protective of groundwater. The resulting site-specific CG for RDX (0.45 mg/kg) ensures that source material posing a threat to groundwater beyond the nearby hypothetical point of exposure will be removed during the corrective measures.

The nature and extent of contamination was presented in the RCRA facility investigation (RFI) report (CB&I Federal Services LLC [CB&I], 2017) for RSA-013, which received concurrence from ADEM on May 25, 2017 (Appendix A). An Alabama Risk-Based Corrective Action

(ARBCA) evaluation for human health and a screening-level ecological risk assessment (SLERA) were prepared for RSA-013 as part of the RFI report. The ARBCA evaluation concluded that no chemicals of concern (COC) requiring action were identified in soil for any receptor scenario. However, perchlorate and RDX in soil pose a threat to groundwater due to leaching and migration to the water table. The SLERA determined that chemicals in surface soil are unlikely to pose a threat to communities or populations of ecological receptors. No further ecological assessment is warranted (CB&I, 2017).

The Army has determined that although groundwater contaminants found under RSA-013 are site related, there are intermingled contaminant plumes from multiple sources within the RSA-151 groundwater unit, and therefore groundwater contamination for RSA-013 is best addressed on a broader scale than the surface media site level. Therefore, groundwater contamination at RSA-013 will be addressed by the RSA-151 groundwater unit corrective measures.

This CMI work plan has been prepared to describe the technical approach and rationale for the activities that will be part of the selected corrective measures for RSA-013.

1.2 Site Description

RSA-013 is located in the southern portion of RSA, within the boundary of the active open burn (OB)/open detonation (OD) area (Figures 1-1 and 1-2). The OB/OD area is secured by a perimeter chain-link fence and locked gate, limiting access to the site. No buildings are located within the RSA-013 site boundary. The site lies above groundwater unit RSA-151, which covers approximately 572 acres in the southern portion of RSA (Figure 1-1).

1.2.1 Site History

Prior to 2009, the footprint for RSA-013 encompassed 4.3 acres and consisted of the area containing two formerly used unlined (earthen) burn pads. Based on the recommendations contained in the potential source area investigation report for RSA-151 (Shaw Environmental, Inc. [Shaw], 2006), the RSA-013 site boundary in the Army Geographical Information System layer was expanded to 5 acres in 2009 to include two noncontiguous sites: RSA-132, Dismantled Popping Furnace (0.5 acre), and RSA-133, Inactive Rocket Washrack/Sump (0.2 acre) (Figure 1-2). This work plan is limited to the original 4.3-acre parcel associated with the two former burn pads (RSA-013); the RSA-132 and RSA-133 RFI reports recommended these sites for no further action for soil (CB&I, 2017). The Army recommended that the RSA-151 groundwater unit be responsible for the groundwater contamination beneath both RSA-132 and RSA-133. Both RSA-132 and RSA-133 received ADEM concurrence for no further action for soil and corrective

measures for groundwater as part of the RSA-151 corrective measures on May 25, 2017 (Appendix A).

The RSA-013 burn pads were used from the 1950s until 1986 for the thermal treatment (burning) of explosives and explosives-contaminated material and reactive waste, primarily propellant. The locations of the burn pads are provided on Figure 1-3. Propellant burned at RSA-013 included waste perchlorate containing relatively high amounts of solvent. The ash, residue, and metal debris left over from burning activities was transported off site and disposed at the RSA-014 trenches, located to the southeast, and at RSA-066, which is located to the north of the embayment (Figure 1-2). The pads, each approximately 200 feet square, were bare ground surrounded by grass fields and crescent-shaped earthen berms on the north, west, and south sides of each pad. Operations were discontinued and investigations were initiated following an ADEM inspection during which burning on unprotected ground was observed, which resulted in ADEM issuing a Notice of Violation in January 1986.

Figure 1-4 shows the current "Unlikely" chemical warfare materiel (CWM) probability and "Low" unexploded ordnance (UXO) probability for RSA-013. The Army manages the UXO and CWM probabilities for RSA sites under the site access control (SAC) program (Army, 2012).

1.2.2 Site Topography

The topography in the vicinity of RSA-013 is relatively flat with the exception of two earthen crescent-shaped berms located directly to the west, north, and south of the former burn pads (Figure 1-3). Varying quantities of materials (e.g., wooden packing crates, pallets, and other miscellaneous debris) associated with the OB/OD operations are currently stored against the berms for the adjacent OB/OD sites but will be removed prior to the implementation of the corrective measures.

Ground elevations within RSA-013 slope gently to the east, ranging from approximately 560 to 578 feet above mean sea level. With the exception of the berms, the site lies within the 100-year floodplain, generally defined as the 565-foot elevation contour.

1.2.3 Climate

Climate is a primary component in the hydrologic cycle and water budget and an integral element of the hydrogeologic framework of a site. Seasonal and storm-related trends in temperature and rainfall influence surface water and groundwater flow conditions. Average annual rainfall at RSA is 52 inches and rainfall is the principal source of groundwater recharge, either directly through infiltration and percolation through the vadose zone (unsaturated overburden) or as runoff to streams, which may also recharge groundwater. On an annual basis,

75 to 90 percent of rainfall at RSA is lost to evapotranspiration (Shaw, 2003). Discounting runoff to surface water, 5 to 13 inches of rainfall remain available to recharge groundwater. Rainfall contributes to groundwater recharge primarily during the winter, when deciduous trees are leafless, reducing overall transpiration. With the onset of the growing season in April, temperatures increase dramatically, and most potential recharge is lost through evaporation and transpiration.

1.2.4 Ecology

Ground vegetation consists primarily of maintained grass. The two berms are covered with trees and scrub brush. Mixed pines and hardwoods border the western site boundary. There are no permanent surface water bodies located within the site boundary. A palustrine forested wetland area is located approximately 80 feet north of the site and another palustrine forested wetland area is located approximately 240 feet west of the site. The Tennessee River is approximately 940 feet west of the site. The entire site lies within the 100-year flood zone on land owned by the Tennessee Valley Authority and permitted for use by the Army. Wildlife access to this site is restricted by fencing; in addition, the OB/OD activities likely deter the presence of mammals and birds.

1.2.5 Geology

Discussions of regional stratigraphic and structural geology, surface and subsurface hydrology, and other physiographic and geographic topics are presented in the RSA-151 RFI report (APTIM, 2018) and the installation-wide work plan (IT Corporation, 2002).

The subsurface geologic setting beneath RSA-013 and adjacent sites includes overburden consisting of fluvial deposits of sand, silt, and clay with gravel from the Tennessee River and residuum derived from in situ chemical weathering of the limestone bedrock. Intervals of chert and limestone fragments increasing with depth represent residual deposits formed by in situ chemical weathering of chert nodules and layers within the limestone bedrock. Based on information recorded on boring logs, the thickness of the residual soil (overburden) ranges from approximately 20 to 41 feet and the average depth to overburden groundwater is 7.38 feet below ground surface (bgs).

Soil. The subsurface geologic setting beneath RSA-013 and adjacent sites includes unconsolidated overburden consisting of fluvial deposits of sand, silt, and clay with gravel from the Tennessee River and residuum derived from in situ chemical weathering of limestone bedrock. Intervals of chert and chert fragments increase with depth and represent residual deposits formed by in situ chemical weathering of chert nodules and layers within the limestone bedrock.

The overburden or unconsolidated soil layer across most of RSA is called residuum because it formed from in situ chemical weathering of the underlying karstic limestone bedrock. This overburden layer consists mainly of clay and silty clay. It also includes varying amounts of residual chert fragments which were present within the parent limestone and have resisted chemical weathering because of their siliceous composition. The chert can be found scattered within the clay matrix as nodules or concentrated locally as near-horizontal layers within the soil. Although there is little compositional variation within the overburden, the residuum does not transmit groundwater uniformly. Groundwater infiltration follows preferred pathways because zones of higher hydraulic conductivity developed during soil-forming processes. Preferred pathways within the overburden directly affect contaminant migration and distribution within the soil column.

Residual clay generally has low horizontal and vertical hydraulic conductivities. At a given location, a layer of chert within the clay may decrease vertical hydraulic conductivity and increase horizontal conductivity, while isolated nodules of chert may increase the vertical conductivity. Preferred groundwater flow pathways in the overburden also include macropores caused by rotting tree roots and burrowing animals.

Additionally, microfractures may be created within the clay during raveling, a process in which the clay slowly subsides as it is eroded and carried away by groundwater in bedrock fractures and conduits. Vertical movement of the soil caused by raveling or sloughing into fractures and conduits results in the development of microfractures in the overlying material. The microfractured clay soils have higher hydraulic conductivities than undisturbed clay and also act as preferred groundwater flow pathways.

Bedrock. Bedrock encountered during drilling operations completed at RSA-013 consists of limestones of the Mississippian-aged lowermost Monteagle Limestone or the uppermost Tuscumbia Limestone. Depth to bedrock in the vicinity of RSA-013 ranges from 20 feet at P13-RS558 to 40.5 feet at P13-RS190 (Figure 1-5).

The highly variable bedrock topography underlying RSA-013 is the product of in situ solutional weathering of the bedrock surface, forming deeply incised rock crevices, or cutters, and intervening pinnacles. This pinnacle-and-cutter topography is referred to as the “epikarst.” The epikarst serves to facilitate hydraulic communication between the fractured and karstic bedrock and the saturated overburden.

Within RSA in general, large solution cavities have been observed in the subsurface in the Monteagle Limestone and upper Tuscumbia Limestone due to their massive thick bedding and

"clean" limestone lithology. In contrast, the lower Tuscumbia and Fort Payne Formations consist of thin, interbedded dolomitic limestone, dolomite, and chert. Vertical fractures and high-angle fractures generally terminate at bed boundaries. Therefore, cavity heights are limited in intervals with thin bedding, and solution features tend to be wider than they are tall, although a few cavity heights observed in boreholes were up to 3 feet. Overall, the degree of karst development observed in the Fort Payne is lower than that observed in the Tuscumbia and occurs as solution enlarged stylolites. In general, the lower Tuscumbia and Fort Payne have smaller cavities (usually less than a few tenths of 1 foot) that form along bedding planes and weathered stylolites.

1.2.6 Hydrogeology

Surface Water. There are no surface water bodies located within the RSA-013 site boundary. An embayment to the Tennessee River is located approximately 200 feet north of the site; the Tennessee River is located approximately 800 feet west of RSA-013. Wetlands are located to the north and west of RSA-013 (Figure 1-2).

Groundwater. Groundwater is encountered at relatively shallow depths at RSA-013, ranging from 1.69 to 10.89 feet bgs (Table 1-1). Construction information for the monitoring wells installed at RSA-013 is presented in Table 1-2. Figure 1-5 depicts the potentiometric surface, based upon measurements collected in February 2016. The primary direction of groundwater flow is to the north-northwest, towards the embayment to the Tennessee River.

1.3 Document Organization

This CMI work plan is organized into the following chapters:

- Chapter 1.0 presents the purpose and overview of the document and includes a brief site description, including the topography, climate, ecology, geology, and hydrogeology associated with the site.
- Chapter 2.0 presents additional background information about the site, including investigation history, the nature and extent of contamination, site risks, fate and transport, and the final conceptual site model (CSM).
- Chapter 3.0 describes the basis for the action, including the corrective measure objectives (CMO), the CG, and a summary of the selected corrective measures.
- Chapter 4.0 describes the activities necessary for implementation of the corrective measures at the site.
- Chapter 5.0 describes the mechanisms to address foreseeable challenges that may arise during execution of the corrective measures described herein.

- Chapter 6.0 provides the references that contributed to the preparation of this CMI work plan.

The following plans and supporting documentation are included as appendices to this CMI work plan:

- Appendix A: ADEM Concurrence Letter for RSA-013 RFI Report
- Appendix B: Request for Redstone RCRA Permit Modification
- Appendix C: CMI Schedule
- Appendix D: Quality Assurance Project Plan (QAPP)
- Appendix E: Site-Specific Safety and Health Plan (SSHP)
- Appendix F: Investigation-Derived Waste, Standard Operating Procedure 4.0
- Appendix G: Construction Best Management Practices Plan (CBMPP) and Notice of Intent (NOI)
- Appendix H: Construction Quality Assurance Plan (CQAP)
- Appendix I: Derivation of Cleanup Goal for RDX
- Appendix J: Underground Injection Control (UIC) Permit Application.

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2.0 Investigation Results

This chapter presents additional background information for RSA-013, including the investigation history, the nature and extent of contamination, the site risks, fate and transport, and the final CSMs.

2.1 Investigation and Remedial Action History

2.1.1 Investigation History

The following investigations have been conducted at RSA-013:

- Initial Army investigation (U.S. Army Environmental Hygiene Agency, 1986)
- Remedial investigation for Unit 2 (P.E. LaMoreaux & Associates, 1988)
- Phase I and II RFI at Unit 2 (Geraghty and Miller, Inc., 1992; 1993)
- Extraction well installation by Enserch Environmental (1994)
- RSA-013 groundwater treatment system construction and operation, various contractors, 1995-2000
- Supplemental investigation (Parsons Engineering Science, Inc., 1997)
- Supplemental remedial investigation (IT Corporation, 2000)
- Comprehensive groundwater sampling (IT Corporation, 2000)
- RSA RCRA facility assessment (ADEM, 2008)
- RSA-151/152/156/157 potential source area investigation (Shaw, 2006)
- RSA-151 RFI (APTIM, 2018)
- RSA-013 RFI (CB&I, 2017)
- RSA-013 corrective measures study (APTIM, 2021a)
- OB/OD groundwater monitoring (APTIM, 2021b and subsequent annual reports).

A complete discussion of the previous site investigations is available in the RFI report for RSA-013 (CB&I, 2017).

2.2 Nature and Extent of Contamination Summary

The RSA-013 RFI report (CB&I, 2017) evaluated the analytical results from all usable soil and groundwater samples. The nature and extent of contamination was determined by comparing sample results to preliminary screening values (PSV) and background screening values (BSV) (for metals) in accordance with ADEM guidance (ADEM, 2017a). PSVs are values to be used for screening purposes only as discussed in ADEM's AEIRG (ADEM, 2017a). The evaluation of leaching threats to groundwater is summarized in Section 2.3.5 of this work plan.

The RFI (CB&I, 2017) evaluated sample data for usability and defined an appropriate data set for characterizing constituents at RSA-013, which consists of analytical results from the following:

- Seventy-five surface soil samples
- Ninety-one subsurface soil samples
- Twenty-four definitive-level groundwater samples.

The samples were analyzed for one or more of the following: volatile organic compounds (VOC), semivolatile organic compounds (SVOC), pesticides/ polychlorinated biphenyls (PCB), cyanides, herbicides, dioxins/furans, metals, explosives, perchlorate, and chemical agent (CA) (mustard and lewisite)/breakdown products (thianes and thiodiglycol). However, cyanide, herbicides, pesticides/PCBs, and dioxins are not in the CSM for soils at RSA-013. The nature and extent of contamination in surface media and groundwater at RSA-013 have been defined. Surface media is defined as surface soil, subsurface soil, surface water, sediment, and/or soil vapor as applicable.

2.2.1 Soil

Metals. The site-to-background comparison identified one anomalous concentration each of arsenic, cadmium, and lead that exceeded BSVs and PSVs in surface soil. The metals exceedances in surface soil are delineated in all directions by sampling results that were determined to be naturally occurring or below BSVs and PSVs. All metals in subsurface soil were determined to be naturally occurring or were present at concentrations less than BSVs and PSVs.

Volatile Organic Compounds. All VOCs detected in representative surface and subsurface soil samples were below PSVs.

Semivolatile Organic Compounds. All SVOC concentrations in representative surface and subsurface soil samples were below PSVs.

Explosive Compounds. One concentration of the explosive compound 2,4,6-trinitrotoluene in surface soil exceeded the PSV. The PSV exceedance is delineated in all directions by sampling results that were below the PSV. All explosive compound concentrations detected in subsurface soil were below PSVs.

Perchlorate. Two concentrations of perchlorate in surface soil and nine concentrations in subsurface soil are greater than the PSV. The lateral extent of perchlorate-contaminated soil is delineated by sampling results that were below the PSV.

Chemical Agent/Agent Breakdown Products. Mustard was not detected in any of the surface or subsurface soil samples analyzed for the compound. Detections of agent breakdown products (thiodiglycol, 1,4-dithiane, and 1,4-oxathiane) were limited to thiodiglycol in surface soil; all concentrations were several orders of magnitude below the PSV. Agent breakdown products were not detected in subsurface soil samples.

2.2.2 Groundwater

Metals. None of the metals detected in the site groundwater samples exceeded both the corresponding BSVs and PSVs; therefore, a site-to-background comparison was not required for metals in groundwater.

Volatile Organic Compounds. Four VOCs (trichloroethene [TCE], 1,1-dichloroethene, 1,2-dichloroethane, and methylene chloride) were detected in groundwater samples at concentrations above PSVs. The exceedances for TCE, 1,1-dichloroethene, 1,2-dichloroethane, and methylene chloride are delineated either by samples from within RSA-013 or on the RSA-151 groundwater unit scale.

Semivolatile Organic Compounds. Four SVOCs (benzo[a]pyrene, benzo[a]anthracene, benzo[b]fluoranthene, and indeno[1,2,3-cd]pyrene) were detected in groundwater from one RSA-013 monitoring well at concentrations above PSVs. The distribution of SVOC exceedances at RSA-013 and throughout the RSA-151 groundwater unit are sporadic and do not contribute to mappable plumes.

Explosive Compounds. Three explosive compounds (RDX, 2-nitrotoluene, and 2,6-dinitrotoluene) were detected at concentrations above PSVs in the most recent groundwater samples. The exceedances for 2-nitrotoluene and 2,6-dinitrotoluene were limited to one well each and are delineated by wells with sampling results that were either below the PSV or nondetect. Recent RDX concentrations in groundwater exceeded the PSV in 8 of the 10 site wells. The RDX PSV exceedances are delineated on the RSA-151 groundwater unit scale.

Perchlorate. Recent perchlorate concentrations in groundwater exceeded the PSV in 8 of the 10 site wells. The presence of perchlorate in soil at concentrations above the PSV and the leachate-based soil screening level (SSL) coupled with the elevated concentrations in groundwater indicate that RSA-013 is a source of perchlorate contamination in groundwater. The perchlorate PSV exceedances in groundwater are delineated on the RSA-151 groundwater unit scale.

Agent Breakdown Products. Agent breakdown products were not detected in definitive-level groundwater samples.

2.3 Site Risk Summary

An ARBCA human health risk evaluation, which included a vapor intrusion evaluation, and a SLERA were performed for RSA-013 (CB&I, 2017). Soil at the original 4.3-acre site was evaluated as a separate parcel from RSA-132 and RSA-133 for human health and ecological risk, but groundwater underlying RSA-013, RSA-132, and RSA-133 was evaluated as one unit because groundwater is a mobile medium.

2.3.1 Land and Resources Use

RSA-013 is located in the Industrial Zone, designated as the Buxton Road Development Plan Area in the RSA Master Plan (Army, 2013). Current and future land use for the site is and will remain Range Operations, Explosive Operations, Storage, Test Areas, Open Space, and Buffer Zone.

The current use of RSA-013 is not residential, nor is it expected to be in the future. The residential scenario was included in the ARBCA evaluation in order to determine if this site is eligible for unrestricted reuse in accordance with ADEM requirements. In the Permit, ADEM has specified that investigations must comply with AEIRG (ADEM, 2017a) and ARBCA guidance (ADEM, 2017b). In order to determine if this site is eligible for unrestricted reuse as defined in Alabama Administrative Code (AAC) 335-5, risks to a residential site user were assessed.

There is no current potable use of groundwater at RSA-013. An installation-wide groundwater interim record of decision (IROD) was instituted to prevent potable use now and in the future and provide management control over nonpotable uses of all groundwater beneath RSA (Shaw, 2007). Monitoring of the environmental use restrictions and controls has been conducted annually by the Army as required by the Permit. Annual reports have shown that the land-use controls (LUC) have been effective in controlling and/or preventing use or exposure to groundwater under RSA, including RSA-013.

2.3.2 Human Health ARBCA

The ARBCA human health evaluation for RSA-013 presented in the RFI report (CB&I, 2017) was prepared in accordance with the ARBCA guidance and consists of a three-tiered process: the preliminary screening level (PSL) evaluation (the first tier), the Risk Management (RM) -1 evaluation (the second tier), and the RM-2 evaluation (the third tier) (ADEM, 2017b). Note that the RM-1 evaluation is optional. It is typically not performed since RSA has an ADEM-approved installation-wide work plan (IT Corporation, 2002, Shaw, 2010a). Instead, the evaluation for RSA-013 proceeded directly from the PSL evaluation to the RM-2 evaluation. The PSL and RM-2 evaluations are described below.

PSL Evaluation. The PSL evaluation consisted of a simple comparison of site concentrations with PSVs, which generally were the EPA (2014) regional screening levels (RSL), based on the lower of an individual excess lifetime cancer risk (IELCR) of $1x10^{-6}$ and a noncancer hazard index (HI) of 0.1. Select PAHs were compared to 2017 PSVs (EPA, 2017), which were revised with updated toxicity values. In the case of groundwater, maximum contaminant levels (MCL) were used as the PSVs, if available. Otherwise, tap water RSLs were used. Residential PSVs were selected for the RSA-013 evaluation in order to consider alternatives to attain unrestricted land use.

The PSL evaluation was conducted for all chemicals that were determined to be site related. Inorganics with maximum detected concentrations that did not exceed their BSVs or shown in a site-to-background evaluation to be naturally occurring were judged not to be site related and were not evaluated further. All other detected chemicals were initially identified as chemicals of potential concern (COPC), and site concentrations were compared to PSVs in the PSL evaluation. A COPC was identified as a chemical of concern (COC) if the maximum detected concentration was greater than a PSV. COCs identified through this comparison to PSVs were then fully evaluated in the RM-2 cumulative risk assessment in accordance with ADEM's ARBCA guidance (ADEM, 2017b).

The PSL evaluation identified arsenic, cadmium, lead, perchlorate, 2,4,6-trinitrotoluene, 2,6-dinitrotoluene, and TCE as COCs in RSA-013 soils.

Perchlorate, four explosive compounds, four polynuclear aromatic hydrocarbons (PAH), and six VOCs were identified as COCs in groundwater because their maximum detected concentrations exceed their PSVs. Four metals, the 2,3,7,8-tetrachlorodibenzo-p-dioxin toxic equivalency quotient, bis(2-ethylhexyl)phthalate, and 10 VOCs were identified as COCs in groundwater only because they have MCLs. The COCs in RSA-013 soils and groundwater were evaluated further in a cumulative risk assessment.

RM-2 Cumulative Risk Evaluation. Receptor scenarios evaluated in the RM-2 evaluation included a commercial worker and a construction worker. A residential receptor was also included as a potential hypothetical future receptor. It is not anticipated that RSA-013 will be developed such that it would be used residentially. Although Army risk policy is to only evaluate those receptors that are actually at a site or that could reasonably be anticipated to occur, the risk assessment included a residential use scenario only to comply with the AEIRG and ARBCA guidance. RSA is legally mandated to comply with the AHWMMA. In the Permit (ADEM, 2021), ADEM requires that these guidance documents, including approved risk assessment work plans (IT Corporation, 2002; Shaw, 2010a), be adhered to during environmental investigations and evaluations. At RSA, the residential scenario is included in the risk assessment in order to determine if a site is eligible for unrestricted use as defined in Alabama Administrative Code 335-5-1-.03(r) or support the use of LUCs as a component of the selected remedy. Therefore, risks to a residential site user receptor were assessed in the RM-2 cumulative risk assessment.

COCs in soil and groundwater were evaluated in an RM-2 cumulative risk assessment. A commercial worker and construction worker were included as plausible receptors under both current and future site-use assumptions. A hypothetical future residential receptor was evaluated as required by ADEM (2017b) to evaluate future use without restrictions and determine whether or not remedial measures and/or LUCs are warranted to achieve no-further-action status. Groundwater was assumed to be hypothetically developed as a potable source.

The ARBCA guidance considers an IELCR of $1x10^{-5}$ to be the target cumulative risk. The target noncancer hazard is an HI of 1.0. Estimated cumulative risks/hazards at or below these targets do not require additional action.

Cumulative IELCR and HI estimates for all receptor scenarios for RSA-013 are summarized in Table 2-1. These risk estimates are based on the contributions from all the COCs carried forward from the PSL evaluation. Table 2-1 shows that the cumulative IELCR did not exceed $1x10^{-5}$ for any of the receptor scenarios for exposure to RSA-013 soil. The cumulative HI estimates for all receptors for exposure to RSA-013 soil alone fall below the threshold level of 1.0.

The cumulative IELCR for exposure to groundwater hypothetically developed as a potable source exceeded the ADEM target level of $1x10^{-5}$ for all receptors (Table 2-1). Similarly, the cumulative HI for exposure to groundwater exceeded the threshold level of 1.0 for all receptors.

Lead was identified as a COC in soil and groundwater. Screening levels of 400 and 800 mg/kg were developed for residential and industrial soils, respectively, from the EPA blood lead levels for very young children and adults. As discussed in the RFI report for this site and in risk

assessment guidance for lead evaluations, the representative concentration (RC) of lead in soil to be used is the arithmetic average. Average concentrations are used as the RC instead of the more conservative upper confidence limit on the mean or the maximum detected concentration because the blood lead models contain modules that statistically adjust for variation in exposure. The average lead concentration in RSA-013 soils of 61.5 mg/kg is less than the residential regional screening level of 400 mg/kg and the industrial RSL of 800 mg/kg (CB&I, 2017). A cleanup level for lead in drinking water of 15 µg/L was developed from the EPA blood lead model for very young children. The maximum detected lead concentration in groundwater of 0.01 µg/L is less than the cleanup level of 15 µg/L. The risk assessment concluded that lead in soil and groundwater does not pose an unacceptable threat to human health (CB&I, 2017).

Table 2-2 is a summary of the RM-2 evaluation of human health for RSA-013. It identifies COCs that contribute significantly to cumulative risk (IELCR of $1x10^{-6}$ or greater) or hazard (HI of 0.1 or greater, although cumulative hazards by target organ may be considered). As shown in Table 2-2, no COCs requiring action were identified in soil for any receptor scenario. The risk results for soil were also confirmed using the most recent PSVs (EPA, 2021). Table 2-2 also identifies the COCs requiring action for groundwater. Groundwater concentrations of perchlorate, benzo(a)pyrene, 1,1-dichloroethene, 1,2-dichloroethane, chloroform, methylene chloride, and TCE exceeded their MCLs. The risks associated with 2,6-dinitrotoluene, 2-nitrotoluene, RDX, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, 1,2-dichloroethane, methylene chloride, and TCE exceeded the acceptable limit of $1x10^{-6}$. The risk associated with the minimum analytical detection limit of dibenz(a,h)anthracene also exceeded the acceptable limit of $1x10^{-6}$ for the hypothetical resident. Hazards associated with perchlorate, RDX, 1,1-dichloroethene, chloroform, methylene chloride, and TCE exceeded ADEM's target level of 0.1.

Vapor Intrusion Evaluation. In addition to the ARBCA evaluation, a screening-level evaluation of vapor intrusion was conducted to determine whether there has been a release of VOCs to groundwater or soil at RSA-013 that may volatilize and migrate upward to pose an unacceptable risk to occupants of commercial/industrial buildings or a hypothetical residential building (CB&I, 2017). It was concluded that VOCs in soil, soil vapor, and groundwater do not represent a source that would pose an unacceptable health threat by the vapor intrusion pathway.

2.3.3 Screening-Level Ecological Risk Assessment

A SLERA was completed for RSA-013 as part of the RFI (CB&I, 2017). Although SLERAs may have limited use for very small sites since population-level effects are very unlikely when only a small area is potentially impacted, ADEM and the Army have agreed that results from SLERAs will be considered in the risk management process for site disposition. Further, SLERAs will be

performed following procedures specified in the ADEM-approved final SLERA supplements to the installation-wide work plan (Shaw, 2010a). Since ADEM has concurred with the SLERA supplements to the installation-wide work plan (Shaw, 2010a), a SLERA was completed for RSA-013 (CB&I, 2017) in accordance with these procedures.

The surface soil data for RSA-013 were compared to their respective BSVs and ecological screening values (ESV). The chemical of potential ecological concern (COPEC) refinement process examined a number of weights of evidence in order to draw conclusions as to whether site-related constituents at RSA-013 have the potential to pose hazards to ecological receptors.

The initial comparison of the detected constituent concentrations in RSA-013 surface soil to ESVs and BSVs identified 13 metals (barium, cadmium, calcium, cobalt, copper, lead, magnesium, manganese, mercury, potassium, selenium, silver, and zinc), perchlorate, thiodiglycol, 1,3,5-trinitrobenzene, 2,4,6-trinitrotoluene, 2-amino-4,6-dinitrotoluene, 4-amino-2,6-dinitrotoluene, HMX, RDX, chloromethane, and TCE as preliminary COPECs that required further evaluation (Table 2-3).

The COPEC refinement process concluded that 6 of the 13 metals identified as preliminary COPECs were likely to be naturally occurring. Additionally, two of the metals are essential nutrients and are not considered to be important bioaccumulative compounds. Many of the explosive compounds were present in less than 5 percent of the site surface soil samples and determined to have negligible contribution to the overall ecological hazards associated with exposures to surface soil. Based on the results of the screening evaluation and COPEC refinement, cadmium, copper, lead, and zinc required community-level (terrestrial plant and invertebrate communities) and food chain assessments (Table 2-3). Barium, perchlorate, thiodiglycol, HMX, RDX, chloromethane, and TCE required only a community-level (terrestrial plant and invertebrate communities) assessment.

Based on the results of the community-level and food chain assessments for RSA-013, it was concluded that all of the COPECs in surface soil at RSA-013 are unlikely to pose hazards to ecological receptor communities and/or populations, and further evaluation of ecological hazards from these COPECs at RSA-013 was not warranted.

2.3.4 Unexploded Ordnance and Chemical Warfare Materiel Probability

A munitions and explosives of concern (MEC) investigation has not been conducted at RSA-013, since this site is not within the Military Munitions Response Program. The Army has assigned a "Low" UXO probability and a CWM probability of "Unlikely" to the site. During numerous field investigations (including intrusive) conducted at RSA-013, MEC has not been encountered.

2.3.5 Contaminant Fate and Transport Summary

This section summarizes the fate of contaminants in the environment and their potential transport mechanisms at RSA-013 (CB&I, 2017). At RSA-013, the major potential contaminant migration pathway is the dissolution of site-related chemicals from soil to form leachate and the subsequent transport to the water table resulting from the downward percolation of infiltrating rainfall. Overland transport of soil contaminants by wind or water is unlikely at RSA-013 because the site is relatively level and partially vegetated.

Based on concentrations of chemicals in soil, 12 constituents (5 metals [arsenic, barium, cadmium, lead, and mercury], perchlorate, 3 explosives [2,4,6-trinitrotoluene, 4-amino-2,6-dinitrotoluene, and RDX], and 3 VOCs [bromomethane, methylene chloride, and TCE]) were evaluated for the potential to leach from soil to groundwater and result in adverse impacts to groundwater. Of the 12 constituents evaluated, only RDX and perchlorate were determined to represent a potential leaching threat to groundwater (CB&I, 2017).

Three concentrations of RDX in surface soil and two concentrations of RDX in subsurface soil exceeded the dilution-attenuation factor (DAF)$_4$ SSL (0.009 mg/kg) (Figure 2-1). The DAF$_4$ SSL exceedances for RDX were evaluated further in the soil-to-groundwater migration evaluation in the RFI report (CB&I, 2017). Although the frequencies of exceedance are low, the magnitudes of the exceedances were high (up to 144 times the DAF$_4$ SSL in surface soil and up to 26 times in subsurface soil), and borehole averages for the three boring locations exceed the DAF$_4$ SSL. Elevated concentrations of RDX up to 111 times the health-based standard are present in groundwater. The soil-to-groundwater migration evaluation concluded that RDX has likely historically leached to groundwater at this site and continues to pose leaching threats. Figure 2-1 illustrates the locations where RDX concentrations in soil exceed the DAF$_4$ SSL.

A further evaluation of the leaching potential of RDX was performed as part the corrective measures study (APTIM, 2021a). Results of the leaching evaluation are presented in Appendix I. Based on the ARBCA-modelled SSL, only one sample exceeds the site-specific SSL for RDX of 0.45 mg/kg. This result is found in the surface soil sample from boring P13-SB02. RDX is present in this boring at a concentration of 1.3 mg/kg which is a factor of 2.9 times greater than the ARBCA-modelled SSL for RDX. This location is highlighted in orange on Figure 2-1.

Two concentrations of perchlorate in surface soil and 11 concentrations of perchlorate in subsurface soil exceeded the leachate-based SSL (1.7 mg/kg); the locations are within or adjacent to the formerly used burn pads (Figure 2-2). Twelve concentrations of perchlorate in surface soil and 45 concentrations in subsurface soil were greater than its RSA-specific DAF4 SSL (0.0125 mg/kg). The magnitudes of the exceedances were high (up to 920 times the DAF$_4$

SSL in surface soil and over 1,500 times in subsurface soil), and borehole averages exceed the DAF_4 SSL. Elevated concentrations of perchlorate are present in groundwater at concentrations up to 3,733 times the health-based standard. The soil-to-groundwater migration evaluation in the RFI report (CB&I, 2017) concluded that leaching of perchlorate has occurred at the site and will continue to occur in the future.

A summary of the results of the fate and transport evaluation is presented below:

Parameter	RSA- Specific DAF_4 SSL [a]/ Leachate-Based SSL [b, c] (mg/kg)	Number Samples > SSL Surface Soil/Subsurface Soil [d]	Maximum Detected Concentration Surface Soil / Subsurface Soil (mg/kg)	Comment
Perchlorate	0.0125/1.7	12/ 45 (2/11)	11.5/19.6	Maximum concentration detected in surface soil and subsurface soil at 013-SB009. Detected in groundwater at concentrations up to 56,000 µg/L (3,733 times the health advisory level).
RDX	0.009/0.45	3/ 2 (1/0)	1.3/0.23	Maximum concentration detected in surface soil exceed the ARBCA-Modelled SSL.at P13-SB02, (0 to 1 foot bgs), Detected in groundwater at concentrations up to 78 µg/L (111 times the PSV).

Notes:

[a] DAF_4 SSL - Dilution-attenuation factor 4 soil screening level value for soil (Shaw Environmental, Inc. (Shaw), 2011, *Development of a Facility-Wide Dilution Attenuation Factor and Process for Evaluating Migration from Soil to Groundwater, Redstone Arsenal, Huntsville, Alabama*, U.S. Army Garrison-Redstone, Madison County, Alabama, February, as updated using EPA (2012) maximum contaminant levels (if available) or the EPA May 2014 tap water RSLs.)

[b] Leachate-based SSL – Leachate-based soil screening level for perchlorate in soil (Shaw, 2009a)

[c] See Appendix I for site-specific soil CG for RDX for protection of groundwater used as the SSL in this summary.

[d] Denotes the number of samples with concentrations exceeding the RSA-specific SSL. Number of surface and subsurface soil samples exceeding the leachate-based SSL for perchlorate and the ARBCA-modelled SSL for RDX shown in parentheses.

mg/kg – Milligrams per kilogram.

2.4 Final Conceptual Site Model

The final CSM was developed for RSA-013 based on historical operations, site information, and soil and groundwater data collected in the RFI. The site-related contaminants included VOCs, SVOCs, explosives, perchlorate, metals, and CA/agent breakdown products. All potential site-related contaminants were included in the sample analyses during the RFI (CB&I, 2017).

Potential release points and sources investigated at RSA-013 included the following:

- Releases of contaminants (solvents, perchlorate, explosives, and metals) through burning in direct contact with surface soil
- Releases of fuel-related SVOCs (PAHs) from fuels used to initiate burning
- Infiltration of contamination to subsurface soil and groundwater
- Potential volatilization of VOC contamination in groundwater through overlying soil
- Potential off-site migration of contaminated groundwater.

Pesticide, PCBs, and cyanide analyses have been conducted on a limited set of historical soil and groundwater samples; however, site history and usage do not support inclusion of these chemicals in the CSM for RSA-013. The final CSM for RSA-013 is presented on Figure 2-3.

2.5 RFI Conclusions

Exposure to RSA-013 soils poses no unacceptable health risk to any of the receptors evaluated herein under commercial/industrial or residential site use. However, based on the soil-to-groundwater migration evaluation, perchlorate and RDX concentrations in soil are considered to be sources of contamination to groundwater from the soil-to-groundwater migration pathway.

A screening-level vapor intrusion evaluation showed that there is no unacceptable risk to occupants of buildings (including residential buildings) erected on the site in the future.

Based on the results of the ecological evaluation, chemicals in surface soil are unlikely to pose a threat to communities or populations of ecological receptors. No further ecological assessment is warranted.

Groundwater underlying RSA-013, RSA-132, and RSA-133 was evaluated for human health risk as a singular data set because groundwater is a mobile medium. The risk assessment for the groundwater data set concluded that groundwater is contaminated with VOCs, SVOCs, explosives compounds, and perchlorate, which pose a threat if groundwater is developed as a potable source. In any case, potable use of groundwater at this site is precluded now and in the future, and nonpotable uses of groundwater are managed in accordance with RSA's SAC program and the terms of the installation-wide groundwater IROD.

3.0 Decision Summary

The RFI determined that an action is needed for RSA-013 soils to address the leaching to groundwater threat from perchlorate and RDX.

3.1 Basis for the Action

Corrective measures are needed for RSA-013 soils to address the leaching to groundwater threat from perchlorate and RDX. Corrective measures for groundwater under RSA-013 will take place in conjunction with the corrective measures required for groundwater unit RSA-151. Although groundwater contaminants under RSA-013 are site related, there are intermingled contaminant plumes from multiple sources within the RSA-151 groundwater unit, and therefore groundwater contamination for RSA-013 is best addressed on a broader scale of the groundwater unit than the surface media site level.

3.2 Corrective Measure Objective

Based on the results of the RFI, the CMO for RSA-013 is as follows:

- Reduce perchlorate and RDX concentrations in soil at RSA-013 to minimize or eliminate perchlorate and RDX in soil as an ongoing source of groundwater contamination.

3.3 Applicable Regulations

In considering corrective measures, various laws and regulations (state and federal) may apply. Consideration of applicable laws and regulations may affect the alternative evaluation and selection. Table 3-1 provides citations to specific laws and regulations that are applicable to selected corrective measures at RSA-013.

3.4 Cleanup Goals for the Selected Corrective Measures

The Army derived a CG for perchlorate in soils at RSA using the EPA Interim Drinking Water HAL of 15 µg/L. This HAL was established as the approved Army groundwater CG for perchlorate in a memorandum from the U.S. Department of Defense (DoD) in 2009 (DoD, 2009). Using this HAL, the Army derived a CG for perchlorate in soils at RSA of 1.7 mg/kg in the *Final Installation-Wide Groundwater Cleanup Strategy* (Shaw, 2009a). This value of 1.7 mg/kg will be used at RSA-013 as the CG for perchlorate in soil. This cleanup value is based on the conservative assumption that exposure would occur immediately under the source and has been used for numerous perchlorate excavations at RSA (e.g., RSA-097/089, RSA-138M, RSA-087, RSA-088, RSA-194, RSA-198, RSA-199, and RSA-204).

The DAF_4 SSL for RDX (0.009 mg/kg) is a conservative screening value calculated for use across RSA sites for evaluating the theoretical potential for RDX leaching to groundwater (Shaw, 2011 and as updated by EPA, 2012; 2014). A site-specific soil SSL to be used as the CG was developed for RDX using ADEM's ARBCA software package to determine a soil concentration of RDX protective of groundwater at the nearest off-site well from the source area in the downgradient direction of groundwater flow (monitoring well P13-RS190). This value has been selected as the CG for RDX in soil. The ARBCA software package provides coded analytical solutions for ADEM's groundwater resource protection calculations discussed in ADEM's 2008 and 2017 guidance. This software package calculates a vertical and horizontal dilution-attenuation factor to a selected point of exposures as can be visualized on Figure B-1 of ARBCA guidance (ADEM, 2017b).

Appendix I summarizes the fate and transport modeling used to develop the CG for RDX. Specifically, the ARBCA model software (ADEM, 2010) uses site-specific parameters for soil and groundwater which were integrated with updates to the default exposure factors, physical parameters, and toxicity values within the model to determine a groundwater resource protection standard for soil at the selected point of exposure. The resulting site-specific CG for RSA-013 (0.45 mg/kg) ensures that source material posing a threat to groundwater will be removed during the corrective measures. The point of exposure selected for this modeling is well within the boundary of the much larger perchlorate plume.

As a point of clarification, there are several reasons why the CGs for perchlorate and RDX were developed using different approaches.

- ***Perchlorate***: EPA has developed an HAL for perchlorate that ADEM has accepted as a suitable groundwater cleanup value. In a leachability study performed in 2008/2009, it was demonstrated that a soil CG of 1.7 mg/kg would be sufficient to prevent leaching of perchlorate to groundwater at a rate that would result in groundwater concentrations greater than the HAL (Shaw, 2011). ADEM and the Army have accepted this CG for use installation-wide at over 10 sites with elevated perchlorate concentrations in soil.

- ***RDX***. RDX is not a common contaminant in soil at RSA. As a result, no leachability testing has been performed for RDX in soil at RSA and the approach used to develop perchlorate's soil CG could not be repeated. Basing the CG on the simplified RSA DAF_4 SSL would result in a CG that is below the detection limit for RDX in soil and thus is not attainable. In addition, this RSA DAF_4 SSL (0.0129 mg/kg) is highly conservative and is not meant for use as a final CG for soil. The CG developed for RDX using ADEM's ARBCA modeling software (0.45 mg/kg) is achievable by laboratories and will still ensure that any additional leaching of RDX to groundwater is limited. Cleanup to the 0.45 mg/kg CG will allow the RDX plume, which is fully contained within the much larger perchlorate plume (RFI report Figures 3-10 for

RDX and 3-12 for perchlorate [CB&I, 2017]), to attenuate in a shorter time period than is expected for the cleanup of perchlorate in groundwater.

A summary of the soil CGs for RSA-013 is provided in Table 3-2.

3.5 Scope and Role of the Corrective Measures

To ensure protection from exposure to potentially contaminated groundwater under these sites and elsewhere on RSA, a groundwater IROD has been approved for installation-wide groundwater LUCs (Shaw, 2007; 2009b). This IROD selected LUCs for groundwater as the interim remedy. LUCs have been implemented to prevent potable use of groundwater and to manage nonpotable uses such that exposure to contaminated groundwater is minimized (Shaw, 2009b). This interim remedy (i.e., LUCs) will form the basis of a site-specific LUC to remain in place for the groundwater under RSA-013 until CGs have been achieved. In addition, the Army-regulated SAC program is currently in place to control access to the RCRA sites at RSA. This program prevents inadvertent exposure to contamination in the interim until required remediation is accomplished (Army, 2012). Via the SAC program, the installation of wells for drinking water is prevented, and all requests for the installation of wells for industrial processes or agricultural purposes on RSA are subject to Army review and approval. This program prevents the use of groundwater as a source of drinking water and allows nonpotable uses of groundwater to be managed.

3.5.1 Overall Remedial Strategy for Redstone Arsenal and RSA-013

The overall strategy for cleanup at RSA has been presented to the regulators in two cleanup strategy documents, the *Installation-Wide Groundwater Cleanup Strategy* (Shaw, 2009a) and the *Installation-Wide Strategy for Cleanup of Impacted Wetlands* (Shaw, 2010b). The overall RSA cleanup strategy includes the following elements:

- Expedite evaluation and release of surface media sites to allow for efficient, mission-related property reuse.
- Expedite cleanup of source areas at surface media sites and secondary sources of ongoing groundwater contamination, including dense nonaqueous-phase liquid.
- Prevent exposures to surface media and groundwater that may result in unacceptable risks through the Army's SAC program and implementation of the groundwater LUCs selected in RSA's groundwater IROD and in the site-specific LUC to be finalized in the corrective measure report.
- Coordinate the evaluation of groundwater sites and their associated surface sites so that approval of groundwater RFIs is not delayed by unresolved surface media site issues.

- Design and implement an installation-wide monitoring network to monitor corrective measures progress and ensure that the selected remedies are protective of human health and the environment on a long-term basis.

The corrective measures for RSA-013 are consistent with this strategy. The corrective measures will support the Army and the federal government overall in reducing future short-term and long-term financial liabilities associated with managing this site and the underlying groundwater unit, RSA-151.

3.5.2 Scope of Problems Addressed by RSA-013 Corrective Measures

The corrective measures at RSA-013 are intended to excavate and dispose off-site contaminated soils that represents a leaching threat to groundwater from perchlorate and RDX contamination. The corrective measures are intended by the Army to be the final action for surface media at RSA-013 and result in unrestricted land use.

3.6 Extent of Contaminated Soil

As shown on Figure 2-2, 2 surface soil and 11 subsurface soil concentrations of perchlorate in soil are greater than its CG (1.7 mg/kg); the nine locations with perchlorate exceedances are within or adjacent to the former burn pads. Maximum concentrations in both surface and subsurface soil are located at soil boring 013-SB009. RDX is present in one surface soil sample (boring P13-SB02) at a concentration above its CG (0.45 mg/kg) (Figure 2-1).

The current estimated boundary of the perchlorate-contaminated soil area for RSA-013 is presented on Figure 3-1. A smaller area (approximately 400 square feet) within the larger perchlorate-contaminated soil area contains RDX in soil at concentrations above the CG (0.45 mg/kg). The projected excavation area at RSA-013 covers approximately 81,700 square feet, and the maximum excavation depth is approximately 8 feet (the average depth to the water table [Table 1-1]). The in-place volume excavated from RSA-013 (excluding benching) is estimated to be 24,200 cubic yards. Saturated soil remaining below the target excavation depth (approximately 8 feet) will be addressed under the RSA-151 groundwater unit corrective measures.

3.7 Corrective Measures Evaluation and Selection

The Army has selected corrective measures consisting of excavation and off-site disposal of contaminated soils for RSA-013. The majority of soil mass requiring remediation is contaminated with perchlorate. Thus, remediation of the perchlorate-contaminated soils at RSA-013 was given a higher priority in selecting a corrective measure. Perchlorate excavation and off-site disposal has been conducted at other RSA sites (e.g., RSA-087, RSA-088,

RSA-089/RSA 097, RSA-095, RSA-142, RSA-194, RSA-198/085, RSA-199, RSA-200, and RSA-204) and has been determined to be the most-cost effective solution for the remediation of perchlorate- and RDX-contaminated soils at RSA-013.

3.7.1 Summary of the Corrective Measure Alternatives Evaluation

This section summarizes the analysis of technologies and alternatives and the selection of the corrective measures for RSA-013 (APTIM, 2021). The following technologies were considered and retained during this evaluation.

- No action
- Excavation and off-site disposal
- Ex situ bioremediation of perchlorate-contaminated soils
- Explosive Remediation Technology (for RDX).

Based on these results, the following corrective measure alternatives were subjected to a detailed analysis or perchlorate- and RDX-contaminated soils:

- Alternative 1: No action. No active corrective measures would be taken to address the perchlorate- and RDX-contaminated soil at RSA-013. Because this alternative would not prevent further leaching of perchlorate- or RDX-contaminated soil to groundwater, it is not considered a good candidate for implementation. The no-action alternative, however, is included in the detailed evaluation process consistent with state and federal guidelines. Evaluation of the no-action alternative will serve as a baseline for evaluating other corrective measures.

- Alternative 2: Excavation and off-site disposal. Soil containing perchlorate or RDX concentrations exceeding their respective CGs would be excavated and transported off site for disposal at a properly licensed landfill. The excavation would then be backfilled with clean soil to complete site restoration.

- Alternative 3: Excavation and on-site treatment using anaerobic bioremediation. Soil containing perchlorate or RDX concentrations exceeding their respective CGs would be excavated and treated on site based on the anaerobic biological reduction of perchlorate to chloride ion by perchlorate-reducing bacteria and RDX to carbon dioxide and water. The excavation would be backfilled with the treated soil.

The detailed evaluation of alternatives is presented in the RSA-013 corrective measures study (APTIM, 2021a). Because Alternative 2 (excavation and off-site disposal) is an effective technology that has been implemented with success at other RSA sites with perchlorate contamination, will achieve the CG, meets requirements as specified in the Army's guidance for the Defense Environmental Restoration Program (DoD, 2018), and ranks high in all evaluation criteria compared to Alternative 1 (no action) and Alternative 3 (excavation and on-site treatment

using anaerobic bioremediation), it was recommended as the preferred corrective measure alternative for soil at RSA-013.

3.7.2 Selected Corrective Measures

The Army selected Alternative 2 as the corrective measure that most appropriately addresses the perchlorate- and RDX-contaminated soil at RSA-013. The major components of the selected corrective measures include the following:

- Preparation of a CMI work plan through ADEM approval.
- Obtaining a UIC permit and stormwater permit.
- Collect synoptic water table elevations prior to the excavation to determine the average depth to groundwater for use in the excavation depth.
- Site preparation, including placement of erosion and storm water controls and vegetation/tree clearing as needed, utility clearance and marking, surveying and marking of the proposed excavation area, and protection of monitoring wells in the vicinity of the excavation area.
- Active monitoring wells (and associated well house) located within the excavation area would require closure and replacement, if needed. There are no wells required by the Permit for monitoring of the active OB/OD units within the proposed excavation limits that would require closure for this excavation effort (and hence a permit modification). However, modification of the Permit would be required if confirmation soil data require the southeast corner of the excavation to extend across the unnamed road to a distance (approximately 20 feet) affecting point of compliance monitoring well OBOD-RS2883. The decision to replace any wells that are closed during the corrective measures will consider the need for these wells for the RSA-151 corrective measures.
- Stockpiling of approximately 4,000 cubic yards of soil located in the two historical blast berms on site for testing and reuse as fill material.
- Removal of 24,200 cubic yards of perchlorate- and RDX-contaminated soils exceeding their respective CGs with an estimated depth of 8 feet bgs planned.
- Collection and analysis of soil confirmation samples to confirm that perchlorate and RDX concentrations remaining in soil are equal to or below their respective CGs.
- Collection of samples from excavated soil for waste characterization
- Transport of perchlorate- and RDX-contaminated soil for final disposal at an approved off-site facility.
- Apply a carbon source (emulsified vegetable oil [EVO] substrate) to bottom of excavation.

- Backfill and grading of the excavated area.
- Site restoration, including revegetation of all disturbed areas.

3.8 Request for Permit Modification

The RFI report for RSA-013 (CB&I, 2017) was approved by ADEM on May 25, 2017. A copy of the ADEM approval letter for the RFI report is included in Appendix A. The request for permit modification (Appendix B) accompanies this CMI work plan for RSA-013 and presents the supporting information, including all procedures necessary to implement and monitor the final corrective measures for the site in accordance with AAC R.335-14-8-.04 (2). The inclusion of this request for permit modification meets requirements specified in Section VI.E.3 of the Permit.

4.0 Corrective Measures Implementation

This chapter provides an overview of the field activities planned to complete corrective measures at RSA-013. Work presented in this chapter will be completed in accordance with the procedures outlined in this CMI work plan and other approved documentation as appropriate.

4.1 General Scope

The general scope of work includes the following:

- Obtain UIC permit
- Obtain a permit under the General National Pollutant Discharge Elimination System permit coverage for stormwater discharges
- Mobilization/demobilization
- On-call UXO support
- Collection of synoptic water table elevations
- Utility clearance and marking
- Installation of surface water and erosion controls
- Vegetation clearing
- Surveying and marking of the proposed excavation area
- Protection/closure of monitoring wells located in the vicinity of the excavation area
- Excavation of contaminated soil
- Confirmation sampling and analysis of the excavated area
- In situ enhanced bioremediation via placement of a carbon source (EVO substrate) at the bottom of the excavation to promote biodegradation of perchlorate in the smear zone and possibly into saturated zone soils
- Waste characterization sampling
- Transport and disposal of excavated soils as nonhazardous waste (Subtitle D landfill)
- Site restoration, including application of backfill and topsoil, and revegetation with approved grass mixtures.

All corrective measures activities at RSA-013 will be subjected to the RSA Job Order Request (JOR) and Record of Environmental Review (RER) process for review and approval of construction practices that may affect environmental resources on the installation. These actions must be coordinated by the Contractor with the RSA Environmental Office in a timely manner to ensure each JOR/RER is approved prior to the implementation of corrective measures.

The general schedule for implementation of corrective measures at RSA-013 is provided in Appendix C. The schedule is approximate. The actual dates of implementation will depend on document review time, contracting, and field conditions encountered during the excavation and disposal activities. The stage of the Tennessee River and precipitation events directly impact aquifer water levels. Excavation activities at RSA-013 will be scheduled to be performed during periods when groundwater levels are expected to be lower, if possible. The proposed excavation area is shown on Figure 3-1.

The schedule for implementation of the CMI activities at RSA-013 is constrained by OB/OD operational periods. If needed, weekend and/or night work will be considered based on site access during corrective measures.

Communication and coordination during the CMI between the Army and APTIM, and between the Army and ADEM will follow the protocol provided in the QAPP (Appendix D). RSA's community involvement plan (CB&I, 2015) provides the basis for communication between the Army and the public. As per the RCRA permitting process, public involvement will occur at least twice, including a public notice to be issued by the Army during the CMI work plan finalization process and in accordance with ADEM's permit modification notification.

4.1.1 Procurement and Subcontracting

The following subcontracted services and imported materials may be required for the completion of the project:

- Vegetation clearance
- Closure/protection of existing monitoring wells
- Storm water erosion and sediment controls
- Surveying
- Excavation and site restoration
- Purchase/transportation of common fill and topsoil
- Analytical laboratory
- Transportation and disposal of contaminated soil
- EVO
- Aggregate (crusher-run, riprap, and drainage stone)
- Seed, fertilizer, and mulch
- Heavy-duty plastic sheeting.

The following equipment may be utilized by subcontractors to complete field remediation activities:

- Excavator/backhoe to excavate contaminated soil
- Front-end loader/skid steer to consolidate soil and move fill material
- Steel-wheeled compactor for compaction of fill material
- Portable tank, pumps, and equipment for mixing and application of EVO
- Large-capacity water truck (or equivalent) for site dust control and hydration of import material for compaction
- Portable fuel tank (mounted on pickup truck)
- Miscellaneous support equipment.

Support equipment and materials will be procured through equipment and scientific supply vendors and shipped directly to the site. Support equipment includes portable storage, radios, relief stations, eyewash stations, sampling supplies and equipment, health and safety supplies and equipment (e.g., personal protective equipment, air monitoring equipment [e.g., dust monitor and photoionization detector]), and other miscellaneous supplies (e.g., wooden stakes, pin flags, and construction fencing materials).

4.1.2 Field Personnel

The following field personnel will likely be utilized to complete field remediation activities:

- Site supervisor
- Site safety officer
- Field construction quality control system manager
- Equipment operators
- Laborers.

The number and schedule of personnel will be adjusted during the project as required for completion.

4.1.3 Quality Control Inspections for Field Activities

Inspections will be performed to determine compliance with this CMI work plan. The inspection criteria are included in the field audit checklist in the CQAP (Appendix H) and will be verified during inspection activities. Inspections may be performed and verified through visual observation, measurement of materials or equipment, examination of documentation/certification, evaluation of performance, or testing.

Inspections will be performed using a three-phase inspection method. Participants in the inspections typically include but are not limited to the task subcontractor, the project quality control manager, the regulatory representative, and the project health and safety representative. The preparatory inspection(s) are performed prior to start-up and will examine training, procedures, equipment and materials, work plans and documents, and overall readiness to perform work. Initial inspection(s) are performed when work begins on a particular feature of work and include an examination of the quality of workmanship and a review of control testing for compliance with work plan requirements. Follow-up inspection(s) are then performed to verify compliance with procedures. Follow-up inspections will ensure a continuation of quality and safety standards established during preparatory and initial inspections until completion of the definable work feature. Final follow-up inspection(s) will be conducted at the completion of the activity. The final follow-up inspection will be performed to ensure that the completed feature of work meets the work plan requirements. Any deficiencies noted during this inspection will be documented and a determination will be made as to the corrective actions necessary to mitigate the deficiency. All significant deficiencies will be corrected prior to completion of the activity. Records of inspections will be maintained in the project files. At a minimum, inspection files will include inspection reports/checklists, inspection responses, and any supporting documents, as well as applicable comments.

4.1.4 Daily Reports

The requirements for preparation and submittal of daily project documentation are outlined in the QAPP (Appendix D) and the CQAP (Appendix H). As indicated in the CQAP, the daily reports (including daily construction logs, etc.) will be provided to the APTIM Project Manager or designee during CMI activities. These reports will be submitted weekly to the CEHNC Contracting Officer's Representative/Project Manager and RSA. The report will include a running inventory of excavated material. Variances, inspection forms, survey data, and dig permits will be included in the project reporting (Section 4.10).

4.1.5 Health and Safety Requirements

All personnel involved in the corrective measures will follow this CMI work plan and the installation-wide accident prevention plan (CEHNC, 2019). Personnel will abide by the health and safety requirements presented in the SSHP prepared by APTIM for implementing the corrective measures (Appendix E).

4.2 Preliminary Activities

Preliminary activities include, but are not limited to, permitting, mobilization, fulfilling requirements for base access, establishing on-call UXO support, surveying of the excavation area, utility marking and obtaining digging permits, establishing site control as needed,

installation of storm water erosion and sediment controls, vegetation clearing, well closure, protection of existing monitoring wells, establishment of soil stockpiles, and removal and sampling of blast berms. All field personnel will follow this CMI work plan, including the attached SSHP (Appendix E) and the QAPP (Appendix D). All field activities will be conducted using on-call UXO construction support personnel for site access and intrusive activities.

Fuel for equipment is expected to be delivered to the site as needed and no fuel storage is anticipated. In accordance with 40 Code of Federal Regulations (CFR) 112, a Spill Prevention, Control, and Countermeasures plan will be prepared if fuel storage is required on site and the aboveground storage capacity of a single container is in excess of 660 gallons or the aggregate aboveground storage capacity is greater than 1,320 gallons.

4.2.1 Permitting

The in situ enhanced bioremediation (ISEB) activities will require preparation of the application and obtaining a UIC permit. A draft application for a Class V UIC permit in accordance with the Safe Drinking Water Act, the Alabama Water Pollution Control Act, and the Alabama Environmental Management Act is included in Appendix J. This permit application includes details regarding the EVO solution to be applied to the excavation floor and any additional details necessary to comply with the requirements for obtaining this permit.

Since the excavation at RSA-013 will be more than 1 acre in size, a National Pollutant Discharge Elimination System construction permit issued by the ADEM will be required. A CBMPP and NOI prepared for the construction effort is included as Appendix G.

4.2.2 Mobilization

Upon notice to proceed, APTIM will begin mobilization, including the deployment of personnel, equipment, subcontractors, and materials necessary to commence CMI activities at RSA-013. After field mobilization, APTIM personnel will attend a preconstruction meeting and safety orientation to review the proposed approach and the sequencing of work to ensure that clear lines of communication are established. All necessary site-specific safety training will be conducted at this time.

4.2.3 Access to Redstone Arsenal

Obtaining access to RSA requires registering at RSA Visitor's Center, located near Gate 9 on Rideout Road. Upon presentation of proper identification and completion of a background check, RSA will issue an installation access badge. Temporary passes may be required for some vehicles. Upon registration, personnel may access RSA through any of the gates in operation at

RSA. Access to RSA is subject to change based upon security alerts or status (e.g., terrorist threat condition or force protection condition).

Military and government personnel may use current military (active, retired, or family) or federal government identification. Additional information can be obtained from the RSA Visitors Center located at Gate 9 at (256) 876-1122 or the Vehicle Registration Office at (256) 876-5770.

APTIM will contact the Redstone Test Center and RSA Safety Office in advance of the CMI field activities to schedule access into the OB/OD area. Access to the OB/OD area will also be requested by contacting Jim Mayo (256-313-0948) to verify access into OB/OD area is permissible. APTIM and subcontractor personnel will be required to sign in at the OB/OD area and upon exiting the site on a daily basis. Based on the OB/OD area operational status, weekend and/or night work will be considered based on OB/OD area access during the corrective measures.

4.2.4 On-Call UXO Support

The probability of encountering UXO has been determined to be Low at this site, and on-call UXO support has been determined to provide the appropriate level of protection during the implementation of all on-site corrective measures. Army personnel who would access this site for the berm removal, excavation activities, and potential future construction activities are trained in accordance with the Explosives Safety Management Plan (Army, 2018) and on-call explosive ordnance disposal personnel are available 24/7 through the U.S. Army Aviation and Missile Command Safety Office if suspected UXO is encountered.

4.2.5 Measurement of Water Levels

The stage of the Tennessee River and precipitation events directly impact aquifer water levels. Synoptic water table elevations will be measured from wells located near RSA-013 in the months prior to implementation of the corrective measures to calculate a representative average depth to groundwater. This data will be used to determine the target depth of excavation for the corrective measures. Excavation activities at RSA-013 will be scheduled to be performed during periods when groundwater levels are expected to be lower, if possible.

4.2.6 Location, Marking, and Surveying of Excavation

A licensed land surveyor will be subcontracted to delineate the project work boundary and mark the excavation area. The surveyor will locate the area based on coordinates provided by APTIM and mark items in the field with highly visible wooden stakes, tape, or pin flags. Surveying methods will follow the procedures specified in the CQAP (Appendix H). The proposed excavation area is shown on Figure 3-1 along with coordinates for the excavation boundary.

4.2.7 Digging Permit and Utility Marking

In advance of any intrusive fieldwork, a JOR that describes the proposed activities will be submitted. This information is provided to RSA through a system that affords various RSA entities the opportunity to review the proposed activities and verify that impacts to RSA resources (e.g., natural, cultural, etc.) are properly managed. The JOR requires an active common access card and appropriate permissions to input the information into the system by the subcontractor. It could take a significant amount of time to obtain a common access card and permissions required for submittal. In addition, it may take several weeks to obtain approval of the JOR.

Prior to conducting any intrusive site activities, APTIM will coordinate with the appropriate RSA personnel to ensure that any underground utilities in the proposed excavation area at RSA-013 are located and marked prior to beginning intrusive field activities. The procedure requires notification by telephone ([256] 876-9881) requesting a work order for a digging permit within 14 days of intrusive activities. Any utility lines that formerly serviced the site, such as water and electrical, will be inspected to ensure they are no longer in service. Water lines will be capped and removed, as appropriate, and any remaining electrical service will be removed, if present.

The digging permit must be renewed every 30 days. To avoid temporary shutdown, APTIM will make a request for permit extension at least 1½ weeks prior to digging permit expiration for the extension to be granted.

4.2.8 Site Control

APTIM will use temporary construction fencing materials, barricades, and warning tape, as necessary, to delineate the site exclusion zone, contamination reduction zone, and site support zone in compliance with their SSHP (Appendix E). Warning signs will be posted at conspicuous locations around the perimeter of the construction areas to discourage unauthorized entry. An equipment storage and material laydown area will be designated during mobilization.

4.2.9 Storm Water and Sediment Controls

Storm water management and erosion and sediment control will be provided in accordance with the *Alabama Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Areas* (Alabama Soil and Water Conservation Committee [ASWCC], 2018). A preliminary best management practices (BMP) layout is included on Figure 4-1. As the excavation at RSA-013 will be more than 1 acre in size, a National Pollutant Discharge Elimination System construction permit issued by the ADEM will be required.

BMPs (surface stabilization, runoff conveyance, sediment control, stormwater management, etc.) will be used to divert clean water away from a disturbed site, minimize erosion and sedimentation, and prevent pollution of water and land at the site. Installation of temporary controls will be coordinated to maintain effective and continuous control of erosion and pollution. The primary erosion control techniques will be silt fencing and hay bales. Erosion control devices will be inspected at least once per week and following any accumulation of rainfall 0.75 inch or more within a 24-hour period. Sediment deposits will be manually removed from the silt fence after each qualifying rainfall event or when sediment reaches one-half of the barrier height. Removed sediment will be added to the contaminated soil for subsequent disposal. Repair of damaged erosion control devices and damaged areas around and beneath the devices will be initiated within 24 hours of report. Upon completion of the project, temporary erosion and sedimentation control devices will be removed and disposed of in an RSA dumpster or off site at the RSA construction and debris landfill. Appendix G provides details on the BMPs that may be used during implementation of the corrective measures.

To reduce the amount of soil transported onto paved roads by motor vehicles or runoff, stone pads with a filter fabric underlayment (construction exit pad) will be constructed at points of vehicular ingress or egress. The construction exit pads will be installed in locations shown on Figure 4-1 in accordance with ASWCC (2018) in Appendix G. New stone will be added as necessary at the site entrance to aid in removing soil from vehicle tires.

4.2.10 Vegetation Removal

APTIM will clear brush and other vegetation currently covering the excavation area at RSA-013 as necessary in preparation for the soil removal action. This will include coordination with the RSA forester for potential removal of any commercial-quality trees. The remaining trees and brush will be cleared using manual and mechanical means (e.g., chainsaw, line trimmer, or heavy equipment). A preliminary vegetation clearance area is shown on Figure 4-1. Care will be taken to protect the perimeter fencing during vegetation clearance.

A time-of-year restriction for clearing any tree with a diameter at breast height of 3 inches or greater was implemented at RSA to protect roost trees of the Indiana and the northern long-eared bats during the active season of April 1 through October 15. This time-of-year restriction may be altered to protect roost habitat during April 1 through October 15, with project specific consultation with the Alabama U.S. Fish and Wildlife Service (USFWS) Field Office. The time-of-year restriction may be waived if USFWS protocol surveys have been completed to verify absence. The USFWS issued a blanket clearance in July 2017 for minor forestry activities that include clear cutting areas of less than 1 acre with current negative bat surveys. The proposed action falls within the blanket clearance and therefore the time of year restriction is waived.

Effort will be taken to minimize the disturbed area and protect adjacent forested habitat. All treed areas will be marked with flagging/signs to distinguish between areas to be cleared/not cleared. The boundary markers will be removed following project completion. All personnel responsible for clearing activities will be informed about the need to follow design plans, stay within flagging, and minimize impacts to wildlife. The clearing activities will be halted, and the Installation Ecologist will be contacted in the event of inadvertent discovery of roosts or bats.

If practical to implement on site, the cleared materials will be mulched and stockpiled for use during site restoration. Materials not used for site restoration will be disposed at the RSA construction and demolition (C&D) landfill. Root balls will be disposed of at the RSA C&D landfill unless analytical results indicate perchlorate or RDX is present in berm soils at concentrations greater than CGs. Material that was in contact with site soils containing elevated perchlorate or RDX concentrations (e.g., root wads) will be disposed in the same manner as the surrounding soil.

4.2.11 Well Closure and Replacement/Existing Well Protection

Two existing monitoring wells (P13-RS110 and P13-RS476) are located within or immediately adjacent to the RSA-013 excavation area (Figure 4-1). These wells will be closed prior to the excavation activities and replaced as part of site restoration activities, if deemed necessary for the RSA-151 groundwater corrective measures. An informal well closure plan will be submitted to ADEM for approval prior to well closure activities. The total well depths and screened intervals for P13-RS110 and P13-RS476 are summarized below:

Well	Monitored Zone	Total Depth (feet bgs)	Screen Interval (feet bgs)	Well Diameter (inches)	Well Construction Material
P13-RS110	Overburden	25	12 - 22	3	PVC
P13-RS476	Interface	38	17 - 37	6	SS

bgs – Below ground surface.
PVC – Polyvinyl chloride.
SS – Stainless steel.

Monitoring wells within close proximity of the work zones at RSA-013 will be conspicuously marked in the field for protection during construction (i.e., safety fencing will be placed around the monitoring wells).

Although every attempt will be made to safeguard the existing monitoring wells, if a monitoring well is inadvertently damaged requiring abandonment, the well will be closed in accordance with an ADEM approved well closure plan (unless closed due to damage), Standard Operating Procedure (SOP) No. 21, *Monitoring Well and Borehole Abandonment* (Shaw, 2013; HydroGeoLogic, Inc. [HGL], 2019), and the AEIRG (ADEM, 2017a). Wells requiring closure

and wells damaged as part of the corrective measure activities at RSA-013 will be replaced in kind, unless deemed unnecessary. Documentation of the well closure activities will be included in the corrective measures report along with a request for a permit modification for any wells included in the groundwater monitoring program for RSA-151 corrective measures or the OB/OD area that require replacement.

If needed, any replacement monitoring wells will be installed following the completion of backfilling operations at RSA-013. Well replacements would be limited to wells damaged or closed as part of excavation activities. Replacement wells would be installed in accordance with procedures outlined in SOP No. 17.0, *Monitoring Well Installation* (Shaw, 2013; HGL, 2019).

4.2.12 Stockpile Work Area

A soil stockpile work area will be established at RSA-013 for staging excavated contaminated soil prior to waste characterization and disposal and for staging of clean backfill from an off-site source, if necessary. The contaminated soil will be stockpiled in maximum of 200-cubic yard piles. Clean backfill material (e.g., blast berms) will be stockpiled separately from potentially contaminated soils. All excavated soil (i.e., blast berms, top 4 feet, soil removed during benching, and soil below 4 feet) will be staged on impervious material such as plastic sheeting and covered with waterproof material (e.g., polyethylene sheeting) until it can be demonstrated with analytical results that perchlorate and RDX concentrations do not exceed CGs. The soil work area will be surrounded by a 1-foot-high berm constructed of clean soil to prevent surface water run-on, if necessary. A preliminary site layout including stockpile locations is shown on Figure 4-1.

4.2.13 Removal and Sampling of Blast Berms

Removal of part of the blast berms is necessary to excavate perchlorate-contaminated soil beneath the berms. The presence of the blast berms is not a requirement of OB/OD operations and their removal will not have any impact on OB/OD operations. Therefore, the berms will not be rebuilt during site restoration. Berm material that is deemed suitable (i.e., perchlorate and RDX concentrations below their respective CGs) will be used as backfill material.

The soil comprising the blast berms will be removed and stockpiled on site for potential use as backfill. Berm material will be staged on impervious material such as plastic sheeting and covered with waterproof material (e.g., polyethylene sheeting) until analytical results demonstrate that perchlorate and RDX concentrations are below CGs. Approximately 4,200 cubic yards of soil located in the two historical blast berms on the west, north, and south sides of the site will be placed in approximately 200-cubic yard stockpiles for testing to determine if it is

suitable for on-site fill material. Soil from the berms will be tested for perchlorate and RDX and analytical results will be compared to the CGs.

The stockpiles will be divided into individual decision units for sampling. Each decision unit will have a maximum of 200 cubic yards. Multi-point composite samples will be randomly retrieved from three exterior points of the pile from a depth between 0 and 2 feet. Two additional samples will be taken from the interior of the pile at a depth between approximately 2 to 5 feet. The soil samples from the five points within each decision unit will be composited. Each of these composites representing 200 cubic yards will be sent to an off-site analytical laboratory and tested for perchlorate and RDX analyses. Stockpile samples will be collected in accordance with the QAPP (Appendix D). No additional quality assurance/quality control samples (other than the method-required batch quality control) will be required for the waste characterization samples.

Stockpiles exhibiting perchlorate/RDX results below CGs will be considered suitable for RSA-013 backfill. Soil from the berms exhibiting either perchlorate or RDX concentrations greater than CGs will be disposed off site along with soil excavated from RSA-013.

4.3 Excavation of Contaminated Soil

Soils requiring excavation at RSA-013 is primarily limited to the presence of perchlorate. However, excavation of a small area containing RDX-contaminated soils located within the larger perchlorate-contaminated area will be performed. The RDX-contaminated soils are located around former boring P13-SB02, which exhibited RDX concentrations above the CG (0.45 mg/kg). The proposed excavation areas are shown on Figure 3-1.

The excavation limits will be surveyed and staked prior to the start of excavation. The total excavation area will cover approximately 81,700 square feet. The depth of excavation for the excavation areas was selected as 8 feet (the average depth to groundwater). If groundwater is encountered at a depth shallower than the average depth to groundwater, the excavation will go no deeper than the depth at which groundwater is encountered. Water level measurements collected from wells closest to the excavation area in the months prior to implementation of the corrective measures will be used to calculate a representative average depth to water to be used as the excavation target depth.

An estimated 24,200 bank cubic yards of soil will be removed for transport and disposal. An estimated 31,460 loose cubic yards of soil may be required for backfilling the excavation to account for shrinkage/swelling of the soil during compaction.

When the excavation area has been cleared and the excavation limits have been demarcated, APTIM will begin excavating using an excavator. Excavation will be conducted in accordance

with the Safety and Health Regulations for Excavations (Occupational Safety and Health Administration 29 Code of Federal Regulations Part 1926 Subpart P). Sidewalls of the excavation will be protected with a shoring system or sloped/benched. Excavation over 4 feet deep will be shored, sloped (1½:1, horizontal:vertical), or benched as required. Spoils will be placed a minimum of 3 feet from the edge of the excavation. Loose soil or rocks will be removed from the sides of excavation walls. Personnel will not enter any excavation over 4 feet deep that is not properly sloped or benched. Soil generated by benching/sloping near the perimeter of the excavations will be segregated and sampled for perchlorate at a frequency of one sample per 200 cubic yards of material to determine if it may be used for backfill. The stockpiled soil may only be used for backfill if chemical analysis demonstrates that the perchlorate concentration does not exceed the CG of 1.7 mg/kg.

Areas with asphalt pavement or concrete surfaces (e.g., roadways) will be sawcut prior to excavation. Hard surfaces (e.g., concrete and asphalt) will be characterized using data from the adjoining soil at the point of waste generation. Concrete or asphalt generated from areas in contact with soil containing perchlorate or RDX that exceeds their CG will be disposed off site along with site soils. Concrete waste generated from areas where adjoining soils contain perchlorate and RDX below CGs will be disposed at the RSA C&D landfill or another appropriately permitted facility for disposal. Asphalt generated from areas in contact with soil containing perchlorate and RDX concentrations below CGs will be transported to the RSA recycling program's designated location for recycling or another appropriately permitted facility for disposal.

Soil that is excavated from below 4 feet deep is assumed to be "contaminated." The majority of soil generated from the top 4 feet of the excavation and benched material is expected to have perchlorate concentrations below the CG of 1.7 mg/kg. These "clean" stockpiles will be segregated from "contaminated" stockpiles for sampling and disposition. However, soil excavated from areas where the top 4 feet exhibited perchlorate concentrations greater than the CG (i.e., sample locations 013-HP006, 013-SB009, 013-HP008, and 013-SB02 [shown on Figure 2-2]) are likely to exceed the CG. Therefore, soil removed from these areas will be combined with excavated soil from below 4 feet (assumed contaminated) for waste characterization sampling. All excavated material (e.g., top 4 feet, soil removed for benching, and soil below 4 feet) will be staged on impervious material such as plastic sheeting and covered with waterproof material (e.g., polyethylene sheeting) until analytical results demonstrate that perchlorate and RDX concentrations do not exceed CGs.

Soil excavated from below 4 feet will be stockpiled for waste characterization (Section 4.6) and off-site disposal. Soil excavated from the top 4 feet (0 to 4 feet bgs) will undergo backfill

sampling for possible reuse as backfill following ADEM approval or off-site disposal if perchlorate or RDX concentrations exceed their respective CGs.

Soil confirmation samples will be collected from the sidewalls following excavation to verify that the CGs for perchlorate (1.7 mg/kg) and/or RDX (0.45 mg/kg) have been achieved. The sidewalls for the smaller excavation surrounding former boring P13-SB02 (containing RDX-contaminated soil) will only be sampled for RDX while the larger excavation area containing perchlorate-contaminated soil will only be sampled for perchlorate.

Section 4.4 discusses the collection of confirmation samples. Because the depth of the excavation is to the water table, confirmation samples from the excavation floor will not be collected since the floor represents saturated zone soils subject to near continuous contact with groundwater. If the sidewall confirmation samples do not achieve the CG, the section of sidewall with exceedances will be expanded out a minimum of one bucket width (approximately 3 feet) and resampled.

The excavated material will be temporarily stockpiled or staged prior to waste characterization sampling and off-site disposal. The excavated material will be staged on impervious material such as plastic sheeting and covered with waterproof material (i.e., tarpaulin or plastic sheeting). Containment will control runoff, leaching, or fugitive dust emissions. Measures will be taken to prevent any surface runoff from entering into or washing away from the stockpile. The excavation will be adequately secured from the public and filled as soon as possible.

Dust at the site will be controlled with water using a water truck with hose and sprayers and mulch such as straw, as necessary. Dry exposed areas will be misted with water until the surface is wet and repeated as needed. Visual observation will assure that water will be applied at rates so that runoff does not occur. In addition, all other equipment used at the site during operations will be operated in a manner that prevents further migration of contamination. Polymers, tackifiers, stabilizers, or chlorides will not be used for dust control. An action level of ½ the Occupational Safety and Health Administration particulate not otherwise specified threshold respirable fraction (2.5 milligrams per cubic meter) within or directly downwind of the work areas will be used to determine when dust suppression is needed. Dust levels will be monitored using a Data Ram PDR 1000 or equivalent real-time aerosol monitor.

4.4 Confirmation Sampling

Following completion of the excavation, confirmation soil samples will be collected from the sidewalls of the excavation area to ensure that the soil contaminant concentrations do not exceed the CGs for perchlorate and/or RDX. The confirmation sampling design is statistically based and

follows the guidelines set forth in (1) Section 9.6 of ADEM *General Soil Sample Collection Standard Operating Procedure (SOP) #2150, Rev. 1.1* (ADEM, 2018); (2) the August 13, 2010 guidance from ADEM, *In-situ Sampling for the Purposes of Waste Characterization/Disposal of Soil* (ADEM, 2010); and (3) Pacific Northwest National Laboratory (2012) *Visual Sample Plan* (Pacific Northwest National Laboratory, 2012).

The proposed confirmation sample locations are shown on Figure 4-2. Confirmation samples will be collected on each sidewall at a maximum spacing of 25 feet between samples with a minimum of one sample per 125 square feet of sidewall area. A multipoint composite sample with a minimum of six aliquots will be collected for each 5-foot depth of sidewall from ground surface to depth (Figure 4-3). Because the depth of the excavation is expected to be 8 feet, two sidewall samples per 25-foot length of sidewall are planned. Each of the samples at RSA-013 will consist of composites collected every 5 feet of depth to the maximum depth of excavation (i.e., composites samples will be collected at intervals from 0 to 5 and 5 to 8 feet bgs). The samples will include two aliquots near the center of the 25-foot sidewall section plus aliquots from the upper and lower left and right quadrants of the sidewall section (Figure 4-3). The intervals may be adjusted if excavation depths change but will not exceed a maximum depth interval of 5 feet.

Confirmation samples are not anticipated to be collected from the floor of the excavation since the excavation will extend to the average groundwater table. However, multi-point composite confirmation soil samples will be collected from the floor of any part of the excavation that does not extend to the saturated soil zone. Floor samples will consist of a minimum of five aliquots and will represent a maximum floor area of 625 square feet. If needed, the multi-point floor sample will include a center point of the floor plus aliquots from the north, south, east, and west quadrants of the floor area.

Confirmation samples collected from the small excavation area at former boring P13-SB02 will be sent to an off-site analytical laboratory for analysis of RDX (EPA Method 8330B) on a 5-day turnaround basis. Confirmation samples from the large excavation area will also be sent to an off-site analytical laboratory for analysis of perchlorate (EPA Method 6850) on a 5-day turnaround basis. Confirmation samples will be collected in accordance with the QAPP provided as Appendix D. Sample designations are shown in Worksheet No. 18 of Appendix D. If sidewall confirmation sample results do not achieve the CGs for a particular excavation area, the excavation will be expanded as discussed in Section 5.1

Samples from the perimeter of the excavation will be collected by a hand auger, stainless steel spoon, or using the excavator bucket. The soil will be thoroughly mixed (homogenized) and then

placed in the appropriate sample containers in accordance with Worksheet No. 20 in the QAPP (Appendix D) and SOP Nos. 2.0, 5.0, 6.0, and 24.0 (HGL, 2019). Sample collection logs will be filled out to document the sampling in accordance with SOP No. 1.0 (HGL, 2019).

Confirmation samples will be collected using routine quality assurance/quality control sample frequencies (i.e., 10 percent field duplicates, 5 percent matrix spike/matrix spike duplicate). All sample containers, preservatives, and holding times will conform to the requirements specified in Worksheet No. 20 in the QAPP (Appendix D).

All analytical data generated from this project will be managed in accordance with the procedures specified in the QAPP, except only the final confirmation sample results will be validated. Sample documentation, custody, packaging, and shipping will follow the procedures specified in the QAPP. Custody will be maintained at all times by the APTIM sampling team prior to shipment to the analytical laboratory using typical chain-of-custody forms.

4.5 In Situ Enhanced Bioremediation Application

Upon achieving maximum vertical extent of excavation based on depth of 8 feet bgs or encountering of groundwater and prior to placing backfill, APTIM will place an EVO substrate (approximately 10,750 pounds total [0.13 pounds per square foot]) in the bottom of the excavation. The EVO will be mixed using the excavator bucket as sections of the excavation are completed to enhance remediation of the smear zone and saturated zone soils. The EVO solution will be metabolized to create reducing conditions and promote contaminant degradation at and near the groundwater/soil interface. Additional information pertaining to the ISEB application is provided in Appendix J.

4.6 Waste Characterization

Contaminated soils will be stockpiled as discussed in Section 4.3 during the excavation at RSA-013. Soil excavated from below 4 feet deep is assumed to be contaminated. The stockpiles will be divided into individual decision units for sampling. Each decision unit will have a maximum of 200 cubic yards. Multi-point composite samples will be randomly retrieved from three exterior points of the pile from a depth between 0 and 2 feet. Two additional samples will be taken from the interior of the pile at a depth between approximately 2 to 5 feet. The samples from the five points within each decision unit will be composited. Each of these composites representing 200 cubic yards will be sent to an off-site analytical laboratory and analyzed for perchlorate and RDX. Stockpile samples will be collected in accordance with the QAPP (Appendix D). No additional quality assurance/quality control samples (other than the method-required batch quality control) will be required for the waste characterization samples.

In addition, “clean” stockpiles consisting of soils with perchlorate concentrations that are expected to be below the CG of 1.7 mg/kg will be generated from the site. These “clean” stockpiles will be produced from the top 4 feet of the excavation along with the benched material. Five-point composite samples will be collected from each clean stockpile at a frequency of one sample every 200 cubic yards. These soil samples will be five-point composites and will be submitted to the laboratory for analysis of perchlorate. If the perchlorate concentrations are below 1.7 mg/kg, the soil will be deemed suitable for use as backfill. If the perchlorate concentrations exceed 1.7 mg/kg, the soil will be disposed of with the contaminated soil stockpile as nonhazardous waste.

Based upon similar soil excavation activities for perchlorate at other RSA sites (e.g., RSA-097/089, RSA-138M, RSA-087, RSA-088, RSA-194, RSA-198, RSA-199, and RSA-204), the perchlorate- and RDX-contaminated soils at RSA-013 are not expected to be characteristically hazardous. No known source of contamination involving a process and/or chemical triggering a listed waste code designation has been identified in the waste soils process of generation. Therefore, it is expected that the excavated soils at RSA-013 will be managed as a nonhazardous special waste and disposed in a Subtitle D landfill. The waste characterization results will be submitted to ADEM for approval, and an ADEM waste certification number will be obtained prior to disposal of the excavated soils.

4.7 Remediation-Derived Waste Management

The management of excavated soils is discussed in Section 4.3. Waste transportation and disposal are discussed in Section 4.8. Other remediation-derived waste (RDW) generated during the CMI activities at RSA-013 is expected to include decontamination fluids and disposable personal protective equipment (PPE).

Solid RDW, liquid RDW, and PPE are examples of RDW that will be managed. All RDW will be containerized, labeled, and stored in compliance with the provisions of AAC r. 335-14 as applicable and as discussed in the AEIRG (ADEM, 2017a). PPE that is contaminated by site media will be disposed of with the contaminated waste stream (i.e., PPE generated during soil excavation will be disposed with the soil). PPE that is uncontaminated will be placed in trash bags and disposed in a dumpster as normal household trash. Other types of RDW, if generated, will be managed in accordance with Table 2 of Appendix G of AEIRG (ADEM, 2017a).

In determining whether to manage RDW as nonhazardous or hazardous, factors such as generator knowledge and real-time field measurements or observations will be considered. AAC r. 335-14-3.01(2) allows the use of generator knowledge in the hazardous waste determination process. Generator knowledge consists of an evaluation of the following four factors:

1. ***Process Knowledge*** – The site processes are evaluated to determine whether any activity might have generated a listed waste which still persists in soil or groundwater.

2. ***Past Management Practices*** – Investigation-derived wastes (IDW) and RDW resulting from various site investigation or remediation activities have been managed at RSA for over 20 years. Changes to regulations directing this management have been minor. The Army intends to follow management practices which have been accepted by ADEM during prior investigations.

3. ***Sampling Results from Past Waste Characterization Sampling*** – Historical waste characterization sampling may indicate whether future IDW or RDW is likely to be a nonhazardous waste or to have characteristics of a hazardous waste.

4. ***Sampling Results from Past Soil and Groundwater Sampling*** – Historical sampling results from soil and groundwater sampling may indicate whether future IDW or RDW is likely to be a nonhazardous waste or to have characteristics of a hazardous waste.

However, if the available generator knowledge from the four factors in inadequate to make an accurate determination, the waste will be tested according to the applicable methods set forth in Subpart C, 40 CFR 261 as specified in 40 CFR 262.11(d)(2).

Wastes will be containerized, labeled, and stored in compliance with the provisions of AAC r. 335-14 as applicable and as discussed in the AEIRG (ADEM, 2017a). Heavily soiled PPE will be drummed after use and subsequently disposed based on the analytical results of the waste characterization soil samples at RSA-013.

Any RDW determined to be hazardous will be managed and disposed of the waste as specified in SOP No. 4.0, *Investigation Derived Waste* (Appendix F). RDW believed to be hazardous will be containerized in 55-gallon drums or other suitable containers with tight-fitting lids or other covers. Presumed hazardous RDW will be labeled, moved to a satellite accumulation area or 90-day storage within 72 hours, or managed on site in a 90-day storage area, as specified in SOP No. 4.0. RDW will be disposed of as specified in SOP No. 4.0, *Investigation Derived Waste*.

A RCRA hazardous waste determination/evaluation is required by AAC r. 335-14-3-.01(2) and will be made utilizing waste identification criteria outlined in AAC r. 335-14-2-.01 through 335-14-2-.04. Process knowledge concerning listed waste and analytical results from soil and groundwater IDW or RDW samples will be used to determine whether the waste is nonhazardous, hazardous waste suitable for land disposal, or hazardous waste requiring treatment.

For RDW considered to be nonhazardous using generator knowledge and field observations, including peripheral soils and decontamination liquids, waste will be containerized and stored on site pending sampling and analysis. Waste determined to be nonhazardous will be disposed of at a Subtitle D landfill. Wastes considered to be hazardous will be managed as discussed above.

Historical uses of RSA-013 indicated the primary COPCs are perchlorate and RDX. These compounds are not characteristic wastes regulated by RCRA. There are no known processes or available historical information for RSA-013 that would indicate any potential listed waste codes would apply to IDW/RDW.

IDW generated during the RSA-013 RFI was handled as nonhazardous. Waste generated during the corrective measures is also anticipated to be nonhazardous. However, analytical results from soil RDW samples will be used to document if the waste is hazardous or nonhazardous and, for nonhazardous RDW, to determine the contaminant concentrations for disposal purposes. For RSA-013, waste characterization analysis for soil will include perchlorate and RDX.

Additional discussions of sampling and analysis of RDW are discussed in Appendix D. For nonhazardous water RDW, possible management options include processing through RSA's sewage treatment plant or an appropriate RCRA-permitted facility. Examples of disposal practices for hazardous waste include disposal of solid (soil) hazardous waste at a disposal facility permitted to accept the waste based on the specific contaminants and concentrations in the soil. Treatment of the RDW hazardous liquids will be in accordance with ADEM regulations and the disposal facility permit. RSA will contact the EPA Region 4 off-site coordinator to ensure that any disposal facilities selected for RDW disposal do not have any operational or regulatory issues.

4.8 Waste Soil Transportation and Disposal

A licensed transportation and disposal subcontractor will be used to complete these activities. It is assumed that the soil will be disposed as special waste (nonhazardous) at a Subtitle D landfill. Transportation and disposal of the excavated waste will begin after approval by the selected waste disposal facility and ADEM or the applicable regulatory agency for the selected disposal facility (typically 4 to 6 weeks after receipt of Solid Waste Profile Sheet). Prior to transport, an RSA representative will review and sign the waste manifest. The haul route will be determined following selection of the disposal facility and borrow sources.

During loading, APTIM will document the quantities of waste loaded onto the dump truck and facilitate the Bill of Lading or shipping paper documentation for the nonhazardous waste shipments. Although not expected, any hazardous waste sent off site for disposal shall be on a

hazardous waste manifest and have a Land Disposal Restriction notification. Transportation will comply with all U.S. Department of Transportation regulations. APTIM will coordinate with the transporters so that the waste will be shipped to arrive on schedule at the landfill. APTIM will also receive written approval from the landfill (and ADEM, if required) prior to shipping waste to their facility.

4.9 Site Restoration and Demobilization

4.9.1 Backfilling and Site Restoration

Upon verification that the confirmation samples from an excavation area do not exceed the relevant CGs for that area, the excavation area will be backfilled until the area has been restored to its original grade. The blast berms will not be restored since they are not required for OB/OD operations. Excavated material approved by ADEM for reuse as backfill will be utilized along with material removed from the RSA-013 blast berms once analytical results demonstrate that concentrations of perchlorate and RDX in the potential backfill material do not exceed their CGs.

Additional fill material will be brought in from an approved off-site borrow source, as required. Representative samples of the borrow source material will be collected to confirm it is acceptable for use as backfill at the site if recent sampling of the borrow source material has not occurred. The off-site borrow material sampling, if required, will include one 5-point composite sample analyzed for target compound list (TCL) SVOCs, TCL pesticides/PCBs, and target analyte list metals and one sample analyzed for TCL VOCs. Borrow samples will be collected in accordance with Worksheet Nos. 18 and 20 in the QAPP provided as Appendix D.

The analytical results for target analyte list metals in off-site borrow sources will be screened against BSVs and residential soil PSVs as supplemented by a site-to-background evaluation, if needed. Soil concentrations for VOCs, SVOCs, and pesticides/PCBs in off-site borrow will be screened against their respective residential soil PSVs to demonstrate that the material is acceptable for use. An existing borrow source may be utilized if the borrow material sample collected previously meets the parameters listed above and this previous sample is still representative of the borrow soil that would be used at RSA-013.

The backfill material will be dumped near the excavation area using a dump truck and placed in the excavation in lifts no greater than 1 foot high, with each lift compacted by the excavator prior to placement of the next lift. During backfilling, dust control will be implemented as discussed in Section 4.3.

Fill material will be compacted to a minimum of 90 percent relative compaction at a moisture content ±5 percent of the optimum moisture. The optimum moisture content and maximum

density of fill materials will be determined by Standard Proctor in accordance with ASTM D 698.

The in-place density and moisture content of fill material will be determined per lift for every 10,000 square feet of material placed. When a failing test is encountered, an additional test shall be performed near the same location. If the re-test fails, the nonconforming area of the lift shall be repaired and tested again.

Once the area has been backfilled and compacted, clean topsoil will be placed over it if necessary. The disturbed area will then be seeded and mulched to promote revegetation and reduce the potential for soil erosion. Seed and mulch will be applied to all disturbed areas according to the ASWCC Permanent Seeding BMP (ASWCC, 2018), which is provided in Appendix G.

The applied grass mixture used will depend on the date scheduled for planting and the area planted. Refer to Alabama Department of Transportation (ALDOT) Standard Specifications (ALDOT, 2018) Section 860.01 for seed mixture for Zone 1-Areas Subject to Frequent Mowing (Appendix G). Initial temporary planting of annual ryegrass is tentatively scheduled to occur in late fall to early winter (November and December). Permanent planting of bermudagrass and white Dutch clover is tentatively scheduled to occur in late spring to early summer (April and May).

A site inspection will be conducted approximately 4 weeks after the seeding to confirm the revegetation is successful. If revegetation is unsuccessful, the site will be reseeded until an adequate stand of vegetation is present. All temporary fencing, plastic sheeting, hay bales, wooden stakes, and other project-related items will be removed from the site and disposed in accordance with SOP No. 4.0, *Investigation Derived Waste* (Shaw, 2013).

4.9.2 Equipment Decontamination

An area will be designated within the boundary of the work areas at RSA-013, adjacent to vehicular ingress and egress areas, for equipment decontamination. A decontamination pad typically consists of a soil-bermed area covered with multiple layers of visqueen sheeting where gross contamination can be removed from equipment. The decontamination pad will contain a sump area or low area where wash water from pressure washing will drain to be pumped into a portable holding tank. Decontamination fluids will be containerized and sampled for perchlorate and explosives per Section 4.7. Settled soil within the sump will be disposed of with the excavated materials from RSA-013.

Nondisposable sampling equipment will be decontaminated prior to beginning work at the site and prior to the collection of individual samples to prevent cross contamination and maintain the integrity of the environmental samples collected. All sampling equipment and ISEB injection equipment will be decontaminated in accordance with procedures specified in the RSA installation-wide QAPP (HGL, 2019), which was prepared in accordance with Appendix E of the AEIRG (ADEM, 2017a).

4.9.3 Temporary Storm Water, Erosion Control, and Sediment Control Removal

Upon completion of site restoration activities, temporary erosion and sediment controls will be removed and disposed of off site at the RSA C&D landfill or with the RDW from the excavation. The silt fence will remain in place until after the vegetation is established. When the silt fence is removed, the posts will be pulled from the ground and the remaining disturbed area will be reseeded. Excess soils will be removed from the silt fence and disposed of with the RDW from the excavation.

4.9.4 Demobilization

Personnel, equipment, and subcontractors will be demobilized from the project site after completion of remedial activities. A small crew and minimal equipment will be retained as required to remove surplus materials and clean staging areas.

Demobilization will primarily consist of disassembly, packing, and return of rented equipment to suppliers and travel for personnel back to their home offices.

4.10 Corrective Measures Implementation Reporting

A CMI report will be prepared in accordance with Section VIII.D of the Permit (ADEM, 2021) and AEIRG (ADEM, 2017a) as discussed in this section. If completion of the CMI requires more than 180 days, the Army will submit quarterly CMI progress reports in accordance with Section VIII.D.1 of the Permit. The CMI report will include the following:

a) A description of activities completed
b) As-built construction drawings presenting the final limits of soil excavations at the site and the locations of confirmation samples
c) Waste manifests indicating the handling of the excavated material that has been shipped off site to a certified disposal facility
d) Monitoring data (soil, air, dust, and water) collected for any reason during the construction period for the purposes of monitoring potential for human and ecological exposure

e) Certification, prepared in accordance with AAC 335-13-8-02 (2)(d) by RSA and a registered professional engineer (State of Alabama), that the corrective measures required by the Permit are complete

f) Appendices consisting of site photographs, analytical reports, data validation documentation, records of well closure (if performed), and waste manifests.

In conjunction with the CMI report, a site-specific probability assessment will be prepared to reduce the UXO probability from "Low" to "None." On-call UXO support would not be required for any future intrusive activities following Army approval of the reduced probability rating.

5.0 Contingencies

The implementation of corrective measures is based on the best information currently available for RSA-013. This chapter includes contingency plans to address different situations that could occur as part of this CMI. Any contingencies will be documented and included with the CMI report for the site.

5.1 Excavation Beyond Proposed Boundaries

The soil excavations at RSA-013 will proceed until the CGs for perchlorate and RDX have been achieved. The following procedures will be followed for overexcavating sidewalls:

- If the sidewall confirmation samples do not achieve the CG, the failing section will be expanded outward a minimum of one bucket width (approximately 3 feet) and resampled. The overexcavation process will continue until the CGs have been achieved.

The security fence will be relocated to maintain the security of the OB/OD Area if excavation on the west side of the site proceeds beyond the fence. The fencing will be restored to its pre-excavation location during site restoration.

5.2 Excavation Sidewall Sloping

Sidewall sloping or benching will be necessary since the expected depth will be greater than 4 feet. The soils removed for these purposes may be stockpiled separately from other site soils for potential use as backfill. All excavated material (e.g., soil removed for benching) will be staged on impervious material such as plastic sheeting and covered with waterproof material (e.g., polyethylene sheeting) until analytical results demonstrate that perchlorate and RDX concentrations do not exceed CGs. These stockpiles will be sampled for perchlorate and RDX. If the results from these analyses are below their respective CGs, the soil may be used as backfill.

5.3 Excavation of Unknown Utilities

If unknown utilities are discovered or existing utilities are compromised during excavation, work will stop in that portion of the work area until the utilities are identified and either relocated or repaired by the utility company or other appropriate authorities. That evaluation will be performed by the Project Safety Officer in consultation with the Health and Safety Manager and the Army as appropriate. In the unlikely event that the utility impacts the removal of the perchlorate- and RDX-contaminated soil, LUCs may be required for contaminated soils that are left in place around the existing utility.

5.4 Excavation Dewatering

In the event that standing surface water and storm water inhibit excavation activities in this area of RSA during seasonal flooding, the water will be removed from the construction area by pumping. Storm water controls will be implemented to direct potential run-on away from the site. Water that has not come into contact with contaminated soil will be removed and discharged downgradient of the excavation. The discharged water will be directed through two silt fence barriers, or equivalent, to remove silt/sediment prior to leaving the project site. If the water does come into contact with contaminated soil, it will be pumped into a tank and sampled for disposal characterization.

5.5 Saturated Soil Removal

Although unlikely, in the event contaminated soil becomes saturated in an excavation or stockpile area, the Site Manager will initiate measures to ensure that the soil can be prepared for transport and disposal. Those measures may include one or more of the following:

- Create an area within or adjacent to the affected area where excess water is allowed to drain and can then be collected.
- Mix saturated soil with dry soil (i.e., post waste characterization) ex situ prior to disposal.
- As a last resort, add absorbent to ensure no free liquids are present during transportation to the disposal facility.

5.6 Discovery of Subsurface Contaminant Sources

Although no subsurface contaminant sources are expected to be encountered during the RSA-013 excavation activities, subsurface piping, drains, or other undiscovered contaminant sources may be encountered. If any of these subsurface contaminant sources are encountered during the excavation, the feature will be handled in the following manner:

- If free liquid is found within the feature, it will be addressed as follows:
  - Small amounts will be mixed with dry soil from the excavation or an absorbent until no free liquid is visible.
  - Amounts too large for mixing/absorption will be removed, tested, and disposed of as a separate waste stream.
- Abandoned piping, drains, etc., that are within the excavation area will be excavated and staged along with the surrounding soil and disposed of in like manner with the surrounding soil.

- If a conduit extends outside the excavation and that boundary of the excavation has passed the CG, the conduit will be plugged with at least 2 feet of cement grout.

5.7 Discovery of Munitions and Explosives of Concern/Chemical Warfare Materiel

Available information, including historical records and recent environmental sampling data, was reviewed with respect to MEC, including CWM, or CA potential at RSA-013. The UXO probability rating is Low and the CWM probability rating is Unlikely. Based on this, no CA monitoring will be required for the CMI but on-call UXO construction support will be required for site access and intrusive activity. In the event any suspicious item is encountered, all work will stop and the Project Manager and Health and Safety Manager will be notified and will be responsible for following the notification requirements in the Explosive Safety Management Program (Army, 2018). If the suspicious item can be positively identified by the qualified UXO personnel as not presenting an explosive or CA hazard or once the hazard has been removed, work will proceed. Further information on this hazard identification, notification, and removal process is presented in RSA's installation-wide accident prevention plan (CEHNC, 2019) and the SSHP accompanying this CMI work plan (Appendix E).

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ATTACHMENT 1

LIST OF ACRONYMS AND ABBREVIATIONS

List of Abbreviations and Acronyms
Redstone Arsenal, Madison County, Alabama

Acronym	Definition
µg/g	micrograms per gram
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
µmhos/cm	micromhos per centimeter
µS/cm	microsiemens per centimeter
µg/m^3	micrograms per cubic meter
ºC	degrees Celsius
ºF	degrees Fahrenheit
%D	percent difference
%R	percent recovery
1,1,2-TCA	1,1,2-trichloroethane
1,1-DCE	1,1-dichloroethene
1,2-DCE	1,2-Dichloroethene
2,4,5-T	2,4,5-trichlorophenoxyacetic acid
2,4,5-TP	2,4,5-trichlorophenoxypropionic acid
2,4-D	2,4-dichlorophenoxyacetic acid
2-ADNT	2-amino-4,6-dinitrotoluene
4-ADNT	4-amino-2,6-dinitrotoluene
AAC	Alabama Administrative Code
AAFES	Army and Air Force Exchange Service
AAP	Army Ammunition Plant
AB	ambient blank
ABLM	adult blood lead model
ABP	agent breakdown products
ABS	dermal absorption factor
ACAD	AutoCadd
ACGIH	American Conference of Governmental Industrial Hygienists
ACM	asbestos-containing material
ACSIM	Assistant Chief of Staff for Installation Management
ADAF	age-dependent adjustment factor
ADEM	Alabama Department of Environmental Management
ADPH	Alabama Department of Public Health
AEC	U.S. Army Environmental Command
AEDA	ammunition, explosives, and other dangerous articles
AEDB	Army Environmental Database
AEIRG	Alabama Environmental Investigation and Remediation Guidance
AEL	airborne exposure limit
AER	annual effectiveness report
AERMOD	American Meteorology Society/Environmental Protection Agency Regulatory Model
AET	apparent effects threshold
AF	soil-to-skin adherence factor
AFFF	Aqueous Fire Fighting Foam
AFS	air filtration system
AGC	advanced geophysical classification
AGS	Alabama Geographic Society
AHA	ammunition holding area
AHWMMA	Alabama Hazardous Wastes Management and Minimization Act
AIPH	Army Institute of U.S. Public Health
AL	Alabama
ALDOT	Alabama Department of Transportation
ALNHP	Alabama Natural Heritage Program
amb.	amber
AMCOM	U.S. Army Aviation and Missile Command
AMRDEC	Aviation and Missile Research, Development, and Engineering Center
amsl	above mean sea level (1988 North American Vertical Datum, NAVD 88)
ANOVA	Analysis of Variance
AOC	area of concern
AOI	area of investigation
AP	armor piercing
APEC	areas of potential ecological concern
APHC	U.S. Army Public Health Center
APT	armor-piercing tracer
APTIM	Aptim Federal Services, LLC
AR	Army Regulation
AR/COC	analysis request/chain of custody
ARAR	applicable or relevant and appropriate requirement
ARBCA	Alabama Risk-Based Corrective Action
AREE	area requiring environmental evaluation
ARFO	ammunition returned from overseas
Army	U.S. Army
AS	air sparging
ASCII	American Standard Code for Information Interchange
ASP	Ammunition Supply Point
ASR	archives search report
AST	aboveground storage tank
ASTM	American Society for Testing and Materials
ASV	alternative screening value
ASWCC	Alabama Soil and Water Conservation Committee
AT	averaging time; arsenic trichloride
ATF	Bureau of Alcohol, Tobacco, Firearms and Explosives
atm-m^3/mol	atmosphere cubic meters per mole
ATS	alternative treatment standard
ATT	Applied and Technical Training
ATSDR	Agency for Toxic Substances and Disease Registry
ATTN	attention
ATV	all-terrain vehicle
AUF	area use factor
AWARE	Associated Water and Air Resources Engineers, Inc.
AWBC	alternative water balance cover

List of Abbreviations and Acronyms
Redstone Arsenal, Madison County, Alabama

Acronym	Definition
AWQC	ambient water quality criteria
AWQS	ambient water quality standard
B	Analyte detected in laboratory or field blank at concentration greater than the reporting limit (and greater than zero)
BAF	bioaccumulation factor
$BAF_{soil\text{-}to\text{-}invert}$	soil-to-invertebrate bioaccumulation factor
BaOH	barium hydroxide
BAP	benzo(a)pyrene
BCF	bioconcentration factor
BCT	BRAC Cleanup Team
BCY	bank cubic yards
BDCM	bromodichloromethane
BCEE	bis(2-chloroethyl)ether
BEHP	bis(2-ethylhexyl)phthalate
BEM	Buried Explosion Module
BERA	baseline ecological risk assessment
BFB	bromofluorobenzene
BFE	base flood elevation
BFM	bonded fiber matrix
BG	Bacillus globigii
bgs	below ground surface
Bhate	Bhate Environmental Associates, Inc.
BHC	hexachlorocyclohexane
BHHRA	baseline human health risk assessment
BIM	basic information map
BIP	blow(n)-in-place
bkg	background
bls	below land surface
BMP	best management practice
BOD	biological oxygen demand
Bp	soil-to-plant biotransfer factors
BR	bedrock
BR-D	deep bedrock
BRAC	Base Realignment and Closure
BSAF	biota-to-sediment accumulation factors
BSC	background screening criterion
BSCRN	bottom of screen
BSV	background screening value
BTAG	Biological Technical Assistance Group
BTEX	benzene, toluene, ethyl benzene, and xylenes
BTOC	below top of casing
BTV	background threshold value
BW	body weight
BZ	breathing zone
C	ceiling limit value
C&D	Construction & Demolition
Ca	carcinogen
CA	chemical agent; corrective action
CAA	Clean Air Act
CAB	chemical warfare agent breakdown products
CACM	Chemical Agent Contaminated Media
$CaCO_3$	calcium carbonate
CAIS	chemical agent identification set
CalEPA	California Environmental Protection Agency
CAMU	corrective action management unit
CAP	corrective action plan; Contractor Acquired Property
CAR	corrective action request
CARA	Chemical, Biological, Radiological, Nuclear, and High-Yield Explosives (CBRNE) Analytical and Remediation Activity
CAS	Chemical Abstracts Service
CASE	Corrective Action System Effectiveness
CASNO	Chemical Abstract Service identification number
CASRN	Chemical Abstracts Service Registry Number
CB	chlorobenzene
CB&I	CB&I Federal Services LLC
CBC	Chemical and Biological Center
CBFM	collodial borescope flowmeter
CBMPP	construction best management practices plan
CBR	chemical, biological, and radiological
CBRN	chemical, biological, radiological, nuclear
CBRNE	Chemical, Biological, Radiological, Nuclear, and High-Yield Explosives
CBZ	chlorobenzene
CCAL	continuing calibration
CCB	continuing calibration blank
CCC	criterion continuous concentration
CCDC	Combat Capabilities Development Command
CCl_4	carbon tetrachloride
CCV	continuing calibration verification
CD	compact disk; Consent Decree
CDE	Chemical Defense Equipment
CDI	chronic daily intake
CDR	Contract Discrepancy Report
CDTF	Chemical Defense Training Facility
CEHNC	U.S. Army Engineering and Support Center, Huntsville
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERFA	Community Environmental Response Facilitation Act
CESAS	Corps of Engineers South Atlantic Savannah
CF	conversion factor
CFC	chlorofluorocarbon
CFDP	Center for Domestic Preparedness
CFR	Code of Federal Regulations

List of Abbreviations and Acronyms
Redstone Arsenal, Madison County, Alabama

Acronym	Definition
cfs	cubic feet per second
C_{fw}	contaminant concentration in fish from surface water
CG	phosgene (carbonyl chloride); cleanup goal
CGI	combustible gas indicator
ch	inorganic clays of high plasticity
CHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
CIH	Certified Industrial Hygienist
cis-1,2-DCE	cis-1,2-Dichloroethene
CK	cyanogen chloride
Cl	chloride, chlorinated
CLIN	contract line item number
ClO_4^-	perchlorate
CLP	Contract Laboratory Program
CLPILM	EPA CLP's prefix designation for the inorganic metals analysis statement of work
CLP M	EPA CLP's prefix designation for the mercury analysis statement of work
CM	corrective measure
cm	centimeter
cm/hour	centimeters per hour
cm^2	cubic centimeter
cm^2/second	square centimeters per second
cm^3/g	cubic centimeters per gram
CMA	U.S. Army Chemical Materials Activity; corrective measure alternative
CMC	criterion maximum concentration
CMD	corrective measures design
CMI	corrective measures implementation
CMICR	corrective measures implementation completion report
CMIP	corrective measures implementation work plan
CMO	corrective measure objective
CMS	corrective measures study
CMT	Continuous Multichannel Tubing
CN	chloroacetophenone
CNB	chloroacetophenone, benzene, and carbon tetrachloride
CNS	chloroacetophenone, chloropicrin, and chloroform
CO	carbon monoxide
CO_2	carbon dioxide
Co-60	cobalt-60
CoA	Code of Alabama
COAC	chemical of analytical concern
COC	when discussing chemicals, COC means chemical of concern; when discussing field paperwork, COC means chain of custody
COE	Corps of Engineers
COI	constituent of interest
Con	skin or eye contact
COPAC	chemical of potential analytical concern
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
COR	Contracting Officer's Representative
CP	communication plan; Competent Person
CPARS	Contractor Performance Assessment Reporting System
CPFF	cost plus fixed fee
CPOM	coarse particulate organic matter
CPSS	chemicals present in site samples
CPVC	chlorinated polyvinyl chloride
C_{pw}	chemical of potential ecological concern concentration in pore water
CQA	construction quality assurance
CQAP	construction quality assurance plan
CQCSM	Construction Quality Control System Manager
CRA	Conestoga-Rovers and Associates
CRDL	contract-required detection limit
CRL	certified reporting limit
CRP	community relations plan; compliance-related program
CRQL	contract-required quantitation limit
CRSA	Central Redstone Arsenal
CRZ	contamination reduction zone
CS	ortho-chlorobenzylidene-malononitrile
CSA	confirmation sampling activities
CSDWP	Comprehensive Site-Specific Demolition Work Plan
C_{sed}	chemical of potential ecological concern concentration in sediment from groundwater
CSEM	conceptual site exposure model
CSM	conceptual site model
CSP	chemical site plan
CSP	corrugated steel pipe
CSS	chemical safety submission
SCWGP	Construction Stormwater General Permit
CT	carbon tetrachloride
CTC	cost to completion
ctr.	container
CVAA	2-chlorovinylarsenous acid
C_w	contaminant concentration in water
CWA	when discussing chemicals, CWA means chemical warfare agent; when discussing laws, CWA means Clean Water Act
CWM	If used in the text of a document this acronym means chemical warfare materiel; if used in an analytical table which summarizes container requirements, this acronym means clear, widemouth container
CWS	Chemical Warfare Service
CX	dichloroformoxime
D	duplicate; duplicate contamination; when used as a validation qualifier, D means dilution
D2PC	Personal Computer Program for Chemical Hazard Prediction
DAD	average dermally absorbed dose
DAVS	detector-aided visual survey
D&I	detection and identification

List of Abbreviations and Acronyms
Redstone Arsenal, Madison County, Alabama

Acronym	Definition
DA	Department of the Army; diphenylchloroarsine
DA PAM	Department of the Army Pamphlet
DAAMS	Depot Area Air Monitoring System
DA_{event}	dermal dose absorbed per event
DAF	dilution-attenuation factor
DAF4	dilution-attenuation factor 4
DANC	decontamination agent, non-corrosive
DAP	diammonium phosphate
DASAF	Department of the Army Safety Office
DAVS	detector-aided visual survey
DBA	dibenz(a,h)anthracene
DBCP	1,2-dibromo-3-chloropropane
DBX	depth bomb explosive
DC	District of Columbia
DCA	dichloroethane
DCB	decachlorobiphenyl
DCE	dichloroethene
DCMA	Defense Contract Management Agency
DCQAP	data collection quality assurance plan
DD	Decision Document
DD	Department of Defense (form only)
DDD	dichlorodiphenyldichloroethane (this is an industry standard acronym for this chemical)
DDE	dichlorodiphenyldichloroethene (this is an industry standard acronym for this chemical)
DDESB	Department of Defense Explosives Safety Board
DDT	dichlorodiphenyltrichloroethane
DEH	Directorate of Engineering and Housing
DEHP	bis(2-ethylhexyl)phthalate
DEMIL	Demilitarization Areas
DEP	depositional soil
DERP	Defense Environmental Restoration Program
DES	Directorate of Environment and Safety
DF	dilution factor
DFTPP	decafluorotriphenylphosphine
DFOW	Definable Feature of Work
DGM	digital geophysical mapping
DHC	*Dehalococcoides* sp.
DI	deionized
DID	data item description
DIMP	di-isopropylmethylphosphonate
DL	detection limit
DLA	Defense Logistics Agency
DM	adamsite
DMBA	dimethylbenz(a)anthracene
DMM	discarded military munitions
DMMP	dimethylmethylphosphonate
DNAPL	dense nonaqueous-phase liquid
DNB	dinitrobenzene
DNBZ	dinitrobenzene
DNOC	4,6-dinitro-2-methylphenol
DNT	dinitrotoluene
DO	dissolved oxygen
DoD	U.S. Department of Defense
DODI	Department of Defense Instruction
DOJ	U.S. Department of Justice
DOT	U.S. Department of Transportation
DP	direct-push
DPDO	Defense Property Disposal Office
DPT	direct-push technology
DQCR	Daily Quality Control Report
DQO	data quality objective
DRMO	Defense Reutilization and Marketing Office
DRO	diesel range organics
DS	deep (subsurface) soil
DS2	Decontamination Solution Number 2
DSERTS	Defense Site Environmental Restoration Tracking System
DSMOA	Defense and State Memorandum of Agreement
DSN	Defense Switched Network
DSR	demolition and site restoration
DSS	data sufficiency summary
DTSC	Department of Toxic Substances Control
DU	decision unit
DUA	data usability assessment
DVD	digital versatile disc or digital video disc
DWEL	drinking water equivalent level
e.g.	for example
E3	Electromagnetic Environmental Effects
EB	equipment blank
EBS	environmental baseline study
EC_{20}	effects concentration for 20 percent of a test population
EC_{50}	effects concentration for 50 percent of a test population
EC	Emergency Coordinator
ECBC	Edgewood Chemical and Biological Center
Eco-RGRG	ecological risk-based remedial goal
Eco-SSL	ecological soil screening level
ECM	earth covered magazine
ED	exposure duration
EDD	electronic data deliverable
EDQL	ecological data quality level
EDS	explosive destruction system

List of Abbreviations and Acronyms
Redstone Arsenal, Madison County, Alabama

Acronym	Definition
EDTA	ethylenediaminetetracetic acid
EE/CA	engineering evaluation and cost analysis
EEL	estimated exposure level
EF	exposure frequency
EFR	enhanced fluid recovery
Eh	oxidation-reduction potential
ELAP	Environmental Laboratory Accreditation Program
Elev.	elevation
EM(1)	electromagnetic
EM(2)	Engineer Manual
EM31	Geonics Limited EM31 Terrain Conductivity Meter
EM61	Geonics Limited EM61 High-Resolution Metal Detector
EMI	electromagnetic induction
Empirical	Empirical Laboratories, LLC
EMSI/EL	Environmental Management Services, Inc./Environmental Laboratories
EMT	emergency medical technician
EOC	Emergency Operation Center
EOD	explosive ordnance disposal
EODT	explosive ordnance disposal team; EOD Technology, Inc.
EP	exit pathway
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
EPDS	Emergency Personnel Decontamination Station
EPIC	Environmental Photographic Interpretation Center
EPP	Environmental Protection Plan
EPRI	Electrical Power Research Institute
EPT	Ephemeroptera, Plecoptera, Trichoptera
EQ	EQ Environmental Quality Company
EQL	estimated quantitation limit
ER	equipment rinsate; USACE Engineer Regulation
ERA	ecological risk assessment
ERH	electrical resistive heating
ERIS	Environmental Restoration Information System
ER-L	effects range-low
ER-M	effects range-medium
ERMA	Environmental Remediation Services Multiple Award
ES	exposed site
ESA	ecologically sensitive area
ESB	Equilibrium Partitioning Sediment Benchmark
ESE	Environmental Science and Engineering, Inc.
ESL	ecological screening level
ESP	explosives site plan
ESMP	Endangered Species Management Plan; Explosives Safety Management Program
ESS	explosives safety submission
ESTCP	Environmental Security Technology Certification Program
ESV	ecological screening value
ET	exposure time
ET_{sw}	exposure time - surface water
EU	exposure unit
EUR	Environmental Use Restriction
EV	event frequency
E-W	east to west
Excel	Excel Geophysical Services
Exp.	Explosives
ExplorTech	ExplorTech, LLC
EXTOXNET	Extension Toxicology Network
Ey	Etowah silty clay loam
EZ	exclusion zone
FA	focus area
FA	fraction absorbed
FAC	facultative wetland
FACU	facultative upland
FACW	facultative wetland
FADL	Field Activity Daily Log
FAE	fuel-air explosive
FAR	Federal Acquisition Regulations
FAV	final acute value
FB	field blank
FBI	Family Biotic Index
FCM	food chain multiplier
FCSV	food chain screening value
FCV	final chronic value
FD	field duplicate
FDA	U.S. Food and Drug Administration
Fe^{+2}	ferrous iron
Fe^{+3}	ferric iron
FEC	fluid electrical conductivity
FedEx	Federal Express, Inc.
FEMA	Federal Emergency Management Agency
FFA	Federal Facilities Agreement
FFCA	Federal Facilities Compliance Act
FFE	field flame expedient
FFP	firm fixed price
FFS	focused feasibility study
FI	fraction of exposure; filtered
FID	flame ionization detector
FIFRA	Federal Insecticide, Fungicide, & Rodenticide Act
FLUTe	Flexible Liner Underground Technologies, Ltd. Co.
FM-ARNGTC	Fort McClellan Army National Guard Training Center

List of Abbreviations and Acronyms
Redstone Arsenal, Madison County, Alabama

Acronym	Definition
FMDC	Fort McClellan Development Commission
FML	flexible membrane liner
f_{oc}	fraction organic carbon
FOIA	Freedom Of Information Act
FOMRA	Former Ordnance Motor Repair Area
FOST	Finding of Suitability to Transfer
Foster Wheeler	Foster Wheeler Environmental Corporation
FR	Federal Register
Frtn	fraction
FS	feasibility study
FSH	Fort Sam Houston
FSP	field sampling plan
FS smoke	sulfur trioxide and chlorosulfonic acid
ft	foot, feet
ft/day	feet per day
ft/ft	feet per foot
ft/yr	feet per year
ft^2	square feet
ft^2/day	square feet per day
FTA	Fire Training Area
FUP	fixed unit price
FWV	fieldwork variance
FY	fiscal year
g	gram
G&M	Geraghty and Miller, Inc.
g/cm^3	grams per cubic centimeter
g/m^2	grams per square meter
g/m^3	gram per cubic meter
G-856	Geometrics, Inc. G-856 magnetometer
G-858G	Geometrics, Inc. G-858G magnetic gradiometer
GA	tabun
GAC	granular activated carbon
GAF	General Aniline and Film; gastrointestinal absorption factor
gal	gallon
gal/min	gallons per minute
GB	sarin (isopropyl methylphosphonofluoridate)
GC	gas chromatograph
GC/MS	gas chromatograph/mass spectrometer
GCL	geosynthetic clay liner
GCMR	Geophysical Classification for Munitions Response
GCWD	Gulf Chemical Warfare Depot
GCWS	Gulf Chemical Warfare Service
GEAE	Generic Ecological Assessment Endpoint
GED	General Equivalency Diploma
GEDIT	gaseous electron donor injection technology
GFAA	graphite furnace atomic absorption
GIP	geophysical investigation plan
GIS	geographic information system
GNSS	Global Navigation Satellite System
GPCR	gas phase chemical reduction
gpm	gallons per minute
GPR	ground-penetrating radar
GPS	global positioning system
GRA	general response action
GRIM	Groundwater Responsibility Information Matrix
GRO	gasoline range organics
GS	ground scar
GSA	when discusing the federal government requirements, GSA means General Services Administration; when discussing geology, GSA means Geologic Survey of Alabama
GSE	Great Southern Engineering
GSR	green and sustainable remediation
GST	ground stain
GSV	geophysical systems verification
GUC	groundwater use control
GW	groundwater
GWDT	Groundwater Design Team
GWMZ	groundwater monitoring well, multizone
GWTR	groundwater monitoring well
H&S	health and safety
H_2O_2	hydrogen peroxide
H_2S	hydrogen sulfide
HA	hand auger; hazard assessment
HAL	Health Advisory level
HAMUST56	Huntsville Arsenal Mustard Plant 2, Lines 5 & 6
Harmon	Harmon Engineering Associates, Inc.
HAZMATCAD™	Hazardous Material Chemical Agent Detector
HAZWOPER	Hazardous Waste Operations and Emergency Response
HBESL	health-based environmental screening level
HC	mixture of hexachloroethane, aluminum powder, and zinc oxide (smoke producer)
HCE	hexchloroethane
HCl	hydrochloric acid
HD	distilled mustard (bis-[dichloroethyl]sulfide); hazard division
HDPE	high-density polyethylene
HE	high explosive
HEAST	Health Effects Assessment Summary Tables
HEAT	High Explosive Anti-Tank
HEPA	high-efficiency particulate air
HEGA	high-efficiency gas absorber

List of Abbreviations and Acronyms
Redstone Arsenal, Madison County, Alabama

Acronym	Definition
Herb.	herbicides
HFD	hazardous fragment distance
HHAWQS	human health Alabama water quality standard
HHRA	human health risk assessment
HHRE	human health risk evaluation
HI	hazard index
HI_{COC}	total hazard index for a given relevant COC, for a given receptor added across all exposure routes for given source medium
Hi_{cum}	cumulative hazard index summed across chemicals and source media
HI_{TO}	total hazard index for a given target organ for a given receptor
Hm	hot measurement
HMW	high molecular weight
HMX	cyclotetramethylenetetranitramine; octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocane
HN	hydrogen mustard
HNC	hydrogen cyanide
HNO_3	nitric acid
HP	hydropunch
HPLC	high-performance liquid chromatography
HQ	hazard quotient
HQ_{COCi}	hazard quotient for the target organ of interest estimated for the ith COC
$'HQ_i$	hazard index for a given chemical summed across exposure routes and source media
$'HQ_{Ri}$	hazard quotient for the given chemical for exposure route i
HQ_{screen}	screening-level hazard quotient
hr	hour
HRR	Historical Records Review
HS	mustard
HSA	hollow-stem auger
HSB	Huntsville Spring Branch
HSDB	Hazardous Substances Data Bank
HSF	historic site feature
HSMR	Huntsville Spring Branch at Martin Road
HT	British Mustard
HTPB	hydroxy-terminated polybutadiene
HTRW	hazardous, toxic, and radioactive waste
HTW	hazardous and toxic waste
HUB	Historically Underutilized Business
HWCL	hazardous waste control limit
HWSA	Hazardous Waste Storage Area
HWSU	hazardous waste storage unit
HY	hydrostratigraphic unit
HYPN	hydropunch
Hz	hertz
I	out of control, data rejected due to low recovery
I-565	Interstate 565
IAP	Installation Action Plan
IATA	International Air Transport Authority
I-AVSS	instrument-aided visual surface sweep
IC	Incident Commander
ICAL	initial calibration
ICAM	improved chemical agent monitor
ICB	initial calibration blank
ICP	inductively coupled plasma
ICS	interference check sample
ICV	initial calibration verification
ID	identification; inside diameter
IDL	instrument detection limit
IDLH	immediately dangerous to life or health
IDM	investigative-derived media
IDQTF	Intergovernmental Data Quality Task Force
IDS	intrusion detection system
IDW	investigation-derived waste; investigative-derived waste
i.e.	that is (in other words)
IELCR	individual excess lifetime cancer risk
$IELCR_{coc}$	total individual excess lifetime cancer risk for a given relevant chemical of concern, for a given receptor added across all exposure routes for a given source medium
$'IELCR_{Cum}$	cumulative cancer risk for a given receptor summed across chemicals and source media
$'IELCR_{Ri}$	cancer risk for the given chemical in a given source medium for exposure route i
$'IELCR_T$	total cancer risk for the given chemical in a given source medium summed across exposure routes
$IELCR_{(Ti)}$	total cancer risk for chemical i in a given source medium summed across exposure routes
IEOC	Installation Emergency Operations Center
IERC	Installation Environmental Response Coordinator
IEUBK	Integrated Exposure Uptake Biokinetic
IF	ingestion factor; inhalation factor
IHF	interim holding facility
IIP	intrusive investigation plan
ILCR	incremental lifetime cancer risk
ILM	EPA CLP's prefix designation for the inorganic metals analysis statement of work for EPA contract laboratory program
IM	interim measure; isobutyl methacrylate
IMO	interim measure objective
IMU	inertial measurement unit
IM-AE	isobutyl methacrylate polymer AE
IMPA	isopropylmethyl phosphonic acid
in.	inch
Inc.	Incorporated
Ing	ingestion
Inh	inhalation
INT	interface
IOSC	Installation On-Scene Coordinator

List of Abbreviations and Acronyms
Redstone Arsenal, Madison County, Alabama

Acronym	Definition
IOU	integrator operable unit
IP	ionization potential
IPS	International Pipe Standard
IR	ingestion rate
IRAO	interim remedial action objective
IRAP-h	Industrial Risk Assessment Program-Human Health
IRDMIS	Installation Restoration Data Management Information System
IR_f	fish ingestion rate
'IR_{sw}	ingestion rate
IRFNA	inhibited red fuming nitric acid
IRIS	Integrated Risk Information System
IROD	interim record of decision
IRP	Installation Restoration Program
IRSL	industrial regional screening level
IS	incremental sampling
ISAB	in situ anaerobic bioremediation
ISBN	International Standard Book Number
ISCO	in situ chemical oxidation
ISCR	in situ chemical reduction
ISEB	in situ enhanced bioremediation
ISL	initial screening level
ISO	industry standard object
ISSC	Installation Support Services Contractor
ISTD	in situ thermal destruction
ISTT	in situ thermal treatment
IT	IT Corporation
ITEMS	IT Environmental Management System™
ITRC	Interstate Technology and Regulatory Council
IV	intervention value
IVS	instrument verification strip
IW	installation-wide
IWGW	installation-wide groundwater
IWGWMP	Installation-Wide Groundwater Monitoring Program
IWWP	installation-wide work plan
J	estimated concentration
J&E	Johnson and Ettinger
JD	jurisdictional determination
JOR	job order request
K	conductivity
KAPSDIDS	Kinetically Adjustable Pore Spaace Dilation Injection Delivery System
K_d	soil-water distribution coefficient
Kd_{bs}	bed sediment-sediment pore water partition coefficient
KeV	kilo electron volt
kg	kilogram
kg/m^3	kilograms per cubic meter
$KMnO_4$	potassium permanganate
KO	Contracting Officer
K_{oc}	organic carbon partioning coefficient
K_{ow}	octanol-water partition coefficient
K_p	permeability coefficient
kPa	kilopascal
kVA	kilovolt-ampere
L	if used as part of the units of measure, the acronym stands for "liter", if used as a chemical name, this acronym stands for lewisite
L/cm^3	liters per cubic centimeter
L/day	liters per day
L/kg/day	liters per kilogram per day
LANL	Los Alamos National Laboratory
lb	pound
LBP	lead-based paint
lbs/year	pounds per year
LC	liquid chromatography
LC_{50}	lethal concentration for 50 percent population tested
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LD_{50}	lethal dose for 50 percent population tested
LDD	lost, damage, or destruction
LEL	lower explosive limit
LF	Leaching Factor
LGAC	liquid-phase granular activated carbon
LiDAR	Light Detection and Ranging
LL	low level
LLC	limited liability company
LNAPL	light nonaqueous-phase liquid
LOAEL	lowest-observed-adverse-effects level
LOD	limit of detection
LOEC	lowest-observable-effect-concentration
LOQ	limit of quantitation
LSA	limited site assessment
LSV	leachate screening value
LTO	long-term operation
LTM	long-term management
LTV	leachate threshold value
LUC	land-use control
LUCAP	land-use control assurance plan
LUCER	land-use control effectiveness report
LUCIP	land-use control implementation plan
LWSV	liquid waste screening value

List of Abbreviations and Acronyms
Redstone Arsenal, Madison County, Alabama

Acronym	Definition
m	meter
m/year	meters per year
m/yr	meters per year
m/second	meters per second
m^3/hour	cubic meters per hour
m^3/kg	cubic meters per kilogram
MACOM	Major Command
MADEP	Massachusetts Department of Environmental Protection
MADL	minimum analytical detection limit
MAG	monitoring acceptance goal
MARB	Munitions Assessment Review Board
max	maximum
MB	method blank
MC	munitions constituents
MCDZ	McDonald Creek discharge zone
MCE	Maximum Credible Event
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MCPA	4-chloro-2-methylphenoxyacetic acid
MCPP	2-(2-methyl-4-chlorophenoxy)propionic acid
MCS	media cleanup standard
MD	munitions debris; Mahalanobis Distance
MDAS	Material Documented as Safe
MDC	maximum detected concentration
MDCC	maximum detected constituent concentration
MDEH	Material Documented as an Explosive Hazard
MDL	method detection limit
MEA	monoethanolamine
MEC	munitions and explosives of concern
MEE	methane, ethane, and ethene
MEP	Multiple Extraction Procedure
MeV	mega electron volt
MFD	maximum fragment distance
Mfp	Mississippian Fort Payne
mg	milligrams
mg/cm^2	milligrams per square centimeter
mg/cm^2/day	milligrams per square centimeter per day
mg/cm^2/event	milligrams per square centimeter per event
mg/day	milligrams per day
mg/kg	milligrams per kilogram
mg/kg-day	milligram per kilogram day
mg/kgbw/day	milligrams per kilogram of body weight per day
mg/L	milligrams per liter
mg/m^3	milligrams per cubic meter
mgal	million gallons
MGFD	munition with the greatest fragmentation distance
mh	highly plastic, inorganic silts, micaceous or diatomaceous fine, sandy or silt soils
MHz	megahertz
MI	multi-incremental
MICC	Mission & Installation Contracting Command
MIDAS	Munitions Items Desposition Action System
MiHPT	Membrane Interface Hydraulic Profile Tooling
min	minimum
MIMS	Munitions Information Management System
MINICAMS	miniature continuous air monitoring system
MIS	Management Information System; multiple incremental samples
mL	milliliter
mm	millimeter
MMAS	Mobile Munitions Assessment Systems
MMBtu/hr	million Btu per hour
MMCS	Missile and Munitions Command School
MM-CX	Military Munitions Center of Expertise
MMOA	mutagenic mode of action
MMRP	Military Munitions Response Program
Mn^{+4}	manganese
MNA	monitored natural attenuation
MnO_4-	permanganate ion
MNR	monitored natural recovery
MOA	Memorandum of Agreement
MOCA	4,4-methylene-bis(2-chloroaniline)
MOGAS	motor vehicle gasoline
MOUT	Military Operations in Urban Terrain
MP	Military Police
MPA	methyl phosphonic acid
MPC	maximum permissible concentration; measurement performance criteria
MPM	most probable munition
MPPEH	Material Potentially Presenting an Explosive Hazard
MPR	4.2-Inch Mortar Proofing Range
MPVE	multiphase vapor extraction
MQL	method quantitation limit
MQO	measurement quality objective
MR	molasses residue; munitions response
MRA	munitions response area
MRC	multiple round container
MRL	method reporting limit
MRL	minimal risk level
MRR	Materials Receiving Report
MRS	Munitions Response Site

List of Abbreviations and Acronyms
Redstone Arsenal, Madison County, Alabama

Acronym	Definition
MRSPP	Munitions Response Site Prioritization Protocol
MS	matrix spike
mS/cm	millisiemens per centimeter
mS/m	millisiemens per meter
MS/MSD	matrix spike/matrix spike duplicate
MSD	when discussing laboratory QC, MSD means matrix spike duplicate; when discussing explosives, MSD means minimum separation distance
MSFC	George C. Marshall Space Flight Center
msl	mean sea level
Mt	Mississippian Tuscumbia Limestone
MTBE	methyl tertiary butyl ether
M&TE	measurement and test equipment
mV	millivolts
MW	monitoring well
Na	sodium
N/A	not applicable
NA	not applicable
NAD	North American Datum
NAD83	North American Datum of 1983
$NaMnO_4$	sodium permanganate
NAPL	nonaqueous-phase liquid
NAS	National Academy of Sciences
NASA	National Aeronautics and Space Administration
NAVD 88	North American Vertical Datum, 1988 adjustment
NAVD88	North American Vertical Datum of 1988
NB	nitrobenzene
NBA	Northern Burial Area
NCEA	National Center for Environmental Assessment
NCP	National Contingency Plan
NCR	nonconformance report
NCRP	National Council on Radiation Protection and Measurements
ND	not detected
NDA	Northern Disposal Area
NDMA	n-nitrosodimethylamine
NDPA	n-nitroso-di-n-propylamine
NE	northeast
NELAP	National Environmental Laboratory Accreditation Program
NEPA	National Environmental Protection Act
NEW	net explosive weight
NFA	no further action
NFG	National Functional Guidelines
NFPA	National Fire Protection Agency
NG	National Guard
ng/L	nanograms per liter
NGB	National Guard Bureau
NGP	National Guardsperson
NGVD	National Geodetic Vertical Datum
Ni	nickel
NIC	notice of intended change
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NJDEP	New Jersey Department of Protection
NLM	National Library of Medicine
NLT	no later than
NMEA	National Marine Electronics Association
No.	number
NO_3^-	nitrate
NOAA	National Oceanic and Atmospheric Administration
NOAEL	no-observed-adverse-effects level
NOEC	no-observable-effect concentration
NONEL	non-electric
NOI	Notice of Intent
NOT	Notice of Termination
NP	nitropropyl
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NPW	net present worth
NR	not requested
NRC	National Research Council
NRCC	National Research Council of Canada
NRHP	National Register of Historic Places
NRL	Naval Research Laboratory
NRT	near real time
ns	nanosecond
NS	not surveyed
N-S	north to south
NSA	New South Associates, Inc.
NT	nitrotoluene
nT	nanotesla
nT/m	nanoteslas per meter
NTCRA	Non-Time Critical Removal Action
NTIS	National Technical Information Service
NTP	National Toxicology Program
NTU	nephelometric turbidity unit
nv	not validated
NY DOH	New York State Department of Health
O&G	oil and grease
O&M	operation and maintenance
O_2	oxygen

List of Abbreviations and Acronyms
Redstone Arsenal, Madison County, Alabama

Acronym	Definition
O_3	ozone
OB/OD	open burn/open detonation
OBL	obligate
OCDD	octachlorodibenzo-p-dioxin
OD	outside diameter; other (nonmunitions) debris
OE	ordnance and explosives
OEC	Ordnance Explosives Center
OEHHA	Office of Environmental Health Hazard Assessment (of the California Environmental Protection Agency)
OESS	Ordnance and Explosives Safety Specialist
OGMS	Ordnance Guided Missile School
oh	organic clays of medium to high plasticity
OH·	hydroxyl radical
ol	organic silts and organic silty clays of low plasticity
OMEMS	Ordnance Munitions and Electronic Maintenance School
OP	organophosphorus; organochlorine pesticide
ORA	Operational Range Assessment
ORAP	Operational Range Assessment Program
Ord	Ordovician
ORP	oxidation-reduction potential
OSA	Open Storage Area
OSC	On-Scene Coordinator
OSD	overage/shortage/damage
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
OU	operable unit
OVA	organic vapor analyzer
OVB	overburden
OVB-S	shallow overburden
OVM	organic vapor monitoring
OVM-PID/FID	organic vapor meter-photoionization detector/flame ionization detector
OWS	oil/water separator
oz	ounce
P&T	pump and treat
PA	preliminary assessment; probability assessment
PA3	Plant Area 3, Incendiaries Manufacturing
PAED	Public Access Exclusion Distance
PAH	polynuclear aromatic hydrocarbon
PAL	preliminary action level
PARCCS	precision, accuracy, representativeness, comparability, completeness, and sensitivity
Parsons	Parsons Engineering Science, Inc.
Pb	lead
PBAA	polybutadiene acrylic acid
PBAN	polybutadiene/acrylic acid/acrylonitrile
PBC	performance-based contract
PBMS	performance-based measurement system
PC	permeability coefficient
PCA	tetrachloroethane
PCB	polychlorinated biphenyl
PCDD	polychlorinated dibenzo-p-dioxins
PCDF	polychlorinated dibenzofurans
PCE	tetrachloroethene
PCHL	2,3,4,5-6-pentachlorocyclohexanol
PCMIA	Personal Computer Memory Card International Association
PCP	pentachlorophenol
PCR	polymerase chain reaction
PCWM	Potential Chemical Warfare Materiel
PD	phenyldichloroarsine
PDA	Personal Digital Assistant
PDB	polyethylene diffusive bag sampler
PDF	Portable Document Format
PDS	Personnel Decontamination System; post-digestive spike
PDT	Project Delivery Team
PEC	probable effect concentration
PEF	particulate emission factor
PEL	permissible exposure limit
PELA	P.E. LaMoreaux and Associates, Inc.
PERA	preliminary ecological risk assessment
PERC	perchloroethene
PES	potential explosive site
Pest.	pesticides
PETN	pentaerythritol tetranitrate
PFAS	polyfluoroalkyl substance
PFO	palustrine forested wetland
PFOA	perfluorooctanoic acid
PFOS	perfluorooctyl sulfonate
PFT	portable flamethrower
PG	professional geologist
pg/g	picograms per gram
PgM	program manager
pH	measure of acidity/alkalinity; hydrogen ion activity (negative of the logarithm, base 10)
PHC	principal hazardous constituent
PID	photoionization detector
PIEZ	piezometer
PINS	portable isotopic neutron microscopy
PK	packer
PLS	Professional Land Surveyor
PLS	Professional (licensed) Land Surveyor
PM	project manager
PMC	Program Management Contract

List of Abbreviations and Acronyms
Redstone Arsenal, Madison County, Alabama

Acronym	Definition
PNMSCM	Product Manager for Non-Stockpile Chemical Materiel
PMP	Project Management Plan
PMTP	Program Management Team Plan
POC	point of contact
POL	petroleum, oils, and lubricants
POTW	publicly owned treatment works
POW	prisoner of war; palustrine open water
Powell	John Powell Chemical Company
PP	Proposed Plan
ppb	parts per billion
ppbv	parts per billion by volume
PPE	personal protective equipment
ppm	parts per million
ppmw	parts per million by weight
PPMP	Print Plant Motor Pool
PPRTV	provisional peer-reviewed toxicity values
ppt	parts per trillion
ppT	parts per thousand
PQL	practical quantitation limit
PR	potential risk
PRA	preliminary risk assessment
PRE	preliminary risk evaluation
PRG	preliminary remediation goal
PRO	petroleum range organics
PS	chloropicrin
PSA	potential source area
PSL	preliminary screening level
PSS	palustrine scrub shrub
PSSC	potential site-specific chemical
PSV	preliminary screening value
pt	peat or other highly organic silts
PT1	an incendiary mixture in munitions
PTFE	Polytetrafluoroethylene (Teflon)
PTMP	program team management plan
PTSM	principal threat source material
PVC	polyvinyl chloride
PWS	performance work statement
PZ	piezometer
QA	quality assurance
QA/QC	quality assurance/quality control
QAM	quality assurance manual
QAO	quality assurance officer
QAPP	quality assurance project plan
QASAS	Quality Assurance Specialist Ammunition Surveillance
QASP	Quality Assurance Surveillance Plan
QC	quality control
QCP	quality control plan
QCSM	Quality Control Site Manager
QCSR	quality control summary report
Q-D	quantity-distance
QL	quantitation limit
QP	Qualified Person
Q-Q	quantile-quantile
QSAR	quantitative structure-activity relationship
QSM	quality systems manual
QST	QST Environmental, Inc.
qty	quantity
Qual	qualifier
QuickSilver	QuickSilver Analytics, Inc.
R	when used as a validation qualifier, R means rejected; when used as a lab qualifier, R means resample; when used in text, R means retardation factor
R&A	relevant and appropriate
R^2	coefficient of determination
RA	remedial action
RAGS	Risk Assessment Guidance for Superfund
RA(O)	remedial action (operations)
RAO	remedial action objective
RAP	recommended action plan
RAR	remedial action report
RARE	Redstone Arsenal Rocket Engine
RASA	Redstone Arsenal Support Activity
RAWP	remedial action work plan
Raytheon	Raytheon Company
RBA	relative bioavailability
RBC	risk-based concentration
RBP	Rapid Bioassessment Protocol
RBRG	risk-based remedial goal
RBSC	risk-based screening concentration
$RBSC_I$	risk-based screening concentration for industrial soil
$RBSC_R$	risk-based screening concentration for residential soil
$RBSC_T$	risk-based screening concentration for tap water
RBTL	risk-based target level
$RBTL_{coc}$	risk-based target level for a given relevant COC, receptor, and source medium
RC	representative concentration; response complete
RC_{coc}	representative concentration of the relevant COC in the given medium
RCA	root cause analysis
RCMD	Recovered Chemical Materiel Directorate
RCRA	Resource Conservation and Recovery Act

List of Abbreviations and Acronyms
Redstone Arsenal, Madison County, Alabama

Acronym	Definition
RCRA CA	Resource Conservation and Recovery Act Corrective Action
RCWM	Recovered Chemical Warfare Materiel
RD	remedial design
RDECOM	U.S. Army Research, Development, and Engineering Command
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine; cyclotrimethylenetrinitramine; 1,3,5-trinitro-1,3,5-triazine (cyclonite); Royal Demolition Explosive
REAT	Regional Environmental Acquisition Tools
REC	Record of Environmental Consideration
REG	regular field sample
REL	recommended exposure limit; reference exposure level
RER	Record of Environmental Review
Rev	Revision
RF	response factor
RFA	request for analysis
RfC	reference concentration
RfD	reference dose
RFI	RCRA facility investigation
RFQ	request for quotation
RG	remedial goal
RGO	remedial goal option
RI	remedial investigation
RIP	remedy in place
RL	reporting limit
RM	risk management
RM-1	Risk Management-1
RM-2	Risk Management 2
RME	reasonable maximum exposure
RMP	risk management plan
Ro	Robertsville silt loam
ROD	Record of Decision
ROF	report of findings
ROI	radius of influence
ROP	Redstone Ordnance Plant
ROPS	roll over protection system
RPD	relative percent difference
RR	range residue
RRF	relative response factor
RRSE	Relative Risk Site Evaluation
RRSL	residential regional screening level
RS	prefix for groundwater monitoring well at Redstone Arsenal
RSA	Redstone Arsenal
RSD	relative standard deviation
RSL	Regional Screening Level
RSP	Redstone Arsenal spring
RTAP	Real-Time Analytical Platform
RTC	Redstone Test Center
RTECS	Registry of Toxic Effects of Chemical Substances
RTK	real-time kinematic
RTO	regenerative thermal oxidizer
RTOP	Request for Task Order Proposal
RTS	robotic total station
RTTC	Redstone Technical Test Center
Rust	Rust Environment and Infrastructure, Inc.
s/n	signal-to-noise ratio
SA	exposed skin surface area; source area
SAA	satellite accumulation area
SAC	site access control
SACIMS	Site Access Control Information Management System
SACP	Site Access Control Plan
SAD	South Atlantic Division
SAE	Society of Automotive Engineers
SAIC	Science Applications International Corporation
SAP	sampling and analysis plan
SAR	structure-activity relationship
SARA	Superfund Amendments and Reauthorization Act
SB	soil boring
SC	specific conductance
SCG	storage compatibility group
SCBA	self-contained breathing apparatus
Sch.	schedule
SCM	site conceptual model
SD	sediment
SDG	sample delivery group
SDS	safety data sheet
SDSW	sediment/surface water
SDWA	Safe Drinking Water Act
SDZ	surface danger zone
SED	Software Engineering Directorate
SEE	steam enhanced extraction
SF	cancer slope factor
SFSP	site-specific field sampling plan
SGF	standard grade fuels
Shaw	Shaw Environmental, Inc.
SHP	safety and health plan
SI	site inspection
SIC	sulfur-impregnated carbon
Sil	Silurian
SIM	Selective Ion Monitoring
SIR	secondary investigation report
SL	standing liquid

List of Abbreviations and Acronyms
Redstone Arsenal, Madison County, Alabama

Acronym	Definition
SLERA	screening-level ecological risk assessment
SLERAP	screening-level ecological risk assessment protocol
SM	sulfur monochloride
SMDP	Scientific Management Decision Point
SMF	smoke munitions filling
SMF 3	Smoke Munitions Filling Plant 3
SMP	site management plan
SNR	signal-to-noise ratio
SO_4	sulfate
SOD	soil oxidant demand
SOP	standard operating procedure
SOPP	standard operating project procedure
SP	submersible pump
SPA	single point anomaly
SPCC	system performance calibration compound
SPCS	State Plane Coordinate System
SPLP	synthetic precipitation leaching procedure
SPM	sample planning module
SPRG	spring
SQG	sediment quality guideline
SQRT	screening quick reference tables
SRA	streamlined human health risk assessment; saturated response area
SRB	sulfate-reducing bacteria
SRI	supplemental remedial investigation
SRM	standard reference material
SS	surface soil
SSC	site-specific chemical
SSHO	site safety and health officer
SSHP	site-specific safety and health plan
SSL	soil screening level
SSSL	site-specific screening level
SSTL	site-specific target level
SSPA	site-specific probability assessment
STB	supertropical bleach; site to background
STC	source-term concentration
STD	standard deviation
Std. units	standard units
STEL	short-term exposure limit
STP	sewage treatment plant
STL	Severn-Trent Laboratories
STT	sludge thickener tank
SU	sampling unit when used in a grid for incremental sampling; when used as a unit for pH, this acronym stands for standard unit
SUXOS	senior UXO supervisor
SV	screening value
SVE	soil vapor extraction
SVOC	semivolatile organic compound
SW-846	U.S. EPA's *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*
SW	surface water
SWCC	State of Alabama Soil and Water Conservation Committee
SWMU	solid waste management unit
SWTR	surface water
SZ	support zone
TA	test area
TAL	target analyte list
TAT	turn around time
TB	trip blank
TBC	to be considered
TBD	to be determined
TC	toxicity characteristic
TCA	trichloroethane
TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
TCDF	tetrachlorodibenzofurans
TCE	trichloroethene
TCH	thermal conductive heating
TCL	target compound list
TCLP	toxicity characteristic leaching procedure
TCMX	tetrachloro-m-xylene
TCRA	time critical removal action
TDGCL	thiodiglycol
TDGCLA	thiodiglycol chloroacetic acid
TDS	total dissolved solids
TEA	triethylaluminum
TEC	threshold effect concentration
TeCA	1,1,2,2-tetrachloroethane
TEF	toxicity equivalency factor
TEGDN	triethylene glycol dinitrate
TEGN	triethylene glycoldinitrate
TEMP	temperature
TEMTADS	Time-Domain Electromagnetic Multisensor Tower Array Detection System
TEQ	toxic equivalency quotient
TERC	Total Environmental Restoration Contract
Tetryl	trinitrophenylmethylnitramine
TEU	Technical Escort Unit
THI	target hazard index
Thiokol	Thiokol Corporation
TIC	tentatively identified compound
TIR	thermal infrared survey
TLV	threshold limit value
TM	Technical Manual

List of Abbreviations and Acronyms
Redstone Arsenal, Madison County, Alabama

Acronym	Definition
TMP	temperature measuring point
TMPW	temporary groundwater monitoring well
TN	Tennessee
TNB	trinitrobenzene
TNT	trinitrotoluene
TO	task order
TOC	use top of casing when defining the well depth; use total organic carbon when defining a general chemistry parameter
TOI	target of interest
TOW	tube-launched, optically-tracked, wire-guided missile
TP	Technical Paper
TPH	total petroleum hydrocarbon
TPI	three-phase inspection
TPP	Technical Project Planning
TR	target cancer risk
TRADOC	U.S. Army Training and Doctrine Command
TRINITY	Trinity Analysis and Development Corp.
TRPH	total recoverable petroleum hydrocarbons
TRS	TRS Group Inc.
TRV	toxicity reference value
TSA	temporary storage area
TSCA	Toxic Substances Control Act
TSCRN	top of screen
TSDF	treatment, storage, and disposal facility
TSLC	target soil leachate concentration
TSS	total suspended solids
TTAP	treatment system tap (port)
TTZ	target treatment zone
Tu	Tupelo silt loam
TVA	Tennessee Valley Authority
TWA	time-weighted average
TXDOT	Texas Department of Transportation
TX-3	small rocket motor used for ballistics testing
U	not detected above reporting limit
U.S.	United States (of America)
UB	potential blank contamination
UCL	upper confidence limit
UCLM	upper confidence limit of the mean
UCR	upper certified range
UDMH	unsymmetrical dimethyl hydrazine
UF	uncertainty factor
UFP	Uniform Federal Policy
UIC	underground injection control
UJ	not detected, estimated due to data validation anomaly
UNEP	United Nations Environment Program
UNO	United Nations Organization
UPL	upper prediction limit; upland
UR	not detected; rejected due to data validation anomaly
URF	unit risk factor
USACE	U.S. Army Corps of Engineers
USACMLS	U.S. Army Chemical School
USAEC	U.S. Army Environmental Command
USAEHA	U.S. Army Environmental Hygiene Agency
USAESCH	U.S. Army Engineering Support Center, Huntsville
USAMPS	U.S. Army Military Police School
USAPHC	U.S. Army Public Health Command
USATCES	U.S. Army Technical Center for Explosive Safety
USATEU	U.S. Army Technical Escort Unit
USATHAMA	U.S. Army Toxic and Hazardous Material Agency
USC	United States Code
USCS	Unified Soil Classification System
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UST	underground storage tank
UTL	upper tolerance limit
UTM	Universal Transverse Mercatir
UTS	universal treatment standard
UTV	utility terrain vehicle
UXO	unexploded ordnance
UXOSP	unexploded ordnance sweep personnel
UXOQCS	UXO Quality Control Supervisor
UXOSO	UXO safety officer
V	vanadium
VC	vinyl chloride
VCE	Virtual Contracting Enterprise
VGIC	liquid-phase granular activated carbon
VI	vapor intrusion
VISL	vapor intrusion screening level
VOA	volatile organic analyte
VOC	volatile organic compound
VOH	volatile organic hydrocarbon
VP	soil vapor point
VQ	validation qualifier
vs	versus
VSI	visual site inspection
VSL	vapor screening level
VSP	Visual Sample Plan
VX	nerve agent (O-ethyl-S-[diisopropylaminoethyl]-methylphosphonothiolate)

List of Abbreviations and Acronyms
Redstone Arsenal, Madison County, Alabama

Acronym	Definition
WAC	Women's Army Corps
WBGT	wet bulb globe temperature
WDTA	Waste Disposal Trench Area
WNWR	Wheeler National Wildlife Refuge
WOE	weight of evidence
WP	white phosphorus
WPL	worker population limit
WPS	Waste Profile Sheet
WQC	water quality criteria
WRS	Wilcoxon rank sum
WS	watershed
WSA	Watershed Screening Assessment
WTP	water treatment plant
WWI	World War I
WWII	World War II
WWTP	wastewater treatment plant
X	Data collected in a manner that is now considered to be inconsistent with good scientific practice. These data are considered unusable. However, since these data exist in the database, additional definitive samples may be needed to verify the presence or absence of any positively detected result.
XRF	x-ray fluorescence
yd^3	cubic yards
ZVI	zero-valent iron

TABLES

Table 1-1

Groundwater Elevation Summary
RSA-013 Corrective Measures Implementation Work Plan
Redstone Arsenal, Madison County, Alabama

Well	Monitored Zone	Well Depth (ft bgs)	Measurement Date	Ground Elevation (ft amsl)	Top of Casing Elevation (ft amsl)	Measured Depth to Water (ft btoc)	Depth to Water (ft bgs)	Groundwater Elevation (ft amsl)	Average Groundwater Elevation (ft amsl)	Average Depth to Water (ft bgs)
P13-RS109	OVB	25.0	09/26/2000	563.52	565.58	11.52	9.46	554.06	555.87	7.65
			09/01/2005			10.29	8.23	555.29		
			05/15/2007			9.45	7.39	556.13		
			07/15/2009			9.16	7.10	556.42		
			10/27/2009			9.85	7.79	555.73		
			06/27/2011			8.96	6.90	556.62		
			10/15/2013			11.05	8.99	554.53		
			12/15/2014			10.78	8.72	554.80		
			02/19/2016			6.34	4.28	559.24		
P13-RS110	OVB	25.0	09/26/2000	564.40	566.62	13.11	10.89	553.51	555.74	8.66
			11/18/2003			12.86	10.64	553.76		
			05/11/2004			10.03	7.81	556.59		
			01/04/2005			10.38	8.16	556.24		
			05/27/2005			10.05	7.83	556.57		
			09/01/2005			11.69	9.47	554.93		
			05/22/2006			9.78	7.56	556.84		
			05/15/2007			10.71	8.49	555.91		
			07/15/2009			10.43	8.21	556.19		
			10/27/2009			11.05	8.83	555.57		
			06/27/2011			10.17	7.95	556.45		
			10/15/2013			12.31	10.09	554.31		
			12/15/2014			12.22	10.00	554.40		
			02/19/2016			7.52	5.30	559.10		

Table 1-1

Groundwater Elevation Summary
RSA-013 Corrective Measures Implementation Work Plan
Redstone Arsenal, Madison County, Alabama

Well	Monitored Zone	Well Depth (ft bgs)	Measurement Date	Ground Elevation (ft amsl)	Top of Casing Elevation (ft amsl)	Measured Depth to Water (ft btoc)	Depth to Water (ft bgs)	Groundwater Elevation (ft amsl)	Average Groundwater Elevation (ft amsl)	Average Depth to Water (ft bgs)
P13-RS188	OVB	29.5	09/26/2000	563.65	565.85	11.78	9.58	554.07	555.77	7.88
			11/18/2003			11.93	9.73	553.92		
			09/01/2005			10.55	8.35	555.30		
			05/22/2006			8.82	6.62	557.03		
			05/15/2007			9.79	7.59	556.06		
			07/15/2009			9.42	7.22	556.43		
			10/27/2009			10.25	8.05	555.60		
			06/27/2011			9.22	7.02	556.63		
			10/15/2013			11.41	9.21	554.44		
			12/15/2014			11.21	9.01	554.64		
			02/19/2016			6.55	4.35	559.30		
P13-RS238	BR	116.0	09/26/2000	563.42	566.38	12.24	9.28	554.14	555.20	8.22
			11/18/2003			12.61	9.65	553.77		
			09/01/2005			11.45	8.49	554.93		
			05/22/2006			9.44	6.48	556.94		
			05/15/2007			10.72	7.76	555.66		
			07/15/2009			10.09	7.13	556.29		
			10/27/2009			11.45	8.49	554.93		
			06/27/2011			9.59	6.63	556.79		
			10/15/2013			11.44	8.48	554.94		
			12/15/2014			12.80	9.84	553.58		

Table 1-1

Groundwater Elevation Summary
RSA-013 Corrective Measures Implementation Work Plan
Redstone Arsenal, Madison County, Alabama

Well	Monitored Zone	Well Depth (ft bgs)	Measurement Date	Ground Elevation (ft amsl)	Top of Casing Elevation (ft amsl)	Measured Depth to Water (ft btoc)	Depth to Water (ft bgs)	Groundwater Elevation (ft amsl)	Average Groundwater Elevation (ft amsl)	Average Depth to Water (ft bgs)
P13-RS475	INT	41.0	09/27/2000	561.08	560.29	6.40	7.19	553.89	555.84	5.24
			11/18/2003			6.54	7.33	553.75		
			05/11/2004			3.83	4.62	556.46		
			01/04/2005			4.00	4.79	556.29		
			05/27/2005			3.71	4.50	556.58		
			09/01/2005			4.95	5.74	555.34		
			05/22/2006			2.50	3.29	557.79		
			05/15/2007			4.33	5.12	555.96		
			07/15/2009			3.97	4.76	556.32		
			10/27/2009			4.89	5.68	555.40		
			10/15/2013			6.08	6.87	554.21		
			12/15/2014			5.69	6.48	554.60		
			02/19/2016			0.9	1.69	559.39		
P13-RS476	INT	38.0	09/27/2000	563.41	561.96	8.22	9.67	553.74	556.79	6.62
			11/18/2003			7.82	9.27	554.14		
			05/11/2004			6.44	7.89	555.52		
			01/04/2005			3.72	5.17	558.24		
			05/27/2005			4.70	6.15	557.26		
			09/01/2005			6.27	7.72	555.69		
			05/22/2006			3.84	5.29	558.12		
			05/15/2007			5.62	7.07	556.34		
			07/15/2009			2.76	4.21	559.20		
			10/27/2009			2.90	4.35	559.06		
			06/27/2011			3.60	5.05	558.36		
			10/15/2013			7.37	8.82	554.59		
			12/15/2014			3.92	5.37	558.04		
			02/19/2016			Above toc		> 561.96		

Average Depth to Water: 7.38 ft bgs

Notes :

amsl - Above mean sea level.
bgs - Below ground surface.
BR - Bedrock.
btoc - Below top of casing.
ft - Feet.
INT - Interface.
OVB - Overburden.

Table 1-2

Monitoring Well Information Summary
RSA-013 Corrective Measures Implementation Work Plan
Redstone Arsenal, Madison County, Alabama

Well Number	Monitored Zone	Status	Installation Date	Depth to Bedrock (ft bgs)	Top of Casing Elevation (ft amsl)	Ground Elevation (ft amsl)	Installed Well Depth (ft bgs)	Screened Interval (ft bgs)	Well Diameter (inches)	Screen Slot Size (inches)	Well Construction Material
P12-RS237	OVB	Active	08/03/1990	>26.0	565.78	563.10	29.1	16.6 - 25.6	2.0	0.01	PVC
P13-RS109	OVB	Active	09/22/1987	>25.0	565.58	563.52	25.0	12.0 - 22.0	3.0	0.01	PVC
P13-RS110	OVB	Active	09/15/1987	>25.0	566.62	564.4	25.0	12.0 - 22.0	3.0	0.01	PVC
P13-RS188	OVB	Active	04/27/1988	30.1	565.85	563.65	29.5	19.0 - 29.5	2.0	0.01	PVC
P13-RS189	OVB	Active	04/27/1988	>35.0	563.21	560.89	35.0	15.0 - 25.0	3.0	0.02	SS
P13-RS190	OVB	Active	05/05/1988	40.5	563.14	560.9	40.5	25.0 - 35.0	3.0	0.01	PVC
P13-RS238	BR	Active	10/08/1990	34.5	566.38	563.42	116.0	106.0 - 115.0	2.0	0.01	PVC
P13-RS239	BR	Active	10/05/1990	41.7	563.79	561.06	192.0	182.0 - 191.0	2.0	0.01	PVC
P13-RS475	INT	Active	06/21/1994	21.5	560.29	561.08	41.0	21.0 - 41.0	6.0	0.02	SS
P13-RS476	INT	Active	06/01/1994	25.0	561.96	563.41	38.0	17.0 - 37.0	6.0	0.02	SS
P13-RS558	OVB	Active	10/26/1996	20.0	567.25	565.17	20.0	10.0 - 20.0	2.0	0.01	PVC

amsl - Above mean sea level.
bgs - Below ground surface.
BR - Bedrock.
ft - Foot (feet).
INT- Interface.
OVB - Overburden.
PVC - Polyvinyl chloride.
SS - Stainless steel.

Table 2-1

Summary of Receptor Cancer Risk and Noncancer Hazard for Chemicals of Concern
Reasonable Maximum Exposure
RSA-013 Corrective Measures Implementation Work Plan
Redstone Arsenal, Madison County, Alabama

CANCER RISK

Receptors	Total Soil IELCR	Groundwater IELCR	CUMULATIVE RISK SOIL AND GROUNDWATER
Industrial Receptors:			
Commercial Worker	1.9E-06	1.0E-03	1.0E-03
Construction Worker	1.5E-07	4.6E-05	4.6E-05
Hypothetical Residential Receptors:			
Lifetime Resident [a]	9.1E-06	2.8E-03	2.8E-03
(With Relevant Groundwater COPACs Included)			
Lifetime Resident [a]	9.1E-06	2.8E-03	2.8E-03

NONCANCER HAZARD

Receptors	Total Soil HI	Groundwater HI	CUMULATIVE HI SOIL AND GROUNDWATER
Industrial Receptors:			
Commercial Worker	0.017	1000	1000
Construction Worker	0.12	1000	1000
Hypothetical Residential Receptors:			
Child Resident [a]	0.36	4000	4000
(With Relevant Groundwater COPACs Included)			
Child Resident [a]	0.36	4000	4000

[a] Risk associated with the hypothetical residential receptor; child and adult resident risk are summed to estimate the cancer risk for the lifetime resident. Noncancer hazard estimates are based on the hypothetical child resident only.

COPAC - Chemical of potential analytical concern.
HI - Hazard index.
IELCR - Individual excess lifetime cancer risk.

Table 2-2

Conclusions of the ARBCA RM-2 Evaluation
RSA-013 Corrective Measures Implementation Work Plan
Redstone Arsenal, Madison County, Alabama

Receptors	Exposure to Soil [a]	COCs Requiring Action in Soil [b,c]	Exposure to Groundwater [a]	COCs for Exposure to Groundwater [c,d]
RSA-013				
Commercial Worker	√	(None)	X	Perchlorate 2,6-Dinitrotoluene RDX Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Indeno(1,2,3-cd)pyrene 1,1-Dichloroethene 1,2-Dichloroethane Chloroform Methylene chloride Trichloroethene
Construction Worker	√	(None)	X	Perchlorate RDX Benzo(a)pyrene 1,1-Dichloroethene 1,2-Dichloroethane Chloroform Methylene chloride Trichloroethene
Hypothetical Resident	√	(None)	X	Perchlorate 2,6-Dinitrotoluene 2-Nitrotoluene RDX Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Indeno(1,2,3-cd)pyrene 1,1-Dichloroethene 1,2-Dichloroethane Chloroform Methylene chloride Trichloroethene Dibenz(a,h)anthracene [e]

Table 2-2

Conclusions of the ARBCA RM-2 Evaluation
RSA-013 Corrective Measures Implementation Work Plan
Redstone Arsenal, Madison County, Alabama

Notes:

√ Cumulative cancer risk and noncancer hazard were found to be acceptable.

X Cumulative cancer risk and noncancer hazard were found to be unacceptable.

[a] Risk conclusions exclude inorganics found to be naturally occurring.

[b] Conclusions regarding risk and identification of COCs requiring action in soil exclude consideration of contribution of risk from exposure to groundwater.

[c] Includes only those COCs requiring action for receptors whose cumulative total risk is greater than 1 x 10^{5}, unless otherwise indicated.

[d] Chemicals with maximum detected concentrations below their maximum contaminant levels are not included as COCs from exposure to groundwater.

[e] Chemical was not detected in groundwater but was included in the RM-2 evaluation because its minimum analytical detection limit exceeded its preliminary screening value.

ARBCA - Alabama Risk-Based Corrective Action.
COC - Chemical of concern.
RM-2 - Risk Management-2.

Table 2-3

Summary of Screening-Level Ecological Risk Assessment Results, Surface Soil
RSA-013 Corrective Measures Implementation Work Plan
Redstone Arsenal, Madison County, Alabama

Detected Chemical	Preliminary COPEC?	Refined COPEC?	Community-Level Assessment Results		Food Chain Assessment	Final COEC?
			RSA Plant Communities	RSA Invertebrate Communities	RSA Populations	
Inorganics						
Aluminum	No	NO FURTHER ACTION REQUIRED				
Antimony	No	NO FURTHER ACTION REQUIRED				
Arsenic	No	NO FURTHER ACTION REQUIRED				
Barium	Yes	Yes	√	√	NA	No
Beryllium	No	NO FURTHER ACTION REQUIRED				
Cadmium	Yes	Yes	√	√	√	No
Calcium	Yes	No (2)				
Chromium	No	NO FURTHER ACTION REQUIRED				
Cobalt	Yes	No (1)				
Copper	Yes	Yes	√	√	√	No
Iron	No	NO FURTHER ACTION REQUIRED				
Lead	Yes	Yes	√	√	√	No
Magnesium	Yes	No (2)				
Manganese	Yes	No (1)				
Mercury	Yes	No (1)				
Nickel	No	NO FURTHER ACTION REQUIRED				
Potassium	Yes	No (1)				
Selenium	Yes	No (1)				
Silver	Yes	No (1)				
Sodium	No	NO FURTHER ACTION REQUIRED				
Thallium	No	NO FURTHER ACTION REQUIRED				
Vanadium	No	NO FURTHER ACTION REQUIRED				
Zinc	Yes	Yes	√	√	√	No
Perchlorate						
Perchlorate	Yes	Yes	√	√	NA	No
Agent Breakdown Products						
Thiodiglycol	Yes	Yes	√ (4)	√ (4)	NA	No
Explosives						
1,3,5-Trinitrobenzene	Yes	No (3)				
2,4,6-Trinitrotoluene	Yes	No (3)				
2-Amino-4,6-dinitrotoluene	Yes	No (3)				
4-Amino-2,6-dinitrotoluene	Yes	No (3)				
HMX	Yes	Yes	√	√	NA	No
RDX	Yes	Yes	√	√	NA	No
Semivolatile Organic Compounds						
2,4-Dinitrotoluene	No	NO FURTHER ACTION REQUIRED				
4-Chloro-3-methylphenol	No	NO FURTHER ACTION REQUIRED				
bis(2-ethylhexyl)phthalate	No	NO FURTHER ACTION REQUIRED				
Diethyl phthalate	No	NO FURTHER ACTION REQUIRED				
Dimethyl phthalate	No	NO FURTHER ACTION REQUIRED				
Di-n-butyl phthalate	No	NO FURTHER ACTION REQUIRED				
Di-n-octyl phthalate	No	NO FURTHER ACTION REQUIRED				
Volatile Organic Compounds						
2-Butanone	No	NO FURTHER ACTION REQUIRED				
Acetone	No	NO FURTHER ACTION REQUIRED				
Bromomethane	No	NO FURTHER ACTION REQUIRED				
Chloromethane	Yes	Yes	√ (4)	√ (4)	NA	No
Methylene chloride	No	NO FURTHER ACTION REQUIRED				
Toluene	No	NO FURTHER ACTION REQUIRED				
Trichloroethene	Yes	Yes	√	√	NA	No

Table 2-3

Summary of Screening-Level Ecological Risk Assessment Results, Surface Soil
RSA-013 Corrective Measures Implementation Work Plan
Redstone Arsenal, Madison County, Alabama

Notes :
COEC - Chemical of ecological concern.
COPEC - Chemical of potential ecological concern.
NA - Not a COPEC for this pathway.
√ - No impacts to communities/populations.

Rationale for Exclusion as a refined COPEC or final COEC:

1 - Naturally occurring or background related based on site-to-background comparisons
2 - Calcium and magnesium have a limited number of concentrations that are elevated with respect to background. They are essential nutrients and are not considered to be important bioaccumulative compounds. Therefore, they are not considered to be refined COPECs.
3 - Low frequency of detection.
4 - Adverse impacts are not expected due to the small size of the area with detected concentrations of this COPEC

Table 3-1

Potential Federal and State Regulations Applicable to RSA-013 Soil Corrective Measures
Corrective Measures Implementation Work Plan
Redstone Arsenal, Madison County, Alabama

Standard, Requirement, or Criterion	Requirement	Applicability	Comments
Federal			
Floodplain Management – 44 CFR Part 9 Executive Order 11988	Federal agencies proposing actions to be located in a floodplain must first evaluate the potential adverse effects those actions might have on the natural and beneficial values served by the floodplain.	Applicable	The site is located within the 100-year floodplain.
Discharge to Offsite Surface Water, 40 CFR 122.26, 122.41, and 122.48	Requires that the selected remedial action must establish a standard of control to maintain surface water quality.	Applicable	The remedial activities at the site may affect an area greater than 1 acre.
State			
Alabama Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, ADEM 335-14-5-.01, Hazardous Waste Program	Establishes location standards for facilities located in 100-year floodplains. Forbids placement of any non-containerized or bulk liquid hazardous waste within any salt dome/salt bed, underground mine or cave.	Applicable	The site is located within a 100-year floodplain.
Alabama Solid Waste Act, Code of Alabama, Title 22, Chapter 27	Establishes sitewide program to provide for the safe management of nonhazardous wastes.	Applicable	Nonhazardous waste is expected to be generated during excavation activities.
Alabama Solid Waste Management Regulations, ADEM 335-13-1 through 335-13-8	Establishes minimum criteria for the processing, recycling, transportation, and disposal of solid wastes and the design, location, and operation of solid waste disposal facilities.	Applicable	Nonhazardous waste may be generated, transported, or disposed as part of remedial activities.
Alabama Stormwater Discharge Regulations, ADEM 335-6-12	Establishes requirements for a storm water discharge permit for construction activities that disturb greater than 1 acre of land.	Applicable	The remedial activities at the site may affect an area greater than 1 acre.
Alabama Wellhead Protection Program, ADEM 335-7-12	Establishes requirements for the closure or abandonment of groundwater monitoring or extraction wells.	Likely applicable	Applicable if any monitoring wells are abandoned or constructed.

ADEM – Alabama Department of Environmental Management.
CFR – Code of Federal Regulations.
MEC – Munitions and explosives of concern.
OB – Open burn.
OD – Open detonation.
UXO – Unexploded ordnance.

Table 3-2

RSA-013 Soil Cleanup Goals
Corrective Measures Implementation Work Plan
Redstone Arsenal, Madison County, Alabama

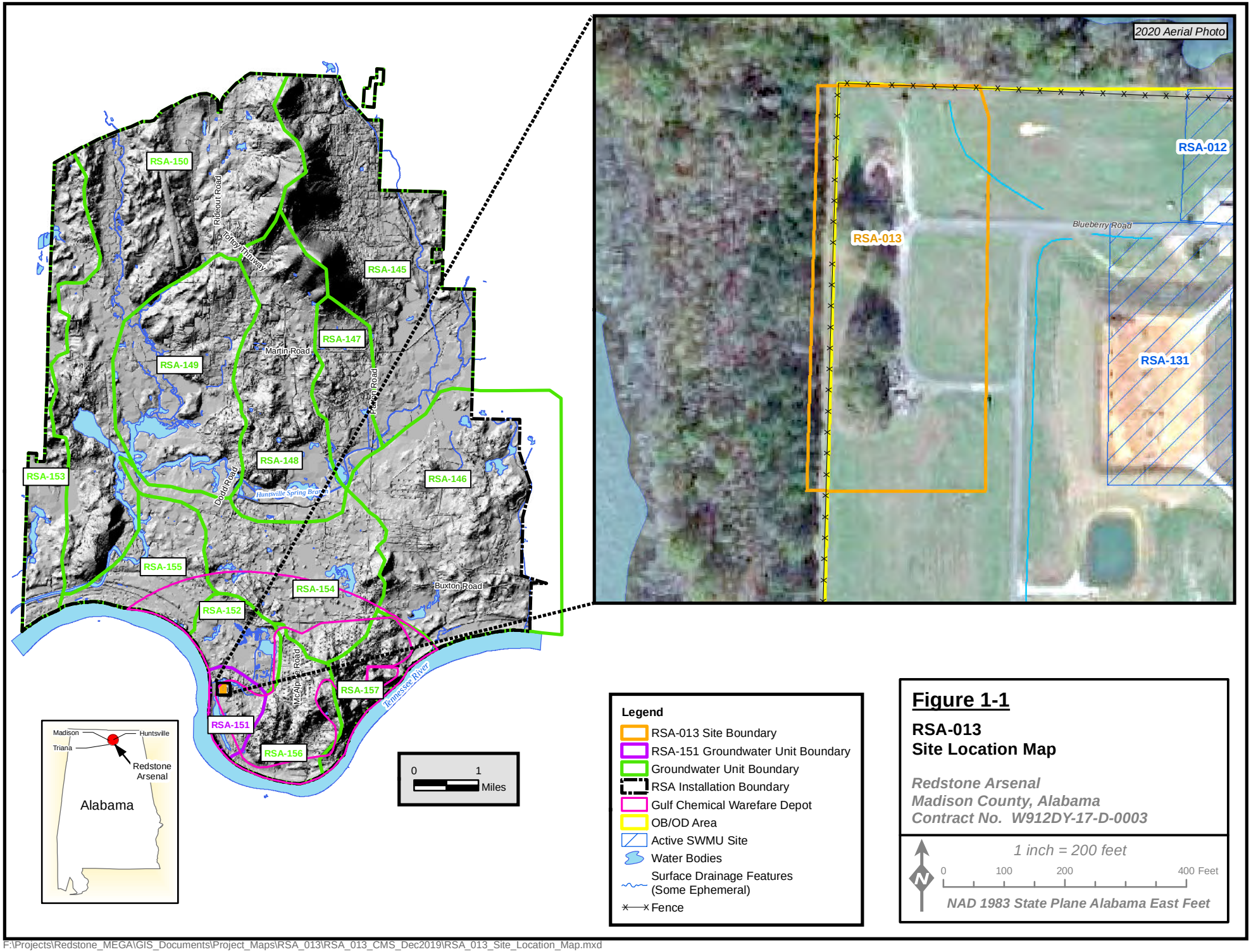
Soil COCs Requiring Action	Soil Cleanup Goals	
	Cleanup Goals (mg/kg)	Basis
Perchlorate	1.7	Leachate-based SSL[1]
RDX	0.45	RSA-013-specific ARBCA groundwater resource protection modeling based SSL[2]

Notes:
ARBCA - Alabama Risk-Based Corrective Action.
COC - Chemical of concern.
mg/kg - Milligrams per kilogram.
SSL - Soil screening level.

[1] RSA-specific cleanup goal for perchlorate based on leachate-based soil screening level (SSL) presented in the Final Installation-Wide Groundwater Strategy (Shaw, 2009).

[2] See Appendix I. Value calculated using the ARBCA computational software package, Version 2.1-R (ADEM, 2010) updated based on ARBCA guidance (2017a) and current physical and toxicological properties for RDX. Model used ADEM's groundwater resource protection formulas per Figure B-1 of the ARBCA guidance.

FIGURES



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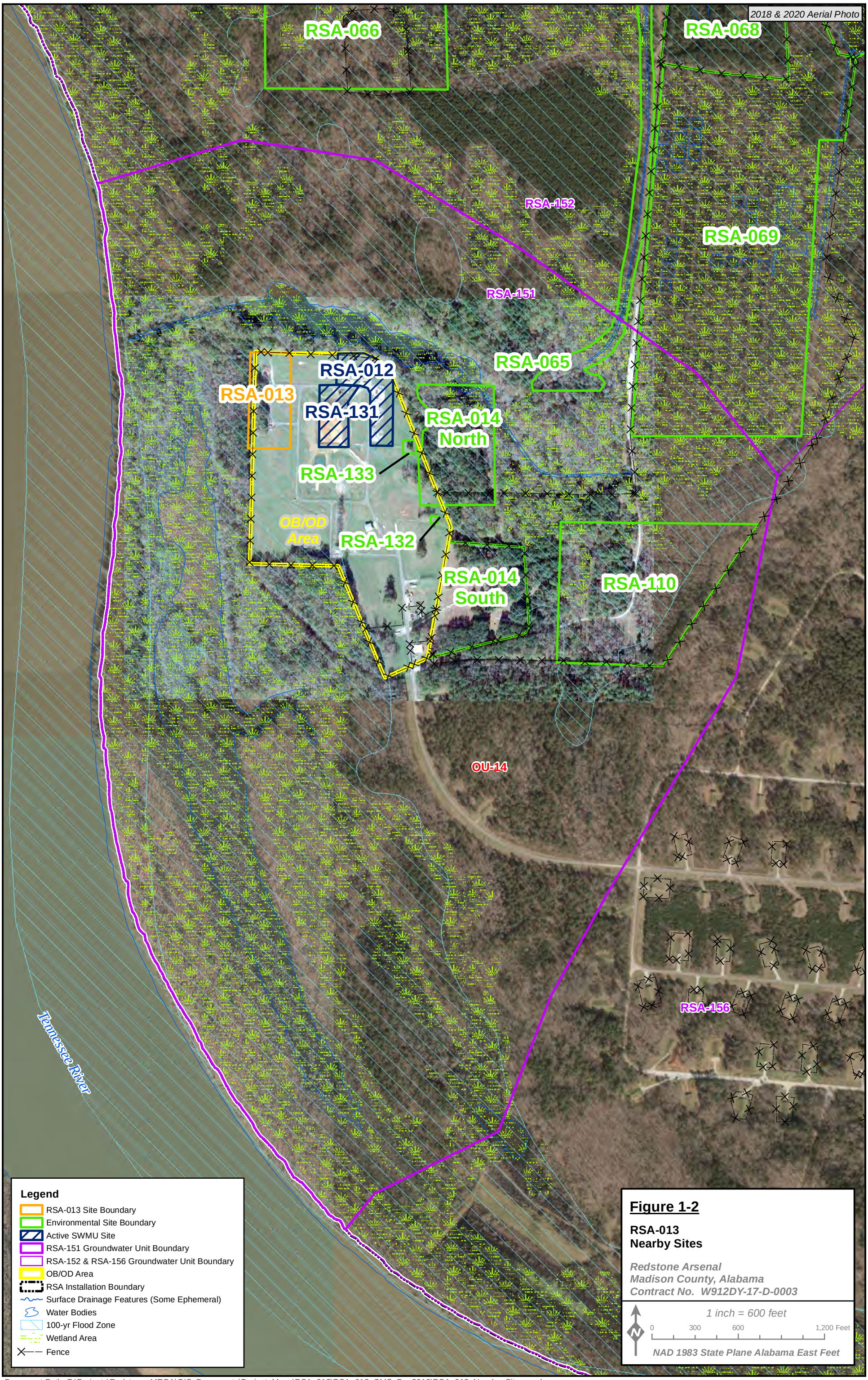

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2018 Aerial Photo

Former Burn Pad

Blueberry Road

Berms

Former Burn Pad

Legend

- RSA-013 Site Boundary
- 10' Topographic Contour, 2013 (Above Mean Sea Level)
- 2' Topographic Contour, 2013 (Above Mean Sea Level)
- Surface Water Drainage (some ephemeral)

Figure 1-3

RSA-013
Site Map

Redstone Arsenal
Madison County, Alabama
Contract No. W912DY-17-D-0003

1 inch = 60 feet

0 30 60 120 Feet

NAD 1983 State Plane Alabama East Feet

Document Path: F:\Projects\Redstone_MEGA\GIS_Documents\Project_Maps\RSA_013\RSA_013_CMS_Dec2019\RSA_013_Site_Map.mxd

UXO Probability

CWM Probability

RSA-013
RSA-012
RSA-131
RSA-133
RSA-014
RSA-132
Blueberry Road
08415
08405
08406
08407
08408
08401
08420
08411
08402

Legend

- RSA-013 Site Boundary
- OB/OD Area
- Environmental Site Boundary
- Road
- Building
- Water Body
- Surface Water Drainage (some ephemeral)

UXO Probability

- Low
- Moderate/High

CWM Probability

- Seldom
- Unlikely

Figure 1-4

RSA-013 and Adjacent Sites
UXO and CWM Probabilities

Redstone Arsenal
Madison County, Alabama
Contract No. W912DY-17-D-0003

1 inch = 300 feet

0 150 300 600 Feet

NAD 1983 State Plane Alabama East Feet

Document Path: F:\Projects\Redstone_MEGA\GIS_Documents\Project_Maps\RSA_013\CMIP_July2021\RSA_013_CWM_UXO_Probability.mxd

2020 Aerial Photo

P12-RS237
559.51

P13-RS558
560.02

P12-RS241
559.60

P13-RS475
560.10

560

P13-RS109
559.57

P13-RS188
559.58

P13-RS238
NM

Blueberry Road

560

P13-RS190
559.46

P13-RS189
559.52

P13-RS239
NM

P13-RS110
559.77

561

P13-RS476
NM

562

563

560

P13-RS477
NM

564

P131-RS212
559.51

P131-RS211
559.47

561

562

Legend

NM = Not Measured

- Overburden Well
- Interface Well
- Bedrock Well
- Deep Bedrock Well
- RSA-013 Site Boundary
- Potentiometric Groundwater Contour (feet above mean sea level)
- Surface Water Drainage (some ephemeral)

Figure 1-5

RSA-013
Poteniometric Surface Map, February 2016

Redstone Arsenal
Madison County, Alabama
Contract No. W912DY-17-D-0003

1 inch = 100 feet

0 50 100 200 Feet

NAD 1983 State Plane Alabama East Feet

Document Path: F:\Projects\Redstone_MEGA\GIS_Documents\Project_Maps\RSA_013\CMIP_July2021\RSA_013_Potentiometric_Feb2016.mxd

2020 Aerial Photo

013-SB001
P13-SS06
013-HP009
P13-SS16
GMIL-2S18
013-SB002
PAR-SB30
PEL-2S2
P13-SS11
P13-SS01
013-SB003
013-HP001
GMIL-2S19
P13-SB01
013-SB015
013-HP010
P13-SS07
013-HP005
P13-SS17
PEL-2S3

P13-SB02	
Depth (ft bgs)	Result (mg/kg)
0 - 1	1.3
2 - 4	0.23 J

013-SB004
PAR-SB31
GMIL-2SB-1
P13-SS02
PEL-2S1
P13-SS12
Blueberry Road

013-HP006	
Depth (ft bgs)	Result (mg/kg)
0 - 1	0.2 J
2 -4	0.0921 J

013-SB006
013-HP011
013-SB010
013-HP018
013-HP002
013-SB005
P13-SB03
P13-SS18
P13-SS08
RSA-013
013-HP019
P13-SS03
013-HP007
P13-SS13
PAR-SB32
013-SB008
013-SB009
013-SB011
013-SB014
P13-SS09
PEL-2S4
013-SB007
P13-SS19
013-HP020
013-HP003
P13-SB04
GMIL-2S20
013-HP021
P13-SS04
013-HP012
RSA-131
P13-SS14

P13-SB05	
Depth (ft bgs)	Result (mg/kg)
0 - 1	0.25 J
2 - 8	ND

PAR-SB33
PEL-2S7
GMIL-2SB-2
013-HP017
013-HP022
P13-SS10
P13-SB06
013-HP008
013-HP013
013-SB012
013-HP004
P13-SS05
PEL-2S5
P13-SS20
013-HP023
P13-SS15
GMIL-2SB-3
013-HP016
PAR-SB34
PEL-2S6
013-HP015
013-HP014
013-SB013
013-HP024
013-HP025

Legend

- Hydropunch Location
- Soil Boring
- Soil Sample Location Not Included in RFI Dataset
- Environmental Site Boundaries
- RSA-013 Site Boundary
- Surface Water Drainage (some ephemeral)

Notes:

Yellow shaded values only exceed the DAF4 SSL (0.009 mg/kg)

Orange shaded values exceed the ARBCA-modeled SSL (0.45 mg/kg)

DAF_4 - Dilution attenuation factor of 4

SSL - Soil screening level.

ft bgs - feet below ground surface

J - Estimated concentration

mg/kg - milligrams per kilogram

ND - Not detected

ARBCA – Alabama Risk-Based Corrective Action

Figure 2-1

RSA-013
RDX DAF_4 SSL Exceedances in Soil

Redstone Arsenal
Madison County, Alabama
Contract No. W912DY-17-D-0003

1 inch = 60 feet

N

0 30 60 120 Feet

NAD 1983 State Plane Alabama East Feet

Document Path: F:\Projects\Redstone_MEGA\GIS_Documents\Project_Maps\RSA_013\CMIP_July2021\RSA_013_RDX_DAF4SSL_Exceed_Soil.mxd

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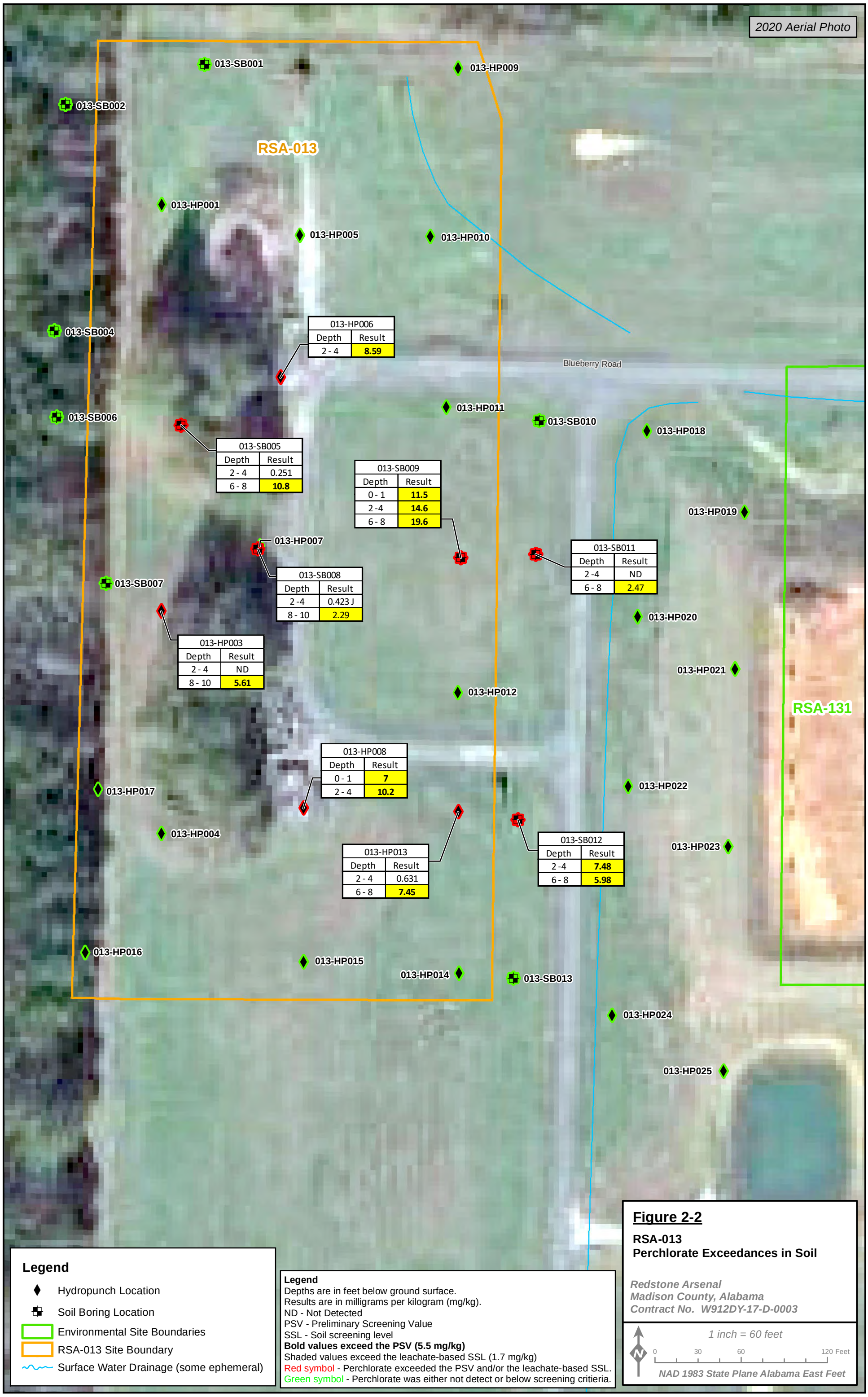

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Sources

RSA-013 (See Note 1)

Unlined Inactive Open Burn Pads

Pathways

Surface Burning

Investigated Media (See Note 4)

Surface Soil (SS) COPCs

VOCs
SVOCs (PAHs Only)
Perchlorate
Explosives
Metals

SS Samples Analyzed

VOCs:	34
SVOCs:	2
Perchlorate:	38
Explosives:	40
ABP:	26
Metals:	32
Chemical Agents:	9

Chemicals Warranting Action

Surface Soil (SS)

Perchlorate
RDX
(See Note 5)

Leaching

Subsurface Soil (DS) COPCs

VOCs
SVOCs (PAHs Only)
Perchlorate
Explosives
Metals

DS Samples Analyzed

VOCs:	62
SVOCs:	4
Perchlorate:	70
Explosives:	73
ABP:	52
Metals:	50
Chemical Agents:	12

Subsurface Soil (DS)
Perchlorate
RDX
(See Note 5)

Leaching
Adsorption
Volatilization
Adsorption/ Condensation
Dissolution

Soil Vapor (SV)
VOCs

Soil Vapor (SV)
None

Groundwater (GW) COPCs

VOCs
SVOCs (PAHs Only)
Perchlorate
Explosives
Metals

GW Samples Analyzed

VOCs:	21
SVOCs:	6
Perchlorate:	21
Explosives:	19
ABP:	11
Metals:	16

Groundwater (GW)
Perchlorate
2,6-Dinitrotoluene
2-Nitrotoluene
RDX
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Indeno(1,2,3-cd)pyrene
1,1-Dichloroethene
1,2-Dichloroethane
Chloroform
Methylene chloride
Trichloroethene
Dibenz(a,h)anthracene

Huntsville supplies potable water:
Madison County controls water-supply well installation

(See Note 3) → Hypothetical Future Resident

(See Note 2) → Industrial Worker

No industrial use of groundwater within RSA-151

Potential Receptors

- Groundskeeper
- Industrial Worker
- Ecological Receptors
- Hypothetical Future Resident

- Hypothetical Future Resident
- Industrial Worker

- Hypothetical Future Resident
- Industrial Worker

LEGEND:

- Known/Assumed Transport
- Potential Transport

NOTES:

1. The current and anticipated future land use of this area is designated as industrial.
2. At Redstone Arsenal, unmanaged exposure to Installation Restoration Program sites is prevented by the Arsenal's Site Access Control Program. Current and potential future receptors include groundskeeper and industrial worker.
3. The hypothetical residential receptor provides the basis for establishing some remedial responses including justification for the selection of land-use controls. Sites that do not exceed acceptable risk limits for a residential receptor can be released for any use without restriction.
4. Samples were analyzed for TCL VOCs, SVOCs, Explosives, Perchlorate, Chemical Agents, ABPs, and metals. Not all chemicals on these standard lists are within the CSM of this site.
5. Perchlorate and RDX in soil require action based on the RFI conclusions of the leaching to groundwater evaluation.

ACRONYMS:

ABPs	Agent Breakdown Products
CSM	Conceptual Site Model
COPCs	Chemicals of Potential Concern
PAHs	Polynuclear Aromatic Hydrocarbons
RDX	Royal Demolition Explosive
SVOCs	Semivolatile Organic Compounds
TCL	Target Compound List
VOCs	Volatile Organic Compounds

Common acronyms are listed in the report acronyms list.

Figure 2-3

RSA-013
Conceptual Site Model

Redstone Arsenal
Madison County, Alabama
Contract No. W912DY-17-D-0003

Redstone_MEGA\GIS_Documents\Output\PDFs\RSA_013\CMIP_July2021\Fig_2_3_RSA_013_CSM
B. Hodges

2020 Aerial Photo

Excavation Corner	Easting	Northing
1	404560.87	1482494.01
2	404672.02	1482352.55
3	404745.77	1482336.75
4	404749.05	1482291.74
5	404647.73	1482240.69
6	404649.04	1482199.89
7	404743.97	1482152.16
8	404736.16	1482109.32
9	404551.40	1482099.81
10	404476.92	1482193.01
11	404450.33	1482277.54
12	404461.22	1482420.40
13	404540.66	1482474.94
14	404560.47	1482474.94
15	404560.94	1482453.00
16	404540.57	1482453.27

013-SB001
013-HP009
013-SB002
013-HP001
013-HP005
013-HP010
013-SB004
P13-SB02
013-HP006
013-SB006
013-SB005
013-HP011
013-SB010
013-HP018
013-HP019
RSA-013
013-HP007
013-SB009
013-SB011
013-SB008
013-SB007
013-HP003
013-HP020
013-HP021
013-HP012
P13-RS110
P13-RS476
013-HP022
013-HP017
013-HP008
013-HP013
013-SB012
013-HP004
013-HP023
013-HP016
013-HP015
013-HP014
013-SB013
013-HP024
013-HP025
Blueberry Road

Legend

- Excavation Corner
- Well to be abandoned/replaced
- Hydropunch Location
- Soil Boring Location
- Area to be Excavated
- Environmental Site Boundaries
- RSA-013 Site Boundary
- Area for Confirmation Sampling for RDX only
- Surface Water Drainage (some ephemeral)

Notes:

1. Excavation will be completed to approximately 8 feet bgs (average depth to groundwater) or saturated zone if the groundwater table is encountered.
2. Excavated soil not suitable for backfill will be transported to Subtitle D landfill for disposal as nonhazardous waste.
3. Two monitoring wells (P13-RS110 and P13-RS476) located within or close to the excavation area are expected to be abandoned and replaced, if necessary.
4. The proposed excavation limits may be revised based upon results of confirmation soil sampling.

bgs - Below ground surface
CG - Cleanup goal

Green symbol - Perchlorate and RDX were either not detected or below CG
Red symbol - Perchlorate and/or RDX exceeded the respective CG of 1.7 and 0.45 milligrams per kilogram (mg/kg)

Figure 3-1

RSA-013
Proposed Excavation Area

Redstone Arsenal
Madison County, Alabama
Contract No. W91ZLK-17-D-0003

1 inch = 60 feet

0 30 60 120 Feet

NAD 1983 State Plane Alabama East Feet

Document Path: F:\Projects\Redstone_MEGA\GIS_Documents\Project_Maps\RSA_013\CMIP_July2021\RSA_013_Proposed_Excav_Area.mxd

2020 Aerial Photo

Notes:

1. See Appendix G for Stormwater Best Management Practices for procedures to utilize in construction of sediment barriers (silt fence), sediment traps, construction exit pads, etc.

2. Final location of stockpiles will be determined during pre-construction meetings with RSA and subcontractors.

P13-RS475
P13-RS109
P13-RS188
P13-RS238
OBOD-RS2882
Blueberry Road
Culvert
Gravel Road
RSA-013
Culvert
(Storm water through culvert
outlet to be rerouted, as necessary)
Asphalt
P13-RS110
RSA-131
Asphalt
Culvert
Culvert
OBOD-RS2883
P13-RS476

Legend

- Overburden Well
- Interface Well
- Bedrock Well
- Area to be Excavated (8 feet bgs)
- Environmental Site Boundaries
- RSA-013 Site Boundary
- Area for Confirmation Sampling for RDX only
- Construction Exit Pad
- Decontamination Area
- Soil Stockpile Area
- Vegetation Removal
- Water Line
- Culvert
- Drainage Ditch
- Erosion and Sedimentation Control Devices
- Surface Water Drainage
- Water Body

P13-RS477
P13-RS478
P131-RS211
P131-RS212

Figure 4-1

RSA-013
Locations of Stockpiles and Erosion and Sedimentation Controls

Redstone Arsenal
Madison County, Alabama
Contract No. W912DY-17-D-0003

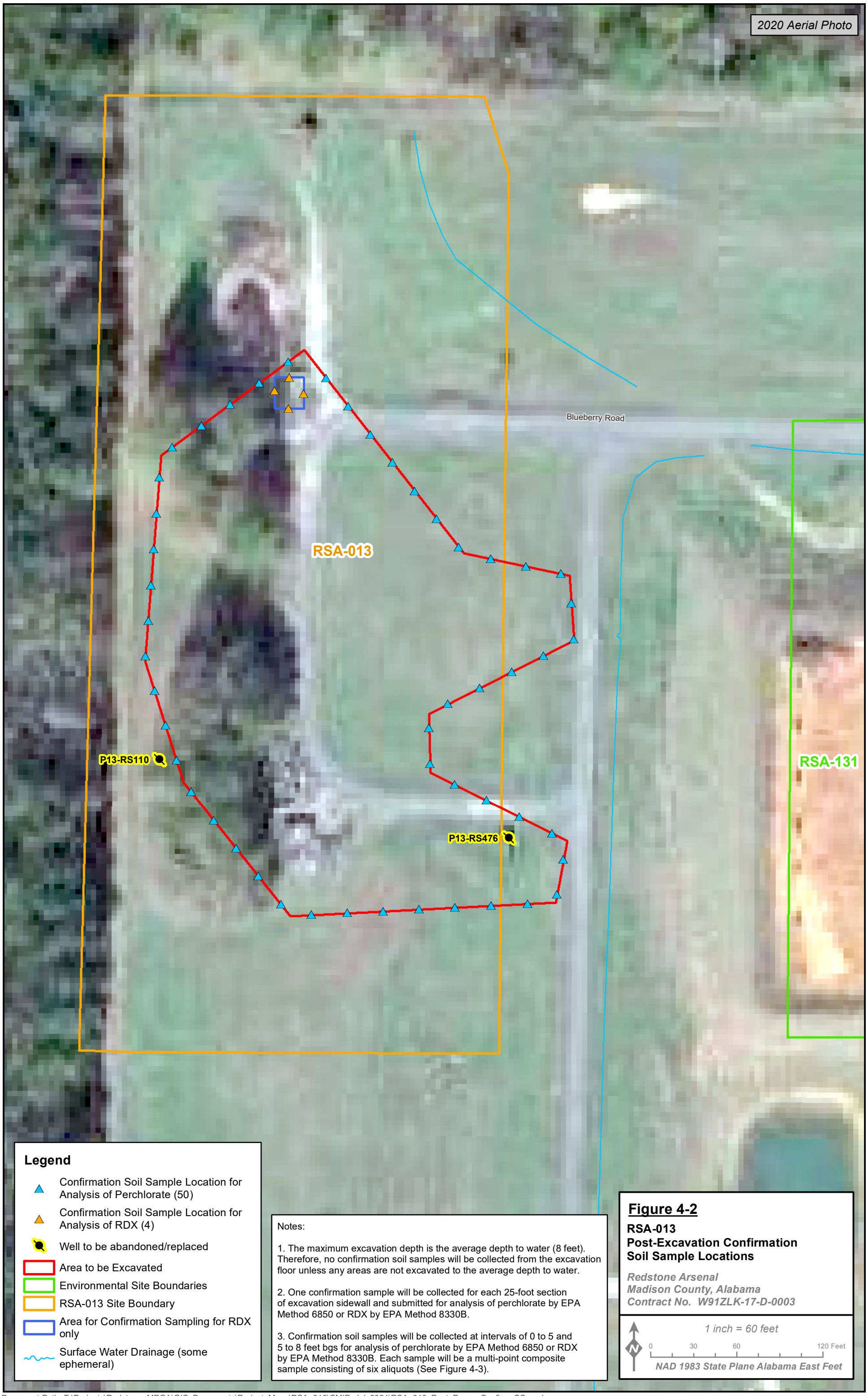
1 inch = 70 feet

N

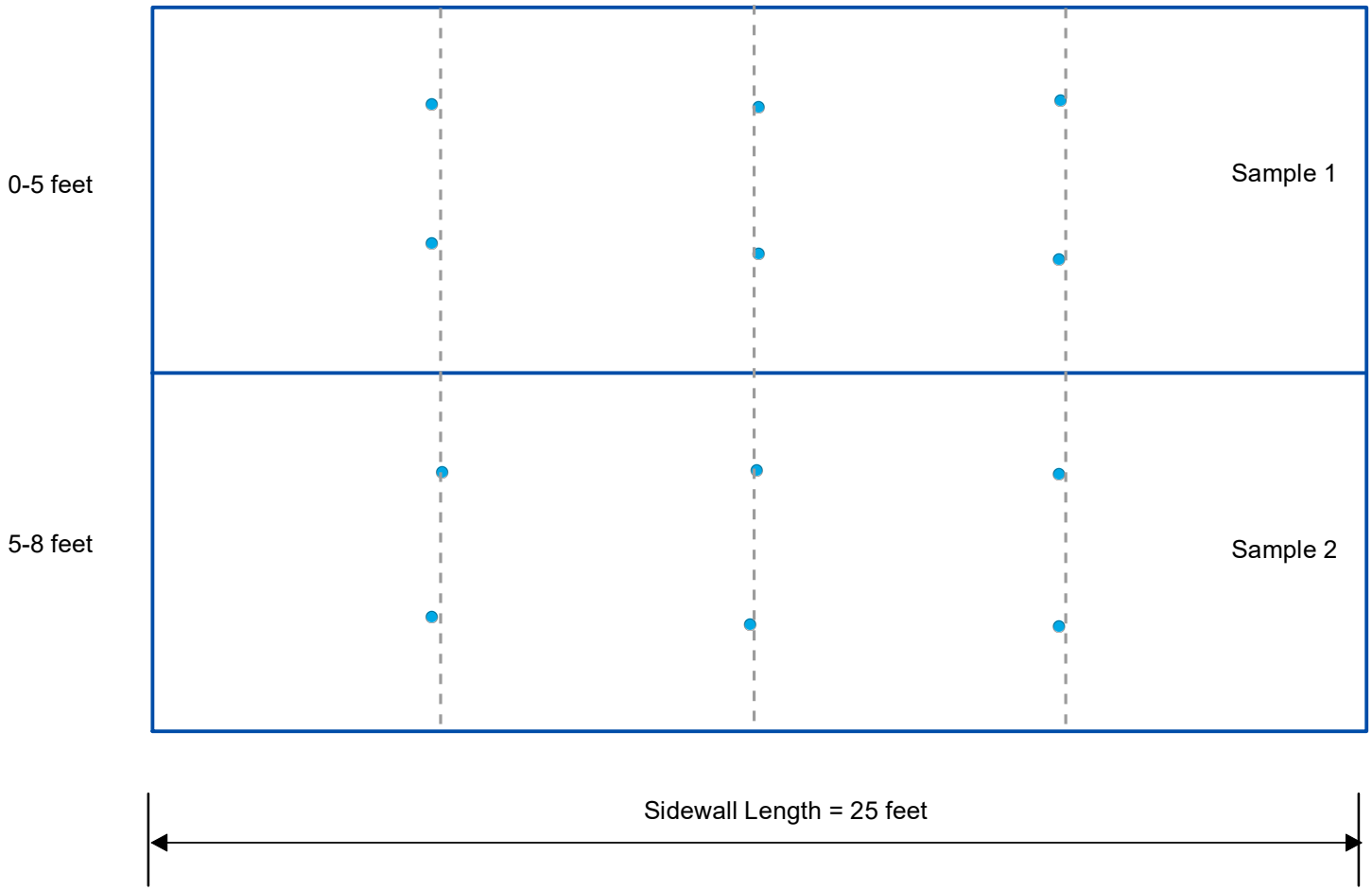
0 30 60 120 Feet

NAD 1983 State Plane Alabama East Feet

Document Path: F:\Projects\Redstone_MEGA\GIS_Documents\Project_Maps\RSA_013\CMIP_July2021\RSA_013_Stockpile_Erosion_Sediment.mxd



Document Path: F:\Projects\Redstone_MEGA\GIS_Documents\Project_Maps\RSA_013\CMIP_July2021\RSA_013_Post_Excav_Confirm_SS.mxd



Legend

- Aliquot

Figure 4-3

RSA-013
Excavation Sidewall Confirmation Sampling Approach

Redstone Arsenal
Madison County, Alabama
Contract No. W912DY-17-D-0003

F:\Projects\Redstone_MEGA\GIS_Documents\Project_Maps\RSA_013\CMIP_July2021\RSA_013_Sidewall_Confirm_Sample_Approach.mxd

APPENDIX A

ADEM CONCURRENCE LETTER FOR RSA-013 RFI REPORT

LANCE R. LEFLEUR
DIRECTOR

KAY IVEY
GOVERNOR

Alabama Department of Environmental Management
adem.alabama.gov

1400 Coliseum Blvd. 36110-2400 ▪ Post Office Box 301463
Montgomery, Alabama 36130-1463
(334) 271-7700 ▪ FAX (334) 271-7950

May 25, 2017

CERTIFIED MAIL # 91 7199 9991 7037 0301 3659

Mr. Terry Hazle, Director
Directorate of Environmental Management
DEPARTMENT OF THE ARMY
Installation Restoration Division
(AMSAM-RA-DEM-IR)
US Army Aviation and Missile Command
Building 4488
Redstone Arsenal, AL 35898

Re: **ADEM Concurrence Letter:**
Revision 1, RCRA Facility Investigation Report, RSA-013, Unlined Inactive Open Burn Pad; RSA-132, Dismantled Popping Furnace; and RSA-133, Inactive Rocket Washrack/Sump, Operable Unit 14, dated March 2, 2017
Redstone Arsenal, Madison County, Alabama
DSMOA Site No 535-223-5545
Facility ID No: AL7 210 020 742

Dear Mr. Hazle:

The Alabama Department of Environmental Management (ADEM or the Department) has completed the review of the aforementioned document received on March 3, 2017. Based on its review, the Department has determined that all comments on the previous version of this document have been resolved and concurs with the recommendation for No Further Action at this time for the surface media at RSA-132 and RSA-133 and corrective measures to be performed for the surface media at RSA-013 to address the leaching to groundwater concerns. With respect to the groundwater under all three SWMUs (RSA-013, RSA-132, and RSA-133), the Department concurs with the recommendation for corrective measures to be performed as part of the RSA-151 groundwater unit.

Since the findings of this RFI Report indicate action is needed for chemicals of concern (COCs) in the surface media at RSA-013 and for COCs in groundwater under all three SWMUs from former site operations, a Corrective Measures Implementation (CMI) plan to address this action is required. In accordance with Permit Condition VI.E.2., the CMI plan must be completed within 120 calendar days following notification from the Department that a CMI Plan is required. Therefore, RSA should submit a CMI Plan to address the surface media for RSA-013 within 120 calendar days of receipt of this letter. The corrective measures to address the groundwater under all three SWMUs should be addressed as a part of the CMI Plan for RSA-151.

ADEM will move RSA-132 and RSA-133 to Table VI.6 (Sites requiring a corrective measures implementation work plan) and list them as no further action required for the surface media and requiring corrective measures for COCs in groundwater as a part of RSA-151. ADEM will also move RSA-013 to Table VI.6 and list it as requiring corrective measures for COCs in the surface media as a part of RSA-013 and for COCs in the groundwater as a part of RSA-151. All of these changes will be incorporated into the facility's Alabama Hazardous Wastes Management and Minimization Act (AHWMMA) permit as part of the next permit modification.

If you have any questions on this matter, please contact Krishna Morrissette of the Facilities Engineering Section via e-mail at kmorrissette@adem.alabama.gov or at (334) 394-4335.

Sincerely,

Stephen A. Cobb, Chief
Governmental Hazardous Waste Branch
Land Division

SAC/JW/KMM

cc: Terry de la Paz, Redstone Arsenal
J Jason Wilson, ADEM
Jason T. Wilson, ADEM (email)
Kelley Hartley, ADEM (email)
Salee Downey, Redstone Arsenal (email)
Brian Roberson, NASA MSFC
Ashley T. Mastin, ADEM
Michelle Thornton, US EPA Region IV (email)
Robert Morris, US EPA Region IV (email)

APPENDIX B

REQUEST FOR REDSTONE RCRA PERMIT MODIFICATION

REQUEST FOR REDSTONE RCRA PERMIT MODIFICATION
RSA-013, UNLINED INACTIVE OPEN BURN PAD
OPERABLE UNIT 14
U.S. ARMY GARRISON – REDSTONE
MADISON COUNTY, ALABAMA
November 2021

B1.0 Introduction

As specified in Section VI.E.3 of the U.S. Army Garrison–Redstone's (hereinafter referred to as the Army) Alabama Hazardous Wastes Management and Minimization Act Hazardous Waste Storage Facility, Thermal Treatment, Solid Waste Management Unit Corrective Action Permit, (hereafter referred to as the Permit) (dated July 19, 2021) (Alabama Department of Environmental Management [ADEM], 2021), a request for permit modification is to be submitted along with a corrective measures implementation (CMI) work plan. The Army has been directed to include this request for permit modification in an appendix to the CMI work plan. Therefore, this request for modification to the Permit has been prepared for Solid Waste Management Unit RSA-013, Unlined Inactive Open Burn Pad, Operable Unit 14 at Redstone Arsenal (RSA) in Madison County, Alabama. The Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) report for RSA-013 (CB&I Federal Services LLC [CB&I], 2017) received concurrence from ADEM on May 25, 2017. The Army has prepared the CMI work plan and is ready to implement corrective measures for perchlorate- and RDX-contaminated soil at RSA-013.

As part of the RFI report, the Army requested that ADEM move this site from Table VI.2 to Table VI.6 in the Permit and list it as requiring corrective measures for soil and groundwater. ADEM subsequently moved RSA-013 to Table VI.6 in Permit Modification No. 11 (ADEM, 2018) as requiring action for soil and groundwater. The groundwater action is part of the RSA-151 groundwater unit corrective measures and is not part of the RSA-013 soil corrective measures. As specified in Section VI.E.3 of the Permit, this modification will serve to incorporate the proposed remedy, including all procedures necessary to implement and monitor the final corrective measures for this site, into the Permit in accordance with Alabama Administrative Code r. 335-14-8-.04(2).

B2.0 Facility and Site Description

RSA is located in the southwestern portion of Madison County, which is in the northern portion of Alabama (Figure 1-1 in the CMI work plan). RSA is a U.S. Army facility that encompasses

approximately 38,300 acres of land, all of which are either owned or controlled by the Army. Development within RSA has largely centered on the historical production (and later disposal) of conventional and chemical munitions and, more recently, development and testing of missiles and rockets. These processes have produced chemical wastes since operations began in the early 1940s.

RSA-013, Unlined Inactive Open Burn Pad, is located on approximately 4.3 acres in the southwestern portion of RSA and overlies the RSA-151 groundwater unit (Figure 1-1 in the CMI work plan). RSA-013 is located within the fenced active open burn (OB)/open detonation (OD) area at the northwest corner. The OB/OD area includes active sites RSA-012 (Active Open Burn Pans [OB]) and RSA-131 (Active Open Detonation Area [OD]), where munitions and materials contaminated with energetics are treated at burn pans and detonation pits.

The RSA-013 burn pads as shown on Figure 1-3 in the CMI work plan were used from the 1950s until 1986 for thermal treatment (burning) of explosives and explosives-contaminated material and reactive waste, primarily propellant. Propellant burned at RSA-013 included waste perchlorate containing relatively high amounts of solvent. The ash, residue, and metal debris left over from burning activities were transported off site and disposed at the RSA-014 trenches, located to the southeast, and at RSA-066, which is located to the north of the embayment. The burn pads, each approximately 200 feet square in size, were unlined (i.e., bare ground) and surrounded by crescent-shaped earthen berms on the north, west, and south sides of each pad. Operations were discontinued and investigations were initiated following an ADEM inspection during which burning on unprotected ground was observed, which resulted in ADEM issuing a Notice of Violation in January 1986.

The RSA-013 site boundary in the Army Geographic Information System was expanded in 2009 to include two noncontiguous sites: RSA-132, Dismantled Popping Furnace, and RSA-133, Inactive Rocket Washrack/Sump (Figure 1-2 in the CMI work plan). The RSA-013 RFI report (CB&I, 2017) included the data relevant to RSA-132 and RSA-133 and recommended no further action for soil for these two sites; ADEM concurrence was received on May 25, 2017 for the recommendation of no further action for soil at these two sites.

B3.0 Investigative History

Environmental investigations relevant to RSA-013 are listed below.

- Initial Army investigation (U.S. Army Environmental Hygiene Agency, 1986)
- Remedial investigation for Unit 2 (P.E. LaMoreaux & Associates, 1988)
- Phase I and II RFI at Unit 2 (Geraghty and Miller, Inc., 1992; 1993)
- Extraction well installation by Enserch Environmental, 1994
- RSA-013 groundwater treatment system construction and operation, various contractors, 1995-2000
- Supplemental investigation (Parsons Engineering Science, Inc., 1997)
- Supplemental remedial investigation (IT Corporation, 2000)
- Comprehensive groundwater sampling (IT Corporation, 2000)
- RSA RCRA facility assessment (ADEM, 2008)
- RSA-151/152/156/157 potential source area investigation (Shaw Environmental, Inc. [Shaw], 2006)
- RSA-013 RFI (CB&I, 2017)
- RSA-151 RFI (Aptim Federal Services, LLC [APTIM], 2018)
- RSA-151 corrective measures study (CMS) report (HydroGeoLogic, Inc., 2020)
- RSA-013 CMS report (APTIM, 2021a)
- OB/OD groundwater monitoring (APTIM, 2021b and subsequent annual reports).

Further details of the investigations are presented in the RSA-013 RFI report (CB&I, 2017) and the RSA-013 CMS report (APTIM, 2021a). The RSA-013 usable data set includes analytical results from 75 surface soil samples, 91 subsurface soil samples, and 24 groundwater samples from site monitoring wells. The samples were analyzed for metals, volatile organic compounds (VOC), semivolatile organic compounds (SVOC), explosive compounds, perchlorate, and chemical agents/breakdown products. The nature and extent of contamination in soil and groundwater have been defined at RSA-013.

B4.0 Scope of the Corrective Measures for RSA-013

The overall strategy for cleanup at RSA has been presented to the regulatory agencies in two cleanup strategy documents, the *Installation-Wide Groundwater Cleanup Strategy* (Shaw, 2009a) and the *Installation-Wide Strategy for Cleanup of Impacted Wetlands* (Shaw, 2010a). These strategy documents have been designed to integrate groundwater units, surface media sites, and wetland areas by incorporating strategies (i.e., cleanup of surface media sites) to 1) ensure that the Army provides a systematic and uniform approach to investigating and remediating these areas to reach closure in an expeditious and fiscally responsible manner, and 2) ensure protection of potential receptors (i.e., implementation of the installation-wide groundwater land-use controls [LUC]) until final corrective measures result in chemicals of concern (COC) meeting the cleanup goals (CG) where applicable. The scope of the corrective measures for RSA-013 is consistent with these strategies. The selected corrective measures for RSA-013 will reduce the contaminant leaching in soil to groundwater, which has and is continuing to result in groundwater posing unacceptable risks if consumed. Corrective measures are required for numerous COCs present as commingled plumes in groundwater under RSA-013 and will be addressed by the regional RSA-151 groundwater unit corrective measures.

B5.0 Site Characteristics

This chapter provides general information on the site characteristics of RSA-013 and identifies the components of the conceptual site models (CSM) for the site. Further discussion of the site characteristics is included in the RFI report (CB&I, 2017).

The topography in the vicinity of RSA-013 is relatively flat with the exception of two earthen crescent-shaped berms located directly west and partially north and south of the former burn pads (Figure 1-3 in the CMI work plan). The RSA-013 berms and former burn pads are overgrown with vegetation; the remainder of the site is primarily maintained grass. A small cluster of trees is located near the eastern site boundary. With the exception of the berms, the site lies within the 100-year floodplain. There are no permanent surface water bodies located within the RSA-013 site boundary. Surface water bodies in the vicinity of the site consist of the Tennessee River to the west and an embayment of the Tennessee River to the north. Wetlands are located to the north and west of RSA-013. Overland flow in the vicinity of the site drains to roadside ephemeral drainage ditches. Based on refusal depths, overburden thickness in the vicinity of RSA-013 ranges from approximately 20 to 41 feet. The average depth to groundwater is 7.38 feet below ground surface. Shallow groundwater flow is to the north-northwest towards the Tennessee River.

The current unexploded ordnance (UXO) and chemical warfare materiel probability ratings for RSA-013 are "Low" and "Unlikely," respectively.

Conceptual Site Model. The final CSM includes the following main components:

- Based on site use and history, contaminants associated with this site included VOCs, SVOCs, explosives, metals, perchlorate, and chemical agents/agent breakdown products.
- Releases of contaminants (solvents, perchlorate, explosives, and metals) through burning in direct contact with surface soil.
- Releases of fuel-related SVOCs (polynuclear aromatic hydrocarbons [PAH]) from fuels used to initiate burning.
- Releases of chemical agents/agent breakdown products from the site's former location in the Gulf Chemical Warfare Depot in the 1940s to early 1950s.
- The most viable contaminant transport pathway is leaching of contaminants from soil to groundwater.
- Current human receptors are limited to commercial and construction workers. Future potential receptors include all current receptors, plus hypothetical child and adult residents under a land reuse scenario.

B6.0 Investigative Results

The RSA-013 RFI report (CB&I, 2017) evaluated the analytical results from all usable soil and groundwater samples. All nature and extent of contamination results are summarized in this section. Further details are presented in the RFI report (CB&I, 2017).

Soil

Metals. The site-to-background comparison identified one anomalous concentration each of arsenic, cadmium, and lead that exceeded background screening values (BSV) and preliminary screening values (PSV) in surface soil. The metals exceedances in surface soil are delineated in all directions by sample results that were determined to be naturally occurring or below BSVs and PSVs. All metals in subsurface soil were determined to be naturally occurring or present at concentrations less than BSVs and PSVs.

Volatile Organic Compounds. All VOCs detected in representative surface and subsurface soil samples were below PSVs.

Semivolatile Organic Compounds. All SVOC concentrations in surface and subsurface soil samples were below PSVs.

Explosive Compounds. One concentration of the explosive compound 2,4,6-trinitrotoluene in surface soil exceeded the PSV. The exceedance is delineated in all directions by sampling results that were below the PSV. All explosive compound concentrations detected in subsurface soil were below PSVs.

Perchlorate. Two concentrations of perchlorate in surface soil and nine concentrations in subsurface soil are greater than the PSV. The lateral extent of perchlorate-contaminated soil is delineated by sampling results that were below the PSV.

Chemical Agent/Agent Breakdown Products. Mustard was not detected in any of the surface or subsurface soil samples analyzed for the compound. Detections of agent breakdown products (thiodiglycol, 1,4-dithiane, and 1,4-oxathiane) were limited to thiodiglycol in surface soil; all concentrations were several orders of magnitude below the PSV. Agent breakdown products were not detected in subsurface soil samples.

Groundwater

Metals. None of the metals detected in the site groundwater samples exceeded both the corresponding BSVs and PSVs; therefore, a site-to-background comparison was not required for metals in groundwater.

Volatile Organic Compounds. Four VOCs (trichloroethene [TCE], 1,1-dichloroethene, 1,2-dichloroethane, and methylene chloride) were detected in groundwater samples at concentrations above PSVs. The exceedances for these compounds are delineated either by samples from within RSA-013 or on the RSA-151 groundwater unit scale.

Semivolatile Organic Compounds. Four SVOCs (benzo[a]pyrene, benzo[a]anthracene, benzo[b]fluoranthene, and indeno[1,2,3-cd]pyrene) were detected in one RSA-013 monitoring well at concentrations above PSVs. The distribution of SVOC exceedances at RSA-013 and throughout the RSA-151 groundwater unit are sporadic and do not contribute to mappable plumes.

Explosive Compounds. Three explosive compounds (RDX, 2-nitrotoluene, and 2,6-dinitrotoluene) were detected at concentrations above PSVs in groundwater samples. The exceedances for 2-nitrotoluene and 2,6-dinitrotoluene were limited to one well each and are

delineated by RSA-013 wells with sampling results that were either below the PSV or nondetect. RDX concentrations in groundwater exceeded the PSV in 8 of the 10 site wells. The RDX exceedances are delineated on the RSA-151 groundwater unit scale.

Perchlorate. Perchlorate concentrations in groundwater exceeded the PSV in 8 of the 10 site wells. The presence of perchlorate in soil at concentrations above the leachate-based soil screening level (SSL) coupled with the elevated concentrations in groundwater indicate that RSA-013 is a leaching source of perchlorate contamination to groundwater (see further discussion for perchlorate concentrations exceeding the SSL in soil in Section B8.3). The perchlorate PSV exceedances in groundwater are delineated on an RSA-151 groundwater unit scale.

Agent Breakdown Products. Agent breakdown products were not detected in groundwater samples collected from RSA-013 monitoring wells.

B7.0 Land and Resource Use

Current and Future Land Use. This site is located in an area designated as an Industrial Zone, designated as the Buxton Road Development Plan Area in the RSA Master Plan (Army, 2013). Current and future land use for this site is and will remain for the foreseeable future as Range Operations, Explosive Operations, Storage, Test Areas, Open Space, and Buffer Zone. Where practical, the Army has restricted entry into the RCRA solid waste management units by fencing them and/or placing warning signs at key entry points in accordance with the site access control (SAC) program (Army, 2012). RSA-013 lies within the OB/OD area, which is secured by a perimeter chain-link fence and locked gate, limiting access to RSA-013. Access to RSA-013 is prohibited when the OB/OD area is active. There are no buildings located within the RSA-013 site boundary. Site redevelopment (e.g., construction of parking lots, buildings, or other structures) may be anticipated for RSA-013 in the future. No future residential or day-care facilities are planned or anticipated for RSA-013.

Current Groundwater Use. Groundwater under RSA-013 is not currently used for human consumption or any nonpotable purposes. RSA's installation-wide groundwater interim record of decision (Shaw, 2007) and LUC remedial design (Shaw, 2009b) as implemented by the Army's SAC program (Army, 2012) prevent the current use of groundwater for potable purposes and ensure that any nonpotable uses of groundwater are reviewed and evaluated by the Army prior to being allowed.

Future Groundwater Use. Future use of groundwater under RSA-013 is possible. However, under the provisions of the installation-wide groundwater interim record of decision (Shaw, 2007) and the Army's SAC program (Army, 2012), future groundwater resources beneath RSA-013 and elsewhere on RSA may not be developed for potable purposes, and groundwater withdrawals for nonpotable uses must be managed until remedies are selected in the final Decision Documents for the various groundwater units within RSA, including the RSA-151 groundwater unit. In the meantime, as part of the Permit, ADEM has required that the Army perform annual monitoring of wells located within the RSA perimeter (ADEM, 2021). This annual monitoring will allow the Army and ADEM both to assess the rate of long-term groundwater recovery and ensure protection for residents living outside of the boundary of RSA (APTIM, 2020).

B8.0 Site Risks

An Alabama Risk-Based Corrective Action (ARBCA) human health risk evaluation and a screening-level ecological risk assessment (SLERA) are summarized in Sections 8.1 and 8.2. The fate and transport evaluation is summarized in Section 8.3. Further detail is presented in the RFI report (CB&I, 2017).

B8.1 Human Health Risk

The human health risk assessment (HHRA) for RSA-013 was prepared and presented in the RSA-013 RFI report (CB&I, 2017), in accordance with the ARBCA guidance (ADEM, 2017a). The ARBCA evaluation may consist of a three-tiered process: the ADEM preliminary screening level (PSL) evaluation, the Risk Management (RM)-1 evaluation, and the RM-2 evaluation. Note that the RM-1 evaluation is optional. It is typically not performed since RSA has an ADEM-approved installation-wide work plan (IT Corporation, 2002, Shaw, 2010b). Instead, the evaluation for RSA-013 proceeded directly from the PSL evaluation to the RM-2 evaluation. The PSL and RM-2 evaluations are described below.

The PSL evaluation consisted of a simple comparison of site concentrations with PSVs, which generally were the U.S. Environmental Protection Agency (EPA) (2014) regional screening levels, based on the lower of an individual excess lifetime cancer risk (IELCR) of 1×10^{-6} and a noncancer hazard index (HI) of 0.1. In the case of groundwater, maximum contaminant levels (MCL) were used as the PSVs, if available. Otherwise, tap water PSVs (EPA, 2014) were used. Select PAHs were compared to 2017 PSVs (EPA, 2017), which were revised with updated toxicity values. Residential PSVs were selected for the evaluation of this site in order to consider alternatives to attain unrestricted land use.

The PSL evaluation was conducted for all chemicals that are determined to be site related. Inorganics with maximum detected concentrations that do not exceed their BSVs or shown in a site-to-background evaluation to be naturally occurring were judged not to be site related and were not evaluated further. All other detected chemicals were initially identified as chemicals of potential concern and site concentrations are compared to PSVs in the PSL evaluation. A chemical of potential concern was identified as a COC if the maximum detected concentration was greater than a PSV. Arsenic, cadmium, lead, perchlorate, 2,4,6-trinitrotoluene, 2,6-dinitrotoluene, and TCE were identified as COCs in total soil. Perchlorate, four explosive compounds (2,6-dinitrotoluene, 2-nitrotoluene, 3-nitrotoluene, and RDX), four PAHs (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, and indeno[1,2,3-cd]pyrene), and six VOCs (1,1,2,2-tetrachloroethane, 1,1-dichloroethene, 1,2-dichloroethane, chloroform, methylene chloride, and TCE) in groundwater were identified as COCs because their maximum detected concentration s exceed their PSVs. Four metals (arsenic, barium, lead, and mercury), 2,3,7,8-tetrachlorodibenzo-p-dioxin, bis(2-ethylhexyl)phthalate, and 10 VOCs (1,1,1-trichloroethane, 1,1,2-trichloroethane, benzene, bromodichloromethane, carbon tetrachloride, cis-1,2-dichloroethene, dibromochloromethane, tetrachloroethene, vinyl chloride, and total xylenes) were identified as COCs in groundwater only because they have MCLs.

The soil and groundwater COCs identified in the PSL evaluation were brought forward for evaluation in the cumulative risk assessment (RM-2 evaluation). Receptor scenarios evaluated in the cumulative risk assessment included a commercial worker, a construction worker, and a hypothetical residential receptor. Receptors under current and future site use of RSA-013 consisted of a commercial worker and a construction worker. A residential receptor was included in the risk assessment as a potential hypothetical future receptor. It is not anticipated that RSA-013 will be developed for residential use. Although Army risk regulations, policy, and guidance are to only evaluate those receptors that are actually at a site or that could reasonably be anticipated to occur, the risk assessment included a residential use scenario only to comply with the Alabama Environmental Investigation and Remediation Guidance (ADEM, 2017b) and ARBCA guidance (ADEM, 2017a). In the Permit, ADEM requires that these guidance documents and approved risk assessment work plans (IT Corporation, 2002; Shaw, 2010b) be adhered to during environmental investigations and evaluations. RSA is legally mandated to comply with the Permit. At RSA, the hypothetical residential scenario is included in the RM-2 HHRA in order to determine whether a site is eligible for unrestricted use as defined in Alabama Administrative Code 335-5-1-.03(r) or support the use of LUCs as a component of the selected remedy. Therefore, risks to a residential site user receptor were assessed in this RM-2 HHRA.

The ARBCA guidance (ADEM, 2017a) considers an IELCR of 1 x 10^{-5} to be the target cumulative risk. The target cumulative noncancer hazard is a HI of 1.0 on a target organ basis. Estimated cumulative risks/hazards at or below these targets do not require action. Cumulative IELCR and HI estimates for all receptor scenarios for RSA-013 are summarized in Table 2-1 in the CMI work plan. These totals are based on the contributions from all the COCs carried forward from the PSL evaluation. As shown in Table 2-1, the cumulative IELCR did not exceed $1x10^{-5}$ for any of the receptor scenarios for exposure to RSA-013 soil. Similarly, the cumulative HI did not exceed the threshold level of 1.0 for any receptor. The risk results for soil were also confirmed using the most recent PSVs (EPA, 2021).

Lead was identified as a COC in soil and groundwater. Screening levels of 400 and 800 milligrams per kilogram (mg/kg) were developed for residential and industrial soils, respectively, from the EPA blood lead levels for very young children and adults. As discussed in the RFI report for this site and in risk assessment guidance for lead evaluations, the representative concentration (RC) of lead in soil to be used is the arithmetic average. Average concentrations are used as the RC instead of the more conservative upper confidence limit on the mean or the maximum detected concentration because the blood lead models contain modules that statistically adjust for variation in exposure. The average lead concentration in RSA-013 soils of 61.5 mg/kg is less than the residential regional screening level of 400 mg/kg and the industrial regional screening level of 800 mg/kg (CB&I, 2017). A cleanup level for lead in drinking water of 15 micrograms per liter (µg/L) was developed from the EPA blood lead model for very young children. The maximum detected lead concentration in groundwater of 0.01 µg/L is less than the cleanup level of 15 µg/L. The risk assessment concluded that lead in soil and groundwater does not pose an unacceptable threat to human health (CB&I, 2017).

Therefore, no chemicals in soil were identified as COCs warranting action for RSA-013 (Table 2-2 in the CMI work plan). The cumulative IELCR for exposure to groundwater hypothetically developed as a potable source exceeded the ADEM target level of $1x10^{-5}$ for all receptors (Table 2-1 in the CMI work plan). Similarly, the cumulative HI for exposure to groundwater exceeded the threshold level of 1.0 for all receptors (Table 2-1 in the CMI work plan).

The COCs warranting action in groundwater for one or more receptors are perchlorate, 2,6-dinitrotoluene, 2-nitrotoluene, RDX, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, 1,1-dichloroethene, 1,2-dichloroethane, chloroform, methylene chloride, and TCE (Table 2-2 in the CMI work plan). Concentrations of perchlorate, benzo(a)pyrene, 1,1-dichloroethene, 1,2-dichloroethane, chloroform, methylene chloride, and TCE also exceeded their MCLs or other regulatory levels. In addition, nondetect PAH dibenz(a,h)anthracene was

identified as a COC warranting action because it contributed significantly to unacceptable cumulative risk when assumed to be present at its minimum detection limit.

In summary, no COCs were identified in soil posing an unacceptable human health risk via direct soil contact. However, numerous COCs present in groundwater at concentrations above health-based standards were found to pose unacceptable risks to human health if the contaminated groundwater were consumed. Groundwater contamination is present as a result of past as well as ongoing leaching of site soil contaminants to groundwater.

Vapor Intrusion Evaluation. A screening-level evaluation of vapor intrusion was conducted to determine whether there has been a release of VOCs to groundwater or soil at RSA-013 that may volatilize and migrate upward to pose an unacceptable risk to occupants of a commercial/industrial building or a hypothetical residential building erected on site in the future (CB&I, 2017). It was concluded that VOCs in soil, soil vapor, and groundwater do not represent a source that would pose an unacceptable health threat by the vapor intrusion pathway.

B8.2 Ecological Risk

The SLERA for RSA-013 (CB&I, 2017) was conducted in accordance with the guidelines set forth in the ARBCA guidance manual (ADEM, 2017a), the RSA installation-wide work plan (IT Corporation, 2002), and the final SLERA supplements to the installation-wide work plan (Shaw, 2010b). A SLERA was performed in order to determine if the site is eligible for no further action in accordance with ADEM requirements. Note that the SLERA evaluation relies on ecological screening values (ESV) rather than on the human-health based PSVs.

Surface soil data for RSA-013 were compared to their respective BSVs (as applicable) and ESVs. Comparison of surface soil data to their respective ESVs and BSVs 13 metals (barium, cadmium, calcium, cobalt, copper, lead, magnesium, manganese, mercury, potassium, selenium, silver, and zinc), perchlorate, thiodiglycol, 1,3,5-trinitrobenzene, 2,4,6-trinitrotoluene, 2-amino-4,6-dinitrotoluene, 4-amino-2,6-dinitrotoluene, HMX, RDX, chloromethane, and TCE as preliminary chemicals of potential ecological concern (COPEC) that required further evaluation. All of the other constituents detected in surface soil at RSA-013 were detected at concentrations less than their respective ESVs and/or BSVs and were considered to pose negligible ecological hazards.

The COPEC refinement process concluded that many of the metals detected in the RSA-013 samples were likely to be naturally occurring. Many of the explosive compounds were present in less than 5 percent of the site surface soil samples and determined to have negligible contribution to the overall ecological hazards associated with exposures to surface soil. Based on the results

of the screening evaluation and COPEC refinement, cadmium, copper, lead, and zinc required community-level (terrestrial plant and invertebrate communities) and food chain assessments (Table 2-3 in the CMI work plan). Barium, perchlorate, thiodiglycol, HMX, RDX, chloromethane, and TCE required only a community-level assessment; further assessment for food chain effects was not warranted because the chemicals are not bioaccumulative.

The results of the community-level and food chain assessments for RSA-013 concluded that all of the COPECs in surface soil at RSA-013 are unlikely to pose hazards to ecological receptor communities and/or populations, and further evaluation of ecological hazards at RSA-013 is not warranted.

In summary, the results of the SLERA indicate that no ecological hazards are present. Further evaluation of ecological hazards at RSA-013 is not warranted.

B8.3 Contaminant Fate and Transport

At RSA-013, the major potential contaminant migration pathway is the dissolution of site-related chemicals from soil to form leachate and the subsequent transport to the water table resulting from the downward percolation of infiltrating rainfall. Overland transport of soil contaminants by wind or water is unlikely at RSA-013 because the site is relatively level and partially vegetated.

Based on concentrations of chemicals in soil, 12 constituents (5 metals, perchlorate, 3 explosives, and 3 VOCs) were evaluated in the RFI report (CB&I, 2017) for the potential to leach from soil to groundwater and result in adverse impacts to groundwater. Of the 12 constituents evaluated through weight-of-evidence criteria, only RDX and perchlorate were determined to represent a potential leaching threat to groundwater.

Three concentrations of RDX in surface soil and two concentrations of RDX in subsurface soil exceeded the dilution-attenuation factor (DAF)$_4$ SSL (Figure 2-1 in the CMI work plan). The DAF$_4$ SSL exceedances for RDX were evaluated further in the soil-to-groundwater migration evaluation. Although the frequencies of exceedance are low, the magnitudes of the exceedances were high (up to 144 times the DAF$_4$ SSL in surface soil and up to 26 times in subsurface soil), and borehole averages for the three boring locations exceed the DAF$_4$ SSL. Elevated concentrations of RDX are present in groundwater at concentrations up to 111 times the health-based standard. The soil-to-groundwater migration evaluation concluded that RDX has likely historically leached to groundwater at this site and continues to pose leaching threats.

Two concentrations of perchlorate in surface soil and 11 concentrations of perchlorate in subsurface soil exceeded the leachate-based SSL (Figure 2-2 in the CMI work plan); the locations are within or adjacent to the formerly used burn pads. The frequencies of exceedance are high, the magnitudes of the exceedances were high (up to 920 times the DAF_4 SSL in surface soil and over 1,500 times in subsurface soil), and borehole averages exceed the DAF_4 SSL. Elevated concentrations of perchlorate are present in groundwater at concentrations up to 3,733 times the health-based standard. The soil-to-groundwater migration evaluation concluded that leaching of perchlorate has historically occurred at the site and will continue to occur in the future.

In summary, corrective measures are required to address the ongoing leaching by perchlorate and RDX in soil to groundwater resulting in groundwater contamination above health-based standards and preventing effective groundwater treatment due to the continued contaminant sourcing.

B9.0 Objectives of the Corrective Measures and Cleanup Goals

The RFI conducted at RSA-013 defined the nature and extent of contamination and concluded that former operations resulted in perchlorate- and RDX-contaminated soil that poses a leaching threat to groundwater. The presence of this source material leaching to groundwater results in groundwater contamination posing an unacceptable risk to human health if groundwater is consumed. Site soils within RSA-013 do not pose an unacceptable risk for exposure to any current or future industrial receptors, future hypothetical resident, or ecological receptors. COCs in groundwater under RSA-013 received ADEM concurrence for performing corrective measures as part of the RSA-151 groundwater unit (CMI work plan, Appendix A).

The corrective measure objective for RSA-013 is as follows:

- Reduce perchlorate and RDX concentrations in soil at RSA-013 to minimize or eliminate perchlorate and RDX in soils as an ongoing source of groundwater contamination.

The Army derived a CG for perchlorate in soils at RSA using the EPA Interim Drinking Water Health Advisory Level (HAL) of 15 µg/L. This HAL was established as the approved Army groundwater CG for perchlorate in a memorandum from the U.S. Department of Defense (DoD) in 2009 (DoD, 2009). Using this HAL, the Army derived a CG for perchlorate in soils at RSA of 1.7 mg/kg in the *Final Installation-Wide Groundwater Cleanup Strategy* (Shaw, 2009a). This

value of 1.7 mg/kg will be used at RSA-013 as the CG for perchlorate in soil. This cleanup value is based on the conservative assumption that exposure would occur immediately under the source.

A site-specific SSL to be used as the CG was developed for RDX using ADEM's ARBCA software package (ADEM, 2010) to determine a soil concentration of RDX protective of groundwater at the nearest off-site well from the source area in the downgradient direction of groundwater flow (monitoring well P13-RS190). To apply this model, site-specific parameters for soil and groundwater were integrated with updates to the default exposure factors, physical parameters, and toxicity values present within the software package. The ARBCA software package provides coded analytical solutions for ADEM's groundwater resource protection calculations discussed in ADEM's 2008 and 2017 guidance. This software package calculates a vertical and horizontal dilution attenuation factor to a selected point of exposures as can be visualized on Figure B-1 of ARBCA guidance (ADEM, 2017a). The point of exposure selected for this modeling is well within the boundary of the much larger perchlorate plume. The value of 0.45 mg/kg is used as the CG for RDX as discussed in Appendix I of the CMI work plan.

A summary of the soil CGs for RSA-013 is provided in Table 3-2 in the CMI work plan. Figure 3-1 in the CMI work plan shows the locations where RDX and perchlorate exceed the CGs.

B10.0 Description and Comparison of Alternatives

A technology screening was performed to evaluate a number of corrective measures technologies that are potentially applicable to the perchlorate- and RDX-contaminated soils at RSA-013. The technologies were screened against the criteria of long-term reliability and effectiveness; reduction of toxicity, mobility, or volume of wastes; short-term effectiveness; ease of implementation; and cost.

The following technologies were considered during the evaluation of alternatives either as a stand-alone remedy or as part of another corrective measure, as detailed in the CMS report (APTIM, 2021a):

- No action
- Excavation and off-site disposal
- LUCs
- Capping
- In situ soil mixing
- Ex situ soil flushing
- In situ bioremediation

- Ex situ bioremediation
- Thermal desorption.

Following an evaluation of these remedial technologies, no action and two process options were retained in the CMS report for development of corrective measures alternatives for RSA-013:

- No action
- Excavation and off-site disposal
- Excavation and on-site anaerobic bioremediation.

Below are the three corrective measures alternatives that were selected for detailed analysis in accordance with the RCRA corrective action plan (EPA, 1994):

- ***Alternative 1:*** No Action. Under the no-action alternative, no corrective measures would be taken to address the contaminated soils posing a leaching threat at RSA-013. Because this alternative would not be protective of human health, it is not considered a candidate for implementation but presents a baseline for the comparison of anticipated risk reduction and costs between other retained alternatives.

- ***Alternative 2:*** Excavation and Off-Site Disposal. Perchlorate- and RDX-contaminated soils would be excavated and transported for disposal at a properly licensed Subtitle D landfill. Emulsified vegetable oil would be added to the bottom of the excavation to promote biodegradation of perchlorate concentrations in groundwater within the saturated zone soil. The excavation would then be backfilled with clean soil, followed by site restoration. Soil comprising the two berms at the site will be tested for use as backfill.

- ***Alternative 3:*** Excavation and On-Site Anaerobic Bioremediation. This alternative involves the excavation of the perchlorate- and RDX-contaminated soil exceeding CGs followed by on-site bioremediation. The bioremediation treatment process would involve mixing the soil with bulking and organic amendments to provide sufficient porosity and balance to allow anaerobic biological reduction of perchlorate to chloride ion by perchlorate-reducing bacteria and to degrade RDX to carbon dioxide and water. Following bioremediation, confirmation sampling would be conducted to verify that soil perchlorate and RDX concentrations have been reduced to below CGs. Emulsified vegetable oil would be added to the bottom of the excavation to promote biodegradation of perchlorate concentrations in groundwater within the saturated zone soil. The remediated soil would be returned to the excavation for use as backfill after it has been allowed to dry.

Because Alternative 2 is an effective and proven technology at numerous RSA sites with perchlorate contamination in soil to achieve no further action, meets requirements specified in the Army's guidance for Defense Environmental Restoration Program (DoD, 2018), and ranks high or moderate-high in all evaluation criteria compared to the other alternatives, it was

recommended as the preferred corrective measure alternative for perchlorate- and RDX-contaminated soil at RSA-013.

B11.0 Selected Corrective Measure

Alternative 2 was selected by the Army as the most appropriate corrective measures alternative to address perchlorate- and RDX-contaminated soil posing a leaching threat to groundwater at RSA-013. The major components of the selected corrective measures include the following:

- Obtain an underground injection control permit
- Obtain a permit under the General National Pollutant Discharge Elimination System permit coverage for stormwater discharges
- Mobilization/demobilization
- Utility clearance and marking
- Installation of surface water and erosion controls
- Vegetation clearing
- Surveying and marking of the proposed excavation area
- Protection/closure of monitoring wells located in the vicinity of the excavation area
- Excavation of contaminated soil from the area shown on Figure 3-1 in the CMI work plan
- Confirmation sampling and analysis of the excavated area to meet the CGs
- In situ enhanced bioremediation via placement of a carbon source (emulsified vegetable oil [EVO] substrate) at the bottom of the excavation to promote biodegradation of perchlorate in the smear zone and possibly into saturated zone soils
- Waste characterization sampling
- Transport and disposal of excavated soils as nonhazardous waste (Subtitle D landfill)
- Site restoration, including application of backfill and topsoil, and revegetation with approved grass mixtures.

Alternative 2 is the excavation of perchlorate- and RDX-contaminated soil and off-site disposal at an approved landfill. This alternative involves a large excavation of approximately 81,700 square feet to a depth of approximately 8 feet (average depth to groundwater) for an estimated 24,200 bank cubic yards. Sidewall confirmation samples of the excavated area will be collected

to ensure the contaminants meet the CGs. Prior to backfilling, EVO will be placed at the bottom of the excavation to promote biodegradation of perchlorate in the smear zone and possibly into the saturated zone soils. The excavated area will then be backfilled with clean fill, sloped to drain, and revegetated to minimize erosion.

In conjunction with the CMI report, a site-specific probability assessment will be prepared to reduce the UXO probability from "Low" to "None". On-call UXO support would not be required for any future intrusive activities following Army approval of the reduced probability rating. Lowering the UXO rating also supports that no LUCs need to be maintained for surface media at this site.

The corrective measures in Alternative 2 address the soil contamination in a manner that is cost-effective and meet the ADEM general standards for corrective measures (overall protection of human health and the environment, attainment of media cleanup standards, control of sources of the release, and compliance with standards for management of wastes).

As discussed in Section B10.0, the selected corrective measures in Alternative 2 were chosen over the other corrective measure alternatives in the CMS report because they provide the best balance of trade-offs among the other corrective measure alternatives with respect to the evaluation criteria. Full removal of soil contaminated with perchlorate and RDX is likely with this alternative. Full removal has the likelihood for clean site closure (i.e., unrestricted use of the land) with no future LUCs or long-term monitoring and maintenance, ultimately eliminating the Army's remaining financial liability associated with RSA-013.

B12.0 Public Involvement

Public participation requirements specified under Alabama Administrative Code r. 335-14-8-.08(6) will be met during the permit modification process for the RSA-013 corrective measure. In addition, the Army will inform the public of the proposed RSA-013 corrective measure for soil in a newspaper announcement in local newspapers.

B13.0 Conclusions

This request for permit modification presents the supporting information needed to allow ADEM to modify the Permit, in accordance with Alabama Administrative Code r. 335-14-8-.04(2), with respect to cleanup status at RSA-013. As part of the RFI report, the Army requested that ADEM move this site from Table VI.2 to Table VI.6 in the Permit and list it as requiring corrective measures for soil and groundwater. ADEM subsequently moved RSA-013 to Table VI.6 in

Permit Modification No. 11 (ADEM, 2018) as requiring action for soil and groundwater as part of the RSA-013 and RSA-151 groundwater unit corrective measures, respectively.

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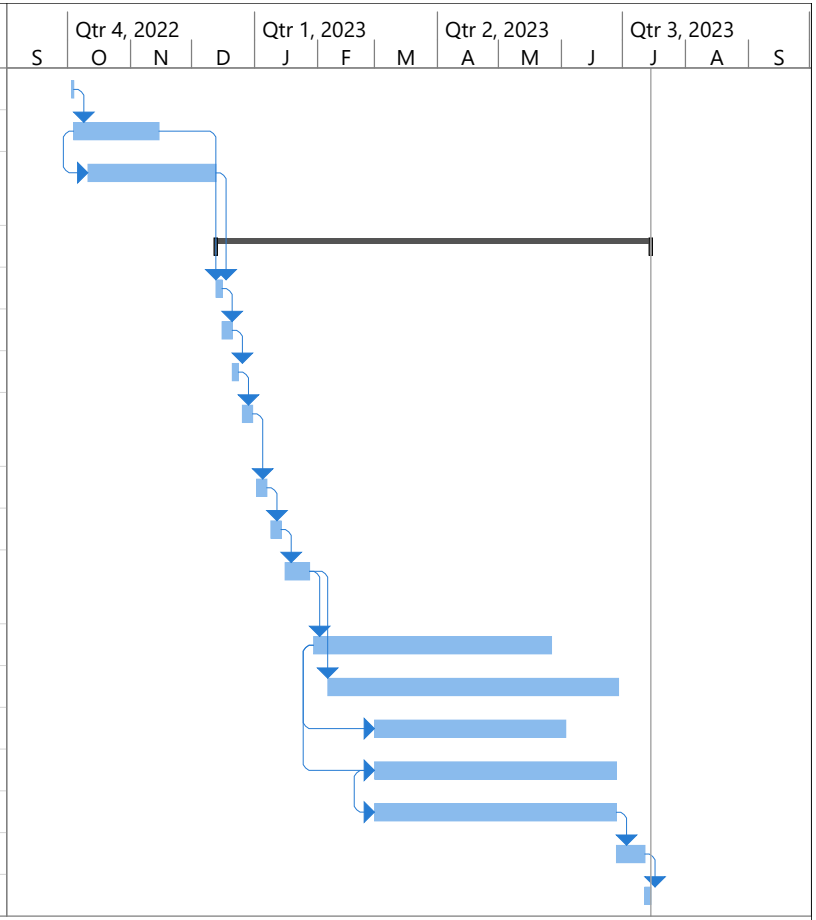
APPENDIX C

CORRECTIVE MEASURES IMPLEMENTATION SCHEDULE

ID	Task Mode	Task Name	Duration	Start
1		Notice To Proceed	1 day	Mon 10/3/22
2		Procurement	30 days	Tue 10/4/22
3		Job Order Request / Record of Environmentl Review	45 days	Tue 10/11/22
4		**CMI Implementation**	**154 days**	**Tue 12/13/22**
5		Mobilization	3 days	Tue 12/13/22
6		Surveying and Marking Excavation	3 days	Fri 12/16/22
7		Marking Utilities / Capping	3 days	Wed 12/21/22
8		Installation of Erosion and Sediment Controls	5 days	Mon 12/26/22
9		Well Abandonment and Protection	5 days	Mon 1/2/23
10		Tree and Vegetation Clearing	5 days	Mon 1/9/23
11		Berm removal, stockpile, and sampling	10 days	Mon 1/16/23
12		Excavation and Stockpiling	85 days	Mon 1/30/23
13		Soil/Waste Sampling and Analyses	103 days	Mon 2/6/23
14		EVO placement in excavation	68 days	Wed 3/1/23
15		Transportation and Disposal	85 days	Wed 3/1/23
16		Backfill and site restoration	85 days	Wed 3/1/23
17		Site Restoration	10 days	Wed 6/28/23
18		Demobilization	3 days	Wed 7/12/23



Project: RSA-013 CMIC.mpp
Date: Wed 9/8/21

Task	Inactive Summary	External Tasks
Split	Manual Task	External Milestone
Milestone	Duration-only	Deadline
Summary	Manual Summary Rollup	Progress
Project Summary	Manual Summary	Manual Progress
Inactive Task	Start-only	
Inactive Milestone	Finish-only	

APPENDIX D

QUALITY ASSURANCE PROJECT PLAN

Appendix D

Quality Assurance Project Plan
for the
Corrective Measures
RSA-013
U.S. Army Garrison-Redstone
Madison County, Alabama
U.S. EPA ID No. AL7 210 020 742

Contract Number W912DY-17-D-0003
Delivery Order No. W912DY-19-F-1116

Prepared for:

U.S. Army Engineering & Support Center
Army Engineering & Support Center, Huntsville
ATTN: CEHNC-OEC
5021 Bradford Drive East
Huntsville, Alabama 35805

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11400 Parkside Drive, Suite 400
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November 2021

List of Quality Assurance Project Plan Worksheets

List of Attachments

D1.0 Introduction

This quality assurance project plan (QAPP) has been prepared to guide the conduct of corrective measures for RSA-013. This QAPP is an appendix to the corrective measures implementation (CMI) work plan for RSA-013. This QAPP has been prepared as a site-specific plan under the *Final Revision 4 Installation-Wide Uniform Federal Policy Quality Assurance Program Plan, U.S. Army Garrison-Redstone, Madison County, Alabama*, December 2019 (HydroGeoLogic, Inc., 2019) or most recent version.

Reference: HydroGeoLogic, Inc., 2019, ***Final Revision 4 Installation-Wide Quality Assurance Program Plan, U.S. Army Garrison – Redstone, Madison County, Alabama, Volumes I and II***, prepared for U.S. Army Corps of Engineers, Huntsville District, U.S. Army Engineering and Support Center, Huntsville, December.

Worksheet Nos. 1 and 2: Title and Approval Page

Site Name/Project Name	Redstone Arsenal, Madison County, Alabama/Huntsville MEGA
Site Location	RSA-013, Unlined Inactive Open Burn Pad
Site Number/Code	RSA-013
Operable Unit (OU)	OU-14
Contractor Name	Aptim Federal Services, LLC (APTIM)
Contract Number	W912DY-17-D-0003
Contract Title	Corrective Measures Implementation at Multiple Sites, Redstone Arsenal
Delivery Order	W912DY-19-F-1116
Guidance used to prepare site-specific plan	Aptim Federal Services, LLC (APTIM), 2021, *Revised Final Corrective Measures Report, RSA-013, Unlined Inactive Open Burn Pad, Operable Unit 014, U.S. Army Garrison-Redstone, Madison County, Alabama*, March. CB&I Federal Services LLC (CB&I), 2017, *Revision 1 RCRA Facility Investigation Report, RSA-013, Unlined Inactive Open Burn Pad, RSA-132, Dismantled Popping Furnace, RSA-133, Inactive Rocket Washrack/Sump, Operable Unit 14, U.S. Army Garrison-Redstone, Madison County, Alabama*, February. Intergovernmental Data Quality Task Force, 2005, *Uniform Federal Policy for Quality Assurance Project Plans.* IT Corporation (IT), 2002, *Draft Installation-Wide Work Plan, Revision 2, Redstone Arsenal, Madison County, Alabama,* prepared for the U.S. Army Corps of Engineers, Savannah District, June. Shaw Environmental, Inc. (Shaw), 2010, *Installation-Wide Work Plan, Final Appendices B, C, D, E, F, Redstone Arsenal, Madison County, Alabama*, September. U.S. Army Corps of Engineers, 2015, Technical Guidance for Military Munitions Response Action, Engineer Manual 200-1-15, 30 October. U.S. Department of Defense (DoD), 2019, *Quality Systems Manual for Environmental Laboratories* Version 5.3, May. U.S. Environmental Protection Agency (EPA), 2014, *National Functional Guidelines for Superfund Inorganic Data Review*, EPA 540-R-013-001, August U.S. Environmental Protection Agency (EPA), 2014, *EPA National Functional Guidelines for Superfund Organic Methods Data Review*, EPA 540-R-014-002, August.

Worksheet Nos. 1 and 2: Title and Approval Page

Regulatory Program	Resource Conservation and Recovery Act (RCRA), ADEM Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), EPA Region 4
Approval Entities	U.S. Army Garrison – Redstone; U.S. Army Engineering and Support Center, Huntsville (CEHNC); Alabama Department of Environmental Management (ADEM)
Work Plan	☒ Corrective Measures Implementation ☐ Generic Field Sampling Plan
Dates of Scoping Session	June 17, 2021 (see Attachment D-1)
Dates and Titles of SFSP Documents Written for Previous Site Work (if applicable)	References for documents used to prepare the CMI Work Plan are included in Chapter 6.0 of the CMI Work Plan.
Organizational Partners (stakeholders) and Their Connection with Lead Organization	U.S. Army Garrison-Redstone – Site manager for RSA-013 and point of contact with regulators. CEHNC – Oversees APTIM's performance under this contract. ADEM – State regulator overseeing RSA environmental and remediation activities. EPA, Region 4 – Federal regulator overseeing RSA environmental and remediation activities.
Data Users	CEHNC, Project/Task Leads, Engineering, support personnel, U.S. Army Garrison-Redstone, ADEM, EPA Region 4

Worksheet Nos. 1 and 2: Title and Approval Page

The below signatures indicate the representatives of the subject organizations have reviewed this RSA-013-specific QAPP and concur with its implementation as written.

Review:

_____ _____
Vicki Graves — Date
APTIM Project Chemist

Approval:

_____ _____
Don Burton, PE — Date
APTIM Project Manager

_____ _____
Ashley Roeske — Date
USACE Project Manager/
Contracting Officer Representative

Worksheet Nos. 3 and 5: Project Organization and QAPP Distribution

CMIP Recipients	Title	Organization	Telephone Number	E-mail Address
Ashley E. Roeske	Contracting Officer Representative	U.S. Army Engineering & Support Center, Huntsville	256-895-1429	Ashley.E.Roeske@usace.army.mil
Clint Howard	Chief Installation Restoration Branch	U.S. Army Garrison - Redstone	256-842-3702	joseph.c.howard1.civ@mail.mil
Robert "Bob" Gorman	Army Site Task Manager	U.S. Army Garrison - Redstone	256-876-3814	robert.p.gorman10.civ@mail.mil
Krishna "Kel" Morrissette	Lead Remedial Project Manager	ADEM	334-394-4335	kMorrissette@adem.alabama.gov
Dr. Heather McDonald, PE	Technical Manager	U.S. Army Engineering & Support Center, Huntsville	256-895-1892	Heather.B.Mcdonald@usace.army.mil
Don Burton, PE	Project Manager	APTIM	865-207-1394	Don.burton@aptim.com
Dennis Seymore	Senior Scientist and Site Technical Lead	APTIM	865-414-6073	Dennis.seymore@aptim.com
Emily Davis	Regulatory Specialist	APTIM	717-737-1049	Emily.davis@aptim.com
Tricia Felt	Corporate Quality Management Director	APTIM	303-741-7426	Tricia.felt@aptim.com
Brian Rhodes	Project QA/QC Manager/Quality Control Site Manager (QCSM)	APTIM	256-714-4200	Brian.rhodes@aptim.com
Vicki Graves	Project Chemist	APTIM	865-310-6773	Vicki.graves@aptim.com
Ken Hurley, PE	Project Engineer	APTIM	865-560-7831	Kenneth.hurley@aptim.com

Notes:

Copies of the corrective measures implementation work plan which contains the QAPP will be distributed to the individuals above.

One controlled hard copy of the corrective measures implementation work plan which contains the QAPP will be maintained in the field trailer as a reference for field workers. The field team members are required to be familiar with their applicable contents through required reading and the sign-off acknowledgement sheet. The QCSM will be the owner of the field copy and standard operating procedures (SOP) and will be responsible to ensure that it is current and that all field sampling personnel have read the work controlling documents and have signed the acknowledgement form.

Worksheet Nos. 3 and 5: Project Organization and QAPP Distribution

Acknowledgement Form

Project Personnel	Title	Telephone Number	Signature	Date CMI Work Plan Read

The individuals who sign above are certifying they have read the applicable sections of the Quality Assurance Project Plan and the corrective measures implementation (CMI) work plan. Upon completion, please forward the original signed form, with all columns completed, to the Corporate Quality Management Director.

Worksheet Nos. 4, 7, and 8: Personnel Qualifications and Sign-Off Sheet

Name	Title	Organizational Affiliation	Responsibilities	Minimum Required Qualifications/Specialized Training/Certifications	Signature/ Date
Ashley Roeske	Contracting Officer Representative	CEHNC	Designate environmental coordinators for Contract No. W912DY-17-D-0003, Delivery Order (DO) W912DY-19-F-1116. Represent the Army's interests in the coordination and implementation of the DO for which they are responsible.	Specified by Army Corp of Engineers requirements	
Bob Gorman	Army Site Manager	U.S. Army Garrison - Redstone	Responsible for the coordination and implementation of the site-specific corrective measure tasks associated with RSA-013, including all technical and regulatory issues.	Specified by Army requirements	
Don Burton, PE	Project Manager	APTIM	Primary POC for coordination with Redstone Arsenal leadership, AEC, CEHNC, regulators, and stakeholders. Plans/administers RSA's assigned corrective measures, including IAP/CTC. Develops and oversees execution of the strategic plan. Responsible for performance, cost/schedule control, estimating, quality, safety in accordance with PWS, PMP, contract requirements, and applicable laws/regulation. Approves staff assignments and oversees PMs on DO. Responsible for monthly progress and cost reporting and change management in response to RSA's mission needs.	(1) A college degree in business, engineering, construction management, geology, chemistry, or related field. (2) Professional registration, in their respective field, if appropriate. (3) Fifteen years experience in Program Management for other contracts and programs, with a minimum of 7 years working experience in Environmental Remediation sites for contracts and programs of similar size and complexity, and oversight of project managers and project teams.	

Worksheet Nos. 4, 7, and 8: Personnel Qualifications and Sign-Off Sheet

Name	Title	Organizational Affiliation	Responsibilities	Minimum Required Qualifications/Specialized Training/Certifications	Signature/ Date
Dennis Seymore	Senior Scientist and Site Technical Lead	APTIM	Primary POC for technical coordination of Redstone Arsenal Contract No. W912DY-17-D-0003, Delivery Order W912DY-19-F-1116 activities. Oversees the activities of all APTIM personnel; ensures compliance with the scope of work and environmental activities and controls project consistency. Additional responsibilities include review and approval of the CMI Work Plan including the QAPP, Health and Safety Plan, and other project-specific attachment and plans; assignment of duties to project staff, including orientation of staff to project needs and requirements; and evaluation of training needs for the project staff. Provides budget and schedule control; reviews any subcontractor work and approves subcontract invoices; establishes the project record management system; ensures that major project deliverables are reviewed for technical accuracy and completeness before release; and ensures that QAPP requirements are satisfied. Provides the Army with an alternative POC for the RSA Contract No. W912DY-17-D-0003, Delivery Order W912DY-19-F-1116 activities.	(1) A college degree in engineering, construction management, geology, chemistry, or related field. (2) Professional registration, in their respective field, if appropriate. (3) Ten years experience in technical leadership for other contracts/programs with a minimum of 7 years working experience in Environmental Remediation sites of similar complexity and scope.	
Ken Hurley, PE	Senior Engineer	APTIM	Provides engineering direction for corrective measures design and provides PE certification of the CMIP.	(1) A college degree in engineering (2) Professional registration in engineering. (3) Ten years experience in engineering leadership for other contracts/programs with a minimum of 7 years working experience in Environmental Remediation sites of similar complexity and scope.	

Worksheet Nos. 4, 7, and 8: Personnel Qualifications and Sign-Off Sheet

Name	Title	Organizational Affiliation	Responsibilities	Minimum Required Qualifications/Specialized Training/Certifications	Signature/ Date
Emily Davis	Regulatory Specialist	APTIM	Single POC responsible for coordination with Army on regulatory issues. Determines applicable regulatory requirements; ensures compliance; negotiates proposed remedies with regulators; determines ARARs, evaluates alternative cleanup methods; and supports Army in resolving legal, regulatory, and policy concerns.	(1) An advanced college degree in law, engineering, public administration, construction management, geology, chemistry, or related field. (2) Professional registration, in their respective field, if appropriate. (3) Ten years experience in regulatory requirements for other contracts/programs with a minimum of 7 years working experience in Environmental Remediation sites, to include innovative approaches to regulatory and technical challenges such as successful experience in developing technical impracticability waivers.	

Worksheet Nos. 4, 7, and 8: Personnel Qualifications and Sign-Off Sheet

Name	Title	Organizational Affiliation	Responsibilities	Minimum Required Qualifications/Specialized Training/Certifications	Signature/ Date
Tricia Felt	Corporate Quality Management Director	APTIM	The Corporate Quality Management Director for the RSA Contract No. W912DY-17-D-0003, Delivery Order W912DY-19F-1116 activities is responsible for ensuring the overall project quality. The Corporate Quality Management Director coordinates with the technical managers of the project team to evaluate status, procedures, and nonconformances from a quality program standpoint. Other responsibilities may include the following: • The Corporate Quality Management Director gathers and coordinates corporate resources and references in the areas of quality improvement, corrective action (CA) control, and quality systems auditing for the project. • Reviews quality-related tasks in the detailed site-specific plans. • Provides project-specific training in QA/QC matters to contractor personnel, as needed, identified, or requested by the PM. • Acts as the QCSM, if required.	(1) A college degree in engineering, construction management, geology, chemistry, or related field and professional registration. (2) Professional registration, in their respective field, if appropriate. (3) A minimum of 5 years Quality Assurance/Control experience, with a minimum of 3 years in Environmental Remediation projects.	
Brian Rhodes	QCSM	APTIM	Reports directly to the Corporate Quality Management Director on all matters within the scope of the project QC program and is responsible for the overall management of the QC program on and off site, including field sampling and characterization, construction, and consulting engineering activities. Duties of the QCSM include but are not limited to the following: • Serves as primary contact for project quality matters and actively identifies and responds to QA/QC needs. Resolves problems and answers requests for guidance or assistance.	BS in environmental science or related field plus 5 years experience in quality assurance	

Worksheet Nos. 4, 7, and 8: Personnel Qualifications and Sign-Off Sheet

Brian Rhodes (Continued)			• Implements project-specific QAPP. • Actively tracks the progress of quality tasks in the QAPP and consults periodically with the Program Manager and PM on quality-related issues. • Prepares and submits QC reports as required to the PM as well as to the corporate QA management. • Approves field CAs prior to implementation. • Verifies that the subcontractor performs appropriate CAs for all APTIM nonconformances and interfaces with the analytical data coordinator or chemist on all quality issues and concerns associated with the subcontracted laboratory, including subcontractor-performed CAs. • Ensures that performance and system inspections are performed. • Ensures that necessary CAs are taken for incidents of nonconformance. • Assists in the implementation of CAs to prevent recurrence of any problems. • If significant adverse conditions exist, implements a CA Request in accordance with APTIM policies and Corporate Quality Management Director oversight. • Assists on training and orientation of field staff regarding task-specific and IW plans • Conducts performance and systems inspections. • Identifies and reports nonconforming items or activities. • Initiates recommended CA. • Verifies implementation of CA. • Monitors subcontractors on and off site. • Certifies submittal documents. • Prepares all QC reports as required by contract specifications. • Notifies the Corporate Quality Management Director of conditions adverse to quality which cannot be resolved at the project level.		

Worksheet Nos. 4, 7, and 8: Personnel Qualifications and Sign-Off Sheet

Name	Title	Organizational Affiliation	Responsibilities	Minimum Required Qualifications/Specialized Training/Certifications	Signature/ Date
Brian Rhodes	Site-Specific Health and Safety Officer	APTIM	Evaluates the health and safety aspects of the on-site tasks to ensure that activities are performed in a safe manner. Coordinates with Task Managers to complete health and safety work plan addenda for each major task work plan and works with on-site personnel to achieve compliance with the applicable health and safety plans. May have additional duties assigned by the PM.	BS in environmental science or related field plus 5 years experience in safety	
Vicki Graves	Project Chemist	APTIM	Works with the project team in formulating plans and approaches and help to assess sampling, analytical, and QA/QC requirements for each project task. Helps to ensure consistency of approach among the various tasks regarding these areas. Reviews analytical data and assists in the interpretation and use of sampling and analytical QA/QC data. Works together with the laboratory PM, laboratory QA Manager, and APTIM's Corporate Quality Management Director to identify and resolve analytical issues and nonconformances and participates in project and laboratory audits. In addition, the Project Chemist or designee: • Interfaces with the laboratory contact to ensure the laboratory is aware of the project data quality objectives, program goals, and analytical QA/QC objectives. • Communicates with the laboratory contact concerning the schedule of sample shipments and the shipment contents, including QC samples. Based on this information, provides status tracking of sample shipments to project management. • Reviews all laboratory data before those data are transferred to permanent storage. Reports to other project participants via electronic deliverable.	BS/BA in chemistry or equivalent 5 years or more experience that includes QA/QC, environmental investigation design, field sampling, field/laboratory analysis, data review, or data management	

Worksheet Nos. 4, 7, and 8: Personnel Qualifications and Sign-Off Sheet

Name	Title	Organizational Affiliation	Responsibilities	Minimum Required Qualifications/Specialized Training/Certifications	Signature/ Date
Vicki Graves (Continued)			• Interfaces with the Data Users, Task Managers, Field Sampling Lead, Sample Coordinator, Data Manager, and Laboratory PM for analytical requirements. • Defines methods and procedures used to achieve desired data quality, and ensures the laboratory is aware of the project data quality objectives, program goals, and analytical QA/QC objectives. Monitors laboratory deliverables for completeness and accuracy. • Assists in identifying and resolving any technical or quality issues regarding sample collection and analysis and interfaces with the laboratory QA Manager to resolve any nonconformances or quality issues. • Ensures that all sample planning tables are distributed to the laboratory contact, and the sample collection coordinator. • Communicates with the laboratory contact to schedule bottle and sample shipments between the field and the laboratory, including QC samples. • Provides status tracking of sample shipments to project management. • Reviews and/or validates all data based on data quality indicators. • Ensures data loaded into the database are accurate and complete. • Works with the Sample Coordinator and the analytical laboratory to ensure the complete and accurate transfer of samples and information from the field into the laboratory. • Receives and reviews analytical data and verifies receipt of analytical data from the laboratory in hard copy and electronic formats.		

Worksheet Nos. 4, 7, and 8: Personnel Qualifications and Sign-Off Sheet

Name	Title	Organizational Affiliation	Responsibilities	Minimum Required Qualifications/Specialized Training/Certifications	Signature/ Date
Don Dill	Data Validation Lead	APTIM	Reviews data against method requirements and project acceptance criteria, loads data into the appropriate database as defined in task project requirements, and performs completeness and accuracy checks on flagged data that do not meet performance objectives.	BS in chemistry, environmental science, or related field or AS plus 5 years experience; plus certification in data validation or 2 years experience using/or reviewing data for each method reviewed	
Annette Hough	Data Manager	APTIM	Loads data and information into APTIM's database and checks for errors, requests data corrections, maintains the integrity of the database, and reports data and information as requested from data users. Prepares and submits the electronic database deliverables via the Project Chemist.	AS or BS in computer science plus 2 years experience in database management or 5 years experience in database management. Supervision is required if experience is less than 2 years.	
Brandi Hodges	Geographic Information System Data Manager	APTIM	Oversees GIS efforts for the project, including Web-based GIS product.	A minimum of 5 years GIS database management experience, with a minimum of 3 years in Environmental Remediation projects.	
Becky Vandergriff	Admin Record/ Document Control	APTIM	Ensures that all the Administrative Records are adequately maintained.	A minimum of five (5) years Document Control experience, with a minimum of three (3) years in Environmental Remediation projects.	

Resumes to be located on line and/or in the project files in APTIM's office.

ADEM – Alabama Department of Environmental Management.
AEC – Army Environmental Center.
APTIM – Aptim Federal Services, LLC.
AS – Associate of Science.
BA – Bachelor of Arts.
BS – Bachelor of Science.
CA – Corrective action.
CEHNC – U.S. Army Engineering and Support Center, Huntsville.
CMI – Corrective measures implementation.
CTC – Cost-to-complete.
DO – Delivery order.
EPA – U.S. Environmental Protection Agency.
GIS – Geographic Information System.

Worksheet Nos. 4, 7, and 8: Personnel Qualifications and Sign-Off Sheet

IAP – Installation Action Plan.
IW – Installation-wide.
PM – Project manager.
PMP – Project management plan.
POC – Point of contact.
PWS – Performance work statement.
QA/QC – Quality assurance/quality control.
QAPP – Quality Assurance Project Plan.
QCSM – Quality Control Site Manager.
RL – Reporting limit.
RSA – Redstone Arsenal.

Worksheet No. 6: Communication Pathways and Procedures

Communication Drivers	Responding Entity	Name	Phone Number	Procedure (Timing, Pathways, etc.)
Point of Contact with CEHNC Ashley Roeske	APTIM Project Manager	Don Burton	865-207-1394	All documents and information are forwarded to the CEHNC by the APTIM Project Manager, or designee.
Point of Contact with Army Bob Gorman	APTIM Project Manager	Don Burton	865-207-1394	All documents and information are forwarded to the Army by the APTIM Project Manager, or designee.
Point of Contact with U.S. Environmental Protection Agency (EPA) Robert Pope	APTIM Project Manager	Don Burton	865-207-1394	All documents and information are forwarded to EPA by the APTIM Project Manager, or designee.
Point of Contact with Alabama Department of Environmental Management (ADEM) Krishna “Kel” Morrissette	APTIM Project Manager	Don Burton	865-207-1394	All documents and information are forwarded to ADEM by the APTIM Project Manager, or designee.
Corporate QA/QC Implementation	APTIM Corporate Quality Management Director	Tricia Felt	303-741-7426	The APTIM Corporate Quality Management Director or designee will review, direct and provide oversight to implement changes or revisions affecting quality following receipt from the QCSM.
Project Management and Technical Issues	APTIM Senior Scientist and Site Technical Lead	Dennis Seymore	865-414-6073	Maintains communication with all project and site technical personnel and communicates with the APTIM Project Manager (PM), at minimum, during the weekly project status meeting and as circumstances require.
Changes to Project Documents and Forms	APTIM Document Control	Becky Vandergriff	865-560-7800	Maintains revision control for all project documents and forms and oversees project documents and records management. All change requests are submitted to Document Control through principal document authors. Documents are issued document revision numbers and uploaded to the Administrative Record for the Project. All document revision slip pages or revised forms are provided to the document/form owner within 10 days following identification of the change.
Changes to quality assurance project plan (QAPP)	APTIM QCSM	Brian Rhodes	256-714-4200	Any field change requests, variance requests, or deviations are communicated to the APTIM Corporate Quality Management Director or designee and the APTIM Project Chemist. The APTIM QCSM or designee is responsible for implementing a tracking system (i.e., Variance Tracking Log, Nonconformance Report [NCR] Tracking Log, Corrective Action [CA] Tracking Log, etc.).
Changes to QAPP	APTIM Project Chemist	Vicki Graves	865-310-6773	If the site-specific QAPP needs modification, the Project Chemist will coordinate with the APTIM QCSM or designee to take appropriate action. If the QAPP is modified, it is submitted for regulatory review and approval.
Field Activities	APTIM QCSM	Brian Rhodes	256-714-4200	Daily field activities are summarized on weekly reports and posted for distribution.

Worksheet No. 6: Communication Pathways and Procedures

Communication Drivers	Responding Entity	Name	Phone Number	Procedure (Timing, Pathways, etc.)
Temporary Change Requests	APTIM QCSM	Brian Rhodes	256-714-4200	Requests to make temporary changes to field or other procedures are submitted to the APTIM Corporate Quality Management Director, who forwards to the APTIM Technical Lead and appropriate individuals for input and approval.
Data Requests and Reporting	APTIM Data Manager	Annette Hough	865-560-7829	All requests for data are directed to the Project Chemist, who forwards to the Data Manager for processing. The Project Chemist reviews data prior to release.
Data Reporting – Electronic Deliverable	APTIM Data Manager	Annette Hough	865-560-7829	The Data Manager ensures that electronic deliverable submittals are prepared and submitted on a regular basis, if required.
Database Issues	APTIM GIS Manager	Brandi Hodges	865-560-7828	All issues relating to operation or maintenance of the GIS database or equivalent database are directed to the GIS Manager, including requests for access and special reporting formats, such as data to support the GIS.

ADEM – Alabama Department of Environmental Management.
CA – Corrective action.
CEHNC – U.S. Army Engineering and Support Center, Huntsville.
DL – Detection limit.
EPA – U.S. Environmental Protection Agency.
GIS – Geographic Information System.
NCR – Nonconformance report.
PM – Project Manager.
QA – Quality assurance.
QAPP – Quality Assurance Project Plan.
QC – Quality control.
QCSM – Quality Control Site Manager.
SOP – Standard Operating Procedure.

Worksheet No. 9: Project Planning Session Summary

Project Title: Multiple Sites Corrective Measures **Project Contract/Delivery Order:** W912DY-17-D-0003/W912DY-19-F-1116 **Project Manager**: Don Burton, PE	**Site Name(s)**: RSA-013/Redstone Arsenal **Site Location**: Madison County, Alabama
Date of Session: June 17, 2021 **Scoping Session Purpose:** See Attachment D-1	

Name	Title	Affiliation	Phone No.	E-mail Address
Ashley Roeske	Contracting Officer Representative	CEHNC	256-895-1429	ashley.e.roeske@usace.army.mil
Dr. Heather McDonald, PE	Technical Manager	CEHNC	256-895-1392	Heather.b.mcdonald@usace.army.mil
Quang Nguyen	Environmental Support Manager	AEC	813-240-5578	quang.d.nguyen15.civ@mail.mil
Robert Gorman	Project Manager	U.S. Army Garrison - Redstone	256-876-3814	robert.p.gorman10.civ@mail.mil
Krishna “Kel” Morrissette	Lead Remedial Project Manager	ADEM	334-394-4335	kMorrissette@adem.alabama.gov
Jason Wilson	Chief, Governmental Hazardous Waste Branch, Land Division	ADEM	334-271-7789	JTWilson@adem.alabama.gov
Don Burton	Project Manager	APTIM	865-207-1394	don.burton@aptim.com
Emily Davis	Technical Lead/Regulatory Specialist	APTIM	717-737-1049	Emily.davis@aptim.com
Dennis Seymore	Senior Scientist and Site Technical Lead	APTIM	865-414-6073	dennis.seymore@aptim.com
Gail Cooley	Subject Matter Expert	APTIM	865-556-1967	gail.cooley@aptim.com
Ray Clark	Subject Matter Expert	APTIM	865-560-7799	ray.clark@aptim.com

ADEM – Alabama Department of Environmental Management.
AEC – U.S. Army Environmental Command.
CEHNC – U.S. Army Engineering and Support Center, Huntsville.
See RSA-013 CMIP Scoping Session Memorandum for the scoping session held on June 17, 2021 in Attachment D-1.

Worksheet No. 10: Conceptual Site Model

Corrective measures are required to address elevated concentrations of perchlorate and RDX in soil posing a continuing leaching threat to groundwater. The presence of this source material leaching to groundwater results in groundwater contamination posing an unacceptable risk to human health if groundwater is consumed. The CMI work plan provides the site description, history, and environmental setting (Section 1.2); investigations conducted and results (Sections 2.1 and 2.2); land use considerations, human health and ecological risk results, and contaminant fate and transport (Section 2.3); and the final conceptual site model (Section 2.4). Background site maps are included in the CMI work plan.

Worksheet No. 11: Project/Data Quality Objectives

Chapter 3 of the corrective measures implementation (CMI) work plan provides the decision summary for the corrective measures at RSA-013, including objectives of the corrective measures, cleanup goals (CG), and the need for the corrective measures. The project quality objectives are presented below.

Step 1. State the Problem

- The Resource Conservation and Recovery Act facility investigation (RFI) concluded that perchlorate and RDX in soil pose a leaching threat to groundwater which results in elevated concentrations of these constituents in groundwater posing unacceptable risks if the groundwater is consumed. Elevated concentrations of numerous chemicals of concern (COC) in groundwater present as commingled plumes will be addressed on a regional basis with the RSA-151 groundwater unit. These problems area a result of former U.S. Department of Defense (DoD) activities.
- If no further action for soils at RSA-013 is to be authorized, cleanup is required for perchlorate and RDX concentrations present in soil above their CGs derived from leachate- and/or modeling-based soil screening levels (SSL).
- COCs in groundwater under RSA-013 require corrective measures; groundwater cleanup will be the responsibility of RSA-151 groundwater unit.

Step 2. Identify the Goal of the Study

- Elevated concentrations of perchlorate and RDX present in soil above the CGs have been identified as requiring corrective measures to address the leaching threat to groundwater, which results in unacceptable risks if the groundwater is consumed. Cleanup to the CGs based on leachate- and/or modeling-based SSLs will be conducted to reduce further impact to groundwater from these constituents in vadose zone soil at the site.

Step 3. Identify Informational Inputs

- Table VI.6 of Redstone Arsenal's Alabama Hazardous Wastes Management and Minimization Act (AHWMMA) Permit states that a CMI work plan is required for RSA-013 soil and groundwater (groundwater is the responsibility of RSA-151).
- Review of historical documents indicate that site was as a burn pad to thermally treat explosives and explosives-contaminated material and reactive waste, primarily propellant including waste perchlorate-containing solvents.
- Results of the existing investigations.
- The conceptual site model (CSM) for RSA-013.
- Existing quality control (QC) and quality assurance (QA) records of data quality checks.

Step 4. Define the Boundaries of the Study

- Study boundaries for the COCs in soil (perchlorate and RDX) were defined in the RFI, which was conducted in accordance with the Department's Alabama Environmental Investigation and Remediation Guidance (AEIRG).
- Based on site history and existing data collected, the current site boundary includes historical site features.
- The historical site features have been identified as release points for potential contaminants.
- Potential locations where releases of perchlorate and RDX may be present have been defined.

Worksheet No. 11: Project/Data Quality Objectives

- Corrective measures will be conducted for elevated perchlorate and RDX concentrations in soil until the confirmatory sample results are less than or equal to the respective CG. The CGs have been established in the corrective measures study and will be summarized in the CMI work plan.

Step 5. Develop the Analytic Decision Approach

- The corrective measures will include confirmatory soil sampling in accordance with the Department's AEIRG for analysis of perchlorate and RDX to determine the effectiveness of the selected alternative.
- If review of the confirmatory soil sampling data indicates the CGs have not been achieved, additional soil removal will be implemented to meet the CGs.
- If review of the confirmatory soil sampling data indicates the CGs have been achieved, no further soil removal will be conducted, as the stated corrective measures objectives will be met.

Step 6. Specify Performance or Acceptance Criteria

- Selected definable features of work and tasks will achieve the performance criteria specified in the CMI work plan and supporting documents
- Soil samples collected will be analyzed by an Environmental Laboratory Accreditation Program (ELAP) certified subcontracted laboratory for the COCs (perchlorate and RDX).
- Analytical results generated by off-site laboratories will be evaluated using procedures outlined in the QAPP portion of the CMI work plan to ensure they are suitable for final decision making.
- Soil sample results will be reviewed by the APTIM Project Chemist or as delegated and the U.S. Army Engineering and Support Center, Huntsville Chemist.
- Analytical results from waste characterization samples will be submitted to the off-site disposal facility to adequately classify waste materials and meet the applicable waste profile package requirements for disposal.

Step 7. Develop/Optimize the Plan for Obtaining Data

- Only qualified personnel will perform corrective measures activities.
- Requirements of the CMI work plan will be subjected to QC and QA reviews.

AEIRG - Alabama Environmental Investigation and Remediation Guidance.
AHWMMA - Alabama Hazardous Wastes Management and Minimization Act.
CG – Cleanup goal.
CMI – Corrective measures implementation.
CMS – Corrective measures study.
COC – Chemical of concern.
CWM – Chemical warfare materiel.
DOD – U.S. Department of Defense.

Worksheet No. 11: Project/Data Quality Objectives

ELAP - Environmental Laboratory Accreditation Program.
QA – Quality assurance.
QC – Quality control.

Worksheet No. 12: Measurement Performance Criteria

Table 12-1– Measurement Performance Criteria – Compound (Matrix)

Matrix	Soil				
Analytical Group	Volatile Organic Compounds (VOC)				
Concentration Level	Low				
Sampling Procedure SOP	**Analytical Method/SOP[1]**	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
Soil: SOP 6.0	SW8260C / VO004	Overall Precision	RPD ≤ 20% when detected in both samples ≥ sample-specific LOQ	Field Duplicates	S
		Analytical Precision (laboratory)	RPD ≤ 20%	Laboratory Sample Duplicates	A
		Analytical Accuracy/Bias (laboratory)	Analyte-specific (QSM)	Laboratory Control Samples	A
		Analytical Accuracy/Bias (matrix interference)	Analyte-specific (QSM)	Matrix Spike Duplicates	S&A
		Overall accuracy/bias (contamination)	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater	Equipment Blanks	S
		Sensitivity	Laboratory compliance with DoD QSM 5.3 guidance for updating DL, LOD, and LOQ values	LOQ verification sample (spiked at LOQ)	A
		Completeness	See Worksheet No. 34	See Worksheet No. 34	

Worksheet No. 12: Measurement Performance Criteria

Table 12-2– Measurement Performance Criteria – Compound (Matrix)

Matrix	Soil				
Analytical Group	Semi-Volatile Organic Compounds (SVOC)				
Concentration Level	Low				
Sampling Procedure SOP	**Analytical Method/SOP[1]**	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
Soil: SOP 6.0	SW8270D / 8270 SIM / SV006, SV007	Overall Precision	RPD ≤ 20% when detected in both samples ≥ sample-specific LOQ	Field Duplicates	S
		Analytical Precision (laboratory)	RPD ≤ 20%	Laboratory Sample Duplicates	A
		Analytical Accuracy/Bias (laboratory)	Analyte-specific (QSM)	Laboratory Control Samples	A
		Analytical Accuracy/Bias (matrix interference)	Analyte-specific (QSM)	Matrix Spike Duplicates	S&A
		Overall accuracy/bias (contamination)	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater	Equipment Blanks	S
		Sensitivity	Laboratory compliance with DoD QSM 5.3 guidance for updating DL, LOD, and LOQ values	LOQ verification sample (spiked at LOQ)	A
		Completeness	See Worksheet No. 34	See Worksheet No. 34	

Worksheet No. 12: Measurement Performance Criteria

Table 12-3– Measurement Performance Criteria – Compound (Matrix)

Matrix	Soil				
Analytical Group	Pesticides/PCBs				
Concentration Level	Low				
Sampling Procedure SOP	**Analytical Method/SOP[1]**	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
Soil: SOP 6.0	8081B/8082A / SV002, SV004	Overall Precision	RPD ≤ 30% when detected in both samples ≥ sample-specific LOQ	Field Duplicates	S
		Analytical Precision (laboratory)	RPD ≤ 30%	Laboratory Sample Duplicates	A
		Analytical Accuracy/Bias (laboratory)	Analyte-specific (QSM)	Laboratory Control Samples	A
		Analytical Accuracy/Bias (matrix interference)	Analyte-specific (QSM)	Matrix Spike Duplicates	S&A
		Overall accuracy/bias (contamination)	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater	Equipment Blanks	S
		Sensitivity	Laboratory compliance with DoD QSM 5.3 guidance for updating DL, LOD, and LOQ values	LOQ verification sample (spiked at LOQ)	A
		Completeness	See Worksheet No. 34	See Worksheet No. 34	

Worksheet No. 12: Measurement Performance Criteria

Table 12-5– Measurement Performance Criteria – Compound (Matrix)

Matrix	Soil				
Analytical Group	Metals				
Concentration Level	Low				
Sampling Procedure SOP	**Analytical Method/SOP[1]**	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
Soil: SOP 6.0	6010C/7470A/7471B / MT009, MT012	Overall Precision	RPD ≤ 20% when detected in both samples ≥ sample-specific LOQ	Field Duplicates	S
		Analytical Precision (laboratory)	RPD ≤ 20%	Laboratory Sample Duplicates	A
		Analytical Accuracy/Bias (laboratory)	Analyte-specific (QSM)	Laboratory Control Samples	A
		Analytical Accuracy/Bias (matrix interference)	Analyte-specific (QSM)	Matrix Spike Duplicates	S&A
		Overall accuracy/bias (contamination)	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater	Equipment Blanks	S
		Sensitivity	Laboratory compliance with DoD QSM 5.3 guidance for updating DL, LOD, and LOQ values	LOQ verification sample (spiked at LOQ)	A
		Completeness	See Worksheet No. 34	See Worksheet No. 34	

Worksheet No. 12: Measurement Performance Criteria

Table 12-6– Measurement Performance Criteria – Compound (Matrix)

Matrix	Soil				
Analytical Group	Perchlorates				
Concentration Level	Low				
Sampling Procedure SOP	**Analytical Method/SOP[1]**	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
Soil: SOP 6.0	6850 / HPLC06	Overall Precision	RPD ≤ 20% when detected in both samples ≥ sample-specific LOQ	Field Duplicates	S
		Analytical Precision (laboratory)	RPD ≤ 15%	Laboratory Sample Duplicates	A
		Analytical Accuracy/Bias (laboratory)	Analyte-specific (QSM)	Laboratory Control Samples	A
		Analytical Accuracy/Bias (matrix interference)	Analyte-specific (QSM)	Matrix Spike Duplicates	S&A
		Overall accuracy/bias (contamination)	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater	Equipment Blanks	S
		Sensitivity	Laboratory compliance with DoD QSM 5.3 guidance for updating DL, LOD, and LOQ values	LOQ verification sample (spiked at LOQ)	A
		Completeness	See Worksheet No. 34	See Worksheet No. 34	

Worksheet No. 12: Measurement Performance Criteria

Matrix	Soil				
Analytical Group	Explosives				
Concentration Level	Low				
Sampling Procedure SOP	**Analytical Method/SOP[1]**	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
Soil: SOP 6.0	SW8330B/ SV010	Overall Precision	RPD ≤ 20% when detected in both samples ≥ sample-specific LOQ	Field Duplicates	S
		Analytical Precision (laboratory)	RPD ≤ 20%	Laboratory Sample Duplicates	A
		Analytical Accuracy/Bias (laboratory)	Analyte-specific (QSM)	Laboratory Control Samples	A
		Analytical Accuracy/Bias (matrix interference)	Analyte-specific (QSM)	Matrix Spike Duplicates	S&A
		Overall accuracy/bias (contamination)	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater	Equipment Blanks	S
		Sensitivity	Laboratory compliance with DoD QSM 5.3 guidance for updating DL, LOD, and LOQ values	LOQ verification sample (spiked at LOQ)	A
		Completeness	See Worksheet No. 34	See Worksheet No. 34	

Worksheet No. 13: Secondary Data Uses and Limitations

Secondary Data	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s) (Originating Org., Data Types, Data Generation/Collection Dates)	How Data Will Be Used	Limitations on Data Use
Data collected during and prior to the RFI (CB&I, 2017).	CB&I Federal Services LLC (CB&I), 2017, *Revision 1 RCRA Facility Investigation Report, RSA-013, Unlined Inactive Open Burn Pad, RSA-132, Dismantled Popping Furnace, RSA-133, Inactive Rocket Washrack/Sump, Operable Unit 14, U.S. Army Garrison-Redstone, Madison County, Alabama*, February.	Refer to Section 2.1 in the CMI Work Plan	Previous data collected for this site were reviewed in Chapter 3 and Table 3-1 of the RFI for usability in the corrective measures.	All usable data brought forward for the CMI work plan have been validated; therefore, no restrictions on data use have been identified.

Data Limitations and Actions from Usability:

After all data evaluations are completed, any limitations on the use of data will be known to the planning team and will be considered during decision making for the corrective measures planning.

Worksheet Nos. 14 and 16: Project Tasks and Schedule

The project tasks are presented in Chapter 4 of the RSA-013 corrective measures implementation work plan and the construction quality assurance plan (Appendix H). Appendix C in the corrective measures implementation plan contains the project schedule.

Worksheet No. 15: Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Worksheet No. 15-3-1 – Soil Volatile Organic Compounds (VOC)						
Matrix: Soil **Analytical Group: VOC - SW8260B** **Concentration: Low** Analyte	CAS Number	Soil BSV [b] (mg/kg)	Redstone-Specific Soil PSV [c] ca - 1 x 10^{-6}; nc - HI = 0.1 (ug/kg)	Laboratory-Specific[a]		
				DL (ug/kg)	LOD (ug/kg)	LOQ (ug/kg)
TCL VOCs						
1,1,1-Trichloroethane (1,1,1-TCA)	71-55-6	---	8.10E+05	16	50	100
1,1,2,2-Tetrachloroethane	79-34-5	---	6.00E+02	21	50	100
1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113; Freon 113)	76-13-1	---	6.70E+05	30	50	200
1,1,2-Trichloroethane	79-00-5	---	1.50E+02	12	50	100
1,1-Dichloroethane (1,1-DCA)	75-34-3	---	3.60E+03	7	25	50
1,1-Dichloroethene (1,1-DCE)	75-35-4	---	2.30E+04	21	50	100
1,2,4-Trichlorobenzene	120-82-1	---	5.80E+03	17	50	100
1,2-Dichlorobenzene	95-50-1	---	1.80E+05	15	50	100
1,2-Dichloroethane (EDC)	107-06-2	---	4.60E+02	22	50	100
1,2-Dichloropropane	78-87-5	---	1.60E+03	26	50	100
1,3-Dichlorobenzene	541-73-1	---	NSV	14	25	50
1,4-Dichlorobenzene	106-46-7	---	2.60E+03	15	50	100
2-Butanone (Methyl ethyl ketone; MEK)	78-93-3	---	2.70E+06	400	1000	2000
2-Hexanone (Methyl butyl ketone; MBK)	591-78-6	---	2.00E+04	200	500	1000
4-Methyl-2-pentanone (Methyl isobutyl ketone; MIBK)	108-10-1	---	3.30E+06	180	500	1000
Acetone	67-64-1	---	6.10E+06	400	1000	2000
Benzene	71-43-2	---	1.20E+03	11	25	50
Bromodichloromethane (Dichlorobromomethane; DBCM)	75-27-4	---	2.90E+02	14	25	50
Bromoform	75-25-2	---	1.90E+04	60	100	200
Bromomethane	74-83-9	---	6.80E+02	90	200	400

Worksheet No. 15: Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Worksheet No. 15-3-1 – Soil Volatile Organic Compounds (VOC)

Matrix: Soil **Analytical Group: VOC - SW8260B** **Concentration: Low** Analyte	CAS Number	Soil BSV [b] (mg/kg)	Redstone-Specific Soil PSV [c] ca - 1 x 10^{-6}; nc - HI = 0.1 (ug/kg)	Laboratory-Specific[a]		
				DL (ug/kg)	LOD (ug/kg)	LOQ (ug/kg)
Carbon Disulfide	75-15-0	---	7.70E+04	40	100	200
Carbon Tetrachloride	56-23-5	---	6.50E+02	14	25	100
Chlorobenzene	108-90-7	---	2.80E+04	10	25	50
Chloroethane	75-00-3	---	1.40E+06	30	50	100
Chloroform	67-66-3	---	3.20E+02	16	50	100
Chloromethane	74-87-3	---	1.10E+04	30	50	100
cis-1,2-Dichloroethene (cis-1,2-DCE)	156-59-2	---	1.60E+04	27	50	100
cis-1,3-Dichloropropene	10061-01-5	---	1.80E+03	14	25	50
Dibromochloromethane	124-48-1	---	8.30E+03	40	100	200
Dichlorodifluoromethane	75-71-8	---	8.70E+03	50	100	200
Ethylbenzene	100-41-4	---	5.80E+03	11	25	50
Methyl Tertiary Butyl Ether (MTBE)	1634-04-4	---	4.70E+04	16	50	100
Methylene Chloride, or Dichloromethane	75-09-2	---	3.50E+04	60	100	400
Styrene	100-42-5	---	6.00E+05	16	50	100
Tetrachloroethene (PCE; PERC)	127-18-4	---	8.10E+03	11	25	50
Toluene	108-88-3	---	4.90E+05	16	50	100
trans-1,2-Dichloroethene (trans-1,2-DCE)	156-60-5	---	7.0E+03	14	25	50
trans-1,3-Dichloropropene	10061-02-6	---	1.80E+03	40	100	200
Trichloroethene (TCE)	79-01-6	---	4.10E+02	19	50	100
Trichlorofluoromethane	75-69-4	---	2.30E+06	40	100	200
Vinyl Chloride (VC)	75-01-4	---	5.90E+01	19	50	100
Xylenes (Total)	1330-20-7	---	5.80E+04	25	50	100

Worksheet No. 15: Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

[a] Detection Limit (DL), Limit of Detection (LOD), and Limit of Quantitation (LOQ).

Bold font – DL is greater than the selected PSV.

* LOQ is greater than the selected PSV.

Bold font – Chemical is considered to be a chemical of potential analytical concern (COPAC).

To determine preliminary COPACs, an evaluation is performed on whether the DL is above the PSV (ADEM Admin. Code R. 335-14). If the DL for the chemical is greater than the PSV, then the chemical is flagged as a preliminary COPAC. For metals, if PSVs are lower than BSVs, the PSV will equal the BSV. Further evaluation of whether corrective actions for analytical methods are needed will be performed for preliminary COPACs in site-specific field sampling plans. This evaluation, if needed, is presented on Worksheet No. 11.

[b] BSV - Background screening value is the lower of the surface or subsurface soil BSV. Gannett Fleming, Inc. and Shaw Environmental, Inc., 2010, *Final Supplemental Installation-Wide Background Soil Study, Redstone Arsenal, Madison County, Alabama*, Prepared for the U.S. Army Corps of Engineers, Savannah District, September.
[c] The preliminary screening value (PSV) is the most conservative residential soil regional screening level (RSL), adjusted, if necessary, to reflect a cancer risk of 1E-6 or an HI of 0.1 (EPA, 2021, *Regional Screening Levels for Chemical Contaminants at Superfund Sites*, May).

ca – Carcinogen.

nc – Noncarcinogen; HI – Hazard index.

NSV – No screening value. Compounds without screening values are evaluated in site-specific reports semi-quantitatively through a consideration of the frequency and magnitude of any positive detections. Although surrogate toxicity data are not applied directly, chemicals with no screening values will also be evaluated by considering the relative frequency and magnitude of detected results for structurally similar surrogates or chemicals within the same analytical class (e.g., PAHs, or phthalates).

mg/kg - Milligrams per kilogram.

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Worksheet No. 15: Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Worksheet No. 15-3-2 – Soil Semivolatile Organic Compounds (SVOC)

Matrix: Soil **Analytical Group: SVOC - SW8270D** **Concentration: Low** Analyte	CAS Number	Soil BSV [b] (mg/kg)	Redstone-Specific Soil PSV [c] ca - 1 x 10^{-6}; nc - HI = 0.1 (ug/kg)	Laboratory-Specific[a]		
				DL (ug/kg)	LOD (ug/kg)	LOQ (ug/kg)
TCL SVOCs						
2,4,5-Trichlorophenol	95-95-4	---	6.30E+05	130	300	600
2,4,6-Trichlorophenol (TCP)	88-06-2	---	6.30E+03	130	300	600
2,4-Dichlorophenol (DCP)	120-83-2	---	1.90E+04	130	300	600
2,4-Dimethylphenol	105-67-9	---	1.30E+05	99	300	600
2,4-Dinitrophenol	51-28-5	---	1.30E+04	270	600	1000
2,4-Dinitrotoluene (DNT)	121-14-2	---	1.70E+03	24	60	120
2,6-Dinitrotoluene	606-20-2	---	3.60E+02	24	60	120
2-Chloronaphthalene	91-58-7	---	4.80E+05	23	60	120
2-Chlorophenol	95-57-8	---	3.90E+04	340	600	2000
2-Methylnaphthalene	91-57-6	---	2.40E+04	25	60	120
2-Methylphenol (o-Cresol)	95-48-7	---	3.20E+05	420	600	2000
2-Nitroaniline	88-74-4	---	6.30E+04	23	60	120
2-Nitrophenol (ONP)	88-75-5	---	NSV	280	300	1000
3,3'-Dichlorobenzidine (DCB)	91-94-1	---	1.20E+03	150	300	500
3-Nitroaniline	99-09-2	---	NSV	22	120	200
4,6-Dinitro-2-methylphenol (DNOC)	534-52-1	---	5.10E+02	270	300	1000
4-Bromophenyl phenyl ether	101-55-3	---	NSV	25	60	120
4-Chloro-3-methylphenol	59-50-7	---	6.30E+05	380	600	2000
4-Chloroaniline	106-47-8	---	2.70E+03	39	60	200
4-Chlorophenyl phenyl ether	7005-72-3	---	NSV	26	60	120
4-Methylphenol (p-Cresol)	106-44-5	---	6.30E+05	650	1080	3600

Worksheet No. 15: Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Worksheet No. 15-3-2 – Soil Semivolatile Organic Compounds (SVOC)

Matrix: Soil **Analytical Group: SVOC - SW8270D** **Concentration: Low** Analyte	CAS Number	Soil BSV [b] (mg/kg)	Redstone-Specific Soil PSV [c] ca - 1 x 10^{-6}; nc - HI = 0.1 (ug/kg)	Laboratory-Specific[a]		
				DL (ug/kg)	LOD (ug/kg)	LOQ (ug/kg)
4-Nitroaniline (PNA)	100-01-6	---	2.50E+04	30	60	120
4-Nitrophenol (PNP)	100-02-7	---	NSV	400	600	2000
Acenaphthene	83-32-9	---	3.60E+03	24	60	120
Acenaphthylene	208-96-8	---	1.80E+05	24	60	120
Anthracene	120-12-7	---	1.80E+06	24	60	120
Benzo(a)anthracene	56-55-3	---	1.10E+03	25	60	120
Benzo(a)pyrene	50-32-8	---	1.10E+02	15	60	120
Benzo(b)fluoranthene	205-99-2	---	1.10E+03	25	60	120
Benzo(g,h,i)perylene	191-24-2	---	1.80E+05	22	60	120
Benzo(k)fluoranthene	207-08-9	---	1.10E+04	25	60	120
bis(2-Chloroethoxy)methane	111-91-1	---	1.90E+04	23	60	120
bis(2-Chloroethyl)ether (BCEE)	111-44-4	---	2.30E+02	25	60	120
Bis(2-chloroisopropyl)ether, or 2,2'-oxybis (1-Chloropropane)	108-60-1	---	3.10E+05	30	60	120
bis(2-Ethylhexyl)phthalate (BEHP)	117-81-7	---	3.90E+04	87	120	400
Butyl benzyl phthalate (BBP)	85-68-7	---	2.90E+05	73	120	400
Carbazole	86-74-8	---	NSV	28	60	120
Chrysene	218-01-9	---	1.10E+05	25	60	120
Dibenz(a,h)anthracene	53-70-3	---	1.10E+02	13	60	120
Dibenzofuran (DBF)	132-64-9	---	7.80E+03	24	60	120
Diethyl phthalate (DEP)	84-66-2	---	5.10E+06	64	120	400
Dimethyl phthalate (DMP)	131-11-3	---	NSV	63	120	400

Worksheet No. 15: Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Worksheet No. 15-3-2 – Soil Semivolatile Organic Compounds (SVOC)

Matrix: Soil **Analytical Group: SVOC - SW8270D** **Concentration: Low** Analyte	CAS Number	Soil BSV [b] (mg/kg)	Redstone-Specific Soil PSV [c] ca - 1 x 10^{-6}; nc - HI = 0.1 (ug/kg)	Laboratory-Specific[a]		
				DL (ug/kg)	LOD (ug/kg)	LOQ (ug/kg)
Di-n-butyl phthalate (DBP)	84-74-2	---	6.30E+05	79	120	400
Di-n-octyl phthalate (DNOP)	117-84-0	---	6.30E+04	59	60	200
Fluoranthene	206-44-0	---	2.40E+05	26	60	120
Fluorene	86-73-7	---	2.40E+05	25	60	120
Hexachlorobenzene (HCB)	118-74-1	---	2.10E+02	28	60	120
Hexachlorobutadiene (HCBD)	87-68-3	---	1.20E+03	62	120	400
Hexachlorocyclopentadiene (HCCPD)	77-47-4	---	1.80E+02	52	120	200
Hexachloroethane (HCE)	67-72-1	---	1.80E+03	33	60	120
Indeno(1,2,3-cd)pyrene	193-39-5	---	1.10E+03	23	60	120
Isophorone	78-59-1	---	5.70E+05	50	60	200
Naphthalene	91-20-3	---	2.00E+03	21	60	120
Nitrobenzene	98-95-3	---	5.10E+03	59	60	200
N-Nitroso-di-n-propylamine (NDPA)	621-64-7	---	7.80E+01	70	120	400
N-Nitrosodiphenylamine (NDPHA)	86-30-6	---	1.10E+05	50	120	240
Pentachlorophenol	87-86-5	---	1.00E+03	240	300	1000
Phenanthrene	85-01-8	---	1.80E+05	26	60	120
Phenol	108-95-2	---	1.90E+06	160	300	600
Pyrene	129-00-0	---	1.80E+05	26	60	120

NOTE: Detection limits require samples with a minimum of 60% solids – anything less will exceed lowest specified detection limits.

[a] Detection Limit (DL), Limit of Detection (LOD), and Limit of Quantitation (LOQ).

Bold font – DL is greater than the selected PSV.

Worksheet No. 15: Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

* LOQ is greater than the selected PSV.

Bold font – Chemical is considered to be a chemical of potential analytical concern (COPAC).

To determine preliminary COPACs, an evaluation is performed on whether the DL is above the PSV (ADEM Admin. Code R. 335-14). If the DL for the chemical is greater than the PSV, then the chemical is flagged as a preliminary COPAC. For metals, if PSVs are lower than BSVs, the PSV will equal the BSV. Further evaluation of whether corrective actions for analytical methods are needed will be performed for preliminary COPACs in site-specific field sampling plans. This evaluation, if needed, is presented on Worksheet No. 11.

[b] BSV - Background screening value is the lower of the surface or subsurface soil BSV. Gannett Fleming, Inc. and Shaw Environmental, Inc., 2010, *Final Supplemental Installation-Wide Background Soil Study, Redstone Arsenal, Madison County, Alabama*, Prepared for the U.S. Army Corps of Engineers, Savannah District, September.

[c] The preliminary screening value (PSV) is the most conservative residential soil regional screening level (RSL), adjusted, if necessary, to reflect a cancer risk of 1E-6 or an HI of 0.1 (EPA, 2021, *Regional Screening Levels for Chemical Contaminants at Superfund Sites*, May).

Acenaphthylene, benzo(g,h,i)perylene, and phenanthrene using pyrene as a surrogate.

ca – Carcinogen.

nc – Noncarcinogen; HI – Hazard index.

NSV – No screening value. Compounds without screening values are evaluated in site-specific reports semi-quantitatively through a consideration of the frequency and magnitude of any positive detections. Although surrogate toxicity data are not applied directly, chemicals with no screening values will also be evaluated by considering the relative frequency and magnitude of detected results for structurally similar surrogates or chemicals within the same analytical class (e.g., PAHs, or phthalates).

mg/kg - Milligrams per kilogram.

Worksheet No. 15: Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Worksheet No. 15-3-4 – Soil Organochlorine Pesticides

Matrix: Soil **Analytical Group: Pesticides- SW8081B** **Concentration: Low** Analyte	CAS Number	Soil BSV [b] (mg/kg)	Redstone-Specific Soil PSV [c] ca - 1 x 10^{-6}; nc - HI = 0.1 (ug/kg)	Laboratory-Specific[a]		
				DL (ug/kg)	LOD (ug/kg)	LOQ (ug/kg)
TCL Pesticides						
4,4'-DDD	72-54-8	---	1.90E+02	0.30	1.00	2.00
4,4'-DDE	72-55-9	---	2.00E+03	0.30	1.00	2.00
4,4'-DDT	50-29-3	---	1.90E+03	0.50	1.00	2.00
Aldrin	309-00-2	---	3.90E+01	0.50	1.00	2.00
alpha-BHC (alpha-HCH)	319-84-6	---	8.60E+01	0.60	2.00	4.00
alpha-Chlordane	5103-71-9	---	3.60E+03	0.30	1.00	2.00
beta-BHC (beta-HCH)	319-85-7	---	3.00E+02	0.60	2.00	4.00
delta-BHC (delta-HCH)	319-86-8	---	5.70E+02	0.30	1.00	2.00
Dieldrin	60-57-1	---	3.40E+01	0.30	1.00	2.00
Endosulfan I	959-98-8	---	4.70E+04	0.70	2.00	4.00
Endosulfan II	33213-65-9	---	4.70E+04	0.30	1.00	2.00
Endosulfan sulfate	1031-07-8	---	3.80E+04	0.90	2.00	4.00
Endrin	72-20-8	---	1.90E+03	0.40	1.00	2.00
Endrin aldehyde	7421-93-4	---	1.90E+03	1.10	2.00	4.00
Endrin ketone	53494-70-5	---	1.90E+03	0.80	2.00	4.00
gamma-Chlordane	5103-74-2	---	3.60E+03	0.30	1.00	2.00
Heptachlor	76-44-8	---	1.30E+02	0.40	1.00	2.00
Heptachlor epoxide	1024-57-3	---	7.00E+01	0.50	1.00	2.00
gamma-BHC (Lindane; gamma-HCH)	58-89-9	---	5.70E+02	0.50	1.00	2.00
Methoxychlor	72-43-5	---	3.20E+04	0.70	2.00	4.00

Worksheet No. 15: Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Worksheet No. 15-3-4 – Soil Organochlorine Pesticides						
Matrix: Soil **Analytical Group: Pesticides- SW8081B** **Concentration: Low**	CAS Number	Soil BSV [b] (mg/kg)	Redstone-Specific Soil PSV [c] ca - 1 x 10^{-6}; nc - HI = 0.1 (ug/kg)	Laboratory-Specific[a]		
				DL (ug/kg)	LOD (ug/kg)	LOQ (ug/kg)
Analyte						
Toxaphene	8001-35-2	---	4.90E+02	9	20	40

[a] Detection Limit (DL), Limit of Detection (LOD), and Limit of Quantitation (LOQ).

Bold font – DL is greater than the selected PSV.

***** LOQ is greater than the selected PSV.

Bold font – Chemical is considered to be a chemical of potential analytical concern (COPAC).

To determine preliminary COPACs, an evaluation is performed on whether the DL is above the PSV (ADEM Admin. Code R. 335-14). If the DL for the chemical is greater than the PSV, then the chemical is flagged as a preliminary COPAC. For metals, if PSVs are lower than BSVs, the PSV will equal the BSV. Further evaluation of whether corrective actions for analytical methods are needed will be performed for preliminary COPACs in site-specific field sampling plans. This evaluation, if needed, is presented on Worksheet No. 11.

[b] BSV - Background screening value is the lower of the surface or subsurface soil BSV. Gannett Fleming, Inc. and Shaw Environmental, Inc., 2010, *Final Supplemental Installation-Wide Background Soil Study, Redstone Arsenal, Madison County, Alabama*, Prepared for the U.S. Army Corps of Engineers, Savannah District, September.

[c] The preliminary screening value (PSV) is the most conservative residential soil regional screening level (RSL), adjusted, if necessary, to reflect a cancer risk of 1E-6 or an HI of 0.1 (EPA, 2021, *Regional Screening Levels for Chemical Contaminants at Superfund Sites*, May).

The noncancer RSL for gamma-BHC (Lindane) at an HI of 0.1 is adopted as the PSV for delta-BHC.

The PSV for endosulfan is adopted as the PSV for endosulfan I and endosulfan II.

The PSV for endrin is adopted as the PSV for endrin aldehyde and endrin ketone.

ca – Carcinogen.

nc – Noncarcinogen; HI – Hazard index.

NSV – No screening value. Compounds without screening values are evaluated in site-specific reports semi-quantitatively through a consideration of the frequency and magnitude of any positive detections. Although surrogate toxicity data are not applied directly, chemicals with no screening values will also be evaluated by considering the relative frequency and magnitude of detected results for structurally similar surrogates or chemicals within the same analytical class (e.g., PAHs, or phthalates).

mg/kg - Milligrams per kilogram.

Worksheet No. 15: Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Worksheet No. 15-3-5 - Soil Polychlorinated Biphenyls (PCB)						
Matrix: Soil **Analytical Group: PCBs - SW8082A** **Concentration: Low** Analyte	CAS Number	Soil BSV [b] (mg/kg)	Redstone-Specific Soil PSV [c] ca - 1 x 10^{-6}; nc - HI = 0.1 (ug/kg)	Laboratory-Specific[a] DL (ug/kg)	LOD (ug/kg)	LOQ (ug/kg)
TCL PCBs						
Aroclor-1016	12674-11-2	---	4.1E+02	5	20	30
Aroclor-1221	11104-28-2	---	2.0E+02	7	20	30
Aroclor-1232	11141-16-5	---	1.7E+02	9	20	30
Aroclor-1242	53469-21-9	---	2.3E+02	7	20	30
Aroclor-1248	12672-29-6	---	2.3E+02	7	20	30
Aroclor-1254	11097-69-1	---	1.2E+02	9	20	30
Aroclor-1260	11096-82-5	---	2.4E+02	6	20	30

[a] Detection Limit (DL), Limit of Detection (LOD), and Limit of Quantitation (LOQ).

Bold font – DL is greater than the selected PSV.

* LOQ is greater than the selected PSV.

Bold font – Chemical is considered to be a chemical of potential analytical concern (COPAC).

To determine preliminary COPACs, an evaluation is performed on whether the DL is above the PSV (ADEM Admin. Code R. 335-14). If the DL for the chemical is greater than the PSV, then the chemical is flagged as a preliminary COPAC. For metals, if PSVs are lower than BSVs, the PSV will equal the BSV. Further evaluation of whether corrective actions for analytical methods are needed will be performed for preliminary COPACs in site-specific field sampling plans. This evaluation, if needed, is presented on Worksheet No. 11.

[b] BSV - Background screening value is the lower of the surface or subsurface soil BSV. Gannett Fleming, Inc. and Shaw Environmental, Inc., 2010, *Final Supplemental Installation-Wide Background Soil Study, Redstone Arsenal, Madison County, Alabama*, Prepared for the U.S. Army Corps of Engineers, Savannah District, September.

[c] The preliminary screening value (PSV) is the most conservative residential soil regional screening level (RSL), adjusted, if necessary, to reflect a cancer risk of 1E-6 or an HI of 0.1 (EPA, 2021, *Regional Screening Levels for Chemical Contaminants at Superfund Sites*, May).

ca – Carcinogen.

nc – Noncarcinogen; HI – Hazard index.

NSV – No screening value. Compounds without screening values are evaluated in site-specific reports semi-quantitatively through a consideration of the frequency and magnitude of any positive detections. Although surrogate toxicity data are not applied directly, chemicals with no screening values will also be evaluated by considering the relative frequency and magnitude of detected results for structurally similar surrogates or chemicals within the same analytical class (e.g., PAHs, or phthalates).

mg/kg - Milligrams per kilogram.

Worksheet No. 15: Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Worksheet No. 15-3-7 - Soil Explosives

Matrix: Soil **Analytical Group: Explosives - SW8330A** **Concentration: Low** Analyte	CAS Number	Soil BSV [b] (mg/kg)	Redstone-Specific Soil PSV [c] ca - 1 x 10^{-6}; nc - HI = 0.1 (mg/kg)	Laboratory-Specific[a]		
				DL (mg/kg)	LOD (mg/kg)	LOQ (mg/kg)
Explosives						
1,3,5-Trinitrobenzene	99-35-4	---	2.20E+02	0.05	0.15	0.30
1,3-Dinitrobenzene	99-65-0	---	6.30E-01	0.03	0.10	0.20
2,4,6-Trinitrophenylmethylnitramine (Tetryl)	479-45-8	---	1.60E+01	0.06	0.15	0.30
2,4,6-Trinitrotoluene (TNT)	118-96-7	---	3.60E+00	0.05	0.10	0.20
2,4-Dinitrotoluene (DNT)	121-14-2	---	1.70E+00	0.06	0.15	0.30
2,6-Dinitrotoluene	606-20-2	---	3.60E-01	0.06	0.15	0.30
2-Amino-4,6-dinitrotoluene	35572-78-2	---	7.70E-01	0.03	0.10	0.20
2-Nitrotoluene (ONT)	88-72-2	---	3.20E+00	0.03	0.10	0.20
3-Nitrotoluene	99-08-1	---	6.30E-01	0.04	0.10	0.20
4-Amino-2,6-dinitrotoluene	19406-51-0	---	1.50E+01	0.05	0.10	0.20
4-Nitrotoluene (PNT)	99-99-0	---	7.70E-01	0.06	0.15	0.30
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	---	8.30E+00	0.06	0.15	0.30
Nitrobenzene	98-95-3	---	5.10E+00	0.05	0.10	0.20
Nitroglycerin	55-63-0	---	6.30E-01	0.12	0.30	0.60
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2691-41-0	---	3.90E+02	0.05	0.10	0.20
Pentaerythritol tetranitrate (PETN)	78-11-5	---	1.30E+01	0.12	0.30	0.60
Nitroguanidine (separate analysis)	556-88-7	---	6.30E+02	0.06	0.12	0.25
Nitrocellulose (separate analysis)	9004-70-0	---	1.90E+07	33	100	200

[a] Detection Limit (DL), Limit of Detection (LOD), and Limit of Quantitation (LOQ).

Bold font – DL is greater than the selected PSV.

* LOQ is greater than the selected PSV.

Worksheet No. 15: Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Bold font – Chemical is considered to be a chemical of potential analytical concern (COPAC).

To determine preliminary COPACs, an evaluation is performed on whether the DL is above the PSV (ADEM Admin. Code R. 335-14). If the DL for the chemical is greater than the PSV, then the chemical is flagged as a preliminary COPAC. For metals, if PSVs are lower than BSVs, the PSV will equal the BSV. Further evaluation of whether corrective actions for analytical methods are needed will be performed for preliminary COPACs in site-specific field sampling plans. This evaluation, if needed, is presented on Worksheet No. 11.

[b] BSV - Background screening value is the lower of the surface or subsurface soil BSV. Gannett Fleming, Inc. and Shaw Environmental, Inc., 2010, *Final Supplemental Installation-Wide Background Soil Study, Redstone Arsenal, Madison County, Alabama*, Prepared for the U.S. Army Corps of Engineers, Savannah District, September.

[c] The preliminary screening value (PSV) is the most conservative residential soil regional screening level (RSL), adjusted, if necessary, to reflect a cancer risk of 1E-6 or an HI of 0.1 (EPA, 2021, *Regional Screening Levels for Chemical Contaminants at Superfund Sites*, May).

ca – Carcinogen.

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NSV – No screening value. Compounds without screening values are evaluated in site-specific reports semi-quantitatively through a consideration of the frequency and magnitude of any positive detections. Although surrogate toxicity data are not applied directly, chemicals with no screening values will also be evaluated by considering the relative frequency and magnitude of detected results for structurally similar surrogates or chemicals within the same analytical class (e.g., PAHs, or phthalates).

mg/kg - Milligrams per kilogram.

Worksheet No. 15: Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Worksheet No. 15-3-8 - Soil Target Analyte List (TAL) Metals

Matrix: Soil **Analytical Group: TAL Metals – 6010C** **Analytical Group: Mercury - 7470A/7471B** **Concentration: Low** Analyte	CAS Number	Soil BSV [b] (mg/kg)	Redstone-Specific Soil PSV [c] ca - 1 x 10^{-6}; nc - HI = 0.1 (mg/kg)	Laboratory-Specific[a]		
				DL (mg/kg)	LOD (mg/kg)	LOQ (mg/kg)
TAL Metals						
Aluminum	7429-90-5	40673	7.70E+03	0.04	0.12	0.24
Antimony	7440-36-0	9	3.10E+00	0.13	0.40	0.80
Arsenic	7440-38-2	15	6.80E-01	0.13	0.40	0.80
Barium	7440-39-3	115	1.50E+03	0.009	0.025	0.050
Beryllium	7440-41-7	1	1.60E+01	0.004	0.012	0.040
Cadmium	7440-43-9	1	7.10E+00	0.006	0.020	0.040
Calcium	7440-70-2	3513	Nutrient	0.24	0.70	1.40
Chromium, total	7440-47-3	97	3.00E-01	0.023	0.070	0.140
Cobalt	7440-48-4	14	2.30E+00	0.04	0.12	0.24
Copper	7440-50-8	21	3.10E+02	0.07	0.20	0.40
Iron	7439-89-6	58199	5.50E+03	0.3	0.9	1.8
Lead	7439-92-1	36	4.00E+02	0.04	0.125	0.25
Magnesium	7439-95-4	1581	Nutrient	0.14	0.40	0.80
Manganese	7439-96-5	1254	1.80E+02	0.025	0.075	0.150
Mercury	7439-97-6	0.13	2.30E+00	0.0021	0.0042	0.0083
Nickel	7440-02-0	21	1.50E+02	0.021	0.060	0.120
Potassium	7440-09-7	1510	Nutrient	4	12	24
Selenium	7782-49-2	1	3.90E+01	0.06	0.20	0.40
Silver	7440-22-4	2	3.90E+01	0.017	0.050	0.100
Sodium	7440-23-5	716	Nutrient	0.0021	0.0042	0.0083
Thallium	7440-28-0	2	7.80E-02	0.08	0.24	0.48

Worksheet No. 15: Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Worksheet No. 15-3-8 - Soil Target Analyte List (TAL) Metals						
Matrix: Soil **Analytical Group: TAL Metals – 6010C** **Analytical Group: Mercury - 7470A/7471B** **Concentration: Low** Analyte	CAS Number	Soil BSV [b] (mg/kg)	Redstone-Specific Soil PSV [c] ca - 1 x 10^{-6}; nc - HI = 0.1 (mg/kg)	Laboratory-Specific[a]		
				DL (mg/kg)	LOD (mg/kg)	LOQ (mg/kg)
Vanadium	7440-62-2	131	3.90E+01	0.012	0.040	0.080
Zinc	7440-66-6	123	2.30E+03	0.05	0.15	0.30

[a] Detection Limit (DL), Limit of Detection (LOD), and Limit of Quantitation (LOQ).

Bold font – DL is greater than the selected PSV.

* LOQ is greater than the selected PSV.

Bold font – Chemical is considered to be a chemical of potential analytical concern (COPAC).

To determine preliminary COPACs, an evaluation is performed on whether the DL is above the PSV (ADEM Admin. Code R. 335-14). If the DL for the chemical is greater than the PSV, then the chemical is flagged as a preliminary COPAC. For metals, if PSVs are lower than BSVs, the PSV will equal the BSV. Further evaluation of whether corrective actions for analytical methods are needed will be performed for preliminary COPACs in site-specific field sampling plans. This evaluation, if needed, is presented on Worksheet No. 11.

[b] BSV - Background screening value is the lower of the surface or subsurface soil BSV. Gannett Fleming, Inc. and Shaw Environmental, Inc., 2010, *Final Supplemental Installation-Wide Background Soil Study, Redstone Arsenal, Madison County, Alabama*, Prepared for the U.S. Army Corps of Engineers, Savannah District, September.

[c] The preliminary screening value (PSV) is the most conservative residential soil regional screening level (RSL), adjusted, if necessary, to reflect a cancer risk of 1E-6 or an HI of 0.1 (EPA, 2021, *Regional Screening Levels for Chemical Contaminants at Superfund Sites*, May).

ca – Carcinogen.

nc – Noncarcinogen; HI – Hazard index.

NSV – No screening value. Compounds without screening values are evaluated in site-specific reports semi-quantitatively through a consideration of the frequency and magnitude of any positive detections. Although surrogate toxicity data are not applied directly, chemicals with no screening values will also be evaluated by considering the relative frequency and magnitude of detected results for structurally similar surrogates or chemicals within the same analytical class (e.g., PAHs, or phthalates).

mg/kg - Milligrams per kilogram.

Worksheet No. 15: Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Worksheet No. 15-3-9 - Soil Select Parameters						
Matrix: Soil **Concentration: Low** Analyte	CAS Number	Soil BSV [b] (mg/kg)	Redstone-Specific Soil PSV [c] ca - 1 x 10^{-6}; nc - HI = 0.1 (mg/kg)	Laboratory-Specific[a]		
				DL (mg/kg)	LOD (mg/kg)	LOQ (mg/kg)
Select Parameters						
Perchlorate	14797-73-0	---	5.5E+00	0.001	0.002	0.004

[a] Detection Limit (DL), Limit of Detection (LOD), and Limit of Quantitation (LOQ).

Bold font – DL is greater than the selected PSV.

* LOQ is greater than the selected PSV.

Bold font – Chemical is considered to be a chemical of potential analytical concern (COPAC).

To determine preliminary COPACs, an evaluation is performed on whether the DL is above the PSV (ADEM Admin. Code R. 335-14). If the DL for the chemical is greater than the PSV, then the chemical is flagged as a preliminary COPAC. For metals, if PSVs are lower than BSVs, the PSV will equal the BSV. Further evaluation of whether corrective actions for analytical methods are needed will be performed for preliminary COPACs in site-specific field sampling plans. This evaluation, if needed, is presented on Worksheet No. 11.

[b] BSV - Background screening value is the lower of the surface or subsurface soil BSV. Gannett Fleming, Inc. and Shaw Environmental, Inc., 2010, *Final Supplemental Installation-Wide Background Soil Study, Redstone Arsenal, Madison County, Alabama*, Prepared for the U.S. Army Corps of Engineers, Savannah District, September.

[c] The preliminary screening value (PSV) is the most conservative residential soil regional screening level (RSL), adjusted, if necessary, to reflect a cancer risk of 1E-6 or an HI of 0.1 (EPA, 2021, *Regional Screening Levels for Chemical Contaminants at Superfund Sites*, May).

ca – Carcinogen.

nc – Noncarcinogen; HI – Hazard index.

NSV – No screening value. Compounds without screening values are evaluated in site-specific reports semi-quantitatively through a consideration of the frequency and magnitude of any positive detections. Although surrogate toxicity data are not applied directly, chemicals with no screening values will also be evaluated by considering the relative frequency and magnitude of detected results for structurally similar surrogates or chemicals within the same analytical class (e.g., PAHs, or phthalates).

TBD – To be determined.

mg/kg - Milligrams per kilogram.

Worksheet No. 17: Sampling Design and Rationale

Soil confirmation sampling and rationale for the planned excavations at RSA-013 are presented in Section 4.4 of the CMI Work Plan. Figure 4-2 presents the confirmation sample locations, and Figure 4-3 presents the confirmation sampling approach for excavation sidewalls. Confirmation samples are not anticipated to be collected from the floor of the excavation since the excavation will extend to the average groundwater table. However, multi-point composite confirmation soil samples will be collected from the floor of any part of the excavation that does not extend to the saturated soil zone. Floor samples, if needed, will consist of a minimum of five aliquots and will represent a maximum floor area of 625 square feet. If needed, the multi-point floor sample will include a center point of the floor plus aliquots from the north, south, east, and west quadrants of the floor area.

Worksheet No. 18 Sampling Locations and Methods/SOPP Requirements

Sample Location	Sample Designation	Sample Depth (ft bgs) (a)	QA/QC Sample Designation		Analytical Suite
			FD*	MS/MSD*	
RSA-013					
Confirmation Sample Locations (RDX Excavation)					
013-EX1-SW01	013-EX1-SW01 -DS- ABG0192 -REG	0-5	013-EX1-EW01-DS-ABG0193-FD		RDX
	013-EX1-SW01 -DS- ABG0194 -REG	5-8			RDX
013-EX1-SW02	013-EX1-SW02 -DS- ABG0195 -REG	0-5		013-EX1-SW01-DS-ABG0195-MS/MSD	RDX
	013-EX1-SW02 -DS- ABG0196 -REG	5-8			RDX
013-EX1-SW03	013-EX1-SW03 -DS- ABG0197 -REG	0-5			RDX
	013-EX1-SW03 -DS- ABG0198 -REG	5-8			RDX
013-EX1-SW04	013-EX1-SW04 -DS- ABG0199 -REG	0-5			RDX
	013-EX1-SW04 -DS- ABG0200 -REG	5-8			RDX
Confirmation Sample Locations (Perchlorate Excavation)					
013-EX2-SW01	013-EX2-SW01 -DS- ABG0201 -REG	0-5			Perchlorate
	013-EX2-SW01 -DS- ABG0202 -REG	5-8	013-EX2-SW01-DS-ABG0203-FD		Perchlorate
013-EX2-SW02	013-EX2-SW02 -DS- ABG0204 -REG	0-5			Perchlorate
	013-EX2-SW02 -DS- ABG0205 -REG	5-8			Perchlorate
013-EX2-SW03	013-EX2-SW03 -DS- ABG0206 -REG	0-5		013-EX2-SW03-DS-ABG0206-MS/MSD	Perchlorate
	013-EX2-SW03 -DS- ABG0207 -REG	5-8			Perchlorate
013-EX2-SW04	013-EX2-SW04 -DS- ABG0208 -REG	0-5			Perchlorate
	013-EX2-SW04 -DS- ABG0209 -REG	5-8			Perchlorate
013-EX2-SW05	013-EX2-SW05 -DS- ABG0210 -REG	0-5			Perchlorate
	013-EX2-SW05 -DS- ABG0211 -REG	5-8			Perchlorate
013-EX2-SW06	013-EX2-SW06 -DS- ABG0212 -REG	0-5	013-EX2-SW06-DS-ABG0213-FD		Perchlorate
	013-EX2-SW06 -DS- ABG0214 -REG	5-8			Perchlorate
013-EX2-SW07	013-EX2-SW07 -DS- ABG0215 -REG	0-5			Perchlorate
	013-EX2-SW07 -DS- ABG0216 -REG	5-8			Perchlorate
013-EX2-SW08	013-EX2-SW08 -DS- ABG0217 -REG	0-5			Perchlorate
	013-EX2-SW08 -DS- ABG0218 -REG	5-8			Perchlorate
013-EX2-SW09	013-EX2-SW09 -DS- ABG0219 -REG	0-5			Perchlorate
	013-EX2-SW09 -DS- ABG0220 -REG	5-8			Perchlorate
013-EX2-SW10	013-EX2-SW10 -DS- ABG0221 -REG	0-5			Perchlorate
	013-EX2-SW10 -DS- ABG0222 -REG	5-8			Perchlorate
013-EX2-SW11	013-EX2-SW11 -DS- ABG0223 -REG	0-5			Perchlorate
	013-EX2-SW11 -DS- ABG0224 -REG	5-8	013-EX2-SW11-DS-ABG0225-FD		Perchlorate
013-EX2-SW12	013-EX2-SW12 -DS- ABG0226 -REG	0-5			Perchlorate
	013-EX2-SW12 -DS- ABG0227 -REG	5-8			Perchlorate
013-EX2-SW13	013-EX2-SW13 -DS- ABG0228 -REG	0-5			Perchlorate
	013-EX2-SW13 -DS- ABG0229 -REG	5-8		013-EX2-SW13-DS-ABG0229-MS/MSD	Perchlorate
013-EX2-SW14	013-EX2-SW14 -DS- ABG0230 -REG	0-5			Perchlorate
	013-EX2-SW14 -DS- ABG0231 -REG	5-8			Perchlorate
013-EX2-SW15	013-EX2-SW15 -DS- ABG0232 -REG	0-5			Perchlorate
	013-EX2-SW15 -DS- ABG0233 -REG	5-8			Perchlorate
013-EX2-SW16	013-EX2-SW16 -DS- ABG0234 -REG	0-5	013-EX2-SW16-DS-ABG0235-FD		Perchlorate
	013-EX2-SW16 -DS- ABG0236 -REG	5-8			Perchlorate
013-EX2-SW17	013-EX2-SW17 -DS- ABG0237 -REG	0-5			Perchlorate
	013-EX2-SW17 -DS- ABG0238 -REG	5-8			Perchlorate

Worksheet No. 18 Sampling Locations and Methods/SOPP Requirements

Sample Location	Sample Designation	Sample Depth (ft bgs) (a)	QA/QC Sample Designation		Analytical Suite
			FD*	MS/MSD*	
013-EX2-SW18	013-EX2-SW18 -DS- ABG0239 -REG	0-5			Perchlorate
	013-EX2-SW18 -DS- ABG0240 -REG	5-8			Perchlorate
013-EX2-SW19	013-EX2-SW19 -DS- ABG0241 -REG	0-5			Perchlorate
	013-EX2-SW19 -DS- ABG0242 -REG	5-8			Perchlorate
013-EX2-SW20	013-EX2-SW20 -DS- ABG0243 -REG	0-5			Perchlorate
	013-EX2-SW20 -DS- ABG0244 -REG	5-8			Perchlorate
013-EX2-SW21	013-EX2-SW21 -DS- ABG0245 -REG	0-5			Perchlorate
	013-EX2-SW21 -DS- ABG0246 -REG	5-8			Perchlorate
013-EX2-SW22	013-EX2-SW22 -DS- ABG0247 -REG	0-5	013-EX2-SW22-DS-ABG0248-FD		Perchlorate
	013-EX2-SW22 -DS- ABG0249 -REG	5-8			Perchlorate
013-EX2-SW23	013-EX2-SW23 -DS- ABG0250 -REG	0-5			Perchlorate
	013-EX2-SW23 -DS- ABG0251 -REG	5-8			Perchlorate
013-EX2-SW24	013-EX2-SW24 -DS- ABG0252 -REG	0-5			Perchlorate
	013-EX2-SW24 -DS- ABG0253 -REG	5-8			Perchlorate
013-EX2-SW25	013-EX2-SW25 -DS- ABG0254 -REG	0-5			Perchlorate
	013-EX2-SW25 -DS- ABG0255 -REG	5-8			Perchlorate
013-EX2-SW26	013-EX2-SW26 -DS- ABG0256 -REG	0-5	013-EX2-SW26-DS-ABG0257-FD		Perchlorate
	013-EX2-SW26 -DS- ABG0258 -REG	5-8			Perchlorate
013-EX2-SW27	013-EX2-SW27 -DS- ABG0259 -REG	0-5			Perchlorate
	013-EX2-SW27 -DS- ABG0260 -REG	5-8			Perchlorate
013-EX2-SW28	013-EX2-SW28 -DS- ABG0261 -REG	0-5		013-EX2-SW28-DS-ABG0261-MS/MSD	Perchlorate
	013-EX2-SW28 -DS- ABG0262 -REG	5-8			Perchlorate
013-EX2-SW29	013-EX2-SW29 -DS- ABG0263 -REG	0-5			Perchlorate
	013-EX2-SW29 -DS- ABG0264 -REG	5-8			Perchlorate
013-EX2-SW30	013-EX2-SW30 -DS- ABG0265 -REG	0-5			Perchlorate
	013-EX2-SW30 -DS- ABG0266 -REG	5-8			Perchlorate
013-EX2-SW31	013-EX2-SW31 -DS- ABG0267 -REG	0-5			Perchlorate
	013-EX2-SW31 -DS- ABG0268 -REG	5-8	013-EX2-SW31-DS-ABG0269-FD		Perchlorate
013-EX2-SW32	013-EX2-SW32 -DS- ABG0270 -REG	0-5			Perchlorate
	013-EX2-SW32 -DS- ABG0271 -REG	5-8			Perchlorate
013-EX2-SW33	013-EX2-SW33 -DS- ABG0272 -REG	0-5		013-EX2-SW33-DS-ABG0272-MS/MSD	Perchlorate
	013-EX2-SW33 -DS- ABG0273 -REG	5-8			Perchlorate
013-EX2-SW34	013-EX2-SW34 -DS- ABG0274 -REG	0-5			Perchlorate
	013-EX2-SW34 -DS- ABG0275 -REG	5-8			Perchlorate
013-EX2-SW35	013-EX2-SW35 -DS- ABG0276 -REG	0-5			Perchlorate
	013-EX2-SW35 -DS- ABG0277 -REG	5-8			Perchlorate
013-EX2-SW36	013-EX2-SW36 -DS- ABG0278 -REG	0-5	013-EX2-SW36-DS-ABG0279-FD		Perchlorate
	013-EX2-SW36 -DS- ABG0280 -REG	5-8			Perchlorate
013-EX2-SW37	013-EX2-SW37 -DS- ABG0281 -REG	0-5			Perchlorate
	013-EX2-SW37 -DS- ABG0282 -REG	5-8			Perchlorate
013-EX2-SW38	013-EX2-SW38 -DS- ABG0283 -REG	0-5			Perchlorate
	013-EX2-SW38 -DS- ABG0284 -REG	5-8			Perchlorate
013-EX2-SW39	013-EX2-SW39 -DS- ABG0285 -REG	0-5			Perchlorate
	013-EX2-SW39 -DS- ABG0286 -REG	5-8			Perchlorate
013-EX2-SW40	013-EX2-SW40 -DS- ABG0287 -REG	0-5			Perchlorate
	013-EX2-SW40 -DS- ABG0288 -REG	5-8			Perchlorate

Worksheet No. 18 Sampling Locations and Methods/SOPP Requirements

Sample Location	Sample Designation	Sample Depth (ft bgs) (a)	QA/QC Sample Designation		Analytical Suite
			FD*	MS/MSD*	
013-EX2-SW41	013-EX2-SW41 -DS- ABG0289 -REG	0-5			Perchlorate
	013-EX2-SW41 -DS- ABG0290 -REG	5-8	013-EX2-SW41-DS-ABG0291-FD		Perchlorate
013-EX2-SW42	013-EX2-SW42 -DS- ABG0292 -REG	0-5			Perchlorate
	013-EX2-SW42 -DS- ABG0293 -REG	5-8			Perchlorate
013-EX2-SW43	013-EX2-SW43 -DS- ABG0294 -REG	0-5			Perchlorate
	013-EX2-SW43 -DS- ABG0295 -REG	5-8		013-EX2-SW43-DS-ABG0295-MS/MSD	Perchlorate
013-EX2-SW44	013-EX2-SW44 -DS- ABG0296 -REG	0-5			Perchlorate
	013-EX2-SW44 -DS- ABG0297 -REG	5-8			Perchlorate
013-EX2-SW45	013-EX2-SW45 -DS- ABG0298 -REG	0-5			Perchlorate
	013-EX2-SW45 -DS- ABG0299 -REG	5-8			Perchlorate
013-EX2-SW46	013-EX2-SW46 -DS- ABG0300 -REG	0-5	013-EX2-SW46-DS-ABG0301-FD		Perchlorate
	013-EX2-SW46 -DS- ABG0302 -REG	5-8			Perchlorate
013-EX2-SW47	013-EX2-SW47 -DS- ABG0303 -REG	0-5			Perchlorate
	013-EX2-SW47 -DS- ABG0304 -REG	5-8			Perchlorate
013-EX2-SW48	013-EX2-SW48 -DS- ABG0305 -REG	0-5			Perchlorate
	013-EX2-SW48 -DS- ABG0306 -REG	5-8			Perchlorate
013-EX2-SW49	013-EX2-SW49 -DS- ABG0307 -REG	0-5			Perchlorate
	013-EX2-SW49 -DS- ABG0308 -REG	5-8			Perchlorate
013-EX2-SW50	013-EX2-SW50 -DS- ABG0309 -REG	0-5			Perchlorate
	013-EX2-SW50 -DS- ABG0310 -REG	5-8			Perchlorate
013-EX2-SW51	013-EX2-SW51 -DS- ABG0311 -REG	0-5			Perchlorate
	013-EX2-SW51 -DS- ABG0312 -REG	5-8			Perchlorate
013-EX2-SW52	013-EX2-SW52 -DS- ABG0313 -REG	0-5	013-EX2-SW52-DS-ABG0314-FD		Perchlorate
	013-EX2-SW52 -DS- ABG0315 -REG	5-8			Perchlorate
013-EX2-SW53	013-EX2-SW53 -DS- ABG0316 -REG	0-5			Perchlorate
	013-EX2-SW53 -DS- ABG0317 -REG	5-8			Perchlorate
013-EX2-SW54	013-EX2-SW54 -DS- ABG0318 -REG	0-5			Perchlorate
	013-EX2-SW54 -DS- ABG0319 -REG	5-8			Perchlorate
013-EX2-SW55	013-EX2-SW55 -DS- ABG0320 -REG	0-5			Perchlorate
	013-EX2-SW55 -DS- ABG0321 -REG	5-8			Perchlorate
013-EX2-SW56	013-EX2-SW56 -DS- ABG0322 -REG	0-5	013-EX2-SW56-DS-ABG0323-FD		Perchlorate
	013-EX2-SW56 -DS- ABG0324 -REG	5-8			Perchlorate
013-EX2-SW57	013-EX2-SW57 -DS- ABG0325 -REG	0-5			Perchlorate
	013-EX2-SW57 -DS- ABG0326 -REG	5-8			Perchlorate
013-EX2-SW58	013-EX2-SW58 -DS- ABG0327 -REG	0-5		013-EX2-SW58-DS-ABG0327-MS/MSD	Perchlorate
	013-EX2-SW58 -DS- ABG0328 -REG	5-8			Perchlorate
013-EX2-SW59	013-EX2-SW59 -DS- ABG0329 -REG	0-5			Perchlorate
	013-EX2-SW59 -DS- ABG0330 -REG	5-8			Perchlorate
013-EX2-SW60	013-EX2-SW60 -DS- ABG0331 -REG	0-5			Perchlorate
	013-EX2-SW60 -DS- ABG0332 -REG	5-8			Perchlorate
Equipment Rinsates					
013-SITE	013-SITE -WA- ABG8002 -ER	NA			RDX
013-SITE	013-SITE -WA- ABG8003 -ER	NA			Perchlorate
013-SITE	013-SITE -WA- ABG8004 -ER	NA			Perchlorate
013-SITE	013-SITE -WA- ABG8005 -ER	NA			Perchlorate
013-SITE	013-SITE -WA- ABG8006 -ER	NA			Perchlorate
013-SITE	013-SITE -WA- ABG8007 -ER	NA			Perchlorate

Worksheet No. 18 Sampling Locations and Methods/SOPP Requirements

Sample Location	Sample Designation	Sample Depth (ft bgs) (a)	QA/QC Sample Designation		Analytical Suite
			FD*	MS/MSD*	
013-SITE	013-SITE -WA- ABG8008 -ER	NA			Perchlorate
Berm Samples					
013-BERM01	013-BERM01 -SO- ABG9013 -REG	NA	013-BERM01-SO-ABG9014-FD		Perchlorate, RDX
013-BERM02	013-BERM02 -SO- ABG9015 -REG	NA		013-BERM02-SO-ABG9015-MS/MSD	Perchlorate, RDX
013-BERM03	013-BERM03 -SO- ABG9016 -REG	NA			Perchlorate, RDX
013-BERM04	013-BERM04 -SO- ABG9017 -REG	NA			Perchlorate, RDX
013-BERM05	013-BERM05 -SO- ABG9018 -REG	NA			Perchlorate, RDX
013-BERM06	013-BERM06 -SO- ABG9019 -REG	NA			Perchlorate, RDX
013-BERM07	013-BERM07 -SO- ABG9020 -REG	NA			Perchlorate, RDX
013-BERM08	013-BERM08 -SO- ABG9021 -REG	NA			Perchlorate, RDX
013-BERM09	013-BERM09 -SO- ABG9022 -REG	NA			Perchlorate, RDX
013-BERM10	013-BERM10 -SO- ABG9023 -REG	NA			Perchlorate, RDX
013-BERM11	013-BERM11 -SO- ABG9024 -REG	NA	013-BERM11-SO-ABG9025-FD		Perchlorate, RDX
013-BERM12	013-BERM12 -SO- ABG9026 -REG	NA			Perchlorate, RDX
013-BERM13	013-BERM13 -SO- ABG9027 -REG	NA		013-BERM13-SO-ABG9027-MS/MSD	Perchlorate, RDX
013-BERM14	013-BERM14 -SO- ABG9028 -REG	NA			Perchlorate, RDX
013-BERM15	013-BERM15 -SO- ABG9029 -REG	NA			Perchlorate, RDX
013-BERM16	013-BERM16 -SO- ABG9030 -REG	NA			Perchlorate, RDX
013-BERM17	013-BERM17 -SO- ABG9031 -REG	NA			Perchlorate, RDX
013-BERM18	013-BERM18 -SO- ABG9032 -REG	NA			Perchlorate, RDX
013-BERM19	013-BERM19 -SO- ABG9033 -REG	NA			Perchlorate, RDX
013-BERM20	013-BERM20 -SO- ABG9034 -REG	NA	013-BERM20-SO-ABG9035-FD		Perchlorate, RDX
013-BERM21	013-BERM21 -SO- ABG9036 -REG	NA			Perchlorate, RDX
Backfill Samples (Top 4 feet of Excavation Area)					
013-BCKFILEXC01	013-BCKFILEXC01 -SO- ABG9037 -REG	NA	013-BCKFILEXC01-SO-ABG9038-FD		Perchlorate, RDX
013-BCKFILEXC02	013-BCKFILEXC02 -SO- ABG9039 -REG	NA			Perchlorate, RDX
013-BCKFILEXC03	013-BCKFILEXC03 -SO- ABG9040 -REG	NA			Perchlorate, RDX
013-BCKFILEXC04	013-BCKFILEXC04 -SO- ABG9041 -REG	NA			Perchlorate, RDX
013-BCKFILEXC05	013-BCKFILEXC05 -SO- ABG9042 -REG	NA			Perchlorate, RDX
013-BCKFILEXC06	013-BCKFILEXC06 -SO- ABG9043 -REG	NA			Perchlorate, RDX
013-BCKFILEXC07	013-BCKFILEXC07 -SO- ABG9044 -REG	NA			Perchlorate, RDX
013-BCKFILEXC08	013-BCKFILEXC08 -SO- ABG9045 -REG	NA			Perchlorate, RDX
013-BCKFILEXC09	013-BCKFILEXC09 -SO- ABG9046 -REG	NA			Perchlorate, RDX
013-BCKFILEXC10	013-BCKFILEXC10 -SO- ABG9047 -REG	NA			Perchlorate, RDX
013-BCKFILEXC11	013-BCKFILEXC11 -SO- ABG9048 -REG	NA	013-BCKFILEXC11-SO-ABG9049-FD		Perchlorate, RDX
013-BCKFILEXC12	013-BCKFILEXC12 -SO- ABG9050 -REG	NA			Perchlorate, RDX
013-BCKFILEXC13	013-BCKFILEXC13 -SO- ABG9051 -REG	NA			Perchlorate, RDX
013-BCKFILEXC14	013-BCKFILEXC14 -SO- ABG9052 -REG	NA			Perchlorate, RDX
013-BCKFILEXC15	013-BCKFILEXC15 -SO- ABG9053 -REG	NA			Perchlorate, RDX
013-BCKFILEXC16	013-BCKFILEXC16 -SO- ABG9054 -REG	NA			Perchlorate, RDX
013-BCKFILEXC17	013-BCKFILEXC17 -SO- ABG9055 -REG	NA			Perchlorate, RDX
013-BCKFILEXC18	013-BCKFILEXC18 -SO- ABG9056 -REG	NA			Perchlorate, RDX
013-BCKFILEXC19	013-BCKFILEXC19 -SO- ABG9057 -REG	NA			Perchlorate, RDX
013-BCKFILEXC20	013-BCKFILEXC20 -SO- ABG9058 -REG	NA			Perchlorate, RDX
013-BCKFILEXC21	013-BCKFILEXC21 -SO- ABG9059 -REG	NA			Perchlorate, RDX
013-BCKFILEXC22	013-BCKFILEXC22 -SO- ABG9060 -REG	NA	013-BCKFILEXC22-SO-ABG9061-FD		Perchlorate, RDX
013-BCKFILEXC23	013-BCKFILEXC23 -SO- ABG9062 -REG	NA			Perchlorate, RDX

Worksheet No. 18 Sampling Locations and Methods/SOPP Requirements

Sample Location	Sample Designation	Sample Depth (ft bgs) (a)	QA/QC Sample Designation		Analytical Suite
			FD*	MS/MSD*	
013-BCKFILEXC24	013-BCKFILEXC24 -SO- ABG9063 -REG	NA			Perchlorate, RDX
013-BCKFILEXC25	013-BCKFILEXC25 -SO- ABG9064 -REG	NA			Perchlorate, RDX
013-BCKFILEXC26	013-BCKFILEXC26 -SO- ABG9065 -REG	NA			Perchlorate, RDX
013-BCKFILEXC27	013-BCKFILEXC27 -SO- ABG9066 -REG	NA			Perchlorate, RDX
013-BCKFILEXC28	013-BCKFILEXC28 -SO- ABG9067 -REG	NA			Perchlorate, RDX
013-BCKFILEXC29	013-BCKFILEXC29 -SO- ABG9068 -REG	NA			Perchlorate, RDX
013-BCKFILEXC30	013-BCKFILEXC30 -SO- ABG9069 -REG	NA			Perchlorate, RDX
013-BCKFILEXC31	013-BCKFILEXC31 -SO- ABG9070 -REG	NA			Perchlorate, RDX
013-BCKFILEXC32	013-BCKFILEXC32 -SO- ABG9071 -REG	NA			Perchlorate, RDX
013-BCKFILEXC33	013-BCKFILEXC33 -SO- ABG9072 -REG	NA	013-BCKFILEXC33-SO-ABG9073-FD		Perchlorate, RDX
013-BCKFILEXC34	013-BCKFILEXC34 -SO- ABG9074 -REG	NA			Perchlorate, RDX
013-BCKFILEXC35	013-BCKFILEXC35 -SO- ABG9075 -REG	NA			Perchlorate, RDX
013-BCKFILEXC36	013-BCKFILEXC36 -SO- ABG9076 -REG	NA			Perchlorate, RDX
013-BCKFILEXC37	013-BCKFILEXC37 -SO- ABG9077 -REG	NA			Perchlorate, RDX
013-BCKFILEXC38	013-BCKFILEXC38 -SO- ABG9078 -REG	NA			Perchlorate, RDX
013-BCKFILEXC39	013-BCKFILEXC39 -SO- ABG9079 -REG	NA			Perchlorate, RDX
013-BCKFILEXC40	013-BCKFILEXC40 -SO- ABG9080 -REG	NA			Perchlorate, RDX
013-BCKFILEXC41	013-BCKFILEXC41 -SO- ABG9081 -REG	NA			Perchlorate, RDX
013-BCKFILEXC42	013-BCKFILEXC42 -SO- ABG9082 -REG	NA			Perchlorate, RDX
013-BCKFILEXC43	013-BCKFILEXC43 -SO- ABG9083 -REG	NA	013-BCKFILEXC43-SO-ABG9084-FD		Perchlorate, RDX
013-BCKFILEXC44	013-BCKFILEXC44 -SO- ABG9085 -REG	NA			Perchlorate, RDX
013-BCKFILEXC45	013-BCKFILEXC45 -SO- ABG9086 -REG	NA			Perchlorate, RDX
013-BCKFILEXC46	013-BCKFILEXC46 -SO- ABG9087 -REG	NA			Perchlorate, RDX
013-BCKFILEXC47	013-BCKFILEXC47 -SO- ABG9088 -REG	NA			Perchlorate, RDX
013-BCKFILEXC48	013-BCKFILEXC48 -SO- ABG9089 -REG	NA			Perchlorate, RDX
013-BCKFILEXC49	013-BCKFILEXC49 -SO- ABG9090 -REG	NA			Perchlorate, RDX
013-BCKFILEXC50	013-BCKFILEXC50 -SO- ABG9091 -REG	NA			Perchlorate, RDX
013-BCKFILEXC51	013-BCKFILEXC51 -SO- ABG9092 -REG	NA			Perchlorate, RDX
013-BCKFILEXC52	013-BCKFILEXC52 -SO- ABG9093 -REG	NA			Perchlorate, RDX
013-BCKFILEXC53	013-BCKFILEXC53 -SO- ABG9094 -REG	NA	013-BCKFILEXC53-SO-ABG9095-FD		Perchlorate, RDX
013-BCKFILEXC54	013-BCKFILEXC54 -SO- ABG9096 -REG	NA			Perchlorate, RDX
013-BCKFILEXC55	013-BCKFILEXC55 -SO- ABG9097 -REG	NA			Perchlorate, RDX
013-BCKFILEXC56	013-BCKFILEXC56 -SO- ABG9098 -REG	NA			Perchlorate, RDX
013-BCKFILEXC57	013-BCKFILEXC57 -SO- ABG9099 -REG	NA			Perchlorate, RDX
013-BCKFILEXC58	013-BCKFILEXC58 -SO- ABG9100 -REG	NA			Perchlorate, RDX
013-BCKFILEXC59	013-BCKFILEXC59 -SO- ABG9101 -REG	NA			Perchlorate, RDX
013-BCKFILEXC60	013-BCKFILEXC60 -SO- ABG9102 -REG	NA	013-BCKFILEXC60-SO-ABG9103-FD		Perchlorate, RDX
013-BCKFILEXC61	013-BCKFILEXC61 -SO- ABG9104 -REG	NA			Perchlorate, RDX
Backfill Samples (Benched Material)					
013-BCKFILBENCH01	013-BCKFILBENCH01 -SO- ABG9105 -REG	NA	013-BCKFILBENCH01-SO-ABG9106-FD		Perchlorate, RDX
013-BCKFILBENCH02	013-BCKFILBENCH02 -SO- ABG9107 -REG	NA		013-BCKFILBENCH02-SO-ABG9107-MS/MSD	Perchlorate, RDX
013-BCKFILBENCH03	013-BCKFILBENCH03 -SO- ABG9108 -REG	NA			Perchlorate, RDX
013-BCKFILBENCH04	013-BCKFILBENCH04 -SO- ABG9109 -REG	NA			Perchlorate, RDX
013-BCKFILBENCH05	013-BCKFILBENCH05 -SO- ABG9110 -REG	NA			Perchlorate, RDX
013-BCKFILBENCH06	013-BCKFILBENCH06 -SO- ABG9111 -REG	NA			Perchlorate, RDX

Worksheet No. 18 Sampling Locations and Methods/SOPP Requirements

Sample Location	Sample Designation	Sample Depth (ft bgs) (a)	QA/QC Sample Designation		Analytical Suite
			FD*	MS/MSD*	
Waste Characterization					
013-SITE	013-SITE -SO- ABG9112 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9113 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9114 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9115 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9116 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9117 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9118 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9119 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9120 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9121 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9122 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9123 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9124 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9125 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9126 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9127 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9128 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9129 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9130 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9131 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9132 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9133 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9134 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9135 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9136 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9137 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9138 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9139 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9140 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9141 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9142 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9143 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9144 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9145 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9146 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9147 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9148 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9149 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9150 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9151 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9152 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9153 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9154 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9155 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9156 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9157 -REG	NA			Perchlorate, RDX

Worksheet No. 18 Sampling Locations and Methods/SOPP Requirements

Sample Location	Sample Designation	Sample Depth (ft bgs) (a)	QA/QC Sample Designation		Analytical Suite
			FD*	MS/MSD*	
013-SITE	013-SITE -SO- ABG9158 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9159 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9160 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9161 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9162 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9163 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9164 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9165 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9166 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9167 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9168 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9169 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9170 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9171 -REG	NA			Perchlorate, RDX
013-SITE	013-SITE -SO- ABG9172 -REG	NA			Perchlorate, RDX
Borrow Material					
013-BORROW01	013-BORROW01 -SO- ABG9173 -REG	NA	013-BORROW1-SO-ABG9174-FD		TCL VOCs, TCL SVOCs, TCL Pesticides/PCBs, TAL Metals, Perchlorate, Explosives
013-BORROW02	013-BORROW02 -SO- ABG9175 -REG	NA		013-BORROW2-SO-ABG9175-MS/MSD	TCL VOCs, TCL SVOCs, TCL Pesticides/PCBs, TAL Metals, Perchlorate, Explosives
013-BORROW03	013-BORROW03 -SO- ABG9176 -REG	NA			TCL VOCs, TCL SVOCs, TCL Pesticides/PCBs, TAL Metals, Perchlorate, Explosives

*The MS/MSD locations are subject to change due to field conditions. Project chemist will be notified and data base updated accordingly.

Sampling SOP Reference

SOPP 1.0, Field Documentation; SOPP 2.0, Collection and Field Screening of Soil Samples; SOPP 3.0, Field Equipment Decontamination.
SOPP 4.0, Investigative Derived Waste, SOPP 6.0, Subsurface Soil Sampling.
SOPP 15.0, Non-Hazardous Sample Handling, Packaging, and Shipping; SOPP 22.0, Description of Geologic Materials.

Worksheet No. 19: Sample Containers, Preservation, and Hold Time Requirements

UFP-QAPP Worksheet No. 19. Sample Container, Preservation, and Holding Time Requirements

Matrix	Analytical Group	Laboratory Analytical and Preparation Method/SOP	Sample Container Quantity and Type	Sample Volume	Sample Preservation	Sample Holding Time
Soil	Volatiles - VOCs	5035/8260C - VO004	2 40-mL VOC vials		Methanol, Cool 0°C to 6°C	365 days to extraction / 365 days to analysis
Soil	Metals/Mercury	3050/6010C/7471B – MT007, MT009, MT012	1 – 4 oz. plastic container		Cool 0°C to 6°C	180 days ICP/28 days mercury
Soil	Perchlorate	6850 - HPLC06	1 – 4 oz. glass; Teflon®-lined cap		Cool 0°C to 6°C	28 days to extraction / 28 days to analysis
Soil	SVOC - PCBs	3546/8082A – SV021, SV004	1 4-oz Amber Gl		Cool 0°C to 6°C	365 days to extraction / 40 days
Soil	SVOC - Pesticides	3546/8081B – SV021, SV002	1 4-oz Amber Gl		Cool 0°C to 6°C	365 days to extraction / 40 days
Soil	SVOC - SVOCs	3546/8270D – SV021, SV006	1 4-oz Amber Gl		Cool 0°C to 6°C	14 days to extraction / 40 days to analysis
Soil	SVOC - Explosives	8330B – SV010	1 4-oz Amber Gl		Cool 0°C to 6°C	14 days to extraction / 40 days to analysis

ICP - Inductively Coupled Plasma.
PCB - Polychlorinated Biphenyl.
SVOC - Semivolatile Organic Compound.
VOC - Volatile Organic Compound.

Worksheet No. 20 Field Quality Control Sample Summary

	Analytical Method	Matrix	Total Number of Samples	FD	MS	MSD	Equip. Rinsate (1/event)	Trip Blank (1/cooler)	TAT Needed[a]	Sample Container/Preservation Requirements[b]	Holding Time	Total Number of Containers
RSA-013 Confirmation Samples												
Confirmation Samples (RDX Excavation)												
RDX	8330B	Soil	8	1	1	1	1	0	5 Days	4 oz jar	14 days extraction; 40 days analysis	12
Confirmation Samples (Perchlorate Excavation)												
Perchlorate	6850	Soil	120	12	6	6	6	0	5 Days	4 oz jar; headspace required	28 Days	150
Berm Samples												
Perchlorate	6850	Soil	21	2	1	1	0	0	5 Days	4 oz jar; headspace required	28 Days	25
RDX	8330B	Soil	21	2	1	1	0	0	5 Days	4 oz jar	14 days extraction; 40 days analysis	25
Backfill (Top 4 feet of Excavation Area) Samples												
Perchlorate	6850	Soil	61	7	4	4	0	0	5 Days	4 oz jar; headspace required	28 Days	76
RDX	8330B	Soil	61	7	4	4	0	0	5 Days	4 oz jar	14 days extraction; 40 days analysis	76
Backfill (Benched Material) Samples												
Perchlorate	6850	Soil	6	1	1	1	0	0	5 Days	4 oz jar; headspace required	28 Days	9
RDX	8330B	Soil	6	1	1	1	0	0	5 Days	4 oz jar	14 days extraction; 40 days analysis	9
Waste Characterization Samples												
Perchlorate	6850	Soil	61	0	0	0	0	0	5 Days	4 oz jar; headspace required	28 Days	61
RDX	8330B	Soil	61	0	0	0	0	0	5 Days	4 oz jar	14 days extraction; 40 days analysis	61
Borrow Soil Samples												
TCL VOCs	5035/8260B	Soil	3	1	1	1	0	0	Normal	2 Terra Cores in Methanol	14 days	12
TCL SVOCs	3540C/8270D	Soil	3	1	1	1	0	0	Normal	4-oz jar	14 days extraction; 40 days analysis	6
TCL Pesticides	3540C/8081B	Soil	3	1	1	1	0	0	Normal	4-oz jar	14 days extraction; 40 days analysis	6
TCL PCBs	3540C/8082A	Soil	3	1	1	1	0	0	Normal	4-oz jar	14 days extraction; 40 days analysis	6
Perchlorate	6850	Soil	3	1	1	1	0	0	Normal	4 oz jar; headspace required	28 Days	6
Explosives	8330B	Soil	3	1	1	1	0	0	Normal	4-oz jar	14 days extraction; 40 days analysis	6
TAL Metals	3050B/6010C/7471B	Soil	3	1	1	1	0	0	Normal	4-oz jar	6 Months; Mercury - 28 days	6

[a] Sample deliverables should include a Level IV, CLP-like data package and EDD for all samples with the exception of IDW samples that require certificates of analysis and EDD only.

[b] All samples should be cooled to 4 degrees Celsius in conjunction with preservation requirements noted prior to shipment to the laboratory.

Worksheet No. 21: Field Standard Operating Procedures (SOP)

The following SOPs from the IW QAPP will be followed during the conduct of the RSA-013 corrective measures.

Reference Number	Title, Revision Date and/or Number	Equipment Type	Comments
01	Installation-Wide Quality Assurance Program Plan Volume II, Rev. 4 December 2019 (or as updated)	As specified in each SOP	List of the SOPs for field activities is presented in IW-UFP-QAPP Volume II and provided below.
02	EPA SW-846 Update III Method 5035A, Draft Revision 1, July 2002	Terra Core samplers	NA
03	EPA Quartering Method, EISOPQAM, Revised November 2001 (EPA, 2001)	Composite samples only	NA
SOP 1.0	Field Documentation Rev. 4 December 2019	NA	The objective of SOP 1.0 is to establish the minimum documentation requirements for personnel performing field activities at RSA.
SOP 2.0	Collection and Field Screening of Soil Samples Rev. 4 December 2019	Terra Core samplers, hand auger, direct-push sampler	SOP 2.0 establishes guidelines and procedures for use by field personnel in collection and field screening of hand-augered, grab, and sleeve-lined split- spoon soil samples from surface or subsurface soils, or sediments.
SOP 3.0	Field Equipment Decontamination Rev. 4 December 2019	Decon supplies, deionized water, detergent and potable water	The objective of SOP 3.0 is to describe the proper methods for decontaminating downhole and sampling equipment used to perform field investigations.
SOP 4.0	Investigation-Derived Waste Rev. 4 December 2019	NA	SOP 4.0 establishes specific management practices for the in-process handling and subsequent disposition of environmental media generated as a result of investigation and removal actions.
SOP 6.0	Subsurface Soil Sampling Rev. 4 December 2019	Hand augers, Shelby tubes, and split- spoon samplers	The objective of SOP 6.0 is to establish guidelines and procedures for use by field personnel in the collection and documentation of subsurface soil samples for physical and chemical analysis from the unconsolidated zone (at a depth of 1 foot or greater below ground surface). Subsurface soils also include those first soils encountered directly under paved or covered surfaces, such as slabs.
SOP 11.0	Field Generated Records Management Rev. 4 December 2019	NA	SOP 11.0 establishes the methods and responsibilities associated with the management of field-generated program and delivery order records.
SOP 15.0	Non-Hazardous Sample Handling, Packaging, and Shipping Rev. 4 December 2019	NA	SOP 15.0 establishes guidelines and procedures for field personnel to use in the packaging and shipping of environmental samples for chemical and physical analysis. This SOP only applies to the packaging and shipping of low-concentration environmental samples.

Worksheet No. 21: Field Standard Operating Procedures (SOP)

Reference Number	Title, Revision Date and/or Number	Equipment Type	Comments
SOP 20.0	Drilling Unconsolidated Materials Rev. 4 December 2019	Hydropunch, hollow-stem auger, or rotosonic drill rigs	SOP 20.0 establishes guidelines and requirements drilling unconsolidated materials at RSA. Soil borings, piezometers, and monitoring wells are commonly installed at RSA during environmental work. Several drilling techniques are available but only the most commonly used methods are presented in this SOP. The selection of a drilling method is made based on the desired outcome of the drilling and knowledge of site conditions. The most common methods used at RSA include hydropunch, hollow-stem auger, and rotosonic methods for drilling in unconsolidated materials.
SOP 21.0	Monitoring Well and Borehole Abandonment Rev. 4 December 2019	Casing splitter, grout, tremie pipe	SOP 21.0 establishes guidelines and procedures for field personnel to use in the supervision of borehole or soil boring abandonment and groundwater monitoring well abandonment (destruction) activities. Additional specific borehole and well abandonment procedures and requirements will be provided in the site-specific plan.
SOP 22.0	Description of Geologic Materials Rev. 4 December 2019	Munsell soil color chart, grain size chart, percentage chart, USCS classification chart	SOP 22.0 specifies the requirements for the description of soil and rock encountered during investigations at RSA.
SOP 23.0	Preparation and Control of Procedures Rev. 4 December 2019	NA	SOP 23.0 provides instructions for the development, issuance, and maintenance of field investigative, quality control, and record management SOPs for RSA. This procedure is applicable to all personnel responsible for the development and use of these procedures. The objective of this procedure is to ensure that all SOPs are developed, issued, and maintained in a consistent manner with all required information.
SOP 24.0	Field Equipment Calibration Rev. 4 December 2019	Manufacturers' calibration guides	SOP 24.0 establishes guidelines and procedures for use by field personnel at RSA for the calibration of field equipment. The performance of proper calibration procedures will result in reliable field data. The general guidelines for calibration apply to all mechanical and/or electronic measurement equipment used in the field.
SOP 28.0	Munitions and Explosives of Concern (MEC) Anomaly Avoidance Support Rev. 4 December 2019	Various geophysical instruments	SOP 28.0 describes surface and subsurface anomaly avoidance procedures and techniques to be used while conducting munitions response and hazardous, toxic or radioactive waste-related activities during investigation, design, and remedial actions.
SOP 29.0	Vegetation Removal Rev. 0 December 2019	Hand operated and mechanical vegetation removal tools and equipment	SOP 29.0 describes the procedures for field personnel to conduct vegetation removal operations.
SOP 34.0	Subsurface Utility Avoidance Rev. 0 December 2019	Utility service location equipment	SOP 34.0 establishes the minimum requirements for avoiding damage to subsurface utilities from unintentional contact with powered equipment.
SOP 39.0	Stop Work Order Notice for Quality Related Issues Rev. 4 December 2019	NA	SOP 39.0 describes the process and responsibilities for issuing, resolving, and verifying acceptable responses/actions for Stop Work Orders associated with quality-related items.

Worksheet No. 21: Field Standard Operating Procedures (SOP)

Reference Number	Title, Revision Date and/or Number	Equipment Type	Comments
SOP 40.0	Receiving Inspection Rev. 2 December 2019	NA	SOP 40.0 describes the process and responsibilities for the performance and documentation of receipt inspection of quality affecting items.
SOP 41.0	Inspection Rev. 3 December 2019	NA	SOP 41.0 describes the methods and responsibilities for performing and documenting inspections on project work activities and materials to ensure compliance with established requirements.
SOP 42.0	Surveillance Rev. 3 December 2019	NA	SOP 42.0 provides instructions for performing and documenting the surveillance of project activities and functional areas. Surveillance generally includes the observation of real-time activities and/or the review of supporting documentation.
SOP 43.0	Nonconforming Reporting Rev. 3 December 2019	NA	SOP 43.0 establishes the system for initiating, processing, and controlling nonconforming items, services, or activities to include disposition and corrective actions.
SOP 44.0	Corrective Action Rev. 3 December 2019	NA	SOP 44.0 defines the requirements for identifying and processing a Corrective Action Request.
SOP 45.0	Quality Audits Rev. 3 December 2019	NA	SOP 45.0 establishes the requirement for a comprehensive system of planned and documented internal quality audits to verify the effectiveness of the Quality Management Program.

1 NA – Not applicable.
2 USCS – Unified Soil Classification System.

Worksheet No. 22: Field Equipment Calibration, Maintenance, Testing, and Inspection

Measurement Quality Objective	Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	Calibration Reference
Ongoing instrument function test	Organic Vapor Monitor or Photoionization Detector	Daily calibration before use with 100 parts per million isobutylene gas	As required by manufacturer specifications	Screen for VOCs.	Check all sensors and battery charge.	At beginning of work activity before use	Within ±10% of calibration gas	If calibration not within ±10%, repeat or tag as "out of calibration – do not use."	APTIM Field Lead	Manufacturer's Instrument Operating and Calibration Manual
Ongoing instrument function test	Lower Explosive Limit Meter/ Oxygen Meter	Daily calibration before use with 100 parts per million methane gas	As required by manufacturer specifications	Screen for combustible gases and oxygen levels.	Check all sensors and battery charge.	At beginning of work activity before use	Within ±10% of calibration gas	If calibration not within ±10%, repeat or tag as "out of calibration – do not use."	APTIM Field Lead	Manufacturer's Instrument Operating and Calibration Manual
Ongoing instrument function test	Hand-Held Metal Detection Instrument	Calibrate in accordance with manufacturer's requirements. Check sensitivity against surrogate verification strip-surrogates to mimic 75 percent of the metal footprint of a 60-millimeter mortar.	As required by manufacturer specifications	Detection of ferrous MEC anomalies	Check all sensors, cables, and battery charge if applicable. Check for proper instrument response by screening known metal object.	At beginning of work activity before use	Meets specification Instrument must respond to known metal object. Instrument must detect all three surrogates in verification strip.	RCA/CA	UXO Field Lead	Manufacturer's Instrument Operating and Calibration Manual

All equipment used by APTIM requiring regular maintenance and calibration (i.e., measurement and test equipment [M&TE]), will be stored at APTIM's facility. APTIM maintains a sufficient number of backup M&TE, as well as spare parts, if repair is needed to maintain the project schedule. M&TE will be maintained and calibrated in accordance with the manufacturer's specification as noted in the SOPs. M&TE that requires annual off-site calibration will be inspected monthly to ensure that calibration

Worksheet No. 22: Field Equipment Calibration, Maintenance, Testing, and Inspection

does not lapse. All M&TE in which calibration has expired, does not pass required calibration, or suffers damage while in active use will be removed from the inventory and tagged as “out of service” to prevent inadvertent use. The defective M&TE will not be allowed back in service until repaired or recalibrated against nationally recognized standards. The site manager is responsible to assign a person to manage the inventory of all consumables to ensure adequate inventory for the completion of the specific task.

Additional equipment, tools, and supplies required for use during the task-specific activity are provided in detail in the SOPs. Any required tools, equipment, and/or supplies that are not listed in the SOPs will be identified in this worksheet and incorporated in the site-specific task or project work plan. The APTIM site manager or designee will be responsible for assuring that there is an adequate amount of consumable supplies, materials, and spare parts for the completion of the task or will have access to a location in which supplies or materials may be procured in a reasonable period of time so that there will be no adverse effect on the project schedule.

All turnkey subcontractors will be responsible for managing and maintaining adequate supplies of consumables and available inventory of spare parts.

ISO – Industry standard object.
M&TE – Measurement and test equipment.
SOP – Standard operating procedure.
VOC – Volatile organic compound.

Worksheet No. 23: Analytical SOP References Table – Laboratory

Lab SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix / Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
MT007 Rev 6.2	Acid Digestion of Waters for Solids and Semi-solids for Total Metals by GFAA and ICP	Definitive	Solids/Metals Prep	Automated sample prep unit	CT Laboratories	N
SV021 Rev 0.4	Microwave Extraction of Semi-Volatiles Solid Samples	Definitive	Soil/Organic Prep	Microwave sample prep unit	CT Laboratories	N
MT009 Rev 5.3	Inductively Coupled Plasma (ICP) Emission – ICP-OES 6000	Definitive	Solids & Water/Metals	ICP	CT Laboratories	N
MT012 Rev 10.1	Mercury Cold Vapor Atomic Absorption (CV)	Definitive	Solids & Water/Metals	CetacM-6000A Mercury Analyzer	CT Laboratories	N
SV002 Rev 9	Organochlorine Pesticides by GC with Extended List	Definitive	Solids & Water/Organics	GC	CT Laboratories	N
SV004 Rev 11	Polychlorinated biphenyls (PCBs) as Aroclors by GC	Definitive	Solids & Water/Organics	GC	CT Laboratories	N
SV006 Rev 0	Semi-volatile Organic Compounds by 8270D	Definitive	Solids & Water/Organics	GC-MS	CT Laboratories	N
SV010 Rev 5.1	Explosives by Modified Method 8330B	Definitive	Solids & Water/Organics	HPLC	CT Laboratories	N
VO004 Rev 3	Analysis of Volatile Organic Compounds by GC/MS (8260C)	Definitive	Solids & Water/Organics	GC-MS	CT Laboratories	N
HPLC06 Rev 8	Perchlorate Method 6850/331.0	Definitive	Solids & Water/Inorganics	HPLC-MS	Microbac	N

GC/MS – Gas chromatography/mass spectrometry.
HPLC – High-performance liquid chromatography.
ICP – Inductively coupled plasma.
SOP – Standard operating procedure.
TCLP - Toxicity Characteristic Leaching Procedure.

Worksheet No. 24: Analytical Instrument Calibration

Instrument	Calibration Procedure*	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
GC	CCV	Daily prior to sample analysis for 12-hour analysis period; at the end of the analytical batch run	All reported analytes and surrogates ±20% of true value. All reported analytes and surrogates ±50% for end of analytical batch CCV.	If analyte exceeds with a positive bias and is nondetect, results will be qualified. Detected analytes and analytes with negative bias will be requested for qualification/narration with client. If client approval is not received, correct problem, then rerun CCV. If that fails, repeat ICAL. Reanalyze all samples since last acceptable CCV. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst/Supervisor	
	ICAL	Prior to sample analysis (minimum five-point) and after ICV or CCV failure	Each analyte must meet one of the three options below: Option 1: RSD for each analyte ≤20%. Option 2: linear least squares regression for each analyte: r2 ≥0.99. Option 3: nonlinear least squares regression (quadratic) for each analyte: r2 ≥0.99 (minimum six-point).	Correct problem then repeat ICAL.	Analyst/Supervisor	SV002 SV004
	ICV	After each ICAL	All analytes within ±20% of the expected value. All reported analytes within established RT windows.	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.	Analyst/Supervisor	

Worksheet No. 24: Analytical Instrument Calibration

Instrument	Calibration Procedure*	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
GC	CCV	Daily prior to sample analysis for 12-hour analysis period	All reported analytes and surrogates ≤20% of true value. All reported analytes and surrogates within established RT windows.	Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyzed all affected samples since the last acceptable CCV.	Analyst/Supervisor	
	Retention Time Window Position Establishment	Once after each ICAL for each analyte and surrogate	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed; on days when ICAL is not performed, the initial CCV is used.	NA	Analyst/Supervisor	
	Retention Time Window Width	At method set-up and after major maintenance	RT width is $\pm$3 times standard deviation for each analyte RT from the 72-hour study.	NA	Analyst/Supervisor	
LC/MS/MS (Perchlorate)	Tuning	Prior to ICAL	Ions should be within +/- 0.3 m/z of masses 83, 85 and 89	Retune instrument. Reanalyze tuning solutions.	Analyst/Supervisor	HPLC06
	ICAL	As needed; when CCV out of criteria	Minimum 5 point calibration Linear regression - correlation coefficient >0.995	Correct problem then repeat ICAL	Analyst/Supervisor	
	Second Source Calibration (ICV)	After ICAL, prior to beginning a sample run	< 15% drift	Correct problem. Rerun ICV. If rerun fails, repeat ICAL.	Analyst/Supervisor	
LC/MS/MS	Continuing calibration verification (CCV)	Daily and after every 10 sample injections	< 15% drift	Correct problem. Rerun CCV. If rerun fails, reanalyze all samples since last successful CCV.	Analyst/Supervisor	
LC/MS/MS	Interference check	At least one ICS must be analyzed daily	< 30% drift	Correct problem. Reanalyze ICS and all samples.	Analyst/Supervisor	

Worksheet No. 24: Analytical Instrument Calibration

Instrument	Calibration Procedure*	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
ICP-AES	Linear Dynamic Range or High-Level Check Standard	Daily ICAL prior to sample analysis; every 6 months	Within ±10% of true value.	Dilute sample within the calibration range, or re-establish/verify the LDR.	Analyst/Supervisor	MT009 MT012
	ICAL – Minimum one High Standard and a Calibration Blank for all Analytes	Daily ICAL prior to sample analysis	If more than one calibration standard is used, $r^2 \geq 0.990$.	Correct problem, then repeat ICAL. Flagging criteria are not appropriate.	Analyst/Supervisor	
	Second Source Calibration Verification (ICV)	Once after each ICAL, prior to beginning a sample run	Value of second source for all analytes(s) within ±10% of true value.	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL. Flagging criteria are not appropriate.	Analyst/Supervisor	
	CCV	After every 10 field samples and at the end of the analysis sequence	Within ±10% of true value.	If analyte exceeds with a positive bias and is nondetect, no corrective action will be performed. Detected analytes and analytes with negative bias will be requested for qualification/narration with client. If client approval is not received, correct problem, then rerun CCV. If that fails, repeat ICAL. Reanalyze all samples since last acceptable CCV. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst/Supervisor	

Worksheet No. 24: Analytical Instrument Calibration

Instrument	Calibration Procedure*	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
ICP-AES	Low-Level Calibration Check Standard	Daily, after one-point ICAL	Within ±20% of true value.	Correct problem, then reanalyze. Flagging criteria are not appropriate.	Analyst/Supervisor	
	ICB/CCB	Immediately after the ICV and immediately after every CCV. Immediately after the ICV and immediately after every CCV	The absolute values of all analytes must be <½ LOQ or <1/10_{th} the amount measured in any sample.	Correct problem. Re-prep and reanalyze calibration blank. All samples following the last acceptable calibration blank must be reanalyzed.	Analyst/Supervisor	
	ICS	After beginning of the analytical run	ICS-A: Absolute value of concentration for all nonspiked analytes <LOD. ICS-AB: Within 20% of true value.	Terminate analysis; locate and correct problem; reanalyze ICS, reanalyze all samples. If corrective action fails, qualify all associated analyte results.	Analyst/Supervisor	
GC	ICAL	Prior to sample analysis (minimum five-point) and after ICV or CCV failure	Each analyte must meet one of the three options below: Option 1: RSD for each analyte ≤20%. Option 2: linear least squares regression for each analyte: r2 ≥0.99. Option 3: nonlinear least squares regression (quadratic) for each analyte: r2 ≥0.99 (minimum six-point).	Correct problem then repeat ICAL.	Analyst/Supervisor	SV002 SV004
	ICV	After each ICAL	All analytes within ±20% of the expected value. All reported analytes within established RT windows.	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.	Analyst/Supervisor	
	CCV	Daily prior to sample analysis for 12-hour analysis period	All reported analytes and surrogates ≤20% of true value. All reported analytes and surrogates within established RT windows.	Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyzed all affected samples since the last acceptable CCV.	Analyst/Supervisor	

Worksheet No. 24: Analytical Instrument Calibration

Instrument	Calibration Procedure*	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
GC	Retention Time Window Position Establishment	Once after each ICAL for each analyte and surrogate	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed; on days when ICAL is not performed, the initial CCV is used.	NA	Analyst/Supervisor	
	Retention Time Window Width	At method set-up and after major maintenance	RT width is ±3 times standard deviation for each analyte RT from the 72-hour study.	NA	Analyst/Supervisor	
HRGC/HRMS	Resolving Power	Prior to ICAL and at the beginning and the end of each 12-hour period of analysis	Static resolving power ≥10,000 (10% valley) for identified masses.	Retune instrument and verify. Rerun affected samples.	Analyst/Supervisor	CF-OA-E-02
HPLC / 8330B, LAB SOP	Initial Calibration (ICAL)	At instrument setup and after ICV or CCV failure, prior to sample analysis. Minimum of 5 levels for linear and 6 levels for quadratic.	ICAL must meet one of the three options below: Option 1: RSD for each analyte ≤ 15%; Option 2: linear least squares regression for each analyte: r^2 ≥ 0.99; Option 3: non-linear least squares regression (quadratic) for each analyte: r^2 ≥ 0.99.	Correct problem then repeat ICAL. No samples may be run until ICAL has passed.	Analyst / Supervisor	SV018 Rev 2.1, SV010 Rev 5.0
HPLC / 8330B, LAB SOP	Initial Calibration Verification (ICV)	Once after each ICAL, analysis of a second source standard prior to sample analysis.	All reported analytes and surrogates within ± 20% of true value.	Correct problem. Rerun ICV. If that fails, repeat ICAL. No samples will be analyzed until the problem has been corrected.	Analyst / Supervisor	SV018 Rev 2.1, SV010 Rev 5.0
HPLC / 8330B, LAB SOP	Continuing Calibration Verification (CCV)	Before sample analysis, after every 10 field samples, and at the end of the analysis sequence.	All reported analytes and surrogates within ± 20% of the true value.	Recalibrate, and reanalyze all affected samples since the last acceptable CCV; or Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze all affected samples since the last acceptable CCV.	Analyst / Supervisor	SV018 Rev 2.1, SV010 Rev 5.0

Worksheet No. 24: Analytical Instrument Calibration

%D - Percent Difference.
AA - Atomic Absorption.
AES - Atomic Emission Spectrometry.
BFB – Bromofluorobenzene.
CCB - Continuing Calibration Blank.
CCV - Continuing Calibration Verification.
DDT – Dichlorodiphenyltrichloroethane.
DFTPP – Decafluorotriphenylphosphine.
GC - Gas Chromatography.
HRGC - High Resolution Gas Chromatography.
HRMS - High Resolution Mass Spectrometry.
HxCDD - Hexachlorodibenzo-p-dioxin.
ICAL - Initial Calibration.
ICB - Initial Calibration Blank.
ICP - Inductively Coupled Plasma.
ICS - Interference Check Solution.
ICV - Initial Calibration Verification.
LDR - Linear Dynamic Range.
LOD - Limit of Detection.
LOQ - Limit of Quantitation.
MS - Mass Spectrometry.
NA - Not Applicable.
RF - Response Factor
RRT - Relative Retention Time.
RSD - Relative Standard Deviation.
RT - Retention Time.
SOP - Standard Operating Procedure.
TCDD - Tetrachlorodibenxo-p-dioxin.

Worksheet No. 25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference[1]
GC/MS	Replace septa, clean injection port, clip column, clip or replace pre-column check auto sampler, clean source	SVOC	Detector, injection port,column, autosampler	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Lab Section Supervisor	SV006, SV007
GC/MS	Replace septa, clean injection port, clip column, check auto sampler, clean source	VOC	Detector, injection port,column, autosampler	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Lab Section Supervisor	VO004
GC	Replace septa, clean injection port, clip column, clip or replace pre-column, check auto sampler	PCBs	Detector, injection port,column, autosampler	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Lab Section Supervisor	SV004
GC	Replace septa, clean injection port, clip column, clip or replace pre-column, check auto sampler	Pesticides	Detector, injection port,column, autosampler	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Lab Section Supervisor	SV002
HPLC	Fill solvent bottles, change precolumn, column frits, flush column, clean pump head	Explosives & Propellants	Autosampler, column flow, detector, column and associated parts	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Lab Section Supervisor	SV018, SV010
ICP-AES	Clean torch assembly, nebulizer, and spray chamber as needed. Check argon gas, vacuum, waste container, and reagent water levels daily. Replace pump tubing as needed.	Metals	Torch, nebulizer chamber, pump and pump tubing, vacuum source, waste container	Daily prior to calibration	Acceptable calibration	Correct problem and recalibrate	Analyst / Supervisor	MT009
CVAA	Check lamp voltage, check autosampler, make necessary pump tube changes.	Metals	Autosampler, gases, pump tubing.	Daily prior to calibration	Acceptable calibration	Correct problem and recalibrate	Analyst / Supervisor	MT0012
LC/MS/MS	Clean turbo spray, interface, nebulizer, curtain plate	Perchlorates	Monitor gas supply pressure, HPLC system pressure, check for leaks	Prior to calibration check and/or as necessary	Acceptable calibration	Correct problem and repeat calibration	Analyst / Supervisor	HPLC06

Worksheet No. 25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection

CVAA –Cold Vapor Atomic Absorption.
GC/MS – Gas chromatography/mass spectrometry.
HPLC – High-performance liquid chromatography.
ICP-AES – Inductively coupled plasma – atomic emission spectrometry.
HRGC - High Resolution Gas Chromatography.
HRMS - High Resolution Mass Spectrometry.
ICAL – Initial calibration.
ICP - Inductively Coupled Plasma.
ICV - Initial Calibration Verification.
LDR - Linear Dynamic Range.
LOD - Limit of Detection.
LOQ - Limit of Quantitation.
LC – Liquid chromatography
MS - Mass Spectrometry.
PCB – Polychlorinated biphenyl.
SVOC – Semivolatile organic compound.
VOC – Volatile organic compound.

Worksheet Nos. 26 and 27: Sample Handling, Custody, and Disposal

Sample Collection, Packaging, and Shipment (Field)
Sample Collection (Personnel/Organization): TBD
Sample Packaging (Personnel/Organization): TBD
Coordination of Shipment (Personnel/Organization): Brian Rhodes
Type of Shipment/Carrier: UPS/FedEx
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Jodi Serstad, Elaine Bender / CT Laboratories
Sample Custody and Storage (Personnel/Organization): Jodi Serstad / CT Laboratories
Sample Preparation (Personnel/Organization): Organics: Jennifer Hagar, Metals: Brianna Martin-Meise / CT Laboratories
Sample Determinative Analysis (Personnel/Organization): Organics: Jim Yoder, Raj Nair, Adam Zurfluh, Jill Van Daalwyk; VOCs: Randy Digmann, Teisha Grundahl, Dan Scott; Metals: Nora Lea Henn, Matthew Szymanski / CT Laboratories; John Richards, Craig Smith / Microbac; Heather Patterson,
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 60 days from receipt
Sample Extract/Digestate Storage (No. of days from extraction/digestion): 3 months from sample digestion/extraction
SAMPLE DISPOSAL
Personnel/Organization: Jodi Serstad / CT Laboratories
Number of Days from Analysis: Minimum 30 days after final report sent to client; unless there is a written request to hold them longer.

Note: Samples will be collected, shipped and received by the contract laboratory under strict chain-of-custody procedures.
TBD – To be determined.

Worksheet Nos. 26 and 27: Sample Handling, Custody, and Disposal

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory):

Procedures to ensure the custody and integrity of the samples begin at the time of sampling and continue through transport, sample receipt, preparation, analysis and storage, data generation and reporting, and sample disposal. Records concerning the custody and condition of the samples are maintained in field and laboratory records.

APTIM shall maintain chain-of-custody (COC) records for all field and field QC samples. A sample is defined as being under a person's custody if any of the following conditions exist: (1) it is in their possession, (2) it is in their view after being in their possession, (3) it was in their possession and they locked it up, or, (4) it is in a designated secure area.

Samples collected in the field shall be transported to the laboratory or field-testing site as expeditiously as possible. When a 0-6 degrees °C requirement for preserving the sample is indicated, the samples shall be packed in ice or with reusable gel-type ice packs to keep them cool during collection and transportation. Samples shall be placed in coolers for transit, with custody seals attached to document any unauthorized opening of the coolers. Sample jars will not have individual custody seals. During transit, it is not always possible to rigorously control the temperature of the samples. As a general rule, storage at low temperature is the best way to preserve most samples. If the temperature of the samples upon receipt exceeds the temperature requirements, the exceedance shall be documented in laboratory records and discussed with APTIM. The decision regarding the potentially affected samples shall also be documented.

Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal):

Once the samples reach the laboratory, they shall be checked against information on the analysis request (AR)/COC form for anomalies. The condition, temperature, and appropriate preservation of samples shall be checked and documented on the COC form. Checking an aliquot of the sample using pH paper is an acceptable procedure except for volatile organic compounds, where an additional sample is required to check preservation. The occurrence of any anomalies in the received samples and their resolution shall be documented in laboratory records. All sample information shall then be entered into a tracking system, and unique analytical sample identifiers shall be assigned. A copy of this information shall be reviewed by the laboratory for accuracy. Sample holding time tracking begins with the collection of samples and continues until the analysis is complete. Holding times for methods required routinely for this work are specified in Worksheet No. 19. Samples not preserved or analyzed in accordance with these requirements shall be resampled and analyzed at no additional cost to the government. Subcontracted analyses shall be documented with the COC form. Procedures ensuring internal laboratory COC shall also be implemented and documented by the laboratory. Specific instructions concerning the analysis specified for each sample shall be communicated to the analysts. Analytical batches shall be created, and laboratory QC samples shall be introduced into each batch.

While in the laboratory, samples shall be stored in limited-access, temperature-controlled areas. Samples for volatile organics determination shall be stored separately from other samples, standards, and sample extracts. Samples shall be stored after analysis until disposed of in accordance with applicable local, state, and federal regulations. Disposal records shall be maintained by the laboratory.

SOPs describing sample control and custody shall be maintained by the laboratory.

Worksheet Nos. 26 and 27: Sample Handling, Custody, and Disposal

Sample Identification Procedures:
All samples shall be uniquely identified, labeled, and documented in the field at the time of collection in accordance with the SOP 15.0, *Non-Hazardous Sample Handling, Packaging, and Shipping*.

COC Procedures:
The following information concerning the sample shall be documented on the COC form:
Unique sample identification
Date and time of sample collection
Source of sample (including name, location, and sample type)
Designation of matrix spike/matrix spike duplicate
Preservative used
Analyses required
Name of collector(s)
Pertinent field data (pH, temperature, etc.)
Serial numbers of custody seals and transportation cases (if used)
Custody transfer signatures and dates and times of sample transfer from the field to transporters and to the laboratory or laboratories
Bill of lading or transporter tracking number (if applicable).

Examples of COC records, sample labels, and custody seals are included in Attachment 2 of the Installation-Wide Quality Assurance Program Plan (HGL, 2019 or most recent).

Worksheet No. 28: Analytical Quality Control and Corrective Action

Matrix: Soil/Aqueous/TCLP
Analytical Group: Organics
Analytical Method/SOP: VOCs 8260C

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Method Blank (MB)	One per preparatory batch of 20 or fewer samples of similar matrix.	No analytes detected > ½ LOQ or > 1/10 amount measured in any sample or 1/10 the regulatory limit, whichever is greater. Common contaminants must not be detected > LOQ	Correct problem. If required, reprep and reanalyze MB and all samples processed with the contaminated blank	Analyst/Group Leader	Same as QC Acceptance Limits.
Laboratory Control Sample (LCS)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM Version 5.3 LCS limits are used, if available. Otherwise, in-house control limits are used for any compounds not specified in QSM 5.3. In-house control limits may not be greater than ± 3 times the standard deviation of the mean LCS recovery	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available	Analyst/Group Leader	Same as QC Acceptance Limits.
Matrix Spike (MS)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM Version 5.3 LCS limits are used, if available. Otherwise, in-house control limits are used for any compounds not specified in QSM 5.3. In-house control limits may not be greater than ± 3 times the standard deviation of the mean LCS recovery	Examine project-specific requirements. Contact the client as to additional measures to be taken. If MS results are outside the limits, data shall be evaluated to determine source(s) of difference (i.e., matrix effect or analytical error)	Analyst/Group Leader	Same as QC Acceptance Limits.
Matrix Spike Duplicate (MSD) or Matrix Duplicate (MD)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM Version 5.3 LCS limits used for a MSD, if available. Otherwise, in-house control limits used for any compounds not specified in QSM 5.3. In-house control limits may not be greater than ± 3 times standard deviation of the mean LCS recovery MSD or MD: RPD of all analytes ≤ 20% (between MS and MSD or sample and MD)	Examine the project-specified requirements. Contact the client as to additional measures to be taken The data shall be evaluated to determine the source of difference	Analyst/Group Leader	Same as QC Acceptance Limits.
Internal Standards (IS)	Every field samples, standard and QC sample	Retention time within ± 10 seconds from retention time of the midpoint standard in the ICAL; IS areas within -50% to +100% of ICAL midpoint standard.	Inspect mass spectrometer and GC for malfunctions and correct problem. Reanalysis of samples analyzed while system was malfunctioning is mandatory	Analyst/Group Leader	Same as QC Acceptance Limits.

Worksheet No. 28: Analytical Quality Control and Corrective Action

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Surrogates	All field and QC samples.	QC acceptance criteria specified by the project, if available; otherwise DoD QSM Version 5.3 limits are used.	Correct problem, then reprep and reanalyze all failed samples for all surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.	Analyst/Group Leader	Same as QC Acceptance Limits.

Worksheet No. 28: Analytical Quality Control and Corrective Action

Matrix: Soil/Aqueous/TCLP
Analytical Group: Organics
Analytical Method/SOP: SVOCs 8270D

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Method Blank (MB)	One per preparatory batch of 20 or fewer samples of similar matrix.	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 regulatory limit, whichever is greater. Common contaminants must not be detected > LOQ	Correct problem. If required, reprep and reanalyze MB and all samples processed with the contaminated blank.	Analyst/Group Leader	Same as QC Acceptance Limits.
Laboratory Control Sample (LCS)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM LCS limits used if available. Otherwise, in-house control limits used for compounds not specified in QSM 5.3. In-house control limits may not be > ± 3 times standard deviation of the mean LCS recovery.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst/Group Leader	Same as QC Acceptance Limits.
Matrix Spike (MS)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM LCS limits used if available. Otherwise, in-house control limits used for compounds not specified in QSM 5.3. In-house control limits may not be > ± 3 times the standard deviation of the mean LCS recovery	Examine the project-specific requirements. Contact client as to additional measures to be taken. If MS results are outside limits, data shall be evaluated to determine source(s) of difference (i.e., matrix effect or analytical error)	Analyst/Group Leader	Same as QC Acceptance Limits.
Matrix Spike Duplicate (MSD) or Matrix Duplicate (MD)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM Version 5.3 LCS limits used for an MSD, if available. Otherwise, in-house control limits used for any compounds not specified in QSM 5.3. In-house control limits may not be greater than ± 3 times standard deviation of the mean LCS recovery. MSD or MD: RPD of all analytes ≤ 20% (between MS and MSD or sample & MD).	Examine the project-specified requirements. Contact client as to additional measures to be taken. The data shall be evaluated to determine the source of difference.	Analyst/Group Leader	Same as QC Acceptance Limits.
Internal Standards (IS)	Every field samples, standard and QC sample.	Retention time within ± 10 seconds from retention time of the midpoint standard in the ICAL; IS areas within -50% to +100% of ICAL midpoint standard.	Inspect mass spectrometer and GC for malfunctions and correct problem. Reanalysis of samples analyzed while system was malfunctioning is mandatory.	Analyst/Group Leader	Same as QC Acceptance Limits.

Worksheet No. 28: Analytical Quality Control and Corrective Action

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Surrogates	All field and QC samples.	QC acceptance criteria specified by the project, if available; otherwise DoD QSM Version 5.3 limits are used. .	Correct problem, reprep and reanalyze all failed samples for all surrogates in associated preparatory batch, if sufficient material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.	Analyst/Group Leader	Same as QC Acceptance Limits

Worksheet No. 28: Analytical Quality Control and Corrective Action

Matrix: Soil/Aqueous
Analytical Group: Organics
Analytical Method/SOP: Pesticides 8081B

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Method Blank (MB)	One per preparatory batch of 20 or fewer samples of similar matrix.	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Correct problem. If required, reprep and reanalyze MB and all samples processed with the contaminated blank.	Analyst/Group Leader	Same as QC Acceptance Limits.
Laboratory Control Sample (LCS)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM LCS limits used if available. Otherwise, in-house control limits used for compounds not specified in QSM 5.3. In-house control limits may not be > ± 3 times the standard deviation of the mean LCS recovery.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst/Group Leader	Same as QC Acceptance Limits.
Matrix Spike (MS)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM LCS limits used if available. Otherwise, in-house control limits used for compounds not specified in QSM 5.3. In-house control limits may not be > ± 3 times the standard deviation of the mean LCS recovery.	Examine the project-specific requirements. Contact the client as to additional measures to be taken. If MS results are outside limits, data shall be evaluated to determine source(s) of difference (i.e., matrix effect or analytical error).	Analyst/Group Leader	Same as QC Acceptance Limits.
Matrix Spike Duplicate (MSD) or Matrix Duplicate (MD)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM LCS limits are used for MSD, if available. Otherwise, in-house control limits are used for any compounds not specified in QSM 5.3. In-house control limits may not be > ± 3 times the standard deviation of the mean LCS recovery. MSD or MD: RPD of all analytes ≤ 30% (between MS & MSD or sample & MD).	Examine the project-specified requirements. Contact the client as to additional measures to be taken. The data shall be evaluated to determine the source of difference.	Analyst/Group Leader	Same as QC Acceptance Limits.
Surrogates	All field and QC samples.	QC acceptance criteria specified by the project, if available; otherwise DoD QSM Version 5.3 limits are used.	Correct problem, then reprep and reanalyze all failed samples for all surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.	Analyst/Group Leader	Same as QC Acceptance Limits.

Worksheet No. 28: Analytical Quality Control and Corrective Action

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Confirmation of positive results (second column)	All positive results must be confirmed (except for single column methods such as TPH by Method 8015 where confirmation is not an option or requirement)	Calibration and QC criteria for second column are the same as for initial or primary column analysis. Results between primary and secondary column RPD ≤ 40%.	N/A.	Analyst/Group Leader	Same as QC Acceptance Limits.

Worksheet No. 28: Analytical Quality Control and Corrective Action

Matrix: Soil/Aqueous
Analytical Group: Organics
Analytical Method/SOP: PCBs 8082A

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Method Blank (MB)	One per preparatory batch of 20 or fewer samples of similar matrix.	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Correct problem. If required, reprep and reanalyze MB and all samples processed with the contaminated blank.	Analyst/Group Leader	Same as QC Acceptance Limits.
Laboratory Control Sample (LCS)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM LCS limits used if available. Otherwise, in-house control limits used for compounds not specified in QSM 5.3. In-house control limits may not be > ± 3 times the standard deviation of the mean LCS recovery.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst/Group Leader	Same as QC Acceptance Limits.
Matrix Spike (MS)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM LCS limits used if available. Otherwise, in-house control limits used for compounds not specified in QSM 5.3. In-house control limits may not be > ± 3 times the standard deviation of the mean LCS recovery.	Examine the project-specific requirements. Contact the client as to additional measures to be taken. If MS results are outside limits, data shall be evaluated to determine source(s) of difference (i.e., matrix effect or analytical error).	Analyst/Group Leader	Same as QC Acceptance Limits.
Matrix Spike Duplicate (MSD) or Matrix Duplicate (MD)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM LCS limits are used for MSD, if available. Otherwise, in-house control limits are used for any compounds not specified in QSM 5.3. In-house control limits may not be > ± 3 times the standard deviation of the mean LCS recovery. MSD or MD: RPD of all analytes ≤ 30% (between MS & MSD or sample & MD).	Examine the project-specified requirements. Contact the client as to additional measures to be taken. The data shall be evaluated to determine the source of difference.	Analyst/Group Leader	Same as QC Acceptance Limits.
Surrogates	All field and QC samples.	QC acceptance criteria specified by the project, if available; otherwise DoD QSM Version 5.3 limits are used.	Correct problem, then reprep and reanalyze all failed samples for all surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.	Analyst/Group Leader	Same as QC Acceptance Limits.

Worksheet No. 28: Analytical Quality Control and Corrective Action

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Confirmation of positive results (second column)	All positive results must be confirmed (except for single column methods such as TPH by Method 8015 where confirmation is not an option or requirement)	Calibration and QC criteria for second column are the same as for initial or primary column analysis. Results between primary and secondary column RPD ≤ 40%.	N/A.	Analyst/Group Leader	Same as QC Acceptance Limits.

Worksheet No. 28: Analytical Quality Control and Corrective Action

Matrix: Soil/Aqueous
Analytical Group: Organics
Analytical Method/SOP: Explosives – 8330B

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Method Blank (MB)	One per preparatory batch of 20 or fewer samples of similar matrix.	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Correct problem. If required, reprep and reanalyze MB and all samples processed with the contaminated blank.	Analyst/Group Leader	Same as QC Acceptance Limits.
Laboratory Control Sample (LCS)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM LCS limits used if available. Otherwise, in-house control limits used for compounds not specified in QSM 5.3. In-house control limits may not be > ± 3 times the standard deviation of the mean LCS recovery.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst/Group Leader	Same as QC Acceptance Limits.
Matrix Spike (MS)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM LCS limits used if available. Otherwise, in-house control limits used for compounds not specified in QSM 5.3. In-house control limits may not be > ± 3 times the standard deviation of the mean LCS recovery.	Examine the project-specific requirements. Contact the client as to additional measures to be taken. If MS results are outside limits, data shall be evaluated to determine source(s) of difference (i.e., matrix effect or analytical error).	Analyst/Group Leader	Same as QC Acceptance Limits.
Matrix Spike Duplicate (MSD) or Matrix Duplicate (MD)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM LCS limits are used for MSD, if available. Otherwise, in-house control limits are used for any compounds not specified in QSM 5.3. In-house control limits may not be > ± 3 times the standard deviation of the mean LCS recovery. MSD or MD: RPD of all analytes ≤ 30% (between MS & MSD or sample & MD).	Examine the project-specified requirements. Contact the client as to additional measures to be taken. The data shall be evaluated to determine the source of difference.	Analyst/Group Leader	Same as QC Acceptance Limits.
Surrogates	All field and QC samples.	QC acceptance criteria specified by the project, if available; otherwise DoD QSM Version 5.3 limits are used.	Correct problem, then reprep and reanalyze all failed samples for all surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.	Analyst/Group Leader	Same as QC Acceptance Limits.

Worksheet No. 28: Analytical Quality Control and Corrective Action

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Confirmation of positive results (second column)	All positive results must be confirmed (except for single column methods such as Thiodiglycol where confirmation is not an option or requirement)	Calibration and QC criteria for second column are the same as for initial or primary column analysis. Results between primary and secondary column RPD ≤ 40%.	N/A.	Analyst/Group Leader	Same as QC Acceptance Limits.

Worksheet No. 28: Analytical Quality Control and Corrective Action

Matrix: Soil/Aqueous/TCLP
Analytical Group: Organics
Analytical Method/SOP: Metals 6010C/7471B

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Method Blank (MB)	One per preparatory batch of 20 or fewer samples of similar matrix.	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Correct problem. If required, reprep and reanalyze MB and all samples processed with the contaminated blank.	Analyst/ Supervisor	Same as QC Acceptance Limits.
Laboratory Control Sample (LCS)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM LCS limits used, if available. Otherwise, in-house control limits used for compounds not specified in QSM 5.3. In-house control limits may not be > ± 3 times the standard deviation of the mean LCS recovery	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst/ Supervisor	Same as QC Acceptance Limits.
Matrix Spike (MS)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM LCS limits are used, if available. Otherwise, in-house control limits are used for any compounds not specified in QSM 5.3. In-house control limits may not be > ± 3 times the standard deviation of the mean LCS recovery	Examine project-specific requirements. Contact client as to additional measures to be taken. If MS results are outside limits, data shall be evaluated to determine source(s) of difference (i.e. matrix effect or analytical error)	Analyst/Supervisor	Same as QC Acceptance Limits.
Matrix Spike Duplicate (MSD) or Matrix Duplicate (MD)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM LCS limits used for an MSD, if available. Otherwise, in-house control limits used for any compounds not specified in QSM 5.3. In-house control limits may not be > ± 3 times standard deviation of the mean LCS recovery. MSD or MD: RPD of all analytes ≤ 20% (between MS & MSD or sample & MD).	Examine project-specified requirements. Contact client as to additional measures to be taken. The data shall be evaluated to determine the source of difference.	Analyst/Supervisor	Same as QC Acceptance Limits.
Dilution Test (Serial Dilution)	One per preparatory batch of 20 or fewer samples of similar matrix if MS or MSD fails.	Five-fold dilution must agree within ± 10% of the original measurement. Only applicable for samples with concentrations > 50 x LOQ (prior to dilution).	No specific CA, unless required by the project.	Analyst/Supervisor	Same as QC Acceptance Limits.
Post-Digestion	Perform if MS/MSD fails.	Recovery within 80-120%.	No specific CA, unless required by the project.	Analyst/Supervisor	Same as QC Acceptance Limits.

Worksheet No. 28: Analytical Quality Control and Corrective Action

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Spike (PDS) Addition	One per preparatory batch (using the same sample as used for the MS/MSD if possible) of 20 or fewer samples of similar matrix.				

Worksheet No. 28: Analytical Quality Control and Corrective Action

Matrix: Soil/Aqueous/SPLP
Analytical Group: Perchlorates
Analytical Method/SOP: 6850

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Method Blank (MB)	One per preparatory batch of 20 or fewer samples of similar matrix.	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Correct problem. If required, reprep and reanalyze MB and all samples processed with the contaminated blank.	Analyst/ Supervisor	Same as QC Acceptance Limits.
Laboratory Control Sample (LCS)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM LCS limits used, if available. Otherwise, in-house control limits used for compounds not specified in QSM 5.3. In-house control limits may not be > ± 3 times the standard deviation of the mean LCS recovery	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst/ Supervisor	Same as QC Acceptance Limits.
Matrix Spike (MS)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM LCS limits are used, if available. Otherwise, in-house control limits are used for any compounds not specified in QSM 5.3. In-house control limits may not be > ± 3 times the standard deviation of the mean LCS recovery	Examine project-specific requirements. Contact client as to additional measures to be taken. If MS results are outside limits, data shall be evaluated to determine source(s) of difference (i.e. matrix effect or analytical error)	Analyst/Supervisor	Same as QC Acceptance Limits.
Matrix Spike Duplicate (MSD) or Matrix Duplicate (MD)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM LCS limits used for an MSD, if available. Otherwise, in-house control limits used for any compounds not specified in QSM 5.3. In-house control limits may not be > ± 3 times standard deviation of the mean LCS recovery. MSD or MD: RPD of all analytes ≤ 20% (between MS & MSD or sample & MD).	Examine project-specified requirements. Contact client as to additional measures to be taken. The data shall be evaluated to determine the source of difference.	Analyst/Supervisor	Same as QC Acceptance Limits.
Internal Standards (IS)	Every sample	Measured 18O IS area within +50% of the value from the avg of the IS area counts of the ICAL. RRT of perchlorate ion must be 1.0+2% (0.98-1.02) (prior to dilution).	Reanalyze sample at increasing dilutions until +50% acceptance criteria met. If not met, reprep samples.	Analyst/Supervisor	Measured 18O IS area within +50% of the value from the avg of the IS area counts of the ICAL. RRT of perchlorate ion must be 1.0+2% (0.98-1.02)

Worksheet No. 28: Analytical Quality Control and Corrective Action

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Isotope Ratio 35CL / 37CL	Every sample	Monitor for either parent ion at masses 99/101 or daughter ion at masses 83/85 depending on which ions are quantitated. Theoretical ratio ~ 3.06. Must fall within 2.3 to 2.8.	Sample must be reanalyzed.	Analyst/Supervisor	Monitor for either parent ion at masses 99/101 or daughter ion at masses 83/85 depending on which ions are quantitated. Theoretical ratio ~ 3.06. Must fall within 2.3 to 2.8.
Limit of detection verification (LODV)	One per batch of 20 samples	Within + 30% of true value.	Correct problem. Rerun LODV and all samples since last successful LODV.	Analyst/Supervisor	Within + 30% of true value.

DoD – U.S. Department of Defense.
ICAL – Internal calibration.
IS – Internal standard.
LCS – Laboratory control sample.
LODV – Limits of detection verification.
LOQ – Limit of quantification.
MB – Method blank.
MD – Matrix duplicate.
MS – Matrix spike.
MSD – Matrix spike duplicate.
QC – Quality control.
QSM - Quality systems manual.

Worksheet No. 29: Project Documents and Records

The following list represents the anticipated documents and records that will be prepared during the course of corrective measures. This list may not be all inclusive and will be revised with additions and deletions for each document prepared for the site-specific task. At the conclusion of the list, information is provided that describes records management and the procedure for obtaining additional detailed information.

Sample Collection Documents and Records	On-Site Analysis Documents and Records	Off-Site Analysis Documents and Records	Data Assessment Documents and Records	Health and Safety
CMI Work Plan	Field Activity Daily Log	APTIM AR/COC	Data Review Checklist, Metals	Accident Prevention Plan
Field Activity Daily Log	Sample Collection Log	Laboratory SDG Report	QCSR	Project-specific Safety and Health Plan
Sample Collection Log	Air Monitoring Data	Preliminary Data and Draft Analytical Reports	Telephone Logs	Project Environmental Safety and Health Plan and Sign-off Sheet
Sample logging and tracking software	Equipment Calibration Receipt	Sample Receipt Forms	Corrective Action Reports	Munitions and Explosives of Concern Guidance for Environmental and Construction Activities
AR/COC	Equipment Calibration Logs	Data Validation Reports	Laboratory QA Plan	Daily Safety Meeting
Drum/Container Sampling Log	Visual Classification – Soil	Final Data Packages and Final Analytical Report	Environmental Laboratory Accreditation Program	Daily Activity Hazard Analysis
Drum/Container Inventory Log	Photo Documentation and Tracking Log	Electronic Data Deliverables		Equipment Calibration Receipt
Sampling Reports	Daily Construction Log			Equipment Calibration Logs
Variance Request				Health and Safety Activity Reports and Documentation
				Training Records
				Accident Reports
				Lessons Learned

Worksheet No. 29: Project Documents and Records

Administrative	Permits	Quality	Project Management	Technical
Memos	Excavation Permits	Management Assessment Reports – Internal	Project Schedule	Corrective Measures Implementation Work Plan
Incoming Correspondence	Right-of-Entry Permits	Independent Assessment Reports – Internal	Project Budget	Decision Documents
Outgoing Correspondence	Construction Permits	Receipt Inspection Checklist	Work Breakdown Structure	Project Reports
Correspondence from Others	Overhead Utility Clearance Permit	Preparatory Inspection Checklist	Contract Change Request	Surveys
Telephone Conversation Logs	Underground Utility Clearance Permit	Initial Inspection Checklist	Project Activity Reports	Drawings and Checklists/Check Prints
Meeting Notes – Internal	Underground Utility Variance	Follow-up Inspection Checklist	Project Summary/Status Report	As-Built Drawings
Meeting Notes – External		Nonconformance Report and Tracking Log	Invoices	Corrective Measures Reports
Project Related Emails		Variance Report and Tracking Log	Insurance	Operation and Maintenance Manuals
		Site QC Reports		

AR/COC – Analysis Request/Chain of Custody.
CMI – Corrective measures implementation.
PCB – Polychlorinated biphenyl.
QA – Quality assurance.
QC – Quality control.
QCSR – Quality control summary report.
SDG - Sample delivery group.

Record-Keeping, Archival, and Retrieval Requirements

Record-keeping, archival, and retrieval requirements will be conducted in accordance with APTIM's SOPs.

Field Records Generation

Field records generation will be in accordance with APTIM's SOPs.

Worksheet No. 29: Project Documents and Records

Record Archival and Retrieval Procedures for Field Information

Record archival and retrieval procedures for field information will be specified in APTIM's SOPs.

Location of Study Records, Reports, and Formal Documents

Program Repository. The program repository will be maintained in accordance with APTIM's SOPs and Army contractual requirements.

Administrative Record. The Administrative Record will be maintained in accordance with APTIM's SOPs and Army contractual requirements.

Record Retention Time Procedures

At the close of this delivery order, all documents and records will be managed in accordance with contractual requirements which specify that records be transferred to the Army.

Note: The Office of Information Resource Management requirements are not applicable to this project since RSA is not a fund-led site.

Additional Record-Keeping, Archival, and Retrieval Procedures for Electronic Data

Additional record-keeping, archival, and retrieval procedures for electronic data will be conducted in accordance with APTIM's SOPs.

Data Handling Equipment and Data Compiling and Analysis

Laboratory analytical data will be processed in a manner that ensures project requirements are being met. Data handling equipment and data compiling and analysis will be in accordance with APTIM's SOPs.

Computer Hardware and Software

APTIM will provide hardware and software commensurate with contract specifications for this project.

As the data is made available for usability, APTIM will utilize various software packages to determine if the data quality objectives have been met and to map, analyze, and disseminate spatial data.

Ensuring Database Accuracy

APTIM will ensure database accuracy in accordance with the project contract.

Worksheet No. 30: Analytical Services Table

Matrix	Analytical Group	Sample Locations/ ID Numbers[1]	Analytical SOP	Data Package Turnaround Time	Laboratory/Organization (Name and Address, Contact Person and Telephone Number) [(4)]	Backup Laboratory/Organization (Name and Address, Contact Person and Telephone Number)
Soil	Metals - TAL Metals		MT012 Rev 10.1 / MT009 Rev 5.3	21 calendar days	CT Laboratories LLC Eric Korthals, Project Manager 1230 Lange Court Baraboo, WI 53913 608.356.2760	CT Laboratories LLC Ceress Berwanger, President 1230 Lange Court Baraboo, WI 53913 608.356.2760
Soil	Volatiles - VOCs		VO004 Rev 3	21 calendar days	CT Laboratories LLC Eric Korthals, Project Manager 1230 Lange Court Baraboo, WI 53913 608.356.2760	CT Laboratories LLC Ceress Berwanger, President 1230 Lange Court Baraboo, WI 53913 608.356.2760
Soil	SVOC - SVOCs		SV006 Rev 0 / SV007 Rev 1.0	21 calendar days	CT Laboratories LLC Eric Korthals, Project Manager 1230 Lange Court Baraboo, WI 53913 608.356.2760	CT Laboratories LLC Ceress Berwanger, President 1230 Lange Court Baraboo, WI 53913 608.356.2760
Soil	SVOC - Pesticides		SV002 Rev 9	21 calendar days	CT Laboratories LLC Eric Korthals, Project Manager 1230 Lange Court Baraboo, WI 53913 608.356.2760	CT Laboratories LLC Ceress Berwanger, President 1230 Lange Court Baraboo, WI 53913 608.356.2760
Soil	SVOC - PCBs		SV004 Rev 11	21 calendar days	CT Laboratories LLC Eric Korthals, Project Manager 1230 Lange Court Baraboo, WI 53913 608.356.2760	CT Laboratories LLC Ceress Berwanger, President 1230 Lange Court Baraboo, WI 53913 608.356.2760
Water	SVOC-Explosive		SV010 Rev 5.1	21 calendar days	CT Laboratories LLC Eric Korthals, Project Manager 1230 Lange Court Baraboo, WI 53913 608.356.2760	CT Laboratories LLC Ceress Berwanger, President 1230 Lange Court Baraboo, WI 53913 608.356.2760
Soil	Perchlorates		HPLC06 Rev 8	21 calendar days	Microbac Laboratories Stephanie Mossberg, Project Manager 158 Starlite Drive Marietta, OH 45750 740.373.4071	Microbac Laboratories Jacqueline Parsons, Project Manager 158 Starlite Drive Marietta, OH 45750 740.373.4071

Worksheet Nos. 31, 32, and 33: Assessments and Corrective Action

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment (Title and Organizational Affiliation)	Person(s) Responsible for Responding to Assessment Findings (Title and Organizational Affiliation)	Person(s) Responsible for Identifying and Implementing Corrective Actions (CA) (Title and Organizational Affiliation)	Person(s) Responsible for Monitoring Effectiveness of CA (Title and Organizational Affiliation)
Management Assessments	Based on project management request	Internal	APTIM	Don Burton, Project Manager, APTIM	Don Burton, Project Manager, APTIM	Don Burton, Project Manager, APTIM	Don Burton, Project Manager, APTIM
Independent Assessments	Based on project management request	External	TBD	TBD	Don Burton, Project Manager, APTIM	Don Burton, Project Manager, APTIM	Don Burton, Project Manager, APTIM
Receipt Inspections	As required	Internal	APTIM	Brian Rhodes, Quality Control Site Manager (QCSM), APTIM	Don Burton, Project Manager, APTIM	Don Burton, Project Manager, APTIM	Don Burton, Project Manager, APTIM
Laboratory Audits and Inspections	Every two years (in accordance with U.S. Department of Defense [DoD] Environmental Laboratory Accreditation Program [ELAP] requirements) if determined necessary to confirm DoD ELAP accreditation audits or for other reasons	External	TBD	Don Burton, Project Manager, APTIM or designee	CT Lab Project Manager Eric Korthals	CT Lab Project Manager Eric Korthals	Vicki Graves, Project Chemist, APTIM
Quality Control Summary Report	Each analytical definable feature of work	Internal	APTIM	Vicki Graves, Project Chemist, APTIM	Not applicable (NA)	NA	NA

Worksheet Nos. 31, 32, and 33: Assessments and Corrective Action

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment (Title and Organizational Affiliation)	Person(s) Responsible for Responding to Assessment Findings (Title and Organizational Affiliation)	Person(s) Responsible for Identifying and Implementing Corrective Actions (CA) (Title and Organizational Affiliation)	Person(s) Responsible for Monitoring Effectiveness of CA (Title and Organizational Affiliation)
Field Inspections	Annually	Internal	Army	Bob Gorman, Site Manager, RSA, Dr. Heather McDonald, PE, Technical Manager, CEHNC or designees	Bob Gorman, Site Manager, RSA, Dr. Heather McDonald, PE, Technical Manager, CEHNC or designees	Bob Gorman, Site Manager, RSA, Dr. Heather McDonald, PE, Technical Manager, CEHNC or designees	Bob Gorman, Site Manager, RSA, Dr. Heather McDonald, PE, Technical Manager, CEHNC or designees
Preparatory Inspections/ meetings	Task kick-off	Internal	APTIM/Army	Don Burton, Project Manager, APTIM, Brian Rhodes, QCSM, APTIM, Bob Gorman, Site Manager, RSA, Dr. Heather McDonald, PE, Technical Manager, CEHNC	Don Burton, Project Manager, APTIM	Brian Rhodes, QCSM, APTIM	Don Burton, Project Manager, APTIM
Initial Inspections	Task as required	Internal	APTIM/Army	Don Burton, Project Manager, APTIM, Brian Rhodes, QCSM, APTIM, Bob Gorman, Site Manager, RSA, Dr, Heather McDonald, PE, Technical Manager, CEHNC	Don Burton, Project Manager, APTIM	Brian Rhodes, QCSM, APTIM	Don Burton, Project Manager, APTIM

Worksheet Nos. 31, 32, and 33: Assessments and Corrective Action

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment (Title and Organizational Affiliation)	Person(s) Responsible for Responding to Assessment Findings (Title and Organizational Affiliation)	Person(s) Responsible for Identifying and Implementing Corrective Actions (CA) (Title and Organizational Affiliation)	Person(s) Responsible for Monitoring Effectiveness of CA (Title and Organizational Affiliation)
Follow-Up Inspections	Task as required	Internal	APTIM/Army	Don Burton, Project Manager, APTIM, Brian Rhodes, QCSM, APTIM, Bob Gorman, Site Manager, RSA, Dr. Heather McDonald, PE, Technical Manager, CEHNC	Don Burton, Project Manager, APTIM	Brian Rhodes, QCSM, APTIM	Don Burton, Project Manager, APTIM
Final Inspections	Task completion	Internal	APTIM/Army	Don Burton, Project Manager, APTIM, Brian Rhodes, QCSM, APTIM, Bob Gorman, Site Manager, RSA, Dr. Heather McDonald, PE, Technical Manager, CEHNC	Don Burton, Project Manager, APTIM	Brian Rhodes, QCSM, APTIM	Don Burton, Project Manager, APTIM

TBD – To be determined.

Worksheet Nos. 31, 32, and 33: Assessments and Corrective Action

Table 31-1 Guidance on Audits and Inspections

Assessment and Audit Frequency
Technical inspections and assessments shall be conducted during initial stages of fieldwork to identify and correct problems as quickly as possible. Independent assessments will be performed in response to project management requests. Laboratory audits may be conducted by the APTIM personnel every two years in accordance with the frequency required by the U.S. Department of Defense (DoD) Environmental Laboratory Accreditation Program (ELAP) if they are deemed necessary to confirm DoD ELAP accreditation audits. More frequent audits may be deemed necessary based on laboratory data quality performance, reporting, or other related issues that could arise over the course of the contract. The laboratory audit will include all sample analysis procedures that will be performed by the laboratory being audited. The Quality Assurance (QA) Manager or Project Manager (PM) may conduct audits at a greater frequency than indicated in Worksheet No. 31. Successful DoD ELAP audits are needed to demonstrate environmental testing laboratories are compliant with the DoD Quality Systems Manual, Version 5.3 (DoD, 2019) or the most current version.

Management Assessments and Independent Assessments
Management assessments and independent assessments may be used to review sample collection, handling, analysis, and documentation procedures. Assessment results are used to evaluate a system's ability to produce data that fulfill program objectives and to identify any areas requiring corrective actions (CA). Inspections are routine qualitative reviews of the overall sampling or measurement system or may have a narrow focus, such as a follow-up inspection, while assessments provide an overall examination of the measurement system.

Assessment and inspection records are reviewed by the QA Manager or designated staff to determine whether data will fulfill the program objectives. Additional inspections or reviews for designated methods may be conducted, or additional information may be requested if data quality problems are indicated.

Management Assessments
Management assessments may be conducted at the request of the Site Operations Manager, PM, or other employees in management authority. Management assessments are informal reviews of work progress, functionality, adherence to policies and procedures, compliance with requirements, or effectiveness of implementation. They provide the basis for follow-up inspections or independent assessments whenever deficiencies are indicated. All observations are documented, and any recommendations or CAs are submitted to the QA Manager for tracking, implementation, additional review (if required) and completion.

Independent Assessments
Independent assessments may be conducted at the request of the PM or by personnel who have the authority and organizational independence to provide an unbiased review of the system or procedure. When performed, a detailed checklist will be used for each procedure or system reviewed and will contain items that delineate the critical aspects of the procedure under review. All observations are documented, and the checklist is submitted with a written assessment and recommendations to the QA Manager, PM, Army Contracting Officer's Representative (COR), representatives of the audited organization, and others as appropriate. The information and any CA documentation also will be summarized and included in program reports.

Worksheet Nos. 31, 32, and 33: Assessments and Corrective Action

Field Inspections

The field inspections are on-site, qualitative reviews of a sampling or analysis system. Inspections are conducted, preferably at the beginning of the sampling task, by the Project Manager or designee, field lead, or a designated qualified technical staff member who has the authority to act independently of the project staff. Critical items for field inspections include:

- Calibration procedures and documentation for field instruments
- Documentation in field logbooks and on sampling data sheets
- Document control
- Equipment decontamination procedures
- Sample collection, storage, and transportation procedures
- Chain-of-custody procedures for sample documentation and for transfer to a laboratory
- Work instructions.

The checklist for each inspection will contain detailed questions regarding the critical items requiring yes/no answers and comments. A debriefing session will be held for all participants to discuss any inspection results and to discuss any required CA. The reviewer then completes the inspection and submits a report, including observations of strengths and deficiencies and any recommendations for improvements. Detailed checklists will be provided for each final version of the site-specific field sampling plans.

Inspections for Field Activities

Inspections will be performed on materials or services to determine compliance with contractual, planning, and other requirements. Criteria will be established prior to the inspection and will be based on project specifications, requirements, code specifications, and product acceptability and conducted in accordance with the SOPs. Acceptance criteria will be adequate for the activity and will be verified during inspection activities. Inspection may be performed and verified through visual observation, measurement of materials or equipment, examination of documentation/certification, evaluation of performance, or testing. Inspection forms must be developed based on the definable features of work described in the CMI work plan.

Inspections may be performed using the three-phase inspection method. The preparatory inspections will be performed prior to start-up and will examine training, procedures, equipment and materials, work plans and documents, and overall readiness to perform work. Initial inspections will be performed when work begins on a particular feature of work and will include an examination of the quality of workmanship and a review of control testing for compliance with contract and work plan requirements. Follow-up inspections will be performed to verify compliance with procedures and will ensure the continuation of quality and safety standards established during preparatory and initial inspections until completion of the definable work feature. Final follow-up inspections will be conducted at the completion of each task. Participants in this inspection may include QA (U.S. Army Garrison-Redstone and CEHNC) and QC (APTIM). The final follow-up inspection will be performed to ensure that the completed feature of work meets contract requirements. Any deficiencies noted during this inspection will be documented, and a determination will be made as to the CAs that may be necessary to mitigate the deficiency. All significant deficiencies must be corrected prior to turnover.

Records of inspections will be maintained in the project files. At a minimum, inspection files will include inspection reports/checklists, inspection responses, any supporting documents, and applicable client comments.

Worksheet Nos. 31, 32, and 33: Assessments and Corrective Action

Receipt Inspections
Standard APTIM procurement procedures will be used to obtain supplies and consumables. These procedures are initiated by the task manager, field coordinator, or other technical lead personnel and then forwarded to project management and procurement personnel for approval and supplier contact. In the request for supplies, the requestor must provide specifications of the material, including any required certifications of purity or QC level. Sample supplies and consumables must be inspected upon receipt to verify that they meet these specifications and that any required manufacturer's documentation is present and retained for the APTIM project files in accordance with the SOPs. Any damaged, unsealed, or used equipment (unless adequately cleaned and returned to service) will not be accepted.

For items that may come in contact with the sampled matrix or sampling device, assurances should be made, through adequate receipt inspection, that such materials are not contaminated. They must remain sealed or be adequately decontaminated before field use. Examples include decontamination water, chemical reagents, in-line water filters, sample bottles and jars, sampling probes/instruments, bailers, soil spoons, or augers.

Performance and System Audits
Scheduled project/laboratory audits will be performed, as project activities allow, to review and evaluate the adequacy of field activities and laboratory performance and to ascertain if the QAPP is being completely and uniformly implemented. The Project Manager or designee is responsible for requesting and establishing an audit team. Biennial audits may be supplemented by additional audits for one or more of the following reasons:

- Significant changes are made in field or laboratory protocols.
- It is necessary to verify that a CA has been taken on a nonconformance reported in a previous audit.
- Audit is requested by the PM.

The objectives of performance and systems audits are 1) to verify that the QAPP developed for this project is being implemented according to the specified requirements, 2) to assess the effectiveness of the plan, 3) to identify nonconformances, and 4) to verify that identified deficiencies are corrected. Upon discovery of any significant deviation from the QAPP, the Project Chemist and Project Manager or designee shall be informed of the nature and extent of the deviation. A nonconformance will be documented and a CA will be taken to remedy the deviation.

Assessment Findings and Corrective Action
All observations and assessment findings will be documented, and the checklist will be submitted with a written assessment and recommendations, including any required or recommended CAs to the Project Manager or designee, PM, CEHNC COR, representatives of the audited organization, and others as appropriate. The information and any CA documentation also will be summarized and included in program reports. The U.S. Environmental Protection Agency and other regulatory agencies shall be notified of any significant CAs by the U.S. Army Garrison-Redstone.

References:

U.S. Department of Defense (DoD), 2019, ***Quality Systems Manual for Environmental Laboratories***, Version 5.3 or most current version.

Worksheet Nos. 31, 32, and 33: Assessments and Corrective Action

Table 31-1 Guidance on Audits and Inspections (continued)

Nonconformance Documentation
Complex field investigation, remediation, sampling, and analysis tasks are sometimes subject to nonconformances. A nonconformance is defined as an unplanned deviation that occurs during the implementation of a task that cannot usually be corrected until after it has occurred. Nonconformance activities may include using unapproved methods, not following procedures specified in the QAPP or CMI work plan or substituting unapproved materials or equipment to perform an activity. Nonconforming supplies may also include suspect and counterfeit items. All nonconformance activities and/or material must go through a cycle of being identified, documented, assessed, corrected, and reported in accordance with APTIM's nonconformance procedure. The steps described in APTIM's guidelines are critical in handling nonconformances as they are encountered.

The identification of a nonconformance is the responsibility of every person assigned to the project. This responsibility is incorporated into each person's understanding of his or her tasks, as assigned by the supervisor or task leader, and each person's function on the project. As individuals perform their duties on the project, they must constantly be aware of the scope of the activity and recognize when a deviation from the planned activity has occurred or is occurring. After recognizing the deviation, they must take action by informing the Project Manager and documenting in writing (using the Nonconformance Report [NCR] form) the specifics of what occurred. The site Quality Control (QC) Officer will maintain a status log of open and closed nonconformances. The log will also serve as the basis for numbering each discrepancy and tracking it through closure.

Satisfactory resolution of nonconformances must be verified by the site QC Officer. Nonconformances are not to be closed until the required corrective and preventative actions have been completed to the satisfaction of the site QC Officer or until long-term CAs have been established and implemented. Nonconformances will be monitored until the action is verified as complete and closed as documented on the NCR.

Nonconformances and associated documentation will be documented in the project file and referenced and discussed in the final task report.

Variance Documentation
Variances are similar to nonconformances with respect to how they are defined, resolved, and documented. The primary difference is the timing of the occurrence of the deviation. A variance can be identified prior to implementation of a task, while a nonconformance is generally not identified until the task is in progress or complete. Therefore, with a variance, alternative techniques, modified methods, or a change in task and data quality objectives can be considered. Substitute data, alternate success criteria, or even the deletion of data points may be contemplated after gathering information on the reason for the deviation and examining the intended use of the data as planned. Project variances will be subject to the same stepwise process of identification, documentation, assessment, correction, and reporting as nonconformances.

The project variance ensures key information is recorded by the personnel who identify variances, review the documentation, assess the impact on task objectives, and consider alternative strategies for corrective action.

Variances will be documented in the project file and will be referenced and discussed in the final task report.

Worksheet Nos. 31, 32, and 33: Assessments and Corrective Action

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, Organization)	Time Frame of Notification [1]	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title, Organization) [2]	Time Frame for Response
Management Assessments	Nonconformance Report (NCR)[3, 4]	Steve Moran, Program Manager, APTIM; Don Burton, Project Manager, APTIM; Dennis Seymore, Senior Scientist and Site Technical Lead, APTIM	5 Days	Corrective Action Request (CAR)	Steve Moran, Program Manager, APTIM; Don Burton, Project Manager, APTIM; Dennis Seymore, Senior Scientist and Site Technical Lead, APTIM	30 Days
Independent Assessments	NCR[3, 4]	Don Burton, Project Manager, APTIM; Tricia Felt, Corporate Quality Assurance (QA)/Quality Control (QC) Director, APTIM; Dennis Seymore, Senior Scientist and Site Technical Lead, APTIM	5 Days	CAR	Steve Moran, Program Manager, APTIM; Don Burton, Project Manager, APTIM	30 Days
Receipt Inspections	NCR[3, 4]	Dennis Seymore, Senior Scientist and Site Technical Lead, APTIM; Brian Rhodes, Quality Control Site Manager (QCSM), APTIM; Tricia Felt, Corporate Quality Management Director, APTIM	Not Applicable (NA)	Item will be rejected and returned to vendor, repaired, or used as-is.	Don Burton, Project Manager, APTIM; Tricia Felt, Corporate Quality Management Director, APTIM; Brian Rhodes, QCSM, APTIM; Dennis Seymore, Senior Scientist and Site Technical Lead, APTIM	NA
Laboratory Audits and Inspections	NCR[3, 4]	Steve Moran, Program Manager, APTIM; Don Burton, Project Manager, APTIM	NA	CAR	Don Burton, Project Manager, APTIM; Brian Rhodes, QCSM, APTIM; Vicki Graves, Project Chemist, APTIM; Tricia Felt, Corporate Quality Management Director, APTIM	NA
Quality Control Summary Report (QCSR)	QCSR	Vicki Graves, Project Chemist, APTIM; APTIM Data Users	NA	NA	NA	NA

Worksheet Nos. 31, 32, and 33: Assessments and Corrective Action

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, Organization)	Time Frame of Notification [1]	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title, Organization) [2]	Time Frame for Response
Field Inspections	NCR[3, 4]	Dennis Seymore, Senior Scientist and Site Technical Lead, APTIM; Don Burton, Project Manager, APTIM; Brian Rhodes, QCSM, APTIM; Tricia Felt, Corporate Quality Management Director, APTIM	NA	CAR	Don Burton, Project Manager, APTIM; Brian Rhodes, QCSM, APTIM; Tricia Felt, Corporate Quality Management Director, APTIM	NA
Preparatory Inspections/ Meetings	NA (Preparatory Inspection is a meeting to determine if all parties are prepared for task)	Don Burton, Project Manager, APTIM; Brian Rhodes, QCSM, APTIM; Dennis Seymore, Senior Scientist and Site Technical Lead, APTIM	NA	NA	NA	NA
Initial Inspection	NCR[3, 4]	Don Burton, Project Manager, APTIM; Tricia Felt, Corporate Quality Management Director, APTIM; Brian Rhodes, QCSM, APTIM; Dennis Seymore, Senior Scientist and Site Technical Lead, APTIM	5 days	CAR, based on the severity of the nonconforming action, service, or item.	Steve Moran, Program Manager, APTIM; Don Burton, Project Manager, APTIM; Tricia Felt, Corporate Quality Management Director, APTIM	30 days
Follow-up Inspections	NCR[3, 4]	Don Burton, Project Manager, APTIM; Tricia Felt, Corporate Quality Management Director, APTIM; Brian Rhodes, QCSM, APTIM; Dennis Seymore, Senior Scientist and Site Technical Lead, APTIM	5 days	CAR, based on the severity of the nonconforming action, service, or item.	Steve Moran, Program Manager, APTIM; Don Burton, Project Manager, APTIM; Tricia Felt, Corporate Quality Management Director, APTIM	30 days
Final Inspections	NCR[3, 4]	Dennis Seymore, Senior Scientist and Site Technical Lead, APTIM; Don Burton, Project Manager, APTIM; Brian Rhodes, QCSM, APTIM; Tricia Felt, Corporate Quality Management Director, APTIM	5 days	CAR, based on the severity of the nonconforming action, service, or item.	Steve Moran, Program Manager, APTIM; Don Burton, Project Manager, APTIM; Tricia Felt, Corporate Quality Management Director, APTIM	30 days

[1] If a nonconforming item or activity is of a nature severe enough to affect the project scope, cost, safety, or the environment, project management shall be notified immediately. An NCR shall be issued within 48 hours following the identification.

[2] The name of individuals(s) receiving the corrective action response will be based on the nature of the CAR or severity of the deviation and the availability of the subject matter expert.

Note: EPA and ADEM will be notified of significant corrective actions.

Worksheet Nos. 31, 32, and 33: Assessments and Corrective Action

[3] Copies of all NCRs need to be directed to the APTIM Project Manager and APTIM Corporate Quality Management Director, depending upon the severity of the nonconforming action or item.

[4] Nonconformance reporting will be conducted in accordance with APTIM's guidelines which establish the system for initiating, processing, and controlling nonconforming items, services, or activities to include disposition and CAs.

Worksheet Nos. 31, 32, and 33: Assessments and Corrective Action

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (Title and Organizational Affiliation)	Report Recipient(s) (Title and Organizational Affiliation)
Field Activity Daily Log	Daily	Daily	Dennis Seymore, Senior Scientist and Site Technical Lead, APTIM or Brian Rhodes, QCSM, APTIM	Tricia Felt, Corporate Quality Management Director or Designee, APTIM
Daily Construction QC Report- Subcontracted	Daily	Daily	Dennis Seymore, Senior Scientist and Site Technical Lead, APTIM or Brian Rhodes, QCSM, APTIM	Tricia Felt, Corporate Quality Management Director or Designee, APTIM
Daily Construction QC Report- Self Performed	Daily	Daily	Dennis Seymore, Senior Scientist and Site Technical Lead, APTIM or Brian Rhodes, QCSM, APTIM	Government entity to be determined for specific sites as described in Document Submission Requirements and Distribution Procedures, Rev. 57
Weekly Construction QC Report	Weekly	Weekly	Dennis Seymore, Senior Scientist and Site Technical Lead, APTIM or Brian Rhodes, QCSM, APTIM	Don Burton, Project Manager, APTIM and other staff as designated by the Project Manager
RSA Small Working Group Teleconference	Weekly	Not applicable	Don Burton, Project Manager, APTIM	Small working group
Laboratory QA Audit Report	Once every two years if determined necessary to confirm DoD ELAP accreditation audits or as required by situation or circumstance	No later than 30 days after the audit	Tricia Felt, Corporate Quality Management Director, APTIM or Designee	Don Burton, Project Manager, APTIM
Laboratory QA Report	When significant plan deviations result from unanticipated circumstances	Immediately	Eric Korthals, CT Laboratories, LLC Project Manager	Vicki Graves, Project Chemist, APTIM; Don Burton, Project Manager, APTIM
Three Phase Inspection Checklist	As needed	As needed	Dennis Seymore, Senior Scientist and Site Technical Lead, APTIM or Brian Rhodes, QCSM, APTIM	Tricia Felt, Corporate Quality Management Director, APTIM; Project Central Files

Worksheet Nos. 31, 32, and 33: Assessments and Corrective Action

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (Title and Organizational Affiliation)	Report Recipient(s) (Title and Organizational Affiliation)
Readiness Review checklist	Completed prior to each field effort	A minimum of two weeks prior to start of field work	Don Burton, Project Manager, APTIM or Designee	Tricia Felt, Corporate Quality Management Director, APTIM
Field Variance	As needed	Prior to executing the definable feature of work	Responsible Party Bob Gorman, Army POC Dennis Seymore, Senior Scientist and Site Technical Lead, APTIM; Don Burton, Project Manager, APTIM; Subject Matter Expert as needed	Don Burton, Project Manager, APTIM and other staff as designated by the Project Manager; Tricia Felt, Corporate Quality Management Director, APTIM; Project Central Files
Nonconformance Report	As needed	As needed	Responsible Party Dennis Seymore, Senior Scientist and Site Technical Lead, APTIM Don Burton, Project Manager, APTIM Subject Matter Expert as needed	Don Burton, Project Manager, APTIM and other staff as designated by the Project Manager; Tricia Felt, Corporate Quality Management Director, APTIM; Project Central Files
Corrective Action Implementation Report	As needed	As defined in the report	Responsible Party Dennis Seymore, Senior Scientist and Site Technical Lead, APTIM Don Burton, Project Manager, APTIM Subject Matter Expert as needed	Don Burton, Project Manager, APTIM; Tricia Felt, Corporate Quality Management Director, APTIM; Project Central Files
Internal Audit Reports	As needed	No later than 30 days after the audit	APTIM Auditors	Dennis Seymore, Senior Scientist and Site Technical Lead, APTIM Tricia Felt, Corporate Quality Management Director, APTIM Don Burton, Project Manager, APTIM
Data Quality Assessment (Note: Data quality assessment is performed in the QCSR)	QCSR report results will be included in the Corrective Measures Implementation Report.	See publication date for corrective measures implementation report in the corrective measures implementation work plan schedule.	Vicki Graves, Project Chemist, APTIM or Designee	Don Burton, Project Manager, APTIM; Ashley Roeske, CEHNC COR; Bob Gorman, Army POC

DoD – U.S. Department of Defense.
ELAP – Environmental Laboratory Accreditation Program.
POC – Point of contact.
QA – Quality assurance.
QC – Quality control.
QCSM – Quality control site manager.
QCSR – Quality control summary report.

Worksheet No. 34: Data Verification and Validation Inputs

Verification Input	Description	Internal/External	Responsible for Verification (Name, Organization)
COC and Shipping Forms	Upon receipt of samples, COC forms and shipping documentation will be reviewed by the laboratory for verification against the sample coolers they represent. The COC form will be signed by all parties having custody of samples, with the exception of commercial carriers.	External	Eric Korthals, CT Laboratories, LLC Project Manager
Field Records	All field records, including AR/COC, field activity logs, well development logs, and sample collection logs, will be verified for completeness.	Internal	APTIM Quality Control Site Managers (QCSM) Vicki Graves, APTIM Project Chemist
Laboratory Data	All laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal.	External	Eric Korthals, CT Laboratories, LLC Project Manager
Laboratory Data	All laboratory data packages will be verified for content upon receipt.	Internal	Vicki Graves, APTIM Project Chemist
Data Input/Verification	Verified information will be entered into EQuIS or a similar database.	Internal	Annette Hough, APTIM Data Manager
Data Input/Verification	EDDs will be loaded into EQuIS or a similar database and self-verified, based on input information.	Internal	Annette Hough, APTIM Data Manager
Data Qualifiers and Use Codes	Following entry of automated data review, data validation qualifiers, and Use Codes, a hard copy validation QC table will be printed and verified against the original data validation checklists.	Internal	Don Dill, APTIM Data Validation Lead
Data Completeness Summary	Data validation information will be reviewed and the number of valid data points will be determined.	Internal	Don Dill, APTIM Data Validation Lead

AR – Analysis request.
COC – Chain of custody.
EDD – Electronic data deliverable.
QC – Quality control.

Data Reduction and Review of Field Activities

Data collected during the field activities will be reviewed by checking the procedures used and comparing the data to previous measurements. The field coordinator or sampling coordinator will be responsible for checking all field samples to verify that sample collection and field measurement protocols have been observed. These checks will include:

- Use of standard operating project procedures
- Calibration method and frequency
- Quality control bottle lot number
- Data and time sampled
- Preservation method
- Sample team members
- Receiving laboratory
- Chain-of-custody number
- Airbill number.

Worksheet No. 34: Data Verification and Validation Inputs

Data Validation Activities

Sample data are validated by the APTIM validation team using the Environmental Protection Agency's (EPA) *Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review* (EPA, 2008) and *Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review* (EPA, 2010) for guidance prior to 2015. Beginning in 2015, validation is performed using the DOD General Validation Guidelines (DOD 2018) and the U.S. Department of Defense QSM, Version 5.3 (U.S. Department of Defense, 2019) or latest revision for analytical specific criteria. EPA Region 3 *Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses* (EPA, 1994) and *Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses* (EPA, 1993) are applied during the blank evaluation portion of the validation activities. Specific quality control criteria identified in Quality Assurance Program Plan Worksheets No. 12 and No. 28, respectively; analytical methods and laboratory standard operating procedures are applied to all sample results. For those analytical methods not addressed by the validation guidelines, the evaluation is based on the published method requirements, laboratory-specific standard operating procedures, and technical judgment following the logic of the Contract Laboratory Program validation guidelines for data qualification.

References:

U.S. Department of Defense (DoD), 2019, ***Quality Systems Manual for Environmental Laboratories***, Version 5.3, May.

U.S. Department of Defense (DoD), 2018, ***General Data Validation Guidelines***, February.

U.S. Environmental Protection Agency (EPA), 2010, ***Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review***, EPA/540/R-94/013, January.

U.S. Environmental Protection Agency (EPA), 2008, ***Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review***, EPA/540/R-08/01, June.

U.S. Environmental Protection Agency (EPA), 1994, ***Region 3 Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses***, September.

U.S. Environmental Protection Agency (EPA), 1993, ***Region 3 Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses***, April.

Worksheet No. 35: Data Verification Procedures

Step IIa/IIb	Validation Input	Description	Responsible for Validation (Name, Organization)
IIa	Compliance Review	Review all laboratory information against Request for Analysis and determine if all samples were preserved, received, and analyzed within project specifications. Determine if sample delivery group (SDG) is complete.	Level 1 Data Validation – APTIM
IIa, IIb	Organics Level 2 DoD QSM 5.3 or latest version Data Validation	Level 2 (QC review only): Perform first-level data validation review. Complete automated data review report and verify exception list or complete data validation checklist based on EPA National Functional Guidelines (NFG) prior to 2015, DoD QSM V5.3 or latest approved after 2015, and project requirements.	APTIM
IIa, IIb	Inorganics Level 2 DoD QSM 5.3 or latest version Data Validation	Level 2 (QC review only): Perform first-level data validation review. Complete automated data review report and verify exception list or complete data validation checklist based on NFG prior to 2015, DoD QSM V5.3 or latest approved after 2015, and project requirements.	APTIM
IIa, IIb	Organics Level 3 DoD QSM 5.3 or latest version Data Validation (or equivalent)	Level 3 (QC validation or equivalent): Perform first-level data validation review. Complete automated data review report and verify exception list or complete data validation checklist based on NFG prior to 2015, DoD QSM V5.3 or latest approved after 2015, and project requirements.	APTIM
IIa, IIb	Inorganics Level 3 DoD QSM 5.3 or latest version Data Validation (or equivalent)	Level 3 (QC validation or equivalent): Perform first-level data validation review. Complete automated data review report and verify exception list or complete data validation checklist based on NFG prior to 2015, DoD QSM V5.3 or latest approved after 2015, and project requirements.	APTIM
IIb	QC Summary Report	Review data validation results and provide concurrence, determine data usability, and summarize data quality issues.	APTIM Project Chemist Vicki Graves

Note(s):

The APTIM Data Validation Group acts independently from field operations. The validators are not responsible for fieldwork or associated with the technical team working on the RSA Project.

Sample data are validated by the APTIM validation team using the DoD General Validation Guidelines (DoD, 2018) and the DoD QSM, Version 5.3 (DoD, 2019). EPA Region 3 *Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses* (EPA, 1994) and *Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses* (EPA, 1993) are applied during the blank evaluation portion of the validation activities. Specific QC criteria identified in the IW QAPP (the most current version), analytical methods, and laboratory standard operating procedures were applied to all sample results. For those analytical methods not addressed by the validation guidelines, the evaluation is based on the published method requirements, laboratory-specific standard operating procedures, and technical judgment following the logic of the Contract Laboratory Program validation guidelines for data qualification.

Worksheet No. 35: Data Verification Procedures

Data validation is based on the DoD General Validation Guidelines and the analytical specifics in the DoD QSM 5.3 or latest version and applies the validation criteria provided in the QAPP (e.g., WS Nos. 12, 28, etc.).

LCS, MS/MSD, and Surrogate Recoveries control limits are presented in Worksheets Nos.12 and 28.

Table 35-1 lists general qualifier guidelines used for the data validation process.

Worksheet No. 35: Data Verification Procedures

Table 35-1 – Validator General Flagging Guidelines

QC Requirement	Criteria	Flag	Flag Applied To
Holding Time	Time exceeded for completion of extraction or analysis	UR for nondetects > 2X hold time, or J for all positive results	All analytes in the sample. In the event that holding time is only marginally exceeded, qualify positive results as J.
LCS	Percent recovery (%R) > upper control limit (UCL) %R < lower control limit (LCL) %R < 10%	J for all positive results J for all positive results UJ for nondetects J for all positive results UR for nondetects	The specific analyte(s) in all samples in the associated analytical batch
LCSD	RPD > CL	J/UJ for all results	The specific analyte(s) in all samples in the associated analytical batch No qualifiers for non-detect if percent recoveries >100%; positive bias
Method Blank	Analyte(s) detected	UB for the results within 5X the blank concentration UB for the results within the 10X for common laboratory contaminants	The specific analyte(s) in all samples in the associated analytical batch Common laboratory contaminants: VOA; methylene chloride, acetone, 2-butanone; and semivolatile organic compounds; phthalates
Equipment Blank	Analyte(s) detected	UB for the results within 5X the blank concentration UB for the results within the 10X for common laboratory contaminants	The specific analyte(s) in all samples with the same sampling date and sampling equipment as the equipment blank
Field Duplicates	Field duplicates > RLs and RPD outside control limits 20 Water; 50soil	J for all positive results or UJ for nondetects	The specific analyte(s) in all samples collected on the same sampling date by the same sampling crew at the same site
MS/MSD	MS or MSD % R > UCL or MS or MSD % R < LCL or MS or MSD %R < 10% MS/MSD RPD > CL	J for all positive results J/UJ for all result J/UJ(*UR) for all results	Where the concentration in the parent sample is <4 times the spike concentration. Qualify MS/MSD sample only. Use professional judgment to qualify other samples in batch. (*UR nondetects if extremely low (example: <50% of QAPP control limits)

Worksheet No. 35: Data Verification Procedures

QC Requirement	Criteria	Flag	Flag Applied To
Sample Preservation / Collection	Preservation / collection requirements not met	Professional judgment will be used for validation of samples when standard temperature guidelines are marginally exceeded.	All analytes in the sample
Laboratory Sample Storage	0± 6ºC	J for all positive results UJ/R for nondetects	All analytes in the sample

Notes:

CL – Control Limit.
J – Results estimated during data validation.
LCS – Laboratory Control Sample.
LCSD – Laboratory Control Sample Duplicate.
LCL – Lower Control Limit.
MS – Matrix Spike.
MSD – Matrix Spike Duplicate.
%R – Percent Recovery.
R – Rejected (during data validation).
RPD – Relative Percent Difference.
UCL – Upper Control Limit.
UJ – Nondetected results estimated during data validation.
UB – Result determined to be nondetect at reported concentrations during validation due to contamination in an associated blank.

Control limits for criteria listed in this table are found on Worksheet Nos.12 and 28.

Worksheet No. 35: Data Verification Procedures

Table 35-2
Guidelines for Reporting Results

Result	Flag *
LOQ	U
> DL < LOQ	J
≥ LOQ	As needed

* Example 1: If the DL is 0.04, the LOQ is 0.9, and the result is 0.03, the concentration reported on the tabulated data form would be ND (0.9) (the sample specific LOQ) and the qualifier would be U.

Example 2: If the DL is 0.04, the LOQ is 0.9, and the result is 0.07, the concentration reported on the result form would be 0.07 and the qualifier flag would be J.

Example 3: If the DL is 0.04, the LOQ is 0.9, and the result is 1.2, the concentration reported on the result form would be 1.2 and the qualifier would be any flag needed because of a data quality problem (e.g., R, J, B, etc.).

Notes:
DL- Decision Limit.
J – Estimated results, detected above the detection limit but below the LOQ.
LOQ – Limit of Quantitation.
U – Results not detected.

Worksheet No. 35: Data Verification Procedures

Table 35-3 – Validator Flagging Guidelines Specific to Inorganic Methods

QC Requirement	Criteria	Flag	Flag Applied To
Initial calibration (minimum one standard and a blank for metals or as required by other inorganic methods)	Linearity criterion not met	J/UR	The specific analyte(s) in all samples associated with the initial calibration UR calibration not performed
Initial Calibration Verification	 %R>110% %R <90% %R<30%	J J/UJ R (unusable)	The specific analyte(s) in all samples associated with the initial calibration
Low-Level Calibration Check Standard (at or below RL)	CL exceeded	J Positives UJ Nondetects < LCL	The specific analyte(s) in all samples associated with the low-level check standard
Second Source Calibration Verification	CL exceeded	J/UJ	The specific analyte(s) in all samples associated with the second source calibration verification
Interference Check Solution (ICS)	%R >120% %R 50-79% %R<50%	J J/UJ J/UR	The specific analyte(s) in all samples associated with the ICS (Professional Judgment: Qualify data if samples with concentrations of interferents that are comparable to, or greater than, their respective levels in the ICS)
Serial Dilution Test	CL exceeded	J for all positive results	The specific analyte(s) in the sample associated with the serial dilution
MS/MSD	CL exceeded	J Positives if > UCL J/UJ all results if <LCL. However if < 30% see post-digestion spike.	The specific analyte(s) in the sample associated with the spike sample (results <4X spike)
Post-Digestion Spike Addition	If MS/MSD CL exceeded and if post-digestion spike lower CL exceeded (i.e., PDS<80%)	UR for nondetects if <LCL otherwise flag as per MS/MSD	The specific analyte(s) in the sample associated with the spike sample UR if not tuned prior to calibration
Mass Spectrometer Tune	Ion abundance criteria not met	J/UR for all results	All analytes in all samples associated with the tune
Internal Standard (ICP-MS)	%RI <30% or >120%	J/UJ(UR*)	Apply J/UJ to all results for specific analytes associated with the internal standard (UR - if extremely low; example:<50% of LCL (30%) to nondetects)

Worksheet No. 35: Data Verification Procedures

NOTES:
CL – Control Limit.
J – Results estimated during data validation.
J/UJ – Results estimated during data validation/nondetected results estimated during data validation.
J/UR – Results estimated during data validation/rejected nondetect.
J/UJ (UR) – Results estimated during data validation/nondetected results estimated during data validation/ Rejected nondetect.
LCL – Lower Control Limit.
MS/MSD – Matrix Spike/Matrix Spike Duplicate.
UCL – Upper Control Limit.
UR – Rejected nondetect.

Worksheet No. 36: Data Validation Procedures

Step IIa/IIb	Matrix	Analytical Group	Concentration Level	Validation Criteria	Data Validator (title and organizational affiliation)
IIb	Soil	VOC	Low	SW8260C; DoD_QSM_5.3 or latest version	APTIM Data validation group or approved subcontractor
IIb	Soil	SVOC/PAH	Low	SW8270D; DoD_QSM_5.3 or latest version	APTIM Data validation group or approved subcontractor
IIb	Soil	Pesticides	Low	SW8081A/B; DoD_QSM_5.3 or latest version	APTIM Data validation group or approved subcontractor
IIb	Soil	PCBs	Low	SW8082A; DoD_QSM_5.3 or latest version	APTIM Data validation group or approved subcontractor
IIb	Soil	Metals-ICP	Low	SW6010C; DoD_QSM_5.3 or latest version	APTIM Data validation group or approved subcontractor
IIb	Soil	Mercury	Low	SW7471A; DoD_QSM_5.3 or latest version	APTIM Data validation group or approved subcontractor
IIb	Soil	Explosives	Low	SW8330B; DoD_QSM_5.3 or latest version	APTIM Data validation group or approved subcontractor
IIb	Soil	Perchlorate	Low	SW6850; DoD_QSM_5.3 or latest version	APTIM Data validation group or approved subcontractor

Note(s):
The APTIM Data Validator Group acts independently from field operations. The validators are not responsible for fieldwork or are associated with the technical team working on RSA.

DOD QSM V 5.3 denotes *U.S. Department of Defense QSM*, Version 5.3 (U.S. Department of Defense, 2019).

ICP - Inductively coupled plasma.

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PAH - Polynuclear aromatic hydrocarbon.

PCB - Polychlorinated biphenyl.

SVOC - Semivolatile organic compound.

EPA - U.S. Environmental Protection Agency.

VOC - Volatile organic compound.

Worksheet No. 37: Data Usability Assessment

Identify the personnel responsible for performing the usability assessment:
Field data generated by the field personnel will be initially reviewed, processed, and evaluated on site by the technical lead, task manager, and/or designee. Copies of the original forms will be maintained on site for reference and the originals will then be forwarded to the data coordinator for further review, inclusion into the project database, and final storage in the project Central Files.

The Project Chemist and/or the task lead will perform the usability assessment on analytical data as defined by definition of precision, accuracy, representativeness, completeness, and comparability (PARCC).

Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:

A combination of checklists and/or data validation summaries will be used to document data validation activities. A quality control summary report (QCSR) or similar documentation will be used to assess the performance of the measurement quality objectives (MQO), (which are the PARCC parameters). These indicators of performance are compared against data quality objectives (DQO) to determine the usability of the data. Guidance from QA-G4/QA-G9 is used as a basis for this assessment.

Hard copy and electronic analytical data will be delivered to the data coordinator for initial review, copying, and distribution, with the original hard copy going to project Central Files. If required, data validators will receive a working hard copy to review. Electronic files will be forwarded to the database manager for checking and uploading into the database. APTIM will then issue summary reports and updates, as required, as final data reviews are completed. The final project deliverables may include electronic file copies for stakeholder use. The data usability assessment will be performed by APTIM for data associated with delineation, risk assessment, or confirmatory sampling.

The APTIM Project Chemist will (1) determine if the MQOs have been met and (2) calculate the data completeness for the project. These results will be included in the data package deliverables for each task.

For a given investigative task, a specific list of target constituents will be formulated; and if they cannot be quantified by the methods summarized in the Installation-Wide (IW) Quality Assurance Program Plan (QAPP), they will be addressed in a task-specific plan. All applicable analyses will meet the recommended method guidance found in *Test Methods for Evaluation of Solid Waste, Physical/Chemical Methods, SW-846,* (U.S. Environmental Protection Agency [EPA], 1997) and its subsequent updates. All other requested analyses must conform to their specified method. These may include the *Annual Book of ASTM Standards* (American Society for Testing and Materials, 2002), *Methods for Chemical Analysis of Water and Waste* (EPA, 1993), and similar sources.

Worksheet No. 37: Data Usability Assessment

Part of the review to determine whether DQOs were met is evaluation of a series of data quality indicators that include measurements of the PARCC and sensitivity parameters. How each of these measurements is to be performed and assessed is discussed in the worksheet. The target acceptance criteria for the results have been developed for a wide variety of anticipated analyses on soil/sediment, surface water, and groundwater matrix samples and are presented in the internal laboratory quality control (QC) validation criteria found in Table 35-1 in Worksheet No. 35. Other data quality indicators may be developed as needed for other sampling media and other analysis programs and presented in their task-specific plans.

Precision

Precision refers to the reproducibility of measurements and is defined as the measurement of mutual agreement among individual measurements of the same property, usually under “prescribed similar conditions.” Precision is expressed in terms of the relative percent difference (RPD) between duplicate determinations or in terms of the relative standard deviation (RSD) when three or more determinations are made. Various measures of precision exist, depending on the prescribed similar conditions.

Overall sampling and analysis precision will be assessed using RPD for duplicate environmental samples. The RPD for matrix spike (MS)/matrix spike duplicate (MSD) sample results will be used to assess laboratory spike recovery precision. RPD is defined as the difference between two measurements divided by their mean and expressed as a percent as shown in Equation (1):

$$\mathrm{RPD} = \left[\frac{|D_1 - D_2|}{\left(\frac{D_1 + D_2}{2} \right)} \right] \times 100 \qquad (1)$$

where:

1. D_1 = The result from the original determination
2. D_2 = The result from a duplicate measurement.

Worksheet No. 37: Data Usability Assessment

RSD is the standard deviation of a set of values divided by the average value expressed as a percent as shown in Equation (2):

$$\text{RSD} = \left(\frac{\sigma_{n-1}}{\overline{X}(x_1 \ldots x_n)} \right) \times 100 \qquad (2)$$

where:

3. σ_{n-1} = The sample standard deviation of the sample data
4. n = The number of determinations
5. $\overline{X}(x_1 \ldots x_n)$ = The arithmetic mean of the sample data.

Accuracy

Accuracy is a measure of the bias in a system or the degree of agreement of a measurement, X (or an average of measurements of the same parameter), against an accepted reference or true value, T. Accuracy is typically expressed as a percent recovery calculated by the ratio of the measurement and accepted true value as shown in Equation (3):

$$\text{Percent Recovery} = \left(\frac{(X - S)}{T} \right) \times 100 \qquad (3)$$

where:

6. X = The experimentally determined concentration
7. S = The sample concentration before spiking
8. T = The “true” concentration.

Analytical accuracy is assessed through the analysis of spikes, such as surrogates, MS/MSDs, and laboratory control samples (LCS); audit samples and/or standard reference materials; and calibration check samples. With the surrogates and MS/MSDs that are spiked onto the actual sample matrix and analyzed, these accuracy indicators must take into account the nature of the matrix in question and the native concentration of the analyte spiked. Matrix variability or interferences from high concentrations of native compounds may adversely affect spike recovery and yield less than conclusive data. Accuracy checks which focus on analytical method and consist of compounds spiked in a “blank” or noninterfering matrix (e.g., LCSs, standard reference

Worksheet No. 37: Data Usability Assessment

materials, or calibration check samples) address the accuracy of the method and/or instrumentation at detecting the target analyte(s) at a certain quantification level and are not considered to be subject to matrix effects.

Measuring the bias of the overall sampling program is also difficult, especially with respect to collection of samples for analysis for volatile organic compounds. These organic compounds can be volatilized and lost from collected samples, resulting in a negative bias, or the sample can become contaminated with foreign compounds during sample collection, handling, and preparation, resulting in a positive bias. Using proven sample collection methods that incorporate steps to minimize sample disturbance during collection, providing for the isolation of samples from known sources of contamination, and incorporating the immediate preservation of samples on ice should reduce the potential for bias. Accuracy of the sampling system, emphasizing cross-contamination with volatile compounds, will be assessed by evaluating analytical results for field quality assurance (QA) samples, including field-prepared field blanks, laboratory-prepared trip blanks, equipment rinsate blanks, laboratory storage blanks, and analytical method blanks.

Representativeness

Representativeness is a qualitative parameter that expresses the degree to which sample data actually represent the matrix conditions. For example, in conducting groundwater monitoring, representativeness requires proper location of wells and the collection of samples under consistent, documented procedures. Wells are located based upon the results of the hydrogeologic study in progress and are designed to provide maximum coverage of the flow conditions. Requirements and procedures for sample collection and handling are designed to maximize sample representativeness. Representativeness can also be monitored by reviewing field documentation and performing field QA audits.

Other sampling approaches in which representativeness is a concern are building composite samples and using an unbiased grid sampling system. In compositing, individual subsamples are collected and combined to represent a greater physical area or cover a particular time period. Often, to characterize a large unknown surface area, a grid sampling pattern is established and then samples are collected at randomized node locations where horizontal and vertical traverse lines intersect. Considerations such as number of samples required and their spatial relationship will affect the degree to which the unbiased grid sample results are representative. In such cases, the sampling objective must be well defined and the intended purpose for the sample data generated must be reviewed to establish through statistical analysis the representativeness of the DQOs. Parameters, such as the number of subsamples composited, the number of samples submitted for analysis, and the sampling interval, can then be specified to increase the confidence interval and improve representativeness when warranted by the performance objective.

Completeness

Data completeness represents the percentage of valid or usable data collected from a sampling/analytical program or measurement system compared to the amount expected to be obtained under optimal or normal conditions. Completeness is calculated for the aggregation of data for each analyte measured for any particular sampling event or other defined set of samples. Completeness is calculated and reported for each method, matrix, and analyte

Worksheet No. 37: Data Usability Assessment

combination. The number of valid results divided by the number of possible individual analyte results and expressed as a percentage determines the completeness of the data set. For completeness requirements, valid results are all results not qualified as rejected in the data review and validation process. The requirement for completeness is 90 percent of all critical field samples requiring chemical or geotechnical analyses. For any instances of samples that could not be analyzed for any reason (holding time violations in which resampling and analysis were not possible, samples spilled or broken, etc.), the numerator of this calculation becomes the number of valid results minus the number of possible results not reported.

The formula for calculating completeness is shown in Equation (4):

$$Completeness = \left(\frac{number\ of\ valid\ (i.e., non-R-flagged)\ results}{number\ of\ possible\ results} \right) \quad (4)$$

Site-specific completeness goals may also be defined in the site-specific sampling and analysis plan.

For statistically based sampling designs, completeness will be dependent upon the number of usable samples that are needed to meet the tolerances for decision errors. The mechanism for determining completeness for statistically based sampling designs will be provided in the site-specific field sampling plans.

Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. Comparability for sampling and analysis tasks is achieved by:

- Specifying well-recognized techniques and accepted standard methods for sampling and analysis using well-trained sampling and analysis technicians to execute the prescribed methods consistently
- Requiring that all involved sampling and analysis personnel produce adequate documentation to record how the prescribed methods were actually executed, noting nonconformances and corrective measures taken.

Worksheet No. 37: Data Usability Assessment

The specification of standardized laboratory methods helps to ensure that the data generated for an event are comparable to past and future activities. Periodic field and laboratory audits to assess consistency of method implementation for these prescribed procedures are also critical in determining comparability.

Sensitivity

Sensitivity is a qualitative parameter that addresses the ability of the analytical method or instrumentation to differentiate between responses that represent concentrations of analytes. Sensitivity is important, as it is the ability to detect the target analytes at the levels of interest so that project-specific goals are met. The requirements of sensitivity include the establishment of various limits such as those for calibration, which include instrument detection limits (DL), and those that are project specific, such as limits of quantitation. The DLs are based on interference-free matrices which do not take into account the matrix effects of environmental samples. Therefore, project-specific LOQs are established to meet project objectives for analytes of interest (these values are provided in Worksheet 15 tables).

The Project Chemist or designee will review all preliminary data for obvious data quality issues, such as sensitivity and QC errors, and will 1) perform a final review of the raw data to ensure that data have been transcribed correctly, 2) review chromatograms and mass spectra to ensure that compounds have been identified correctly, and 3) review QC data to ensure that all data have been qualified correctly. The Project Chemist will not recalculate data from raw data. When required, any recalculations will be performed by the Data Validator. The Data Validator will review a minimum of 10 percent of the raw data against the QC requirements presented in the IW QAPP.

The following guidelines will be considered during evaluation for usability:

- Review the case narratives pertaining to the data packages and establish that corrective actions (CA) were performed.
- Review all qualifier flags based on acceptance criteria.
- Ascertain if the representativeness objective for the project was achieved.
- Be aware of previous investigations for the specific projects and pre-existing data gaps.
- Calculate completeness of sample and analytical data collection to check against the objectives of the project.
- Identify data gaps based on completeness and nonconformance events.

Worksheet No. 37: Data Usability Assessment

- Identify data that do not meet project-specific sensitivity requirements.
- Determine if the data gaps prevent RSA from making decisions intended in DQOs.
- Document instances where professional judgment should be used; and discuss them with the CEHNC Chemist and, if necessary, the Alabama Department of Environmental Management chemist and/or the EPA Region 4 chemist.
- Document all evaluations, calculation, rejections, and recommendations and provide rationale for all specific validation actions.
- Submit a QCSR.

The following items should be considered when evaluating data usability when acceptance criteria have been exceeded:

- **Holding Times** – Consider the stability of the different analytes when holding times have not been met. Volatile organics are more susceptible to loss over time than semivolatile organic compounds, such as pesticides and dioxins or metals. Samples that are reanalyzed a few days past holding time because the QC results are outside acceptance criteria but also have both passing criteria in the reanalysis and comparable results to the original analyses, should not be rejected with the exception of volatile organics. If the holding time for volatile organics is exceeded, the data will be rejected and there will be no further use of the data.
- **Blanks** – If the concentration of the analyte in the sample is greater than five times the concentration in the blank, do not qualify the sample concentration as “B.” Pay special attention when the result is near the governing criterion.
- **Sample Preservation** – For preservation of all analytes in the sample, if a sample is received at no greater than 10 degrees Celsius, is within 48 hours of collection, there is documentation that the sample was properly preserved with ice at the time of shipment, then qualify the samples as UJ for nondetects for positive results. Adhere to sample preservation criteria whenever possible and reject volatiles samples that are improperly preserved.
- **Surrogates** – Matrix effects may impact surrogate recovery. If surrogates are within acceptance criteria in the LCS and the method blank and the internal standard area counts are acceptable in the sample, evaluate the raw data to see if the results in the sample are acceptable. In multiple surrogate methods, one surrogate may be slightly outside acceptance criteria and the data for that sample may still be usable. The Data Validator should investigate whether the root cause of the poor recoveries was examined by the laboratory and, when necessary, whether the CA was performed before accepting the data. Evaluate the raw data for usability based on DQOs.

Worksheet No. 37: Data Usability Assessment

- **Surrogates and Matrix Spikes** – Surrogates and MSs with concentrations diluted out cannot be evaluated.

- **Sensitivity** – Where generic action limits are used as action levels, use the lowest achievable laboratory DL to evaluate sensitivity. Where project- or task-specific action levels have been developed, identify sample results that do not meet the expected sensitivity requirements during a preliminary review of the data and determine why the exceedance occurred. If the exceedance is determined to be minor, (i.e., less than 20 percent) evaluate the sample result against the laboratory's detection limits and review similar data collected to determine the extent of the condition. If a systematic error has occurred, determine the overall impact to the data and report the condition to the project/task manager and regulators as needed to determine if additional sampling should be performed. If the results are clearly unusable (i.e., exceedance greater than 20 percent), determine the cause for the exceedance, initiate CA if required, and request reanalysis and/or resampling, as appropriate.

In the event that the Data Validator needs to modify the data qualifiers due to a scenario that is not presented in the IW QAPP, the APTIM Project Chemist will contact the CEHNC chemist for discussion on effects on the data and CA.

Describe the evaluative procedures used to assess overall measurement error associated with the project:
Data verification is defined as "confirmation by examination and provision of objective evidence that specified requirements have been fulfilled." Data validation is defined as "confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use have been fulfilled" (EPA QA/G-5).

The APTIM Project Chemist or designee will review the entire definitive data report package with the field records and apply the final data qualifiers for the definitive data. APTIM will evaluate laboratory data, QC results, and laboratory data qualifiers and apply data validation qualifiers. These qualifiers may be different from those applied by the laboratory. APTIM will use various checklists during the verification process to document all the verification activities. Completed checklists will be available for review upon request; however, these checklists should not be included as part of the data packages. All qualifications must be explained in the Data Validation Report. All qualified data near the governing criteria will be evaluated against project DQOs for fitness for use.

Note that all criteria that are included in the IW QAPP are to be considered target goals. Generally, the data are flagged by the laboratory and a more detailed evaluation of the data is performed. Evaluation of the exceedances by the analytical Data Coordinator, the Laboratory Project Manager, and the Laboratory QA officer will be completed, and a recommendation will be made concerning the usefulness of the data. CA procedures may then be formulated and implemented in the field or laboratory to avoid reoccurrence of the condition. In all cases, the results of the usefulness of the evaluation will be documented and discussed in the project reports.

Worksheet No. 37: Data Usability Assessment

To determine the precision of an analytical method and/or laboratory analyst, a routine program of duplicate analyses is performed. The results of the duplicate analyses are used to calculate the RPD, which is the governing QC parameter for precision. APTIM will determine the precision of the analyses conducted during this investigation by reviewing the results of field replicate samples and laboratory duplicate samples (where applicable), then, if sufficient data are obtained, the arithmetic mean and standard deviation of a group of results may be calculated.

The accuracy of a method is an estimate of the difference between the true value and the determined mean value. Certain QA parameters, such as LCSs, reagent water spike samples, QC check samples, MS samples, and surrogate spike samples, have known concentrations prior to analysis. By comparing the percent recovery of the analysis of these samples to the true value, it is possible to measure the accuracy of the analysis.

Percent recovery values and control limits or DQOs are reported by the laboratory as a measure of method accuracy and will be compared with the established laboratory limits or the published U.S. Department of Defense (DoD) Quality Systems Manual (QSM) Version 5.3 criteria or latest approved for the accuracy of an individual method. QC data not meeting the established laboratory criteria or DoD QSM Version 5.3 or latest version target criteria for accuracy may be flagged and their usability assessed. Associated field sample data should be considered estimated.

Data completeness will be expressed both as the percentage of total tests conducted that are deemed valid and as the percentage of the total tests required in the scope of work that are deemed valid. Percent completeness is calculated with respect to the purpose of analysis (i.e., chemical, geotechnical, soil classification), as well as type of sample (i.e., field sample or QA/QC sample). The purpose and total number of each type of sample planned in the scope of work will be calculated and tabularized in the task work plan for each specific task. As part of the evaluation of the task completeness performed in the task final report, the actual number of samples collected will be compared to the planned number, and completeness will be discussed in the task-specific report. The completeness goal for all the different types of samples on this project is 90 percent, except for QA/QC samples. Completeness of QA/QC samples will have to be judged on a case-by-case basis in the report documents. Enough QA/QC data must be available to allow a thorough assessment of data quality to be performed.

APTIM will review the QC (laboratory and field) samples and field logs and appropriately flag any of the associated samples identified with the QC samples, as explained in Tables 35-1, 35-2, and 35-3. At minimum, case narratives, calibrations, blanks, spikes, and duplicates will be reviewed. Additionally, raw data, such as chromatograms, mass spectra, and instrument output, will be reviewed for transcription errors. Each MS sample will only be qualified by the laboratory, while APTIM will apply the final qualifying flag for a matrix effect to all samples collected from the same site as the parent sample or all samples showing the same lithologic characteristics as the MS/MSD.

Worksheet No. 37: Data Usability Assessment

Definitions for Data Qualifiers:

• Validation	• Definition
"null"	Detected and no qualifications during data validation
U	Not detected
J	Estimated due to data value between RL/LOQ and DL/MDL or due to validation anomaly
UJ	Not detected, estimated due to data validation anomaly
UB	Potential blank contamination
R	Rejected due to data validation anomaly
UR	Not detected; Rejected due to data validation anomaly
X1, X2, X3	Historical data that have been collected in a manner that is now considered to be inconsistent with good scientific practice; these data are considered unusable
X	Sample has been excavated.

Preliminary Data Use

To meet the goals of the RSA Program Management Contract, it may be necessary to make use of preliminary data, but not for site closure or action level compliance. The data must be released by the APTIM Project Chemist or APTIM Corporate Quality Management Director to the project staff for use. Ideally, the data will have been reviewed against the RSA QC criteria before the data are released to the project team. The team will be made aware that the data has not been completely validated and that they are using the data at risk. Acceptable uses for preliminary data include step-out discussions, additional sampling requirements, etc. Unacceptable uses of preliminary data include public meetings, risk assessment decisions, no further action decisions, and final decision-making purposes.

References:

American Society for Testing and Materials, 2002, ***Annual Book of ASTM Standards***.

U.S. Department of Defense, 2019, ***Quality Systems Manual for Environmental Laboratories,*** Version 5.3, May.

U.S. Environmental Protection Agency (EPA), 1993, ***Methods for Chemical Analysis of Water and Waste***, EPA 600/4-79-020, Revision 2.0.

U.S. Environmental Protection Agency (EPA), 1997, ***Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods***, SW-846, Third Edition, Office of Solid Waste, June.

ATTACHMENT D-1

ARMY SCOPING SESSION MEMORANDUM

DRAFT
SYSTEMATIC PROJECT PLANNING
CMIP SCOPING MEETING MEMORANDUM

Corrective Measures Implementation Work Plan
RSA-013, Unlined Inactive Open Burn Pad
Redstone Arsenal, Madison County, Alabama

1.0 Introduction

This document provides a record of the Scoping Meeting for the Corrective Measures Implementation Work Plan (CMIP) for RSA-013, Unlined Inactive Open Burn Pad at the Redstone Arsenal (RSA) in Huntsville, Alabama. This virtual meeting commenced at 1:00 p.m. CST on June 17, 2021 using the Microsoft Teams application and phone in option. The meeting was attended by the Project Team members listed in Table 1.1. Decisions and action items covered during the meeting are summarized in Section 1.2. Meeting materials are listed in Section 2.0 and provided as Attachment A, *Slide Presentation*, and Attachment B, *Data Quality Objectives*.

Table 1.1: RSA-013 CMIP Scoping Meeting Participants

Participant Information	
CEHNC COR Ashley Roeske	APTIM PM Don Burton
ADEM POC Kel Morrissette	APTIM SME Gail Cooley
ADEM Hydro Jason T. Wilson	APTIM Technical Lead/SME Emily Davis
CEHNC Technical Manager Dr. Heather McDonald, PE	APTIM SME Dennis Seymore
RSA PM Bob Gorman	APTIM Design Engineer/SME Ray Clark
AEC Technical Manager Quang Nguyen	

ADEM – Alabama Department of Environmental Management.
AEC – Army Environmental Center.
CEHNC – U.S. Army Engineering and Support Center, Huntsville.
COR – Contracting Officer Representative.
PM – Project Manager.
RSA – Redstone Arsenal.
SME – Subject Matter Expert.

1.1 Objectives

The purpose of the meeting was to present the CMIP execution strategy and proposed CMIP activities for RSA-013 to the Project Team and stakeholders. To support this presentation, a site description/history; document status; Resource Conservation and Recovery Act facility investigation, Corrective Measures Study (CMS), and statement of basis/decision document summaries; CMIP execution strategy, proposed corrective measures, schedule, and path forward were presented.

APTIM is performing this project for the CEHNC under Contract No. W912DY-17-D-0003, Delivery Order (DO) No. W912DY19F1116 for the corrective measures at RSA-013, RSA-014, RSA-109, RSA-122, RSA-141-R-01, RSA-183, RSA-221-R-01, RSA-312-R-01, and RSA-313-R-01 at RSA in Huntsville, Alabama.

The objectives for RSA-013 under this DO are:

1) Achieve Department of the Army (DA) approval of the CMS report (complete).

2) Achieve DA approval and regulatory concurrence of the CMIP.

3) Achieve DA approval of the Statement of Basis/Decision Document.

4) Conduct of the Safety Submission (if required), Corrective Measures Implementation-Construction activities, and the Corrective Measures Report for RSA-013 are optional tasks that can be exercised by the Army.

1.2 Meeting Discussion Topics

Mr. Burton introduced the Project Team members and then led them through the CMIP Scoping Meeting presentation slides for RSA-013 (Attachment A), except for a discussion of the data quality objectives which were led by Ms. Davis. Mr. Seymore aptly led the audio-visual team. The following comments and discussion occurred during and following the presentation:

- Slide 20: Mr. Morrissette asked if any amendments would be added to the bottom of the excavation with Alternative 2. Mr. Burton confirmed that EVO amendments are planned to be added to the bottom of the excavation before backfilling.

- DQO Slides, Step 5: Mr. Morrissette asked if any portion of the excavation is not excavated to the water table, will post-excavation confirmation floor samples be collected? Ms. Davis confirmed that post-excavation confirmation floor samples will be collected in any portion of the excavation(s) that is not excavated to the water table (~8 feet bgs). Mr. Morrissette said he is good with this plan and is happy to hear that EVO will be spread across the bottom of the excavation. Ms. Davis agreed and noted that getting the EVO into the saturated soils and epikarst will be proactive for the commingled plumes under the site and being addressed by the RSA-151 groundwater unit corrective measures. Mr. Wilson noted that the additives will probably require a UIC permit from ADEM; he will confirm this requirement for a UIC permit with the new person over the UIC permits at ADEM and also the typical duration for review and approval of the permit. Mr. Burton noted that in the past this review and approval process has been about 6 to 9 months. Mr. Burton stated that the UIC permit application process will need to commence early with the CMIP. Ms. Davis stated that the excavated soil should be able to be disposed at a Subtitle D Landfill but if not, the waste will be handled accordingly.

All perchlorate dig sites to date at RSA have been able to use Subtitle D Landfills for soil disposal.

- Slides 25: Mr. Burton showed the approximate area of the excavation and stated that two existing monitoring wells may need to be abandoned if it is determined that they lie within the area to be excavated. Mr. Morrissette asked if they would be replaced. Mr. Burton stated that they would need to be if the wells are in the Permit; otherwise, a decision has not yet been made.

- Slide 27. Mr. Burton emphasized the need to arrange removal of the OB/OD materials currently being stored in the areas of the former burn pads. Mr. Gorman will coordinate their removal prior to the design optimization sampling. These areas will need to available for design optimization sampling and later for excavation, equipment staging, and soil stockpiling area. Mr. Burton also mentioned the plan is to use the two existing berms for backfill if sampling during the design optimization determines that the soil is suitable for use as backfill.

- Slide 29: Mr. Burton discussed the schedule impacts to be considered in the CMIP. In terms of the coordination with the mission-critical OB/OD area, early discussions with the OB/OD team revealed that they may be able to end their work day early one day during the week and then weekend hours would be mostly open for the RSA-013 excavation activities.

- Slide 30: Mr. Burton stated that the CMIP is currently scheduled to be submitted to the Army by 6-Aug-21 and the current due date to ADEM is 21-Sep-21. This is an extremely aggressive schedule especially with the need to perform the design optimization sapling before completion of the CMIP. Mr. Burton and Mr. Clark emphasized that completing the design optimization sampling is critical to development of the CMIP. Ms. Roeske stated that the over and above work request may be the likely funding mechanism for the design optimization sampling; this will be discussed more at the next biweekly COR meeting (22-Jun-21). Mr. Burton mentioned to Mr. Morrissette that it is very probable that this site will need an extension letter for the CMIP. Mr. Morrissette stated that the extension makes sense and to please add sufficient detail noting what has been done to date and what needs to be performed in the future to substantiate the request.

- Mr. Burton opened the meeting for any remaining questions. Ms. Cooley clarified that the two monitoring wells potentially impacted by the excavation are not the Permit for monitoring at the OB/OD but that their replacement, if needed, needs to be coordinated with the contractor conducting the RSA-151 corrective measures. Mr. Burton stated that the pilot study for RSA-151 has been recently funded and that APTIM would coordinate with the HGL/APTIM team to determine if the two monitoring wells, potentially impacted by the RSA-013 excavation, are needed for the RSA-151 pilot study and subsequent CMIP. Ms. Cooley also clarified that the apparent error on Slide 29 regarding coordination with the excavation at RSA-014 is actually correct. If the verification

sampling for TCE at RSA-014 reveals that an excavation is still required at RSA-014 and schedules align, there would be coordination needed between work crews at RSA-013 and RSA-014. Mr. Morrissette, Mr. Wilson, and Ms. Roeske said they had no additional questions or comments.

- Action Items:
  1) Mr. Gorman will coordinate with the OB/OD folks to have the materials stored in the former burn pad areas removed before the design optimization sampling begins.
  2) Mr. Wilson will contact the staff member in charge of UIC permits to find out the approximate lead time for review and approval of the UIC permit needed for this site.
  3) Mr. Burton and Ms. Roeske will discuss funding for the design optimization sampling to be conducted during the preparation of the CMIP.
  4) Mr. Burton, Mr. Gorman, and Ms. Roeske will generate a detailed schedule extension letter request for the Rev. 0 CMIP submittal to ADEM. The current 21-Sep-21 submittal date to ADEM is not achievable given the need to complete the upfront design optimization sampling.
  5) APTIM will fix a typo on Slide 13 to change the RFI report submittal to ADEM from March 2, 2107 to March 2, 2017. The date for the CMIP Scoping Meeting for RSA-013 will be changed on Slide 30 from 11 June 2021 to 17 June 2021.

The meeting was adjourned at approximately 2 p.m. CST.

2.0 Meeting Materials

The following meeting materials are provided as an attachment to this memorandum:

- Attachment A: Slide Presentation
- Attachment B: Data Quality Objectives.

ATTACHMENT A

Slide Presentation

SCOPING SESSION CORRECTIVE MEASURES IMPLEMENTATION WORK PLAN FOR RSA-013

Redstone Arsenal, Madison County, Alabama

17 June 2021

US Army Corps of Engineers

APTIM

SCOPE OF SERVICES

- Base Delivery Order Objectives for RSA-013:
  - Achieve Department of Army (DA) approval of Corrective Measures Study (CMS) Report for RSA-013.
  - Achieve DA and Regulatory approvals of Corrective Measures Implementation Plan (CMIP) for RSA-013.
  - Achieve DA approval of Statement of Basis/Decision Document (SB/DD) for RSA-013.
- Optional Delivery Order Objectives for RSA-013:
  - Achieve DA approval of the safety submission (SS) for RSA-013.
  - Achieve DA and Regulatory approvals of the CMI-C activities and the corrective measures report (CMR) for RSA-013 (complete remediation services and achieve response complete).

REGULATORY BASIS

- Resource Conservation and Recovery Act (RCRA) Corrective Action Program
- Alabama Hazardous Wastes Management and Minimization Act (AHWMMA) Hazardous Storage Facility/Thermal Treatment/Solid Waste Management Unit (SWMU) Corrective Action Permit (ID # AL7210020742)
- RSA is a federal facility on the National Priorities List and actions are required to meet the substantive requirements of the National Oil and Hazardous Substances Pollution Contingency Plan under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

COMPLIANCE REQUIREMENTS

- RCRA
- Department of Defense
- Department of Army
- US Army Corps of Engineers - Data Item Descriptions (DID)
- US Army Garrison - Redstone Arsenal (RSA)
- Federal and State Regulations and Guidance to include Interim Guidance (IG)

AGENDA

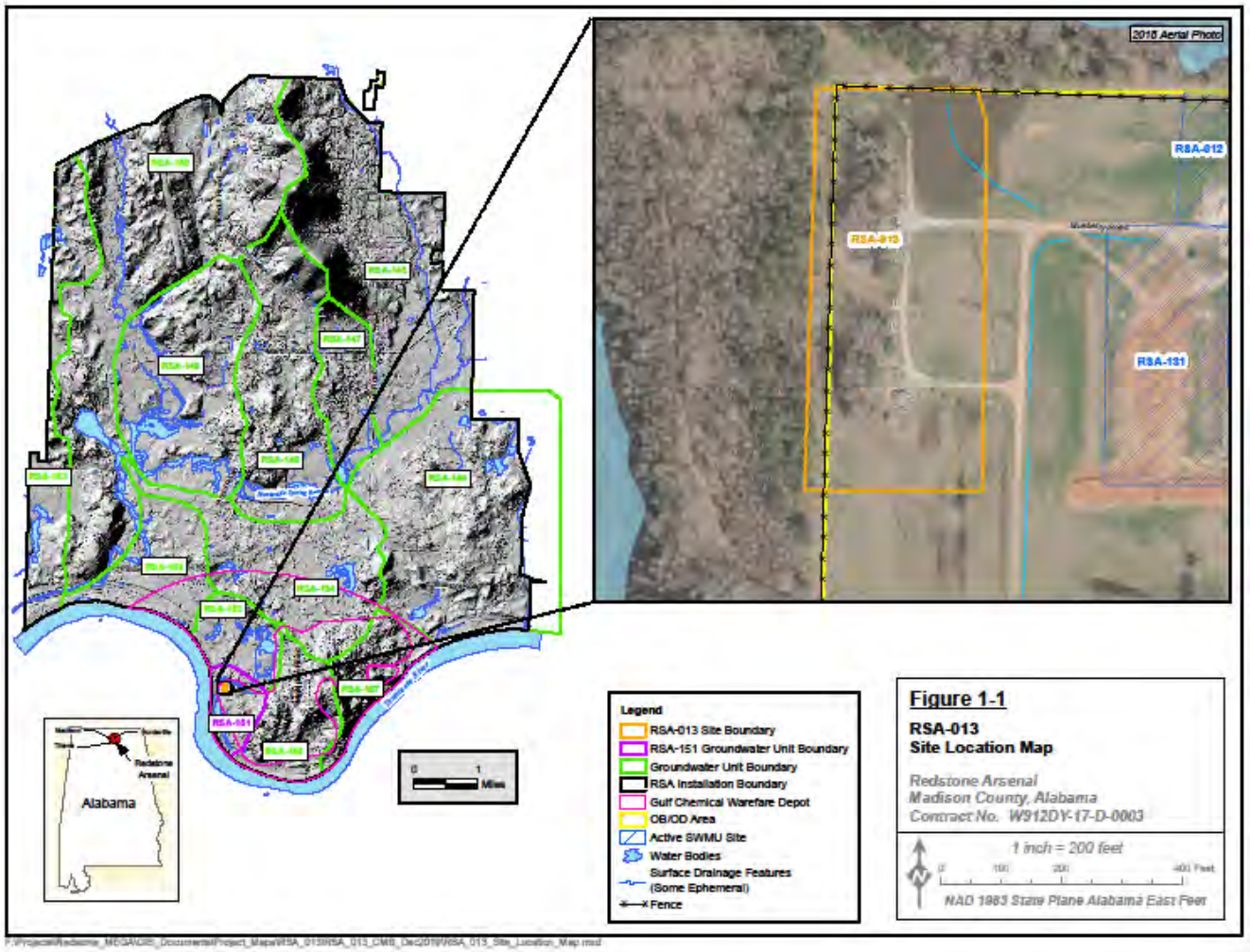
- Site Description/History
- Document Status
- Resource Conservation and Recovery Act Facility Investigation (RFI) Summary
- CMS Summary
- SB/DD Summary
- CMIP Execution Strategy
- Proposed CMIP Activities
- Schedule
- Path Forward

RSA-013 – UNLINED INACTIVE OPEN BURN PAD

SITE DESCRIPTION/HISTORY

- RSA-013 is located in the southern portion of RSA, above the RSA-151 groundwater unit. Site acreage: approximately 4.3 acres.
- The site lies within the fenced Open Burn/Open Detonation (OB/OD) area, where hazardous waste military munitions and materials contaminated with energetics are treated at burn pans and detonation pits.
- Consisted of two unlined burn pads, each approximately 200 feet square, with crescent-shaped earthen berms on the north, west, and south sides of each pad.
- Burn pads used from the 1950s to 1986 for thermal treatment of explosives and explosives-contaminated material and reactive waste, primarily waste propellant containing solvents (e.g., TCE).
- Following burning, the ash material was transported to RSA-014 or RSA-066 for disposal.

SITE LOCATION MAP



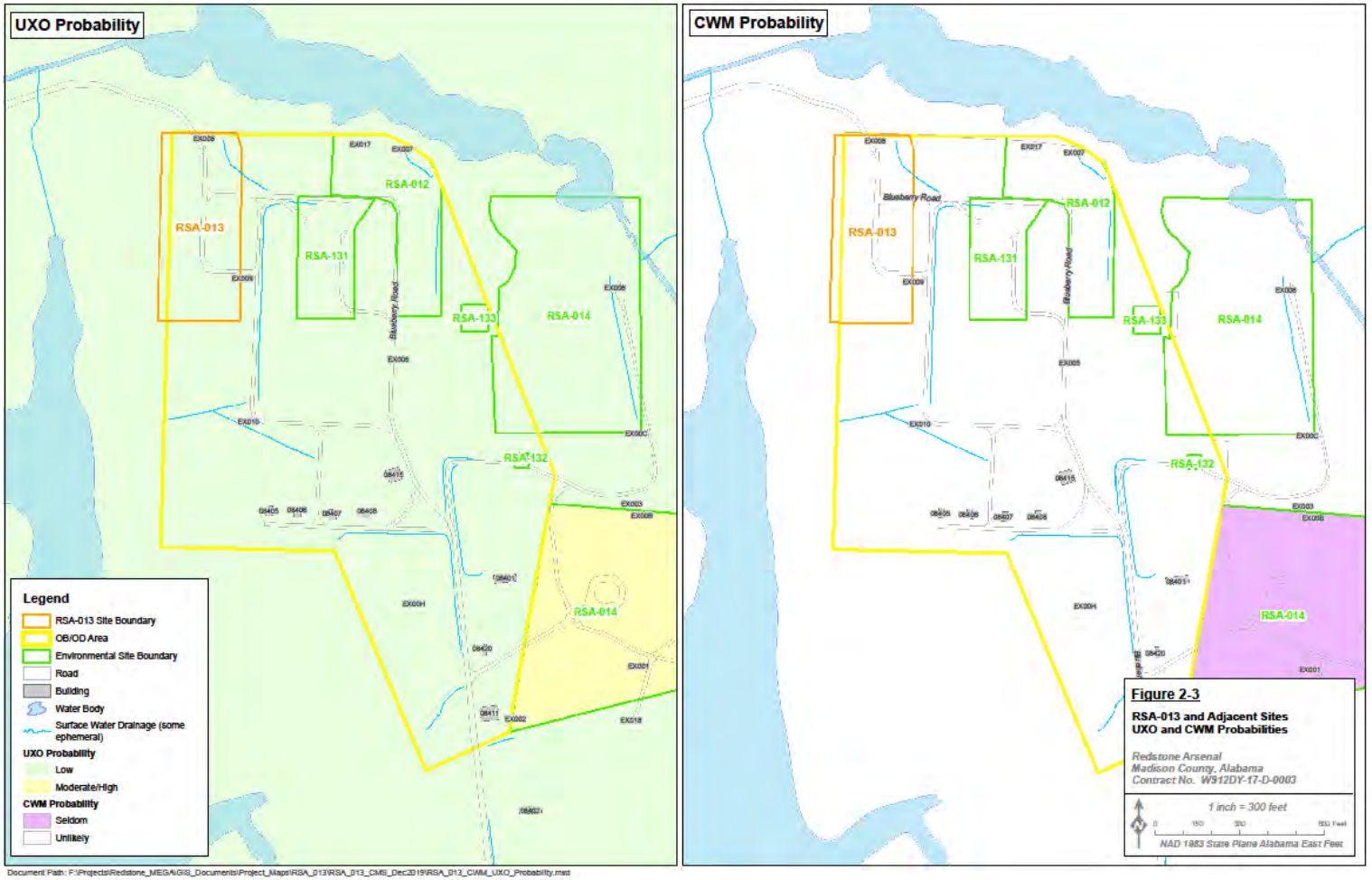
SITE DESCRIPTION/HISTORY (CONTINUED)

- Army currently uses areas within the site for surface storage of items (e.g., machinery, crates, componentry, etc.) that are within the proposed area of corrective measures.
- Unexploded ordnance (UXO) Probability is “Low.” Chemical warfare materiel (CWM) probability is “Unlikely.”
- Land use: Industrial Zone, representing range operations, explosive operations, storage, test areas, open space, and buffer zone.
- Two nearby sites, RSA-132 (Dismantled Popping Furnace) and RSA-133 (Inactive Rocket Washrack/Sump), were added to RSA-013 in 2009 for the purpose of completing the RFI. Both sites received No Further Action decisions for soil from ADEM and are not part of the soil corrective measures for RSA-013.

SITE MAP

NEARBY SITES

UXO / CWM PROBABILITY MAP



RCRA DOCUMENT STATUS

- Restoration Status:
  - **RFI report**: The Rev. 1 RFI report was submitted to ADEM on March 2, 2017 and received concurrence on May 25, 2017.
  - **Final CMS report:** The Final CMS report was submitted to Army on June 6, 2017 following RSA reviews and approval.
  - **Revised Final CMS report**:
    - **Advance Review**: To Army on January 17, 2020. Received official CEHNC and CX comments on March 17, 2020.
    - **Backcheck**: To Army April 2, 2020. CEHNC and CX reviewers had no further comments (April 29, 2020 email). Comments received from AEC review (March 9, 2021). Backcheck to Army on March 22, 2021 for review/concurrence. Comments received from EMCX on April 12, 2021, no revisions to CMS report required. Email from COR on **May 6, 2021** that AEC had no further comments on CMS report.
  - **SB/DD**: Revised Final SB/DD submitted April 6, 2018.

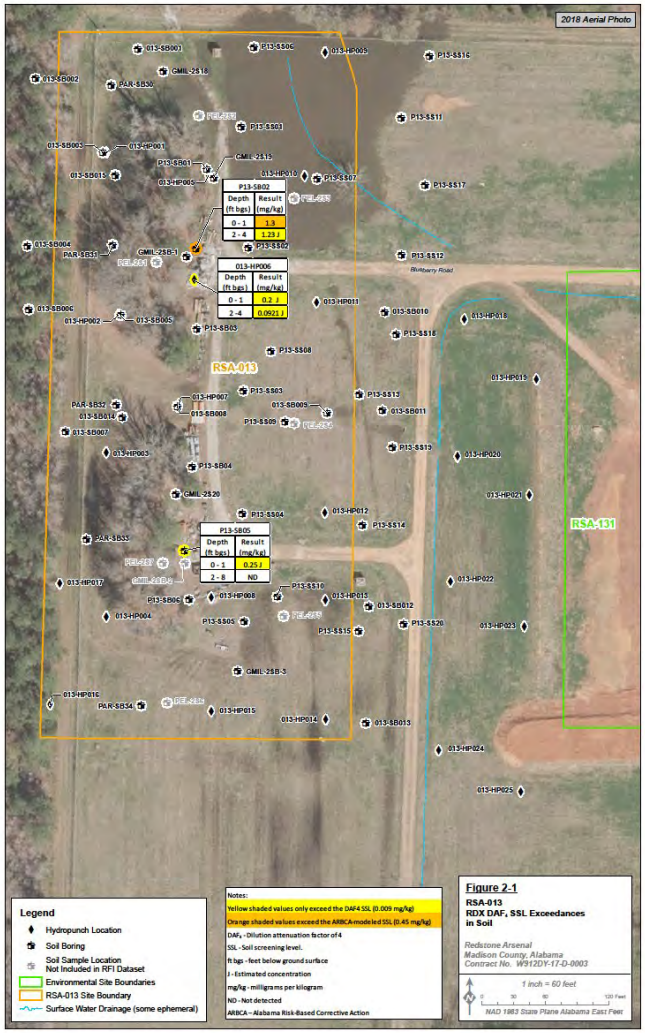
RCRA DOCUMENT STATUS (CONTINUED)

- Contracted Work
  - CMS report: Revised Final CMS report has received COR approval.
  - SB/DD: Revise SB/DD to be consistent with Revised Final CMS report. Respond to any additional review comments and obtain DA approval.
  - CMIP: Prepare CMIP and obtain DA and Regulatory approvals.
- Optional Work
  - SS: Prepare SS and obtain DA approval.
  - CMIC: Conduct corrective measures in accordance with approved CMIP.
  - CMR: Prepare CMR and obtain DA approval and Regulatory concurrence.

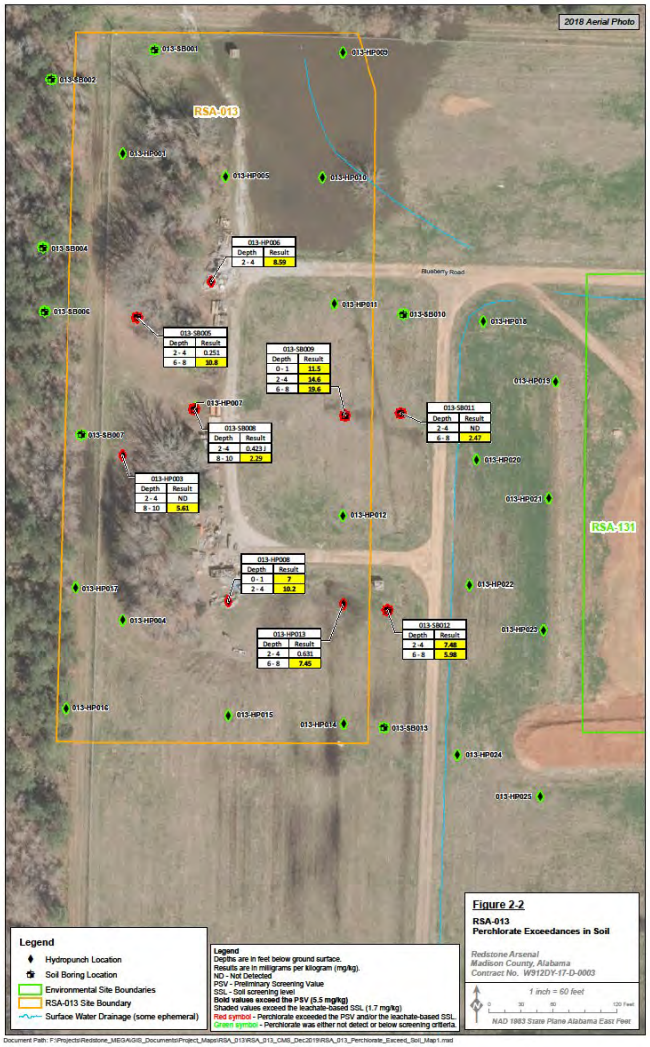
RFI SUMMARY

- Conceptual site model (CSM) includes:
  - Volatile organic compounds (VOC), semivolatile organic compounds (SVOC) including polynuclear aromatic hydrocarbons (PAH), metals, explosives, and perchlorate from burning operations.
  - Chemical agent/agent breakdown products due to the site's proximity to chemical agent storage within the former Gulf Chemical Warfare Depot.
- Soil:
  - Constituents detected in soil have been delineated to concentrations below applicable screening criteria.
  - No constituents in soil pose unacceptable risk to human health, ecological receptors, or the environment through direct contact routes of exposure including ingestion, dermal contact and inhalation.
  - Concentrations of perchlorate (large volume of soil) and RDX (collocated with perchlorate in smaller soil volume) pose a leaching threat to groundwater resulting in an unacceptable risk to human health should groundwater be consumed.
  - RFI recommended soil corrective measures to manage the leaching to groundwater threat from perchlorate and RDX.

RDX IN SOIL EXCEEDING LEACHING CRITERIA



PERCHLORATE IN SOIL EXCEEDING LEACHING CRITERIA



RFI SUMMARY (CONTINUED)

- Groundwater:
  - Numerous VOCs, PAHs, explosives, and perchlorate are present in groundwater under RSA-013 posing unacceptable risks if groundwater is consumed.
  - Since the groundwater chemicals of concern are present as intermingled plumes from multiple sources, the RFI recommended that they be addressed on a broader scale with the RSA-151 groundwater unit corrective measures.
- Alabama Department of Environmental Management (ADEM) concurred with the soil and groundwater RFI recommendations on May 25, 2017.

CMS REPORT

- Based on information and recommendations in the RFI report, a CMS report was prepared for RSA-013 soil.
- The CMS presented corrective measures to address the leaching threat to groundwater from perchlorate and RDX.
- Corrective measures objective (CMO) is to reduce perchlorate and RDX concentrations in soil, thereby eliminating the ongoing source of groundwater contamination from these constituents.
- Cleanup Goal for Perchlorate - 1.7 mg/kg
  - Based on leachate-based soil screening level using the EPA Interim Drinking Water Health Advisory Level of 15 micrograms per liter.
- Cleanup Goal for RDX - 0.45 mg/kg
  - Derived using the ARBCA model software using site-specific parameters for soil and groundwater.
  - Model determines a soil concentration protective of groundwater at the nearest downgradient, off-site monitoring well from the source area.

CMS REPORT (CONTINUED)

- Technologies evaluated in the CMS:
  - Perchlorate: Capping, Institutional Controls, Excavation and Off-Site Disposal, In Situ Soil Mixing, Ex Situ Soil Flushing, In Situ Bioremediation, Ex Situ Bioremediation, and Thermal Desorption
  - RDX: Excavation and Off-Site Disposal and Excavation and On-Site Anaerobic Bioremediation
- Alternatives evaluated in the CMS:
  - Alternative 1: No Action
  - Alternative 2: Soil Excavation with Off-Site Disposal
  - Alternative 3: Soil Excavation and On-Site Treatment Using Anaerobic Bioremediation.

CMS REPORT (CONTINUED)

- Following a detailed analysis of alternatives, **Alternative 2** (Soil Excavation with Off-Site Disposal) was recommended for RSA-013.
- DA has concurred with the recommendation of **Alternative 2**.

SB/DD SUMMARY

- SB/DD presents Army's preferred corrective measure alternative in accordance with public participation requirements under RCRA and CERCLA and the Army's Defense Environmental Restoration Program (DERP) guidance.
- SB/DD presents a declaration, decision summary, and responsiveness summary as outlined in EPA protocol for proposed plans, RODs, and other decision documents and in format agreed upon by the Army.
- SB/DD contains:
  - Summary of site description/history, investigation history and results, human health and ecological risks
  - Problems warranting action from the RFI report, CMOs, CGs, feasible technologies evaluated, corrective measure alternatives, and evaluation of the alternatives to the criteria in the EPA RCRA corrective action plan guidance along with consideration of public and regulatory acceptance
  - Army's preferred alternative from the CMS report
  - Responsiveness summary detailing public involvement in the corrective measures including a public comment period, public meeting (if requested), and any responses to comments received
  - Supporting tables and figures

SB/DD SUMMARY (CONTINUED)

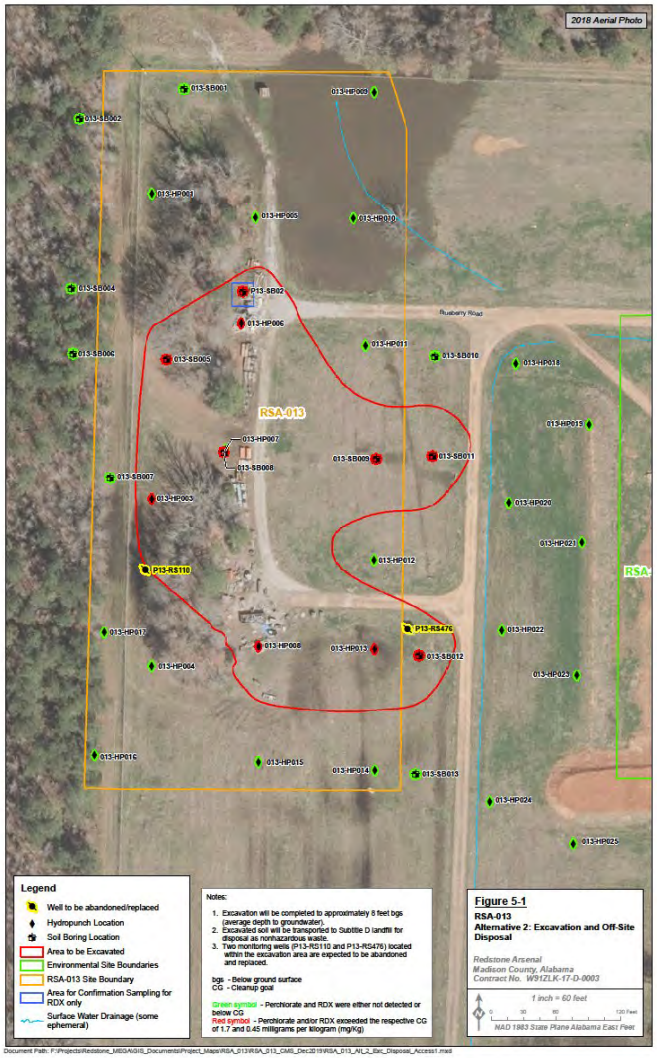
SB/DD:

- Advance Draft SB/DD submitted to Army on June 30, 2017.
- RSA had no comments.
- Public comment period held August 6, 2017 to September 4, 2017; no comments received.
- Final SB/DD submitted September 8, 2017.
- Revised Final SB/DD submitted December 12, 2017 to address informal RSA Legal and site manager comments.
- AEC Comments received February 21, 2018.
- Backcheck to RSA on April 4, 2018. Concurrence from RSA on April 5, 2018.
- Revised Final SB/DD submitted April 6, 2018.

SB/DD SUMMARY (CONTINUED)

- The SB/DD was based on the June 2017 CMS report and requires revision based on the revised **March 2021** CMS report for RSA-013.
  - Revise cleanup goal for RDX.
  - Revise volume of RDX soil requiring excavation.
  - Revise costs
  - Update tables/figures.
- Advance review SB/DD to be submitted to Army for review during preparation of the CMIP.
- Following receipt of RSA, CEHNC, and EMCX comments, the SB/DD and responses to comments to be submitted for backcheck review.
- If no further comments from RSA, CEHNC, and EMCX, the SB/DD is submitted to AEC for review concurrently with submittal of CMIP to ADEM. Respond to AEC comments and receive backcheck approval.
- Prepare and submit a final SB/DD for DA approval to meet delivery order objective.
- AEC will staff the SB/DD through G9 (formerly ACSIM) signature delegation.

CORRECTIVE MEASURES FIGURE



CMIP EXECUTION STRATEGY

- Prepare CMIP to implement the CMS recommended **Alternative 2** (Soil Excavation and Off-site Disposal) and obtain DA and Regulatory approvals.
- The CMIP will present the following in accordance with Attachment G of the Performance Work Statement (PWS):
  - Summaries of site history/description, environmental setting, investigation history, nature and extent of contamination, fate and transport, site risks, and final CSM
  - Basis for action, including the CMOs, CGs, and selected corrective measures
  - Planned CMI activities
  - Contingencies will be discussed for unforeseen but possible events at the site (e.g., excavation dewatering, unknown utilities encountered)

PROPOSED CORRECTIVE MEASURES

- Proposed DQOs for RSA-013 (refer to separate DQO file)
- Prior to implementation of corrective measures, surface stored items (e.g., crates, machinery, componentry, etc.) that are within the proposed area of corrective measures will require moving or relocation by the Army. *Removal/relocation of items will be conducted by the Government as stated in the Response to Contractor Question #5 received on 25-Jul-2019.*
- Design optimization sampling is planned prior to the start of the corrective measures to:
  - Refine area requiring excavation
  - Determine if any soil (e.g., 0-4 feet bgs) could be stockpiled and used for backfill of excavation.
- Excavation and Off-site Disposal:
  - Site preparation, including application and receipt of underground injection control permit for the emulsified vegetable oil to be added to bottom of excavation, dig and storm water permits, site clearing, monitoring well closure for two wells within excavation areas, and placement of storm water controls
  - Determine potential for soil comprising the berms as backfill (otherwise clean fill would be used from another RSA location)

PROPOSED CORRECTIVE MEASURES (CONTINUED)

- Removal of perchlorate- and RDX-contaminated soils.
  - The excavation will cover approximately 81,675 square feet with estimated excavation depth of 8 feet below ground surface (average depth to groundwater).
  - The volume of soil contaminated with perchlorate and RDX to be excavated and disposed is approximately 24,200 cubic yards.
- Collect post-excavation confirmation samples to confirm that perchlorate and/or RDX concentrations remaining in soil are below CGs.
- Collect samples from excavated soil for waste characterization.
- Place emulsified vegetable oil in bottom of excavation.
- Transport of excavated soil off-site to ADEM-approved Subtitle D landfill for nonhazardous waste
- Backfill and grading of the excavated area
- Replace wells, if needed
- Site restoration to pre-existing conditions.
- Although site access will be restricted by the active OB/OD area fencing, corrective measures will return soil to unrestricted site use.

SCHEDULE IMPACTS TO BE CONSIDERED IN THE CMIP

- The CMIP will address the following potential schedule impacts to implement the corrective measures:
  - Tree clearing limitations during Gray Bat active season (April 1 to November 30).
  - Worker safety issues with deep excavation using benching or sloping methods.
  - Coordination of work schedules with ongoing OB/OD operations and excavation at RSA-014.
  - Minimizing surface water run-on and groundwater seepage into excavation prior to backfilling.
  - Managing potential schedule impacts with seasonal flooding of this area preventing site access.

PATH FORWARD

- CMIP Scoping Meeting RSA-013: 17 June 2021
- Minutes and revised scoping slides to Army within 14 days of meeting
- RSA-013 Advance Review Rev. 0 CMIP to Army: 6 August 2021 ***or*** 30 days following Army and Regulatory approval of corrective measures as presented during the CMIP Scoping Meeting in accordance with Table 4-1 List of Submittals of the 25 July 2019 PWS
- Current due date of R0 RSA-013 CMIP to ADEM: 21-Sept-21.

ADDITIONAL QUESTIONS/COMMENTS

Don Burton
don.burton@aptim.com
865 207 1394

ATTACHMENT B

Data Quality Objectives

Proposed DQOs for RSA-013 CMIP:

Task Related DQO Planning	
Step 1. State the Problem	• The Resource Conservation and Recovery Act facility investigation (RFI) concluded that perchlorate and RDX in soil pose a leaching threat to groundwater which results in elevated concentrations of these constituents in groundwater posing unacceptable risks if the groundwater is consumed. Elevated concentrations of numerous chemicals of concern (COC) in groundwater present as commingled plumes will be addressed on a regional basis with the RSA-151 groundwater unit. These problems are a result of former Department of Defense (DoD) activities. • If no further action for soils at RSA-013 is to be authorized, cleanup is required for perchlorate and RDX concentrations present in soil above their CGs derived from leachate- and/or modeling-based soil screening levels (SSL). • COCs in groundwater under RSA-013 require corrective measures; groundwater cleanup will be the responsibility of RSA-151 groundwater unit.
Step 2. Identify the Goal of the Study	• Elevated concentrations of perchlorate and RDX present in soil above the CGs have been identified as requiring corrective measures to address the leaching threat to groundwater, which results in unacceptable risks if the groundwater is consumed. Cleanup to the CGs based on leachate- and/or modeling-based SSLs will be conducted to reduce further impact to groundwater from these constituents in vadose zone soil at the site.
Step 3. Identify Informational Inputs	• Table VI.6 of Redstone Arsenal's Alabama Hazardous Wastes Management and Minimization Act (AHWMMA) Permit states that a CMI work plan is required for RSA-013 soil and groundwater (groundwater is the responsibility of RSA-151). • Review of historical documents indicate that site was as a burn pad to thermally treat explosives and explosives-contaminated material and reactive waste, primarily propellant including waste perchlorate containing solvents. • Results of the existing investigations. • The conceptual site model (CSM) for RSA-013. • Existing quality control (QC) and quality assurance (QA) records of data quality checks.

Task Related DQO Planning	
Step 4. Define the Boundaries of the Study	• Study boundaries for the COCs in soil (perchlorate and RDX) were defined in the RFI, which was conducted in accordance with the Department's Alabama Environmental Investigation and Remediation Guidance (AEIRG). • Based on site history and existing data collected, the current site boundary includes historical site features. • The historical site features have been identified as release points for potential contaminants. • Potential locations where releases of perchlorate and RDX may be present have been defined. • Corrective measures will be conducted for elevated perchlorate and RDX concentrations in soil until the confirmatory sample results are less than or equal to the respective CG. The CGs have been established in the corrective measures study and will be summarized in the CMI work plan.
Step 5. Develop the Analytic Decision Approach	• The corrective measures will include confirmatory soil sampling in accordance with the Department's AEIRG for analysis of perchlorate and RDX to determine the effectiveness of the selected alternative. • If review of the confirmatory soil sampling data indicates the CGs have not been achieved, additional soil removal will be implemented to meet the CGs. • If review of the confirmatory soil sampling data indicates the CGs have been achieved, no further soil removal will be conducted, as the stated corrective measures objectives will be met. • If removal of contaminated soils is prevented by a barrier, such as an existing building, the soil volume beneath the building will be considered capped and this residual contamination will be addressed through LUCs.
Step 6. Specify Performance or Acceptance Criteria	• Selected definable features of work and tasks will achieve the performance criteria specified in the CMI work plan and supporting documents • Soil samples collected will be analyzed by an Environmental Laboratory Accreditation Program (ELAP) certified subcontracted laboratory for the COCs (perchlorate and RDX). • Analytical results generated by off-site laboratories will be evaluated using procedures outlined in the Quality Assurance Project Plan portion of the CMI work plan to ensure they are suitable for final decision making. • Soil sample results will be reviewed by the APTIM Project Chemist or as delegated and the U.S. Army Engineering and Support Center, Huntsville (CEHNC) Chemist. • Analytical results from waste characterization samples will be submitted to the off-site disposal facility to adequately classify waste materials and meet the applicable waste profile package requirements for disposal.
Step 7. Develop/Optimize the Plan for Obtaining Data	• Only qualified personnel will perform corrective measures activities. • Requirements of the CMI work plan will be subject to QC and QA reviews.

APPENDIX E

SITE-SPECIFIC HEALTH AND SAFETY PLAN

Appendix E

Site-Specific Safety and Health Plan

Corrective Measures Implementation
RSA-013, Unlined Inactive Open Burn Pad
Operable Unit 14
U.S. Army Garrison-Redstone
Madison County, Alabama
EPA ID No. AL7 210 020 742

Prepared for:

U.S. Army Engineering & Support Center, Huntsville
5021 Bradford Drive East
Huntsville, Alabama 35805

Prepared by:

Aptim Federal Services, LLC
11400 Parkside Drive, Suite 400
Knoxville, TN 37934

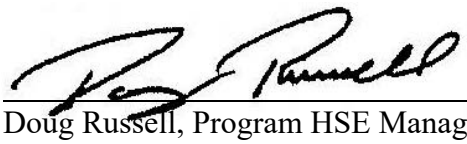
Contract No. W912DY-17-D-0003
Delivery Order No. W912DY19F1116
APTIM Project No. 501388

November 2021

Site Safety and Health Plan
Corrective Measures Implementation, RSA-013
Redstone Arsenal, Madison County, Alabama

Contract No. W912DY-17-D-0003

Plan Preparer:

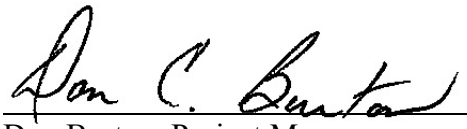


11/10/2021

Doug Russell, Program HSE Manager
Aptim Federal Services, LLC

Date

Plan Approval:



11/10/2021

Don Burton, Project Manager
Aptim Federal Services, LLC

Date

ACKNOWLEDGEMENTS

The approved version of this site-specific safety and health plan (SSHP) for corrective measures implementation of soil at RSA-013 has been provided to the Quality Control Site Manager (QCSM). I acknowledge my responsibility to provide the QCSM with the equipment, materials, and qualified personnel to implement fully all safety requirements in this SSHP. I will formally review this plan with the health and safety staff at least annually until project completion.

Don Burton, APTIM Project Manager — 11/10/2021 Date

I acknowledge receipt of this SSHP from the Project Manager and that it is my responsibility to explain its contents to all site personnel and cause these requirements to be fully implemented. Any change in conditions, scope of work, or other change that might affect worker safety requires me to notify the Project Manager and the Health and Safety Field Manager.

Brian Rhodes, APTIM QCSM — 11/10/2021 Date

SAFETY AND HEALTH PLAN
ACKNOWLEDGEMENT FORM

I have been informed of and will abide by the procedures set forth in this site-specific safety and health plan for the RSA-013 corrective measures implementation at Redstone Arsenal. By signing this acknowledgement form, I certify receipt of hazard communication training required for safe performance of my job at Redstone Arsenal, Madison County, Alabama.

Printed Name	***Signature***	***Representing***	***Date***

EMERGENCY CONTACT INFORMATION

In case of emergency or unplanned situation, contact the appropriate responder from the list below.

- In emergency situations, contact the site Point of Contact (POC) who will then contact the appropriate response teams.
- If a serious, life threatening emergency arises, contact emergency personnel before contacting the site POC.

EMERGENCY TELEPHONE NUMBERS AND PROJECT CONTACTS

Emergency Medical Care		
Hospital: Huntsville Hospital (Emergency/Trauma Center)	911 (256) 265-1000	
Core Health Networks	(877) 347-7429	
Occupational Health Center, Crestwood Family Practice	(256) 721-9916	
Crestwood Workers Care Madison	(256) 830-8930	
Chemical Agent Emergencies (state that you are at Redstone)	911	
National Poison Control Center	(800) 222-1222	
National Response Center Environmental Emergencies	(800) 424-8802	
Federal Occupational Safety and Health Administration (OSHA) Emergency Hotline	(800) 321-6742	
Local Emergency Numbers		
Fire Department Emergency ask for Redstone Arsenal Fire Department	Emergency Nonemergency	911 (256) 876-2117
Law Enforcement Military Police	Emergency Nonemergency	911 (256) 876-2222
Installation Emergency Operations Center	Nonemergency	(256) 313-1043
Installation Operations Center	Nonemergency	(256) 313-1043
Garrison Safety Office Safety Manager Safety & Occupational Health Specialist Munitions and Explosives of Concern (MEC) support	Nonemergency Michael Moore Keith Coates Rusty Brands	(256) 876-2944 (256) 313-3297 (256) 876-3383 (256) 876-3855
USACE and Army		
U.S. Army Engineering and Support Center, Huntsville (CEHNC) Contracting Officer's Representative (COR) and Project Manager (PM)	Ashley Roeske	(256) 895-1933
CEHNC-OEC, Safety Chief	John Lewis	(256) 895-1589 (office) (251) 721-5276 (mobile)

CEHNC-OEC Operations Manager	Wilson Walters	(256) 895-1290 (office) (256) 990-1512 (mobile)
US Army Garrison-Redstone	Clint Howard	(256) 758-7084 (office) (256) 842-3702 (mobile)
Chemical, Biological, Radiological, Nuclear, and High-Yield Explosives Analytical and Remediation Activity	Charles Hendricks	(870) 540-6711
APTIM Contact Information		
Health and Safety Emergency Number		(800) 537-9540 opt. 2
Project Manager	Don Burton	(865) 207-1394
Program HSE Manager	Doug Russell	(865) 414-9545 (cell) (865) 560-7918 (office)
Corporate Quality Management Representative	Tricia Felt	(303) 741-7426
Senior Unexploded Ordnance (UXO) Supervisor	To be determined	
Site Safety & Health Officer	Brian Rhodes	(256) 714-4200
Senior Vice President Health, Safety, Environmental	Jeff Thompson, CSP	(303) 741-7163
Project Certified Industrial Hygienist	Larry Verdier	(513) 378-8021
Occupational Physician	Dr. William Nassetta	(225) 756-2673

DIRECTIONS TO THE EMERGENCY MEDICAL CENTER

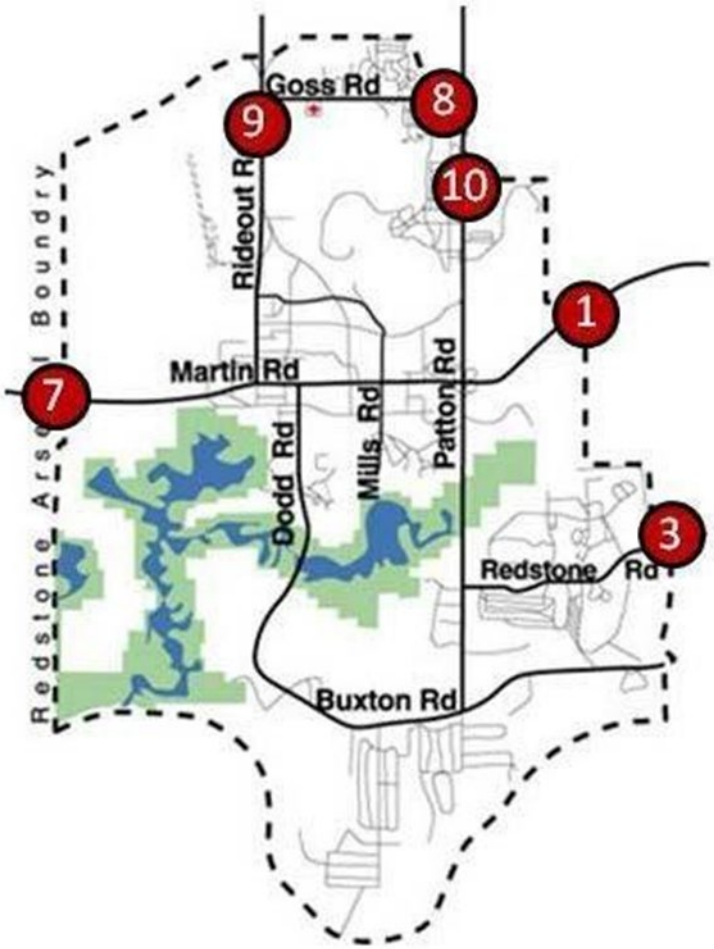
The Huntsville Hospital is located at 101 Sivley Road SW, Huntsville, Alabama, 35801 as shown on Figure E-1.

Redstone Arsenal Gate Hours

Location	Weekdays	Weekends
Gate1	0530 - 2100	Closed
Gate 3	0530 – 1300*	Closed
Gate 7	0530 – 1300*	Closed
Gate 8	0530 – 2100	0530 - 2100
Gate 9	24/7	24/7
Gate 10	0530 – 2100	Closed
Visitor Center 1	0600 - 1430	Closed
Visitor Center 9	0600 - 1700	Closed

*Gate 3 outbound lanes will remain open until 1800
*Gate 7 outbound lanes will remain open until 1800

Gate hours and conditions are subject to change because of homeland defense initiatives; therefore, the point of contact for the current gate operational hours is the Provost Marshall Office at (256) 876-4195.



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List of Acronyms and Abbreviations

°F	degrees Fahrenheit
ACGIH	American Conference of Governmental Industrial Hygienists
ADEM	Alabama Department of Environmental Management
AHA	Activity Hazard Analysis
APP	Accident Prevention Plan
APTIM	Aptim Federal Services, LLC
CCP	COVID-19 Control Plan
CA	chemical agent
CB&I	CB&I Federal Services LLC
CCP	COVID-19 Control Plan
CDHS	Corporate Director of Health and Safety
CEHNC	U.S. Army Engineering Support Center, Huntsville
CFR	Code of Federal Regulations
CMI	corrective measures implementation
COR	Contracting Officer's Representative
COVID-19	Coronavirus Disease 2019
CPR	cardiopulmonary resuscitation
CRZ	contamination reduction zone
CWM	chemical warfare materiel
dBA	A-weighted decibel
DEET	N,N-Diethyl-m-toluamide
DDESB	Department of Defense Explosives Safety Board
ECT	equivalent chill temperature
EM	engineer manual
EZ	exclusion zone
F-B	flash to bang
HAZWOPER	Hazardous Waste Operations and Emergency Response
HSM	Health and Safety Manager
IAW	in accordance with
IEOC	Garrison Installation Emergency Operations Center
MEC	munitions and explosives of concern
OB	open burn
OD	open detonation
OSHA	Occupational Safety and Health Administration

List of Acronyms and Abbreviations *(Continued)*

PM	Project Manager
PPE	personal protective equipment
PWP	plasticized white phosphorus
RFI	Resource Conservation and Recovery Act facility investigation
RSA	Redstone Arsenal
SDS	safety data sheet
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
SZ	support zone
LV®	threshold limit value
TSM	tailgate safety meeting
USACE	U.S. Army Corps of Engineers
UXO	unexploded ordnance
WBGT	wet bulb globe temperature
WP	white phosphorus

E1.0 Site Description and Contamination Characterization

E1.1 RSA-013 Site Description

RSA-013 is in the southern portion of Redstone Arsenal (RSA), within the RSA-151 groundwater unit. The site lies within the boundary of the active open burn (OB)/open detonation (OD) area. No buildings are located within the RSA-013 site boundaries. RSA-013 is located east of the Tennessee River and south of an embayment to the river (corrective measures implementation [CMI] work plan Figure 1-1). The RSA-151 groundwater unit underlying RSA-013 covers approximately 572 acres in the southern portion of RSA.

Prior to 2009, the footprint for RSA-013 encompassed 4.3 acres and consisted of the area containing two formerly used unlined (earthen) burn pads. Based on the recommendations in the potential source area investigation report for RSA-151 (Shaw Environmental, Inc., 2006), the RSA-013 site boundary in the Army Geographical Information System layer was expanded to 5 acres in 2009 to include two noncontiguous sites: RSA-132, Dismantled Popping Furnace (0.5 acre), and RSA-133, Inactive Rocket Washrack/Sump (0.2 acre). This CMI is limited to the original 4.3-acre parcel associated with the two former burn pads (RSA-013); the RSA-132 and RSA-133 Resource Conservation and Recovery Act facility investigation (RFI) reports recommended these sites for no further action for soil (CB&I Federal Services LLC [CB&I], 2017), and both RSA-132 and RSA-133 received Alabama Department of Environmental Management (ADEM) concurrence for no further action for soil on May 25, 2017.

The RSA-013 burn pads were used from the 1950s until 1986 for the thermal treatment (burning) of explosives and explosives-contaminated material and reactive waste, primarily propellant. Propellant burned at RSA-013 included waste perchlorate containing relatively high amounts of solvent. The ash, residue, and metal debris left over from burning activities were transported off site and disposed at the RSA-014 trenches, located to the southeast, and at RSA-066, which is located to the north of the embayment (CMI work plan Figure 1-3). The pads, each approximately 200 feet square, were bare ground surrounded by grass fields and earthen berms on the west side of each pad. Operations were discontinued and investigations were initiated following an ADEM inspection during which burning on unprotected ground was observed, which resulted in ADEM issuing a Notice of Violation in January 1986.

A site map for RSA-013 is presented on Figure 1-3 of the CMI work plan. The topography in the vicinity of RSA-013 is relatively flat with ground elevations that range from 560 to 578 feet above mean sea level, except for two earthen berms located directly to the west of the former

burn pads. With the exception of the berms, the site lies within the 100-year floodplain, generally defined as the 565-foot elevation contour. The RSA-013 berms and former burn pads are overgrown with vegetation; the remainder of the site is primarily maintained grass. Varying quantities of materials (e.g., wooden packing crates, pallets, and other miscellaneous debris) are stored against the berms for the adjacent OB/OD sites. Based on information recorded on boring logs, the thickness of the residual soil (overburden) ranges from approximately 20 to 41 feet and the average depth to overburden groundwater is 7.38 feet below ground surface (CB&I, 2017).

The current chemical warfare materiel (CWM) and unexploded ordnance (UXO) probability designations for RSA-013 are "Unlikely" and "Low." According to the RSA Master Plan, the site is located in an area designated as Industrial Zone, representing Range Operations, Explosive Operations, Storage, Test Areas, Open Space, and Buffer Zone in the RSA Master Plan. RSA-013 is within the OB/OD area. Due to the "Low" UXO probability at RSA-013, the project team will be required to have On-Call UXO construction support during excavation activities The Army manages the CWM and UXO probabilities for RSA-013 under the site access control program (U.S. Army Garrison-Redstone, 2012).

E1.2 Project Objective

The U.S. Army is conducting investigation and remediation of known or suspected waste sites at RSA in Madison County, Alabama, under the Resource Conservation and Recovery Act. The Army has contracted Aptim Federal Services, LLC (APTIM) to perform remediation services under the management of the U.S. Army Environmental Command. APTIM, on behalf of the Army, prepared this CMI work plan site-specific safety and health plan (SSHP) for RSA-013, Unlined Inactive Burn Pad, located within Operable Unit 14 (Figure 1-1 of the CMI work plan). This plan incorporates applicable elements of ADEM Hazardous Waste Facility Permit No. AL7 210 020 742 and the most recent edition of the Alabama Environmental Investigation and Remediation Guidance. This plan protects employees' human health from hazardous constituents at concentrations exceeding applicable limits.

The CMI work plan describes the corrective measures necessary to support completion of corrective measures and achievement of response complete at RSA-013. The RFI report for RSA-013 concluded that the Army's historical operations have resulted in a release of perchlorate and RDX to soil within RSA-013 that poses a leaching threat to groundwater. Corrective measures for chemicals of concern in groundwater under RSA-013 will be conducted with the RSA-151 groundwater unit corrective measures under a separate contract.

E1.3 Project Tasks

The following project activities to meet the CMI objectives in support of a soil removal action are detailed in the RSA-013 CMI work plan:

- Obtain underground injection control permit
- Mobilization/demobilization
- Utility clearance and marking
- Vegetation clearance
- Protection and/or closure of existing monitoring wells
- Excavation of contaminated soil
- Post-excavation soil confirmation sampling and analysis
- Placing of a carbon source at the bottom of the excavation to promote biodegradation of perchlorate in the smear zone and possibly into saturated zone soils
- Waste characterization sampling
- Transport and disposal of excavated soils contaminated with perchlorate/RDX as nonhazardous waste (Subtitle D landfill)
- Site restoration, including application of backfill and topsoil and revegetation with approved grass mixtures.

This SSHP is intended to be used in conjunction with the approved Final Installation-Wide Accident Prevention Plan (APP) for RSA (U.S. Army Engineering and Support Center, Huntsville [CEHNC], 2019), as applicable. All personnel on this site shall have received training, informational programs, and medical surveillance as outlined in the Final Installation-Wide APP (CEHNC, 2019) and be familiar with the requirements of this SSHP.

E1.4 Contamination Characterization

Based on review of available data for RSA-013, perchlorate and RDX present a leaching threat to groundwater resulting in concentrations of these constituents in groundwater that pose an unacceptable risk to human health should groundwater be consumed. Otherwise, perchlorate and RDX pose no unacceptable risks to residential or industrial receptors or to the environment. The principal source of perchlorate and RDX is primarily associated with former site activities. A detailed discussion of perchlorate and RDX at RSA-013 is provided in the CMI work plan. It is extremely unlikely, based on the concentration of site contaminants, that personnel performing

soil disturbance activity will be exposed to industrial chemicals at or above their respective 8-hour or short-term occupational exposure limit.

E2.0 Activity Hazard Analysis

E2.1 Anticipated Hazards

The nature and extent of contamination at RSA-013 has been characterized. The results of the RSA-013 RFI indicated that perchlorate and RDX in soil at RSA-013 poses a continuing leaching threat to groundwater resulting in concentrations of these constituents in groundwater that pose an unacceptable risk to human health should groundwater be consumed. Otherwise, perchlorate and RDX pose no unacceptable risks to construction workers, residential receptors, or the environment.

Thus, based on the results from the RFI for RSA-013, a corrective measure is required for perchlorate and RDX in soil from past Army activities that pose a leaching threat to groundwater. Chemicals of concern in groundwater pose unacceptable risks to receptors who may consume the groundwater; however, installation-wide restrictions are in place to prohibit consumption of groundwater for potable purposes and manage nonpotable uses.

Table E2-1 lists contaminants of interest and potential acute health effects.

Unexploded Ordnance and Chemical Warfare Materiel Probability. RSA-013 has a "Low" UXO probability and the CWM probability is "Unlikely."

Munitions and explosives of concern (MEC) items are military munitions that may pose unique explosives safety risks, such as UXO, discarded military munitions, or munitions constituents present in high enough concentrations to pose an explosive hazard. Munitions constituents are any materials originating from UXO, discarded military munitions, or other military munitions, including explosive and nonexplosive materials, and emission, degradation, or breakdown elements of such ordnance or munitions (10 U.S. Code 2710[e][3]) and 10 U.S. Code 2710[e][2]).

Section E2.4.9 is provided to describe safety measures in the unlikely event that MEC, explosives, CWM, or chemical agents (CA) are encountered.

Should any suspicious item be encountered during site activities, protocol as documented in Section 5.7 of the RSA-013 CMI work plan will be followed, which includes but is not limited to stopping all work and notifying appropriate project personnel.

E2.2 COVID-19 Virus Hazards

Coronavirus Disease 2019 (COVID-19) is a respiratory disease caused by the SARS-CoV-2 virus. COVID-19 spread from China to many other countries around the world, including the United States. The COVID-19 pandemic is impacting all aspects of daily life, including travel, trade, tourism, food supplies, and financial markets. Procedures and information for awareness and education, screening methods, contamination prevention and sanitation, and reporting and illness/exposure management are presented in AMS-710-01-FM-04201, *COVID-19 Control Plan* (CCP).

- A continual assessment of hazards is required to maintain a current awareness of exposures and the effectiveness of current controls. These methods will ensure employees have access to current information on how the pandemic is progressing, known site-specific exposures, site-specific controls and how to effectively implement them, and reporting requirements.

- Employees can be exposed both at the job site and away from the job site. Fever/chills, coughing, shortness of breath/difficulty breathing, fatigue, muscle/body aches, headache, new loss of taste or smell, sore throat, congestion/runny nose, nausea/vomiting, and diarrhea are currently the primary symptoms that may occur between 2 and 14 days from contraction of the virus. It is critical to remind employees to identify any of these symptoms and to quickly isolate employees who are symptomatic from other employees.

- Current medical understanding is that the virus is primarily transmitted via respiratory droplets. The virus can potentially survive on varying surfaces from hours to multiple days. Primary routes of entry include the mouth, eyes and nose. Practices such as "sick employees stay at home," social distancing, and the use of face masks will be used as prevention measures against the virus spread. Sanitation of work areas, office trailers, and restroom facilities will be performed regularly, including additional attention to personal hygiene and hand washing.

- APTIM has suspended all non-essential business travel. Essential business travel must be approved by APTIM leadership. Anyone approved to travel will be screened prior to reporting back to the jobsite.

- Additional reporting and illness management procedures will also be implemented as a management tool to help understand the virus and prevent its spread. This includes a listing of roles and responsibilities for APTIM's management team, employees, and medical providers. APTIM expects subcontractors to protect their employees through compliance with APTIM's CCP or the development and implementation of a CCP specific to their risks. APTIM and CEHNC leadership must approve subcontractor plans before implementation at the job site.

These requirements are in effect at least for the duration of the pandemic. The APTIM COVID-19 Task Force will amend these requirements or suspend their operation when no longer necessary.

E2.3 Activity Hazard Analyses

Detailed project-specific hazards and controls for each major definable feature of work/activity will be addressed in task-specific activity hazard analyses (AHA) (Attachment 1).

AHAs have been prepared for the following corrective measures activities at RSA-013:

- Mobilization and demobilization
- Visual site inspections and civil surveys
- Site surveys (utility)
- Vegetation clearance or removal
- Excavation and backfilling
- Soil sampling
- Waste management and disposal of investigation-derived waste
- Equipment decontamination
- Pressure washing
- Site restoration
- COVID-19 job site work practices
- Vehicle and fueling operations.

If new operations or tasks are introduced, the Site Safety and Health Officer (SSHO) will perform a hazard analysis. If operations change significantly during the course of this project, the related AHA will be updated to accommodate these changes. The SSHO will approve any changes in personal protective equipment (PPE) or operating procedures before they are implemented. Changes will be communicated to the field team(s) during daily tailgate safety meeting (TSM). The SSHO will be responsible for ensuring that the required controls are being properly implemented for each operation or task.

E2.4 Classic Safety Hazards

E2.4.1 Slip, Trip, and Fall Hazards

Hazard Identification

Work areas may contain slip, trip, and fall hazards for site workers, such as:

- Holes, pits, or ditches
- Slippery surfaces
- Uneven and rough terrain

- Vegetation and debris such as fallen branches, vines, and roots
- Weather conditions that make surfaces slippery and obscure visibility, and thunderstorms and tornados.

Hazard Mitigation/Prevention

Site personnel will be instructed to look for these potential safety hazards and immediately inform the SSHO about any encountered or new slip, trip, or fall hazards. If the hazard cannot be immediately removed or mitigated, action will be taken to notify site personnel about the hazard. Slips, trips, and fall hazards will be a daily tailgate safety briefing item. Operations will cease if weather conditions will cause activities to become hazardous.

E2.4.2 Motor Vehicles and Heavy Equipment

Hazard Identification

Site tasks such as site preparation, brush clearing, excavation, and vehicle and/or heavy equipment operation may present a hazard. Injuries can result from being hit or run over by a moving vehicle; from vehicles overturning; or from being struck, burned, or otherwise injured by moving parts. Vehicles and heavy equipment design and operation will be according to 29 Code of Federal Regulations (CFR) Subpart O, 1926.600 through 1926.602. The types of heavy equipment anticipated to be used on site include earth-moving machinery, pickup trucks, track hoes, utility trailers, flatbed trucks, and dump trucks.

Hazard Mitigation/Prevention

Before any machinery or mechanized equipment is placed into use, it will be inspected and tested to verify that it is in safe operating condition. Records of tests and inspections will be maintained at the site.

Procedures for mitigation and prevention of hazards associated with motor vehicles are contained in AMS-710-02-PR-02700, *Non-Commercial Motor Vehicle Safety;* AMS-710-02-PR-05700, *Mechanized and Marine Equipment*; and AMS-710-02-PR-03900, *Commercial Motor Vehicle Safety* (Attachment 2). APTIM has also implemented additional protocols for motor vehicle use on RSA. A 360-degree walk-around is required before placing vehicles and equipment in motion that have been parked or temporarily staged. Traffic cones are required at the rear of all parked site trucks to facilitate the 360-degree walk-around. Personnel working at remote areas on site with limited roadway space shall position vehicles in the direction of egress to facilitate quick exit in event of emergency. Additionally, use of cellular phones while driving on RSA is strictly

prohibited. Violators are subject to fines and loss of driving privileges on base when cited by Military Police in violation of this regulation.

The following safety procedures will be adhered to on sites using heavy machinery and equipment:

- APTIM will designate a competent person to be responsible for the daily inspection of all machinery and equipment and during use to ensure that it is in safe operating condition. Tests will be made at the beginning of each day during which the equipment is to be used to determine that the brakes and operating systems are in proper working condition. Inspections will be documented on AMS-710-02-FM-05701, *Mechanized and Marine Equipment Inspection Report* (Attachment 2).

- Preventive maintenance procedures recommended by the manufacturer will be followed. Any machinery or equipment found to be unsafe will immediately be removed from service and its use prohibited until unsafe conditions have been corrected. A tag indicating that the equipment may not be operated will be placed in a conspicuous location on the equipment. The tag will remain until it is demonstrated to the individual tagging the equipment that it is safe to operate. Where possible, lockout procedures are the preferred method of control to use.

- Only designated personnel will operate machinery and mechanized equipment. Equipment deficiencies that affect safe operation observed at any time will be corrected before continuing operation. Seats and seat belts will be installed and used by operators and passengers of heavy equipment. The only exception to this requirement will be for heavy equipment designed for stand-up operation. Entering or exiting any equipment while it is in motion is prohibited. Machinery or equipment requiring an operator will not be permitted to run unattended. Machinery or equipment will not be operated in a manner that will endanger individuals or property, and safe operating speeds or loads will not be exceeded.

- Equipment operated on the public roads will be equipped with turn signals visible from the front and rear. Mechanized equipment will be shut down prior to and during fueling operations. Closed systems with automatic shut-off that prevent spillage if connections are broken, may be used to fuel diesel-powered equipment left running.

- All towing devices used on any combination of equipment will be structurally adequate for the weight drawn and securely mounted. Persons will not be permitted to go between a towed and towing piece of equipment except to connect the equipment. All equipment with windshields will be equipped with powered wipers. Vehicles that operate under conditions that cause fogging or frosting of windshields will be equipped with operable defogging or defrosting devices.

- Whenever the equipment is parked, the parking brake will be set. Equipment parked on inclines will have the wheels chocked or track mechanism blocked and the parking brake set.

- Personnel will not work or pass underneath the loads handled by lifting or digging equipment.

- Each piece of heavy equipment on site will be equipped with at least one dry chemical or carbon dioxide fire extinguisher.

- A warning device or signal person will be provided where there is danger to nearby workers from moving equipment such as swinging loads, buckets, or booms. Where manual (hand) signals are used, only one person will be designated to give signals to the operator. The signal person will be located to see the load and be clearly visible to the operator. Employees will be required to stay clear of any vehicle being loaded or unloaded to avoid being struck by any spilling or falling materials.

- Loose, ill-fitting clothing and jewelry can become caught in heavy equipment; therefore, jewelry will be removed, and proper fitting clothing will be worn during field activities that involve heavy equipment. Long hair that extends below the hard hat will be tied in a manner to prevent contact with moving equipment parts. PPE will be required of all persons working with or near heavy equipment operations, in accordance with (IAW) this SSHP. Employees exposed to public vehicular traffic will be provided with, and will wear, warning vests or other suitable garments marked with or made of reflective or highly-visible material.

E2.4.3 Underground Utilities

Hazard Identification

The specific hazards include, but are not limited to, utilities such as sewers, telephone, cable, fiber optic, water, fuel, gas, and electrical lines.

Hazard Mitigation/Prevention

Before excavating, the existence and location of underground pipe, electrical equipment, and gas lines will be determined. This will be done IAW AMS-710-02-PR-01610, *Utility Contact Prevention* (Attachment 2) by contacting the appropriate RSA representative to mark the location of the lines. Before beginning any intrusive activities, the SSHO will obtain a digging clearance if appropriate, and will document phone calls, correspondence, and confirmation numbers. Site personnel will not enter underground utilities. If the local utility service cannot access all areas of the site where utilities may be located, geophysical instruments or utility locators will be used to scan for buried utilities.

E2.4.4 Trenching and Excavation

During excavation and trenching, AMS-710-02-PR-01600, *Excavation and Trenching*; AMS-710-02-PR-01610, *Utility Contact Prevention;* and AMS-710-02-PR-05700, *Mechanized and Marine Equipment* (Attachment 2), must be followed. This procedure complies with

Occupational Safety and Health Administration (OSHA) Regulations 29 CFR 1926.650 through 29 CFR 1926.652 and Engineer Manual (EM) 385 1-1. No one is permitted to enter any excavation more than 4 feet deep. If during excavation conditions occur placing personnel or equipment at potential risk of falling into the excavation, sloping shall occur and take into account at a minimum the angle of incline required to prevent a cave-in with differences in such factors as the soil type, environmental conditions of exposure, and application of surcharge loads.

All excavation shall be performed from a stable ground position. Daily inspections of the excavation shall be made as needed throughout work shifts and after every rainstorm or other hazard-increasing occurrence by a competent person who has received training and is competent in excavation safety. The competent person shall determine the likelihood of a cave-in, and reasonable actions such as sloping or shoring shall be taken if the walls appear to be unstable. When it is necessary for personnel to be near the excavation for photographic documentation, an excavation-competent person must deem it safe to do so. Otherwise, all photographs of the excavation shall be performed by the excavator operator from within the cab when it is safe to do so.

All spoil shall be located at least 3 feet from the edge of the excavation to prevent loading on the excavation platform. The excavation shall be guarded on all sides by barricades or caution tape at least 10 feet from the edge. Class II protection around excavations within the delineated exclusion zone (EZ) shall be utilized.

E2.4.5 Hazardous Energy Control

It is crucial to be aware of hazardous energy to prevent accidents. At the sites included in this contract, overhead and underground utilities are a hazardous energy of concern. Additionally, stored energy associated with heavy equipment hydraulics can be released during servicing or maintenance. Accidents can occur when hazardous energy sources are not evaluated. Accidents also occur when equipment is not properly isolated, shut down, and/or de-energized.

Lock-out/tag-out activities shall follow AMS-710-02-PR-01500, *Control of Hazardous Energy* (Attachment 2). APTIM will coordinate lock-out/tag-out with the Department of Public Works in cases where they are required to assist in hazardous energy control and an APTIM employee or subcontractor is not the authorized user.

E2.4.6 Cumulative Trauma Disorder

Hazard Identification

Injuries may occur from hand digging with shovels, clearing and grubbing tools, and hand augers. Workers will be instructed to avoid over-reaching, lifting, and twisting while moving equipment and to verify that footing is solid before lifting commences.

Hazard Mitigation/Prevention

The following actions will be taken to minimize ergonomic risks:

- Use a hand truck or other mechanical aids to move heavy objects.
- Push rather than pull whenever possible.
- Readjust the load before moving it or change position to avoid twisting or stretching the body to lift the load.
- Consider the size, shape, and weight of the object to be lifted. No individual employee is permitted to lift any object that weighs over 50 pounds. Multiple employees or the use of mechanical lifting devices is required for objects over the 50-pound limit.
- Consider that the safe lifting zone is between the knees and shoulders. If the object is below knee level, bend the knees and lift with the legs. If the load is above the shoulders, use a sturdy step ladder.
- Inspect the anticipated path to the destination for the presence of slip, trip, and fall hazards and clear obstacles before commencing to move the load/object. Place feet far enough apart for good balance and stability (typically shoulder width).
- Get as close to the load as possible. Bend legs at the knees.
- Keep the back as straight as possible and abdominal muscles tightened.
- Avoid twisting motions when performing manual lifts.
- Straighten legs from their bent position to lift the object.
- Take small turning steps without twisting the knees or the back if it is necessary to turn with the load.
- Never carry a load that cannot be seen over or around.

E2.4.7 Vibration

Hazard Identification

Both hand-held and stationary tools that transmit vibration through a work piece can cause vibration "white fingers" or hand-arm vibration syndrome. The use of these types of tools is not anticipated on this project; however, if they should be required, proper control measures will be used to minimize hand-arm vibration.

Hazard Mitigation/Prevention

The control measures may include the following:

- Using anti-vibration tools and/or gloves
- Keeping hands and body warm
- Minimizing the vibration coupling between the hand and the tool
- Participating in the medical surveillance program
- Adhering to the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV®) for hand-arm vibration.

E2.4.8 Material Handling and Lifting

Hazard Identification

Improper handling and lifting of materials and equipment on site can result in specific injuries to the body, most notably the back.

Hazard Mitigation/Prevention

Site personnel will exercise care in lifting and handling heavy or bulky items. No site worker will attempt to lift any item in excess of 50 pounds without assistance or use of a mechanical device. Materials being lifted either mechanically or manually will not be moved or suspended over personnel unless precautions have been made to protect the personnel from falling objects. Whenever heavy or bulky material is to be moved manually, the size, shape, and weight of the object and the distance and path of movement must be considered to prevent joint and back injuries. Adhere to the following hierarchy in selecting a means for material handling:

1. Movement of the material by mechanical device (lift truck, earth-moving machinery, , and similar)

2. Movement by manual means using mechanical aid (dolly or cart)

3. Movement manually in a planned manner with an adequate number of personnel.

The SSHO will train employees in proper lifting techniques and require that they lift objects properly. The following procedures will be followed:

1. Ensure the hands and object are free of oil, grease, or water that might prevent a firm grip. A firm grip on the object is essential.

2. Keep hands, and especially the fingers, away from any points where pinching or crushing could occur, particularly when setting the object down.

3. Inspect the item for metal slivers, jagged edges, burrs, rough or slippery surfaces, and pinch points, and, if necessary, use gloves to protect the hands.

4. Place the feet far enough apart for good balance and stability.

5. Ensure that solid footing is available before lifting the object. When lifting, remain as close to the load as possible, bending legs at the knees, keeping the back as straight as possible, and lifting the object with the legs while straightening from a bended position.

6. Never carry a load that cannot be seen over or around while carrying it.

7. When setting an object down, keep the stance and position identical to that for lifting, with the back straight and the legs bent at the knees while the object is lowered.

8. When two or more people are required to carry an object, distribute the load uniformly. Each person should face the direction in which the object is being carried as much as possible.

E2.4.9 Explosive Ordnance Hazards

MEC Hazard Safety

All site personnel will be given ordnance recognition training prior to working on the site. The training will be verified by signature on the site training form. Personnel should be alert for UXO and munitions debris.

If MEC is encountered or suspected to have been encountered during any phase of work, the Site Manager and the SSHO will be immediately notified. In general, the following MEC safety precautions and protocols will be followed:

- Personnel will follow the 3R's: **Recognize**, **Retreat**, and **Report**. The location(s) will be marked, personnel will be kept out of the area, and appropriate personnel will be notified.

- Always remain alert at all times for MEC, UXO, and related scrap or material potentially presenting an explosive hazard.

- Observe the cardinal principle involving ordnance, explosives, ammunition, severe fire hazards, or toxic materials i.e., to limit the exposure to a minimum number of personnel, for the minimum amount of time, to a minimum amount of hazardous material consistent with a safe and efficient operation.

- Always assume MEC hazards contain a live charge until determined otherwise.

- DO NOT forget that death or injury can occur from MEC/UXO and explosive-related accidents.

- DO NOT forget that the age or condition of a MEC hazard does not decrease the effectiveness. MEC that has been exposed to the elements for an extended period of time can become more sensitive to shock, movement, and friction because the stabilizing agent in the explosives may be degraded.

- Consider MEC that has been exposed to fire as extremely hazardous. Chemical and physical changes to the contents may have occurred that render it more sensitive than it was in its original state.

- DO NOT approach leaking plasticized white phosphorus (PWP) or white phosphorus (WP) munitions. Burning PWP/WP may detonate the explosive burster charge.

- DO NOT touch crusted-over PWP/WP. Handling of crusted-over PWP/WP munitions will be done only at the discretion of the Unexploded Ordnance Safety Officer.

- DO NOT touch, move, or jar any ordnance items regardless of the markings or apparent condition. Under no circumstances will any MEC be handled during avoidance activities or moved in an attempt to make a positive identification.

- DO NOT touch, pick up, kick, or move anything that is unfamiliar or unknown.

- DO NOT roll the item over or scrape the item to identify markings.

- MEC suspected of containing CWM shall not be handled by APTIM or subcontractor personnel. All suspect CWM material shall be handled and managed by chemical, biological, radiological, and nuclear analytical and remediation activity.

- DO NOT approach or enter a munitions site if an electrical storm is occurring or approaching. If a storm approaches during site operations, leave the site immediately and seek shelter.

- DO NOT transmit radios or cellular phones in the vicinity of suspect MEC hazards.
- DO NOT walk across an area where the ground surface cannot be seen and that has not been cleared of MEC hazards by the UXO technician.
- DO NOT rely on color codes for positive identification of ordnance items or their contents.
- DO NOT drive vehicles into a suspected MEC area. Use clearly marked lanes.
- DO NOT carry matches, cigarettes, lighters, or other flame-producing devices into a MEC site.
- DO NOT be misled by markings on the MEC item stating, "practice bomb," "dummy," or "inert." Practice ordnance can have explosive charges that are used to mark and/or spot the point of impact, or the item could be marked incorrectly.
- Post the following warning on site:

— WARNING —

Removing or taking any munitions, explosive, UXO, or munitions-related debris from the site by any employee is strictly prohibited.

E2.5 Chemical Hazards

Table E2-1 lists potential contaminants that may have been used at RSA-013 and the potential routes of exposure and symptoms for each contaminant that may be encountered. Other information such as TLVs®, Permissible Exposure Limits, Immediately Dangerous to Life or Health values, Worker Protection Limits, and physical properties are also included.

Chemical hazards associated with site activities also includes fuels and oils brought on site for equipment use and maintenance. All site personnel will follow the procedures and precautions outlined in the appropriate Safety Data Sheet (SDS) for the appropriate use and storage of these materials. The SDS binder will be kept in the SSHO site vehicle or office and available to all employees on request.

E2.6 Night Operations

Night operations are not planned for RSA-013. If night operations should become necessary because of the site's location adjacent to the OB/OD Area, the lighting requirements are presented in Table E2-2. The SSHO will conduct prescribed light surveys to verify employees working on specific site work areas have adequate lighting IAW EM 385-1-1. During night work, portable light plants or fixtures will be positioned to provide adequate lighting in select site work areas such as:

- Excavation areas
- Loading areas
- Support area.

The lighting will be directed towards the work area and positioned to provide optimum work area illumination. Personnel may also use hand-held portable or body-attached lighting as necessary to provide focused beam lighting. If, at any time, the lighting conditions do not provide a safe work environment, activities will be halted and necessary adjustment to portable lighting made or additional light plants procured.

A Testo 545 Light Meter or equivalent with National Institute of Standards and Technology calibration certificate will be used to measure lighting at the site. Before the light meter is used, it will be calibrated according to the manufacturer recommendations. The light meter units will be set to measure in foot-candles/Lumens/square foot. A light monitoring log will be maintained. All light measurement logs will be turned over to site quality control for the site report. The SSHO or designee will be trained in the use of the light meter.

E2.7 Physical Hazards

E2.7.1 Severe Weather

Hazard Identification

During the course of field operations, severe weather may be encountered, including thunderstorms, rainstorms, tornados, and other unsafe weather conditions (i.e., high winds). Criteria indicating that severe weather conditions may exist include:

- High winds (greater than 40 miles per hour – depending on the tree cover and other site-specific conditions)
- Tornado watch or warning in place for the area
- Visible lightning or audible thunder
- Extreme temperatures (e.g., greater than 100 degrees Fahrenheit [°F] or less than 32°F)
- Heavy rainfall or fog that makes footing treacherous and visibility difficult.

Hazard Mitigation/Prevention

The SSHO will be responsible for checking the weather conditions at least twice a day through the use of local radio and television broadcasts, internet weather sites, or a weather radio. When

severe weather threatens, the SSHO will be responsible for deciding if site operations should cease.

If work is suspended, the SSHO will notify the teams and individuals via radio or cellular telephone. These individuals will be responsible for relaying the work suspension to other personnel in their areas. All personnel will cease operations, secure equipment if time permits, and expeditiously move to designated assembly areas for further instruction. Once the severe weather hazard has passed, the SSHO will notify the Site Manager that work may resume.

If a tornado is projected to impact the location of the job site, several measures will be taken. If the tornado's projected path is forecast to move through the area, the site and all equipment will be secured, and personnel will evacuate to a designated safe location, if time allows. If there is not enough time, personnel will immediately evacuate to a designated storm shelter without securing the site or equipment. The specific directions from the site to the closest shelter will be detailed during the site-specific briefing or TSM.

If there is not enough time to get to a shelter, possible actions include:

- Immediately get into a vehicle, buckle the seat belt, and try to drive to the closest sturdy shelter. If hit by flying debris while driving, pull over and park.
- Take cover in a stationary vehicle. Put the seat belt on and cover head with arms and a blanket, coat, or other cushion if possible.
- Lie in an area noticeably lower than the level of the roadway and cover head with arms and a blanket, coat, or other cushion if possible.

In all situations:

- Do not get under an overpass or bridge. Low, flat locations are safer.
- Never try to outrun a tornado in urban or congested areas in a car or truck. Instead, leave the vehicle immediately for safe shelter.
- Watch out for flying debris. Flying debris from tornadoes causes most fatalities and injuries.

E2.7.2 Lightning

Hazard Identification

Noting the time from lightning flash to the bang of the associated thunder offers a way to estimate the distance of the lightning to a given person's position. For each 5-second count from flash to

bang (F-B), lightning is 1 mile away. Thus, an F-B of 10 means that lightning is 2 miles away and an F-B of 15 means that lightning is 3 miles away, and so on. The lightning safety evacuation plan will be implemented at a count of 50 (10 miles) or as soon as lightning is observed or thunder is heard. This plan will be enacted for a minimum of 30 minutes after the last audible thunder or visible flash of lightning.

Hazard Mitigation/Prevention

If a lightning storm is observed, all outdoor site activities will cease, and personnel will seek safe shelter. A safe shelter may consist of:

- Fully enclosed metal vehicles with windows up and vehicle radio off
- Enclosed buildings
- Low ground.

Unsafe shelter areas include all nearby outdoor metallic objects such as flagpoles, fences, high mast lightpoles, gates, etc. Trees, water, and open fields will be avoided, and personnel will avoid using the telephone.

E2.7.3 Hazardous Noise

Hazard Identification

Planned activities may involve the use of noise-producing equipment such as weed trimmers, bobcats, backhoes, and other noise-producing equipment. The unprotected exposure of site workers to this noise during activities can result in noise-induced hearing loss.

A hazardous noise condition exists as a rule of thumb when communication between individuals separated by 3 feet requires shouting.

Hazard Mitigation/Prevention

Hearing protection is required any time the noise level reaches 85 a-weighted decibel (dBA) or greater or when communication between individuals separated by 3 feet requires shouting. Double protection is required anytime noise levels exceed 115 dBA. The SSHO will ensure that either earmuffs or disposable foam earplugs are available to, and used by, all personnel near sources of hazardous noise.

Where equipment generates high levels of continuous or impact noise, the SSHO will conduct a noise survey to verify that appropriate PPE is being used.

E2.7.4 Heat and Cold Stress

A detailed discussion of heat and cold stress symptoms, mitigation, and prevention is provided in Chapter 8.0.

E2.8 Biological Hazards

Personnel will be made aware of the various biological hazards that may be encountered while working at the sites, including ticks, poisonous insects (for example, fire ants, chiggers, and disease-bearing mosquitoes), poison ivy, and snakes, during the initial site safety orientation. Appropriate preventative measures will be employed to minimize potential exposure to biological hazards, including designating a field member to watch for biological hazards. Table E2-3 shows the biological hazards for the site. Additionally, hazards associated with COVID-19 are discussed in Section E2.2 and associated AHAs (Attachment 1).

The SSHO will be responsible for instructing personnel in avoiding or minimizing exposure to biological hazards. The keys to avoiding biological hazards are awareness of one's surroundings and general knowledge of the habits of various species that may present a threat. In general, the vertebrates will escape to avoid human contact when encountered. Reptiles will often seek out warm sunny locations in morning hours and during cold weather. A reconnaissance of the site work area should be conducted every morning to identify the presence of potential threat species of plants, insects, and animals. Clearings of vegetation and soil excavation near burrows are activities that potentially disturb reptiles or hornet nests in proximity to personnel. Extra care and caution should be exercised in any work area that disturbs vegetation or soil or when entering any vegetated area where one cannot directly see the ground surface at all times.

The work sites may contain ticks, venomous spiders, and venomous insects. Venomous insects and spiders are generally reclusive, and the greatest potential for exposure arises when personnel are opening containers, structures, buildings, and well casings; handling idle equipment; or moving construction material stockpiles. For example, caution should be taken when opening the casing around monitoring wells or moving material that have been idle on site.

E2.8.1 Mosquitoes

Mosquitoes are bothersome and may carry diseases, such as the West Nile and Zika viruses. They are attracted by heat, sweat, body odor, and carbon dioxide. Site personnel should wear protective clothing and insect repellent containing N,N-Diethyl-m-toluamide (DEET). Insect repellent should be reapplied at least every four hours. The following suggestions should provide some protection from mosquitoes (OSHA, 2016):

- Review the hazards associated with the West Nile virus and Zika virus through exposure to mosquito bites periodically during the TSMs. Zika virus prevention is an important issue because contracting this virus during pregnancy appears to pose a significant risk of neurological birth defects including microcephaly. Infection appears to be much less dangerous for healthy adults. Get regular updates on transmission and controls from Centers for Disease Control (nwww.cdc.gov/zika/).

- Document the briefing and the topics covered. Standard tailgate forms can be used as long as the form documents the topics covered. Have all sign attendees sign to verify training on Zika virus has been conducted.

- Apply sunscreen first and then insect repellent.

- Take extra precautions like Thermocell units and head nets (as long as they do not interfere with visual acuity).

- Increase protective measures when working at dawn, dusk, and in the early evening.

- Reduce the area of exposed skin when working outdoors. Long-sleeved shirts with sleeves rolled down are recommended; however, it should be understood that mosquitoes may bite through thin clothing. To avoid mosquitoes, personnel should evaluate the actual Level D clothing worn. For example, heavy long-sleeved work shirts and heavy dungarees/jeans may mitigate mosquito bites. The use of a disposable coverall, such as Tyvek®, may further reduce the risk of mosquito bites.

- Use an insect repellent containing approximately 30 percent DEET. Use the repellent according to the manufacturer's directions provided on the container. Frequent reapplication or saturation is not necessary for repellent containing DEET to be effective. Avoid prolonged and excessive use of DEET. (Caution: some individuals may be sensitive to DEET–always read and follow label directions.) After returning from outdoor field activities, wash treated skin with soap and water.

- Use commercially prepared clothing and gear with insect repellants containing 0.5 percent permethrin when additional protection against mosquitoes is necessary. These repellants, such as Repel Permanone™, are available in the sporting goods departments at major retailers. Clothing and gear insect repellants are not for use on skin. Use the repellent according to the manufacturer's recommendations provided on the container.

- Avoid using fragrances.

- Prevent accumulation of water, which can provide breeding grounds for mosquitoes.

The Zika virus is primarily transmitted through mosquitoes but may also be spread via bloodborne (contact) transmissions and sexual transmission (partner to partner). Only one in five infected individuals develops signs and symptoms, which include fever, rash, joint and muscle

pain, headaches, and red or pink eyes. Symptoms begin to occur between 2 and 7 days after exposure, are usually mild, and can last up to a week.

E2.8.2 Fire Ants

Nests should not be allowed to form near structures and areas where personnel will continue to have a need for access. If bitten, personnel should wash the bite area with soap and water, apply cool compress to the area, elevate the area, and apply a pasteof baking soda and water for itching.

E2.8.3 Stinging Insects

Workers should keep alert for bee and wasp activity and avoid wearing bright-colored clothing and scented toiletries when working outside. Be wary of areas around structures where bees and wasps may live. If bee or wasp activity is noted, the area should be avoided if possible. The use of insect repellants containing DEET is not effective in preventing stings. Anyone can have an allergic reaction to a bee sting, even people who were stung before with no reaction. Allergic reactions to bee stings may include swelling around the lips and eyes, rapid development of a rash, difficulty breathing, or signs of shock (pale skin, rapid pulse, and fainting). If any of these symptoms occur, call 911 immediately. Individuals who have had a previous reaction should notify the SSHO before fieldwork begins and carry a "bee-sting kit," EpiPen®, or Ana-Kit. All personnel will immediately report stings to the SSHO.

Nests should not be allowed to form near structures and areas where personnel will continue to have a need for access. If stung, personnel should wash the bite area with soap and water, apply a cool compress to the area, elevate the area on a pillow, and make a paste of baking soda and water for itching.

Africanized Honey Bees ("killer bees") are more aggressive and dangerous than other types of bees. If attacked by bees, workers should cover their faces, run away from the hive, and seek shelter in an enclosed area. If stung, the stinger should be removed and first aid sought if necessary.

E2.8.4 Centipedes

Centipedes are commonly found throughout Alabama and grow up to 3 inches in length. Centipedes are venomous though rarely fatal; however, if bitten, observe the individual for signs of allergic reaction for a minimum of 30 minutes. If a team member is bitten by a centipede, immediately report the incident to the SSHO to provide first aid treatment.

E2.8.5 Black, Brown, and Red Widow Spiders

The widow family of spiders are not usually aggressive unless agitated when the female is guarding her egg sac. They live in a variety of natural and domestic habitats such as under rocks and wooden boards and in dense plant growth. The female widows typically have bulbous, glossy abdomens approximately 1 inch long and marked with a characteristic marking on the underside of the abdomen (red hourglass on black for black widows and yellow hourglass on brown for brown widows, and the red widow is typically red-legged, black abdomen with yellow/red patches). The male is rarely seen and is smaller.

Widow spider venom affects the nervous system. The venom causes pain in the lymph nodes. Other symptoms of a severe bite include nausea, elevated blood pressure, sweating, tremors, and increased white blood cell counts. The wound may appear as a bluish red spot surrounded by a whitish area. Victims of a widow bite may exhibit the following signs or symptoms:

- Sensation of pinprick or minor burning at the time of the bite.
- Appearance of small punctures (sometimes none are visible).
- After 15 to 60 minutes, intense pain is felt at the site of the bite. The pain quickly spreads and is followed by profuse sweating, rigid abdominal muscles, muscle spasms, breathing difficulty, slurred speech, and poor coordination, dilated pupils, and generalized swelling of the face and extremities.

E2.8.6 Brown Recluse Spiders

Adult brown recluse spiders are soft bodied, yellowish tan to dark brown, about ¼ to ½ inch long, and have long, delicate grayish to dark brown legs covered with short, dark hairs. The leg span is about the size of a half-dollar.

The spider's most distinguishing characteristic is the existence of three pairs of eyes arranged in a semicircle on the forepart of the head and a dark, violin-shaped marking immediately behind the semicircle of eyes. Normally, all spiders have four pairs of eyes; eight altogether. The neck of the violin points toward the abdomen.

The spider may be found in sheltered corners among debris, in woodpiles, and under loose bark and stones. Hands, underarms, lower abdomen, and the ankles are the areas of the body most likely to be bitten. A bite may go unnoticed for six to eight hours before a reddening, swelling, and blistering area around the wound starts to appear. A severe bite can produce an area of dead skin tissue that may require surgery. Victims of a brown recluse bite may exhibit the following signs or symptoms:

- Blistering at the site of the bite, followed by a local burning at the site 30 to 60 minutes after the bite.
- Formation of a large, red, swollen, pustule lesion with a bulls-eye appearance.
- Systemic affects may include a generalized rash, joint pain, chills, fever, nausea, and vomiting.
- Pain may become severe after eight hours, with the onset of tissue necrosis.

There is no effective first aid treatment for black widow or brown recluse bites. Except for very young, very old, or weak victims, spider bites are not considered to be life threatening. Medical treatment must be sought, however, to reduce the extent of damage caused by the injected toxins. If the spider can be retrieved, it should be taken with the patient to medical treatment. If venomous spiders are suspected or known to be on site, the SSHO will brief the site personnel as to their identification and avoidance. As with stinging insects, site personnel should report to the SSHO if they locate these spiders on site or notice any type of bite while involved in site activities.

E2.8.7 Ticks

Nearly all work sites on this project may contain ticks. Working in tall grass, especially in or at the edge of wooded areas, increases the potential for ticks to bite workers. Ticks can be particularly numerous in the spring and fall. Ticks are vectors of many different diseases, including Lyme disease. Ticks attach to the skin and feed on blood, creating an opportunity for disease transmission.

The primary symptoms of tick-borne diseases are high fever, head and joint aches, nausea, and vomiting. Additionally, persons develop rashes or experience occasional coughs, chest pain, and severe pneumonia. Lyme disease usually presents a distinctive bull's eye rash at the site of the bite in addition to flu-like symptoms and swollen lymph nodes.

If ticks are prevalent, treat clothing with a permethrin-based product like Permanone™ as directed by the manufacturer. Use an insect repellent containing approximately 30 percent DEET on any bare skin. Insect repellant will be available to personnel. (Caution: some individuals may be sensitive to DEET – always read and follow label directions.) Close pant legs with tape or elastic bands or tuck them into socks. Tuck shirts into pants.

Periodically during the workday, employees should inspect themselves for the presence of ticks. If a tick is discovered, use the following procedure to remove it:

- Use fine-tipped tweezers to detach a tick. Do not try to detach the tick with bare fingers because bacteria from a crushed tick may penetrate even unbroken skin.
- Grip the tick as close to the skin as possible and gently pull it straight away from the skin until it releases its hold.
- Do not twist the tick as it is pulled and do not squeeze its body; this may inject bacteria into the skin.
- Wash hands and the bite area thoroughly with soap and water, and then apply an antiseptic to the bite area.

E2.8.8 Venomous Snakes

Alabama has a variety of snakes; however, the Coral Snake, Eastern Diamondback Rattlesnake, Pygmy Rattlesnake, Timber Rattlesnake, Copperhead, and Cottonmouth (or Water Moccasin) are the venomous varieties native to the state. All except the Coral Snake are within the venomous pit viper family. The Coral Snake belongs to elapid family.

Coral Snake

The Coral Snake is typically seldom seen and tends to be nocturnal. They are small snakes, averaging approximately 20 inches in length. Coral Snakes have rings of red, yellow, and black along the length of their bodies. Their noses are always black, with a yellow ring. They do not have long fangs and would need to "chew" on a person in order to inject their venom. Many snakes mimic the Coral Snake; however, the Coral Snake is the only snake that has red and yellow stripes touching.

Eastern Diamondback Rattlesnake

The Eastern Diamondback Rattlesnake is the largest rattlesnake native to North America, with average lengths reaching 6 feet. They are characterized by their large brown, black, and beige diamond marks on their back. The snake lives in forests near palmetto bushes and makes its home typically in old animal burrows. As a precaution, it is important to note that an Eastern Diamondback Rattlesnake does not always rattle before it strikes.

Pygmy Rattlesnake

The Pygmy Rattlesnake is a relatively small snake, with a length of 18 to 30 inches. They are gray with brownish round markings along the spine (top). They are typically very aggressive.

Timber Rattlesnakes

Timber Rattlesnakes are not aggressive and are sometimes reluctant to bite. If this snake is encountered, leave it alone. Its venom is highly toxic and can be fatal. Timber Rattlesnakes range

in size between 3 and 5 feet. The coloration of this species is blackish, yellowish, pinkish, or grayish with dark, bent, cross bands aligned along the dorsal length of its body. A reddish dorsal stripe runs between the cross bands, and it has a black tail. Timber Rattlesnakes typically inhabit forest, nearby fields, and swampy areas and may be found throughout Alabama.

Copperhead

Copperheads are usually not aggressive, and theirbite is very rarely lethal. Like most members of the pit viper family, the Copperhead is a heavy-bodied snake.These snakes range between 24 and 36 inches in length and are covered in hourglass-shaped crossbands which vary in coloration among different populations. The crossbands may be copper, pinkish, reddish brown, or orange. Copperheads are found state-wide in forests and sometimes in fields. The tips of the tails of young Copperheads are yellow, and they flick them back and forth in a manner that attracts prey.

Cottonmouth

Cottonmouths are typically found near a water source, mostly in dormant water. Coloration varies according to age and habitat, but typically are black to greenish-brown. Their lengths can span up to 5 feet.

E2.8.9 Snake Bite First-Aid Treatment

If bitten, a person's physical reaction to the venom is aggravated by fear, anxiety, the amount of venom injected, and the speed of absorption of venom into the victim's circulation; the size of the victim; protection provided by clothing (including shoes and gloves); how quickly the victim receives antivenom therapy; and the location of the bite.

It should be noted that the American Red Cross does not advocate the use of snakebite kits for snakebite injuries. Experience has shown that the victim has a better chance of recovery without permanent damage when the site of the wound is immobilized and the victim rushed to the closest emergency medical facility (preferably within 30 minutes).

What to Do if Bitten by a Venomous Snake

1. According to the American Red Cross, take the following steps:
    a) Wash the bite with soap and water.
    b) Immobilize the bitten area and keep it lower than the heart.
    c) Keep the victim as calm as possible.
    d) Get medical help.

2. If a victim is unable to reach medical care within 30 minutes, take the following steps:
    a) Allow bite to bleed freely for 15 to 30 seconds.

b) Cleanse and rapidly disinfect area.

c) Wrap leg/arm rapidly with 3- to 6-inch Ace bandage past the knee or elbow joint. Leave fang marks open. Apply suction cup extractor (if available) immediately. Wrap bandage no tighter than one would for a sprain.

d) Apply extractor until there is no more drainage from fang marks. The extractor can be left in place 30 minutes or more if necessary. It also aids in keeping the venom from spreading by applying a negative pressure against the tissue where the venom was initially deposited.

e) If an extractor is not available: Apply direct pressure over the bite using a 4H4-gauze pad folded in half twice. Tape in place with adhesive tape.

f) Soak gauze pad in Betadine™ solution if available.

g) Strap gauze pad tightly in place with adhesive tape.

h) Overwrap dressing above and below bite area with ACE or crepe bandage.

i) Wrap ACE bandage as tight as one would for a sprain; not too tight.

j) Check for pulse above and below elastic wrap; if too tight, unpin and loosen

k) Immobilize bitten extremity, use splinting if available.

l) Transport victim to nearest hospital or medical facility as soon as possible.

m) Try and identify, kill, and bring (ONLY if safe to do so) the offending snake.

3. Do NOT take the following actions if bitten by a venomous snake:

a) DO NOT permit removal of pressure dressings or ACE bandage until at a facility that is ready and able to administer antivenin. As soon as the dressings are released the venom will spread. The hospital at this time must be prepared to administer the antidote (antivenin).

b) Do not eat or drink anything unless approved by medical sources.

c) Do not engage in strenuous physical activity.

d) Do not apply oral (mouth) suction to bite.

e) Do not cut into or incise bite marks with a blade.

f) Do not drink any alcohol or use any medication.

g) Do not apply either hot or cold packs.

h) Do not apply a narrow, constrictive tourniquet such as a belt, necktie, or cord.

E2.8.10 Protective Measures for Snakes

1. Learn to identify poisonous snakes. The site-specific safety training will review this information.

2. Observe areas before being seated, placing hands and feet. Observe where to place feet when exiting a vehicle.

3. Avoid rock piles, crevices, and brushy areas. If movement of materials (such as rocks or brush) is necessary, use a remote means to initially relocate the material. Prior to entering an area, look and listen carefully.
4. Do not place hands into holes, crevices, debris, or anyplace that may hide a snake.
5. Never handle snakes that appear to be dead.
6. Do not attempt to capture or kill ANY snakes.

E2.8.11 Allergenic Plants

A variety of hazardous plants may be encountered on site. The ailments associated with these plants range from mild hay fever to contact dermatitis to carcinogenic effects. The plants that present the greatest degree of risk to site personnel (i.e., potential for contact versus effect produced) are those that produce skin reactions and skin and tissue injury.

Some of the most common and severe allergic reactions resulting from contact with hazardous plants are caused by poison ivy, poison oak, and poison sumac. The most distinctive features of poison ivy and poison oak are their leaves, which are composed of three leaflets. In certain seasons, both plants also have greenish-white flowers and berries that grow in clusters.

Poison sumac is a tall shrub or small tree with 6 to 12 leaflets arranged in pairs with a single leaflet at the end. Pictures of poison ivy, poison oak, and poison sumac are shown in Table E2-3.

Contact with the poisonous sap (urushiol) of these plants produces a severe rash characterized by redness, blisters, swelling, and intense burning and itching. Although most cases occur in the spring and summer months, it is important to note that contact dermatitis from poison ivy, poison oak, and poison sumac is prevalent in the winter since the vines and stems of the plants also contain urushiol. In some cases, the victim may develop a high fever and may become very ill. Ordinarily, the rash begins within a few hours after exposure, but it may take as long as 24 to 48 hours to appear. The following preventive measures can prove effective for most site personnel:

- Avoid contact with any hazardous plants on site.
- Remove gloves prior to touching face, neck, or other exposed areas of the body.
- Wash hands, face, or other exposed areas at the beginning of each break period and at the end of each workday.
- Keep the skin covered as much as possible (i.e., long pants and long-sleeved shirts) in areas where these plants are known to exist.
- Wash any clothing suspected of being exposed separately in hot water with detergent.

- Be vigilant not to handle tools or equipment suspected of contacting these plants. Clean tools with rubbing alcohol or soap and water. Urushiol can remain active on the surface of objects for several years.

Workers who have come into contact with these plants should do the following:

- Rinse skin immediately with rubbing alcohol, specialized poison plant washes, degreasing soap (such as dishwashing soap) or detergent, and lots of water. Do not use soaps with lotions, they will spread the plant oils. Rinse frequently so that wash solutions do not dry on the skin and further spread the urushiol. Scrub under the fingernails with a brush.
- Apply wet compresses, calamine lotion, or hydrocortisone cream to the skin to reduce itching and blistering.
- Take an antihistamine such as diphenhydramine (Benadryl) to help relieve itching (follow directions).

E2.8.12 Bloodborne Pathogens

Bloodborne pathogens enter the human body and blood circulation system through punctures, cuts, or abrasions of the skin or mucous membranes. They are not usually transmitted through ingestion (swallowing), through the lungs (breathing), or by contact with whole, healthy skin. However, under the principle of universal precautions, all blood will be considered infectious, and all skin and mucous membranes will be considered to have possible points of entry for pathogens.

Potential bloodborne pathogen exposures include:

- Contact with contaminated medical equipment or medical waste or sharps
- Medical emergency response operations such as administering first aid or cardiopulmonary resuscitation (CPR)
- Contact with human wastes such as domestic sewage
- Accidental contact with someone's blood from cuts and scratches incurred during field operations such as brush clearing, excavation, or clearance of munitions debris.

Whenever there is a potential for exposure, personnel will wear the proper PPE (including gloves and masks, when appropriate) to prevent exposure to bloodborne pathogens. If exposure to bloodborne pathogens is suspected, the SSHO will be informed and immediate medical attention will be sought. First aid responders shall follow the guidelines contained in AMS-710-01-PR-00300, *Bloodborne Pathogens* (Attachment 2).

All occupational injuries or illness shall be immediately reported and investigated IAW APTIM Management System procedures. Attachment 3 contains the Incident Reporting Management Procedure.

E2.9 Mishap Reporting and Investigation

E2.9.1 Exposure Data (Man-Hours Worked)

The Project Manager (PM) is responsible for reporting and maintaining records of all exposure and accident experiences incidental to the work, including those of subcontractors. The PM is responsible for ensuring the information is reported to the U.S. Army Corps of Engineers (USACE). At a minimum, these records will include exposure work hours and equivalents as prescribed by 29 CFR 1904. This exposure data will be provided to USACE using the USACE Prime Contractor Monthly Record of Work-Related Injuries/Illnesses and Exposure Form or equivalent format accepted by the Contracting Officer's Representative (COR).

E2.9.2 Accident Investigations, Reports, and Logs

The Site Manager, SSHO, and PM shall conduct accident/incident investigations in consultation with the Health and Safety Manager (HSM). A report is completed by the Site Manager or SSHO and must be submitted to the HSM and entered in the Aptim Incident Management system. The incident reporting forms are provided in AMS-710-05-FM-02401, *Incident Report* (Attachment 3). The PM shall report all accidents to the U.S. Army Garrison, Chief Installation Restoration Branch, and COR as soon as possible but no more than 24 hours after the incident/accident.

Engineer Form 3394 is required to be prepared and submitted in reporting Lost Work Day cases, accidents where three or more persons are admitted to a hospital, a fatality, permanent totally disabling injury, permanent partial disabling injury, or property damage greater than $500,000. ENG Form 3394 must be submitted to the Contracting Officer or authorized representative following the accident IAW EM 385-1-1 as soon as possible but no more than 5 days following the accident. The CEHNC Preliminary Accident Notification form is also to be utilized for collection of information relating to accidents. These forms are included in Attachment 3.

Minor incidents such as near-misses or on-site first-aid injuries shall be included in the daily field quality control reports. These incidents shall also be reported immediately to the HSM and be documented IAW AMS-710-05-PR-02200, *Incident Reporting.*

E2.9.3 Immediate Notification Requirements

Immediate notification and investigation of accidents is an important component of APTIM's accident prevention program. A full report will be provided to the HSM within 24 hours. Accidents involving the following categories shall immediately be reported to the Government

Designated Authority or authorized representative; HSM; and APTIM Environmental, Health, and Safety Hotline:

a. A fatal injury or illness

b. A permanent total disability injury/illness

c. A permanent partial disabling injury/illness

d. Hospitalization of three or more people as inpatients resulting from a single occurrence

e. Property damage of $500,000 or more or damage in an amount specified by USACE in current accident reporting regulations

f. Arc flash incident/accident

g. Army aircraft destroyed or missing

h. Three or more individuals ill or with medical condition suspected to be related to a site condition, or a hazardous or toxic agent on the site.

The SSHO will investigate the accident after all emergency actions have been taken. ENG Form 3394 and/or the Preliminary Accident Notification form will be filled out by the SSHO and submitted to the HSM. A verbal notification should be given to the HSM that the forms are being filled out.

IAW 29 CFR 1904.39, the contractor will notify OSHA within eight hours when there is a fatality or the hospitalization (in-patient) of one or more persons as a result of a single occurrence. IAW DID HNC-001.02, HNC-002, the contractor will immediately report to the Contracting Officer or government designated authority any accident that could bring adverse attention or publicity to the USACE. Other lost-time or OSHA-recordable accidents/incidents will be formally reported (i.e., using a written report) to CEHNC within five working days. An OSHA 300 log of work-related injuries and illnesses will be maintained at the site.

E2.9.4 Accident Response

The nearest workers will immediately assist a person who shows signs of medical distress or who is involved in an accident as long as the accident scene is safe. The SSHO will be immediately summoned if not already aware of the situation to begin immediate first aid. The SSHO will immediately make contact with other field personnel to alert them of a medical emergency situation and recommended action if required. The SSHO will advise the following information:

a. Location of the victim at the work site
b. Nature of the emergency
c. Whether the victim is conscious
d. Specific conditions contributing to the injury, if known.

For additional information pertaining to Mishap Reporting, please refer to Section 8.0 of the Installation-wide APP (CEHNC, 2019). Attachment 3 contains the APTIM Incident Notification, Reporting, and Management Procedures and applicable forms IAW EM 385-1-1, Section 01, Paragraph 01.D, sub-paragraph 01.D.05 as provided in Section 8.0 of the installation-wide APP (CEHNC, 2019). Engineer Form 3394 and the CEHNC Preliminary Accident Notification form are included in Attachment 3.

E3.0 Staff Organization, Qualifications, and Responsibilities

The staffing organization has been based on the proposed corrective measures to be conducted on site and IAW Chapter 6 of Engineer Pamphlet 75-1-2 (USACE, 2004) based on the current UXO probability rating of "Low."

E3.1 Health and Safety Manager

The HSM, Doug Russell, in coordination with the SSHO, is responsible for the development, implementation, and oversight of the SSHP. The HSM shall be available for emergencies and on-site consultation.

E3.2 Project Manager

The PM, Don Burton, is ultimately responsible for ensuring that all project activities are completed IAW requirements set forth in this plan. The PM is responsible for conducting at least one on-site safety inspection each month during the project and ensuring all accidents, incidents, and near misses on the project are reported and thoroughly investigated. The PM must approve in writing any addenda or modifications of the APP with the concurrence of the HSM for the project. Other responsibilities include:

- Enforcing the requirements of the SSHP. This includes performing safety inspections of the work site and, at a minimum, one formal site safety inspection each month.
- Stopping work, as required, to ensure personal safety and protection of property, or where life or property-threatening noncompliance with safety requirements is found.
- Working with the SSHO to ensure that all site personnel have received the proper medical clearance, ensuring that all site personnel have met appropriate training requirements and have the appropriate training documentation on site, and monitoring all team members to ensure compliance with the SSHP.

E3.3 Site Safety and Health Officer

The SSHO, Brian Rhodes, has the ultimate responsibility to stop any operation that threatens the health and safety of the team or surrounding populace or that causes significant adverse impact to the environment. Mr. Rhodes is the designated competent person for planned activities at RSA-013. Attachment 4 contains proof of qualifications and experience. Other responsibilities include but are not limited to:

- Implementing all safety procedures and operations on site
- Observing work crew members for symptoms of on-site exposure or stress

- Upgrading or downgrading, in coordination with the HSM and the PM, the levels of personal protection based upon site observations and monitoring results
- Informing the project HSM of significant changes in the site environment that require equipment or procedure changes
- Arranging for the availability of first aid and on-site emergency medical care, as necessary
- Determining evacuation routes, establishing and posting local emergency telephone numbers, and arranging emergency transportation
- Ensuring that all site personnel and visitors have received the proper training and medical clearance prior to entering the site
- Establishing EZs, contamination reduction zones (CRZ), and support zones (SZ)
- Presenting TSMs and maintaining attendance logs and records
- Ensuring that the respiratory protection program is implemented
- Ensuring that decontamination procedures meet established criteria
- Ensuring that there are qualified first-aid persons on site who are trained in universal precautions and the use of PPE
- Coordinating safety activities such as training, identifying site hazards, and establishing controls for all site workers as necessary.

E3.4 Subcontractors and Suppliers

The subcontractors for the provided definable features of work/activities (Section E2.3) have not been identified at this time. Subcontractor personnel proof of training and competency and certificates of employee medical surveillance program participation will be provided to the COR and CEHNC safety office for review and approval prior to the start of any activities. A notice to proceed will not be requested by APTIM until training, qualification and medical surveillance records are reviewed and accepted by the safety office. Each subcontractor working on the project site will be required to adhere to the installation-wide APP/SSHP and the requirements presented below.

- All subcontractors performing work on site will be prequalified and screened for safety performance and compliance with federal alcohol and substance abuse requirements prior to being issued any contract. APTIM will utilize AMS-710-02-PR-04400, *Subcontractor Evaluation, Selection, and Monitoring*, to provide a consistent approach to subcontractor procurement, including review of their internal safety programs, plans, and procedures. Subcontractors will comply with the requirements

for site safety as outlined in this SSHP. The SSHO will be responsible for oversight of the conduct and control of APTIM subcontractors.

- All subcontractor employees are subject to the same training and medical surveillance requirements as APTIM personnel, which is dependent upon their specific job activity. All activities involving the potential for worker exposure to site-related hazardous materials will require medical and training certification as mandated by 29 CFR 1910.120, *General Industry Regulations HAZWOPER*; 29 CFR 1910.1200, *Hazard Communication*; and EM 385-1-1, *USACE Safety and Health Requirements Manual*.

- All subcontractor personnel will be required to sign in daily and to attend a daily meeting discussing operations and safety issues. This includes meeting applicable COVID-19 pre-work screening requirements. All incidents involving subcontractor employees shall be reported immediately to the PM and HSM, and a copy of the subcontractor's and APTIM incident report shall be submitted to the SSHO within 24 hours. Subcontractors are required to read and sign the SSHP and comply with all requirements of this SSHP. Contractors not in compliance will be immediately dismissed from the site.

- Suppliers delivering various materials to the project site or providing equipment and/or equipment maintenance will comply with all APTIM rules and regulations. Supplier personnel will not be permitted into restricted areas unless training and medical surveillance are IAW 29 CFR 1910.120.

- The management organization of each subcontractor is responsible for the compliance of their personnel with the installation-wide APP/SSHP as well as their own health and safety program. The PM and SSHO will ensure subcontractor compliance with this SSHP. Since subcontractors are hired for their specific expertise, they must assume primary responsibility for the safety and health of their personnel. However, APTIM is still responsible for the actions of the subcontractors, which is why subcontractors must abide by the installation-wide APP/SSHP. APTIM may elect to allow subcontractors to follow their own health and safety plan procedures as long as they are more protective of APTIM's or EM 385-1-1 requirements following review and approval by the HSM and client as applicable.

E3.5 Stop Work Authority

All personnel have the right and duty to stop work when conditions are unsafe and to assist in correcting these conditions IAW AMS-710-05-PR-00400, *Stop Work Authority* (Attachment 2). If the SSHO determines that workplace conditions present an immediate uncontrolled risk of injury or illness, immediate resolution with the PM shall be sought. If the PM is unable to correct the unsafe conditions, the PM will consult with the HSM and will be authorized and required to issue a Stop Work Order, which shall be immediately binding on all affected APTIM employees, subcontractors, and operations.

E4.0 Training

E4.1 Initial and Supervisory Training

All APTIM or subcontractor employees performing work at RSA shall receive initial safety indoctrination training before beginning actual fieldwork. This training will be performed by the competent/qualified Site Manager or SSHO. At a minimum, this initial training shall include but not be limited to the following:

a. RSA facility-specific health and safety training
b. Site location and description, including emergency routes, first-aid kit locations, occupational medical clinics, and hospital locations
c. Statement of the APTIM health and safety policy
d. Project organization, key personnel, and responsibilities
e. Chemical, physical, and biological hazards including RSA Explosives Safety Management Program
f. AHA
g. Hazard communication program
h. Heat/cold stress
i. Hearing conservation
j. Control of hazardous energy
k. COVID-19 Control Plan
l. Sanitation
m. Buddy system requirements
n. Fire prevention and protection/hot work
o. Excavation safety
p. PPE
q. Site control measures
r. Exposure monitoring air sampling
s. Medical surveillance
t. Emergency Response and Contingency Plan
u. Record keeping and data management
v. Incident and near miss reporting and investigation
w. Site-specific hazard communication.

E4.2 Mandatory Training and Certifications

IAW 29 CFR 1926.65(e), *Hazardous Waste Operations and Emergency Response* (HAZWOPER); EM 385 1-1, *Safety and Health Requirements Manual*, Section 28; HAZWOPER, EM 385-1-97; and AMS-710-04-PR-00300, *Hazardous Waste Operations* (Attachment 2), mandatory training and certifications applicable to the field personnel at the start of the project and any additional personnel assigned during project execution, and some subcontractors include the following at a minimum:

a. Installation-Wide APP (CEHNC, 2019)/SSHP training
b. HAZWOPER 40-hour training
c. Twenty-four-hour supervised training
d. Hazardous Waste Site Supervisor training (for HAZWOPER supervisors)
e. Thirty-hour OSHA Construction Safety Training (for SSHO)
f. Eight-hour HAZWOPER refresher training
g. APTIM defensive driver training (APTIM only)
h. Hazard communication training
i. CPR and first-aid training for a minimum of two people.

Depending on the nature of work and risk assessment, the above requirements may be altered for certain activities.

Personnel who are designated first-aid and CPR responders shall follow the guidelines contained in AMS-710-01-PR-00300, *Bloodborne Pathogens* (Attachment 2).

E4.3 Emergency Response Training

There are no tasks in the scope of work that require specific emergency response training beyond what is required in Sections E4.1 and E4.2. All APTIM personnel who have completed the APTIM 40-hour HAZWOPER training are qualified as emergency first responder awareness level per 29 CFR 1926.65(q)(6)(i). Site-specific emergency response procedures will be reviewed with all site personnel as applicable to the scope of work as a part of site indoctrination. If unanticipated hazardous material is identified during site work, APTIM will stop work; secure and leave the location; and notify the PM, SSHO, HSM, and RSA Fire Department as applicable.

E4.4 Supervisory and Employee Safety Meetings

E4.4.1 Daily Safety and Tailgate Meetings

The SSHO will conduct daily TSMs at the start of each work shift for all on-site personnel and require any subcontractors to follow equivalent meeting procedures and participate in the APTIM daily safety meetings. The tailgate meeting is a short training or informative session that provides safety guidelines for the planned work activities for the day. The daily tailgate form includes project name and number, date and time, client, work activities, hospital name, address and phone number, ambulance, chemical hazards, physical hazards, PPE, new equipment introduced on site, and other safety topics. All attendees shall sign off on the tailgate safety form as well as the competent person conducting the meeting. The SSHO will also provide assistance with delivery of safety topics relevant to the day's activity. Additionally, the SSHO shall employ the use of a daily job safety analysis IAW AMS-710-05-PR-01700, *Work Area Hazard Assessment* (Attachment 2).

Supervisors, safety personnel, and PMs shall participate in regional leadership safety councils chaired by senior management. Safety council participation is mandatory and tracked by the HSM, secretary for the safety council.

E4.5 Visitor Training

All visitors are required to comply with the provisions of this APP and all applicable federal, state, local, and RSA regulations. Visitors to the site shall abide by the following ("visitor" means persons not involved in routine site work activities):

- All visitors must stay outside the EZ and CRZ and remain within the SZ during the extent of their stay. Visitors shall be escorted at all times when observing site operations
- Visitors who observe work within the EZ must wear all appropriate PPE before entry into that zone. If respiratory protective devices are necessary, visitors who wish to enter the EZ must produce evidence that within the past 12 months they have had a complete physical examination and respiratory protection training and have been fit tested for the respirator to be used. Visitors are responsible for providing their own National Institute for Occupational Safety and Health-approved respirators which coincide with applicable cartridges as applicable to site hazard assessment.
- Visitors must check in at the office, where the purpose of their visit will be evaluated. At a minimum, any visitor planning to access a work area will be briefed on the daily TSM information and will sign off attending the safety briefing.

E4.6 UXO Training

Non-UXO Personnel. All non-UXO trained site personnel will be trained in MEC/CA recognition, hazards, and actions to take in the event that they are encountered.

E4.7 Training Documentation

Documentation of training requirements is the responsibility of APTIM and the subcontractors. Written documentation verifying compliance with 29 CFR 1926.65 (e)(3), (e)(4) (as applicable), and (e)(8) will be submitted to the SSHO before beginning work at the site. Personnel proof of training and competency will be provided to the COR and CEHNC safety office for Army review and approval prior to commencement of field operations. A notice to proceed will not be requested by APTIM until training, qualification and medical surveillance records are reviewed and accepted by the safety office. Types of training documentation include 40-hour HAZWOPER, 8-hour HAZWOPER refresher, 8-hour supervisor training, 30-hour OSHA construction safety, UXO, bloodborne pathogens, hazard communication, first aid, CPR, current physician's certificate, excavation competent person, and applicable qualified operator certification. Documentation of all workers' current training credentials will be kept on site.

E5.0 Personal Protective Equipment

The SSHO will perform daily hazard assessments of work areas and immediately correct any situation where PPE is not being used IAW EM 385-1-1 or this SSHP. The daily assessments will entail compliance with the AHA provided in the SSHP and the job safety analysis, which are the primary forms of hazard evaluation to determine PPE.

APTIM personnel on site will have completed 40-hour HAZWOPER training and annual refresher courses. This training includes when and what type PPE is most protective; how to don, doff, inspect, and wear appropriate PPE; and limitations, care, testing, maintenance, useful life, storage, and proper disposal of PPE.

If APTIM or supervision suspects or is made aware that an employee may not have the proper understanding and skill required of the training, that employee shall be retrained by internal training programs or on site as a daily safety topic associated with pre-shift TSMs and documented as to who received the training and the subjects taught. When new PPE is procured, if previous training was not encompassing specific to the equipment, on-site training will be implemented by competent persons.

AMS-710-02-PR-03000, *Personal Protective Equipment* (Attachment 2), outlines minimum PPE requirements as well as PPE that is provided by APTIM. This procedure, coupled with health and safety management experience, training in proper selection use and maintenance of PPE, site-specific conditions, potential environmental contaminants, physical hazards, and Department of Army guidance documents, will dictate site-specific requirements. Initial protection levels provided in the SSHP have been established for the site work activities based on the anticipated levels of site contaminants, physical hazards, and scope of work. The SSHP and AHAs, in conjunction with AMS-710-02-PR-03000, shall serve as the written certification for use of PPE. All selected PPE shall be used IAW manufacturer's recommendations and best management practices. Once on site, visual inspection of the work activities by the SSHO or PM may indicate the need for changes in PPE level(s). Any significant change in the PPE level will be approved by the program HSM and/or Certified Industrial Hygienist. PPE requirements and procedures for COVID-19 are presented in Section E5.2.

E5.1 PPE Summary

Hazard and risk assessment is a continuing process to be conducted through the duration of the project. Changes in specific PPE may be made IAW information obtained from actual

implementation of site activities. As a rule, levels of PPE or the incorporation of respiratory protection will need to be reassessed if any of the following occur:

- Appearance of previously unidentified or anticipated chemicals, conditions, or task hazards
- Change in ambient weather conditions that impact the use of assigned PPE
- Introduction of a new task or expansion in scope of a previously assigned and evaluated task.

The SSHO will ensure PPE complies with all applicable OSHA, USACE, and Army regulations. It is the responsibility of each employee to report to work wearing proper attire and inspect the necessary PPE.

Personnel will use the appropriate type of PPE specified in this plan for each individual task. The work activities will begin in the following levels of protection.

Task	Initial Level of PPE
Mobilization and equipment staging	Level D
Utilities identification and locating	Level D
Soil verification sampling	Level D
Construction of erosion controls	Level D
Vegetation clearing and grubbing	Level D
Protection and/or closure of existing wells	Level D
Surveying and marking the proposed excavation areas	Level D
Soil excavation	Level D
Post-excavation confirmation soil sampling and analysis	Level D
Waste characterization sampling	Level D
Transport and disposal of excavated soils contaminated with perchlorate and RDX as nonhazardous waste (Subtitle D landfill)	Level D
Backfilling	Level D
Heavy equipment decontamination	Modified Level D
Site restoration	Level D

Complete descriptions of Level D and Modified Level D protection follow.

Level D. The following equipment will be used for Level D protection:

- Long-sleeved shirt and long pants
- Leather gloves (when handling sharp objects)
- Nitrile gloves (when handling potentially contaminated materials)
- Steel/composite-toed safety boots
- Safety glasses

- Hard hat
- Hearing protection (when working near/adjacent to operating equipment).

Modified Level D. The following equipment will be used for Modified Level D protection:

- Permeable Tyvek®, Kleenguard, or its equivalent
- Latex boot covers
- Nitrile gloves (outer)
- Lightweight nitrile gloves (inner)
- Steel/composite-toed safety boots
- Safety glasses
- Hard hat
- Hearing protection (when working near/adjacent to operating equipment).

Operators of pressure washing equipment shall wear a face shield, metatarsal guards for the protection of the feet, and leg guards. This will be required in addition to Modified Level D PPE.

Level C. Level C protection is not anticipated unless an upgrade in respiratory protection is required based on air monitoring action levels. The equipment to be used for Level C protection will be provided by SSHO as applicable.

Table E5-1 provides PPE action levels.

E5.2 Special PPE Considerations

The following considerations will be observed in the selection of PPE:

- During COVID-19 working conditions and when not overruled by any EZ respiratory PPE requirements, each unvaccinated employee shall wear a face mask or other facial covering (as practical) when around other people, especially when social distancing measures (distance of 6 feet in separation) are not practical to maintain. It is also recommended that employees, as practical, wear nitrile gloves at a minimum when working outside the EZ.

- Hard hats will be required when working on any construction site or an overhead hazard exists.

- Where safety or steel-toe boots are not required for an activity, it will be noted in that activity's AHA.

- Safety glasses will be selected that provide site personnel with the best protection from physical hazards, such as flying objects, and adequate splash protection.

- Site tasks should continually be evaluated to identify hazards, and PPE will be provided to ensure the safety and health of site personnel, based on activity they perform.

E5.3 PPE Inspection, Cleaning, Maintenance, And Storage

All PPE will be inspected before being used to ensure that it is in functional order and that its structural integrity has not been compromised. Reusable PPE (such as safety glasses and hard hats) also will be inspected before being used if it has been in storage for any length of time and following any maintenance. Hard hats will be inspected for expiration dates. Site personnel finding a piece of PPE that is defective will report it to the SSHO, and the defective article will be repaired or replaced.

PPE will be maintained IAW the manufacturer's instructions, and only by personnel who have received proper instruction in the maintenance of the PPE. PPE will be stored in a way that does not compromise the natural shape of the equipment.

E5.4 Respiratory Protection

The level of respiratory protection selected will be based on real-time air monitoring of the work environment IAW AMS-710-02-PR-03500, *Respiratory Protection Program* (Attachment 2). Based on the site contaminants (perchlorate and RDX) and review of enforceable published exposure standards, respiratory protection will not be required.

E5.5 Personal Protective Equipment for Visitors

An adequate supply of hard hats, safety glasses, and other basic PPE will be maintained on site for use by government personnel and other visitors. This does not apply to other government contractors, who must supply their own PPE.

E6.0 Medical Surveillance

APTIM will utilize the services of a Board-Certified Occupational Medicine physician for the medical surveillance requirements of this project IAW AMS-710-01-PR-05000, *Medical Surveillance Program* (Attachment 2). Dr. William Nassetta (contact information below) will review all APTIM employee medical examinations and will be available for medical consultation on an as-needed basis.

Dr. William Nassetta, MD, MPH
CORE Health Services
12091 Bricksome Avenue, Suite B
Baton Rouge, Louisiana 70816
(225) 756-2673 (office)
(225) 295-4846 (fax)

Subcontractors are responsible to provide APTIM medical surveillance documentation reviewed and approved by their licensed occupational physician. The medical clearance shall reference an applicable exam has been performed IAW 29 CFR 1910.120 and 29 CFR 1926.65.

A copy of applicable medical clearance for APTIM and subcontractor personnel shall be maintained on site and furnished to the COR prior to commencement of work

E6.1 COVID-19 Virus Control Plan

AMS-710-01-FM-04201, *COVID-19 Control Plan*, presents the following medical procedures and guidelines that will be followed during the COVID-19 pandemic:

- Medical screening methods and reporting and illness management
- Return to work protocol
- Guidance for potential or known exposures to COVID-19 and employees with COVID-19 symptoms
- Roles and responsibilities for APTIM's preferred Occupational Medical Provider
- Additional resources from the Centers for Disease Control and Prevention.

E6.2 Medical Examination

As required by APTIM, all personnel working hazardous, toxic, and radioactive waste or HAZWOPER projects shall have successfully completed a pre-placement or periodic/updated physical examination. The contents of this examination were determined by the Occupational

Medical Physician. The HSM may consult with the physician and recommend additional testing of employees or subcontractors.

Workers exposed to site hazards, including all employees of APTIM, will participate in a program of medical surveillance of the type specified in 29 CFR 1926.65, the OSHA standard on "Workplace Health and Safety in Hazardous Waste Operations and Emergency Response." Such workers must present a physician's statement that they are medically qualified for (1) work in hazardous waste operations, and (2) the use of respirators. The SSHO will evaluate all physicians' letters and refer any questions to the HSM or Corporate Director of Health and Safety (CDHS). Annual or biennial medical certification is required; a physician's statement must be no older than two years.

E6.3 Pre-Placement Examination

This examination was designed to meet the requirements of 29 CFR 1926.65 and 29 CFR 1910.120. The APTIM medical surveillance program examination, at a minimum, consists of:

a. Medical and occupational history questionnaire that includes information on past gastrointestinal, hematologic, renal, cardiovascular, reproductive, immunological, and neurologic problems

b. Physical examination

c. Blood pressure measurements

d. Complete blood count and differential to include hemoglobin and hematocrit determinations, red cell indices, and smear of peripheral morphology

e. Blood urea nitrogen and serum creatinine

f. Pulmonary function test (spirometry)

g. Respiratory protection clearance

h. Electrocardiogram

i. Audiogram

j. Drug screening

k. Visual acuity.

The employee and his immediate supervisor will be informed of any medical conditions that would result in work restriction or prevent the employee from working at hazardous waste sites.

E6.4 Annual Examination

APTIM field employees performing conventional HAZWOPER receive an annual update examination meeting the requirements of 29 CFR 1926.65 and 29 CFR 1910.120. The results of these exams are compared to previous results and the baseline physical to determine if any effects due to exposure have occurred. Appropriate actions are taken as recommended by the physician should the results indicate an exposure; otherwise, employees are cleared for continued work.

The SSHO will note any restrictions stated on a physician's statement and make arrangements to avoid any prohibited activity or condition. In addition, the SSHO will monitor all employees to detect early signs of exhaustion, heat stress, or other conditions that might suggest a lack of fitness for a particular task.

Medical treatment received related to a workplace injury or illness will be managed IAW the OSHA standard referenced in Section E6.2. The SSHO will notify the HSM immediately if such an event occurs.

E7.0 Exposure Air Monitoring and Air Sampling Program

The primary contaminants of concern based on review of historical information and analytical data from previous soil sampling activities is perchlorate and RDX. Exposure to RSA-013 soils poses no unacceptable health risk to any of the receptors evaluated under commercial/industrial or residential site use. However, perchlorate and RDX concentrations in soil are sources of contamination to groundwater from the soil-to-groundwater migration pathway. Chemical exposure through skin contact and inhalation during corrective measures is unlikely. The SSHO or qualified field leader will perform air monitoring for total dust during the following activities:

- Site setup and installation of best management practices
- Excavation of contaminated soil.

A calibrated combustible gas/oxygen analyzer with a photoionization detector (i.e., MSA Sirius or equivalent) will be utilized to monitor the work area for potential flammable and/or oxygen-deficient atmospheres and volatile organic compounds. A DataRam 1000 aerosol monitor or equivalent will be used to determine if airborne material may be present that would necessitate engineering controls such as wetting soils or upgrading of protection level. Action levels for air monitoring are provided in Table E7-1. A conservative action limit for soil is based on maximum concentrations detected. Table E7-2 provides the minimum air monitoring frequency and locations.

E8.0 Heat Stress and Cold Stress

The potential for heat stress is high due to the physical nature of the work that will be performed during the summer months. Care must be taken to control work schedules and hydration and to observe and respond to symptoms.

E8.1 Heat Stress Monitoring Plan

Heat Stress. There is a potential for heat stress for this project because fieldwork may be conducted during the summer months. Team members must realize that extra care must be taken to observe and respond to symptoms as the weather gets warmer and humidity increases. Sweating does not cool the body unless the sweat is evaporated from the body. The use of some PPE (e.g., semipermeable or nonpermeable clothing) can reduce the body's ability to eliminate heat because the evaporation of sweat is hampered. When this occurs, heat stress is a potential for concern. Increased body temperature and physical discomfort also promote irritability and a decreased attention to the performance of potentially hazardous tasks.

Types of Heat Stress

- **Heat Rash** is a red or pink rash usually found on body areas covered by clothing. It can develop when the sweat ducts become blocked and swell and often leads to discomfort and itching. It is common in hot, humid climates. To help relieve symptoms start by removing or loosening clothing and moving to a cool, shady spot. Let the skin air-dry instead of using towels. Avoid ointments or other lotions, because they can irritate the skin.

- **Heat Cramps** are painful, brief muscle cramps that occur during or after exercise or work in a hot environment. Muscles may spasm or jerk involuntarily. Cramping may also be delayed and occur a few hours later. Heat cramps are thought to be caused by a deficiency in electrolytes. Heat cramps signs and symptoms are painful muscle spasms usually involving the legs, chest, or abdomen. Rest briefly and cool down. Drink clear juice or an electrolyte-containing sports drink. Practice gentle, range-of-motion stretching and gentle massage of the affected muscle group. Do not resume strenuous activity for several hours or longer after heat cramps go away. Call a doctor if cramps persist after one hour.

- **Heat Exhaustion** occurs when the body gets too hot. Heat exhaustion requires immediate attention because it can progress to heat stroke, a life-threatening illness. The primary treatment for heat exhaustion is to rest in a shady spot or, better, an air-conditioned room, and to drink cool (not icy) fluids. Core body temperature can be lowered by immersion in cold water or spraying with cold water and fanning.

Drinking water is usually enough to reverse dehydration, but drinking a sports drink that contains electrolytes is also helpful.

- **Heat Stroke** occurs when the body's temperature regulatory system has failed. Skin is hot, dry, red, and spotted. These skin color changes may not be readily evident in darker skinned individuals and other signs must be relied upon. The affected person may be mentally confused, delirious, and convulsions may occur. A person exhibiting signs of heat stroke should be removed from the work area to a shaded area immediately. The person should be soaked with water and fanned to promote evaporation. Medical attention must be obtained immediately.

Early Symptoms of Heat Stress. Personnel should recognize these early symptoms of heat stress:

- Reduced performance
- Lack of coordination
- Lack of alertness
- Unsteady walk
- Excessive fatigue
- Muscle cramps
- Dizziness.

Treatment of Heat Stress. Workers who exhibit heat stress shall seek medical attention. Those employees with more than one heat-related episode in a month will have a doctor's written release prior to returning to exposures in a potential heat stress environment. Table E8-1 provides first-aid steps suggested for victims of heat stress.

Heat Stress Prevention. Procedure AMS-710-01-PR-00600, *Heat Stress Prevention and Control*, will be used to establish the minimum requirements for heat stress prevention and control. In hot environments, the following guidelines will be followed to prevent heat-related injury.

a. Drinking water will be made available to employees, and employees will be encouraged to frequently drink small amounts (for example, 1 cup every 15 to 20 minutes). The water will be kept reasonably cool.

b. Initial project safety training will include training on the symptoms of heat-related problems, contributing factors to heat-related injuries, and prevention measures. These topics will be repeated during the daily tailgate safety briefing, as needed.

c. When practical, work will be scheduled for cooler periods during the day.

d. A buddy system will be established to encourage fluid intake and watch for symptoms of heat-related injury

e. The SSHO will monitor those individuals who may be more susceptible to heat-related illness. This includes those individuals who have had a previous heat-related illness, are known to be on certain medications which increase the chance for susceptibility to heat injury, or exhibit signs of possibly having consumed large amounts of alcohol in the previous 24 hours.

f. Breaks will be taken in shaded or air-conditioned areas at intervals to prevent harmful heat stress.

g. Individuals who are not acclimated will be allowed additional breaks. The period and number should be determined by the SSHO and provided to the supervisor and employee for implementation.

h. Additional measures will be taken, as needed, to minimize heat stress. These measures may include measures such as pop-up tents over the work area and personal cooling products such as water-retentive bandanas and neck wraps.

i. Sunscreen should be applied to prevent sunburn. Sunscreen with a sun protection factor of at least 30 will be encouraged, in addition to the use of hats, long-sleeved shirts, sunglasses, or other protective attire.

Heat Stress Monitoring. The SSHO will monitor heat stress and adjust heat stress controls to control the hazard to personnel. This monitoring will include visual monitoring of work and work site conditions as well as feedback from work crews.

When conditions at the site exceed 75°F, the SSHO will conduct heat stress monitoring. The preferred method of monitoring is through use of a wet bulb globe temperature (WBGT) heat stress monitor (such as the 3M Questemp QT32 or similar) and the heat stress TLV®. The SSHO may also use local reports of heat index or applications such as OSHA's Heat Safety Tool.

The risk of heat-related illness among healthy workers who are acclimated to hot work is low if the WBGT value does not exceed the ACGIH "screening criteria" shown in Table E8-2 (ACGIH, 2019). To use Table E8-2, the SSHO must determine the worker's metabolic heat load (light, moderate, heavy, or very heavy) and determine if a heat stress situation may exist.

It is important to note that Table E8-2 is intended for permeable clothing ensembles only. Nonpermeable ensembles are not anticipated for work at this site; if it is determined that nonpermeable clothing is required, the SSHO will post and implement a similar table for nonpermeable clothing ensembles. Table E8-3 defines the different workloads.

Note: These values are intended as an initial screening tool to evaluate whether a heat stress situation may exist and thus, the values are more protective that the TLV®. Because the values are more protective, they are not intended to prescribe work and recovery periods (ACGIH, 2019).

If impermeable clothing such as rain gear is worn in hot environments, additional controls such as cooling vests will be implemented. Physiological monitoring will also be conducted if impermeable clothing is being worn. The following heart rate guidance should be used:

- Count the radial (wrist) pulse during a 30-second period as early as possible in the rest period.
- If the heart rate exceeds 180 beats per minute minus the person's age in years (i.e., 180-age) at the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same.
- If the heart rate still exceeds the calculated heart rate at the next rest period, shorten the following work cycle by an additional one-third and keep the rest period the same.

Additional physiological monitoring, such as continual pulse or core temperature, may be implemented, as needed.

E8.2 Cold Stress Monitoring Plan

Cold Stress. In addition to the exposure to high temperatures presented in the previous section, exposure to low temperatures presents a risk to employee safety and health through the direct effect of low temperature on the body and collateral effects such as slipping on ice, decreased dexterity, and reduced dependability of equipment. The average low temperature in the winter months at the site can approach 18°F, with January being the coolest month on average. The effects of cold exposure include frostbite and hypothermia, with wind increasing the chances of these effects taking place.

Types and Symptoms of Cold Stress. Hypothermia is a life-threatening condition in which the core body temperature falls below 95°F. Hypothermia can occur at temperatures above freezing particularly when the skin or clothing becomes wet. During exposure to cold, maximum shivering occurs when the core temperature falls to 95°F. As hypothermia progresses, depression of the central nervous system becomes increasingly more severe (Table E8-4). This accounts for the progressive signs and symptoms ranging from sluggishness and slurred speech to disorientation and eventually unconsciousness.

Frostbite is a term which denotes areas of cold injury on a body. Frostbite rarely occurs unless environmental temperatures are below freezing, usually below 20°F. Injuries from frostbite normally occur on the distal parts of the body (nose, earlobes, hands, and feet) that are subject to intense vasoconstriction when they get cold. The three general categories of frostbite are presented in Table E8-5.

Cold Stress Prevention. The potential for cold stress is determined primarily by two variables: the temperature of the air and the speed of the wind. The cooling effects of moving air on exposed flesh can be expressed as an equivalent chill temperature (ECT), which combines temperature and air speed. At a given temperature, calm air is less dangerous.

Table E8-6 shows values of ECT for various temperature and speed combinations. The conditions represented by Zones B and C are extremely dangerous to exposed skin. Continuous exposure of exposed skin should not be permitted if the ECT is 25°F or less. Work under conditions represented by Zone A is much less dangerous to exposed skin. However, workers can suffer frostbite injury in the less severe environment if they develop a false sense of security and fail to take precautions.

At low ECT values, precautions against hypothermia are necessary, even if workers are dressed in well-insulated clothing. The danger of hypothermia is especially severe if immersion in water is possible during the work.

The SSHO will make an assessment of the potential for cold stress before fieldwork begins, primarily through local weather reports but also by using thermometers or wind speed measuring equipment on site as needed. When the wind chill falls below 0°F (-17 degrees Celsius), the air temperature and wind speed will be monitored every 2 hours or more frequently.

Work rules related to the prevention of cold-related injury will be required if conditions of the types represented in Zones A, B, or C in the ECT table are anticipated. Under such conditions, the SSHO will measure temperature and wind speed when work commences each day and at routine intervals (at least every 4 hours) thereafter, unless he/she believes that some other means of hazard assessment is adequate. The CDHS must approve any alternative means of hazard assessment. When work is conducted under conditions represented in Zones A, B, or C, the SSHO will implement the work rules described below to manage the potential hazard.

- Employees will receive training on the dangers and symptoms of cold-related injury and the work rules adopted to prevent it.

- Site workers will be warned that older individuals and people with circulatory problems might be at increased risk for cold-related injury and that added precautions might be necessary to protect them.
- Each employee will be under protective observation by someone else during work (use of the "buddy system" will be required).
- Employees who experience pain in the extremities or are shivering will be removed from exposure to the cold work environment.
- Work must be halted if frostbite cannot be prevented. Continuous skin exposure will not be permitted when the ECT is -25°F or less (Zones B and C on the ECT table).
- Tasks should be scheduled to avoid long periods during which workers must sit or stand still.
- Work expectations for new employees should be adjusted downward for the first few days, to permit acclimatization to the cold conditions.
- Dehydration, which decreases blood flow to the extremities, should be avoided. Employees will be encouraged to replenish water lost to perspiration and respiration. The SSHO will provide soups and warm sweet drinks as appropriate.
- The SSHO will develop procedures that reduce the likelihood of immersion in water or soaking of the clothing by other means during project work. Such precautions should apply to any work with liquids like gasoline, alcohols, solvents, or cleaning fluids.
- The SSHO will plan for any likely scenarios that would lead to wet clothing (through immersion in water, soaking by mist, etc.), and provide for quick changing into dry clothing and treatment for hypothermia.
- Emergency plans will give special attention to the prevention of cold-related injury (hypothermia and freezing of damaged tissues).

If continuous work must be performed at an ECT below 19.4°F, then the SSHO or PM will provide a heated shelter (truck, car, tent, cabin, or similar space) for warming after exposure to the cold environment. Employees should be encouraged to use the shelter at frequent intervals and upon (1) onset of pain or heavy shivering; (2) occurrence of minor frostbite; or (3) onset of feelings of excessive fatigue, drowsiness, irritability, or euphoria. For these conditions, the SSHO will monitor weather and environmental conditions and implement a mandatory work/warming regimen according to Table E8-7.

The rules implemented by the SSHO will require that employees wear adequately insulating dry clothing if conditions of the type represented in Zones A, B, or C in the ECT table are

anticipated. Workers should wear cold-protective clothing appropriate for the environmental conditions and the level of physical activity. The following considerations should guide the selection and use of protective clothing:

- Layered clothing will be used to preserve body heat. An easily removable outer windbreak garment should be worn in windy conditions.
- Inner garments and underwear will be made of fabrics that dry quickly and wick moisture away from the body.
- Outer garments will be made with provisions for easy ventilation to prevent inner layers to be wetted by sweat.
- An employee will not enter or remain in a cold work environment if his or her clothing is wet because of sweating. If clothing is wet, then the employee must change into dry clothing before returning to the cold environment.
- Gloves and/or mittens will be used as necessary to protect the hands, and employees will be warned not to touch very cold objects and surfaces with bare skin.
- Workers will routinely change socks and removable felt insoles to reduce moisture around the feet.
- Eye protection suitable to the type of hazard will be used. Special precautions against ultraviolet light and glare might be necessary in snow-covered terrain.
- Hard hat liners will be used. If work must be done on slippery surfaces, then shoe attachments that enhance traction shall be used.

E9.0 Standard Operating Safety Procedures, Engineering Controls, and Work Practices

This chapter outlines the general hazards and safe work practices that all site personnel will follow to eliminate or reduce the risk of exposure to anticipated site hazards. These controls are presented as a guide for site personnel and do not cover all compliance issues. The Site Manager and SSHO will ensure full compliance with applicable regulatory requirements.

E9.1 Site Rules/Prohibitions

General safe work practices for every job site include the following:

- ***Using the Buddy System.*** Employees will not work alone. Every employee is required to work near someone else who could offer assistance or summon help in the event of an accident or illness. At all times, an employee on a field site must be observable by at least one other person or sufficiently close to at least one other person to communicate by voice.
- ***Reporting Unsafe Conditions.*** Site personnel will immediately stop unsafe work and report to the SSHO any unsafe acts or conditions, including violations of this document or the Installation-Wide APP (CEHNC, 2019).
- ***Reporting Injuries and Illnesses.*** All injuries or illnesses, including the potential harmful effects of the COVID-19 virus and apparently minor ones such as insect bites, will be reported to the SSHO promptly.
- ***Near Miss and Great Catch.*** Within 24 hours, site personnel shall complete the Near Miss/Great Catch Form (AMS-710-05-FM-02301) and ensure the same data are entered into the APTIM Incident Management System. This represents the minimum initial incident data. A Near Miss Incident is where no property was damaged and no personal injury was sustained. However, given a slight shift in time or position, damage to property and/or personal injury could have occurred. A Near Miss differs from a Great Catch due to the fact that there has been a release of energy (i.e., an incident). A Great Catch is a condition identified/observed prior to any incident occurring which may have resulted in property damage or personal injury, but where given a slight shift in time or position, damage to property and/or personal injury could have easily occurred.
- ***Reporting Pre-Existing Medical Conditions.*** Site personnel will inform the SSHO of any known medical conditions that may cause illness in the workplace, aggravate a possible work-related illness, or increase the likelihood of accidents. This includes hypersensitive allergic reactions to stinging and biting insects or to contact with poisonous plants; diabetes; high blood pressure; skin or eye sensitivity to sunlight and ultraviolet radiation; chronic illness; and acute illnesses such as a cold, the flu, or stomach/intestinal disorders. Persons with known hypersensitive allergic

reactions to stinging/biting insects or to toxic plants will carry appropriate emergency medical antidotes on their person at all times when on site.

- ***Prohibiting Horseplay.*** Site personnel will not engage in horseplay, running, or other irresponsible behavior or harm people, property, or the environment.

- ***Avoiding Skin Contact with Poisonous Plants.*** Personnel in vegetated or wooded areas will wear long-sleeve shirts with the sleeves rolled down to reduce contact with poisonous plants.

- ***Eating, Drinking, and Smoking Restrictions.*** Eating, drinking, and smoking will be permitted only in areas designated by the SSHO and at designated break times after employees have washed their hands. Eating, drinking, and smoking will be forbidden in any EZ or nearby decontamination area.

- ***Prohibiting Ignition Sources.*** Ignition of flammable materials in any work area is prohibited, unless approved in writing by the SSHO. Matches, lighters, or other sources of sparks will not be allowed in any EZ or nearby decontamination area.

- ***Limiting Personnel Exposed to Potential Risks.*** The number of personnel in any work area will be the minimum number necessary to perform work tasks in a safe and efficient manner.

- ***Reporting the Location of Site Personnel.*** Site personnel will check in with the SSHO before leaving the site and upon returning to the site.

- ***Escorting Site Visitors***. Site visitors are to be escorted by the SSHO, or an appropriate designee, at all times.

- ***Qualifying Personnel for Specific Tasks.*** Site personnel will perform only those tasks for which they are qualified by training and, when applicable, appropriate certifications. Such certifications will include those required by this document.

- ***Limiting Admission to Work Areas.*** No one may enter a site work area without the approval of the SSHO. The SSHO will consider the qualifications of each entrant and the risks present in the areas into which entry is desired.

- ***Housekeeping.*** All work areas will be maintained in a clean, neat, and orderly fashion, free of loose debris and scrap. Any materials and equipment not being used will be stored or discarded properly. All work areas will be supplied with a trash receptacle that includes a lid. The contents of all trash receptacles either will be removed from the site daily or emptied daily into a larger trash storage container that will be tightly closed each night prior to departure of personnel from the sites.

E9.2 Work Permit Requirements

The scope of work for this project does not anticipate work requiring work permits, such as radioactive work, hot work, confined space, etc. Should a work permit be required, AMS-710-02-PR-06400, *Permit to Work* (Attachment 2), will be followed.

E9.3 Material Handling Procedures

Execution of on-site activities will require handling of numerous items. Precautions shall be taken when lifting or handling heavy or bulky items. Back strain or injury may be prevented by using proper lifting techniques. The fundamentals of proper lifting include:

a. Consider the size, shape, and weight of the object to be lifted. Two persons must lift an object if it cannot be lifted safely alone (e.g., greater than 60 pounds).

b. The hands and the object should be free of dirt or grease that could prevent a firm grip.

c. Gloves must be used, and the object inspected for metal slivers, jagged edges, and burrs, rough or slippery surfaces.

E9.4 Drum/Container/Tank Handling

Improper handling of drums and containers can result in severe injuries. These include painful back sprains, smashed toes and fingers, or exposure to potentially hazardous chemicals, if the contents are leaking. Proper work practices can minimize risk of injury, so personnel should use the following recommendations:

a. Prior to handling the drum, read the label on the drum and look for symbols, words, or other marks that indicate if its contents are hazardous, corrosive, toxic, or flammable. If the drum is not labeled, consider the contents hazardous until they are positively identified.

b. Look around the drum to see if it is leaking. Before cleaning up any spill, make sure the substance has been identified. Make sure that you have been trained in the hazards of the chemical and have the correct materials for cleaning it up. Find and review the appropriate SDS.

c. Before moving the drum or barrel, replace missing bungs and/or lids and secure as necessary.

d. Depending upon the contents of the drum, estimate its weight. Determine whether you can move it yourself or need assistance. A 55-gallon drum can weigh 400 to 800 pounds, depending on content.

e. Use a forklift or heavy equipment, such as a hand truck or a drum cart that is designed specifically for drum handling.

f. If the drum can be rolled, stand in front of it and place both hands on the far side of the chime. Pull the drum forward until it balances on the bottom chime. You can now roll the drum on its chime, being careful to keep your hands from crossing over one another. You can also lower the drum to the ground for rolling by shifting your hands to the bottom side of the chime (not where they will be crushed). Then slowly lower the drum to the floor. Keep your back straight and bend at your knees. Then roll the drum with both hands. Do not use your feet or grasp the ends.

E9.5 Fatigue Management Plan

The following workday duration limitations shall be in effect for work at the site:

- Personnel working on site, including those who are operating hoisting equipment or mobile construction equipment, may work up to 12 hours at the site, not including travel time to/from their home/motel or uncompensated lunch breaks. This workday duration is subject to reduction by the other requirements and factors described in the bullets below. The 12-hour limit is primarily because of motor vehicle driving restrictions.

- While on duty, personnel, will not operate motor vehicles after being in a duty status (regardless of their role or function) for more than 12 hours during any 24-hour period without at least 8 consecutive hours of rest. Personnel may work an additional 2 hours at the motel or their home (for a total 14-hour day), though they are still subject to reduction by the other requirements and factors described below. A minimum of 8 consecutive hours will be provided for rest in each 24-hour period.

- Personnel shall not operate motor vehicles after being in a duty status (regardless of their role or function) for more than 12 hours during any 24-hour period without at least 8 consecutive hours of rest. A minimum of 8 consecutive hours shall be provided for rest in each 24-hour period.

- No employee may drive continuously for more than 10 hours in any single, on-duty period (or 24-hour period without at least eight consecutive hours of rest.)

Training provided to personnel in the Safety and Occupational Health Orientation will include symptoms of fatigue, habits and actions the worker may take to avoid fatigue, actions workers should take if they observe fatigue in a co-worker, a discussion of fatigue impacting driving to and from work, and controls in place to prevent fatigue.

The SSHO is responsible for adjusting the workday duration within the limits set above. The following factors will be considered for adjusting the workday duration:

- Time of year (e.g., reduce the workday duration because there is less daylight in winter).

- Temperature/weather (e.g., reduce workday duration when the temperature is very hot or very windy).
- Type of work (e.g., reduce workday duration for personnel involved in physically demanding phases of work).

E9.6 Hearing Conservation

Equipment and tools generate noise. Hearing loss resulting from occupational exposure to noise can be prevented through the use of hearing protection. Personnel will wear hearing protection when working with or around operating equipment or power tools that generate noise at 85 dBA or above—levels that require a person to raise his/her voice to carry on a conversation at a distance of 3 feet. Warning signs will be posted in areas where noise greater than 85 dBA necessitates the use of hearing protection. The use of headphones for entertainment purposes is prohibited.

E9.7 Fire Prevention Plan

Any APTIM activities that could cause a spark will be carefully monitored. At least one 10BC rated fire extinguisher will be kept in each site vehicle and maintained on site during operations. The SSHO will ensure that the extinguishers are inspected monthly. The following standard safety measures will also be implemented during site field activities to minimize the risk of fire and/or explosion:

a. Smoking is permitted on site only in the designated smoke area at least 50 feet from operations with a potential fire hazard.

b. Good housekeeping procedures will be required on site to keep work areas clear of accumulating combustible scrap and debris.

c. Material storage methods will be IAW manufacturers' recommendations.

d. Flammable liquids will be stored in approved portable containers.

e. All handling or use of flammable and combustible liquids shall be conducted by trained personnel.

f. Entry and exit pathways and fire lanes shall be kept clear of debris or obstacles.

g. An APTIM hot work permit is required for all spark- and flame-producing operations, and the RSA Fire Inspector shall be notified in advance of planned hot work.

h. Work areas will be cleared of excess vegetation and obstructions.

If a fire or explosion occurs, the SSHO will notify the nearest fire department and Emergency Medical Services, contact the PM, and escort the response personnel to the location of the fire or explosion. The SSHO will determine the extent of the fire, use available on-site fire extinguishers (Type 2A:10BC) on incipient stage fires only, and provide emergency first aid as needed. Site personnel will not fight fires containing explosives. The responding fire department personnel will be informed of the nature of the fire and if explosives are present.

E9.8 Hazard Communication

SDSs for hazardous chemicals that may be required during site operations will be provided on site to all affected employees. The SSHO will manage the SDS file and chemical inventory. AMS-710-01-PR-00400, *Hazard Communication*, will be implemented on site (Attachment 3). Employee hazard communication training occurs on an annual basis as a component of the APTIM 8-hour HAZWOPER refresher course and site-specific training is a component of initial safety orientation training. HAZCOM training provided in the APTIM 8-hour refresher includes the latest requirements under the Globally Harmonized System.

E10.0 Site Control Measures

Work zones will be established so that on-site activities do not spread contamination. The site will be set up so that there is a clearly defined EZ and a clearly defined SZ with a CRZ as a transition between the EZ and SZ.

E10.1 Work Zone Access Control and Security

The SSHO and Site Manager will control access to the site during operations and enforce the restrictions found elsewhere in this document upon site visitors. If difficulties related to access control and site security arise, the SSHO will confer with the HSM to identify corrective action. As applicable, workers and site visitors will be screened for COVID-19 IAW AMS-710-01-FM-04201, *COVID-19 Control Plan*.

E10.2 Work Zones

Site Work Zones. The purpose of establishing work zones and maintaining site control is to minimize potential contamination of workers, protect the public, and prevent unauthorized entry to work areas. Site control involves the physical arrangement of, and controlling access into, established work zones. The Layout Plan will help ensure protection against the hazards presented by confining activities to the appropriate areas.

To reduce the spread of hazardous materials by workers from the contaminated areas to the clean areas, zones will be delineated to aid in controlling the flow of personnel and equipment between the zones. The establishment of the work zones will help ensure that personnel are properly protected against the hazards present where they are working, work activities and contamination are confined to the appropriate areas, and personnel can be located and evacuated in an emergency. The work zones allow the use of multiple teams or portions of teams conducting excavations simultaneously. The two work zones, designated the EZ and the SZ, are described in greater detail below.

Exclusion Zone. The EZ is the area in which contamination does or could occur. An EZ will be established during site operations to prevent personnel from entering the active work areas without proper PPE. The EZ around a potentially hazardous operation will be determined in each case by the SSHO. The size of the EZ will depend on the activity being performed and the hazards present at the site. For the purpose of the removal action, the EZ shall be the perimeter of active excavation activities.

APTIM personnel and subcontractors will be properly trained in controlling and minimizing access to the EZ. If an unauthorized person enters the EZ, work will stop and said person will be stopped and escorted out of the EZ and met by the SSHO or Site Superintendent to determine if there is a need for decontamination or medical assistance. Work will not commence again until the unauthorized person has left the EZ. In addition, site control measures will be reevaluated. The unauthorized entry will be recorded in the field notebook.

Contamination Reduction Zone. The CRZ is the transition area between the contaminated area and the clean area. If required, the personnel decontamination station will be located within the CRZ, preferably upwind in the prevailing wind direction. This zone provides an area to prevent or reduce the transfer of hazardous materials that may have been picked up by personnel or equipment leaving the EZ. Personnel exiting the EZ shall doff disposable PPE into appropriate plastic bags. Heavy equipment shall remain in the EZ until excavation is complete and then be cleaned to remove large soil deposits before being released from site. The SSHO shall verify equipment being released has undergone appropriate cleaning.

Support Zone. The SZ is considered a clean area and will be located at a sufficient distance from the intrusive activity to ensure the safety of the SZ personnel. The SZ is separated from the CRZ by the contamination control line. Public access beyond the contamination control line will be prevented during intrusive operations. The SZ contains the command post and other support supplies. Level D PPE is appropriate apparel within this zone. Contaminated clothing and equipment are not permitted in the SZ.

E10.3 Site Communications

Effective on-site and off-site communication will be established prior to initiation of site activities. On-site communication will be used to coordinate site operations, to maintain site control, to convey safety information, and to alert site personnel to emergency situations. Off-site communication will be available to ensure effective coordination with off-site management personnel, the USACE, and emergency response services.

All site personnel will be familiar with the different methods of both on-site and off-site communication. The methods that will be used for on-site and off-site communication will include the following:

- Cellular telephones
- Air horns, bullhorns, sirens, or hand signals, as needed.

Site personnel will use cellular telephones or other supplied communication systems for off-site

communication. The SSHO will verify that the 911 service is available andwill make appropriate alternative arrangements if it is not available.

E11.0 Personnel Hygiene and Decontamination

Sanitary and washing facilities, personnel and Level D decontamination, and waste control plans are discussed below. Additional minimum sanitation requirements presented in AMS-710-01-FM-04201, *COVID-19 Control Plan*, will be implemented due to the COVID-19 pandemic.

E11.1 Sanitary Facilities

APTIM will ensure toilet facilities are available, with at least one unit for each 15 workers, IAW AMS-710-01-PR-01000, *Sanitation and Potable Water* (Attachment 2), and EM 385-1-1, Section 2 (USACE, 2014).

E11.2 Washing Facilities

APTIM will provide hand-washing supplies convenient to the work area, including potable washing water and soap IAW AMS-710-01-PR-01000, *Sanitation and Potable Water* (Attachment 2). All hand-washing facilities will be supplied with soap, paper towels, and trash receptacles. All washing facilities or areas will be kept clean and free of trash. For remote locations, hand washing may be accomplished using hand sanitizer or disposal sanitary wipes that meet the requirements of AMS-710-01-FM-04201, *COVID-19 Control Plan*.

All field personnel will wash their hands and faces before eating and drinking and before leaving the site for the day.

E11.3 Personnel Decontamination

Effective decontamination is not simply removing contaminants; it begins with preventing contamination. Work practice controls limiting direct contact with soil will occur. Employees are always reminded to operate upwind of remedial action operations. For limited soil contact, i.e., sampling, personnel will utilize disposable sampling equipment, minimize direct hand contact with media, and wear nitrile gloves during sample collection activities.

E11.4 Waste Control and Disposal

Solid trash, paper towels, and other items used in the work areas will be classified as solid waste, containerized, and disposed of appropriately.

E12.0 Equipment Decontamination

An equipment decontamination station will be set up in the CRZ for equipment to be decontaminated when exiting the EZ. Due to the COVID-19 pandemic, hand tools and work surfaces will be decontaminated at the equipment decontamination station and not shared with co-workers unless decontamination is completed. Hand tools will be decontaminated at the equipment decontamination station and common work surfaces using soap and water followed by a bleach solution.

For heavy equipment, the operator cab area, including but not limited to equipment controls, will be decontaminated with a mild bleach solution or with a solution that contains at least 60 percent denatured alcohol.

E13.0 Emergency Equipment and First Aid

The equipment and personnel required for first aid and CPR will be maintained on site by the SSHO. Emergency equipment required to be on site will have the capacity to respond to project-specific emergencies. Site emergencies may require (but should not be limited to) PPE and equipment to control fires, leaks and spills, or chemical (contaminant or treatment process) exposure.

The emergency equipment listed in Table E13-1 will be on site, stored in the location indicated, and available for use during the operation specified. Emergency equipment assigned to an area or team will be maintained in proper working order by the team, as directed by the team leader. The SSHO will conduct an inspection of all emergency equipment at least weekly to ensure completeness and proper working order.

The size and number of first-aid kits will be sufficient to accommodate the maximum number of people (including government personnel and visitors) on site at any given time.

When required, portable eyewash bottles will be available for immediate use while the injured person is transported to the area where the 15-minute eye flushing station will be available. After flushing, the eyes will be bandaged lightly, and the person will be transported to the appropriate medical facility for further evaluation and treatment, if needed.

Personnel administering first aid and/or CPR will comply with the following:

- Personnel will wear disposable latex gloves if there is any visible body fluid.
- The CPR Pocket Mask will be used when performing CPR and disposed of after use.
- Personnel will immediately change clothing that becomes contaminated with body fluids as a result of performing first aid, or as soon as feasible.
- Personnel will wash their hands immediately after performing first-aid procedures.

E14.0 Emergency Response and Contingency Procedures

The frequency and severity of emergency situations can be dramatically reduced through proper implementation of the Installation-Wide APP (CEHNC, 2019). However, if an emergency does occur, quick, decisive action is required. Delays of only minutes can create or escalate life-threatening situations. In an emergency situation, site personnel involved in emergency response and rescue must be prepared to respond immediately. All required equipment must be on hand, in proper working order, and ready to use. To ensure rapid, effective response to a site emergency, the procedures and contingency plans outlined in this section must be implemented before and during any site activities involving exposure to safety and health hazards.

E14.1 Pre-Emergency Planning with Local Emergency Responders

Identification of Local Emergency Services. APTIM has obtained emergency and non-emergency telephone numbers for emergency services (Emergency Management, Police, or Fire). In the event that evacuation of the general public is required because of either normal site operations or an emergency event, the safety point of contact, the PM, or SSHO is responsible for contacting the appropriate local officials who execute and coordinate an evacuation.

Anyone calling for emergency medical services on RSA by dialing 911 with a cellular phone must state that he/she is located on RSA in order for the call to be directed to the proper emergency management office. Any suspect CA exposure requires notification IAW the Explosive Safety Management Program. In the event a medical or MEC emergency occurs, notify the Garrison Installation Emergency Operations Center (IEOC) at (256) 313-1043 after initial emergency contacts have been completed in order to update IEOC on the situation.

E14.2 Personnel and Lines of Authority for Emergency Situations

Key personnel roles, lines of authority, and communications plan are detailed in Section 4 of the APP. Emergency response roles are discussed below.

Personnel On-Scene Incident Commander. If an emergency arises, the SSHO assumes the responsibility of the site, with the Site Manager as alternate if the SSHO is unavailable or incapacitated. The SSHO has responsibility for directing all on-site and off-site response personnel and, as soon as possible, advises the PM and HSM of the emergency situation. The SSHO has full responsibility and commensurate authority for responding to any emergency that may occur at the work site until APTIM is relieved by the proper authorities.

On-Site Emergency Response Services. APTIM personnel are trained to provide first-aid treatment for minor injuries. At least two people on site will be trained in first aid and CPR. The SSHO will determine whether any injury requires treatment in addition to first aid.

Off-Site Emergency Response Services. Off-site emergency response services that may be needed in the event of a site emergency include medical and law enforcement personnel. All requests for emergency services are accessible via the 911 telephone system. For emergencies, state the location as RSA when contacting 911.

E14.3 Emergency Recognition and Prevention

During the development of this SSHP, great attention has been given to identifying potential safety and health hazards associated with conducting site activities. Once identified, these hazards were assessed to determine if they could result in an emergency situation. During an emergency, all active areas will be secured and all work will stop. Field crews will return to predesignated rally points for further direction or the best place of refuge or for evacuation instructions. Emergency alerts will be broadcast on mobile and/or hand-portable field radios. The SSHO will inform the PM of emergencies, security issues, and response actions by telephone as soon as practicable, followed by a written report providing full details. The following potential emergencies may result during site activities:

- Injury or illness
- Fire/explosion
- Inclement weather.

If additional site or task hazard information becomes available during the project, the HSM will assess this information to determine whether the contingency plans in this section need to be updated.

E14.4 Evacuation Routes and Procedures

Evacuation routes and procedures are discussed below.

Evacuation Route. The established evacuation route will be checked by the SSHO and then reviewed by all site personnel before the start of site activities to become familiar with the route. Emergency meeting points will vary from day to day depending on work location. The planned evacuation route will be discussed with the field crew at the daily tailgate safety briefing.

Emergency evacuation routes will be posted in the field office. All exit routes will be unobstructed and kept free of debris.

Medical Facilities. Huntsville Hospital is the designated Emergency/Trauma Center for the project. Contact information for the hospital and other emergency services has been placed at the front of this SSHP. Non-life threatening occupational injuries/illness beyond on-site first aid shall be evaluated at the Core Health Networks occupational physician clinic, Crestwood Family Practice, or Crestwood Workers Care Madison.

Directions to Hospital. To facilitate the quick retrieval of information in the event of an emergency, a summary that includes emergency contact information has been placed at the front of this SSHP. Figure E-1 is a map showing the route from the project site to the hospital and occupational clinics.

Medical Evacuation. Medical evacuation requirements will be determined by the emergency first responder. Personnel requiring additional treatment will be evacuated to the hospital. Any further treatment or evacuation will be arranged by the hospital site personnel who will receive specialized training that will be given by the SSHO and conducted prior to initiating site activities involving safety and health hazards. Training will be documented using the site training log and will include the subjects listed below:

- Emergency chain-of-command communication methods and signals
- Emergency equipment and PPE
- Removal of injured personnel from the site
- Emergency contacts, telephone numbers, and hospital route.

E14.5 Emergency Alerting and Response Procedures

Emergency response procedures include all steps to be taken for notifying, evaluating, reacting to, documenting, and following up on a given emergency situation. To ensure all necessary elements are covered, implement the procedural steps outlined in this paragraph for each emergency, regardless of its nature.

Notification. Once the SSHO has been informed of the emergency, the SSHO will use radio communication to:

- Notify personnel and get their attention
- Stop work activity as required
- Lower noise levels to speed and simplify communication
- Begin emergency or evacuation procedures.

If on-site APTIM personnel or off-site emergency personnel are to enter the site in response to the emergency, the SSHO, to the extent possible, will notify response personnel about:

- What happened and when it happened
- Where on the site the emergency situation occurred
- Who is involved and, if possible, the cause of the emergency
- The extent of damage and what hazards may be involved
- What response actions are required.

E15.0 References

American Conference of Governmental Industrial Hygienists (ACGIH), 2019, ***Threshold Limit Values® for Chemical Substances and Physical Agents and Biological Exposure Indices***.

CB&I Federal Services LLC (CB&I), 2017, ***Revision 1 RCRA Facility Investigation Report, RSA-013, Unlined Inactive Open Burn Pad, RSA-132, Dismantled Popping Furnace, RSA-133, Inactive Rocket Washrack/Sump, Operable Unit 14, U.S. Army Garrison-Redstone, Madison County, Alabama***, February.

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TABLES

Table E2-1

Toxicological and Physical Properties of Chemicals
RSA-013, Unlined Inactive Open Burn Pad
Redstone Arsenal, Madison County, Alabama

Substance [CAS]	IP[a] (eV)	Odor Threshold (ppm)	Route[b]	Symptoms of Exposure	Treatment	TWA[c]	STEL[d]	Source[e]	IDLH (NIOSH)[f]
Ammonium Perchlorate [7990-98-9]	n/a	None	Inhalation Absorption Ingestion	Ingestion causes cramps;, headache, coma, death; pulmonary irritation; kidney and liver damage; aspiration causes severe lung irritation, coughing	Eye: Irrigate immediately Skin: Water flush immediately Breath: Respiratory support Swallow: Immediate medical attention	n/a	n/a		NE
Coal tar pitch volatiles (e.g., pyrene, phenanthrene, chrysene, anthracene, benzo(a)pyrene) [65996-93-2]	?	?	Inh Con	Bronchitis [potential occupational carcinogen]; dermatitis.	Eye: Irrigate immediately Skin: Water flush immediately Breath: Respiratory support Swallow: Immediate medical attention	o.2 mg/m3 0.1 mg/m3		PEL TLV REL	80 mg/m3
Cyclotrimethylenetrinitramine RDX [121-82-4]	n/a		inhalation, skin absorption, ingestion, skin and/or eye contact	irritation eyes, skin; headache, irritability, lassitude (weakness, exhaustion), tremor, nausea, dizziness, vomiting, insomnia, convulsions	Eye: Irrigate immediately Skin: Soap flush immediately Breathing: Respiratory support Swallow: Medical attention immediately	NIOSH REL TWA 1.5 mg/m3 ST 3 mg/m3 [skin] OSHA PEL none		REL	NE

Table E2-1

Toxicological and Physical Properties of Chemicals
RSA-013, Unlined Inactive Open Burn Pad
Redstone Arsenal, Madison County, Alabama

Substance [CAS]	IP[a] (eV)	Odor Threshold (ppm)	Route[b]	Symptoms of Exposure	Treatment	TWA[c]	STEL[d]	Source[e]	IDLH (NIOSH)[f]
Fuel oil (diesel oil, medium)	None	None	Ing Inh Con	Ingestion causes nausea, vomiting, and cramps; depressed central nervous system, headache, coma, death; pulmonary irritation; kidney and liver damage; aspiration causes severe lung irritation, coughing, gagging, dyspnea, sub-sternal stress, pulmonary edema; broncho-pneumonia; excited, then depressed, central ner-vous system.	Eye: Irrigate promptly Skin: Soap wash Breath: Respiratory support Swallow: Immediate medical attention Aspiration: Immediate medical attention	n/a n/a TWA 100 mg/m3 (as kerosene)		PEL TLV REL	NE
Gasoline [8006-61-9]	None	0.3	Inh Ing Con	Intoxication, headaches, blurred vision, dizziness, nausea; eye, nose throat irritation; potential kidney and other cancers. Car-cinogenic.	Eye: Irrigate immediately (15 min) Skin: Soap wash promptly Breath: Respiratory support Swallow: Immediate medical attention	300 ppm Ca, lowest feasible conc. (LOQ 15 ppm)	500 ppm	PEL TLV REL	1400 ppm 10% LEL
Hydrogen chloride (hydrochloric acid) [74-90-8]	12.74	0.255-10.6	Inh Ing Con	Inflamed nose, throat, larynx; cough, burns throat, choking; burns eyes, skin; dermatitis; in animals; laryngeal spasm; pulmonary edema.	Eye: Irrigate immediately Skin: Water flush immediately Breath: Respiratory support Swallow: Immediate medical attention	NIOSH REL C 5 ppm (7 mg/m3) OSHA PEL C 5 ppm (7 mg/m3)	C5 ppm C5 ppm C5 ppm	PEL TLV REL	100 ppm
Isopropyl alcohol (isopropanol) [67-63-0]	10.16	43-200	Inh Ing Con	Mild irritation of the eyes, nose, and throat; drowsi-ness, dizziness, headache; dry, cracked skin.	Eye: Irrigate immediately Skin: Water flush Breath: Respiratory support Swallow: Immediate medical attention	400 ppm 400 ppm 400 ppm	500 ppm 500 ppm 500 ppm	PEL TLV REL	2,000 ppm

Table E2-1

Toxicological and Physical Properties of Chemicals
RSA-013, Unlined Inactive Open Burn Pad
Redstone Arsenal, Madison County, Alabama

Substance [CAS]	IP[a] (eV)	Odor Threshold (ppm)	Route[b]	Symptoms of Exposure	Treatment	TWA[c]	STEL[d]	Source[e]	IDLH (NIOSH)[f]
Methanol	10.85	4.2-5960	Inh Abs Ing Con	Irritated eyes, headache, drowsiness, lightheadedness, nausea, vomiting, disturbance in vision, blindness.	Eye: Irrigate immediately Skin: Water flush promptly Breath: Fresh air Swallow: Immediate medical attention	NIOSH/OSHA 200 ppm (260 mg/m3)	260 ppm	PEL TLV REL	6000 ppm
Nitric acid [7697-37-2]	11.95	0.3-1	Inh Ing Con	Irritated eyes, mucous membranes, and skin; delayed pulmonary edema, pneumonitis, bron-chitis; dental erosion.	Eye: Irrigate immediately Skin: Water flush promptly Breath: Respiratory support Swallow: Immediate medical attention	2 ppm 2 ppm 2 ppm	4 ppm 4 ppm 4 ppm	PEL TLV REL	100 ppm
Petroleum hydrocarbons (Examples: oils, grease, diesel) *[See specific compound and/or product-specific SDS*	Varies	Varies by compound	Inh Ing Con Abs	Irritated skin, eyes, nose, and throat; headache, dizziness; dermatitis; some components of gasoline and diesel exhaust are carcinogenic	Eye: Irrigate immediately Skin: Soap wash immediately Breath: Respiratory support Swallow: Immediate medical Attention	Varies by compound	Varies by compound	NA	Varies by compound
Portland cement			Inh	Fine gray powder that can be irritating if inhaled or in eyes.	Eye: Irrigate immediately Skin: Soap wash flush Breath: Respiratory support Swallow: Immediate medical attention	10 mg/m^3 15 mg/m^3 total dust 5 mg/m^3 respirable fraction 10 mg/m^3/total dust 5 mg/m^3 respirable fraction		TLV PEL REL	NE

Table E2-1

Toxicological and Physical Properties of Chemicals
RSA-013, Unlined Inactive Open Burn Pad
Redstone Arsenal, Madison County, Alabama

Chemical substances italicized represent material that will be used onsite and is not representative of site contaminants.

[a]IP - Ionization potential (electron volts).
[b]Route - Inh, Inhalation; Abs, Skin absorption; Ing, Ingestion; Con, Skin and/or eye contact.
[c]TWA - Time-weighted average. The TWA concentration for a normal work day (usually 8 or 10 hours) and a 40-hour work week, to which nearly all workers may be repeatedly exposed, day after day without adverse effect.
[d]STEL - Short-term exposure limit. A 15-minute TWA exposure that should not be exceeded at any time during a workday, even if the TWA is not exceeded.
[e]PEL - Occupational Safety and Health Administration (OSHA) permissible exposure limit (29 CFR 1910.1000, Table Z).
AEL - Airborne Exposure Limit.
TLV - American Conference of Governmental Industrial Hygiene (ACGIH) threshold limit value—TWA.
REL - National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit.
[f]IDLH (NIOSH)—Immediately dangerous to life or health (NIOSH). Represents the maximum concentration from which, in the event of respirator failure, one could escape within 30 minutes without a respirator and without experiencing any escape-impairing or irreversible health effects.
NE - No evidence could be found for the existence of an IDLH (NIOSH Pocket Guide to Chemical Hazards, Pub. No. 90-117, 2012).
C - Ceiling limit value which should not be exceeded at any time.
Ca - Carcinogen.
NA - Not applicable.
? - Unknown.
LEL - Lower explosive limits.
LC_{50} - Lethal concentration for 50 percent of population tested.
LD_{50} - Lethal dose for 50 percent of population tested.
NIC - Notice of intended change (ACGIH).

References:

American Conference of Governmental Industrial Hygienists Guide to Occupational Exposure Values, 2019, compiled by the American Conference of Governmental Industrial Hygienists.
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Table E2-2

Lighting Requirements for Night Operations
RSA-013, Unlined Inactive Open Burn Pad
Redstone Arsenal, Madison County, Alabama

Location	Illuminance – lx (lumens per square foot)	Monitoring Frequency
Construction areas-general outdoor	33 (3)	Initial shift start/mid-shift
Work areas-general	325 (30)	
Administrative areas (offices, drafting and meeting rooms, etc.)	540 (50)	
Outdoor parking areas	33 (3)	
Visitor areas	215 (20)	
Outdoor storage	33 (3)	

Table E2-3

Biological Hazards
RSA-013, Unlined Inactive Open Burn Pad
Redstone Arsenal, Madison County, Alabama

Ticks



Snakes

Coral Snake

Copperhead

Timber Rattlesnake

Eastern Diamondback Rattlesnake

Pygmy Rattlesnake

Cottonmouth (water moccasin)

Spiders

Black Widow

Brown Widow

Red Widow

Brown Recluse

Table E2-3

Biological Hazards
RSA-013, Unlined Inactive Open Burn Pad
Redstone Arsenal, Madison County, Alabama

Stinging and Biting Insects

Various Bees and Wasps

Ants (including Fire Ants)

Mosquitoes

Centipedes

Poisonous Plants

Poison Ivy **Poison Oak** **Poison Sumac**

Table E5-1

PPE Action Levels
Corrective Measures Implementation
RSA-013, Unlined Inactive Open Burn Pad
Redstone Arsenal, Madison County, Alabama

Level of Protection	Activity Example	Criteria for Use	Action Taken for Upgrade Criteria
Level D	Site setup, vegetation clearing, surveying, waste characterization sampling, confirmation sampling, excavation backfilling, site restoration.	Required for all work outside of EZs or during nonintrusive activities	If unanticipated chemical hazards are encountered
Level D	Soil excavation, post-excavation confirmation soil sampling, decontamination.	Initial level of protection for all work in EZ	Upgrade to Level C if: • Air monitoring detects industrial chemicals at or above action levels. • Presence of strange odor. • Discovery of discolored soils.
Level C	Soil excavation, post-excavation confirmation soil sampling.	Initial level of protection when: • Air monitoring detects possible industrial chemicals at or above Action Levels and below 1 x STEL. • No chemical splash hazards.	• Must contact HSM. SSHP amendment required for Level C PPE.

EZ – Exclusion zone.
HSM – Health and Safety Manager.
PPE – Personal protective equipment.
SSHP – Site-specific safety and health plan.
STEL – Short-Term Exposure Limit.

Table E7-1

VOC Concentrations and PPE Action Levels
Corrective Measures Implementation
RSA-013, Unlined Inactive Open Burn Pad
Redstone Arsenal, Madison County, Alabama

When in Level D Modified/D PPE

Analyte	Action Level	Required Action
VOCs	≥ 10 ppm above background in Breathing Zone	Stop activities, suspend work activities for 15 to 30 minutes; if readings are sustained, contact HSM.
Oxygen	≥ 20%, <23%	Normal operations
	< 20%, > 23%	Stop work, evacuate work area; contact HSM.
Flammable vapors	≥ 10% LEL	Stop work, evacuate work area; contact HSM.
	< 10% LEL	Continue operations, monitor for VOCs.
Respirable dust	≥ 2.5 mg/m^3	Water suppression dust control.

When in Support Zone

Analyte	Action Level	Required Action
VOCs	≥ 1 ppm above background in Breathing Zone	Evacuate support zone and re-establish perimeter of exclusion zone.

No one is permitted to downgrade levels of PPE without authorization from the HSM.

HSM – Health and Safety Manager.
LEL – Lower explosive limit.
PPE – Personal protective equipment.
ppm – Parts per million.
TLV – Threshold limit value.
VOC – Volatile organic compound.

Table E7-2

Air Monitoring Frequency and Location
Corrective Measures Implementation
RSA-013, Unlined Inactive Open Burn Pad
Redstone Arsenal, Madison County, Alabama

Work Activity	Instrument	Frequency	Location
Excavation	OV Monitor CGI/O_2/H_2S Data Ram	Periodically	BZ of employees in excavation area
Confirmation soil sampling	CGI/O_2/H_2S OV Monitor	Periodically	BZ of employees

BZ - Breathing zone.
CGI - Combustible gas indicator.
H_2S - Hydrogen sulfide.
ISEB – In situ enhanced bioremediation.
OV - Organic vapor (photoionization detector 10.6-electron volt lamp).
O_2 - Oxygen.

Table E8-1

Suggested Treatment Actions for Heat Stress
RSA-013, Unlined Inactive Open Burn Pad
Redstone Arsenal, Madison County, Alabama

Heat Rash	• Keep the affected area dry. • Use dusting powder to increase comfort.
Heat Cramps	• Stop all activity. • Sit in a cool place. • Do not return to work for a few hours after the cramps subside – further exertion may lead to heat exhaustion or stroke. • Seek medical attention if the worker has heart problems, worker is on a low-sodium diet, or the cramps do not go away in an hour
Heat Exhaustion	• Move to a cool, shaded (or air-conditioned) area. • Loosen any restrictive clothing. • Drink plenty of water. • Pat skin with a damp rag or sponge.
Heat Stroke	• **CALL 911** (or designated emergency number). • Move to a cool, shaded location. • Cool by soaking clothes with water, spraying or showering them with water, or fanning body.

Adapted from Centers of Disease Control and Prevention Workplace Safety and Health Topics, www.cdc.gov/niosh/topics/heatstress

Table E8-2

ACGIH Screening Criteria and Action Limit for Heat Stress Exposure (WBGT Values in Degrees Celsius/°F) RSA-013, Unlined Inactive Open Burn Pad Redstone Arsenal, Madison County, Alabama

Work/Recovery Cycle (each hour)	TLV®				Action Limit			
	Light	Moderate	Heavy	Very Heavy	Light	Moderate	Heavy	Very Heavy
75 - 100% work	31/87.8	28/82.4	-	-	28/82.4	25/77	-	-
50 - 75% work	31/87.8	29/82.2	27.5/81.5	-	28.5/83.3	26/78.8	24/75.2	-
25 - 50% work	32/89.6	30/86	29/84.2	28/82.4	29.5/85.1	27/80.6	25.5/77.9	24.5/76.1
0 - 25% work	32.5/90.5	31.5/88.7	30.5/86.9	30/86	30/86	29/79	28/82.4	27/80.6

Values from the current edition of the ACGIH publication Threshold Limit Values (TLV®) and Biological Exposure Indices.

Proposed Heat Stress Index for working conditions

APTIM Heat Stress Guideline					
Heat Stress Index					
Danger Category	Heat Index ºC	Heat Index ºF	Heat Syndrome	Resting Time	Water Needed
Extreme Danger	55-59	129.3-138.2	Sun stroke imminent without following rest and water intake requirements	15 minutes / hour	250 ml (8.5 oz) / 10 minutes
Danger	46-54	114.8-129.2	Heat Cramps or Heat Exhaustion likely. Heat Stroke possible with prolonged exposure and physical activity.	10 minutes / hour	250 ml (8.5 oz) / 10 minutes
Extreme Caution	38-45	98.7-113	Heat Cramps or Heat Exhaustion possible with prolonged exposure and physical activity.	5 minutes / hour	250 ml (8.5 oz) / 20 minutes
Caution	<37	<98.6	Fatigue possible with prolonged exposure and physical activity.	Normal / Scheduled	250 ml (85 oz) / 30 minutes
Do not drink more than 1.5 liters (33.8 oz) per hour (maximum water absorption rate of human body)					

Source: APTIM Procedure Number AMS-710-01-PR-0600 Heat Stress Prevention and Control, Attachment 7.1.

ºC – degrees Celsius.
ºF – degrees Fahrenheit.
oz – ounce.

Table E8-3

Work Load Definitions, Modified ACGIH Table 3, Metabolic Rate Changes
RSA-013, Unlined Inactive Open Burn Pad
Redstone Arsenal, Madison County, Alabama

Work Load	Examples
Rest	Sitting.
Light	Sitting with light manual work with hands or hands and arms and driving. Standing with some light arm work and occasional walking.
Moderate	Sustained moderate hand and arm work, moderate arm and leg work, moderate arm and trunk work, or light pushing and pulling. Normal walking. Examples: Scrubbing in a standing position. Walking about with moderate lifting or pushing. Walking on level ground at 3.75 miles/hour while carrying a 6-pound load.
Heavy	Intense arm and trunk work, carrying, shoveling, manual sawing, pushing and pulling heavy loads and walking at a fast pace. Examples: Intermittent heavy lifting with pushing or pulling (e.g. pick and shovel work).
Very Heavy	Very intense activity at a fast to maximum pace. Shoveling wet sand.

ACGIH – American Conference of Governmental Industrial Hygienists.

Table E8-4

Symptoms of Hypothermia
RSA-013, Unlined Inactive Open Burn Pad
Redstone Arsenal, Madison County, Alabama

Core Temperature (°F)	Symptoms
98.6	Normal body temperature
96.8	Person feels cold
95	Shivering
93.2	Clumsy, irrational, confused; may appear drunk
91.4	Muscle stiffness
89.6	Shivering stops, collapse
87.8	Semiconscious
86	Semiconscious; no response to painful stimulus
84.2	Slow pulse and breathing
82.4	Cardiac arrest; no obvious pulse or breathing; pupils dilated

Table E8-5

Types and Symptoms of Frostbite
RSA-013, Unlined Inactive Open Burn Pad
Redstone Arsenal, Madison County, Alabama

Condition	Symptoms
Frostnip	Area of skin whitened; slightly burning or painful.
Superficial Frostbite	Waxy, white skin with a firm sensation but with some resiliency. Feels "warm" to the victim with a notable cessation of pain.
Deep Frostbite	Tissue damage deeper than the skin, sometimes down to the bone. Skin is cold, numb, and hard.

Table E8-6

Equivalent Chill Temperature (°F) at Various Air Temperatures and Wind Speeds
RSA-013, Unlined Inactive Open Burn Pad
Redstone Arsenal, Madison County, Alabama

Estimated Wind Speed (mph)	Actual Temperature Reading (^{0}F)											
	50	**40**	**30**	**20**	**10**	**0**	**-10**	**-20**	**-30**	**-40**	**-50**	**-60**
	Equivalent Chill Temperature (^{0}F)											
Calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
>40 has little additional effect	***LITTLE DANGER*** *In less than 1 hour with dry skin. Maximum danger is false sense of security.*				***INCREASING DANGER*** *From freezing of exposed flesh within 1 minute.*			***GREAT DANGER*** *Flesh may freeze within 30 seconds.*				
	Zone A				***Zone B***			***Zone C***				
	Trench foot and immersion foot may occur at any point on this chart.											

Notes:

* Developed by U.S. Army Research Institute of Environmental Medicine, Natick, MA.
* Equivalent chill temperature requiring dry clothing to maintain core body temperature above 96.80F per ACGIH cold stress TLV.

°F – Degrees Fahrenheit.

Table E8-7

Work/Warming Schedule for a 4-Hour Shift
RSA-013, Unlined Inactive Open Burn Pad
Redstone Arsenal, Madison County, Alabama

Air Temp. (°F)	Air Speed (mph)				
	Calm	**5**	**10**	**15**	**20**
-15 to -19	Normal Breaks (1)	Normal Breaks (1)	75 min. max. work period with 2 breaks	55 min. max. work period with 3 breaks	40 min. max. work period with 4 breaks
-20 to -24	Normal Breaks (1)	75 min. max. work period with 2 breaks	55 min. max. work period with 3 breaks	40 min. max. work period with 4 breaks	30 min. max. work period with 5 breaks
-25 to -29	75 min. max. work period with 2 breaks	55 min. max. work period with 3 breaks	40 min. max. work period with 4 breaks	30 min. max. work period with 5 breaks	
-30 to -34	55 min. max. work period with 3 breaks	40 min. max. work period with 4 breaks	30 min. max. work period with 5 breaks		
-35 to -39	40 min. max. work period with 4 breaks	30 min. max. work period with 5 breaks	**Nonemergency work should cease.** NOTE: The above work/warming regimens are applicable to workers in dry **not** wet clothing.		
-40 to -44	30 min. max. work period with 5 breaks				
-45 and below					

Break period is a 10-minute warmup time in a warm location. Source: ACGIH TLVs and BEIs, Cincinnati, OH, 2015
Adapted from the Occupational Health and Safety Division, Saskatchewan Department of Labor
°F – Degrees Fahrenheit.
mph – Miles per hour.

Table E13-1

Emergency Equipment Requirements
RSA-013, Unlined Inactive Open Burn Pad
Redstone Arsenal, Madison County, Alabama

Emergency Equipment	No. Per Location	Area Where Item(s) Will Be Stored	Operation Requiring Specified Equipment
Portable Eye Wash Kit*	2 each	Each vehicle	All operations
First Aid Kit	1 each	On site	All operations
Fire Extinguisher	1 each	Support vehicles, and SZ	All operations
Cellular Telephone/ Site Communication	1 each	Site Manager/SSHO and SZ	All operations

*For use if employees are exposed to corrosives, strong irritants, or toxic chemicals.
SSHO – Site Safety and Health Officer.
SZ – Support Zone.

FIGURES

Go south out of site on Blueberry Rd (1.4 miles)
Turn LEFT on Mcalpine Rd (1.68 miles)
Turn RIGHT on Buxton Rd (1.04 miles)
Turn LEFT on Patton Rd (3.8 miles)
Turn LEFT on Martin Rd (0.50 mi)
Turn RIGHT on Rideout Rd (4.21 mi)
Continue on Rideout Rd./St Hwy 255 until you reach Oakwood Rd. NW (5.4 mi)
Turn RIGHT onto Oakwood Rd. NW (0.6 mi)
Turn RIGHT on Adventist Blvd. NW (1.2 mi)
Turn LEFT onto Sparkman Dr. NW, your destination is on the RIGHT. (0.3 mi)
Arrive Crestwood Family Practice
1868 Sparkman Dr. NW, Huntsville, AL 35816 (256) 721-9916

Go south out of site on Blueberry Rd (1.4 miles)
Turn LEFT on Mcalpine Rd (1.68 miles)
Turn RIGHT on Buxton Rd (1.04 miles)
Turn LEFT on Patton Rd (3.8 miles)
Turn LEFT on Martin Rd (0.50 mi)
Turn RIGHT on Rideout Rd (4.21 mi)
Loop RIGHT on I-565 West on-ramp (0.4 mi)
Take the first exit onto Madison Blvd (1.07 mi)
Clinic is on the corner at Slaughter Rd.
Arrive Crestwood Workers Care
7736 Madison Blvd, Huntsville, AL 35806
(256) 830-8930

Go south out of site on Blueberry Rd (1.4 miles)
Turn LEFT on Mcalpine Rd (1.68 miles)
Turn RIGHT on Buxton Rd (1.04 miles)
Turn LEFT on Patton Rd (3.8 miles)
Turn RIGHT on Martin Rd heading East (5.70 mi)
Loop RIGHT on US Hwy 231 heading North (3.49 mi)
Exit Governors Dr SW
Turn RIGHT on Governors Dr SW (0.7 mi)
Turn LEFT on Madison St SE (400 ft)
Arrive Huntsville Hospital Emergency on LEFT
878 Madison St SE, Huntsville, AL 35801

Crestwood Family Practice Clinic
1868 Sparkman Dr NW

Crestwood Workers Care Madison Clinic
7736 Madison Blvd

Huntsville Hospital
878 Madison St SE

Oakwood Rd Nw
Adventist Blvd Nw
Sparkman Dr Nw
University Dr Nw
State Hwy 255
I-565 W
Madison Blvd
Rideout Rd
Governors Dr Sw
Us Hwy 231
Martin Rd
Patton Rd
Buxton Rd
Mcalpine Rd
Blueberry Rd
RSA-013

Legend
- Huntsville Hospital
- Crestwood Family Practice Clinic
- Crestwood Workers Care Madison Clinic
- Route to Hospital
- Route to Family Practice
- Route to Workers Care
- RSA-013 Site Boundary
- RSA Installation Boundary

Figure E-1

RSA-013
Directions from the Site to Huntsville Hospital and Crestwood Clinics

Redstone Arsenal
Madison County, Alabama
Contract No. W912DY-17-D-0003

1 inch = 7,200 feet

0 3,500 7,000 14,000 Feet

NAD 1983 State Plane Alabama East Feet

APTIM

ATTACHMENT 1

ACTIVITY HAZARD ANALYSES

List of AHAs RSA-013

01 – Mobilization and Demobilization

02 – Visual Site Inspections and Civil Surveys

03 – Site Survey, Utility Clearance and Marking

04 – Vegetation Clearance

05 – Excavation & Backfilling

06 – Soil Sampling

07 – Equipment Decontamination

08 – Pressure Washing

09 – Waste Management

10 – Fueling Operations

11 – Disposal of RDW

12 – Vehicle Operations

13 – Site Restoration

14 – COVID-19 Job Site Practices

Activity Hazard Analysis (AHA)

Activity/Work Task: Mobilization (and Demobilization)	Overall Risk Assessment Code (RAC) (Use highest code)	**M**
Project Location: RSA-013 Redstone Arsenal Huntsville AL	**Risk Assessment Code (RAC) Matrix**	
Contract Number: W912DY-17-D-0003	**Severity**	**Probability**
Date Prepared: 06/21/2021, Revised 9/17/21		Frequent / Likely / Occasional / Seldom / Unlikely
Prepared by (Name/Title): Ray Clark, Engineer	Catastrophic	E / E / H / H / M
	Critical	E / H / H / M / L
Reviewed by: Doug Russell/HSE Manager	Marginal	H / M / M / L / L
	Negligible	M / L / L / L / L

Notes: (Field Notes, Review Comments, etc.)
This AHA serves as the hazard assessment

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom, or Unlikely.

"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

- **E = Extremely High Risk**
- **H = High Risk**
- **M = Moderate Risk**
- **L = Low Risk**

Job Steps	Hazards	Controls	EM 385-1-1	RAC
Travel at project site.	Vehicle Operation.	See AHA 2.0.	18.A	**M**
Arrival of new personnel at site.	Untrained personnel.	All personnel working on hazardous, toxic, and radioactive waste (HTRW) shall submit HAZWOPER training certificates (40-hour, 8-hour (if applicable), and supervisor (if applicable) to a Site Safety and Health Officer (SSHO). All personnel shall attend a site safety orientation. Other training certifications shall also be made available on site.	18.A	**M**
	Medical qualifications.	All personnel working on HTRW shall submit current physician's certificate stating that employee is participating in an appropriate medical surveillance program meeting 29 Code of Federal Regulation (CFR) 1910.120	01.B.03 01.E.01 28	**L**
	Allergies.	All personnel should complete the Known Allergies Questionnaire (voluntary only).	01.C.01	**L**

Job Steps	Hazards	Controls	EM 385-1-1	RAC
Arrival of new personnel at site (continued).	Unfamiliarity with: site, general (chemical, physical, environmental) site hazards, project safety rules and hazard control procedures, chain of command, and emergency procedures.	All personnel shall attend the site orientation training. The site orientation shall include a review of the phone locations, evacuation routes, and any special requests from the manager of the facility. After personnel are trained in the contents of the Accident Prevention Plan (APP), APP Addenda, and they shall sign the APP Acknowledgment Form. Personnel who may participate in intrusive activities shall attend Munitions and Explosives of Concern Awareness Training. All pertinent AHAs shall be reviewed with personnel (as applicable). Post all hazard warning signs, emergency maps, and emergency phone numbers.	01.B.03 01.E.01 28 03.A.01.b	**M**
Unload equipment/prepare site.	Failure to properly plan daily activities.	A Job Safety Analysis (JSA), as required by Aptim shall be prepared by the crew prior to commencing daily activities. The JSA may be used as a component of the morning Tailgate Safety Meeting. The JSA shall be revised at any time throughout the workday when new tasks are initiated, unforeseen circumstances arise, or if working conditions change. Personnel shall implement Hazard Assessment Resolution Program.		**M**
	Heavy lifting, strains, and sprains.	No individual employee is permitted to lift any object that weighs over 50 pounds. Proper lifting techniques shall be used. Multiple employees or the use of mechanical lifting devices are required for lifting objects over the 50-pound limit.	14.A.01	**M**
	Use of mechanical equipment.	Only qualified personnel shall be permitted to operate equipment. Mechanical equipment shall be inspected daily. Deficiencies in equipment shall be noted on the inspection form. Equipment found to be unsafe shall not be used. All equipment shall be operated at safe speeds and in a safe manner. Equipment operators shall wear safety belts and hearing protection. Ground personnel shall not position themselves between equipment and stationary objects. Personnel are only permitted to approach equipment after a signal from the operator	18.G	**M**
Prepare site.	Hand injuries.	Items to be handled shall be inspected for sharp edges prior to being handled. Personnel shall wear leather gloves when handling sharp materials. Personnel shall be aware of and avoid pinch point hazards.	05.A.08	**L**
	Electrical.	Ground-fault circuit interrupters shall be used on all power tools and extension cords. Extension cords, power tools, and lighting equipment shall be inspected before each use, protected from damage, and kept out of wet areas. Keep extension cords off of roads. Only qualified and authorized electricians will perform electrical installations or maintenance.	11.A	**M**

Job Steps	Hazards	Controls	EM 385-1-1	RAC
Prepare site (continued).	Fire.	Fire extinguishers shall be placed in work areas. The SSHO shall establish smoking areas in compliance with the facility policy. Fire extinguishers will be available in all Aptim work trucks and office facilities. Site personnel shall complete annual fire extinguisher training. Use caution with vehicle exhaust systems in grassy areas. Flammable or combustible liquids will be stored in approved Type 1 or Type 2 safety cans.	09.E.01 09.A.06	**L**
	Chemical hazards.	The Exclusion Zones and Contamination Reduction Zones shall be set-up and appropriately marked with signage. The Emergency Eyewash station shall be inspected, cleaned, filled, and then placed in service. Notify all personnel of the emergency eyewash station location. Employees shall be instructed to the chemical hazards they may be exposed by instruction from the manufacturers SDS. Any hazardous chemicals procured during the work shall be accompanied by SDS. Contact HSM before procuring hazardous chemicals.	28 06.B.02.b 06.B.01.b	**L**

Equipment to be Used	Training Requirements/Competent or Qualified Personnel Name(s)	Inspection Requirements
Personal Protective Equipment - Level D: Hard Hat Safety Glasses Safety-Toed Boots Work Gloves ANSI Class 2 reflective warning vests Equipment: Fire Extinguishers Emergency Eyewash First Aid Kit Deep-Woods Off or Ultrathon Repel® Permanone I® Drinking water Weather radio or AM/FM radio	Training Requirements: Site safety orientation Applicable AHAs HAZWOPER 40-Hour Qualified equipment operators Lifting/back safety Fire extinguisher use Emergency procedures Biological hazard identification and control Tornado shelter locations National Lightning Safety Institute Lightning Safety Procedures	Daily site safety inspection CP (SSHO) – Brian Rhodes Check Known Allergies Questionnaire, training, and medical certifications against personnel roster Mechanized equipment (daily) Overhead and underground utilities Housekeeping (daily) Fire extinguisher (monthly) Vehicle inspection daily Equipment and tools inspection daily and before use Survey areas for poisonous plants, insects, and animals Check body for ticks

Activity Hazard Analysis (AHA)

Activity/Work Task: Visual Site Inspections and Civil Surveys	Overall Risk Assessment Code (RAC) (Use highest code)	**M**
Project Location: RSA-013 Redstone Arsenal Huntsville AL	**Risk Assessment Code (RAC) Matrix**	
Contract Number: W912DY-17-D-0003	**Severity** / **Probability**	
Date Prepared: 06/21/21		
Prepared by (Name/Title): Ray Clark, Engineer		
Reviewed by: Doug Russell/HSE Manager		
Notes: (Field Notes, Review Comments, etc.) This AHA serves as the hazard assessment		

Severity	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	**E**	**E**	**H**	**H**	**M**
Critical	**E**	**H**	**H**	**M**	**L**
Marginal	**H**	**M**	**M**	**L**	**L**
Negligible	**M**	**L**	**L**	**L**	**L**

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom, or Unlikely.

"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

- **E = Extremely High Risk**
- **H = High Risk**
- **M = Moderate Risk**
- **L = Low Risk**

Job Steps	Hazards	Controls	EM 385-1-1	RAC
Arrival of new personnel at site.	Unfamiliarity with: site, general site hazards, project safety rules, chain of command, and emergency procedures.	All personnel shall attend the site orientation training.	01.B.03 01.E.01 28	**M**
Visual site inspections and surveys.	Poor planning.	Complete Job Safety Analysis for each task. Use Hazard Assessment Resolution Program frequently – for each task to be completed.		**M**
	Heavy lifting, strains, and sprains.	No individual employee is permitted to lift any object that weighs over 50 pounds. Proper lifting techniques shall be used. Multiple employees or the use of mechanical lifting devices are required for lifting objects over the 50-pound limit.	14.A.01	**M**
	Struck-by/against.	Wear reflective warning vests when exposed to vehicular traffic. Personnel working on or near roads and only remain on road long enough to complete work. Personnel walking along roadway shall stay off roadway as far as possible and walk on the side facing traffic.	05.F	**M**
	Munitions and Explosives of Concern (MEC) / Unexploded Ordnance (UXO).	Personnel shall attend site-specific MEC Awareness (and recognition) Training prior to the commencement of any site activities.	01.B.01 33.A.01	**M**

Job Steps	Hazards	Controls	EM 385-1-1	RAC
Visual site inspections and surveys (continued).	Slips, trips, and falls.	Keep work areas clear and maintain housekeeping. Personnel shall not jump from elevated surfaces. Personnel shall use caution when walking on rocky, slippery, or uneven terrain.	14.C.01-10	**M**
	Hand injuries.	Items to be handled shall be inspected for sharp edges prior to being handled. Personnel shall wear leather gloves when handling sharp materials. Personnel shall be aware of and avoid pinch point hazards.	05.A.08	**L**
	Insect bites/West Nile virus.	Wear PPE and tape joints to keep insects away from the skin. Use protective insect repellents containing N,N-diethyl-m-toluamide, such as, Deep Woods OFF, 3M Ultrathon™, or equivalent and clothing insecticide preparations containing permethrins (Repel® Permanone® or equivalent) to prevent insect bites. Check limbs/body for insects/insect bites before showering. Notify Site Safety and Health Officer (SSHO) of flu-like symptoms.	06.D.01	**L**
	Contact dermatitis and poison ivy.	Check around work areas to identify if poison ivy is present. Wear long-sleeve shirts/trousers or Tyvek® coveralls to avoid skin contact with plants or other skin irritants. Learn to identify poisonous plants Remove clothing or Tyvek® coveralls by inside-out method to avoid contact with potentially contaminated outer surfaces. Avoid unnecessary clearing of plant/vegetation areas. Cover vegetation with plastic (visqueen) where sampling position raises exposure potential. Apply protective cream / lotion to exposed skin to prevent poison ivy or similar reactions. Identify workers known to contract poison ivy. Follow procedures outlined in the SSHP.	06.D.03	**L**
	Severe weather.	The SSHO will monitor weather conditions each day in order to plan and prepare for hazardous conditions. The SSHO will identify a suitable tornado shelter at each work location. Work activities will be suspended prior to weather conditions becoming hazardous so that workers have ample time to seek shelter. When lightning is observed within a 10 mile radius or upon hearing thunder, outdoor activities shall be suspended and personnel shall be evacuated to safe areas (inside vehicles, buildings, or tornado shelters as appropriate). A waiting period of at least 30 minutes from the last nearby lightning strike will be observed before resuming activities. Follow procedures outlined in the SSHP.	06.1	**L**
	Hazardous atmospheres.	Personnel shall immediately notify the SSHO if odors are detected.		**L**
	Heat stress and cold stress.	Follow procedures outlined in the SSHP. Use ACGIH guidelines for WBGT TLV values.	06.I	**M**

Job Steps	Hazards	Controls	EM 385-1-1	RAC
Visual site inspections and surveys (continued).	Fire.	Smoking shall be permitted in designated areas. Vehicles shall not be parked in tall dry grass. Engines shall be shut off before refueling. A 10-B:C fire extinguisher shall be available when refueling. Site personnel shall complete annual fire extinguisher training. Smoking shall not be permitted near fueling areas. Gasoline shall be stored in safety cans with flash arrestors and spring-loaded vents.	09.E.01 09.A.06 09.B.08	**M**

Equipment to be Used	Training Requirements/Competent or Qualified Personnel Name(s)	Inspection Requirements
Personal Protective Equipment - Level D: Hard hat Safety glasses Safety-toed boots Work gloves ANSI Class 2 reflective warning vests Equipment: Survey instrumentation Fire extinguishers Emergency eyewash First aid kit Deep-Woods Off or Ultrathon™ Repel® Permanone® Drinking water Weather radio or AM/FM radio	Competent Person (CP) / Qualified Person (QP): Brian Rhodes– CP/SSHO TBD– QP/First Aid and CPR Training Requirements: Site safety orientation HAZWOPER 40-Hour MEC Awareness Lifting/back safety Fire extinguisher use Emergency procedures Biological hazard identification and control Tornado shelter locations National Lightning Safety Institute Lightning Safety procedures	Daily site safety inspection (SSHO) – Brian Rhodes Daily site safety inspection (QCO) – TBD Check Known Allergies Questionnaire Housekeeping (daily) Fire extinguisher (weekly) Vehicle inspection daily Equipment and tools inspection daily and before use Survey areas for poisonous plants, insects, and animals Check body for ticks Verify tornado shelter available Monitor approaching storms

Activity Hazard Analysis (AHA)

Activity/Work Task: Site Surveys, Utility Clearance and Markings	Overall Risk Assessment Code (RAC)					**L**
Project Location: RSA-013 Redstone Arsenal, Huntsville AL	**Risk Assessment Code (RAC) Matrix**					
Contract Number: W912DY-17-D-0003	**Severity**	**Probability**				
Date Prepared: 06/25/20		Frequent	Likely	Occasional	Seldom	Unlikely
Prepared by (Name/Title): Ray Clark, Engineer	Catastrophic	**E**	**E**	**H**	**H**	**M**
	Critical	**E**	**H**	**H**	**M**	**L**
Reviewed by: Doug Russell/HSE Manager	Marginal	**H**	**M**	**M**	**L**	**L**
	Negligible	**M**	**L**	**L**	**L**	**L**

Notes: (activity description) This AHA serves as the hazard assessment.
A licensed subcontractor will conduct a utility survey to locate subsurface drilling hazards using multiple geophysical methods, including electromagnetic induction and ground penetrating radar. Utility lines found in the immediate vicinity of the proposed limits of intrusive activity will be marked using color-coded surveyor paint.

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom or Unlikely.

"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

- **E = Extremely High Risk**
- **H = High Risk**
- **M = Moderate Risk**
- **L = Low Risk**

Job Steps	Hazards	Controls	RAC
Walking the Site Lifting Equipment and Materials	Slips, trips, and falls	• Inspect work areas for washes, potholes, or other surface irregularities that could cause slips, trips or falls. • Always establish good footing. • Maintain good housekeeping. Keep walkways clear of debris and tools.	**L**
	Muscle strains	• Observe 50 pound individual lifting limit. • Do not lift and twist. • Get help for loads greater than 50 pounds. • Train workers in safe lifting techniques.	**L**
Mobile Equipment	Striking workers or equipment	• Use spotters when backing. • Inspect area for overhead and underground hazards. • Know the safest route to and from your work area. • Use flags, traffic cones to control traffic.	**L**

Job Steps	Hazards	Controls	RAC
Changed or Unanticipated Conditions	Safety or health hazards that may be derived from changed or unanticipated conditions	• Modify the AHA as often as necessary to address new or unanticipated hazards. Use ”Job Safety Analysis” form to facilitate field documentation.	**NA**

Equipment to be Used	Training Requirements/Competent or Qualified Personnel name(s)	Inspection Requirements
• Level D personal protection: safety boots, Safety eyewear, long pants protection, abrasion resistant gloves	• Tailgate safety meeting • Worker must be trained in the safe application of task specific tools and materials • Brian Rhodes – CP/SSHO	• Inspect all equipment at least daily • Utility clearance checklist • Inspect non-construction equipment and power tools per manufacturer requirements.

Activity Hazard Analysis (AHA)

Activity/Work Task: Vegetation Clearance	Overall Risk Assessment Code (RAC) (Use highest code)	**M**
Project Location: RSA-013 Redstone Arsenal Huntsville AL	**Risk Assessment Code (RAC) Matrix**	
Contract Number: W912DY-17-D-0003	**Severity** / **Probability**	
Date Prepared: 06/21/21 Revised 9/17/21		
Prepared by (Name/Title): Ray Clark, Engineer		
Reviewed by: Doug Russell/HSE Manager		
Notes: (Field Notes, Review Comments, etc.) This AHA serves as the hazard assessment		

Severity	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	**E**	**E**	**H**	**H**	**M**
Critical	**E**	**H**	**H**	**M**	**L**
Marginal	**H**	**M**	**M**	**L**	**L**
Negligible	**M**	**L**	**L**	**L**	**L**

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom, or Unlikely.

"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

- **E = Extremely High Risk**
- **H = High Risk**
- **M = Moderate Risk**
- **L = Low Risk**

Job Steps	Hazards	Controls	EM 385-1-1	RAC
Arrival of new personnel at site.	Unfamiliarity with: site, general site hazards, project safety rules, chain of command, and emergency procedures.	All personnel shall attend the site orientation training.	01.B.03 01.E.01 28	**M**
Vegetation removal.	Poor planning.	Complete Job Safety Analysis for each task, as specified in "Job Safety Analysis (JSA)." Use Hazard Assessment Resolution Program frequently – for each task to be completed.		**M**
	Heavy lifting, strains, and sprains.	No individual employee is permitted to lift any object that weighs over 50 pounds. Proper lifting techniques shall be used. Multiple employees or the use of mechanical lifting devices are required for lifting objects over the 50-pound limit.	14.A.01	**M**
	Struck-by/Against.	Wear reflective warning vests when exposed to vehicular traffic. Personnel working on or near roads and only remain on road long enough to complete work. Personnel walking along roadway shall stay off roadway as far as possible and walk on the side facing traffic.	05.F	**M**
	Intrusive activities.	Follow procedure for intrusive activities prior to commencing clearing and grubbing activities. Follow MEC avoidance techniques in accordance with EM 385-1-97 during all vegetation removal.	25.A.01	**M**
	Slips, trips, and falls.	Keep work areas clear and maintain housekeeping. Personnel shall not jump from elevated surfaces. Personnel shall use caution when walking on rocky, slippery, or uneven terrain.	14.C.01-10	**M**

Job Steps	Hazards	Controls	EM 385-1-1	RAC
Vegetation removal (continued).	Hand injuries.	Items to be handled shall be inspected for sharp edges prior to being handled. Personnel shall wear leather gloves when handling sharp materials. Personnel shall be aware of and avoid pinch point hazards.	05.A.08	L
	Use of heavy equipment.	Only qualified personnel shall be permitted to operate equipment. Heavy equipment shall be inspected daily after the initial U.S. Army Corps of Engineers inspection (and documented). Do not use unsafe equipment. All equipment shall have backing alarms. All equipment shall be operated at safe speeds and in a safe manner. Equipment operators shall wear safety belts. Personnel are only permitted to approach equipment after a signal from the operator. Ground personnel, working near heavy equipment, shall wear high visibility conspicuity vests. Ground personnel shall not enter the swing radius of equipment. Ground personnel shall not position themselves between equipment and stationary objects. Personnel shall verify all mechanical guards are in place and functioning properly. Moving equipment shall be equipped with a back-up alarm. All equipment shall be shut down with energies dissipated prior to performing maintenance activities - lock out/tag out procedures may apply. Only qualified mechanics shall work on or repair heavy equipment. Heavy equipment shall be equipped with Falling Object Protective Structure. Ensure everyone is clear of fall radius when using heavy equipment to push over trees.	18.A 18.G 18.B 05.F 18.B.12	M
	Injury from chain saws, wood/falling trees, chips, cuts, and noise.	Chain saw operators shall wear a specially designed helmet system (consisting of head, face, and hearing protection). Use gloves and chaps at all times when using saw. Operators shall wear chain saw protective boots with steel toes. Secure loose fitting clothing with duct tape. Keep other personnel at least two tree lengths away from tree being felled. Operators shall have escape routes planned that are at 45 degrees from the projected direction of the falling tree. Keep escape routes clear of all tools, materials, and wood/brush. Always cut away from the body. Shut off chain saws when walking between work areas. Have spotter assist when falling large or tall trees. Only cut trees, logs, or branches from ground height. Shut off engines before freeing pinched chains. Chain saw operators shall always hold the saw with both hands during cutting operations. Inspect chain saw before each use. Do not use saws in which any safety feature is not functioning. Frequently check and adjust tension on chain. Do not use saws with or dull cutters. Do not increase force used as cutters become dull. The idle speed shall be properly adjusted to prevent the chain from moving when the engine is idling. Keep bar groove clean. Use only new chains or professionally sharpened chains. Replace sprockets, which show signs of wear. Remain alert to kickback hazards and keep a firm, proper grip on chain saw at all times. All chain saws shall be equipped with automatic chain brake and other anti-kickback devices. Use wedges to prevent binding of the chain. Do not cut with the tip (nose) of the bar. Do not use dull chains. Do not overreach with chain saw. Personnel shall not operate	13.F 13.A 31.C	M

Job Steps	Hazards	Controls	EM 385-1-1	RAC
		chain saws above shoulder height. Personnel shall be familiar with cutting techniques.		
Vegetation removal (continued).	Small tree and brush removal/chipping.	Machete use is prohibited. Personnel operating weed whackers shall wear hearing protection and eye/face protection. Steel blade use on weed whackers is prohibited. The procedures outlined in *Safety and Health Requirements Manual*, Sections 31.C, 31.D and 31.E shall be conveyed to all personnel involved in the operations. Remain clear of feed and discharge chutes on chippers.Small tree (< 3 inch diameter) falling shall consist of pushing over with heavy equipment. No one shall climb trees.	31.C 31.D 31.E	**M**
	Fatigue.	Chainsaw and equipment operators shall be given ample rest breaks.		**M**
	Insect bites/West Nile Virus.	Wear personal protective equipment (PPE) and tape joints to keep insects away from the skin. Use protective insect repellents containing N,N-Diethyl-m-toluamide, such as, 3M Ultrathon™ or equivalent and clothing insecticide preparations containing permethrins (Repel® Permanone® or equivalent) to prevent insect bites. Check limbs/body for insects/insect bites before showering. Notify Site Safety and Health Officer (SSHO) of flu-like symptoms.	06.D.01	**L**
	Contact dermatitis and poison ivy.	Check around work areas to identify if poison ivy is present. Wear long-sleeve shirts/trousers or Tyvek® coveralls to avoid skin contact with plants or other skin irritants. Remove clothing or Tyvek® coveralls by inside out method to avoid contact with potentially contaminated outer surface. Learn to identify poisonous plants. Avoid unnecessary clearing of plant/vegetation areas. Cover vegetation with plastic (visqueen) where sampling position raises exposure potential. Apply protective cream/lotion to exposed skin to prevent poison ivy or similar reactions. Identify workers who are known to contract poison ivy.	06.D.03	**L**
	Severe weather.	The SSHO will monitor weather conditions each day in order to plan and prepare for hazardous conditions and will use lightning and severe weather detection devices to evaluate potential weather threats. Work activities will be suspended prior to weather conditions becoming hazardous so that workers have ample time to seek shelter. When lightning is observed within a 10-mile radius or upon hearing thunder, outdoor activities shall be suspended and personnel shall be evacuated to safe areas (inside vehicles, buildings, or tornado shelters as appropriate). A waiting period of at least 30 minutes from the last nearby lightning strike will be observed before resuming activities. Follow procedures outlined in the SSHP.	06.I	**L**
	Hazardous atmospheres.	Personnel shall immediately notify the SSHO if odors are detected.		**L**
	Heat stress and cold stress.	Follow procedures outlined in the SSHP. Use ACGIH guidelines for WBGT TLV values	06.I	**M**
	Dust.	Dust shall be monitored and controlled. PPE use is required when working in contaminated areas.	28	**L**

Job Steps	Hazards	Controls	EM 385-1-1	RAC
Vegetation removal (continued).	Fire.	Smoking shall be permitted in designated areas. Vehicles shall not be parked in tall dry grass. Engines shall be shut off before refueling. A 10-pound A:B:C: fire extinguisher shall be available on heavy equipment. Site personnel shall complete annual fire extinguisher training. Gasoline shall be stored in safety cans with flash arrestors and spring-loaded vents.	09.E.01 09.A.06 09.B.08	L
	Controlled burns	RSA Fire Department will plan controlled burns and manage their activities in relation to a Wildfire Control Plan.	09.K	M

Equipment to be Used	Training Requirements/Competent or Qualified Personnel Name(s)	Inspection Requirements
Personal Protective Equipment - Level D - Modified: Hard Hat Safety Glasses Safety-Toed Boots Work Gloves ANSI Class 2 reflective warning vests Disposable coveralls and protective gloves (when contact with irritating plants possible) Helmet systems for chain saw use Protective chaps for chain saw use Hearing protection Equipment: Magnetometers Geophysics Instruments Excavator or Bush Hog Equipped Skid Steer Rubber or track loader Fire Extinguishers Emergency Eyewash First Aid Kit Deep-Woods Off or Ultrathon™ Repel® Permanone® Drinking water Weather radio or AM/FM radio Chain saws Extra chains Plastic or wood wedges	Competent Person: (SSHO) Brian Rhodes Training Requirements: Site safety orientation UXO Technicians must be qualified IAW DDESB TP 18 Applicable AHAs HAZWOPER 40-Hour MEC Awareness Qualified equipment operators Lifting/back safety Fire extinguisher use Biological hazard identification and control Emergency procedures Tornado shelter locations National Lightning Safety Institute Lightning Safety Procedures	Daily site safety inspection (SSHO) – Brian Rhodes Check Known Allergies Questionnaire Housekeeping (daily) Fire extinguisher (monthly) Vehicle inspection daily Overhead and underground utilities Mechanized equipment (daily) Equipment and tools inspection daily and before use Survey areas for poisonous plants, insects, and animals Check body for ticks Monitor approaching storms

Activity Hazard Analysis (AHA)

Activity/Work Task: Excavation & Backfill	Overall Risk Assessment Code (RAC) (Use highest code)	**M**
Project Location: RSA-013 Redstone Arsenal Huntsville AL	**Risk Assessment Code (RAC) Matrix**	
Contract/Project Number: W912DY-17-D-0003	**Severity** / **Probability**	
Date Prepared: 06/25/20, Revised 9/17/21		
Prepared by (Name/Title): Ray Clark, Engineer Scientist		
Reviewed by: Doug Russell/HSE Manager		

Severity	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	**E**	**E**	**H**	**H**	**M**
Critical	**E**	**H**	**H**	**M**	**L**
Marginal	**H**	**M**	**M**	**L**	**L**
Negligible	**M**	**L**	**L**	**L**	**L**

Notes: (Field Notes, Review Comments, etc.)
This AHA serves as certification of hazard assessment.

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom, or Unlikely.

"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

- **E = Extremely High Risk**
- **H = High Risk**
- **M = Moderate Risk**
- **L = Low Risk**

Job Steps	Hazards	Controls	RAC
Verify overhead and underground utilities locations. Set up equipment for operation. Inspect equipment for use. Inspect work area where equipment is to be used. Isolate work area, as appropriate. Move equipment to work area.	Newly hired personnel and visitors. Unfamiliarity with: site, general (chemical, physical, environmental) site hazards, project safety rules and hazard control procedures, chain of command, and emergency procedures.	All personnel shall attend a site safety orientation. After personnel are trained in the contents of the Installation-Wide RSA Accident Prevention Plan (APP) and the Site Safety and Health Plan (SSHP), they shall sign the APP Acknowledgment Form and the SSHP Acknowledgment Form. Review emergency procedures and evacuation plans.	**M**
	Unqualified operator(s).	Verify operator is qualified and authorized for the equipment being used. Only personnel authorized by employer shall operate equipment.	**M**
	Failure to properly plan daily activities.	A Job Safety Analysis (JSA) shall be prepared by the crew prior to commencing daily activities. The JSA shall be used as a component of the morning Tailgate Safety Meeting. The JSA shall be revised at any time throughout the workday when new tasks are initiated, unforeseen circumstances arise, or if working conditions change. Personnel shall implement Hazard Assessment Resolution Process and Safety Step Back. Personnel to conduct focused and leading indicator "Target" observations.	**M**

Job Steps	Hazards	Controls	RAC
Excavation and backfill.	Complacency.	All personnel shall attend the morning safety meetings to re-focus themselves to hazards, emergency procedures and equipment, operational aspects, and change(s) in site/work conditions. Recommended control measures for the hazards shall be part of the discussion.	**M**
	Fire.	Fire extinguishers shall be available in work areas. A 4-A:60-B:C fire extinguisher shall be available when refueling at the project site. Excavators shall be equipped with a 10-B:C fire extinguisher. Site personnel shall complete annual fire extinguisher training. The SSHO shall establish smoking areas. Smoke only in designated areas. Only discard cigarette butts in proper receptacles – never discard cigarette butts onto the ground. Smoking shall not be permitted within 50 feet of fueling operations. Use caution with vehicle exhaust systems in grassy areas. Do not run vehicles or equipment while parked in dry, grassy areas. Engines shall be shut off and allowed to cool before refueling. Follow AHA for “Fueling Operations.”	**M**
	Unsafe equipment.	Before excavating equipment is placed in use at the project, it shall be inspected and tested in accordance with the manufacturer’s recommendations and shall be certified in writing by a competent person to meet the manufacturer’s recommendations. Subsequent re-inspections will be conducted at least annually thereafter. These inspections shall be documented on a Checklist for Construction Equipment. All safety deficiencies noted during the inspection shall be corrected prior to the equipment being placed in service at the project. All excavating equipment shall be inspected by the operator prior to use on the project and shall then be inspected on a daily basis .Deficiencies in equipment shall be noted on the inspection form. Do not use equipment that is not in proper operating condition. Attach a “Danger – Do Not Use” tag to inoperable equipment, remove key from equipment, and give key to the supervisor when notifying him/her of the inoperable equipment.. Verify all manufacturers' safety guards, features, controls, back-up alarms, horns, and equipment are functioning properly and as intended by the manufacturer. Install and maintain equipment attachments and their operating systems according to manufacturer's specifications. Make frequent visual inspections of quick-disconnect systems (systems for connecting attachments to excavators) especially after changing attachments. Verify controls are properly labels as to equipment function.	**M**

Job Steps	Hazards	Controls	RAC
Placing and moving equipment. Excavation and backfill.	Overhead/aboveground hazards and utilities.	Follow AMS-710-02-PR-01610, Utility Contact Prevention. Overhead and aboveground hazards shall be evaluated prior to moving equipment on the project site. Complete a Site Layout Plan prior to mobilizing the equipment. The plan shall identify all overhead and aboveground hazards in the active work area(s) and travel routes - include utilities, pipe racks, structures, restricted areas, pedestrian routes, and equipment/vehicle traffic. Power lines shall be assumed to be energized unless verified to be de-energized and visibly grounded. Operation beneath a power line that has not been verified as de-energized and grounded must maintain clearance distances stated below. Nominal System Voltage — Minimum Required Clearance Distance Up to 50 kV — 10 feet (3 m) Over 50 - 200 kV — 15 feet (4.6 m) Over 200 - 350 kV — 20 feet (6 m) Over 350 - 500 kV — 25 feet (7.6 m) Over 500 – 750 kV — 35 feet (10.7 m) Over 750 – 1,000 kV — 45 feet (13.7 m) For over 1,000 kV, the minimum required clearance distance will be established by the utility owner/operator or professional engineer who is a qualified person with respect to electrical power transmission and distribution. Identify and provide temporary visual barriers that help prevent encroachment with the lines. In areas where it is not feasible to use barricades, spotters shall be provided; however, the minimum clearance distances from electrical lines must be observed. Each work crew member shall be trained in the electrocution hazards and emergency procedures associated with contacting energized power lines. Post overhead hazard warning signs as necessary.	**M**

Job Steps	Hazards	Controls	RAC
Placing and moving equipment. Excavation and backfill.	Underground utilities and other underground hazards.	Follow AMS-710-02-PR-01610, Utility Contact Prevention. Follow any additional procedures for intrusive activities identified in APP and Work Plan prior to commencing intrusive activities. Utilities shall be located and marked prior to commencing intrusive activities. Contact utility one-call service (811) at least 48 hour but not more than 10 days prior to commencing intrusive activities, excluding weekends or any state or federal holidays. Retain a copy of mark-out ticket for documentation purposes and QC purposes. Documentation of utility mark-out must be completed using the Utility Mark-out Documentation form (EIG-HS-308.03). Evaluate the work areas, ground conditions, and travel paths to identify any sensitive underground structures, unstable areas, dangerous slopes, and existing open excavations. Complete a Site Layout Plan prior to mobilizing the equipment. The plan shall identify all underground utilities and other underground hazards in the active work areas and travel routes. Cease work immediately if unknown utilities or utility markers are uncovered. Use manual excavation within 3 feet of known utilities. Once the line or cable is exposed, heavy equipment can be used but must remain at least 3 feet from the exposed line or cable. Each work crew member shall be trained in electrocution hazards, explosion/fire hazards, and emergency procedures associated with contacting energized power lines and pipelines. Immediately contact Public Works Department in event utilities are encountered that were not previously marked. Notify Public Works in event any damage to utilities occur.	**M**
	Hand injuries.	Personnel shall wear appropriate leather, heavy cotton or synthetic gloves when handling materials with sharp edges, splinters, burrs, rough surfaces, etc. Items to be handled shall be inspected for sharp edges, splinters, burrs, rough surfaces, etc. prior to being handled. Personnel shall be aware of and avoid pinch point hazards.	**M**
	Noise.	All personnel shall wear hearing protection when operating noisy equipment. Personnel working in vicinity of noisy equipment shall wear hearing protection. Verify personnel noise exposures are safe by performing noise dosimetry.	**L**

Job Steps	Hazards	Controls	RAC
Excavation and backfill.	Use of excavators and backhoes.	Only qualified personnel shall be permitted to operate equipment. It is the responsibility of the operator to read and understand the manufacturer's operator manual, the manufacturer's recommendations for each type and model of equipment to be operated, and the requirements of AMS-710-02-PR-05700 prior to operating equipment. Operators must know the capacity and operating characteristics of the equipment to be operated. When mounting or dismounting equipment, clean shoes and hands before climbing. Always use handrails, grab rails, and steps. Maintain a three-point contact/control with steps and handholds. Never jump on or off equipment. Never attempt to mount or dismount a moving machine. Do not use steering wheel or control levers as a handhold. Lower the boom (and loader when equipped) to a safe position with the bucket/attachment on the ground and turn off the excavator before dismounting equipment. The equipment must be attended at all times or attachments must be placed in the “transport lock position” or lowered to the ground. The operator is responsible for keeping the windows clear and keeping cab clean at all times. Equipment operators must wear seat belt at all times and keep body (hands, arms, legs, head, etc.) inside the protected area of the cab. Operations are to be performed only from the operators control station. All equipment shall be operated at safe speeds and in a safe manner. If equipped with such, use the machine stabilizers. Loads must be carried as low as possible to maintain stability of the equipment and operator visibility. Do not operate equipment on grades steeper than those specified by the manufacturer. When operating on a sloped area, always move up or down the slope and not across the slope. Avoid making turns on inclines. If it is necessary, make turns wide and slowly with load carried low. When traveling up or down inclines, do so with loaded buckets facing uphill and empty buckets facing downhill. The operator of equipment shall not use cellular telephone devices or head/earphones for entertainment purposes while operating equipment. The use of cell phones and other communication devices are permitted for job-related communications or emergency situations, when the equipment is not operating.	**M**

Job Steps	Hazards	Controls	RAC
Excavation and backfill.l	Use of excavators and backhoes (continued).	The operator shall not use attachments for which they were not designed to be used for, e.g., using a bucket to transport telephone poles. Follow the manufacturer's instructions for using positive locks on quick-disconnect equipment. Securely latch attachments such as quick-disconnect buckets before beginning work. Make frequent visual inspections of quick-disconnect systems — especially after changing attachments. The operator is to stay alert and focused at all times when the excavator or backhoe is in operation.	**M**
	Excavation and trenching.	All excavation and trenching activities will be conducted in accordance with AMS-710-02-PR-01600 *Excavation and Trenching* and EM-385-1-1 Section 25 Excavation and Trenching as applicable. Excavation from stable ground. Slope side walls if spalling is observed. Keep all personnel, equipment and spoils at least 3 feet from excavation. No one is permitted to enter excavation except those in cabs of heavy equipment.	**M**
	Struck by and against	Wear PPE with high visibility vests when walking or working near moving equipment or vehicles. Prevent unauthorized workers or bystanders from entering work areas with equipment operations. Verify "**DANGER – STAY CLEAR"** (or equivalent) warning sign(s) is visibly posted on the equipment. Personnel shall maintain a safe distance from operations. Keep alert for movement of equipment, loads, excavations, piles, and ejected matter. Personnel shall not be permitted in the swing radius of the equipment. Precautions must be implemented to keep personnel out of excavations and at least 10 ft. (3 m) away from the equipment and its maximum boom and/or counterweight swing radius when operating. Accessible areas within the swing radius of the equipment are to be barricaded to prevent personnel from being struck or crushed, as appropriate.	**M**

Job Steps	Hazards	Controls	RAC
Excavation and backfill.		Do not approach an excavator or backhoe without first establishing communication with the operator or spotter (eye contact and then a signal to proceed after the equipment has been shut down: • Excavator bucket planted, powered down, and controls locked. • Backhoe bucket planted, engine shut off. Don't allow anyone to stand under a suspended load or the boom, arm, or bucket. Operator to stop operations if personnel are observed within the swing radius.	
	Spotter operations.	Use designated spotters as necessary and as determined by the operator or supervisor. Establish communication before starting work – hand signals, whistles, radios, air horn, audible alarm, or other means of effective jobsite communication. When a designated spotter is used, the equipment shall not be moved unless the designated spotter giving signals is in full view of the operator. The spotter must maintain line of site or communication with the equipment operator. For movement of mobile equipment in congested areas, a designated spotter shall be in full view of the operator and shall direct the movement. In some cases, multiple spotters may be required.	**M**
	Sampling from bucket.	Position the sampling support and collection area on the cab side of the excavator to minimize operator blind spots created by the excavator boom assembly. Verify the operator is aware of your intention to collect samples from the bucket. Prior to sampling, the equipment operator shall fully lower the bucket to the ground, set the safety lockout lever to isolate joystick controls, decelerate the engine to idle level and signal the sample technician it is safe to approach the bucket. For backhoes, the bucket shall be planted on the ground and the engine shut down prior to approaching the bucket to obtain a sample. Keep out from between the excavator bucket and fixed objects, vehicles, or equipment when sampling. The operator should swing the machine to where the boom is at least at a 45-degree angle away from the excavation.	M
	Excavation hazards.	Follow the project Excavation/Trenching Plan contained in the CMIP.	**M**

Job Steps	Hazards	Controls	RAC
Excavation and backfill.	Dust or potential airborne chemical hazards	Control dust by maintaining equipment operation rates. Control dust by applying water when action level 2.5 mg/m^3 is exceeded. Personnel shall stay out of dust and work from upwind when possible. Perform dust monitoring as specified in the SSHP. Real-time air monitoring will be executed in accordance with SSHP requirements to mitigate potential worker exposure.	**M**
Use heavy haul units.	Dump truck operations.	Dump trucks shall be inspected and found to be in safe condition prior to being placed in service at the site. Overhead hazards shall be re-evaluated prior to allowing dump trucks onto the project site. Areas with overhead hazards shall be barricaded with caution tape to prevent dump bed from contacting. In areas where it is not feasible to used barricades, then spotters shall be provided; however, the minimum distances from electrical lines must be observed. Operators shall wear seat belts while trucks are in motion at the project site. Spotters shall assist trucks when backing as necessary. Trucks shall be equipped with audible backup alarms. Cab shall be equipped with elevated bed indicator. Material shall not be loaded over cab of trucks. Personnel shall stay away from trucks when being loaded. Tires shall be inspected for accumulation of debris and cleaned as needed to avoid tracking on roadways.	**L**
General site activities.	Slips, trips, and falls.	Understand the hazards of slips, trips, and falls – consider the consequences. Do not jump from equipment or elevated surfaces. Clean-up work areas throughout the day and at the end of each workday. Use three-point contact rule for entering/exiting vehicles, trucks, and equipment. Use hand rails and other stationary objects (door frames, door knobs, steering wheels, walls, etc.) to increase stability. Use extra caution when walking on wet, muddy, frosty, icy, or snow-covered surfaces. Consider postponing work as necessary and feasible. Increase your awareness, keep alert, stay focused, and know your environment. Stay away from slopes, hills, and grades. Be cautious when using stairs. Remove snow and ice when possible (shoveling, chipping, and salt application). Apply traction aids, such as sand, gravels, and straw. Lower your center of gravity when necessary. Slow down - take smaller steps.	**M**

Job Steps	Hazards	Controls	RAC
General site activities.	Insect bites and stings.	Review injury and illness potential with workers. Inspect work areas for bee nests and activity prior to commencing work in that area. Wear PPE, such as disposable coveralls, to keep insects away from the skin. Expect to encounter insects when working in warm weather – especially at locations with vegetation present. Use protective insect repellents containing DEET (Deep Woods Off or equivalent) to prevent insect bites, unless individual allergies and sensitivities prevent its use. Consider applying Permethrin (Repel® Permanone® or equivalent) preparations to clothing to repel ticks, chiggers, mosquitoes, and/or spiders. Check limbs/body for insects/ insect bites upon removing PPE and again during showering. Immediately notify supervisor or SSHO of insect bites, stings, irritations, rashes, or flu-like symptoms.	**L**
	Contact dermatitis from poisonous and irritating plants (poison ivy, poison oak, and poison sumac).	Learn to identify poisonous and irritating plants. Check around work areas to identify if poisonous and irritating plants are present. Identify workers who are known especially sensitive to poisonous and irritating plants and plan work accordingly. Wear Tyvek® coveralls to avoid skin contact with irritating plants. Immediately notify the SSHO if you suspect you contacted an irritating plant. Avoid unnecessary clearing of plant/vegetation areas. Remove clothing or Tyvek® coveralls by inside-out method to avoid contact with potentially contaminated outer surfaces. Follow additional procedures outlined in the APP.	**L**
	Severe weather.	The SSHO to monitor weather conditions each day in order to plan and prepare for hazardous conditions. The SSHO to identify the nearest suitable storm shelter at each work location. Upon seeing lightning or hearing thunder, outdoor activities shall be suspended and personnel shall be evacuated to safe areas (inside vehicles, buildings, or tornado shelters as appropriate).	**M**

Job Steps	Hazards	Controls	RAC
General site activities.	Heat and Cold stress.	Follow procedures outlined in the SSHP. Use ACGIH guidelines for WBGT TLV values.	M
	Struck by material	Personnel shall never place themselves under suspended/overhead loads. Material shall be loaded over the dump bed and not allowed to pass over operator cab. Haul units shall be equipped with adequate Falling Object Protective Structure. All loads are to be covered when traveling on the road weather on base or off base. NO driver operator shall climb into truck or over 6 feet above ground level with out proper fall protection	L
Placement of EVO.	Material handling	Only trained, authorized and qualified personnel will operate forklifts. Inspect pallets and totes for signs of damage before movement. Keep all personnel away from fall radius of material handling operations. Use a designated spotter when moving material with forklift.	L
	Exposure to EVO	EVO is non-toxic but can create slippery conditions on any surfaces it contacts. Read SDS for EVO. Do not heat or vaporize EVO. Wear disposable nitrile or leather work gloves to keep hands clean.	L
	Open excavation	Keep EVO delivery system at least 3 feet away from excavation side walls. Do not position personnel where an exposure to a vertical fall 6 feet or greater exists. EVO will be delivered by hose system which is gravity feed. Hose placement as needed with heavy machinery to eliminate personnel entering excavation.	L
	HAZCOM	All containers shall be properly labeled as to content and SDS readily available onsite.	L

Equipment to be Used	Training Requirements/Competent or Qualified Personnel Name(s)	Inspection Requirements
<u>Personal Protective Equipment</u> Hard hat Safety glasses with side shields Safety-toed boots Work gloves Class 2 high visibility vests Hearing protection, as necessary <u>Other Equipment</u>: Fire Extinguishers Caution tape Excavation perimeter protection First Aid Kit Drinking water Weather radio	Competent Person (CP) / Qualified Person (QP): CP/SSHO Brian Rhodes_____ Alternate CP/SSHO_____ QP/First Aid and _____ QP/First Aid and CPR Brian Rhodes_____	Daily site safety inspection (SSHO) Brian Rhodes Daily site safety inspection (QCO) _____ Initial and daily equipment inspections. Overhead utilities and hazards (prior to operating equipment in area) Locate underground utilities (prior to intrusive activities) Excavation (at least daily) Housekeeping (daily) Fire extinguisher (monthly) Equipment and tools inspection (daily and before use) Survey areas for poisonous plants, insects, and animals(each work area) Check body for ticks (each evening during tick season) Identify closest usable storm shelter that is available

Insect repellant with DEET (Deep Woods Off™ or equivalent) Repel Permanone™ Communication devices Air monitors per SSHP (aerosol, LEL, CO, O_2) Water truck Excavator Dump truck Front end loader EVO totes Forklift	Training Requirements (as determined by the SSHO): Site safety orientation Emergency procedures Hearing conservation Applicable AHAs and SDS Lifting/back safety Fire extinguisher use Biological hazard identification and control Storm shelter location Lightning safety procedures Heat stress prevention and heat stroke treatment Cold stress prevention Excavation and trenching Subcontractor Personnel Proof of Training and Competency and Certifications of Employee Medical Surveillance Program Participation to be provided to the COR and SO prior to the commencement of field operations for review and approval.	

Activity Hazard Analysis (AHA)

Activity/Work Task: Soil Sampling	Overall Risk Assessment Code (RAC) (Use highest code)	**M**
Project Location: RSA-013 Redstone Arsenal Huntsville AL	**Risk Assessment Code (RAC) Matrix**	
Contract Number: W912DY-17-D-0003	**Severity** / **Probability**	
Date Prepared: 06/21/21, Revised 9/17/21		
Prepared by (Name/Title): Ray Clark, Engineer		
Reviewed by: Doug Russell/HSE Manager		
Notes: (Field Notes, Review Comments, etc.)	Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)	
This AHA serves as the hazard assessment	**"Probability"** is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom, or Unlikely.	**RAC Chart**
	"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible	**E = Extremely High Risk**
	Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.	**H = High Risk**
		M = Moderate Risk
		L = Low Risk

Severity	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Job Steps	Hazards	Controls	EM 385-1-1	RAC
Arrival of new personnel at site.	Unfamiliarity with: site, general site hazards, project safety rules, chain of command, and emergency procedures.	All personnel shall attend the site orientation training.	01.B.03 01.E.01 28	M
Soil sampling	Poor planning.	Complete Job Safety Analysis for each task. Use Hazard Assessment Resolution Program frequently – for each task to be completed.		M
	Heavy lifting, strains, and sprains.	No individual employee is permitted to lift any object that weighs over 50 pounds. Proper lifting techniques shall be used. Multiple employees or the use of mechanical lifting devices are required for lifting objects over the 50-pound limit.	14.A.01	M
	Intrusive activities and underground utilities.	Follow procedure for intrusive activities in the CMIP and SSHP prior to commencing activities. Personnel shall not enter excavation > 4 feet for sample collection.	25.A.01	M
	Overhead hazards/utilities.	Overhead hazards shall be evaluated prior to moving equipment on the project site. Overhead power lines shall be shut-off and locked-out if minimum separation distances cannot be achieved in accordance with EM 385-1-1 Table 11-1. Areas with overhead hazards shall be barricaded with caution tape to warn personnel In areas where it is not feasible to use barricades, spotters shall be provided: however, the minimum distances from energized overhead electrical lines must be observed.	11.F.04	M

Job Steps	Hazards	Controls	EM 385-1-1	RAC
Soil sampling (continued)	Underground utilities and other underground hazards.	Follow any additional procedures for intrusive activities identified in the CMIP prior to commencing intrusive activities. Utilities shall be located and marked prior to commencing intrusive activities. Contact utility one-call service (811) at least 48 hours but not more than 10 days prior to commencing intrusive activities, excluding weekends or any state or federal holidays. Retain a copy of mark-out ticket for documentation purposes and QC purposes. Follow requirements of AMS-710-02-PR-01600,*Excavation and Trenching,* and AMS-710-02-PR-01610, *Utility Contact Prevention.* Evaluate the work areas, ground conditions, and travel paths to identify any sensitive underground structures, unstable areas, dangerous slopes, and existing open excavations. Complete a Site Layout Plan prior to mobilizing the equipment. The plan shall identify all underground utilities and other underground hazards in the active work areas and travel routes.		**M**
	Underground utilities and other underground hazards. (continued)	Cease work immediately if unknown utilities or utility markers are uncovered. Use manual excavation within 3 feet of known utilities. Once the line or cable is exposed, heavy equipment can be used but must remain at least 3 feet from the exposed line or cable. Each work crew member shall be trained in electrocution hazards, explosion/fire hazards, and emergency procedures associated with contacting energized power lines and pipelines. Immediately contact utility one-call service (811) if an underground utility is damaged, dislocated, or disturbed.		
	Slips, trips, and falls.	Keep work areas clear and maintain housekeeping. Personnel shall not jump from elevated surfaces. Personnel shall use caution when walking on rocky, slippery, or uneven terrain.	14.C.01-10	**M**
	Hand injuries.	Items to be handled shall be inspected for sharp edges prior to being handled. Personnel shall wear leather gloves when handling sharp materials. Personnel shall be aware of and avoid pinch point hazards.	05.A.08	**L**

Job Steps	Hazards	Controls	EM 385-1-1	RAC
Soil sampling (continued).	Use of heavy equipment.	Only qualified personnel shall be permitted to operate equipment. Heavy equipment shall be inspected daily. Do not use unsafe equipment. All equipment shall have backing alarms. All equipment shall be operated at safe speeds and in a safe manner. Equipment operators shall wear safety belts. Personnel are only permitted to approach equipment after a signal from the operator. Ground personnel, working near heavy equipment, shall wear high visibility conspicuity vests. Ground personnel shall not enter the swing radius of equipment. Ground personnel shall not position themselves between equipment and stationary objects. Personnel shall verify all mechanical guards are in place and functioning properly. Moving equipment shall be equipped with a back-up alarm. Mechanical excavation equipment will only be used within one foot of suspected subsurface target anomalies. All equipment shall be shut down with energies dissipated prior to performing maintenance activities - lock out/tag out procedures may apply. Only qualified mechanics shall work on or repair heavy equipment.	18.A 18.G 18.B 05.F	**M**
	Insect bites/West Nile Virus.	Wear personal protective equipment (PPE) and tape joints to keep insects away from the skin. Check limbs/body for insects/insect bites before end of shift. Notify SS of flu-like symptoms.	06.D.01	**L**
	Contact dermatitis and poison ivy.	Check around work areas to identify if poison ivy is present. Wear long-sleeve shirts/trousers or Tyvek® coveralls to avoid skin contact with plants or other skin irritants. Learn to identify poisonous plants. Remove clothing or Tyvek® coveralls by inside-out method to avoid contact with potentially contaminated outer surfaces. Avoid unnecessary clearing of plant/vegetation areas. Cover vegetation with plastic (visqueen) where sampling position raises exposure potential. Apply protective cream/lotion to exposed skin to prevent poison ivy or similar reactions. Identify workers who are known to contract poison ivy. Follow procedures outlined in the SSHP.	06.D.03	**L**
	Severe weather.	The Site Supervisor (SS) will monitor weather conditions each day in order to plan and prepare for hazardous conditions and will use lightning and severe weather detection devices to evaluate potential weather threats. Work activities will be suspended prior to weather conditions becoming hazardous so that workers have ample time to seek shelter. When lightning is observed within a 10 mile radius or upon hearing thunder, outdoor activities shall be suspended and personnel shall be evacuated to safe areas (inside vehicles, buildings, or tornado shelters as appropriate). A waiting period of at least 30 minutes from the last nearby lightning strike will be observed before resuming activities. Follow procedures outlined in the SSHP.	06.I	**L**
	Hazardous atmospheres.	Personnel shall immediately notify the SS if odors are detected.		**L**

Job Steps	Hazards	Controls	EM 385-1-1	RAC
Soil sampling (continued).	Heat stress and cold stress.	Follow procedures outlined in the SSHP.	06.I	**M**
	Dust.	All visible dust shall be controlled. PPE use is required when working in contaminated areas. Water will be utilized to keep dust levels low.	28	**L**
	Fire.	Smoking shall be permitted in designated areas. Vehicles shall not be parked in tall dry grass. Engines shall be shut off before refueling. A 10 pound A:B:C fire extinguisher shall be available in work trucks. Site personnel shall complete annual fire extinguisher training.Smoking shall not be permitted near fueling areas. Gasoline shall be stored in labeled metal Type II red safety cans with flash arrestors and spring-loaded vents. Fire watch shall be stationed to monitor area at least one hour after hot work activities.	09.E.01 09.A.06 09.B.08	**L**

Equipment to be Used	Training Requirements/Competent or Qualified Personnel name(s)	Inspection Requirements
Personal Protective Equipment – Modified Level D: Hard Hat as applicable Safety Glasses Chemical Resistant Boots Work Gloves Permeable Tyvek if needed ANSI Class 2 reflective warning vests Equipment: Fire Extinguishers Emergency Eyewash First Aid Kit Drinking water Weather radio or AM/FM radio Hand tools Heavy equipment Sampling equipment i.e., trowels, hand auger, etc.	Training Requirements: Competent Person (SSHO) Brian Rhodes Site safety orientation HAZWOPER 40-Hour MEC Awareness Qualified equipment operators Lifting/back safety Fire extinguisher use Emergency procedures Biological hazard identification and control Tornado shelter locations National Lightning Safety Institute Lightning Safety Procedures	Daily site safety inspection (SSHO) – Brian Rhodes Vehicle inspection daily Check Known Allergies Questionnaire Housekeeping (daily) Fire extinguisher (monthly) Vehicle inspection daily Overhead and underground utilities Mechanized equipment initial inspection Mechanized equipment (daily) Equipment and tools inspection daily and before use Survey areas for poisonous plants, insects, and animals Check body for ticks Verify tornado shelter available Monitor approaching storms

Activity Hazard Analysis (AHA)

Activity/Work Task: Equipment Decontamination	Overall Risk Assessment Code (RAC) (Use highest code)	**M**
Project Location: RSA-013 Redstone Arsenal Huntsville AL	**Risk Assessment Code (RAC) Matrix**	
Contract Number: W912DY-17-D-0003	**Severity** / **Probability**	
Date Prepared: 06/21/21		
Prepared by (Name/Title): Ray Clark, Engineer		
Reviewed by: Doug Russell/ HSE Manager		
Notes: (Field Notes, Review Comments, etc.) This AHA serves as the hazard assessment		

Severity	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom, or Unlikely.

"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

- **E = Extremely High Risk**
- **H = High Risk**
- **M = Moderate Risk**
- **L = Low Risk**

Job Steps	Hazards	Controls	EM 385-1-1	RAC
Clean equipment.	Failure to properly plan daily activities.	Complete Job Safety Analysis for each task, as specified in, "Job Safety Analysis (JSA)." Use Hazard Assessment Resolution Program frequently – for each task to be completed.		M
	Exposure to contaminants.	Maintain work zones and decontamination areas. Level D - Modified personal protective equipment shall be worn as required in the Accident Prevention Plan or Site Safety and Health Plan. Personnel shall perform proper decontamination procedures each time when exiting the Exclusion Zone.	28 05.A.01	L
	Poor lighting.	Additional lighting shall be put in place as necessary. Temporary lighting shall be protected with ground fault circuit interrupters (GFCI).	07.A.01 11.D.05	L
	Slips, trips, and falls.	Work areas shall be kept organized during work activities. Housekeeping shall be maintained. Personnel shall use caution when walking/working on wet surfaces.	14.C.01-10	M
	Electrical.	GFCIs shall be used on all power tools and extension cords. Extension cords, power tools, and lighting equipment shall be inspected before each use, protected from damage, and kept out of wet areas.	11.D.05 11.A.03	M
	Heavy lifting.	No individual employee is permitted to lift any object that weighs over 50 pounds. Proper lifting techniques shall be used. Multiple employees or the use of mechanical lifting devices are required for lifting objects over the 50-pound limit.	14.A.01	M
	Noise.	Personnel shall wear hearing protection when operating pressure washer.	05.C	L

Job Steps	Hazards	Controls	EM 385-1-1	RAC
Clean equipment (continued).	Liquid splash, eye, face injury	Full body PVC raingear or polyethylene coated coveralls shall be worn by pressure washer operators. Orifice operators shall use a full-face shield. Other crew members shall use a of ANSI Z87.1 compliant safety glasses with side shields, goggles or face shield.		**M**
	Skin contact with contaminated wash-water	Remove PVC raingear polyethylene coated coveralls by inside-out method to avoid contact with potentially contaminated outer surfaces. Dispose of polyethylene coated coveralls while turned inside-out. Manually decontaminate reusable PVC raingear using trisodium phosphate (TSP) or other approved decontamination solution.		**L**
	Fire.	Fire extinguishers shall be placed in work areas. Smoking shall only be allowed in designated areas. Site personnel shall complete annual fire extinguisher training.	09.E.01 09.A.06	**L**
	Heat and Cold stress.	Follow procedures outlined in the SSHP.	06.I 02.C	**M**
	Use of pressure or steam washer.	The pressure/steam washer shall be inspected before each use. The manufacturer's instruction manual shall be used to guide the inspection process. Personnel shall be trained in the use of the washing equipment. All personnel working in the equipment decontamination area shall be trained in the emergency shut-off procedures for the equipment being used. The minimum amount of steam/pressure that will complete the job should be used. Pressure washers exceeding 3000 psi shall not be used. The spray from such equipment shall only be directed at surfaces to be cleaned and never at body parts or other personnel. Personnel in the immediate area shall use face shields and metatarsal/shin guards. Personnel shall keep firm grip on wand and not point it at anything that is not being washed. Pressure washer operators must maintain good footing. The trigger on the wand shall never be wired/fixed open. Operators are to take adequate breaks to avoid fatigue. Hot surfaces shall be avoided. Units shall be shut off and allowed to cool prior to re-fueling (if gas-powered). Carbon monoxide shall be monitored if gas-powered pressure washers are used in areas with limited ventilation. Carbon monoxide concentrations shall not be allowed to exceed 25 parts per million within any work areas.	13.A.02 13.A.02 09.B.21 13.A.12	**L**

Job Steps	Hazards	Controls	EM 385-1-1	RAC
Clean equipment (continued).	Spills of decontamination water.	All waste handling activity shall be performed on visqueen (polyethylene sheeting) lined work surfaces. Waste liquids shall be stored with secondary containment. Lids and bungs shall be secured when drums are in storage or are being moved. Spill cleanup equipment shall be readily available when handling wastes. Drums containing waste shall be inspected on a daily basis. Spills shall be immediately reported to the Site Safety and Health Officer.	09.B.18	L

Equipment to be Used	Training Requirements/Competent or Qualified Personnel name(s)	Inspection Requirements
Personal Protective Equipment - Level D - Modified: Hard hat Safety glasses Safety-toed boots Face shield Metatarsal and leg protection Work gloves PVC rain-gear or Poly coated Tyvek Protective over-boots Hearing protection Equipment: GFCI Fire extinguishers Emergency eyewash First aid kit Drinking water Weather radio or AM/FM radio Spill control equipment	Competent Person (CP) / Qualified Person (QP): Brian Rhodes – QP/SSHO Brian Rhodes – QP/First Aid and CPR Training Requirements: Site safety orientation HAZWOPER 40-Hour Lifting/back safety Fire extinguisher use Emergency procedures National Lightning Safety Institute Lightning Safety procedures	Daily site safety inspection (SSHO) – Brian Rhodes Daily site safety inspection (UXOSO) – TBD Housekeeping (daily) Fire extinguisher (weekly) Equipment and tools inspection daily and before use Monitor approaching storms

Activity Hazard Analysis (AHA)

Activity/Work Task: Pressure Washing	Overall Risk Assessment Code (RAC)	**M**
Project Location: RSA-013 Redstone Arsenal Huntsville AL	**Risk Assessment Code (RAC) Matrix**	
Contract Number: W912DY-17-D-0003	**Severity** / **Probability**	
Date Prepared: 06/21/21		
Prepared by (Name/Title): Ray Clark, Engineer		
Reviewed by: Doug Russell, HSE Manager		

Severity	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	**E**	**E**	**H**	**H**	**M**
Critical	**E**	**H**	**H**	**M**	**L**
Marginal	**H**	**M**	**M**	**L**	**L**
Negligible	**M**	**L**	**L**	**L**	**L**

Notes: (Field Notes, Review Comments, etc.)
This AHA serves as the hazard assessment

Equipment will be decontaminated by washing with pressurized water.

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom or Unlikely.

"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

- **E = Extremely High Risk**
- **H = High Risk**
- **M = Moderate Risk**
- **L = Low Risk**

Job Steps	Hazards	Controls	RAC
Preparation for Pressure Washing	Musculoskeletal injury from handling heavy objects	Observe proper lifting techniques Obey sensible lifting limits (50 lbs. Maximum per person manual lifting) Use mechanical lifting equipment (hand carts, trucks, forklift) to move large loads, awkward loads	**M**
	Unauthorized access to work area	The work areas shall be defined by barrier tape, rope or other suitable barriers and be marked with warning signs. The perimeter should be outside of the effective range of the water jet wherever possible.	**M**
	Equipment failure	Inspect equipment according to manufacturer's specifications Ensure all fittings and hoses have the correct pressure rating and in good condition Do not use damaged or defective equipment	**M**
	Lack of communication	Before starting, the team members shall agree on signals to be used during the operation of the equipment.	**M**

Job Steps	Hazards	Controls	RAC
Preparation for Pressure Washing (continued)	Improper use of pressure washing equipment	All equipment shall be operated consistent with the manufacturer's instructions. Water jetting equipment shall only be operated by persons who are trained and knowledgeable in the safe operation of the equipment to be used. The orifice operator must always be able to shut down the water jet by releasing pressure on the trigger, switch or foot valve pedal Control devices shall be kept in proper working order and shall not be altered or tampered with. Equipment shall not be repaired or connections tightened when the unit is in operation or the pump is running. All pressurized water cleaning operations shall comply with the Contractor's Pressurized Water Cleaning and Cutting Operations procedures.	**M**
	Slips, trips, falls	Use proper stance for sound footing while operating pressure washer Clear walkways, platforms, access steps and work areas of equipment, tools, and debris Mark, identify, or barricade tripping hazards Hose shall be arranged so that tripping hazards to not occur.	**L**
Pressure Washing	Working alone	A minimum of two persons, one at the pump and one at the orifice or gun, shall be employed at all times.	**M**
	Foot injury from high pressure water jet	Jetting gun operators shall be protected with waterproof boots with steel toecaps, shanks, and metatarsal guards.	**M**
	Hand injury	Hand protection shall be used where there is a reasonable probability of injury and if required by the original equipment manufacturers' specifications.	**M**
	Liquid splash, eye, face injury	Full body PVC raingear or polyethylene coated coveralls shall be worn by pressure washer operators. Orifice operators shall use a full face shield. Other crew members shall use a of ANSI Z87.1 compliant safety glasses with side shields, goggles or face shield.	**M**
	Skin contact with contaminated wash-water	. Remove PVC raingear polyethylene coated coveralls by inside-out method to avoid contact with potentially contaminated outer surfaces. Dispose of polyethylene coated coveralls while turned inside-out. Manually decontaminate reusable PVC raingear using trisodium phosphate (TSP) or other approved decontamination solution.	**L**
	Noise	Pressure water jetting operations may produce high noise levels. Use ear protection.	**M**

Job Steps	Hazards	Controls	RAC
Pressure Washing (continued)	Heat Stress	Watch workers for symptoms of heat stress Allow for adequate break time Drink plenty of fluids to prevent dehydration	L
Changed or Unanticipated Conditions	Safety or health hazards that may be derived from changed or unanticipated conditions	Modify the AHA as often as necessary to address new or unanticipated hazards. Use ”Job Safety Analysis” form to facilitate field documentation	L

Equipment to be Used	Training Requirements/Competent or Qualified Personnel name(s)	Inspection Requirements
Modified Level D: including poly-coated coveralls or PVC raingear, hard hats with attached face shield, Waterproof boots with steel toecaps and shanks and metatarsal guards, hearing protection Hand Tools Pressure Washer Unit	This AHA Site-specific orientation Workers must be trained in the safe operation of all assigned equipment TBD – CP/SSHO	Inspect all equipment daily prior to use and in accordance with manufacturer’s requirements. Inspect the work area daily for unanticipated hazards. Inspect non-construction equipment and power tools per manufacturer requirements.

Activity Hazard Analysis (AHA)

Activity/Work Task: Waste Management	Overall Risk Assessment Code (RAC)	**M**
Project Location: RSA-013 Redstone Arsenal Huntsville AL	**Risk Assessment Code (RAC) Matrix**	
Contract Number: W912DY-17-D-0003	**Severity** / **Probability**	
Date Prepared: 06/21/21		
Prepared by (Name/Title): Ray Clark, Engineer		
Reviewed by: Doug Russell/HSE Manager		

Severity	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Notes: (Field Notes, Review Comments, etc.)
This AHA serves as the hazard assessment

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom or Unlikely.

"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

- **E = Extremely High Risk**
- **H = High Risk**
- **M = Moderate Risk**
- **L = Low Risk**

Job Steps	Hazards	Controls	RAC
Drums Handling	Handling heavy objects	Observe proper lifting techniques. Obey sensible lifting limits (50 lbs. maximum per person manual lifting). Use mechanical lifting equipment (handcarts, trucks, and forklift) to move large loads, awkward loads. Check and secure drum lids before moving.	M
	Caught in/between moving parts/pinch points	Identify and understand parts of equipment, which may cause crushing, pinching, rotating, or similar motions. Remove all jewelry, especially rings, bracelets, watches Watch hand placement and foot placement Assure guards are in place to protect from these parts of equipment during operations. Abrasion resistant work gloves when the possibility of pinching, or other injury may be caused by moving / handling large or heavy objects. Maintain all equipment in a safe condition. Keep all guards in place during use. De-energize and lock-out machinery before maintenance or service.	M

Job Steps	Hazards	Controls	RAC
Drums Handling (continued)	Slips, trips, falls	Clear walkways, platforms, access steps and work areas of equipment, tools, and debris. Mark, identify, or barricade other obstructions. Work areas, platforms, and walkways should be kept free of materials, debris, and obstructions such as ice, grease, or oil that could cause a surface to become slick or otherwise hazardous. Maintain three-point contact when mounting / dismounting heavy equipment. Maintain good housekeeping.	**M**
	Sharp objects	Wear abrasion resistant work gloves. Inspect hand tools before use. Keep guards in place during use.	**M**
	Vehicle traffic	Use spotter when backing. Survey route to work locations. Inform crew of hazards. Wear reflective vest when exposed to heavy equipment or traffic.	**M**
	Struck by/against heavy equipment, protruding objects	Isolate equipment swing area. Require backup alarms on all heavy equipment. Make eye contact with operators before approaching equipment. Understand and review hand signals.	**L**
	Inhalation and contact with hazardous substances	Review hazardous properties of site contaminants with workers before work begin. Monitor breathing zone pursuant to SSHP. Avoid skin contact with contaminated waste. Avoid inhalation of dust or vapors.	**M**

Equipment to be Used	Training Requirements/Competent or Qualified Personnel name(s)	Inspection Requirements
• Level D: hard hat, safety glasses, safety boots, ear protection, abrasion resistant gloves • Hand tools • Drum dolly • Forklift	• Tailgate Safety Meeting • Site-specific orientation • HAZWOPER 40-hr. • HAZWOPER 8-hour refresher • 8-hr Supervisor training • Forklift operator training • Brian Rhodes – CP/SSHO	• Use this AHA as a checklist • Inspect all equipment and tools prior to use per manufacturer requirements.

Activity Hazard Analysis (AHA)

Activity/Work Task: Fueling Operations	Overall Risk Assessment Code (RAC) (Use highest code)	**M**
Project Location: RSA-013 Redstone Arsenal Huntsville AL	**Risk Assessment Code (RAC) Matrix**	
Contract Number: W912DY-17-D-0003	**Severity** / **Probability**	
Date Prepared: 06/21/21		
Prepared by (Name/Title): Ray Clark, Engineer		
Reviewed by: Doug Russell/HSE Manager		
Notes: (Field Notes, Review Comments, etc.) This AHA serves as the hazard assessment		

Severity	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom, or Unlikely.

"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

- **E = Extremely High Risk**
- **H = High Risk**
- **M = Moderate Risk**
- **L = Low Risk**

Job Steps	Hazards	Controls	EM 385-1-1	RAC
Fueling operations.	Exposures to fuels.	Personnel shall periodically review the Safety Data Sheets (SDS) for the fuels that are being used at the project. The handling and use of fuels shall be performed in well-ventilated areas – preferably outside of buildings. Personnel shall avoid skin and eye contact with fuels. Safety glasses and disposable nitrile gloves shall be worn while handling fuels. If personnel sustain skin contact with fuels, then the affected area shall be immediately washed with soap and water. If fuel contact with clothing is made, then clothing shall be removed and changed immediately.	06.B.01 09.B.07 05.B.01 09.B.05	L
	Fire: extinguisher requirements.	10 pound A:B:C fire extinguisher shall be readily available when fueling equipment at any location on site. Trucks with flammable/combustible fuels must be equipped with 20 pound A:B:C fire extinguisher. Personnel who intend to extinguish small fires shall be trained annually in the use of fire extinguishers. Equipment and property are of secondary concern in a fire situation - personnel shall never try to extinguish a fire if there is any doubt that it can be extinguished safely.	09.E.03 09.B.03	L

Job Steps	Hazards	Controls	EM 385-1-1	RAC
Fueling operations (continued).	Fire: elimination of ignition sources – hot surfaces.	All vehicles and equipment shall be shut down prior to fueling. Small equipment, such as generators, mowers, pressure washers, etc. shall be allowed to cool prior to re-fueling. Heavy equipment with the fuel cap near the engine or near other hot surfaces shall also be allowed to cool prior to re-fueling.	09.B.21	**M**
	Fire: elimination of ignition sources – arcs/sparks/open flames.	Smoking shall not be allowed within 50 feet of fueling operations. Personnel shall visually survey the immediate area for open flames and other ignition sources prior to commencing fueling operations. Personnel are prohibited from using cell-phones or two-way radios during all fueling operations.	09.B.02	**L**
	Fire: elimination of ignition sources – static electricity.	Personnel shall never fill portable fuel cans that are in the bed of a pickup truck or in the trunk of an automobile. Filling fuel containers on plastic pickup truck bed-liners can cause static electric discharges, which may ignite the fuel. The fuel can(s) shall be removed from the truck bed or automobile trunk and placed on the ground before adding fuel. Electrical continuity shall be maintained between the portable fuel can and the tank being filled. A bonding cable shall be used to maintain continuity between the metal fuel container and the equipment fuel tank. Allowing free-fall of fuel into the tank is prohibited. Personnel shall not re-enter vehicles while fueling is underway due to the static electric charge generated between clothing and vehicle seats. If you absolutely have to get in your vehicle while the gas is pumping, make sure you get out, close the door touching the metal, before you pull the nozzle out. This way the static from your body will be discharged before you remove the nozzle.	09.B.21	**L**
	Storage and transportation: five-gallon cans in pick-up trucks.	Gasoline shall be stored and transported in properly marked/labeled five-gallon, or smaller-size safety cans (equipped with self-venting cap and flash arrestor). Gasoline cans shall be secured to prevent movement during transportation. No more than six - five gallon containers of gasoline may be transported in vehicles (back of pick-up trucks or trailers) at the same time unless all the Department of Transportation (DOT) Hazardous Material Regulations are complied with, such as proper packaging, completing shipping papers, placarding (as required), and the appropriate HM 126 Training (as well as having been provided emergency response information and training.) The total quantity of hazardous materials may never exceed 440 pounds total. Hazardous materials must be secured prior to transporting.	09.B.08 09.B.11	**L**
	Communication of hazards.	Drivers must be notified that they are transporting hazardous materials. Drivers shall review SDS for the fuels transported in their vehicle.	01.B.01	**L**

Job Steps	Hazards	Controls	EM 385-1-1	RAC
Fueling operations (continued).	Storage of fuels on-site.	Portable safety gasoline cans must be stored within a flammable materials storage area, have appropriate warning signs, be posted as “No Smoking’, and have a fire extinguisher available in the area.	09.B.02 09.B.18	**M**
	Spills.	All spills shall be immediately cleaned-up. Spill control equipment shall be readily available. All spills shall be reported to the Site supervisor (SS) and Site Safety and Health Officer (SSHO).	09.B.19	**M**
	Storage and transportation: safety containers and saddle tanks in pick-up trucks.	Gasoline shall not be transported in portable saddle tanks – only diesel fuel shall be transported in saddle tanks. All portable saddle tanks mounted in pick-up trucks shall be manufactured to meet DOT specifications. Portable saddle tanks shall be securely mounted to the pick-up truck, as recommended by the manufacturer. Saddle tanks shall be properly marked (see 49 Code of Federal Regulation 172.101) with the proper shipping name and labeled for “No Smoking.” No more than 110 gallons of diesel fuel may be transported in a saddle tank unless all the DOT Hazardous Material Regulations are complied with, such as proper packaging, completing shipping papers, placarding, and the appropriate HM 126 Training (as well as having been provided emergency response information and training.)	09.B.08	**L**
	Bulk storage of diesel fuel on-site.	Caps on saddle tanks shall be securely closed. Saddle tanks shall be inspected weekly to check for leaks. Bulk storage tanks shall not be permitted on site without express permission from the Contractor’s Project Manager and Health and Safety Manager. Containment measures shall be implemented.		**M**

Equipment to be Used	Training Requirements/Competent or Qualified Personnel name(s)	Inspection Requirements
Personal Protective Equipment - Level D: Hard Hat Safety Glasses Safety-Toed Boots Disposable nitrile gloves ANSI Class 2 reflective warning vests Equipment: Fire Extinguishers Saddle tanks Bonding cable Five-gallon safety cans (equipped with self-venting cap and flash arrestor) Basic spill kit (55-gallon open top drum, shovels, plastic sheeting, sorbent pads and granular material)	Training Requirements: Bonding techniques Materials of Trade Hazard communication - Review Material Safety Data Sheet for fuels Portable fire extinguisher use Lifting/back safety	Daily site safety inspection (SSHO) – Brian Rhodes Daily site safety inspection (UXOSO) – TBD Survey area for ignition sources (prior to commencing fueling operations) Verify SDSs for fuels are available in vehicles transporting fuels Saddle tanks (daily) Verify eye wash bottle is readily available Fire extinguisher (before fueling equipment)

Activity Hazard Analysis (AHA)

Activity/Work Task: Disposal of Investigative Derived Waste	Overall Risk Assessment Code (RAC) (Use highest code)	**M**
Project Location: RSA-013 Redstone Arsenal Huntsville AL	**Risk Assessment Code (RAC) Matrix**	
Contract Number: W912DY-17-D-0003	**Severity** / **Probability**	
Date Prepared: 06/21/21		
Prepared by (Name/Title): Ray Clark, Engineer		
Reviewed by: Doug Russell/HSE Manager		

Severity	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Notes: (Field Notes, Review Comments, etc.)
This AHA serves as certification of hazard assessment.

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom, or Unlikely.

"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

- **E = Extremely High Risk**
- **H = High Risk**
- **M = Moderate Risk**
- **L = Low Risk**

Job Steps	Hazards	Controls	RAC
Investigative waste disposal	Personnel injury, property damage, and/or equipment damage	Use qualified and trained forklift operators. The operator shall not exceed the load capacity rating for the forklift. The load capacity shall be clearly visible on the forklift. Forklift operators shall inform their supervisor of any prescribed medication that they are taking that would impair their judgment.	M
	Cross-contamination and contact with potentially contaminated materials	Loads to be transported shall be inspected for container integrity and secured prior to movement. Sampling technicians will wear proper protective clothing and equipment to safeguard against potential contamination. Only essential personnel will be in the work area. All personnel will follow good hygiene practices. Proper decontamination procedures will be followed. All liquids and materials used for decontamination will be contained and disposed of in accordance with federal, state, and local regulations.	L
	Heavy lifting	Use proper lifting techniques. Lifts greater than 50 pounds require assistance or mechanical equipment; size up the lift. Avoid sudden or awkward motion. Lift with legs.	L
	Slip, trip and falls	Housekeeping shall be a routine task throughout daily activities.	M

Job Steps	Hazards	Controls	RAC
Investigative waste disposal	Drum handling	Stay upwind when filling a drum (with either soil or water), be careful not to make contact with the contained waste. Conduct air monitoring as specified in the SSHP. Wear appropriate gloves and or splash protection. Make sure lid or bung of drum is secure. If moving a drum unassisted, be sure to leverage properly, use proper lifting techniques, and wear safety glasses and steel-toed boots. When using a drum dolly, make sure straps and lid catch are securely attached. Leverage properly when tilting drum. Be sure toes stay away from drum.	**M**
	Tripping Hazards	Site Safety and Health Officer (SSHO) will ensure that workers are aware of potential slippery surfaces and tripping hazards. Personnel will inform Site Supervisor (SS) or SSHO of any observed potential slip, trip, or fall hazards.	**L**
	Manual lifting	Workers will be trained in proper lifting techniques and the potential for injuries due to lifting, to be discussed during site-specific training. No bulky item or items assessed at over 50 lbs will be lifted without assistance or use of a lift assist device (e.g., handcart).	**M**
	Improper labeling or shipping papers	All generated waste shall be labeled in accordance with Department of Transportation regulations based on waste stream profile and be accompanied by required documentation based on waste characterization criteria per Resource Conservation and Recovery Act and 40 Code of Federal Regulations (CFR). Only personnel with the required training shall characterize and profile waste.	**L**

Equipment to be Used	Training Requirements/Competent or Qualified Personnel Name(s)	Inspection Requirements
Personal Protective Equipment Level D with Nitrile gloves Equipment: Air monitoring equipment Fire Extinguishers First Aid Kit Trucks Drums Packing materials Drum dolly	Competent Person (CP) / Qualified Person (QP): Brian Rhodes HAZWOPER 40-Hour Site safety orientation Emergency procedures Hazard communication Hazardous materials shipping Applicable AHAs Fire extinguisher use	Daily site safety inspection (SSHO) – Brian Rhodes Daily site safety inspection (UXOSO) –TBD Housekeeping (daily) Fire extinguisher (weekly) Vehicle inspection daily Inspect shipping containers and labeling

Activity Hazard Analysis (AHA)

Activity/Work Task: Vehicle Operations	Overall Risk Assessment Code (RAC) (Use highest code)	**M**
Project Location: RSA-013 Redstone Arsenal Huntsville AL	**Risk Assessment Code (RAC) Matrix**	
Contract Number: W912DY-17-D-0003	**Severity** / **Probability**	
Date Prepared: 06/21/21		
Prepared by (Name/Title): Ray Clark, Engineer		
Reviewed by: Doug Russell, HSE Manager		

Severity	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Notes: (Field Notes, Review Comments, etc.)
This AHA serves as the hazard assessment

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom, or Unlikely.

"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

- **E = Extremely High Risk**
- **H = High Risk**
- **M = Moderate Risk**
- **L = Low Risk**

Job Steps	Hazards	Controls	EM 385-1-1	RAC
Project vehicle use.	Operation of motor vehicles and trucks-General.	All company owned, leased, or rented vehicle operations shall comply with the requirements of AMS-710-02-PR-02700, *Non-Commercial Motor Vehicle Safety*, and AMS-710-02-PR-05700 *Mechanized and Marine Equipment*. All company owned, leased, or rented commercial vehicle operations shall comply with the requirements of AMS-710-02-PR-03900, *Commercial Motor Vehicle Safety*. Subcontractors operating motor vehicles shall comply with all federal, state, and local traffic regulations. Subcontractors shall only use vehicles that are in good condition and safe to operate. All personnel shall drive defensively and wear seat belts while vehicles are in motion.	18.A.01 18.A.02 18.A.03 18.C.02 18.C.03	**M**
	Operation of motor vehicles and trucks-Accidents	In the event of an accident: Stop; call for medical assistance; notify police; complete Vehicle Accident Report and submit to your supervisor. If an APTIM employee is injured, the medical forms per Section 8.0 of the Installation-Wide APP (CEHNC, 2019). Attachment 3, must completed at the health clinic or Emergency Room. Refer to "Aptim Federal Services, LLC Incident Notification, Reporting, and Management Procedure" summary in Attachment 3 of the Site Safety and Health Plan (SSHP).	01.D.01	**M**

Job Steps	Hazards	Controls	EM 385-1-1	RAC
Project vehicle use (continued).	Operation of motor vehicles and trucks-Backing	Back into parking spaces upon arrival, whenever possible. When preparing to move or back vehicles at the project site, walk around the vehicle before backing to identify any new conditions or obstructions. Use a spotter when backing whenever possible, and sound horn prior to backing. Determine and agree upon hand signals (between spotter and driver) before attempting to back vehicle. Check the rear-view and side mirrors prior to backing (Note: All vehicles, other than automobiles, must have small convex mirrors attached to the side mirrors.) Back slowly in areas of obstructed vision. Anticipate others who may be backing out into your pathway and adjust accordingly.	18.C.14 08.B.04 08.B.06	**L**
	Operation of motor vehicles and trucks - Unfamiliar with the vehicle	Familiarize yourself with the vehicle before moving. Review the dashboard controls, steering radius, overhead, and side clearances. Locate windshield wipers and lights. Properly adjust mirrors and seat.		**M**
	Operation of motor vehicles and trucks-Speed	Obey all posted speed limits. Radar detectors are prohibited in all company owned, leased, or rented vehicles. Reduce travel speed during hazardous conditions (i.e., rain, fog, snow).	08.B.06 18.C.04 18.C.05	**M**
	Operation of motor vehicles and trucks-Spacing/Distance	Identify if your vehicle has Anti-Lock Brakes. Follow the 3-second rule. Increase the 3-second rule as necessary during hazardous travel conditions. Always “leave yourself an out” during travel – this applies to stoplights as well. When stopping, make sure that you leave enough distance between you and the car in front of you (you should be able to see the rear tires of the vehicle in front, when stopped). When at a red light, and it turns green, use the “delayed start” technique, by counting to three before you take your foot off the brake. DO NOT TAILGATE! Allow extra spacing and braking time for trucks and vehicles towing trailers. Trailers shall be equipped with brakes		**M**
	Operation of motor vehicles and trucks-Skids	If the vehicle has begun to skid out of control, turn the steering wheel in the direction of the skid and re-adjust the wheel, as necessary. Slow travel speeds during hazardous travel conditions. Use 4-wheel drive, if available, when driving vehicles off road, on steep inclines, muddy conditions, etc. Do not take vehicles “off road” if they cannot be operated safely.	18.C.05	**M**

Job Steps	Hazards	Controls	EM 385-1-1	RAC
Project vehicle use (continued).	Operation of motor vehicles and trucks-Blind Spots	Become familiar with any blind spots associated with your vehicle. Adjust mirrors properly. Make sure you use your directional signals. Always look over your shoulder to assure the lane is clear when changing lanes.		**M**
	Operation of motor vehicles and trucks-Cellular phones	Exercise caution when approaching other driver's blind spots. Do not use handheld cellular phones while driving. Pull over to the side of the road when making a call.	18.C.01	**M**
	Operation of motor vehicles and trucks-Equipment Failure	Perform daily inspections of your vehicle. Any vehicle with mechanical problems that may endanger the safety of the driver, passengers, or the public shall not be used.	18.A.03 18.A.04	**M**
	Operation of motor vehicles and trucks-Safety Equipment	Ensure safety equipment is in the vehicle. Safety equipment should include a spare tire, jack, first-aid kit, fire extinguisher, and flashlight. Flares and/or reflective triangles shall be available in larger trucks. Verify that the proper documentation is in the vehicle - documentation includes an operations manual for the vehicle, insurance card, vehicle registration, and APTIM Incident forms.	18.A.03	**M**
	Operation of motor vehicles and trucks- Influenced by drug and alcohol	Never drive under the influence of drugs or alcohol. Disciplinary action, including termination, will be taken against anyone who is convicted of or who pleads no-contest to the charges of driving under the influence in accordance with AMS. Project-assigned hourly employees are not permitted to operate company owned, leased, or rented vehicles after 10:00 p.m. without written authorization from their supervisor.	01.C.02	**M**
	Operation of motor vehicles and trucks-Driver Attitude/Fatigue	Do not operate any vehicle when abnormally tired, temporarily disabled, or under the influence of drugs or alcohol. Keep an even temper when driving. Do not let the actions of others affect your attitude. Avoid "highway-hypnosis" and "falling asleep at the wheel." Take plenty of breaks when driving long distances. Rotate driving responsibility with your partner. No employee is authorized to operate a company vehicle (including rentals) after having been on-duty for a period of 12-hours. No employee may drive for more than 10-hours in a single on-duty period.	01.C.04	**M**
	Operation of motor vehicles and trucks-Vehicle Loading	DO NOT OVERLOAD the vehicle. Secure all equipment within the body of the vehicle. Do not block side view mirrors with load. Do not transport Department of Transportation manifested hazardous materials without a commercial driver's license. Dispatch all equipment and personnel with proper forms and identification.	18.C.13 18.C.16	**M**

Equipment to be Used	Training Requirements/Competent or Qualified Personnel Name(s)	Inspection Requirements
Personal Protective Equipment – N/A: Equipment: Seatbelt Spare tire and jack First aid kit Fire extinguisher Flashlight Operations manual for the vehicle Insurance card Vehicle registration Accident report forms	Training Requirements: Site safety orientation Licensed vehicle operators Defensive driving (all APTIM personnel)	Daily site safety inspection (QCSM) –Brian Rhodes Vehicle inspections (daily) Vehicle inspections (prior to trips greater than 50 miles for APTIM provided vehicles)

Activity Hazard Analysis (AHA)

Activity/Work Task: Site Restoration	Overall Risk Assessment Code (RAC) (Use highest code)	**M**
Project Location: RSA-013 Redstone Arsenal, Huntsville AL	**Risk Assessment Code (RAC) Matrix**	
Contract Number: W912DY-17-D-0003	**Severity** / **Probability**	
Date Prepared: 06/21/21		
Prepared by (Name/Title): Ray Clark, Engineer		
Reviewed by: Doug Russell/HSE Manager		
Notes: (Field Notes, Review Comments, etc.) This AHA serves as the hazard assessment		

Severity	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom, or Unlikely.

"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

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Job Steps	Hazards	Controls	EM 385-1-1	RAC
Arrival of new personnel at site.	Unfamiliarity with: site, general site hazards, project safety rules, chain of command, and emergency procedures.	All personnel shall attend the site orientation training.	01.B.03 01.E.01 28	**M**
Restore site.	Poor planning.	Complete Job Safety Analysis for each task. Use Hazard Assessment Resolution Program frequently – for each task to be completed.		**M**
	Heavy lifting, strains, and sprains.	No individual employee is permitted to lift any object that weighs over 50 pounds. Proper lifting techniques shall be used. Multiple employees or the use of mechanical lifting devices are required for lifting objects over the 50-pound limit.	14.A.01	**M**
	Intrusive activities and underground utilities.	Follow procedure for Utility Contact Prevention in Accident Prevention Plan (APP) prior to commencing excavation activities. Utilities shall be located and marked prior to commencing intrusive activities. The Alabama One Call Law must be followed. Contact Digger's Hotline of Alabama at least 10 days but not less than prior 48 hour to commencing intrusive activities off base, excluding weekends or any state or federal holidays. Retain a copy of mark-out ticket for documentation purposes and QC purposes. On base utilities shall be cleared by the RSA Public Works Department.	25.A.01	**M**

Job Steps	Hazards	Controls	EM 385-1-1	RAC
Restore site (continued).		Follow requirements of AMS-710-02-PR-01600,*Excavation and Trenching,* and AMS-710-02-PR-01610, *Utility Contact Prevention.* Evaluate the work areas, ground conditions, and travel paths to identify any sensitive underground structures, unstable areas, dangerous slopes, and existing open excavations. Use manual excavation within 3 feet of known utilities. Once the line or cable is exposed, heavy equipment can be used but must remain at least 3 feet from the exposed line or cable. Each work crew member shall be trained in electrocution hazards, explosion/fire hazards, and emergency procedures associated with contacting energized power lines and pipelines. Immediately contact utility one-call service (811) if an underground utility is damaged, dislocated, or disturbed.		
	Overhead hazards/utilities.	Before equipment is moved, the travel route shall be surveyed for overhead and terrain hazards. The minimum distances from electrical lines must be observed in accordance with EM-385-1-1 Table 11-1. Power lines shall be assumed to be energized unless verified to be de-energized and visibly grounded. Operation beneath a power line that has not been verified as de-energized and grounded must maintain clearance distances stated above. A high-visibility elevated warning line or barricade shall be erected at the minimum approach distance. Each work crew member shall be trained in the electrocution hazards and emergency procedures associated with energized power lines. RSA public works personnel who may be required to deenergize overhead electric lines shall follow NFPA 70E requirements and be familiar with arc flash protection requirements.	11.F.04	**M**
	Slips, trips, and falls.	Keep work areas clear and maintain housekeeping. Personnel shall not jump from elevated surfaces. Personnel shall use caution when walking on rocky, slippery, or uneven terrain.	14.C.01-10	**M**
	Hand injuries.	Items to be handled shall be inspected for sharp edges prior to being handled. Personnel shall wear leather gloves when handling sharp materials. Personnel shall be aware of and avoid pinch point hazards.	05.A.08	**L**

Job Steps	Hazards	Controls	EM 385-1-1	RAC
Restore site (continued).	Use of heavy equipment.	Only qualified personnel shall be permitted to operate equipment. Heavy equipment shall be inspected daily after the initial U.S. Army Corps of Engineers inspection (and documented). Do not use unsafe equipment. All equipment shall have backing alarms. All equipment shall be operated at safe speeds and in a safe manner. Equipment operators shall wear safety belts. Personnel are only permitted to approach equipment after a signal from the operator. Ground personnel, working near heavy equipment, shall wear high visibility conspicuity vests. Ground personnel shall not enter the swing radius of equipment. Ground personnel shall not position themselves between equipment and stationary objects. Personnel shall verify all mechanical guards are in place and functioning properly. Moving equipment shall be equipped with a back-up alarm. All equipment shall be shut down with energies dissipated prior to performing maintenance activities - lock out/tag out procedures may apply. Only qualified mechanics shall work on or repair heavy equipment.	18.A 18.G 18.B 05.F	**M**
	Insect bites/West Nile Virus.	Wear PPE and tape joints to keep insects away from the skin. Use protective insect repellents containing N,N-Diethyl-m-toluamide, such as, 3M Ultrathon™ or equivalent and clothing insecticide preparations containing permethrins (Repel® Permanone® or equivalent) to prevent insect bites. Check limbs/body for insects/insect bites before showering. Notify Site Safety and Health Officer (SSHO) of flu-like symptoms.	06.D.01	**L**
	Contact dermatitis and poison ivy.	Check around work areas to identify if poison ivy is present. Wear long-sleeve shirts/trousers or Tyvek® coveralls to avoid skin contact with plants or other skin irritants. Learn to identify poisonous plants. Remove clothing or Tyvek® coveralls by inside-out method to avoid contact with potentially contaminated outer surfaces. Avoid unnecessary clearing of plant/vegetation areas. Cover vegetation with plastic (visqueen) where sampling position raises exposure potential. Apply protective cream/lotion to exposed skin to prevent poison ivy or similar reactions. Identify workers who are known to contract poison ivy.	06.D.03	**L**
	Severe weather.	Follow procedures outlined in the SSHP.	06.I	**L**
	Hazardous atmospheres.	Personnel shall immediately notify the SSHO if odors are detected.		**L**
	Heat stress and cold stress.	Follow procedures outlined in the SSHP. Use ACGIH guidelines for WBGT monitoring and TLVs.	06.I	**M**
	Dust.	Dust shall be monitored and controlled. Respiratory protection may be required if dust cannot be adequately controlled.		**L**

Job Steps	Hazards	Controls	EM 385-1-1	RAC
Restore site (continued).	Fire.	Smoking shall be permitted in designated areas. Vehicles shall not be parked in tall dry grass. Engines shall be shut off before refueling. A 40-B:C fire extinguisher shall be available when refueling. Site personnel shall complete annual fire extinguisher training. Smoking shall not be permitted near fueling areas. Gasoline shall be stored in safety cans with flash arrestors and spring-loaded vents.	09.E.01 09.A.06 09.B.08	**L**
	Dump truck operations.	Dump trucks shall be inspected and found to be in safe condition prior to being placed in service at site. Overhead hazards shall be re-evaluated prior to allowing dump trucks onto the project site. Areas with overhead hazards shall be barricaded with caution tape to prevent dump bed from contacting. In areas where it is not feasible to use barricades, then spotters shall be provided: however, the minimum distances from electrical lines must be observed (see SSHP). Operators shall wear seat belts while trucks are in motion at the project site. Spotters shall assist trucks when backing is necessary.	18.A.03 18.G.26 11.F	**M**
	Use of fertilizers.	The material safety data sheet for fertilizers shall be read and understood. Personnel shall avoid contact with fertilizer.	06.B.01	**L**
	Electrocution.	Only qualified electricians shall perform electrical disconnection activities.	11.A	**M**

Equipment to be Used	Training Requirements/Competent or Qualified Personnel name(s)	Inspection Requirements
Personal Protective Equipment - Level D: Hard hat Safety glasses Safety-toed boots Work gloves ANSI Class 2 reflective warning vests Equipment: Fire extinguishers Emergency eyewash First aid kit Deep-Woods Off or Ultrathon™ Repel® Permanone ® Drinking water Weather radio or AM/FM radio	Competent Person (CP) / Qualified Person (QP): Brian Rhodes – CP/SSHO Brian Rhodes – CP/First Aid and CPR Training Requirements: Site safety orientation Applicable AHAs HAZWOPER 40-Hour Qualified equipment operators Lifting/back safety Fire extinguisher use Emergency procedures Biological hazard identification and control Tornado shelter locations National Lightning Safety Institute Lightning Safety procedures	Daily site safety inspection (SSHO) – Brian Rhodes Check Known Allergies Questionnaire, training, and medical certifications against personnel roster Mechanized equipment (U.S. Army Corps of Engineers form prior to use) Mechanized equipment (daily) Overhead and underground utilities Housekeeping (daily) Fire extinguisher (weekly) Vehicle inspection daily Equipment and tools inspection daily and before use Survey areas for poisonous plants, insects, and animals Check body for ticks Verify tornado shelter available

Activity Hazard Analysis (AHA)

Activity/Work Task: COVID-19 Job Site Practices	Overall Risk Assessment Code (RAC) (Use highest code)	**L**
Project Location: RSA-013 Redstone Arsenal, Huntsville, AL	**Risk Assessment Code (RAC) Matrix**	
Contract Number: W912DY-17-D-0003	**Severity** / **Probability**	
Date Prepared: 06/21/21		
Prepared by (Name/Title): Dennis Seymore		
Reviewed by (Name/Title): Doug Russell, HSE Manager		
Notes: (Field Notes, Review Comments, etc.) This AHA serves as the hazard assessment		

Severity	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	**E**	**E**	**H**	**H**	**M**
Critical	**E**	**H**	**H**	**M**	**L**
Marginal	**H**	**M**	**M**	**L**	**L**
Negligible	**M**	**L**	**L**	**L**	**L**

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom, or Unlikely.

"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

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- **H = High Risk**
- **M = Moderate Risk**
- **L = Low Risk**

Job Steps	Hazards	Controls	RAC
Mobilization to site	Inadequate preparation and training that can lead to possible infection	• Site Safety & Health Officer (SSHO) to identify potential infection sources due to the task, location, and surrounding areas. Include discussion of same in site specific training. • SSHO to discuss Coronavirus hazards and controls in the readiness review and initial tailgate safety meeting and include at least the topics listed below. The meeting should be held outdoors or in a space large enough to allow space between participants. SSHO to verify that the necessary equipment and supplies are available and in good condition: gloves, safety glasses, sanitizer. 1.The virus is highly contagious and is probably spread primarily by airborne droplets ejected when infected people cough, sneeze, or possibly just breathe. These droplets settle out of the air within about 6 feet. 2.The most frequent symptoms are fever, coughing, shortness of breath. 3. Maintain 6-foot separation unless the job task requires working closely. If working closer than 6 feet wear a mask. • All personnel shall follow guidance in AMS-710-01-FM-04201, *COVID-19 Control Plan*. • Check of the APTNet Corona Virus webpage for the latest CDC guidance and update recommendations, as applicable. • Site workers are required to report travel to high-risk areas, potential exposure to infected people, and symptoms of illness. • Do not share tools, pens, or anything else without disinfecting between uses. Use your own pen. • When practical, a single person should be in a vehicle. If 2 or more people are in a vehicle, all should wear masks. Adjust vehicle's air handling system to maximize outside air.	**L**

Job Steps	Hazards	Controls	RAC
		• Discuss and follow any state and local restrictions on gatherings (# of people that can congregate) and closings. Be aware that stores, restaurants and coffee locations that you may have frequented may be closed. Bring your own food and drinks. • In addition to what is provided in this AHA, subcontractors and Government personnel are directed to follow their Corporate HR policies. • CDC document How It Spreads: https://www.cdc.gov/coronavirus/2019-ncov/prepare/transmission.html • Avoid air travel if possible. If air travel is necessary, wear a face mask during the flight and maintain as much distance from other passengers as allowed by seating airplane seating arrangements. • If renting a vehicle, request a rental vehicle that has been idle. Three days is best because all or nearly all virus particles on surfaces are inactivated by 72 hours of exposure to air. At least 75% of virus particles are inactivated by 24 hours of exposure to air. • Wipe the steering wheel and other high-contact surfaces of rental vehicles with disinfectant. Any cloth or tissue saturated with disinfectant such as >60% isopropyl alcohol, >120 proof clear liquor (keep sealed or in trunk when in transit), or commercial disinfectant. Concentrated alcohol is flammable so use in well ventilated area away from ignition sources. Any disinfectant product from a reputable supplier (Kimberly-Clark, S. C. Johnson, Lysol, Clorox) should inactivate the virus. See this EPA report on disinfectants for additional information: https://www.epa.gov/sites/production/files/2020-03/documents/sars-cov-2-list_03-03-2020.pdf • Designate a representative to monitor for signs of illness in the workplace, and if someone is showing symptoms, SSHO shall ask them to leave. • Designate a representative to take employees' temperatures with a digital forehead thermometer that is disinfected appropriately between applications. This should be done PRIOR TO any individual entering the job site. Individuals' temperatures should also be taken when leaving or at the end of their shift. Personnel will be sent home if their temperature exceeds 100.4° F (38.0° C). SSHO shall keep records of temperatures taken and appeared normal. Note that some people with COVID-19 may not have a fever, so this should not be the only means of detection. • Sick employees shall be separated immediately from others. CDC recommends that employees who appear to have acute respiratory illness symptoms (i.e., cough, shortness of breath) upon arrival to work or become sick during the day should be separated from other employees and be sent home immediately. Individuals that have been asked to leave should NOT be allowed to enter any occupied area at any time prior to leaving. • Provide tissues and encourage employees to cover their noses and mouths with a tissue (or elbow or shoulder if a tissue is not available) when coughing or sneezing and disposable hand towels and no-touch trash receptacles. • Limit the exchange/sharing of paper documents by encouraging use of electronic communication whenever possible and do not allow sharing of tools or any multi-user devices and accessories such as iPads, laptops, hand-held radios, computer stations, etc. • Provide soap and water and hand sanitizer with alcohol content between 65% and 90% in the workplace. Ensure that adequate supplies are maintained. Place hand sanitizers in multiple	

Job Steps	Hazards	Controls	RAC
		locations on the job site, in the office, in or around portable toilets, or in conference rooms to encourage hand hygiene. • Provide disposable gloves where appropriate; instruct workers to wash hands after removing gloves. • Communicate key CDC recommendations (and post signage where appropriate) to your staff and tradespeople.	
Hotel Stays	Infection	• Request a room that has been idle. Three days is best because all or nearly all virus particles on surfaces are inactivated by 72 hours of exposure to air. AT least 75% of virus particles are inactivated by 24 hours of exposure to air. • Request no maid service for short stays. • Minimize time spent in common areas like the hotel lobby, exercise facility, or restaurant. Practice social distancing with hotel staff and other guests. • Wipe high-contact areas like doorknobs and countertops with disinfectant. Any cloth or tissue saturated with disinfectant such as >60% isopropyl alcohol, >120 proof clear liquor, or commercial disinfectant spray. Concentrated alcohol is flammable so use in well ventilated area away from ignition sources. Note that any disinfectant from a reputable supplier (Kimberly-Clark, S.C. Johnson, Lysol, Clorox) is likely to be effective on Coronavirus. See this EPA report on disinfectants for additional information: https://www.epa.gov/sites/production/files/2020-03/documents/sars-cov-2-list_03-03-2020.pdf	**L**
Transportation or shipment of disinfectants	Violation of Department of Transportation hazardous materials shipping regulations Spills, leaks, fires	• Transport disinfectants in vehicles in compliance with DOT Materials of Trade exception: o Materials in labeled leak-tight containers. o Containers secured so that they do not move while in transit, driver aware of hazardous materials in vehicle. o No more than 5 gallons of flammable liquid in any single container. o If disinfectants must be shipped (for example by FedEx) use ground shipment.	**L**
Site tasks	Infection or spread of infection to other site personnel	• Stay at least 6 feet from other personnel unless closer spacing is necessary for the work (and maintain this spacing during breaks and lunch). If unable to maintain 6 feet distance, personnel should wear a surgical mask or face covering. If there are lifts that are greater than 50 lbs, use a mechanical lifting device in order to avoid close proximity to another worker during the lift assist. If unavoidable, both should wear masks. • Also, when the buddy system is employed maintain spacing of at least 6 feet. • Hold tailgate safety meetings outdoors or in a space large enough to allow separation. • To the extent practical, limit time within trailers and office spaces. Each trailer is equipped with its individual HVAC unit that includes a filter. • All Site Worker's temperatures will be monitored at the beginning of each workday by designated personnel. • Personnel will be sent home if their temperature exceeds 100.4° F (38.0° C). • Do not share pens, tools or personal protective equipment (PPE). • Avoid touching high contact surfaces like portable toilet handles, doorknobs, etc. with your bare skin and if you cannot avoid that, wash or disinfect your hands afterward. • Avoid handshakes and hugs.	**L**

Job Steps	Hazards	Controls	RAC
		• Provide handwashing station or hand sanitizer and use often. Soap is preferable to hand sanitizers when it is available. Sanitizers can break down the skin making an individual more prone to chemical and biological exposures. • Clean high-contact surfaces daily with disinfectant.	
Site-specific tasks: Multiple operators in equipment, multiple drivers of work vehicles, sharing ice cooler, sharing hand tools, sharing analog instruments, sharing portable toilet	Possible infection or spread of infection	• Limit operators and decontaminate equipment and vehicles twice daily. • Pack water in personal backpacks and small coolers. • Each team member will have a personal shovel and instrument to use for job duration. • Portable toilet commonly touched surfaces will be cleaned after each use.	L
Confirmed infection	Infection of others Logistical issues related to managing infected personnel far from home	• Personnel who develop symptoms like fever, cough, or shortness of breath that might indicate infection are to self-quarantine and notify the SSHO. SSHO is to notify PM and Corporate lead entity. SSHO may not release the name of quarantined personnel to others without authorization from Corporate lead entity. • Subcontractor and Government personnel who develop symptoms like fever, cough, or shortness of breath that might indicate infection should notify the SSHO and follow guidance within their Corporate HR policies. • APTIM's PM, in concert with senior management, will provide coordination and support to facilitate quarantine. If infected person is local the person will be asked to self-quarantine at home or go to a hospital if seriously ill. If infected person is not local, the person may have to quarantine in a hotel, unless seriously ill. If/when this occurs it will be reported up the chain and situation-specific responses will be determined. • If suspected infected personnel must be within 6 feet of other personnel (in a car, for instance) the suspected infected individual and any personnel within a 6 foot radius should wear an N95 if available, face covering or surgical mask. • If an employee tests positive for COVID-19, they should follow HGL's requirements for sick leave, benefits, and return to work. Subcontractors and Government personnel are directed to follow guidance within their Corporate HR policies regarding employee leave. In addition, before returning to the project site the site worker must provide the SSHO with documentation of a negative test, a note from a doctor, or a state or local testing facility. • Contact Tracing: All of the people that the positive testing employee had sustained contact with for more than 10 minutes (within a 6 foot distance) will be made aware of their potential for exposure and will be told to do daily self-checks and monitor their symptoms and temperature.	L
Restricting Job Site Visitors	Possible Exposure by Unvetted Visitor	• Restrict the number of visitors to the job site, including the trailer or office. • All visitors should be screened in advance. If the visitor can answer "yes" to any of the following questions (without identifying which question applies), the visitor will not be permitted to access the facility. The questions are: ○ Have you been asked to self-quarantine since December 2019?	L

Job Steps	Hazards	Controls	RAC
		○ Have you been in close contact with any person(s) who has been asked to self-quarantine since December 2019? ○ Have you experienced a recent onset of any illness-related symptoms, such as fever, cough, or shortness of breath? ○ Have you traveled outside of North America in the past 14 days? ○ Have you been in close contact with any person(s) who have traveled outside of North America in the last 14 days? ○ Have you been in close contact with any person(s) who has been diagnosed with COVID-19?	
Site clean-up and demobilization	Possible infection or spread of infection Employee stopped or prevented from traveling home due to state restrictions due to stay at home orders	• Decontaminate equipment before shipping to home office. • Decontaminate GPS units before returning. • Clean boots, work clothes, and gear used at work prior to travel home to prevent further exposure and spread. • Plan ahead for specific state restrictions personnel will travel through during demobilization and provide a letter stating employee is essential personnel.	**L**

Equipment to be Used	Training Requirements/Competent or Qualified Personnel name(s)	Inspection Requirements
Personal Protective Equipment - Level D: Hard hat Safety glasses Safety-toed boots Work gloves/chemical resistant gloves Equipment: As needed for task	Competent Person (CP) / Qualified Person (QP): TBD - CP/SSHO TBD - CP/First Aid and CPR Training Requirements (as determined by SSHO): Tailgate meetings Emergency procedures Hazard communication	Daily site safety inspection (SSHO) – TBD Housekeeping (daily) Hand washing station or hand sanitizer solution available and used. Distancing being practiced. Do any personnel show signs of infection? SSHO to notify Project Manager and HR of any reports of signs of infection immediately. SSHO is not to provide names of involved personnel to others without authorization from HR.

ATTACHMENT 2

AMS HEALTH AND SAFETY PROCEDURES

AMS-710-02-PR-02700, Non-Commercial Motor Vehicle Safety
AMS-710-02-PR-05700, Mechanized and Marine Equipment
AMS-710-02-PR-03900, Commercial Motor Vehicle Safety
AMS-710-02-PR-01610, Utility Contact Prevention
AMS-710-02-PR-01500, Control of Hazardous Energy
AMS-710-01-PR-00300, Bloodborne Pathogens
AMS-710-05-PR-00400, Stop Work Authority
AMS-710-04-PR-00300, Hazardous Waste Operations
AMS-710-05-PR-01700, Work Area Hazard Assessment
AMS-710-02-PR-03000, Personal Protective Equipment
AMS-710-02-PR-03500, Respiratory Protection Program
AMS-710-02-PR-06400, Permit to Work
AMS-710-01-PR-05000, Medical Surveillance Program
AMS-710-01-PR-01000, Sanitation and Potable Water
AMS-710-02-PR-01600, Excavation and Trenching
AMS-710-01-FM-04201, COVID-19 Control Plan
AMS-710-02-FM-05701, Mechanized and Marine Equipment Inspection Report
AMS-710-01-PR-00600, Heat Stress Prevention and Control

PROCEDURE
Procedure Number:
AMS-710-02-PR-02700
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1
Procedure Owner:
HSE
Issuing Authority:
VP HSE & Security
Approval Date:
3/4/2019

NON-COMMERCIAL MOTOR VEHICLE SAFETY

Rev	Changes	Approved	Date
1	Clarification regarding the use of the point system for existing employees, sections 4.2.3, 4.2.5-4.2.7.	M. Hetzler	3/4/2019
0	Initial Issue	M. Hetzler	2/22/2019

Parent Document: N/A

NON-COMMERCIAL MOTOR VEHICLE SAFETY

1.0 PURPOSE

The purpose of this Procedure is to establish the minimum requirements for using non-commercial motor vehicles on APTIM sites and driving on company business. More stringent regulatory agency or client procedures may supersede these requirements. Each project is responsible for identifying the most stringent procedure and including those requirements in the site-specific safety plan. The most stringent of the requirements shall be adhered to.

The following deliverables are defined within this procedure:

Deliverable	Producer	Customer
Vehicle Inspection Form AMS-710-02-FM-02701	Driver	Site Files / Equipment Services Group
Motor Vehicle Procedure Acknowledgement Form AMS-710-02-FM-02702	Driver / Supervisor	HR Personnel Files
Notice of Citation Form AMS-710-02-FM-02704	Driver	HSE Rep and HR Personnel Files
Request for Check of Driving Record Form AMS-710-02-FM-02705	Driver / Site Manager /HR Representative / Hiring Manager	Supervisor, HSE Rep, and MVR Coordinator
Training	Drivers	Site Files / Learning Management System

2.0 SCOPE

This procedure addresses the operation of non-regulated over-the-road vehicles (e.g., cars, trucks, and vans with gross weight of 10,000 lbs or less) by Company authorized drivers. On-site mobile equipment, rough terrain vehicles, golf carts, and similar utility vehicles are not covered in this procedure.

This procedure applies to all APTIM employees, contractors, and subcontractors associated with an APTIM site who operate a motor vehicle on behalf of APTIM (e.g. company- owned, rented, or leased by APTIM or its clients – hereafter referred to as “company vehicle”). In addition, this procedure applies to the use of personal vehicles on company business.

The requirements for operating Commercial Motor Vehicles (i.e. those which typically require a Commercial Driver’s License and/or are regulated by DOT) can be found in the Commercial Motor Vehicle Safety Procedure (AMS-710-02-PR-03900).

- It should be noted that the requirements of AMS-710-02-PR-03900 apply to non-commercial vehicles when the combined Gross Vehicle Weight Rating (GVWR) or Gross Combination Weight Rating (GCWR) of the vehicle and its load/attachments exceed 10,000 pounds.

- Any vehicle, no matter how small, hauling hazardous materials in quantities requiring placards is defined as a Commercial Motor Vehicle, and the driver requires a Commercial Driver's License with proper endorsements.

3.0 RESPONSIBILITIES

The following personnel have responsibilities defined in this procedure:

- APTIM Human Resources
- APTIM Managers
- APTIM Supervisors
- APTIM Employees
- APTIM Equipment Services Group
- APTIM Contractors
- APTIM Subcontractors

4.0 PROCEDURE

4.1.1 All personnel who operate a company vehicle and those operating a personal vehicle for business purposes (all hereby referred to as "driver(s)") shall be familiar with this procedure and certify acceptance of the requirements by completing Motor Vehicle Procedure Acknowledgement Form (AMS-710-02-FM-02702).

4.1.2 Company vehicles are to be utilized exclusively for business purposes and occupied by authorized passengers as defined in this procedure.

4.1.3 Drivers shall have a valid driver's license for the area in which they are operating a vehicle. Any person with a suspended license is prohibited from driving any company vehicle.

4.1.4 Drivers shall comply with all local, state, and federal traffic regulations.

4.1.5 Drivers are personally responsible for any and all citations incurred by violating traffic regulations. Citations issued while driving a company vehicle or a personal vehicle while on company business shall be reported using the Notice of Citation Form (AMS-710-02-FM-02704).

4.1.6 Drivers shall be familiar with and abide by all laws and regulations applicable to the operation of their vehicle and should not drive motor vehicles in areas (i.e. other countries) where they are unsure of or inexperienced in local driving rules and regulations.

4.1.7 Drivers shall use cell phones/cellular devices in accordance with Cellular Device Use Procedure (AMS-710-02-PR-05600).

4.1.8 Drivers shall notify their supervisor immediately of any event that might alter their driver's license status, to include suspension or revocation of driver's license.

4.1.9 Where applicable, requests for reinstatement of denied or revoked driving privileges can be made to the appropriate SBU HSE Lead.

4.1.10 Smoking in company-owned, leased, or rented vehicles is prohibited.

4.1.11 No pets are allowed in company-owned, leased, or rented vehicles.

4.1.12 Failure to comply with this procedure may result in disciplinary action up to and including termination.

4.2 Driver Qualification and Status

4.2.1 New hire candidates (including non-APTIM personnel) may be subject to a Motor Vehicle Record background check (MVR), based on the position for which he/she is applying, prior to driving for APTIM business purposes.

4.2.2 The applicable hiring manager, HR Rep, or other APTIM personnel shall complete a Request for Check of Driving Record Form (AMS-710-02-FM-02705) and provide a copy to an MVR Coordinator.

4.2.2.1 MVR Coordinators shall perform the following steps:

4.2.2.2 Generate an MVR.

4.2.2.3 Evaluate results and render a decision based on the Driving Record Point System shown in section 4.2.3.

4.2.2.4 Communicate results back to the MVR requestor.

4.2.3 Drivers shall be evaluated in accordance with the Driving Record Point System shown in the table below.

Description of Violation	Assigned Point Value
Non-Moving: vehicular equipment deficiency, no seatbelt use, failure to secure load.	1
Moving: speeding (less than 15 miles per hour over limit, disobey traffic control signal, failure to signal, tailgating, use of cell phone while driving.	2
At-fault accident	3

Major citations: speeding (15 mph or more over limit, reckless driving, suspended license for driving violation, speed contest, open alcohol container (Non-Work Related).	6
Driving under the influence (Non-Work Related), Hit and run (leaving the scene of an accident), Refusal to submit to testing.	8
Driving under the influence (DWI/DUI) Work Related, Work Related Open Alcohol Container	Ineligible / Termination

Driving Privilege Status Description	**Past 12 Months**	**Past 24 Months**
Can drive without restriction.	0-3 points	0-5 points
Can drive with understanding of probationary status.	4-6 points	6-8 points
Not eligible for company driving privileges for 12 months.	7-11 points	9-15 points
Not eligible for company driving privileges.	12 points or more	16 points or more

4.2.4 Pre-Employment Driving Record Point System

4.2.4.1 If a new hire candidate has accumulated three points or less in the last 12 months or five points or less in the last 24 months per date of MVR, they shall be given the privilege to drive motor vehicles on company business without restrictions.

4.2.4.2 If a new hire has accumulated four to six points in the last 12 months or six to eight points in the last 24 months, they shall be placed on probation for a period of 12 months. They shall be afforded the privilege to drive motor vehicles on company business during this probationary period. Any driving infractions (e.g., speeding tickets, at-fault accidents, and any other citations) accumulated during this probationary period shall result in termination of the privilege to drive a motor vehicle on company business.

4.2.4.3 If the new hire candidate has accumulated seven to eleven points in the last 12 months or nine to fifteen points in the last 24 months, they shall not be eligible for company driving privileges. Employment can only be offered with the strict understanding of denial of the privilege to drive motor vehicles on company business. After the first 12 months of employment, the employee can petition the appropriate SBU President and SBU HSE Lead for reconsideration of driving privileges. An MVR will be generated at this time.

4.2.4.4 If a new hire candidate is expected to drive a vehicle to fulfill the responsibilities of his/her role and there has been an accumulation of twelve points or more in the last 12 months or sixteen points or more in the last 24 months, the candidate shall not be hired.

4.2.5 Existing Drivers

4.2.5.1 Requiring drivers to maintain an acceptable driving record is a risk mitigation measure utilized by the company for continued driving privileges. Accordingly, each affected driver's MVR traffic record may be subject to periodic review to ensure compliance with state and federal regulations, as well as company policy.

4.2.5.2 The applicable APTIM Manager/Supervisor or HSE Representative may initiate the MVR process by completing a Request for Check of Driving Record Form (AMS-710-02-FM-02705) and submitting the form to the HSE Representative.

4.2.5.3 Drivers shall provide verbal and written notice to their supervisor of traffic or vehicular citations in accordance with 4.2.6 - 4.2.7.

4.2.6 Work Related Traffic Violations

4.2.6.1 Drivers shall provide verbal and written notice to their supervisor of citations involving company vehicles within 24 hours of the event. This applies to citations occurring during business hours and non-business hours.

4.2.6.2 This verbal notice shall be followed by the driver completing a Notice of Citation Form (AMS-710-02-FM-02704), which shall be forwarded to the respective SBU HSE Lead or designee.

4.2.7 Non-Work Related Traffic Violations

4.2.7.1 It is not necessary for drivers to report non-work related citations to their supervisor as they occur, with the exception of Driving Under the Influence (DWI/DUI).

4.2.7.2 However, drivers have the responsibility to keep track of their non-work related vehicular citations and utilize established evaluation criteria, as described in the table shown in section 4.2.3, to determine if their overall traffic citations exceed acceptable company limits.

4.2.7.3 Additionally, if a driver's overall MVR record (work related or not) exceeds the company's established points system criteria, the driver shall verbally inform their supervisor as soon as practical, but no longer than the following business day after the occurrence.

4.2.7.4 Continued employment may only be extended with the strict understanding of denial/revocation of the privilege to drive company vehicles, or personal vehicles on company business. After the first 12 months following driving privilege revocation, the driver can petition their respective SBU President and SBU HSE Lead for reconsideration of driving privileges.

4.2.8 Drivers assigned a company vehicle are responsible to ensure that other drivers are qualified in accordance with this procedure before operating the vehicle. Failure to do so may result in disciplinary action up to and including termination.

4.3 Incident Reporting

4.3.1 Drivers shall report all vehicle citations and incidents while driving a company vehicle or personal vehicle incurred while on company business to their supervisor, or responsible APTIM personnel, as soon as possible, but not later than 24 hours after the occurrence.

4.3.2 Incidents involving company vehicles or personal vehicles being used for business purposes shall be reported in accordance with the Incident Reporting Procedure (AMS-710-05-PR-02300).

4.4 Use of Personal Vehicles for Business Purposes

4.4.1 Personal vehicles shall only be used for company business on APTIM sites if approved by the Site Manager or his designee.

4.4.2 Drivers using personal vehicles for Company business, other than on project sites, shall not be reimbursed for any damage sustained by or to their vehicle. The Company also assumes no liability for any incident while operating personal vehicles.

4.4.3 Drivers using personal vehicles on Company business shall maintain liability coverage that meets or exceeds statutory minimum limits. Drivers are recommended to maintain the following limits: $100,000 per person, $300,000 per occurrence, and $25,000 property damage.

4.5 Vehicle Inspection & Maintenance

4.5.1 All drivers shall perform a visual 360 degree walk around prior to each use.

4.5.2 All company vehicles shall be inspected, at a minimum, on a weekly basis by using the Vehicle Inspection Form (AMS-710-02-FM-02701). Completed Inspection forms shall be sent to the Equipment Services Group.

4.5.3 Drivers that have been assigned a company vehicle shall ensure that the vehicle is maintained in accordance with manufacturer specifications. The Driver Responsibility sheet in each vehicle outlines the services to be rendered at prescribed mileage intervals.

4.5.4 Drivers using a personal vehicle are responsible to ensure that the vehicle is maintained in accordance with manufacturer specifications and applicable federal, state, and local requirements.

4.6 Impaired Driving

4.6.1 Personnel shall not operate a vehicle for company business when mental or physical impairment might interfere with their ability to operate the vehicle in a safe manner.

4.6.2 Personnel shall not operate a vehicle for company business while impaired, intoxicated or under the influence of alcohol or illegal drugs as outlined in the Substance Abuse Program Procedure (AMS-710-01-PR-03600).

4.6.3 Personnel shall not operate a vehicle for company business while under the influence of medication that may interfere with motor vehicle operation.

4.6.4 Personnel shall not operate a vehicle for company business when under conditions of extreme stress, fatigue, or any other physical or mental impairment that may hinder safe vehicle operation.

4.7 Driver Safety Notification Sticker

4.7.1 A safety notification bumper sticker shall be applied to all US/Canada based company vehicles in an effort to ensure continued compliance with driving safety regulations.

4.7.2 The notification service shall be managed by a third party fleet safety management company and shall serve as the recipient of all calls that are placed concerning unsafe driving behavior. The Equipment Services Group shall serve as the first point of contact as it pertains to notifications that are received from the third party company who administers the bumper sticker safety call in service.

4.7.3 Upon receiving a report from the third party administrator, the Equipment Services Group shall contact the respective SBU HSE Lead or designee. The SBU HSE Lead or designee shall then contact the affected driver's supervisor concerning the complaint and provide an Employee Counselling Record (AMS-710-05-FM-00201), where applicable. All third party reports should be closed out by the driver's supervisor as instructed on the report.

4.7.4 Upon verification that the report was made in error or the caller statement was verified to be unsubstantiated, the SBU HSE Lead or designee should request the report be removed from the system. Reports can only be removed from the system with final authorization from the SBU HSE Lead or designee.

4.7.5 Deemed the primary/responsible operator of the vehicle, it is the responsibility of the driver to ensure that the sticker remains on the vehicle and is legible at all times. If the vehicle is project or program assigned and there is no designated primary operator, then the Project/Site Manager shall be considered the primary/responsible party.

4.7.6 The primary/responsible party shall contact the Equipment Services Group immediately upon recognizing that the sticker is defaced or removed so a new one can be applied. Failure on the part of the primary operator to ensure that a legible sticker remains on the vehicle shall result in disciplinary action up to and including revocation of vehicle usage or possible termination of employment.

4.8 Global Positioning System

4.8.1 Global Positioning System (GPS) speed and location gathering devices may be installed in company vehicles. The company utilizes data generated by these devices to track vehicle use, substantiate reports of unsafe driving, and monitor driving behavior.

4.8.2 Unsafe and unlawful driving behavior (i.e. excessive speeding), reported by GPS devices shall be investigated to evaluate the circumstances. Where applicable, the driver may be subject to disciplinary action up to and including termination of employment per the HSE Disciplinary Action Procedure (AMS-710-05-PR-00200).

4.8.3 Drivers caught disabling, tampering, or refusing to drive Company vehicles equipped with GPS shall be subject to disciplinary action up to and including immediate termination.

4.9 Transporting Personnel and Materials

4.9.1 Personnel shall not be used to support or steady loads while a vehicle is in motion.

4.9.2 Truck running boards shall not be ridden by personnel.

4.9.3 Drivers and passengers shall be seated with arms and legs inside the vehicle.

4.9.4 Personnel shall mount and dismount vehicles only when stopped and the gear in park. For manual transmissions, the gear shall be set based on manufacturer's recommendations with the parking brake engaged.

4.9.5 Personnel shall vacate all vehicles that are being loaded by a crane, backhoe, shovel, loader, or other equipment and shall move away from the vehicle during loading.

4.9.6 Loads extending beyond the bed of a truck or wagon shall be flagged and marked appropriately.

4.9.7 If left overnight, loads extending beyond the bed of a truck or wagon shall be flagged and marked appropriately (i.e. cones, reflective tape, etc.).

4.9.8 Drivers are responsible for safe loading, unloading, and securing of cargo.

4.9.9 Load shall not exceed manufacturer's specifications.

4.9.10 Where passengers are permitted to ride in the bed of trucks, the following requirements shall be met:

- Seats shall be firmly attached or passengers shall sit flat on the bed of the truck and shall not lean against the tailgate. Passengers shall keep their arms and legs inside the boundaries of the truck.
- The maximum speed at which the vehicle may travel on site is 10 mph, unless posted signage dictates a lower speed.

- At a minimum, passengers shall wear safety glasses unless the bed of the truck is enclosed.
- The weight of the people and their materials/tools shall not exceed the weight capacity of the vehicle.
- Passengers shall not be transported on the back of flatbed trucks.

4.9.11 Vehicles shall not be left running while unattended.

4.9.12 If a vehicle is parked on an incline or grade, the parking brake shall be engaged and wheels properly chocked.

4.9.13 When repair work or maintenance of any sort is performed on any vehicle, the parking brake shall be engaged.

4.10 Safety Features and Supplies

All company vehicles used on site shall be equipped in accordance with state and local laws and regulations. The Company also requires the following equipment:

4.10.1 First-aid Kit (when necessary due to the set-up of the site)

4.10.2 Snow tires and chains where conditions warrant

4.10.3 A minimum 2 1/2 pound ABC-rated fire extinguisher

4.11 Training

To help equip employees with the knowledge and skills of defensive driving, the following has been established:

4.11.1 New Hire Training - personnel expected to be driving a company vehicle or driving a personal vehicle on company business shall be required to complete a standard/initial defensive driver training program. This typically will apply to professional employees and certain craft employees, based upon roles and responsibilities.

4.11.2 Refresher Training – APTIM drivers will be required to complete a “refresher” defensive driver training program once every 2 years.

4.11.3 Post-Incident Training – Employees involved in an incident while driving on company business may be required to take post-incident training.

4.11.4 In the event one of APTIM’s clients has an established Driver Qualification program that meets or exceeds the company approved defensive driver training as approved by Corporate HSE, then the employee is only required to complete one training.

4.11.5 Recordkeeping - All training forms and supporting documentation shall be retained in the company’s learning management system.

5.0 TERMINOLOGY

Key terms within the context of the procedure. Terminology is to be listed in a table as shown below:

Term	Definition
Authorized Passengers	Authorized passengers in APTIM Company Vehicles are limited to: • Company employees or employees of all subsidiaries • Consultants or subcontractors to the Company when on Company business • Company clients or potential clients, Company vendors, and other on legitimate Company business
Company Vehicle	Any motor vehicle that is owned, leased, rented, provided by a Client or otherwise provided by or through Company
Company	APTIM and its subsidiaries and affiliates
Driver	Individuals who are assigned a company vehicle or drive a company- owned/leased/rented vehicle, or personal vehicle, on Company business.
Motor Vehicle	Motor vehicle means motorized over-the-road vehicles to include: any passenger vehicle, cars, trucks used upon the highway for transporting passengers and/or property, as well as driving of company vehicles on site locations. This includes personal vehicles operated on company business.
Motor Vehicle Operator (MVO)	Individuals who are assigned a company vehicle or drive a company- owned/leased/rented vehicle, or personal vehicle, on Company business.
Motor Vehicle Report (MVR)	Motor Vehicle Report or MVR is a report from a driver's license agency that shows a list of violations and accident history.
Project Assigned Employees	Any employee that is assigned to a field operations project position. This designation includes: Project Managers, Site Managers/Supervisors, Foremen, Technicians, Scientists, Geologists, and Project Business Accountants. This does not include employees that are typically assigned to an office but are visiting a site for brief periods of time, such as to provide technical assistance, perform audits, and perform program reviews.
Site	Any location, facility, or project where APTIM is performing work. Sites may include, but are not limited to, laboratories, offices, shops, owned facilities, leased facilities, and/or project sites.

6.0 REFERENCES

6.1 Required Forms/Checklists

AMS-710-02-FM-02701	Vehicle Inspection Form
AMS-710-02-FM-02702	Motor Vehicle Procedure Acknowledgement Form
AMS-710-02-FM-02704	Notice of Citation
AMS-710-02-FM-02705	Request for Check of Driving Record

6.2 Other Internal References

AMS-710-05-PR-02300	Incident Reporting
AMS-710-02-PR-05600	Cellular Device Use
AMS-710-02-PR-03900	Commercial Motor Vehicle Safety
AMS-710-01-PR-03600	Substance Abuse Program

6.3 Other External References

None

7.0 ATTACHMENTS

Attachment	Attachment Title
Attachment 7.1	Vehicle Inspection Form
Attachment 7.2	Motor Vehicle Procedure Acknowledgement Form
Attachment 7.3	Notice of Citation
Attachment 7.4	Request for Check of Driving Record
Attachment 7.5	Driver Qualification Process Flow
Attachment 7.6	Vehicle Inspection Process Flow

ATTACHMENT 7.1
VEHICLE INSPECTION FORM

NON-COMMERCIAL MOTOR VEHICLE SAFETY

Make		Model			
Unit #		Inspection Date		Odometer Reading	

The items below are to be inspected on a weekly basis. Report ALL items in need of repair to the mechanics at the time of inspection. Return the completed sheet to the Equipment Superintendent and Safety Department at the end of the week.

Inspection		Notes
Lubrication	☐	
Starting System	☐	
Instruments (speedometer & temperature gauge)	☐	
Cooling System (Radiator)	☐	
Air System	☐	
Glass	☐	
Mirrors (Rear-view & left outside)	☐	
Defroster	☐	
Brakes	☐	
Steering System	☐	
Tires	☐	
Headlights	☐	
Tail lights	☐	
Brake lights	☐	
Horn	☐	
Windshield Wipers	☐	
Fire Extinguisher	☐	
Seat belts	☐	
Back-up alarm	☐	
Condition of vehicle body	☐	
Initials & badge # of inspector	☐	
Driver Notification Sticker present and legible	☐	
Other	☐	

To be completed by Mechanic / Equipment Services Group:

Date Reported	Repairs Made	Date Repaired

This form must be sent to ESGdocs@aptim.com

Signature of Mechanic / ESG Representative	

ATTACHMENT 7.2
MOTOR VEHICLE PROCEDURE ACKNOWLEDGEMENT FORM

NON-COMMERCIAL MOTOR VEHICLE SAFETY

I, the undersigned, acknowledge that I have been provided with the Company's Non-Commercial Motor Vehicle Safety Procedure and/or the Commercial Motor Vehicle Safety Procedure (if a CDL driver). I was afforded an opportunity to ask questions about these procedures, acknowledge that they apply to me, and understand that I may speak with my supervisor about any parts of the policy or procedures that I may not understand. Key elements of APTIM's Motor Safety Policy and Procedures include:

As an APTIM employee, or a Non-APTIM employee operating an APTIM vehicle or personal vehicle on company business, I understand that these driving activities are privileges and not rights of employment. My driving status and possibly my employment are conditioned upon the policy, procedures, and my adherence to them.

I further understand and acknowledge that I am required to follow federal, state, and local laws, including laws relating to licensing and the operation of motor vehicles, as well as the applicable procedures, rules, and regulations of APTIM clients relating to my operation of a motor vehicle. When such procedures, rules, or regulations conflict, I will follow the most conservative and safest practice and promptly speak with my supervisor for clarification.

Printed Name: _____ Date: _____

Employee ID Number (if applicable): _____

Signature: _____

Supervisor Printed Name: _____ Date: _____

Project / Location: _____

Signature: _____

Please send a copy of this form to the designated HR Representative to be kept in the personnel file.

ATTACHMENT 7.3
NOTICE OF CITATION FORM

NON-COMMERCIAL MOTOR VEHICLE SAFETY

This form is to be completed each time an APTIM approved driver is issued a citation while driving a company vehicle or a personal vehicle for business purposes. Once complete, it is to be signed by the driver's supervisor and forwarded to the appropriate Human Resources Representative and the Corporate HSE Fleet Safety Department.

Driver Name _____ Employee No. (If applicable) _____

Nature of Citation _____

Date Citation Received: _____ Time Citation Received: _____

Location of Citation (City, State) _____

Law Enforcement or entity Issuing Citation: _____

Is Citation Being Contested? No Yes Details _____

_____

Court Location and Court Date from Citation: _____

Driver Signature _____ Date _____

Corrective Action Being Taken _____

_____

_____

Supervisor Signature _____ Date _____

PLEASE PROVIDE A COPY OF THIS FORM TO SBU HSE LEAD AND YOUR HUMAN RESOURCES REPRESENTATIVE.

CORPORATE HSE USE ONLY

MVR Check ran on Employee ___Y ___N Date: _____

Total Point Count: _____

New Driving Status: _____ Change in Driving Status: ___ Y ___ N

ATTACHMENT 7.4
REQUEST FOR CHECK OF DRIVING RECORD

Fair Credit Reporting Act Disclosure Statement

In accordance with the provisions of Section 604 (b) (2) (A) of the Fair Credit Reporting Act, 15 U.S.C. 1681 et seq, as amended by the Consumer Credit Reporting Reform Act of 1996 (title II, Subtitle D, Chapter I, of Public Law 104-208, 110 Stat. 3009-426) and other applicable consumer credit legislation, you are being informed that reports verifying your driving record may be obtained for employment purposes. These reports are required by Sections 382.413, 391.23 and 391.25 of Federal Motor Carrier Safety Administration Regulations. You have the right to receive a copy of the reports and have the prescribed allotment of time by law to have any errors corrected and the reports obtained after corrections have been posted.

Violation	Assigned Point Value
Overweight, loss of load, vehicular equipment infraction, etc.	1
Moving violation: speeding, failure to stop, failure to signal turn, etc.	2
At-fault accident	3
Major citation: reckless driving (including speeding 15 or more miles per hour over the limit), tailgating, suspended license, speed contest, improper lane usage, open container, etc.	6
Driving under the influence or Hit and Run (Leaving the Scene)	8

In the space provided below, please list all violations and accidents (regardless of fault) currently listed on your driving record by the state issuing your driver's license (include all states for which you have held a driver's license during the last two [2] years). Determine the number of points assigned from the table above, and write in column labelled Points. Finally, write the sum total of all points where indicated. If you are unsure if a violation is on your record, write it down.

Violations	Driver's License Number	State of Issue	Date of Violation (M/Y)	Points as Determined from Above
Attach a blank sheet of paper if additional space is needed. *DO NOT WRITE ON THE BACK OF THIS FORM.*				
			Total Points	

I hereby certify that the information provided is a complete and accurate statement of my driving record for the previous twenty-four (24) months. I authorize the company to obtain a copy of my driving record from the state of issuance of my license(s) prior to my hire, post-accident, annually, and/or as determined necessary to ensure compliance with Federal, state, and local law, and with APTIM policies and/or procedures. Any driving record check that is conducted on me will fall under the Fair Credit Reporting Act as explained above. **I also understand that falsification of data may disqualify me from being hired or result in revocation of my company driving privileges or other disciplinary action as provided by company policies and procedures.**

Signature _____ Date _____ Position/Applied For _____

Driver License No. State of Issue Expiration Date

Do You Have a CDL? ☐ Y ☐ N List all Endorsements on CDL: _____

Printed Name_____ SSN _____ DOB _____ Employee # _____

Current Address _____ City _____ State ____ Zip _____

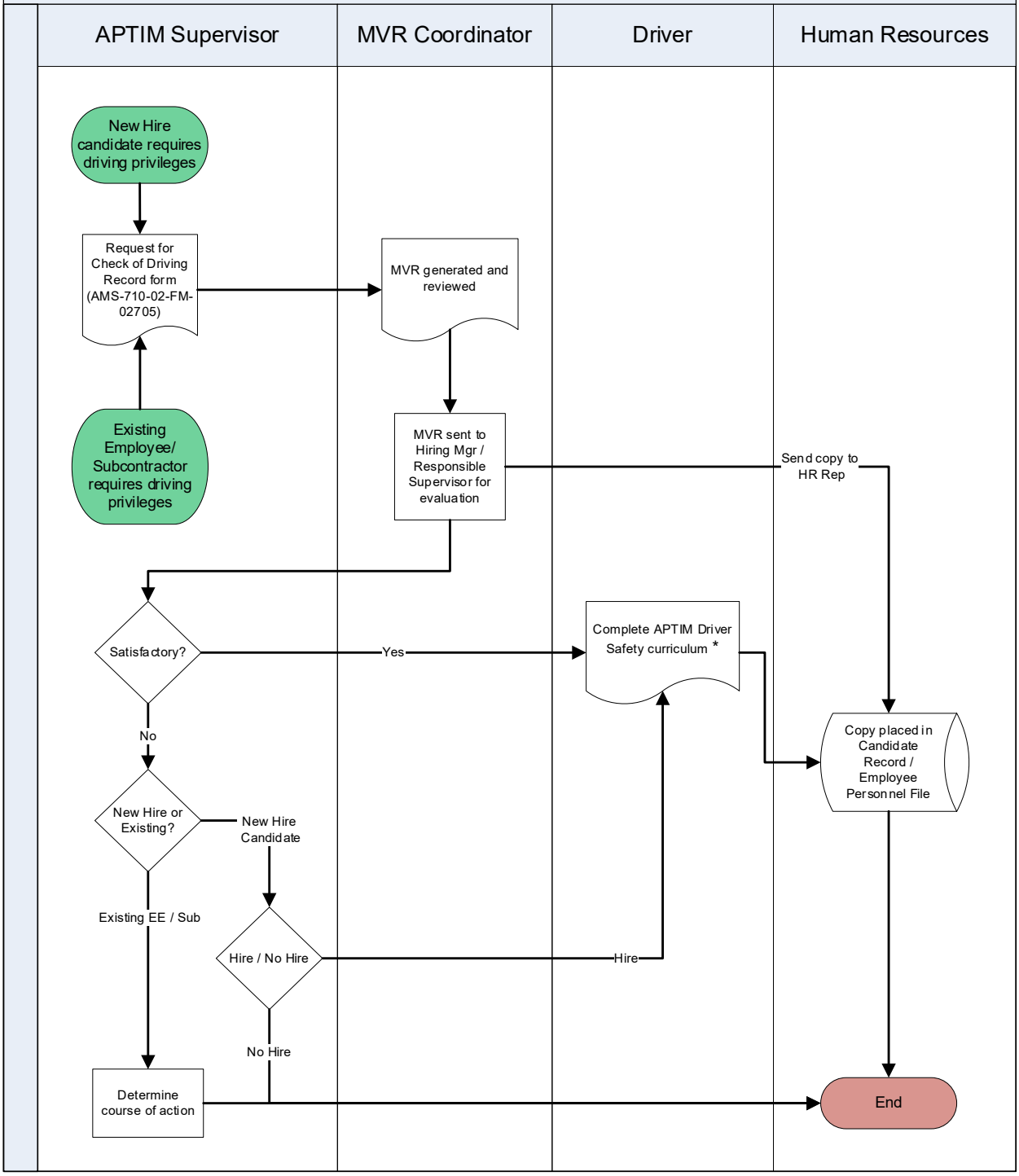
Requesting Authority (printed name) _____ Site / Location _____

--- Send completed form to your respective MVR Coordinator ---

ATTACHMENT 7.5
DRIVER QUALIFICATION PROCESS FLOW

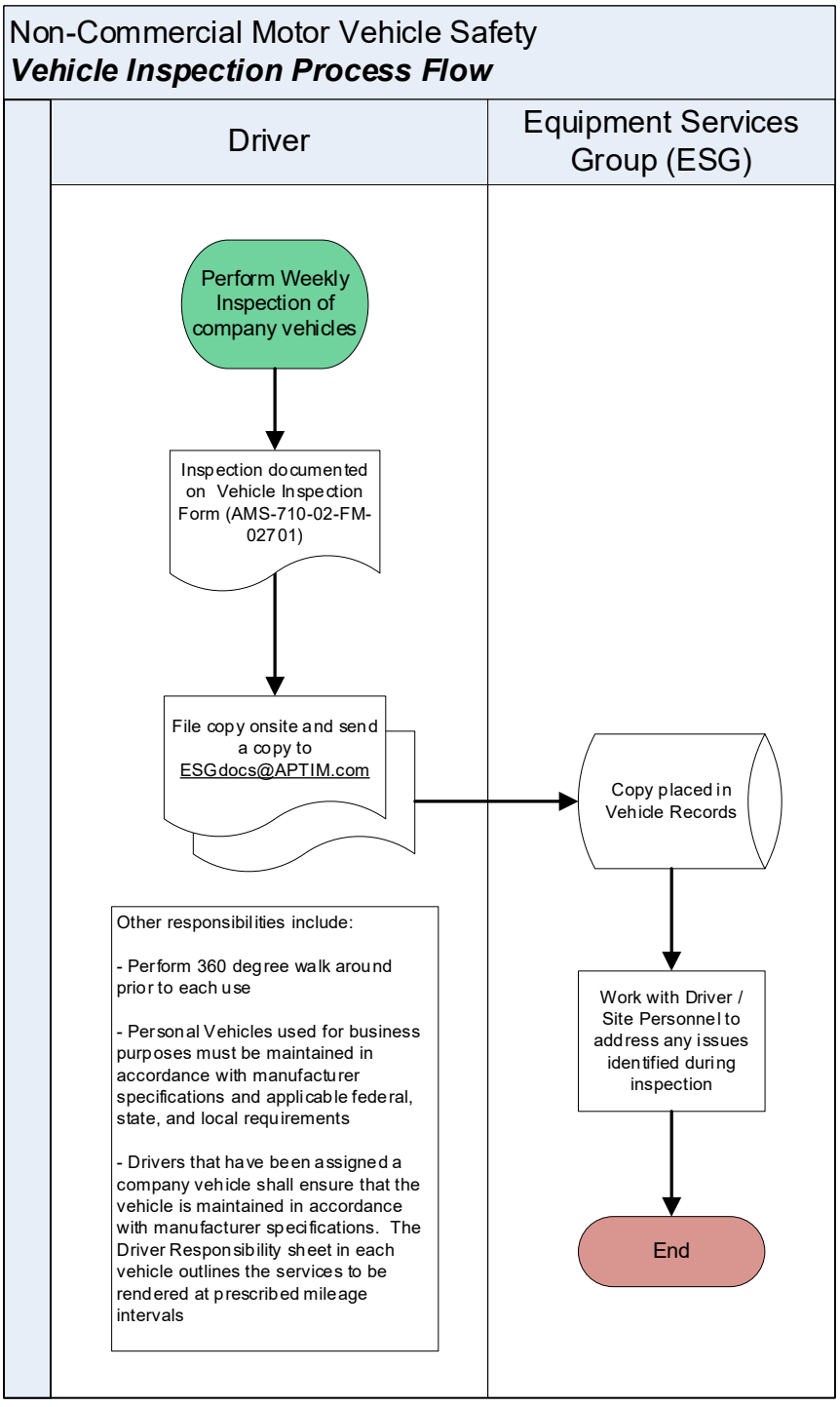
NON-COMMERCIAL MOTOR VEHICLE SAFETY

Non-Commercial Motor Vehicle Safety
Driver Qualification Process Flow



ATTACHMENT 7.6
VEHICLE INSPECTION PROCESS FLOW

NON-COMMERCIAL MOTOR VEHICLE SAFETY



PROCEDURE

Procedure Title:	**Mechanized and Marine Equipment**	**AMS Number:**	**AMS-710-02-PR-05700**
Procedure Owner:	**HSE**	**Issuing Authority:**	**APTIM Quality Management**

MECHANIZED AND MARINE EQUIPMENT

INT	Issued for Interim Use	M. Hadacek & S. Lachney	7/30/2017
Rev	**Changes**	**Approved**	**Date**

1.0 PURPOSE

The purpose of this Procedure is to establish the minimum requirements for Mechanized and Marine Equipment used on APTIM sites.

2.0 SCOPE

This procedure applies to all APTIM employees, contractors, subcontractors, and visitors associated with a APTIM site.

3.0 RESPONSIBILITIES

- APTIM Managers
- APTIM Supervisors
- APTIM Employees
- APTIM Contractors
- APTIM Subcontractors
- APTIM Visitors

4.0 PROCEDURE

Each site shall make every attempt to prevent the possibility of incidents to employees or damage to the equipment or facilities when performing work activities with Mechanized and Marine Equipment through compliance with safety regulations, training of employees to properly perform their job activities and through employee involvement in safe work activities.

4.1 Mechanized and Marine Equipment

4.1.1 Mechanized and marine equipment covered by this procedure are those that operate within an off-highway project/facility, not open to public traffic.

4.1.2 These rules apply to the following types of mechanized and marine equipment: scrapers, loaders, crawler or wheel tractors, bulldozers, off-highway trucks, graders, compactors, backhoes, excavators, pile driving, agricultural and industrial tractors, and similar equipment.

4.1.3 The safety requirements, ratios, or limitations applicable to machines or attachment usage covered in Construction Manual 300, shall be complied with, and shall apply to cranes, machines, and attachments.

4.1.4 All mechanized and marine equipment covered by this procedure shall comply with the requirements of AMS-710-02-PR-06600 Working Around Overhead Power Lines when working or being moved in the vicinity of power lines or energized transmitters.

4.2 General Requirements

4.2.1 Do not use equipment that is not in proper operating condition. Attach a “Danger – Do Not Use” tag to inoperable equipment, remove key from equipment, and give key to the supervisor when notifying him/her of the inoperable equipment.

4.2.2 No modifications or additions which affect the capacity or safe operation of the equipment shall be made without the manufacturer's written approval.

4.2.2.1 If such modifications or changes are made, the capacity, operation, and maintenance instruction plates, tags, or decals shall be changed accordingly.

4.2.2.2 In no case shall the original safety factor of the equipment be reduced.

4.2.3 All equipment left unattended at night, adjacent to a highway in normal use, or adjacent to construction areas where work is in progress, shall have appropriate lights or

reflectors, or barricades equipped with appropriate lights or reflectors, to identify the location of the equipment.

4.2.4 A safety tire rack, cage, or equivalent protection shall be provided and used when inflating, mounting, or dismounting tires installed on split rims, or rims equipped with locking rings or similar devices.

4.2.5 Heavy machinery, equipment, or parts thereof, which are suspended or held aloft by use of slings, hoists, or jacks shall be substantially blocked or cribbed to prevent falling or shifting before employees are permitted to work under or between them. Bulldozer and scraper blades, skid steer loader buckets, dump bodies, and similar equipment, shall be either fully lowered or blocked when being repaired or when not in use. All controls shall be in a neutral position, with the motors stopped and brakes set, unless work being performed requires otherwise.

4.2.6 All equipment shall have a service brake system, an emergency brake system, and a parking brake system. These systems may use common components, and shall be maintained in operable condition.

4.2.7 Whenever the equipment is parked, the parking brake shall be set. Equipment parked on inclines shall have the wheels chocked and the parking brake set.

4.2.8 The use, care and charging of all batteries shall conform to the applicable requirements which include the following;

4.2.8.1 Face shields, aprons, and rubber gloves shall be provided for workers handling acids or batteries.

4.2.8.2 Facilities for quick drenching of the eyes and body shall be provided within 25 ft. (7.62 m) of battery handling areas.

4.2.8.3 When batteries are being charged, the vent caps shall be kept in place to avoid electrolyte spray. Vent caps shall be maintained in functioning condition.

4.2.9 Whenever visibility conditions warrant additional light, all equipment/vehicles, or combinations of equipment/vehicles, in use shall be equipped with at least two headlights and two taillights in operable condition.

4.2.10 All equipment/vehicles, or combination of equipment/vehicles, shall have brake lights in operable condition regardless of light conditions.

4.2.11 All equipment with cabs shall be equipped with windshields and powered wipers. Cracked and broken glass shall be replaced.

- All cab glass shall be safety glass, or equivalent, that introduces no visible distortion affecting the safe operation of the equipment.

4.2.12 Equipment operating in areas or under conditions that cause fogging or frosting of the windshields shall be equipped with operable defogging or defrosting devices.

4.2.13 All equipment with enclosed cabs operated in hot weather environments should be outfitted with cooling units, and personnel should be monitored for heat stress.

4.2.14 Equipment/vehicles used to transport employees shall have seats firmly secured and adequate for the number of employees to be transported.

4.2.15 Tools and material shall be secured to prevent movement when transported in the same compartment with employees.

4.2.16 Equipment shall not be loaded beyond its established load limit and the load shall be secured for safe transport

4.2.17 Passengers shall not be allowed on equipment unless seated in a manufacturer's installed seat and with the seat belt fastened.

4.2.18 All equipment/vehicles, whose pay load is loaded by means of cranes, power shovels, skid steer loaders, or similar equipment, shall have a cab shield and/or canopy adequate to protect the operator from shifting or falling materials.

4.2.19 All equipment/vehicles with dump bodies shall be equipped with positive means of support, permanently attached, and capable of being locked in position to prevent accidental lowering of the body while maintenance or inspection work is being done.

4.2.20 Operating levers controlling hoisting or dumping devices on haulage bodies shall be equipped with a latch or other device which will prevent accidental starting or tripping of the mechanism.

4.2.21 Trip handles for tailgates of dump trucks shall be so arranged that, in dumping, the operator will be in the clear.

4.2.22 Pneumatic-tired earth-moving equipment (trucks, scrapers, tractors, and trailing units) whose maximum speed exceeds 15 mph (24 kph), shall be equipped with fenders on all wheels.

- Mud flaps may be used in lieu of fenders whenever motor equipment/vehicle is not designed for fenders.

4.2.23 Scissor points on skid steer loaders and similar equipment, which constitute a hazard to the operator during normal operation, shall be guarded.

4.2.24 Mobile equipment shall be equipped with a fire extinguisher with a minimum rating of 10BC.

4.2.25 Never use buckets, forks, or attachments as a work platform or personnel carrier.

4.2.26 All rubber-tired, self-propelled scrapers, rubber-tired skid steer loaders, rubber-tired dozers, wheel-type agricultural and industrial tractors, crawler tractors, crawler-type skid steer loaders, and motor graders, with or without attachments that are used in construction work shall be equipped with rollover protective structures (ROPS) and seat belts. This requirement does not apply to side boom pipe laying tractors.

4.2.27 When a signal person is used, the equipment shall not be moved unless the designated signal person giving signals is in full view of the operator.

4.2.28 For movement of mobile equipment in congested areas, a designated signal person shall be in full view of the operator and shall direct the movement. In some cases, multiple signal persons may be required.

4.2.29 No one shall be allowed within the boom, bucket, or counterweight swing radius, when it is in operation. Barricades shall be erected to keep workers from entering, as appropriate.

4.2.30 Walk behind compactors (or similar) shall be equipped with a continuous pressure (dead man type) control to stop the equipment if released.

4.2.31 Personnel such as surveyors, who are required to work around heavy earthworking equipment, shall wear a high visibility vest or clothing.

4.2.32 The operator must place marker guides, lighting or other effective signs to indicate to the driver the limit of safe approach to the tipping area when dumping operations are being carried out (whether by day or night).

4.2.33 Drivers of trucks delivering materials to site in multi-stage tippers or side un-loaders must take into account the gradient of the ground on which they are tipping, the nature of the material being discharged and to watch out for "hang up" of material during discharge. If necessary, a spotter must be used to direct discharge via radio communication or hand signals.

4.2.34 When it is necessary (e.g., maintenance/refueling) to approach closer than 20 meters (65 feet) to a heavy vehicle, this shall only be done with the verbal permission of the driver/operator of the heavy vehicle. The following rules shall apply to parking of heavy equipment:

- Only park in designated areas;
- Lower all attachments on equipment fitted with moveable attachments (i.e., forks, buckets, blades, ripper's) when parking;
- If on an incline chock the wheels;
- Turn wheels into the side of the bank or road; and
- Apply the park brake and slew brake where applicable.

4.2.35 Vehicles used for the primary purpose of transporting fuel, explosives, oils etc. shall not haul passengers.

4.2.36 Smoking is not allowed in or within 50' of vehicles transporting fuel, explosives, oils, etc.

4.3 General Requirements for Operators

4.3.1 It is the responsibility of the operator to read and understand the operator's manual and the manufacturers' recommendations for each type and model of equipment to be operated and the requirements of this procedure.

4.3.2 The equipment must be inspected by the operator (designated person) prior to each use. Do not use equipment that is not in proper operating condition or is not within the last monthly inspection period. Attach a "Danger — Do Not Use" tag to inoperable equipment and notify the supervisor. Remove key from the equipment.

4.3.3 When so equipped, check the "operator presence/seat interlock" prior to starting equipment. Do not operate the equipment if the system is not functioning properly.

4.3.4 Operators must know the capacity and operating characteristics of the equipment to be operated.

4.3.5 The equipment must be attended at all times or attachments must be placed in the "transport lock position" or lowered to the ground.

4.3.6 The operator must check the work area for slopes, obstructions, potholes, etc. prior to beginning work. Check for overhead obstructions such as power lines, pipe racks, etc. and ensure proper clearances. See AMS-710-02-PR-06600 Working Around Overhead Power Lines.

4.3.7 When mounting or dismounting equipment, clean shoes and hands before climbing. Always use handrails, grab rails, and steps. Maintain a three-point contact with steps and handholds. Never jump on or off equipment. Never attempt to mount or dismount a moving machine. Do not use steering wheel or control levers as a handhold.

4.3.8 Loads must be carried as low as possible to maintain stability of the equipment and operator visibility.

4.3.9 Operations are to be performed only from the operators control station.

4.3.10 When equipped with "roll over protective structures" (ROPS), the operator must wear seat belt at all times and keep their body (hands, arms, legs, head) inside the protected area.

4.3.11 Never lift loads over people, occupied buildings, or operating equipment.

4.3.12 Use caution when handling objects such as round bales, poles, stumps, cylinders, sheets of plywood, etc. with skid steer loaders. Lifting too high or rolling the bucket too far back could result in objects sliding down the loader arms and falling onto the operator's control station.

4.3.13 Obey posted speed limits. When operating on the project/facility, take it slow and easy. Give right of way to loaded machines and maintain a safe distance from other machines.

4.3.14 Avoid steep slopes or unstable surfaces. When operating on a slope, keep the load low and use extreme caution. Avoid sudden starts, stops, and turns when operating on inclines.

4.3.15 When moving mobile equipment, plan the move by evaluating road or ground conditions, overhead obstacles, traffic and congestion, and work adjacent to the travel path.

4.3.16 When driving on a sloped area, always drive up or down the slope and not across the slope. . Avoid making turns on inclines. If it is necessary, make turns wide and slowly with load carried low. When traveling up or down inclines, do so with loaded buckets facing uphill and empty buckets facing downhill.

4.3.17 When parking, select a place out of the traffic areas. Select a level area whenever possible. When it is necessary to park on an incline, position the machine at right angles to the incline. Secure or lower buckets, blades, and attachments and set the parking brake. Shut down the machine and chock wheels. Cycle the controls to ensure all attachments are secure.

4.3.18 The driver of a haul or dump truck shall not enter or leave the cab while the truck is being loaded.

4.3.19 The driver of a shovel or loader shall not cause the bucket of the shovel or loader to be traversed over the driver's cab of a truck or other motor vehicle during loading operations.

4.4 Transporting or Driving Equipment on Public Highways

4.4.1 When traveling on public roads, lock dual brake pedals together. Make sure all clearance flags, lights, and warning signs are in place and visible. Make sure the “Slow Moving Vehicle” emblem is visible to traffic approaching from the rear. Use escort vehicles, as required.

4.4.2 When loading or unloading equipment, select a level surface. Chock the transport vehicle to prevent movement. Keep trailer bed and ramps free of oils, mud, snow, ice, and debris. On articulated machines, attach the steering frame lock after loading and remove it before unloading. Chain and block the machine securely. Secure all attachments in the transport mode and lower buckets or blades. Cover or remove “Slow Moving Vehicle” emblems before transporting.

4.4.3 Only the equipment operator and personnel trained and qualified to load equipment shall be allowed in the area during equipment loading or unloading.

4.4.4 Unless qualified as an operator of the specific type of equipment to be transported, the truck driver shall not be allowed to drive the equipment onto or off of the trailer.

4.5 General Requirements for Excavations

4.5.1 The location of underground utilities, i.e., electric, gas lines, water lines shall be identified prior to beginning excavation.

4.5.2 Check with the supervisor or the facility owner for permit requirements. If unidentified encumbrances or utilities are struck, stop all work and notify the supervisor.

4.5.3 Precautions must be implemented to keep personnel out of excavations and at least 10 ft. (3 m) away from the equipment and its maximum boom and/or counterweight swing radius when operating. Accessible areas within the swing radius of the equipment are to be barricaded to prevent personnel from being struck or crushed.

4.5.4 Vehicles/equipment shall not approach an excavation while employees are in the excavation.

4.5.5 When excavating, extreme caution should be utilized to avoid hazards caused by cave in, i.e., roll over, tipping, or objects falling from overhead. If equipped with such, use the machine stabilizers. Avoid dangers such as rock or earth slides, when working at the base of excavations, overhangs, or stockpiles. See AMS-710-02-PR-01600 Excavation and Trenching for additional requirements.

4.5.6 The supervisor must confirm that the design, layout, construction and maintenance of any dumping or stockpiling operations take the following into account:

- The nature of the material being dumped;
- The size and weight of the equipment being used;
- The site conditions, including stability of the area on which the dump is built; and
- The weather conditions.

4.5.7 The operator must not dump rock or other material from a haul or dump truck over a bank or into a bin unless there is an effective backstop provided or a person (spotter) suitably stationed to guide and direct the driver to a safe dumping position, via radio communications or hand signals.

4.6 Equipment Specific Precautions

4.6.1 Trencher

4.6.1.1 Prior to operating this equipment, the operator shall receive proper training and study the operator's manual to ensure a comprehensive understanding of the machine operation and controls.

4.6.1.2 When operating a trencher, ensure the equipment is ready for the job it must do.

- Use a digging boom of the right length with a tooth pattern appropriate to soil conditions.
- Keep guards, personnel restraints and trench cleaner in proper adjustment in relation to the digging chain.

4.6.1.3 If the trencher is a riding model, operate the machine only from the operator's seat. The digging chain, auger, or wheel of the trencher can throw rock or debris a considerable distance. Use proper face and eye protection.

4.6.1.4 Never allow anyone in the trench while digging.

4.6.1.5 When beginning a new trench, set the digging boom down carefully with the chain moving slowly. The chain will tend to pull the machine. Be prepared to counteract the pull. Dropping a rapidly moving digging chain to the ground can cause the trencher to move quickly and unexpectedly.

4.6.1.6 Use caution when trenching on hillsides. Avoid the potential for roll over or tipping. Always try to dig with the trencher in a level position. Vibration will tend to make the trencher slip sideways down a slope. Thoroughly evaluate the potential hazards and design the job such that equipment will remain stable throughout the course of the job.

4.6.1.7 Avoid fences, walls, or other obstructions. If the tip of the digging boom makes contact with an obstacle, the machine can climb up and tip backwards onto the operator.

4.6.1.8 During digging, if the machine strikes an unforeseen encumbrance and begins to labor, or jams, shut down the machine and inspect the worksite

and the chain. Never attempt to free a stuck chain while the trencher is running.

4.6.1.9 Stop the engine before attempting to service the chain.

4.6.2 Backhoes and Excavators (Trackhoes)

4.6.2.1 Prior to operating this equipment, the operator shall receive proper training and study the operator's manual to ensure a comprehensive understanding of the machine operation and controls.

4.6.2.2 Never operate the controls from the ground. Always operate from the operators control station.

4.6.2.3 Use stabilizers if equipped. Apply enough pressure to the stabilizers to support and level the machine. Do not elevate the tires off the ground higher that required.

4.6.2.4 Never enter, or allow anyone to enter the backhoe's pivot-point area or the swing radius of the boom. Maintain a clear zone of at least 10 ft. (9 m) beyond the maximum reach of the boom or counterweight.

4.6.2.5 Do not dig under the equipment or stabilizers.

4.6.2.6 When operating on a slope, swing to the uphill side to dump the load, if possible. If downhill dumping is necessary, swing only as far as required to dump the load. Use extreme caution. It equipped, use stabilizers to support the machine.

4.6.2.7 When using the backhoe/excavator bucket for hoisting:

- Consult the manufacturer's manual for lifting capacity.
- Position the machine so that load lowering is done over the front or back of the machine, not the side.
- For backhoes, always use stabilizers, and in soft soil place pads under each stabilizer.
- Ensure that the load is balanced and move slowly to maintain control of the load. Use tag lines when needed.
- Never lift the load higher than necessary to clear obstacles.
- Lower the load as soon as the obstacle is cleared and never hoist loads over people.

4.6.3 Skid Steer Loaders

4.6.3.1 Prior to operating this equipment, the operator shall receive proper training and study the operator's manual to ensure a comprehensive understanding of the machine operation and controls.

4.6.3.2 All skid-steer style loaders with cabs shall be fitted with a manufacturer-approved safety glass front door, front cage cover of equivalent effectiveness.

4.6.3.3 Skid steer loaders can tip quickly due to their short wheelbase and operating characteristics if the operator does not stay within the manufacturer operational limits.

4.6.3.4 Operators must maintain complete control at all times and operate at a speed suitable to site conditions.

4.6.3.5 Operate the skid steer loader from the operator's compartment—never from the outside.

4.6.3.6 Stay seated when operating the skid steer loader controls.

4.6.3.7 The operator must keep hands, arms, legs, and head inside the cab while operating the skid steer loader.

4.6.3.8 Travel and turn with the bucket in the lowest position possible. Come to a complete stop before raising the bucket to dump.

4.6.3.9 When changing direction, look both ways to ensure adequate clearance from personnel and equipment.

4.6.3.10 Use extreme caution when operating in and around excavations to avoid tipping.

4.6.3.11 Always travel up and down slopes with the loaded bucket facing up the hill or the empty bucket facing down the hill.

4.6.3.12 Avoid sudden starts, stops, and turns to prevent tipping or striking other equipment or people.

4.6.3.13 Attachments used with skid steer loaders must be approved by the manufacturer and used in accordance with manufacturer instructions. Equipment capacities must be adjusted to accommodate such attachments.

4.6.3.14 On skid steer loaders where the operator's seat and controls are between the lift arms and in front of the lift arm pivot points, and where the operators must enter and exit from the loader through the front of the machine and over the bucket, operators must use great care to avoid contact of foot or hand controls that may be activated and cause movement of the lift arms, bucket, or other attachment.

4.6.4 Compactors

4.6.4.1 Prior to using compaction equipment, the operator shall receive proper training and study the operator's manual to ensure a comprehensive understanding of the machine operation and controls.

4.6.4.2 Operators are required to wear safety toe shoes and metatarsal guards while operating hand held compaction equipment. Other types of personal protective equipment may be required, e.g., hearing protection, respiratory protection.

4.6.4.3 Caution must be exercised when working in or around excavations to avoid tipping or cave in. When in excavations 4 ft. (1.2 m) deep and greater, sides must be sloped or shored to prevent cave in. Shoring evaluation must consider the additional load, which may be imposed due to the compaction activity.

4.6.4.4 To minimize personnel exposure on steep slopes and exposures to excavation hazards in areas such as washouts or in excavations that are not shored or sloped, a remotely-controlled compactor should be used. Personnel shall stay clear of the equipment when in operation.

4.6.5 Burial Plow Attachment

4.6.5.1 When transporting a burial plow attachment, raise the plow to its fully elevated position and engage the transport lock. For parking, the plow should be either locked in the transport position or lowered to the ground.

4.6.5.2 Know the location of underground utilities and clear the area of all obstructions or bystanders before operating the machine.

4.6.5.3 When plowing on slopes, the machine's stability is increased due to the blade in the ground. Always enter or exit the ground slowly. Rapid entry or exit may cause the machine to tip.

4.6.6 Horizontal Boring Attachment

4.6.6.1 Prior to operating this equipment, the operator shall receive proper training and study the operator's manual to ensure a comprehensive understanding of the machine operation and controls.

4.6.6.2 Do not guide drill rod or pipe with hands, arms, feet, or other bodily contact. Use only guide tools as recommended by the manufacturer.

4.6.6.3 Keep bystanders and unauthorized personnel out of the work area and away from exposed drill rod or pipe.

4.6.6.4 Do not use excessive crowd (pushing) force on drill rod or pipe. Whipping action may result increasing the potential for incidents or injury.

4.6.6.5 Never use fasteners or hardware other than that supplied by the manufacturer to retain drill rod or pipe connectors

4.6.6.6 Do not service drill rod or pipe while engine is running.

4.6.7 Rock Cutting Attachment

4.6.7.1 Prior to operating this equipment, the operator shall receive proper training and study the operator's manual to ensure a comprehensive understanding of the machine operation and controls.

4.6.7.2 Read and understand the danger, caution, and warning signs on the equipment prior to beginning work.

4.6.7.3 Rock cutting may require hearing and/or respiratory protection. Check with your supervisor to determine the proper personal protective equipment.

4.6.7.4 Keep all unauthorized personnel away from the work area.

4.6.8 Industrial/Agricultural Mower

4.6.8.1 Prior to operating this equipment, the operator shall receive proper training and study the operator's manual to ensure a comprehensive understanding of the machine operation and controls.

4.6.8.2 Ensure that chain, flexible, or solid deflector shields are in place on the front and rear of the mower deck and are in good repair. Do not operate with damaged or missing shields.

4.6.8.3 Check for broken, missing, bent, or severely worn blades.

4.6.8.4 Check work area for debris and foreign objects to avoid them being picked up and thrown out by the mower. Inspect for rough terrain, drop-offs, ditches, potholes, steep slopes, stumps, standing water, mud, soft soil, or slippery conditions.

4.6.8.5 Keep unauthorized personnel out of the work area. The mower may throw objects up to 300 ft. (91 m).

4.6.8.6 Do not operate mower in transport position.

4.6.8.7 Avoid excessive ground speed for terrain conditions and sudden starts, stops, or turns.

4.6.8.8 Plan to mow downhill on steep slopes. Avoid over-speed of the power take off.

4.6.8.9 Ensure all required guards are in place.

4.6.8.10 Keep clear of rotating blades, parts, and drivelines.

4.7 Seat Belts

4.7.1 Seat belts shall be provided on all equipment covered by this procedure.

4.7.1.1 Seat belts need not be provided for equipment that is designed only for stand-up operation.

4.7.1.2 Seat belts need not be provided for equipment that does not have rollover protective structure (ROPS) or adequate canopy protection

4.7.2 Tractors shall have seat belts as required for the operators when seated in the normal seating arrangement for tractor operation, even though backhoes, breakers, or other similar attachments are used on these machines for excavating or other work.

4.8 Audible Alarms

4.8.1 All bi-directional equipment shall be equipped with a horn, distinguishable from the surrounding noise level, which shall be operated as needed when the machine is moving in either direction. The horn shall be maintained in an operative condition.

4.8.2 All bi-directional equipment that has an obstructed view to the rear to be used in reverse gear shall be equipped an operational reverse signal alarm distinguishable from the surrounding noise level.

4.9 Access Roads and Grades

4.9.1 No earthmoving and hauling equipment shall move upon any access roadway or grade unless the access roadway or grade is constructed and maintained to accommodate safely the movement of the equipment.

4.9.2 Every emergency access ramp and berm shall be constructed to restrain and control runaway equipment.

4.10 Pile Driving Equipment General Requirements

4.10.1 Boilers and piping systems which are a part of, or used with, pile driving equipment shall meet the applicable requirements of the ASME, Power Boilers (Section I).

4.10.2 All pressure vessels which are a part of, or used with, pile driving equipment shall meet the applicable requirements of the ASME, Pressure Vessels (Section VIII).

4.10.3 Overhead protection, which will not obscure the vision of the operator, shall be provided. Protection shall be the equivalent of 2-inch (50 mm) planking or other solid material of equivalent strength.

4.10.4 Stop blocks shall be provided for the leads to prevent the hammer from being raised against the head block.

4.10.5 Boom stops will be provided to prevent the leads from being pulled past “Top Dead Center” towards the operators cab.

4.10.6 Any work that would require an employee to work down line from an energy source, will fall into the lockout, tagout and try safety procedure.

4.10.7 A blocking device, capable of safely supporting the weight of the hammer, shall be provided for placement in the leads under the hammer at all times while employees are working under the hammer.

4.10.8 Guards shall be provided across the top of the head block to prevent the cable from jumping out of the sheaves.

4.10.9 When the leads must be inclined in the driving of batter piles, provisions shall be made to stabilize the leads.

4.10.10 Fixed leads shall be provided with ladder, and adequate rings, or similar attachment points, so that the loft worker (pile buck) may engage his safety lanyard to the leads. If the leads are provided with loft platforms(s), such platform(s) shall be protected by standard guardrails.

4.10.11 Air and steam hose leading to the hammer or jet pipe shall be securely attached to the hammer with an adequate length of at least 1/4-inch (9 mm) diameter chain or cable to prevent whipping in the event the joint at the hammer is broken. Safety chains, or equivalent means, shall be provided for each hose connection to prevent the line from thrashing around in case the coupling becomes disconnected.

4.10.12 Steam line controls shall consist of two shutoff valves, one of which shall be a quick-acting lever type within easy reach of the hammer operator.

4.10.13 The use of steam as a testing medium for equipment is prohibited without prior approval of the Senior Site Manager / Supervisor and the Site EHS Manager / Supervisor / Representative (or the Construction Business Line Management representative in the absence of the Site EHS Manager / Supervisor / Representative).

4.10.14 Guys, outriggers, thrust-outs, or counterbalances shall be provided as necessary to maintain stability of pile driver rigs.

4.10.15 Vibrations of pile driving rigs may cause loosening of bolts and other connections. Daily inspections at the beginning of the shift, and as necessary thereafter, shall be made to control these hazards.

4.10.16 Piles are usually delivered to the jobsite in railroad flatcars or trailer trucks. Upon arrival at the jobsite, an inspection shall be made of each load. Spacers, binders or dunnage may shift while in transit causing problems such that piles could fall, roll, or slip during unloading. Stanchions shall remain in place until all piles have been removed from the trailer or flatcar. Tag lines will provide proper control during movement of the pile by crane to the storage area. Workers shall not be allowed on top of the load if all stakes and reinforcing wire have been removed. Piling tongs shall not be permitted.

4.11 Pile Driving

4.11.1 Setting up the Pile Driving Rig

4.11.1.1 A coordinated effort is needed by each worker in setting up the pile driving rig. All equipment shall be inspected prior to assembly. The rig shall be assembled on solid ground, firmly supported by heavy timber sills or substantial cribbing. In some cases, heavy mats may be needed due to soil conditions. Steel blocks and wire rope shall be used for hoisting and pulling. All pile driving leads should be assembled separately and erected with power equipment. The crane shall be set level to enable the swing brake to hold and to maintain the boom angle consistent with the boom angle indicator. The jib shall be removed from boom for pile driving operations.

4.11.2 Operation

4.11.2.1 All employees shall be kept clear when piling is being hoisted into the leads.

4.11.2.2 Piles shall be properly placed for handling by the driving rig as close to the hoisting center as possible. Proper spacing with dunnage is necessary for the rig to safely hook onto the next desired pile. Tag lines are essential for the proper placement of the pile by the rig. Workers shall not guide the pile directly by hand until the pile is close to the driving lead.

4.11.2.3 When lifting a pile into the driving leads, all personnel not actually engaged in this operation shall be kept at least 2 pile lengths distance from the area.

4.11.2.4 Dogs on pile-driven hoist drums that automatically disengage either by relieving the load or rotating the drum shall be prohibited.

4.11.2.5 Pulling piles with hammer or pile line rigged through the head block is prohibited, unless driver and rigging are designed to safely withstand the imposed strain.

4.11.2.6 Stirrups shall be provided for worker's use on sheet piles or a mechanical device shall be used to guide the pile into place. If it is required to go aloft on sheet piling, the worker shall use a ladder or aerial lift.

4.11.2.7 There shall be head room at least twice the length of the individual sheet when interlocking sheet piling from the top of a driven sheet pile.

4.11.2.8 When piles are being driven in an excavated pit, the walls of the pit shall be sloped to the angle of repose or sheet-piled and braced. See AMS-710-02-PR-01600 Excavation and Trenching.

4.11.2.9 When steel tube piles are being "blown out", employees shall be kept well beyond the range of falling materials.

4.11.2.10 When it is necessary to cut off the tops of driven piles, pile driving operations shall be suspended except where the cutting operations are located at least twice the length of the longest pile from the driver.

4.11.2.11 When driving jacked piles, all access pits shall be provided with ladders and bulkheaded curbs to prevent material from falling into the pit.

4.11.3 Barges or floats supporting pile driving operations shall meet the applicable requirements for marine operation as outlined in 4.14 of this procedure.

4.11.3.1 All hose connections supplying power or that has material passing through them shall be secured at the connections with 1/4” diameter chain or cable to prevent whipping.

4.11.3.2 Lines supplying power to the hammer or other high pressure equipment shall be equipped with quick-acting, single action shut-off values.

4.11.3.3 Work areas shall be kept clear of obstructions such as extra hose footage, piling cutoffs or materials spoils.

4.11.3.4 A safe work area of 1 1/2 times the height of the leads shall be “Red” barricaded and maintained free of all personnel not directly involved in the pile driving operations.

4.11.4 Inspection and Maintenance

4.11.4.1 All equipment shall be maintained in accordance with established guidelines and/or the manufacture’s guidelines, which ever depicts the most stringent application for achieving optimum safety results.

4.11.4.2 Monthly inspection records shall be maintained. Crane inspection documents will be supplied before any crane operation begins.

4.11.4.3 Provisions shall be installed to allow for a general maintenance of the leads top sheaves to be accomplished from ground level.

4.11.4.4 Equipment will only be operated in a manner as it was designed to do. Alterations shall require site management approval at minimum.

4.11.4.5 Any piece of equipment that will not or does not operate in the manner designed by the manufacture shall be tagged “Defective” and taken out of service until properly repaired.

4.11.5 Pile Driving Equipment Operators

4.11.5.1 Only qualified and designated employees shall operate any piece of equipment.

4.11.5.2 Operators shall operate their assigned equipment only and shall only operate it in a safe and responsible manner.

4.11.6 Pile Driving Equipment Signaling

4.11.6.1 Equipment and winch operators shall accept signals only from the designated signal person. See AMS-710-02-PR-05900 General Crane and Derrick Safety

4.11.6.2 One person shall be the designated signal person.

4.11.6.3 When assigned to signal a piece of equipment, this employee accepts the shared responsibility for the safe operation of that piece of equipment.

4.11.7 Pile Driving Operations on, Over, or Adjacent to Water

4.11.7.1 The width of hulls for floating pile drivers shall not be less than 45% of the height of lead above the water.

4.11.7.2 Pile driver and dredge fairlead sheaves and spudline sheaves shall be guarded to prevent workers or tools from being drawn into them.

4.11.7.3 All walkways over water shall be a minimum of 20-inch wide with standard handrails along both sides on structures and gang planks.

4.11.8 Pile Extraction

4.11.8.1 Extreme stress on equipment can develop during pile extraction especially in water where the current is strong. Normal extraction is done with an extracting hammer designed for this purpose. The vibratory and sonic hammers designed for extraction have proved to be very satisfactory. For pile extraction, the following shall be executed:

4.11.8.2 If piling cannot be pulled without exceeding the load rating of equipment, a pile extractor shall be used.

4.11.8.3 When pulling piling, crane booms shall not be raised in excess of the crane manufacturer's written specifications for such operations and the crane shall not be allowed to tip. Remove jib from boom for extraction operations.

4.11.8.4 Extractor hooks shall be carefully inspected daily for signs of failure.

4.11.8.5 The screwbolt should be locked in the extractor pin with a spring clip or the vibration may loosen the bolt.

4.11.9 Personnel Protective Equipment

4.11.9.1 Guidelines shall be followed per the project Dress code which identifies the personnel protective equipment required.

4.11.9.2 Appropriate gloves shall be worn at all times.

4.11.9.3 Hearing protection areas shall be established and maintained.

4.11.9.4 Employees working where a fall exposure exist, shall be protected by Fall Protection Procedure.

4.11.10 Material Handling

4.11.10.1 The loading, unloading or moving of material shall be done in a safe manner that will not expose personnel to inherent dangers and *as* being under loads or pinch points.

4.11.10.2 All load hooks will have operable safety latches.

4.11.10.3 When possible, loads shall be lifted in a flat and controlled manner.

4.11.10.4 Piling lifted by one end shall be attached in a positive manner to prevent slippage. Examples not all inclusive would be: Place a full wrap on round material and pre-cut a hole in I-beam material to secure the shackle.

4.12 Site Clearing General Requirements

4.12.1 Employees engaged in site clearing shall be protected from hazards of irritant and toxic plants and suitably instructed in the first aid treatment available.

4.12.2 All equipment used in site clearing operations shall be equipped with rollover guards (ROPS). In addition, rider-operated equipment shall be equipped with an overhead and rear canopy guard meeting the following requirements:

4.12.2.1 The overhead covering on this canopy structure shall be of not less than 1/8-inch (3 mm) steel plate or 1/4-inch (9 mm) woven wire mesh with openings no greater than 1 inch (25 mm), or equivalent.

4.12.2.2 The opening in the rear of the canopy structure shall be covered with not less than 1/4-inch woven wire mesh with openings no greater than 1 inch (25 mm).

4.13 Industrial Trucks

4.13.1 Industrial trucks shall meet the requirements of AMS-710-02-PR-00800 Forklifts and Powered Industrial Trucks.

4.14 Marine Material Handling Operations

4.14.1 Access to Barges

4.14.1.1 Ramps for access of equipment/vehicles to or between barges shall be of adequate strength, provided with side boards, well maintained, and properly secured.

4.14.1.2 Unless employees can step safely to or from the wharf, float, barge, or river towboat, either a ramp, meeting the requirements of paragraph 4.15.1.1 of this procedure, or a safe walkway, shall be provided.

4.14.1.3 Jacob's ladders shall be of the double rung or flat tread type. They shall be well maintained and properly secured.

4.14.1.4 A Jacob's ladder shall either hang without slack from its lashings or be pulled up entirely.

4.14.1.5 When the upper end of the means of access rests on or is flush with the top of the bulwark, substantial steps properly secured and equipped with at least one substantial hand rail approximately 33 inches (838 mm) in height, shall be provided between the top of the bulwark and the deck.

4.14.1.6 Obstructions shall not be laid on or across the gangway.

4.14.1.7 The means of access shall be adequately illuminated for its full length.

4.14.1.8 Unless the structure makes it impossible, the means of access shall be so located that the load will not pass over employees.

4.14.2 Working Surfaces of Barges

4.14.2.1 Employees shall not be permitted to walk along the sides of covered lighters or barges with coamings more than 5 ft. (1.5 m) high, unless there is a 3 ft. (1 m) clear walkway, or a grab rail, or a taut handline is provided.

4.14.2.2 Decks and other working surfaces shall be maintained in a safe condition.

4.14.2.3 Employees shall not be permitted to pass fore and aft, over, or around deckloads, unless there is a safe passage.

4.14.2.4 Employees shall not be permitted to walk over deckloads from rail to coaming unless there is a safe passage. If it is necessary to stand at the outboard or inboard edge of the deckload where less than 24 inches (610 mm) of bulwark, rail, coaming, or other protection exists, all employees shall be provided with a suitable means of protection against falling from the deckload.

4.14.3 First-Aid and Lifesaving Equipment.

4.14.3.1 Provisions for rendering first aid and medical assistance shall be provided.

4.14.3.2 The employer shall ensure that there is in the vicinity of each barge in use at least one U.S. Coast Guard-approved 30-inch (762 mm) lifering with not less than 90 feet (28 m) of line attached, and at least one portable or permanent ladder which will reach the top of the apron to the surface of the water. If the above equipment is not available at the pier, the employer shall furnish it during the time that he is working the barge.

4.14.3.3 Employees walking or working on the unguarded decks of barges shall be protected with U.S. Coast Guard-approved work vests or buoyant vests.

4.15 Inspection and Maintenance

4.15.1 Frequent Inspection

4.15.1.1 All equipment shall have as a minimum a Frequent Inspection conducted by a designated person(s) upon its arrival on the project/facility and monthly intervals thereafter.

4.15.1.2 The initial and monthly frequent inspections shall be documented using the Mechanized and Marine Equipment Inspection Form AMS-710-02-FM-05701.

4.15.1.3 A designated person(s) shall inspect each piece of equipment covered by this procedure for defects. All equipment in use shall be visually checked at the beginning of each shift to assure the equipment, and accessories are in safe operating condition and free of apparent damage that could cause failure while in use.

4.15.1.4 All defects shall be corrected before the equipment is placed in service.

4.15.1.5 For rental equipment, it is recommended that

- The rental company be required to conduct the initial inspection, along with a APTIM designated person, upon initial delivery to the site and
- Conduct the monthly inspection of their equipment along with a APTIM designated person.

4.15.2 Preventive Maintenance

4.15.2.1 A preventive maintenance schedule shall be established per manufacturer's requirements.

4.15.2.2 Do not service or repair moving parts on equipment while it is running.

4.15.2.3 Bleed pressure, hot liquid, etc. before performing maintenance or repairs. Lotto (Lock Out, Tag Out, Try Out). See AMS-710-02-PR-01500 Control of Hazardous Energy.

4.15.2.4 Properly block equipment or loads before repairing or maintaining equipment.

4.15.2.5 Preventive maintenance records. See 4.17 of this procedure.

4.15.3 General Requirements for Fueling and Maintenance

4.15.3.1 Refueling and/or battery charging shall be done in well-ventilated and designated areas.

4.15.3.2 Shut down equipment before refueling. Sufficient time should be allowed for the engine to cool before refueling.

4.15.3.3 Use approved fuel hose with embedded grounding and approved connections. If not available, attach a static ground from equipment to fuel transfer equipment to avoid fuel ignition due to static discharge.

4.15.3.4 Always ensure the availability of safety shower or eyewash facilities near fueling areas. Fire protection equipment must be readily available.

4.15.3.5 Starting aids, such as jumper cables or ether, may only be used with extreme caution and according to manufacturer's instructions. Always connect the ground cable last. The ground cable should be attached to the engine at a point away from the battery.

4.15.3.6 Only trained and authorized personnel are permitted to perform equipment maintenance. This includes inflating or changing tires and "jump starting." Control of the sudden release of hazardous energy must be implemented during service or maintenance.

4.15.3.7 Equipment towing should be avoided. If it is necessary, use a rigid tow bar and consult the manufacturer's requirements.

4.16 Document Retention

4.16.1 Inspection documents shall be kept in the Project/Facility HSE Mgr. file.

4.16.2 The qualification and training records shall be kept in the Project/Facility HSE Mgr. file readily available for review.

4.16.3 Preventive maintenance records shall be completed and retained in the project/facility maintenance files.

4.17 Equipment Operator Qualification Procedure

4.17.1 The project/facility manager or his designated Competent Person shall:

- Prior to skills testing, train the operators using the manufacturer's manual for the equipment on which they are to be qualified.
- Evaluate the skills of each prospective operator to ensure that they have the physical abilities and knowledge to safely operate the equipment they are being qualified on.
- After fulfilling these requirements, complete the Mechanized and Marine Operators Qualification Form AMS-710-02-FM-05702.
- Issue each operator a AMS-710-02-FM-02803 Type C Wallet Card.

4.17.2 Operators of dump trucks, tractor/trailer trucks, buses, and any equipment that can be driven on a public roadway must also be licensed by the government/state to operate the vehicles on public roads or property.

4.17.3 Operators of mobile equipment covered in this procedure with the exception of crane operators and drivers of equipment driven on public roadways shall complete a Medical Questionnaire AMS-710-02-FM-05202 prior to being assigned work requiring the use of such equipment.

- The completed form shall be reviewed by the project/facility manager and the project/facility HSE manager.
- Occupational Health Services or a medical doctor shall resolve any concerns that might affect the ability of the prospective operator to safely operate the equipment.

5.0 REFERENCES

AMS-710-02-PR-00800	Forklifts and Powered Industrial Trucks
AMS-710-02-PR-01400	Electrical Safety
AMS-710-02-PR-01500	Control of Hazardous Energy
AMS-710-02-PR-01600	Excavation and Trenching
AMS-710-02-FM-02803	Type C Wallet Card
AMS-710-02-FM-05202	Medical Questionnaire
AMS-710-02-PR-05900	General Crane and Derrick Safety
AMS-720-01-FM-00020	Business Glossary
AMS-720-01-FM-00021	Technical Glossary
Construction Manual 300	Mobile Crane Safety

6.0 TERMINOLOGY

Term	***Definition***
ASME	American Society of Mechanical Engineers
Backhoe	A tractor mounted attachment for digging trenches and excavations.
Bulldozer	A track mounted machine with a front mounted blade designed for moving materials by pushing it from one place to another.
Coaming	A raised edge around a hatch or opening in a deck of a ship or roof to prevent water from running down below.
Designated Person	A person selected or assigned by the employer or employer's representative as being competent to perform specific duties.
Dump Trucks	A vehicle with a tilting body to facilitate unloading itself.
Frequent Inspection	Daily or monthly intervals, by a designated person.
Loft Worker	A craft employee sometime referred to as a "pile buck" that assists with the placement and alignment of piles.
Skid Steer Loader	A machine with a bucket attachment designed for loading loose materials for transport.
ROPS	Roll Over Protective Structures mounted on equipment to protect the operator.
Scraper	Vehicles designed for removing soil by simultaneously scraping, loading, and transporting excavated materials.
Site	Any location, facility or project where APTIM is performing work. Sites may include, but are not limited to, laboratories, offices, shops, owned facilities, leased facilities and/or project sites.
Excavator	A track-mounted backhoe with a revolving superstructure.
Tractor/Trailer Dump Bed	A trailer type vehicle, which has a tilting body to facilitate unloading itself and which is moved by an independent tractor or truck.

7.0 EXHIBITS

Exhibit 7.1	AMS-710-02-FM-05701 – Mechanized and Marine Equipment Inspection Form
Exhibit 7.2	AMS-710-02-FM-05702 – Mechanized and Marine Equipment Operators Qualification Form
Exhibit 7.3	AMS-720-01-FM-00020 – Business Glossary
Exhibit 7.4	AMS-720-01-FM-00021 – Technical Glossary

8.0 ATTACHMENTS

None

PROCEDURE

Procedure Title:	**Commercial Motor Vehicle Safety**	**AMS Number:**	**AMS-710-02-PR-03900**
Procedure Owner:	**HSE**	**Issuing Authority:**	**APTIM Quality Management**

COMMERCIAL MOTOR VEHICLE SAFETY

INT	Issued for Interim Use	M. Hadacek & S. Lachney	7/30/2017
Rev	**Changes**	**Approved**	**Date**

1.0 PURPOSE

This procedure covers the minimum requirements for operation and maintenance of commercial motor vehicles. This procedure establishes the minimum standards for compliance of regulated carriers within APTIM..

2.0 SCOPE

This procedure applies to all APTIM operators of Commercial Motor Vehicles (CMV). This procedure does not supersede any Federal, State, or Local laws.

3.0 RESPONSIBILITIES

The following personnel have responsibilities defined in this procedure:

- APTIM Human Resources
- APTIM Risk Management
- APTIM Managers
- APTIM Supervisors
- APTIM Employees

4.0 PROCEDURE

4.1 Sites wishing to establish one or more commercial drivers shall contact the applicable Transportation Administrator within their Operating Group for enrollment in the random drug testing pool and validation of compliance procedures.

4.2 All questions related to Drug and Alcohol testing will be referred to the Corporate HSE and the Substance Abuse Program procedure (AMS-710-01-PR-03600).

4.3 All Commercial Motor Vehicle Operators shall adhere to requirements listed in Non-Commercial Motor Vehicle Safety procedure (AMS-710-02-PR-02700).

4.4 Required Manuals (only applies to U.S.A. locations)

4.4.1 All U.S. sites operating CMVs shall maintain a current copy of the Federal Motor Carrier Safety Regulations (FMCSR) and the Hazardous Materials Regulations (HMR).

4.4.2 All U.S. regulated drivers will receive the latest version of the FMCSR pocketbook at time of hire. The driver will sign and return an acknowledgement statement showing receipt. This receipt is maintained in the Driver Qualification (DQ) file.

4.5 Training Requirements

4.5.1 Training requirements for all drivers include the following minimum courses:

4.5.1.1 Defensive Driver Training (DDT)

4.5.1.2 Entry Level Driver Training (when applicable)

4.5.1.3 Hazardous Materials Training (when applicable) at least every three years which may include:

- Cargo Tank Training
- Asbestos Training
- Materials of Trade Training
- Basic Hazmat Shipper Training (includes General Awareness, Function-Specific, Safety, Security Awareness, Emergency Response, and HazMat Incident Reporting Training)
- Compressed Gas Cylinder Training
- Written Security Plan Training

4.5.1.4 Corporate HSE Designated Training (conducted by either Operating Group, Business Line, or Corporate) required of all CMV drivers at hire and annually will include:

- Log Books/Pre and Post Trip Inspections (U.S.A. only)
- Load Securement
- Hours of Service (U.S.A. only)
- Drug and alcohol awareness
- CSA 2010 training (U.S.A. only)
- Other training directed by the Operating Group, Business Unit, or Training Department

4.5.1.5 Supervisors of regulated vehicles and drivers will also receive:

- Reasonable Suspicion Training
- Required Maintenance Awareness
- Dispatcher Training
- Required Documentation for Drivers

4.5.1.6 Drivers with less than 1 year experience will undergo Corporate HSE Designated Entry Level Driver Training.

4.5.1.7 Refresher training is required for all CMV drivers at least once per year.

4.6 Compliance

Each site shall monitor overall compliance as required by this procedure.

4.7 Auditing

One targeted in-house transportation compliance audit will be conducted on each Business Unit per year by the Fleet Safety Manager or designee.

4.8 Minimum Requirements

A person is qualified to operate a CMV if he or she is:

4.8.1 At least 21 years old;

4.8.2 Can read and speak the English language sufficiently to converse with the general public, to understand highway traffic signs and signals in the English language, to respond to official inquiries, and make entries on reports and records;

4.8.3 Can by reason of experience, training, or both, safely operate the type of motor vehicle he or she drives;

4.8.4 Is physically qualified to drive a CMV in accordance with applicable federal regulations.

4.8.5 Can by reason of experience, training, or both, determine whether the cargo to be transported has been properly located, distributed, and secured in or on the motor vehicle;

4.8.6 Is familiar with methods and procedures for securing cargo in or on the motor vehicle; and

4.8.7 Has a complete and current Driver Qualification File in the possession of the appropriate Transportation Administrator.

4.9 Financial Responsibility for Motor Carriers

CMV drivers shall meet financial responsibility requirements dictated in AMS-710-02-WI-03092 (Financial Responsibility for Motor Carriers). .

4.10 Notification and reporting of accidents

Motor Vehicle Accident notifications and reporting shall be conducted in accordance with AMS-710-02-WI-03903 (Notification and Reporting Motor Vehicle Accidents).

4.11 Qualifications of Drivers

CMV drivers shall meet the qualification requirements detailed in AMS-710-02-WI-03904 (Qualification of Commercial Motor Vehicle Drivers).

4.12 Driving of Commercial Motor Vehicles

Authorized passengers are limited to employees of APTIM and those subcontractor, client, or regulatory personnel who are integral to a task being performed.

4.13 Driving Practices

4.13.1 The operator of the vehicle will wear a seat belt and is responsible for ensuring that all passengers in the vehicle wear applicable restraints.

4.13.2 Cell phone use shall be in accordance with AMS-710-02-PR-05600 (Cellular Device Use).

4.13.3 In accordance with Federal, State, Local, and company regulations, a radar detector shall not be used in a CMV.

4.13.4 All applicable rules and regulations outlined in the Non-Commercial Motor Vehicle Safety procedure (AMS-710-02-PR-02700) will also apply.

4.13.5 Negative Transportation Reports/Roadside Inspections/CMV Driver Violations

4.13.5.1 Transportation reports that are generated as a result of a scale-side, road-side, or other inspection will be handled in a manner consistent with the negative public (Driver Check) report, as defined in AMS-710-02-PR-02700 (Non-Commercial Motor Vehicle Safety).

4.13.5.2 All roadside inspections and citations will be reported to the driver's manager and the appropriate Transportation Administrator within 72 hours of the inspection. This includes any inspection regardless if no violations were found or if said inspection included violations.

4.13.5.3 Any violation during a roadside inspection or accident will stay on the driver's CMV record for a period of 24 months. Any driver receiving points will be subject to the following:

- Can drive without restriction. Past 24 months point total 0-20 points. Verbal counselling and violation training reviewed.
- Can drive with understanding of probationary status. Past 24 months point total 21-39 points. Driver receives Written Warning and will operate under Probationary Status.
- Company driving privileges revoked for 12 months. Past 24 months point total 40 or more. Driver revocation for 12 months.
- Points incurred by a driver that is reasonably beyond their control (i.e., mismatched brake chambers) will be reviewed by a committee and if found to be reasonably beyond the driver's control, may be removed from the driver's score.

4.13.5.4 Repeat offenses within 12 months will be reviewed by committee and subject to receive written warning, placed on probationary status, and subject to disciplinary action.

4.13.5.5 A driver's manager or site manager will also be held responsible and subject to disciplinary actions for any violation or citation resulting from improper or unauthorized operations of a CMV if said driver was directed to operate the CMV by their manager without proper qualifications and / or

training. Disciplinary actions up to and including termination shall be based on severity of violation for the manager.

4.14 Inspection, Repair, and Maintenance

4.14.1 Applicability

All CMVs shall be included in a scheduled preventive maintenance program. Service intervals shall be in terms of miles or hours of operation. Service intervals and service requirements shall be, at a minimum, per the manufacturer's recommendations with manufacturer recommendations documented in the Vehicle Maintenance File with the appropriate maintenance department.

4.14.2 Manufacturer Recommended Service

Whenever manufacturer service recommendations either fail to cover company's utilization of the equipment or are unavailable, preventative maintenance shall be done in accordance with AMS-855-01-WI-00400 (Repair and Maintenance for Equipment Services Fleet).

4.14.3 Pre Trip

4.14.3.1 All drivers shall conduct a pre-trip inspection (including tow bars, aerial devices, and saddle mounts as applicable) before operating a CMV and a documented post-trip inspection at the end of each shift. No CMV shall be operated unless the following parts and accessories are in good working order:

- Service brakes (including trailer brake connections)
- Parking brake
- Steering mechanism
- Lighting devices and reflectors
- Tires
- Horn
- Windshield wiper(s)
- Rear-vision mirror(s)
- Coupling devices
- Wheels & Rims
- Emergency Equipment

4.14.3.2 The Driver's Inspection Report Form (AMS-710-02-FM-02701) shall be used. A copy is to be submitted to the Maintenance Supervisor and the original is to remain with the CMV. When repairs are complete, the mechanic is to make the appropriate entry in the Vehicle Maintenance File and sign the original Driver's Inspection Report in the CMV. The on-coming driver shall verify that repairs have been made, sign the Driver's Inspection Report and turn in the final copy. Final (original) copy shall be forwarded to the local Transportation Representative for comparison with Driver's Daily Logs and retention.

4.14.4 Drivers' Vehicle Inspection Report

All Drivers' Vehicle Inspection Report forms shall be forwarded to the local Transportation Representative or other assigned representative and remain on file for three months.

4.14.5 Annual Inspection

All CMVs shall be subject to an annual safety inspection. A copy of this inspection shall be forwarded to the Maintenance Supervisor for inclusion into the CMVs maintenance file. Note that the vehicle shall either carry a copy of the inspection or be marked with a sticker/decal displaying the information.

4.14.6 Limited Inspection

A limited safety inspection is required to be performed in accordance with scheduled preventative maintenance guidelines for the specific CMV and is to be noted in the home terminal Vehicle Maintenance File.

4.14.7 Inspectors

4.14.7.1 Inspectors shall meet the qualification requirements.

4.14.7.2 Have a combination of training or experience totalling at least 1 year

4.14.7.3 Are knowledgeable of and have mastered the methods, procedures, tools, and equipment used when performing vehicle inspections.

4.14.8 Brake Inspectors

Brake inspectors shall meet the qualification which generally includes completion of an approved training program or one year of documented experience. (Use forms provided in DOT Manual.) Any driver making brake adjustments shall also have certification of qualifications on file with the Transportation Administrator and the local shop or maintenance facility performing the maintenance.

4.14.9 Driver Inspections

Where APTIM employees perform inspections and repairs, documentation of qualifications shall be on file with the local Transportation Representative and the local shop or maintenance facility

4.14.10 Outside Vendor Repair

Where an outside vendor is used for inspection and repair, APTIM management shall verify that the vendor understands and will comply with inspector qualification requirements.

4.14.11 Maintenance File

The Maintenance/Inspection Check list (see FMCSR) shall be used to check completeness of Vehicle Maintenance Files.

4.14.12 Out of Service

The current version of the North American Uniform Out-of-Service criteria shall be followed in determining the service status of all CMVs.

4.14.13 Cargo Tankers

All cargo tanks shall have a copy of the manufacturer's data report and required recertification in the maintenance file. Qualifications for recertification vendors shall be on file with the local Transportation Representative

4.14.14 Exemption Vehicles

All exemption vehicles or trailers are required to carry a copy of the exemption on the vehicle.

4.15 Hours of Service of Drivers (only applies to U.S.A. locations)

4.15.1 Hours of Service Applicability

No motor carrier shall permit or require any driver used by it to drive a property-carrying CMV, nor shall any such driver drive a property-carrying CMV:

- More than 11 cumulative hours following 10 consecutive hours off duty; or
- For any period after the end of the 14th hour after coming on duty following 10 consecutive hours off duty, No motor carrier shall permit or require a driver of a property-carrying CMV to drive, nor shall any driver drive a

property-carrying commercial motor vehicle, regardless of the number of motor carriers using the driver's services for any period after-

- Having been on duty 60 hours in any period of 7 consecutive days if the employing motor carrier does not operate CMVs every day of the week; or
- Having been on duty 70 hours in any period of 8 consecutive days if the employing motor carrier operates commercial motor vehicles every day of the week.
- Any period of 7 consecutive days may end with the beginning of any off-duty period of 34 or more consecutive hours; or
- Any period of 8 consecutive days may end with the beginning of any off-duty period of 34 or more consecutive hours.

4.15.2 Utility Service Vehicles

As noted above, Utility Service Vehicles are exempt from the Hours-of-Service, but not any other portion of the regulation outlined by the FMCSR including but not limited to the proper maintenance of the record of duty status.

4.15.3 Log Submissions (only applies to U.S.A. locations)

All required drivers shall record their duty status on the Driver's Daily Log (see DOT Manual), including recap. Logs shall be completely filled out and submitted to home terminal management daily, or no less often than every 13 days for extended trips. Note that a driver's daily log cannot be used as a time card only.

4.15.4 Log Violations (only applies to U.S.A. locations)

Local management shall carefully review all Drivers' Daily Logs. They shall require the driver to correct any errors and take follow-up action (training or progressive discipline) where regulations or company procedures have been violated.

4.15.5 Log Auditing (only applies to U.S.A. locations)

The Driver Management Online Log Checker System or manual verification shall be used by management to review Driver's Daily Logs.

4.15.6 Log Books

All original Drivers' Daily Logs shall be forwarded to the Transportation Administrator or locally appointed representative or supervisor by the thirteenth day following completion of the log and remain there for six months. Copies shall also be retained at the local office for six months.

4.16 Load Securement

4.16.1 Drivers shall not operate a CMV unless the vehicle's cargo is properly distributed and adequately secured

4.16.2 Driver shall ensure the CMV's cargo or any other objects does not obscure the driver's view ahead or to the right or left sides.

4.17 Transportation of Hazardous Materials

4.17.1 Driving and Parking Rules

4.17.1.1 APTIM shall maintain a Certificate of Hazardous Materials Registration for elements registered to transport Hazmat so that certain hazardous materials defined in that section can be transported. APTIM's current U.S. Registration can be obtained by contacting the Corporate HSE Fleet Department. A copy of this Registration or other country equivalent that shows the Certificate number shall be kept in trucks.

4.17.1.2 APTIM shall have a written Security Plan that shall be implemented whenever the hazardous materials defined in that section are being

shipped from a jobsite. Implementation shall include training those hazmat employees to the elements of the security plan.

4.17.1.3 APTIM shall obtain a Hazardous Materials Safety Permit if any of the materials listed in that section are to be transported.

4.17.1.4 If APTIM determines that the fleet will function as a transporter of hazardous waste, APTIM shall comply with requirements for hazardous waste transporters as well as all applicable transportation regulations. These requirements will include obtaining a federal and/or state environmental agency identification number and potentially additional training for drivers.

4.17.2 Additional Driver Requirements

4.17.2.1 A driver of a commercial motor vehicle that will haul a quantity of hazardous materials that requires placarding shall obtain a hazardous materials endorsement.

4.17.2.2 A driver of a commercial motor vehicle that will haul a quantity of hazardous materials that requires placarding shall have a means of contact, such as a cellular telephone, radio, or an electronic tracking or monitoring system.

4.17.3 Pre-, En route, and Post-Shipment Vehicle Requirements

4.17.3.1 Pre-Shipment Requirements: When loading hazardous materials onto a truck, loading personnel shall strictly adhere to the separation/segregation requirements.

4.17.3.2 The driver shall complete a Daily Vehicle Inspection Report (AMS-710-02-FM-02701).

4.17.3.3 The driver shall ensure the following documents are in the truck: Emergency Response Guidebook, Certificate of Hazardous Materials Registration copy or the Registration number, a current vehicle inspection (annual), hazardous materials shipping papers if applicable, current license tags, current liability insurance certificate, Hazardous Materials Safety Permit copy or the Permit number.

4.17.3.4 En route Shipping Requirements: All movement of hazardous materials in commerce will be performed per regulatory requirements.

4.17.3.5 Post-Shipping Requirements: transporters shall keep a copy or electronic image of hazardous materials shipping papers for 375 days.

4.17.4 Carriage by public highway

4.17.4.1 All loads of hazardous materials or hazardous wastes shall be accompanied by shipping papers or hazardous waste manifest, respectively. All documents shall be retained for at least 3 years by site. Shipping documents using any generic descriptions shall also contain the technical name of the hazardous substance in parentheses following the basic description.

4.17.4.2 Shipping documents shall be within the drivers reach and readily visible. When the driver is out of the cab, they shall be in the driver's door pocket or on the driver's seat.

4.17.4.3 All hazardous materials/waste loads shall be marked, labeled, and placarded.

4.17.4.4 All hazardous materials/waste loads shall be reported and segregated.

4.17.4.5 In the event of a spill of reportable quantity, the jurisdictional chemical response hotline should be contacted. In the United States, CHEMTREC should be notified.

4.18 Drug and Alcohol Policy

Employees shall adhere to the requirements detailed in AMS-710-01-PR-03600 (Substance Abuse Program).

4.19 Transportation of Explosives

Transportation of explosives shall be conducted in accordance with AMS-710-02-PR-03900 and AMS-710-02-WI-07012 (Transportation of Explosives).

5.0 REFERENCES

AMS-710-01-PR-03600	Substance Abuse Program
AMS-710-02-PR-02700	Non-Commercial Motor Vehicle Safety
AMS-855-01-WI-00500	Commercial Motor Vehicle (CMV) Driver Vehicle Inspection Reports (DVIR)
AMS-710-02-PR-05600	Cellular Device Use
AMS-710-02-WI-07012 (Transportation of Explosives).	Transportation of Explosives
AMS-710-02-WI-03902	Financial Responsibility for Motor Carriers
AMS-710-02-WI-03903	Notification and Reporting Motor Vehicle Accidents
AMS-710-02-WI-03904	Qualification of Commercial Motor Vehicle Drivers
AMS-855-01-WI-00400	Repair and Maintenance for Equipment Services Fleet

6.0 TERMINOLOGY

Term	**Definition**
Commercial Motor Vehicle (CMV) Requiring CDL Drivers	In accordance with Federal Motor Carrier Safety Regulations (FMCSR) 383.91, there are three vehicle groups which require a fully qualified, documented DOT driver holding a Commercial Driver's License. These classes are as follows: Group A, Group B and Group C.
Company	APTIM and its majority owned entities, subsidiaries, and affiliates.
DOT	United States Department of Transportation
Transportation Administrator	The Transportation Administrator for Capital Services is located in Findley, OH. The Transportation Administrator for other DOT sites is the Fleet Safety Manager in The Woodlands, TX.
FMCSA	Federal Motor Carrier Safety Administration
FMCSR	Federal Motor Carrier Safety Regulations
MCS-150	Document to register and file with the DOT/FMSCA for operations that will perform Interstate/Intrastate commerce in the U.S.A.
Commercial Motor Vehicles NOT Requiring CDL Drivers	"Commercial Motor Vehicle means any self-propelled or towed vehicle used on public highways in interstate commerce to transport passengers or property when...the vehicle has a gross weight rating or gross combination weight rating of 10,001 or more pounds."

7.0 EXHIBITS

Exhibit 7.1	AMS-720-01-FM-00020 – Business Glossary
Exhibit 7.2	AMS-720-01-FM-00021 – Technical Glossary

8.0 ATTACHMENTS

None

PROCEDURE

Procedure Number:

AMS-710-02-PR-01610

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HSE

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UTILITY CONTACT PREVENTION

Rev	Changes	Approved	Date
0	Initial Issue	M, Karr	9/3/2019

Parent Document: N/A

UTILITY CONTACT PREVENTION

1.0 PURPOSE

The purpose of this document is to provide the minimum requirements to ensure that all utilities are properly identified, to prevent personal injury, property damage and/or causing negative impact to the surrounding community and environment.

The following deliverables are defined within this procedure:

Deliverable	Producer	Customer
Authorization to Drill Permit Form (AMS-710-02-FM-01611)	Competent Person – Utility Contact Prevention	Project Manager HSE Employees External Client
Utility Mark-Out Documentation Form (AMS-710-02-FM-01612)	Competent Person – Utility Contact Prevention	Project Manager HSE Employees External Client
Intrusive Activities Checklist (AMS-710-02-CK-01613)	Competent Person – Utility Contact Prevention	Project Manager HSE Employees External Client

2.0 SCOPE

This procedure applies to all APTIM sites planning above ground or intrusive activities, where the utility locations and clearances are not positively identified.

Work conducted around overhead power lines with mobile equipment is addressed in AMS-710-02-PR-06600, Equipment Operation Around Overhead Power Lines.

This procedure authorizes implementation of local, or client required procedures, when those procedures are more protective. Applicable local and/or client specific procedures shall be documented in the project-specific Health and Safety Plan (HASP), Work Plan, or Accident Prevention Plan.

2.1 Exceptions

Exceptions must be approved per the requirements of AMS-710-05-PR-01300, HSE Request for Variances.

3.0 RESPONSIBILITIES

The following personnel have responsibilities defined in this procedure:

- APTIM Managers
- APTIM Project Managers

- APTIM Utility Contact Prevention – Competent Person
- APTIM Supervisors
- APTIM Employees
- APTIM Contractors
- APTIM Subcontractors

3.1 APTIM Managers

APTIM Managers are to ensure their Project Managers are adhering to these expectations.

3.2 APTIM Project Managers

Project Managers have to designate their Competent Persons and ensure they're implementing these expectations.

3.3 APTIM Utility Contact Prevention – Competent Person

See detailed responsibilities in section 4.1.1.

3.4 APTIM Supervisors, Employees, Contractors and Subcontractors

Supervisors, employees, contractors and subcontractors are required to not proceed or act outside of the expectation.

4.0 PROCEDURE

4.1 Underground Utility Contact Avoidance during Intrusive Activities

4.1.1 Preliminary Requirements

4.1.1.1 The Project Manager - Designates a Competent Person – Utility Contact Prevention (UCP), to manage the aspects of work associated with the intrusive activities, supervise the employees who have the potential to contact any utilities, and fulfill the requirements of this procedure.

4.1.1.2 The Competent Person - UCP is responsible for the following:

- Determining location-specific regulations and client requirements for the notification, identification, locating, marking, contact prevention, and protection of utilities.
- Ensuring boundaries of intrusive activities have been clearly marked, prior to contacting utility locating services.
- Ensuring National One-call center and/or other utility locating services have been contacted, and formal notification of the pending intrusive activities has been completed.

- Ensuring that utility owners are contacted to mark the location of their facilities in the area of the intrusive activities. They shall obtain and document the utility mark-out confirmation number or ticket number provided by the One Call Center. Generally, this notification for a mark-out request must be made from at least two (2) business days (48 hours) to three (3) business days (72 hours) before beginning intrusive activities.
- Ensuring private utility locating services have been contacted and have completed mark-outs, in areas not covered by a One-call center.
- Ascertaining the requirements for maintaining the open ticket with the One Call Center (or local equivalent), client, and/or property owner after the initial formal notification and taking action required to maintain the open ticket, until intrusive activities are completed.
- Ensure time requirements for allowing utility owners to mark locations are met, and authorizing intrusive activities, after satisfaction that all utilities have been located and marked.
- Ensuring all above ground utilities are marked, flagged, or otherwise protected, in areas where equipment could come into contact with them.
- Photograph all utility markings.
- Ensure markings are protected and preserved as feasible.

4.1.1.3 Due to the sensitivity and costs associated with damage to fiber optic cables, the Competent Person - UCP must ensure and document verbal contact and an agreement with the fiber optic cable owner, for all work within 50 feet of fiber optic cables. Additional protective measures for intrusive activities near fiber optic cables shall be specified in site specific HASP, Site Safety Plan, etc.

4.1.1.4 The Competent Person - UCP must verify that the necessary emergency procedures to be taken if underground utilities become damaged are provided in the HASP, work plan, Job Safety Analysis, or Activity Hazard Analysis. These emergency procedures must be conveyed to employees as specified in Section 4.2.3, Field Crew Training (below).

4.1.2 General Requirements

4.1.2.1 A designated Competent Person - UCP shall be onsite at all times when intrusive activities are conducted.

4.1.2.2 Overhead utility locations must be marked where heavy equipment or other equipment has the potential for contacting overhead or adjacent utilities. Where required by law, advanced notification to the utility company may be required for any work where potential exists for incidental contact with utility lines. Daily site inspections are required to determine where activities will take place and to ensure all adjacent above ground utilities are identified, marked, and/or protected, to prevent contact. Provide updated information to employees in daily tailgate meetings.

4.1.2.3 Maintain a minimum of 10 feet from overhead power lines, up to 50 kV. Adjust distances based on voltages over 50 kV by adding 0.4 inches per kV to the minimum 10 foot clearance. 20 feet of separation from lines, is required if voltage is unknown. Spotters are required to ensure safe clearance is maintained.

4.1.2.4 Prior to conducting any intrusive activities, the Competent Person - UCP must verify the Intrusive Activities Checklist (AMS-710-02-CK-01613) and the Utility Mark-out Documentation form (AMS-710-02-FM-01612) have been completed. No intrusive activities work is to be performed until all utility mark-outs are verified and until the facility owner-members have all provided the appropriate positive response.

4.1.2.5 Location specific procedures may not always be conveyed to contractors. The property owner, client, and/or facility operator must be consulted on the issue of underground utilities. All knowledge of past and present utilities must be evaluated prior to conducting work.

4.1.2.6 Only hand digging is permitted within 3 feet of underground high voltage lines, product lines, gas lines, or fiber optic cables. Once the line or cable is exposed, heavy equipment can be used but must remain at least 3 feet from the exposed line or cable.

4.1.2.7 If possible, shoveling/digging should be conducted parallel to the expected utility run.

4.1.3 Operating Requirements Specific to Excavation Activities

4.1.3.1 Refer to Section 5.0, Terminology to determine the applicable activities considered to be included as excavation.

4.1.3.2 The requirements of AMS-710-02-PR-01600, Excavation and Trenching must be followed.

4.1.3.3 After all mark outs have been completed, and the excavation locations have been accepted by the Competent Person - UCP prior to mechanical excavation, each utility identified inside the excavation location must be hand dug or vacuum excavated to a verify the utility location. The utility locations must be exposed in enough locations to verify its path of travel. If possible, the excavation location should be moved away from any utilities.

4.1.3.4 All utilities exposed during an excavation will be protected from accidental damage.

4.1.3.5 Utilities which are found to change elevation (shallower or deeper) or direction of run (curve) require UCP approval prior to soil removal/excavation operations.

4.1.3.6 When excavating close to a utility, outside the required 3 foot radius, the excavator should have a spotter to assist and guide the excavation equipment operator.

4.1.3.7 While the excavation is open, underground installations shall be protected, supported, or removed as necessary to safeguard employees.

4.1.3.8 The utility owner should be contacted for guidance on protecting the utility from damage when backfilling excavations. When excavation is complete, as practical, 6 inches of soil may be placed over the utility to shield/protect during backfilling operations

4.1.3.9 Areas of refusal (tree roots, large rocks, concrete structures) which prevent either digging to depth or exposing utilities require UCP approval prior to beginning soil removal operations.

4.1.4 Operating Requirements Specific to Drilling Activities

4.1.4.1 Refer to Section 5.0, Terminology to determine the applicable activities considered to be drilling activities.

4.1.4.2 Follow all requirements in Section 4.1.1. & 4.1.2

4.1.4.3 After all mark outs have been completed, prior to drilling, each individual location must be hand dug or vacuum excavated to a minimum of 5 feet below ground surface (bgs).

4.1.4.4 Should the local geology be prone to refusal or should there be any other reason the drilling location cannot be cleared to a minimum of 5 feet bgs by hand digging or vacuum extraction, then the appropriate geophysical techniques should be utilized to verify the drilling location is clear of utilities to 5 feet bgs.

4.1.4.5 At any drilling location that cannot be cleared by hand digging or vacuum extraction, then an Authorization to Drill Permit (AMS-710-02-FM-01611) must be approved by the Director of Operations (or designee, which may be delegated to the business line manager for each area) in addition to the project/program manager/director. The SBU HSE lead may be consulted, but signature is not required.

4.1.5 Operating Requirements for Boring & Trenching Activities at Retail Fuel Dispensing Stations

4.1.5.1 Work in and around known retail fuel systems (lines and tanks) may be best performed by a licensed, APTIM approved tank subcontractor.

4.1.5.2 Gauge tank pit observation wells prior to beginning drilling activities.

4.1.5.3 Locate emergency shut off system prior to drilling activities.

4.1.5.4 Look for any visual indications that product lines or utilities have been installed in boring location (cracked concrete, sagging concrete, patched concrete, trench cuts, etc.)

4.1.5.5 Establish “No Drill Zones” if possible. No Drill Zones are areas around UST’s, gas dispensers, lines or the canopy of retail fuel dispensing stations.

4.1.5.6 Boring and trenching activities at retail fuel dispensing systems should be moved to a pea gravel free area of the site when possible.

4.1.5.7 If relocation is not possible, an air knife or vacuum extraction approach will be used for pre-clearance of underground utilities.

4.1.5.8 If pea gravel is encountered, stop work and either move the bore hole location or install with vacuum extraction techniques to a depth of 5 feet, if possible.

4.1.5.9 Standard pre-clearance tools (i.e. hand augurs, post hole diggers, spud bars, etc.) are prohibited when working in and around pea-gravel due to the possibility of damage to fiberglass tanks and lines from tool strikes.

4.1.6 Operating Requirements Specific to Sheet Piling Activities

4.1.6.1 Follow Section 4.1.4, Operating Requirements Specific to Drilling Activities.

4.1.6.2 After all mark outs have been completed, prior to installation of piling, each utility identified inside the sheet piling location must be hand dug or vacuum excavated to a verify the utility location. Additional planning may be necessary to change the location of the sheet piling location or the location of the utilities.

4.2 Training Requirements

4.2.1 Competent Person – Utility Contact Prevention

The Competent Person UCP must have successfully completed APTIM's internal Underground and Overhead Utility Contact Prevention training. It is the Project Manager's responsibility to verify that the Competent Person –UCP has completed training prior to overseeing activities.

4.2.2 Competent Person - Excavation Training

The Competent Person - Excavation shall have documented training or documented experience in excavation activities.

4.2.3 Field Crew Training

4.2.3.1 Prior to assignment of work, the Competent Person - UCP will provide the above and underground utilities information obtained to affected field crew personnel via the job safety analysis (JSA). Information will include:

- The utilities identified in work areas that may be affected by operations.
- The location and depth of the utilities associated with the affected essential services
- Any conditions on the proposed intrusive activities work and clearance requirements.

4.2.3.2 Prior to assignment of work, the Competent Person - UCP will also provide the following information to affected field crew personnel:

- The requirements of this procedure.

- The required work practices and controls to prevent contacting utilities.
- The emergency procedures necessary if utilities are damaged.
- The roles and responsibilities of each worker within the work crew.

4.3 Incident Reporting Requirements

4.3.1 Employees are required to immediately report to their direct supervisor any utility contact incident or near miss incident.

4.3.2 All incidents involving utility contact shall be reported by the Competent Person – UCP and site supervisor as required by AMS-710-05-PR-02200, Incident Reporting.

4.3.3 Any damage caused or discovered to natural gas, liquid petroleum, or any hazardous liquid utilities, underground utilities must be immediately reported by the Competent Person – UCP, to emergency services, to the facility owner, and utility owner.

4.3.4 All other utilities contact, and damages are to be reported to the facility operator and the One Call Center (or local equivalent) by the Competent Person - UCP.

4.3.5 The Competent Person - UCP shall verify that all other local reporting requirements are met, e.g., reporting underground pipeline damages involving excavation in Texas to the Railroad Commission of Texas.

5.0 TERMINOLOGY

Key terms within the context of the procedure. Terminology is to be listed in a table as shown below:

Term	Definition
As-Built Drawings	As-built drawings are blueprints that are usually obtained from the facility owner or client. They show original buried utilities and any modifications that have been made.
Company	APTIM
Competent Person – Utility Contact Prevention	Assigned by the Project Manager: An APTIM employee who is capable of identifying existing and predictable hazards presented by utilities located at an APTIM site that may be, hazardous, or dangerous to employees, could result in property damage, or negatively impact the community or environment. The Competent Person Utility Contact Prevention has successfully completed APTIM's in-house 'Underground/Overhead Utility Contact Prevention' training course, possesses an appropriate educational background, field experience, and has the authority to correct deficiencies or take prompt corrective measures to eliminate them. The required identification and documentation procedure for competent persons is specified in AMS-710-02-PR-04200, Competent/Qualified Person Procedure.

UTILITY CONTACT PREVENTION

Drilling Activities	Any mechanical or manual penetration of the earth's surface using drilling, boring, auguring, or similar type of equipment. For the purposes of this procedure, drilling activities include the use of direct-push equipment and driving equipment such as hammers, impact hammers, vibratory drivers, or similar types of equipment.
Driving Activities	Any mechanical or manual penetration of the earth's surface using driving equipment. Driving activities include the installation of piles, sheet piles, poles, stakes, and fence posts.
Excavation	Any operation in which earth, rock, or other material in or on the ground is moved, removed, or otherwise displaced by means of any tools, power equipment or explosives, and includes, without limitation, grading, trenching, digging, ditching, drilling, augering, boring, tunneling, scraping, cable or pipe plowing, piling, and driving. Any manmade cut, cavity, trench, or depression in an earth surface formed by earth removal.
Excavation Activities	Any mechanical or manual penetration of the earth's surface using heavy equipment such as excavators, backhoes, dozers, etc. Excavation activities also include manual use of hand shovels, pick-axes, etc. The use of 3-foot or larger diameter augers is also considered excavation activity.
Fiber Optic Cables	Optical communication cables that are buried underground.
Intrusive Activities	Any mechanical or manual penetration of the earth's surface, including drilling activities, driving activities, and/or excavation activities using drilling equipment, driving equipment, or excavating equipment.
No Drill Zones	No Drill Zones are areas located on retail petroleum sites where drilling is not permitted due to the presence of Underground Storage Tanks's (UST's), gas dispensers, lines or the canopy of retail fuel dispensing stations.
One Call Center	811-One Call, Dig Safe, Miss Dig, etc. dial-in telephone number for requesting the location and mark-out of buried utilities, such as gas lines, electrical lines, telephone/cable lines, sewer lines, and water lines
Private Utility Locating Service	A private utility locating service is a firm established to locate underground utilities using specialized locating equipment, such as ground penetrating radar location devices or radio transmitter type utility locating equipment.
Site	Any location, facility or project where APTIM is performing work. Sites may include, but are not limited to, laboratories, offices, shops, owned facilities, leased facilities, and/or project sites.
Site Survey	Inspection of the site to look for signs of buried utilities that may not be indicated through as-built drawings or through utility locating services. The survey typically involves inspection of overhead electrical services, basements, utility rooms, garages,

	etc., for signs of old electrical conduits or fuel/water/septic lines.
Utility	Any active or inactive above ground or subsurface structure that is or was designed to service a public or private facility. These may include, but are not limited, to the following: • Electric power lines • Propane lines • Natural gas lines • Telephone lines • Telephone cables • Fiber optic lines • Fiber optic cables • Water lines • Steam and pneumatic lines • Sewer/sewage lines • Drain lines • Underground storage tanks • Septic tanks • Process or product lines • Reclaimed water lines
Vacuum Excavator	Equipment that excavates underground utilities with a combination of alternating water-and-air or air-and air pulsations (e.g., air knife, water knife, etc.)

6.0 REFERENCES

Forms/checklists and other supporting policies, work processes, and procedures, included in the body of the procedure.

6.1 Required Forms/Checklists

Forms and checklists that are required for use by the procedure should be listed in Section 6.1.

AMS-710-02-FM-01611	Authorization to Drill Permit Form
AMS-710-02-FM-01612	Utility Mark-Out Documentation Form
AMS-710-02-CK-01613	Intrusive Activities Checklist

6.2 Other Internal References

AMS-710-02-PR-04200	Competent/Qualified Person Procedure
AMS-710-02-PR-06600	Working Around Overhead Power Lines with Mobile Equipment
AMS-710-02-PR-01600	Excavation and Trenching
AMS-710-05-PR-01300	HSE Request for Variances

AMS-710-05-PR-02200	Incident Reporting

6.3 Other External References

None

7.0 ATTACHMENTS

Attachment	Attachment Title
None	

PROCEDURE

Procedure Title:	**Control of Hazardous Energy**	**AMS Number:**	**AMS-710-02-PR-01500**
Procedure Owner:	**HSE**	**Issuing Authority:**	**APTIM Quality Management**

CONTROL OF HAZARDOUS ENERGY

INT	Issued for Interim Use	M. Hadacek & S. Lachney	7/30/2017
Rev	**Changes**	**Approved**	**Date**

1.0 PURPOSE

The purpose of this Procedure is to establish the minimum requirements for Control of Hazardous Energy on APTIM sites.

The following deliverables are defined within this procedure:

- Written site specific control of hazardous energy sources (lock-out/tag-out) plan
- Annual inspections of control of hazardous energy procedures and controls
- Control of Hazardous Energy training for affected and authorized employees

2.0 SCOPE

This procedure is to be utilized when creating a site specific plan for control of hazardous energy, inspections of procedures and controls, and training of authorized employees.

3.0 RESPONSIBILITIES

The following personnel have responsibilities defined in this procedure:

- APTIM Managers
- APTIM Supervisors
- APTIM Employees
- APTIM Electrical Superintendent
- APTIM Contractors
- APTIM Subcontractors
- APTIM Visitors

4.0 PROCEDURE

Upon commencement of site activities, the Site Manager and Site HSE Manager shall develop a written plan for the control of hazardous energy sources (Lock-out/Tag-out) to prevent the possibility of incidents to employees when performing work activities on or around hazardous energy sources. The plan shall be maintained in the site electronic data management system. This procedure applies to all equipment, vehicles, processes or systems that are powered by Electrical, Mechanical, Hydrostatic, or Pneumatic energy. When APTIM shares a site with client personnel, the APTIM Plan shall compliment the Client program. If APTIM is required to work to the client program, the plan must address the program interfaces and verify the minimum requirements set forth in this Procedure shall be met. Employees shall not be allowed to work on energized systems or equipment without written authorization from the Site Manager and consultation of the HSE Manager.

4.1 General

4.1.1 This Procedure specifies methods of controlling hazardous energy sources during construction and maintenance activities involving work on electrical services, facilities, shop equipment, engine-driven equipment, pressurized pipelines, and systems used as service lines for construction. This Procedure also covers activities to be used during start-up phases.

4.1.2 APTIM employees, contractors, subcontractors, and visitors shall adhere to requirements listed in this procedure.

4.1.3 If an energy isolating device is not capable of being locked out, the Tag-out procedure will be used.

4.1.4 If an energy isolation device is capable of being locked out, then the Lock-out procedures shall be used.

4.1.5 Whenever replacement or major repair, renovation or modification of a machine or equipment is performed, and whenever new machines or equipment are installed,

energy isolating devices for such a machine shall be designed to accept a lock-out device.

4.1.6 Affected workers, where Lock-out/Tag-out and/or Blinding/Blanking are performed, shall be made aware of systems that are being worked on in their areas.

4.2 Energy Control Procedures

4.2.1 Procedures shall be developed, documented and utilized for the control of potentially hazardous energy when employees are engaged in activities where Lock-out is required.

4.2.2 The procedures shall clearly outline the scope, purpose, authorization, rules, and techniques to be utilized for the control of hazardous energy, and the means to enforce compliance including but not limited to the following:

- A specific statement of the intended purpose of the procedure.
- Specific procedural steps for the shutting down, isolating, blocking and securing machines or equipment to control hazardous energy.
- Specific procedural steps for the placement, removal and transfer of lockout and tagout devices and the responsibility for them and;
- Specific requirements for testing a machine or equipment to determine and verify the effectiveness of lockout/tagout devices and other energy control measures.

4.3 Protective Materials and Hardware

4.3.1 A standard “DANGER - DO NOT OPERATE” tag (AMS-710-05-FM-01503) and individually keyed locks shall be used by each site.

4.3.2 Tags used shall be dated, signed, a description of the work being performed shown on the tag, and securely attached to the equipment/lock.

4.3.3 Tags shall not be reused, but destroyed immediately upon removal. No alterations to a tag are permitted.

4.3.4 No device shall be operated with a tag or lock attached regardless of circumstances.

4.3.5 No person shall remove another person’s tag or lock unless it is deemed an emergency situation and the requirements of 4.9 are adhered to.

4.3.6 It is the discipline Supervisor’s responsibility to ensure that no work is performed beyond the protection of blinds, blanks, locks, and tags.

4.3.7 Tags required beyond one shift shall be replaced by the oncoming shift. In no case will locks and tags be permitted to remain for more than 30 days without another inspection and redating with signatures.

4.3.8 Each authorized worker performing work on a system is required to affix a lock and tag on the system even though the equipment or system is already locked out. In these situations, a multiple locking device shall be used.

4.3.9 Lockout devices and tagout devices shall be singularly identifiable; shall be only devices used for controlling energy; shall not be used for other purposes; and shall meet the following requirements:

4.3.9.1 Lockout and tagout devices shall be capable of withstanding the environment to which they are exposed for the maximum amount of time the exposure is expected.

4.3.9.2 Tagout devices shall be constructed and printed so that exposure to weather conditions or wet and damp locations will not cause the tag to deteriorate or the message on the tag to become illegible.

4.3.9.3 Lockout and tagout devices shall be standardized within the facility in at least one of the following criteria: color, shape, or size; and additionally, in the case of tagout devices, print and format shall be standardized.

4.3.10 Lockout and tagout devices shall be substantial enough to prevent removal without the use of excessive force or unusual techniques, such as with the use of bolt cutters.

4.3.11 Tagout devices, including their means of attachment, shall be substantial enough to prevent inadvertent or accidental removal. Tagout device attachment means shall be

- non-reusable.
- attachable by hand.
- self-locking.
- non-releasable with a minimum unlocking strength of 50 lbs.

4.3.12 At least equivalent to a one-piece, all-environment nylon cable tie. Lockout devices and tagout devices shall indicate the identity of the employee applying the device.

4.4 Types of Systems Requiring Lock-out/Tag-out and/or Blinding/Blanking

4.4.1 Examples of types of energy sources requiring lock-out/tag-out and/or blinding/blanking are as follows:

4.4.1.1 Electrical systems prior to being connected to a power source and energized will be locked out until they are released for service. Any time repairs or modifications are made to electrical systems, either temporary or permanent, they shall be locked out. Locks/Tags shall be applied to the main disconnect whenever possible.

4.4.1.2 Lines, valves, and similar systems that are being tested pneumatically with gases shall be tagged and/or locked out in accordance with 4.3, to prevent accidental discharge of the pressure within the line. In addition, areas affected by the pneumatic test shall be barricaded against entry and the Site HSE Manager notified before commencement of the test. For safe test distance requirements for personnel see 4.8.2.

4.4.1.3 Sources of energy such as pipelines, valves, and pumps shall be locked, blanked off, and otherwise secured to prevent charging, energizing, or creating any type of hazard to persons working on systems or inside a confined space.

4.4.2 Electrical Operated Systems

4.4.2.1 Whenever work on electrical equipment or services are scheduled, the power source (disconnects, circuit breakers, switches) controlling electrical equipment or systems shall be de-energized.

4.4.2.2 The Electrical Superintendent or their designee shall assure that any power panel(s), distribution panel(s), or equipment controller(s) have been de-energized. Control circuit devices, such as push buttons, selector switches, and interlocks, may not be used as the sole means of de-energizing circuits or equipment.

4.4.2.3 Stored electrical energy which might endanger personnel shall be released. Capacitors shall be discharged and high capacitance elements shall be short-circuited and grounded, if the stored electrical energy might endanger personnel.

4.4.2.4 Completed Danger – Do Not Operate Tag(s) and locks shall be attached to the controlling device by:

- The person responsible for de-energizing the system, and
- The craft supervisor responsible for this operation.

4.4.2.5 Each authorized worker required to work on the de-energized equipment or systems shall ascertain that the craft supervisor's and/or their foreman's completed Danger Tag and lock is attached to the controlling device or devices and place their lock and tag on the device before they begin work.

4.4.2.6 The de-energized equipment or system shall be tested using a voltmeter on the downstream side of the tagged-out controlling device. If the equipment is wired directly to a power panel box and is energized by turning on a push button or butterfly switch on the equipment, the power panel box on the downstream side shall be tested using a voltmeter.

4.4.2.7 The Electrical Superintendent or their designee will establish and maintain a lockout log. (See AMS-710-02-FM-01501).

4.4.2.8 The lockout log shall list craft workers or personnel applying a lock and tag on any power panel, distribution panel, or equipment-controlling device.

4.4.2.9 Each employee shall detail in the lockout log the time of day the lock was applied, the necessity for the lockout, the area or machine where the work is being performed and the approximate length of time that the power panel, distribution panel, or equipment controller will be de-energized.

4.4.2.10 When the work is completed, the employees shall report this information to the Electrical Superintendent before removing their lock. The employees shall log the time the work was completed in the lockout log and the time the lock was removed.

4.4.2.11 The last lock on the lockout device shall not be removed until the Electrical Superintendent inspects the power panel, distribution panel, or the equipment controller that was de-energized.

4.4.2.12 Faceplates, doors, and covers shall be installed and in place before the panels are re-energized.

4.4.2.13 The Electrical Superintendent shall notify craft workers in the area that the power panel, distribution panel, or controller is about to be re-energized. The Electrical Superintendent or his designee may then remove that last lock.

4.4.2.14 The Electrical Superintendent or their designee shall check the re-energized power panel, distribution panel or equipment controller for proper operation.

4.4.2.15 The date and time of day when these panels or equipment controllers were restored to service shall be entered in the lockout log.

4.4.2.16 To lock out electrically powered shop equipment to ensure maximum employee safety, a power disconnect switch shall be installed between the main power supply panel and each piece of electrically driven equipment which is directly connected to the power panel box. (This does not apply to equipment, which is equipped with a plug connection, including welding equipment.) This disconnect switch shall be located close to the equipment and properly identified. Pushbuttons or butterfly controls of equipment shall not be locked out. A short circuit can occur between a locked out pushbutton and relay causing the equipment to be energized with full power. Since some equipment is wired with dual controls and locking out one pushbutton does not render that equipment inoperable, after tag and lockout try start buttons to be certain disconnect is complete.

4.4.3 Construction Equipment or Facilities

4.4.3.1 The Electrical Superintendent, or their designee, shall open the switch, pull fuses and place his lock and tag on the equipment and then shall try the system.

4.4.3.2 Other employees shall place their locks and tags on the lockout device.

4.4.3.3 Employees shall complete lockout log information.

4.4.3.4 Upon completion of the work the employees shall remove their locks and tags. The Electrical Superintendent shall be that last person to remove their locks.

4.4.4 Operating Facilities and Equipment

4.4.4.1 Operating unit electrician shall de-energize the system or equipment and demonstrate accuracy to the Electrical Superintendent or their designee.

4.4.4.2 Electrical Superintendent or their designee shall ascertain that the system is de-energized and place their lock and tag on the lockout device.

4.4.4.3 Other employees working on the system shall place their locks and tags on the device and complete the lockout log.

4.4.4.4 Upon completion of the work, the Electrical Superintendent or their designee is the last construction personnel to remove their lock and tag in the presence of the Operating Unit Electrician.

4.4.4.5 The Operating Unit Electrician then assumes control of the system.

4.4.5 Mechanical Work

4.4.5.1 Whenever work is scheduled on mechanical equipment or pressurized systems, controlling devices such as circuit breakers, switches, valve handles, and other operating mechanisms shall be locked and tagged out to prevent their manipulation or operation.

4.4.5.2 Affected workers required to work on mechanical equipment or pressurized systems shall determine that the craft supervisor's and their foreman's completed Lock/Danger Tag is attached to the controlling device or devices before they begin work.

4.4.5.3 Where controlling devices permit, a lock shall be placed on the device by each employee to ensure that the controlling device is not inadvertently energized.

4.4.5.4 De-energized equipment or systems shall be checked or tested to verify that the equipment is inoperable or that the pressurized system has been drained of its contents on the downstream side. To prevent harmful exposures, pressurized systems shall then be flushed out with water if liquids are involved or with inert gas if compressed gases are involved.

4.4.5.5 Appropriate air tests shall be conducted whenever pressurized systems have previously contained hazardous gases or liquids, especially if welding and burning operations are involved when the system has been shut down. When isolating a pressurized system, slip-blind or blanks are required.

4.4.5.6 All work that may involve pressurized vessels, pipes, or systems shall be done in accordance with 4.3.

4.5 Isolation of Structures and Pipelines

4.5.1 Safety Rule

4.5.1.1 All structures and pipelines, on which hot work is to be performed, shall be physically isolated from sources of contamination, be clean, and gas free.

The only exception to this rule is USA municipal potable water tanks and hot taps approved by Corporate HSE.

- Flange class designation is not the design pressure of the flange.
- Sample for lower flammable limit (LFL) and oxygen on all municipal potable water tanks before entry or any hot or cold work.

4.5.1.2 The isolation, emptying, cleaning, and gas freeing are to be performed by the customer unless special arrangements have been agreed upon beforehand with Business Unit/Operating Group HSE Director. Blanks can be sized for the design pressure of the pipeline when known or the flange class when the design pressure is unknown. All blinds shall be per the current edition of ASME B16.5 or B16.47, matching the mating flange Class (150, 300) and diameter.

4.5.2 Isolation Method

4.5.2.1 The preferred methods of isolation for structures and pipelines are illustrated in AMS-710-02-FM-05302 Isolation of Structures and Pipelines New/Repair Work/Maintenance, Figure 1.0. These methods use a “free air space” between the source of contamination and the structure or pipeline. These methods are applicable for new construction, repairs and maintenance work, but if the pipeline contains an expansion joint, Engineering-Assigned shall approve the method of isolation before the disconnect is made.

4.5.2.2 The isolation methods in AMS-710-02-FM-05302 Figure 2 shall only be used when the methods in Figure 1.0 are not physically possible. To use Figure 2 isolation methods requires:

- Authorization by the local Operation or Construction Manager after site inspection to assure this method of isolation is necessary.

4.5.2.3 Prior to installation of the isolation blank, the blank is examined by a qualified APTIM employee for correctness; identified (steel stencil) such that after installation, it can be confirmed to be installed at the correct location.

- A qualified APTIM employee confirms the blank is installed at the correct location with gaskets on either side and a tag is attached.

4.5.3 Isolation Exception

4.5.3.1 Exceptions to isolation illustrated in AMS-710-02-FM-05302 Figure 1.0 and Figure 2.0 can only be approved by Corporate Risk Analysis. Exceptions will only be considered after a written safety plan is submitted to Corporate HSE.

4.5.3.2 The safety plan must provide adequate HSE Supervision to control potential hazards. A minimum of one full time HSE Supervisor is required. Additional supervisors may be required to insure complete control of safety on large turn arounds, special projects or process facilities. This HSE supervision shall be furnished by APTIM.

4.5.4 Remote Blank/Blind With Vapor Barrier

4.5.4.1 When it is impractical to isolate at the structures, it is permissible through the Isolation Exception 4.5.3 to install an appropriately sized blank/blind at a remote location (i.e., battery limit). A vapor barrier is required at the structure so no product residue or liquid from low-areas in the piping can enter the structure. The vapor barrier can be 3/16 to 1/4 inch (4.76 to 6.35 mm) thick, skillet blind with a 1 inch wide X 6 inches long (25 to 152 mm)

handle. The skillet blind shall have a ¼ inch (6.35 mm) hole in the handle to attach a tag.

4.5.5 Company Policy on cleaning and gas-freeing vessels

4.5.5.1 APTIM personnel are not to assume responsibility for the cleaning and gas-freeing of any structure or pipeline. Exceptions to this rule shall be approved by Corporate HSE.

4.5.6 Blank Thickness

4.5.6.1 Carbon steel blank thickness can be determined based on pipeline design pressure when available, or flange class as follows:

- DESIGN PRESSURE KNOWN – Using Table 1.0, Exhibit 7.1, follow the pipe size vertically down to a pressure equal to or greater than the required design pressure, then horizontally across to the left to determine the required blank thickness i.e., 320 psi design pressure, 18" pipe - blank thickness required is 1-1/8 inches (minimum allowable temperature is 15° F - See Table 3.0, Exhibit 7.1
- FLANGE CLASS KNOWN – Using Table 1.0, Exhibit 7.1, flange class is stamped on the flange i.e., Class 600 flange, 18 inch pipe - blank thickness required is 2-3/8 inches (minimum allowable temperature is 40° F - See Table 3.0, Exhibit 7.1.

4.5.6.2 Test pressure maximum 1-1/2 times design pressure of pipeline

4.5.6.3 Blank thickness/pressure calculated per ASME B31.3 paragraph 304.5.3

4.5.6.4 Allowances, such as corrosion, assumed to be zero

4.5.6.5 Gasket required on both sides of installed blank

4.5.6.6 Sizes larger than 24 inches based on ASME B16.47 Series A

- Maximum temperature A283-C is 200° F
- Maximum temperature A36 is 700° F
- Minimum temperature - See Table 3.0, Exhibit 7.1

4.5.6.7 Stainless steel blank thickness can be determined based on pipeline design pressure when available or flange class as follows:

- DESIGN PRESSURE KNOWN - Using Table 2.0, Exhibit 7.1, follow the pipe size vertically down to a pressure equal to or greater than the required design pressure, then horizontally across to the left to determine the required blank thickness. i.e., 540 psi design pressure, 10 inch pipe - blank thickness required is 7/8 inches
- FLANGE CLASS KNOWN - Using Table 2.0, Exhibit 7.1, flange class is stamped on the flange i.e., Class 600 flange, 10 inch pipe - blank thickness required is 1-1/4 inches

4.5.6.8 Test pressure maximum 1-1/2 times design pressure of pipeline

4.5.6.9 Blank thickness/pressure calculated per ASME B31.3 paragraph 304.5.3

4.5.6.10 Allowances, such as corrosion, assumed to be zero

4.5.6.11 Temperature range is -325° F to 300 F for solution heat treated material

4.5.6.12 Gasket required on both sides of installed blank

4.6 Unauthorized Use of a Danger – Do Not Operate Tag

4.6.1 The standard Danger – Do Not Operate Tag shall be used only for the purpose of identifying a de-energized piece of equipment or system. It is not to be used as a substitute for a defective tag or a Caution Tag.

4.6.2 A Caution Tag is to be used to inform personnel of special precautions or instructions for safe and proper operation of equipment.

4.6.3 Do not use a Caution Tag to warn against operating a system or piece of equipment. Only a Danger – Do Not Operate Tag (AMS-710-02-FM-01503) may be used to prevent the operation of a system or piece of equipment.

4.7 Unauthorized Actions

4.7.1 The unauthorized removal of a Danger Tag from the controlling device of de-energized systems or pieces of equipment shall be grounds for immediate termination of the employee(s) involved.

4.7.2 The unauthorized operation of a controlling device of a de-energized system or piece of equipment that has been tagged out with a Danger Tag shall be grounds for immediate termination of the employee(s) involved.

4.7.3 The unauthorized removal of a blind or blank from a de-energized system or piece of equipment shall be grounds for immediate termination of the employee(s) involved.

4.8 Testing

4.8.1 Functional Testing

4.8.1.1 When the performance of a work activity requires the functional testing of a machine, component, or system, the locks and tags may be temporarily removed in accordance with this procedure, to perform the test. As a result of the testing, if it is determined that the equipment needs further work, the locks and tags shall be positioned back on to the device. If it is not necessary to replace all the locks and tags, then the unnecessary locks and tags shall be returned to the Lockout/Tagout Coordinator. The Site HSE Manager shall initial the Lockout/Tagout Request in the removal block to indicate that these locks and tags have been removed.

- Make sure all danger areas are clear of personnel.
- Verify that the main disconnect switch or circuit breaker cannot be moved to the on position.
- Use a voltmeter or other equipment to check the switch on electrical devices.
- Press all start buttons and other activating controls on the equipment itself.
- Shut off all machine controls when the testing is finished.

4.8.1.2 When multi-worker or multi-craft situations exist, a multi-lockout tag is to be used. These devices allow for multiple locks for protection of all craft involved. Each lock shall be properly tagged.

4.8.2 Safe Test Distances for Personal

4.8.2.1 The following AMS Procedures shall be reviewed for establishing safe personal test distances:

- Hydro-Pneumatic Testing of Field Erected Pressure Vessels - AMS–830-05-PR-46002
- Hydrostatic Testing of Field Erected Pressure Vessels – AMS-830-05-PR-46003
- Pneumatic Testing of Field Erected Pressure Vessels – AMS–830-05-PR-46004
- Safe Working Distance for Hearing Protection during Hydrotest of Piping – AMS–830-06-FM-40003
- Safe Working Distance for Hearing Protection During Pneumatic Testing of Piping – AMS–830-06-FM-40004

4.9 Emergency Removal of Employee's Lockout Lock

4.9.1 Lockout/tagout device removal

4.9.1.1 Each lockout/tagout device shall be removed from each energy-isolating device by the employee who applied the device. When the employee who applied the lockout/tagout device is not available to remove it, the device may be removed only after the following steps have been completed.

- The craft supervisor and general foreman/foreman shall verify that the employee who applied the lockout/tagout device is not at the facility or available to return.
- The craft supervisor and general foreman/foreman shall make a reasonable effort to contact the employee to inform him or her that the lockout/tag-out device shall be removed. The employee shall return to the site, to remove the lock if possible.
- The craft supervisor and the general foreman/foreman shall "walk-down" the entire system to verify it is safe to start the system.
- The craft supervisor and general foreman/foreman shall complete an "Emergency Lockout Device Removal" form (AMS-710-02-FM-01502) and present it to the site superintendent and the Site HSE Manager for approval to remove the lock.

Note: If the Site Superintendent or the Site HSE Manager is absent, the Site Manager assumes their signature authority. If the Site Manager is also absent then the designees that have received signature authority by designation may sign the "Emergency Lock-out Device Removal" form only after contacting the person they are receiving this signature authority from and that person has granted verbal permission to do so.

- The craft supervisor and/or general foreman/foreman shall ensure that the employee whose lock was removed has been notified prior to returning to work on the system.

4.10 Training

4.10.1 Personnel shall receive Lock-Out/Tag-Out Training as required by the OSHA Standard for Control of Hazardous Energy Sources.

4.10.2 Authorized employees shall also be trained to recognize hazardous energy sources, the type and magnitude of the energy available in the workplace, and the methods and means necessary for energy isolation and control.

4.10.3 Each affected employee shall be instructed in the purpose and use of the energy control procedure. workers shall receive Lock-Out/Tag-Out Training to include the following minimum requirements:

4.10.3.1 Retraining of all affected employees shall be conducted and documented when there is a change in:

- Assignments
- Machines
- Equipment
- Processes
- When lock out/tag out inspections reveal a need, or supervision sees a need
- New hazards or changes in the energy control procedure

4.10.4 When tagout systems are used, employees shall also be trained in the following limitations of tags:

4.10.4.1 Tags are essentially warning devices affixed to energy isolating devices, and do not provide the physical restraint on those devices that is provided by a lock.

4.10.4.2 When a tag is attached to an energy isolating means, it is not to be removed without authorization of the authorized person responsible for it, and it is never to be bypassed, ignored, or otherwise defeated.

4.10.4.3 Tags must be legible and understandable by all authorized employees, affected employees, and all other employees whose work operations are or may be in the area, in order to be effective.

4.10.4.4 Tags and their means of attachment must be made of materials which will withstand the environmental conditions encountered in the workplace.

4.10.4.5 Tags may evoke a false sense of security, and their meaning needs to be understood as part of the overall energy control program.

4.10.4.6 Tags must be securely attached to energy isolating devices so that they cannot be inadvertently or accidentally detached during use.

4.10.5 Sites shall maintain a list of the names and job titles of all employees who are authorized to lock out/tag out the specified machine, system or equipment.

4.10.6 A written record shall be maintained of all employees who have been trained in the company or site's lock out/tag out program.

4.11 Periodic Inspections

4.11.1 Periodic inspections of the energy control procedures shall be conducted at least annually.

4.11.1.1 The periodic inspection shall be performed by an authorized employee other than the one utilizing the energy control procedure.

4.11.1.2 The periodic inspection shall be conducted to correct deviations or inadequacies identified.

4.11.1.3 Where lockout is used for energy control, the periodic inspection shall include a review between each authorized and affected employee, of that employee's responsibilities under the energy control procedure.

4.11.1.4 The site shall certify that periodic inspections have been performed. The certification shall identify the machine or equipment on which the energy control procedure was being utilized, the date of the inspection, and the person performing the inspection.

5.0 `REFERENCES

29 CFR 1910.147	Control of Hazardous Energy
ASME B16.5	Pipe Flanges and Flanged Fittings
ASME B16.47	Series A Flanges

6.0 TERMINOLOGY

Term	***Definition***
Affected employee	An employee whose job requires him/her to operate or use a machine or equipment on which servicing or maintenance is being performed under lockout or tagout, or who's job requires him/her

	to work in an area which such servicing or maintenance is being performed.
Authorized employee	A person who locks out tags out machines, systems or equipment in order to perform servicing or maintenance on that machine, system or equipment. An affected employee becomes and authorized employee when the employees' duties include performing servicing.
Blanking or Blinding	The absolute closure of a pipe, line or duct by the fastening of a solid plate (such as a spectacle blind or skillet blind) that completely covers the bore, that is capable of withstanding the maximum pressure of the pip, line or duct with no leakage beyond the plate.
Capable of being locked out	An energy isolating device is capable of being locked out if it has a hasp or other means of attachment to which, or through which, a lock can be affixed, or it has a locking mechanism built into it. Other energy isolating devices are capable of being locked out, if lockout can be achieved without the need to dismantle, rebuild, or replace the energy isolating device or permanently alter its energy control capability.
Caution Tag	This tag is used to inform personnel of special precautions or instructions about safe and proper operation of equipment. This tag is not to be used to prevent the machines, systems, or equipment from being operated.
Danger – Do Not Operate Tag	This tag is attached to warn others that the machines, systems, and/or equipment has been isolated from its power source (de-energized) and that employees are working on the machines, systems, or equipment.
Double Valve and Vent	A valve arrangement in a piping system in which three valves are arranged in conjunction with a vent line. One valve is upstream of the vent, another downstream, on one is on the vent itself. To isolate the downstream system, the vent valve is opened, the other two are closed and all three valves are locked into position.
Energy Sources	Any source of energy, i.e., electrical, spring, gravity, hydraulic, pneumatic, and chemical.
Qualified Person	A person who by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated his/her ability to solve or resolve problems related to the subject matter, the work, or the project.
Site	Any location, facility or project where APTIM is performing work. Sites may include, but are not limited to, laboratories, offices, shops, owned facilities, leased facilities and/or project sites.

7.0 EXHIBITS

Exhibit 7.1	Tables
Exhibit 7.2	AMS-710-02-FM-01501 – Lock Out Log
Exhibit 7.3	AMS-710-02-FM-01502 – Emergency Lock Out Device Removal
Exhibit 7.4	AMS-710-02-FM-01503 – Do Not Operate Tag
Exhibit 7.5	AMS-710-02-FM-05302 – Isolation of Structures and Pipelines

	New/Repair Work/Maintenance
Exhibit 7.6	AMS-720-01-FM-00020 – Business Glossary
Exhibit 7.7	AMS-720-01-FM-00021 – Technical Glossary

8.0 ATTACHMENT

None

TABLE 1.0
CARBON STEEL BLANKS
(16.1 ksi stress - ASTM A283-C/A36)

		PIPE SIZE															
		1	1 1/2	2	3	4	6	8	10	12	14	16	18	20	24	30	36
		DESIGN PRESSURE (psi)															
THICKNESS (in)	1/4	3120	1480	950	440	270	120	70	50	30	30	20	20	10	10	10	0
	3/8	7010	3320	2140	990	600	280	160	100	70	60	50	40	30	20	10	10
	1/2	12460	5910	3810	1750	1060	490	290	190	130	110	80	70	50	40	20	20
	5/8		9230	5950	2740	1660	760	450	290	210	170	130	100	80	60	40	30
	3/4			8560	3940	2390	1100	650	420	300	250	190	150	120	80	50	40
	7/8				5370	3250	1500	880	570	400	340	260	200	160	110	70	50
	1				7010	4240	1960	1150	740	530	440	340	270	210	150	100	70
	1 1/8				8870	5370	2480	1460	940	670	550	420	340	270	190	120	80
	1 1/4					6630	3060	1800	1160	830	680	520	410	340	230	150	100
	1 3/8					8020	3700	2180	1400	1000	830	630	500	410	280	180	130
	1 1/2					9540	4400	2600	1670	1190	990	750	600	480	340	210	150
	1 3/4						5990	3530	2280	1620	1340	1030	810	660	460	290	200
	2						7830	4620	2970	2110	1750	1340	1060	860	600	380	270
		BLANK THICKNESS (in)															
Class 150		1/4	1/4	1/4	1/4	3/8	3/8	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 1/2	1 3/4	2 1/8
Class 300		1/4	1/4	1/4	3/8	1/2	5/8	7/8	1	1 1/4	1 3/8	1 1/2	1 3/4	1 7/8	2 1/4	2 7/8	3 3/8
Class 600		1/4	1/4	3/8	1/2	5/8	7/8	1 1/4	1 1/2	1 5/8	1 7/8	2 1/8	2 3/8	2 3/4	3 1/4	4	5

TABLE 2.0
STAINLESS STEEL BLANKS
(20 ksi stress - ASTM A240 type 304/316)

		PIPE SIZE															
		1	1 1/2	2	3	4	6	8	10	12	14	16	18	20	24	30	36
		DESIGN PRESSURE (psi)															
THICKNESS (in)	1/4	3870	1830	1180	540	330	150	90	60	40	30	30	20	20	10	10	0
	3/8	8710	4130	2660	1220	740	340	200	130	90	80	60	50	40	30	20	10
	1/2	15480	7340	4730	2180	1320	610	360	230	160	140	100	80	70	50	30	20
	5/8		11470	7390	3400	2060	950	560	360	260	210	160	130	100	70	50	30
	3/4			10640	4900	2960	1370	810	520	370	310	230	190	150	100	70	50
	7/8				6670	4030	1860	1100	710	500	420	320	250	200	140	90	60
	1				8710	5270	2430	1430	920	660	540	420	330	270	190	120	80
	1 1/8				11020	6670	3080	1810	1170	830	690	530	420	340	230	150	100
	1 1/4					8230	3800	2240	1440	1030	850	650	510	420	290	190	130
	1 3/8					9960	4590	2710	1750	1240	1030	790	620	500	350	220	160
	1 1/2					11850	5470	3230	2080	1480	1220	940	740	600	420	270	190
	1 3/4						7440	4390	2830	2010	1670	1280	1010	820	570	360	250
	2						9720	5740	3690	2620	2180	1670	1320	1070	740	470	330
		BLANK THICKNESS (in)															
Class 150		1/4	1/4	1/4	1/4	1/4	3/8	1/2	5/8	3/4	3/4	7/8	1	1 1/8	1 1/4	1 5/8	1 7/8
Class 300		1/4	1/4	1/4	3/8	3/8	5/8	3/4	7/8	1 1/8	1 1/4	1 3/8	1 1/2	1 3/4	2	2 1/2	3
Class 600		1/4	1/4	3/8	1/2	5/8	7/8	1	1 1/4	1 1/2	1 3/4	1 7/8	2 1/8	2 3/8	2 7/8	3 1/2	4 1/4

TABLE 3.0
MINIMUM TEMPERATURE FOR BLANKS W/O IMPACT TESTING
(A283-C/A36)

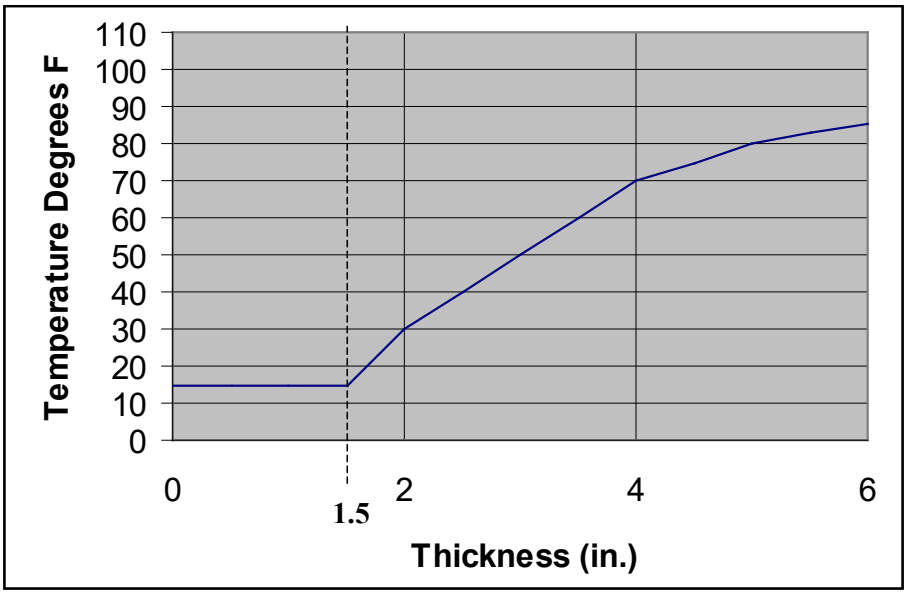


TABLE 4.0
BLANK AND GASKET DIAMETERS

Pipe Size	Class 150			Class 300			Class 600		
	Blank	Gasket		Blank	Gasket		Blank	Gasket	
	O.D.	O.D.	I.D.	O.D.	O.D.	I.D.	O.D.	O.D.	I.D.
1	2 1/2	2 5/8	1.0625	2 3/4	2 7/8	1.0625	2 3/4	2 7/8	1.0625
1 1/2	3 1/4	3 3/8	1.91	3 5/8	3 3/4	1.91	3 5/8	3 3/4	1.91
2	4	4 1/8	2 3/8	4 1/4	4 3/8	2 3/8	4 1/4	4 3/8	2 3/8
3	5 1/4	5 3/8	3 1/2	5 3/4	5 7/8	3 1/2	5 3/4	5 7/8	3 1/2
4	3/4	6 7/8	4 1/2	7	7 1/8	4 1/2	7 1/2	7 5/8	4 1/2
6	8 5/8	8 3/4	6 5/8	9 3/4	9 7/8	6 5/8	10 3/8	10 1/2	6 5/8
8	10 7/8	11	8 5/8	12	12 1/8	8 5/8	12 1/2	12 5/8	8 5/8
10	13 1/4	13 3/8	10 3/4	14 1/8	14 1/4	10 3/4	15 3/8	15 3/4	10 3/4
12	16	16 1/8	12 3/4	16 1/2	16 5/8	12 3/4	17 7/8	18	12 3/4
14	17 3/8	17 3/4	14	18 3/4	19 1/8	14	19 1/4	19 3/8	14
16	19 7/8	20 1/4	16	20 7/8	21 1/4	16	22 1/8	22 1/4	16
18	21 1/4	21 5/8	18	23 1/8	23 1/2	18	24	24 1/8	18
20	23 1/2	23 7/8	20	25 3/8	25 3/4	20	26 3/4	26 7/8	20
24	27 7/8	28 1/4	24	30 1/8	30 1/2	24	31	31 1/8	24
30	34 1/4	34 3/4	30	37	37 1/2	30	37 3/4	38 1/4	30
36	40 3/4	41 1/4	36	43 1/2	44	36	44	44 1/2	36

Procedure Title:	**Bloodborne Pathogens**	**AMS Number:**	**AMS-710-01-PR-00300**
Procedure Owner:	**HSE**	**Issuing Authority:**	**VP HSE**

BLOODBORNE PATHOGENS

0	Added 4.3.4.5 “Hand-washing Facilities”	M. Hetzler	2/1/2018
INT	Issued for Interim Use	M. Hadacek & S. Lachney	7/30/2017
Rev	**Changes**	**Approved**	**Date**

1.0 PURPOSE

The purpose of this Procedure is to establish the minimum requirements for the control of Bloodborne Pathogens on APTIM sites.

2.0 SCOPE

This procedure applies to all APTIM employees, contractors, subcontractors and visitors associated with APTIM site.

3.0 RESPONSIBILITIES

The following personnel have responsibilities defined in this procedure:

- APTIM Managers
- APTIM Supervisors
- APTIM Employees
- APTIM Contractors
- APTIM Subcontractors
- APTIM Visitors

4.0 PROCEDURE

APTIM sites shall use this procedure as the minimum requirements for their site specific Bloodborne Pathogens Standard.

4.1 Program Development

The Bloodborne Pathogens Program Coordinator/Site HSE Manager shall ensure that the exposure determination is conducted during the mobilization stages of the project and that the Exposure Control Plan (ECP) is completed.

4.2 Exposure Determination

4.2.1 Exposure Determination includes:

4.2.1.1 Exhibit 7.1 - List I - list of job classifications in which all employees have occupational exposure.

4.2.1.2 Exhibit 7.2 - List II - list of job classifications in which some employees have occupational exposure.

4.2.1.3 Exhibit 7.3 - List III - list all tasks and Practices in which occupational exposure occurs and that are performed by employees in job classifications included in the lists above.

4.3 Exposure Control Plan

4.3.1 The Site HSE Manager completes the APTIM ECP.

4.3.2 The ECP is a template which includes the information as listed in 4.3.4, 4.3.5, 4.3.6, and 4.4. This Plan provides the overall requirements for compliance with this Practice, and instructs each project to include site specific information for disposal of contaminated waste, care of Personal Protection Equipment (PPE), laundering materials, personal hygiene, decontamination etc.

4.3.3 The Site HSE Manager implements the elements of the APTIM ECP and uses the template to develop the specific procedures and practices.

4.3.4 The ECP shall address the following Methods of Compliance at a minimum:

4.3.4.1 Engineering and Work Practice Controls

4.3.4.2 Universal Precautions

4.3.4.3 Personal Protective Equipment (PPE)

4.3.4.4 Housekeeping:

- Decontamination
- Handling of Regulated Waste
- Laundry

4.3.4.5 Hand-washing Facilities - If provision of handwashing facilities are not feasible, then an appropriate antiseptic hand cleanser in conjunction with cloth/paper towels or antiseptic towelettes must be provided.

4.3.5 The ECP shall address the following Medical Management at a minimum:

4.3.5.1 Hepatitis B Vaccination

4.3.5.2 Post-Exposure Evaluation and Follow-up

4.3.6 The ECP shall address the following training elements at a minimum:

4.3.6.1 Bloodborne Pathogen Training for employees included in the plan

4.3.6.2 Awareness training for all employees

4.3.6.3 Employees covered under this plan due to reasonably anticipated exposure shall be provided training that includes at least:

- A copy of APTIM's reference standard and any additional country or regional specific standards.
- A general explanation of epidemiology and symptoms of bloodborne diseases
- An explanation of modes of transmission
- An explanation of the ECP
- Appropriate methods of identifying tasks that may involve exposure
- An explanation of use and limitations of methods to prevent or reduce exposure
- PPE information
- Selection basis for PPE
- Hepatitis B vaccination information
- Actions and notification in emergency situation
- Practices to follow in event of exposure
- Post-exposure evaluation and follow-up
- Signs and labels or color-coding system
- Opportunity for interactive questions and answers

4.3.6.4 Training shall be done at the time of initial assignment and at least annually thereafter, within one year of their previous training.

4.3.6.5 Employees who are not expected to contact blood or Other Potentially Infectious Materials (OPIM) shall be informed of the existence of the ECP and the responsible individuals on site.

4.3.7 The ECP shall address the communication of hazards to employees, recordkeeping and the procedure for the evaluation of circumstances surrounding exposure incidents.

4.3.8 The ECP shall be accessible to employees so they can have the opportunity to examine and copy the plan.

4.3.9 The ECP shall be reviewed and updated at least annually and whenever necessary to reflect new or modified task and procedures which affect occupational exposure and to reflect new or revised employee positions with occupational exposure. The revisions to the ECP will also reflect changes in technology that eliminate or reduce exposure to bloodborne pathogens.

4.3.10 The Site HSE Manager will solicit input from non-managerial employees responsible for direct patient care who are potentially exposed to injuries from contaminated sharps in the identification, evaluation, and selection of effective engineering and work practice controls and shall document the solicitation in the ECP, as applicable.

4.4 Medical Management

4.4.1 Hepatitis B Vaccination Series

4.4.1.1 All employees who, due to the nature of their assignment are at risk of occupational exposure (those are the employees included in List I and List II above) shall be offered the Hepatitis B vaccination series. The offer shall be made following training and within 10 days of initial assignment. The employee need not accept the offer of the vaccination; however, the declining employee must complete the Declination Form included in the AMS-710-01-FM-00301 Bloodborne Pathogens Plan Template prior to performing any assigned duties.

4.4.1.2 If an employee initially declines HBV vaccination but at a later date, while still covered under the program decides to accept the HBV vaccine, APTIM will provide the vaccine at that time. Should a booster dose be recommended at a future date, such booster dose(s) shall be provided.

4.4.2 Post-Exposure Evaluation and Follow-Up

4.4.2.1 Following an exposure incident, APTIM will make available to each potentially exposed employee, a confidential medical evaluation and follow-up. This follow-up will include documentation of the route(s) of exposure and the circumstances under which the exposure incident occurred, identification and documentation of the source individual (unless the identification cannot be established or it is prohibited by a local law), appropriate testing, prophylaxis for Hepatitis B virus, illness reporting, evaluation of reported illnesses, and counselling following a report of an occupational exposure incident to blood or other potentially infectious materials.

4.4.2.2 Employees covered in the ECP (those included in List I and List ii) who are exposed to blood or other potentially infectious materials shall be offered the post exposure evaluation and follow-up within 24 hours of the exposure.

4.4.2.3 If an employee, who was not included in the program, has an occupational exposure through a “Good Samaritan” act, the employee will be offered the post-exposure evaluation and follow-up in addition to the Hepatitis B vaccination at no charge and at a reasonable time and place (within 24 hours of the exposure).

4.4.2.4 The site HSE Manager shall ensure that the healthcare professional evaluating an employee after an exposure incident is provided the following information:

- A copy of any applicable regulation;
- A description of the exposed employee’s duties as they relate to the exposure incident;
- Documentation of the route(s) of exposure and circumstances under which exposure occurred;
- Results of the source individual’s blood testing, if available; and
- All medical records relevant to the appropriate treatment of the employee including vaccination status.

4.5 Regulated Waste Handling and Disposal

4.5.1 Each site shall make arrangements for the proper disposal of medical wastes (i.e., bandages, gauze, sharps, etc.) in accordance with AMS-710-04-PR-04123.

4.6 Record Retention

4.6.1 The following records shall be maintained in the site HSE files for the duration of the employee's employment plus thirty (30) years.

4.6.1.1 Medical Records. The medical records shall include:

- Name and social security number, as applicable, of the employee;
- A copy of the employee's hepatitis B vaccination status including dates of all the hepatitis B vaccinations and any medical records relative to the employee's ability to receive vaccination;
- A copy of all results of examinations, medical testing, and follow up procedures;
- Healthcare written opinion; and
- A copy of the information provided to the healthcare professional.

4.6.1.2 Training. Training records shall include the following:

- Dates of training sessions;
- Contents or a summary of the training sessions;
- Names and qualifications of persons conducting the training; and
- Names and job titles of all persons attending the training session.

4.6.1.3 Sharps Injury Log. The Sharp Injury Log shall contain:

- Type and brand of device involved in the incident;
- Department or work area where the exposure incident occurred; and
- Explanation of how the incident occurred.
- Data will be entered into APTIM's HSE Data Management System for use as the Sharps Injury Log.

5.0 REFERENCES

AMS-720-01-FM-00020	Business Glossary
AMS-720-01-FM-00021	Technical Glossary
AMS-710-04-PR-04123	Medical Waste Management

6.0 TERMINOLOGY

Bloodborne Pathogens	Pathogenic microorganisms that are present in human blood and can cause disease in humans. These pathogens include, but are not limited to, hepatitis B virus (HBV) and human immunodeficiency virus (HIV).
Engineering Controls	Controls (e.g., sharps disposal containers, self-sheathing needles, safer medical devices, such as sharps with engineered sharps injury protections and needleless systems) that isolate or remove the bloodborne pathogens hazard from the workplace.
Other Potentially Infectious Materials (OPIM)	(1) The following human body fluids: semen, vaginal secretions, cerebrospinal fluid, synovial fluid, pleural fluid, pericardial fluid, peritoneal fluid, amniotic fluid, saliva in dental procedures, any body fluid that is visibly contaminated with blood, and all body fluids in situations where it is difficult or impossible to differentiate between body fluids;

	(2) Any unfixed tissue or organ (other than intact skin) from a human (living or dead); and (3) HIV-containing cell or tissue cultures, organ cultures, and HIV- or HBV-containing culture medium or other solutions; and blood, organs, or other tissues from experimental animals infected with HIV or HBV
Regulated Wastes	Liquid or semi-liquid blood or other potentially infectious materials; contaminated items that would release blood or other potentially infectious materials in a liquid or semi-liquid state if compressed; items that are caked with dried blood or other potentially infectious materials and are capable of releasing these materials during handling; contaminated sharps; and pathological and microbiological wastes containing blood or other potentially infectious materials.
Site	Any location, facility or project where APTIM is performing work. Sites may include, but are not limited to, laboratories, offices, shops, owned facilities, leased facilities and/or project sites.
Universal Precautions	An approach to infection control. According to the concept of Universal Precautions, all human blood and certain human body fluids are treated as if known to be infectious for HIV, HBV, and other bloodborne pathogens.
Work Practice Controls	Controls that reduce the likelihood of exposure by altering the manner in which a task is performed (e.g., prohibiting recapping of needles by a two-handed technique).

7.0 EXHIBITS

Exhibit 7.1	List I – Job Classifications with Regular Exposure
Exhibit 7.2	List II – Job Classifications with Some Exposure
Exhibit 7.3	List III – Tasks and Practices With Exposure
Exhibit 7.4	Bloodborne Pathogens Plan Template – AMS-710-01-FM-00301

8.0 ATTACHMENTS

None

9.0 EXHIBIT 7.1 – LIST I JOB CLASSIFICATIONS WITH REGULAR EXPOSURE PAGE 1 0F 1

JOB CLASSIFICATION	REGULAR EXPOSURE	SOME EXPOSURE	NO EXPOSURE
Staff Physician	X		
Registered Nurse	X		
Licensed Practical Nurse	X		
Emergency Medical Technician	X		

AMS Number:	Revision:	Approval Date:
AMS-710-01-PR-00300	0	2/1/2018

EXHIBIT 7.2 – LIST II JOB CLASSIFICATIONS WITH SOME EXPOSURE PAGE 1 OF 1

JOB CLASSIFICATION	REGULAR EXPOSURE	SOME EXPOSURE	NO EXPOSURE
First Aid/CPR Certified Personnel		X	
Safety Representative		X	
Security Representative		X	
Custodian		X	
Non-Designated EMT and First Aid/CPR Certified Personnel (Good Samaritans)			X
All Other APTIM Personnel (Good Samaritans)			X

EXHIBIT 7.3 - LIST III TASKS AND PRACTICES WITH EXPOSURE **PAGE 1 OF 1**

TASKS AND PROCEDURES
Bleeding Control With Spurting Blood
Bleeding Control With Minimal Bleeding
Emergency Childbirth
Blood Drawing (Phlebotomy, Needle sticks, Etc.)
Starting An Intravenous (IV) Line
Endotracheal Intubation, Esophageal Obturator Use
Oral/Nasal Suctioning, Manually Cleaning Airway
Handling And Cleaning Instruments With Microbial Contamination
Giving Injections
Rendering First Aid
Rendering Cardiopulmonary Resuscitation (CPR)
Decontamination Following Accidents/Injuries
Vehicle/Equipment Accidents Where There Is Presence Of Blood
Rescue Of Bleeding Employee
Medical Procedures With Blood (Suturing And Suture Removal)
Handling Of Regulated Waste Containers
Laboratory Blood Processing
Wound Care
Epistaxis (Nosebleed) Control
Handling Of Contaminated Waste
Handling Of Contaminated Personal Protective Clothing & Equipment
Handling Of Contaminated Laundry And Personal Clothing
Housekeeping/Custodial Duties Where There Is Presence Of Blood

10.0 ATTACHMENTS

None

PROCEDURE

Procedure Title:	**Stop Work Authority**	**AMS Number:**	**AMS-710-05-PR-00400**
Procedure Owner:	**HSE**	**Issuing Authority:**	**VP HSE**

STOP WORK AUTHORITY

1	Added sections 4.5.3.7 and 4.5.3.8 to give more clarity on existing requirements.	M. Hetzler	5/31/2018
0	Updated to incorporate the APTIM branded STOP WORK Authority Card	M. Hetzler	2/9/2018
INT	Issued for Interim Use	M. Hadacek & S. Lachney	7/30/2017
Rev	**Changes**	**Approved**	**Date**

1.0 PURPOSE

The purpose of this procedure is to outline the requirement of all employees to stop an unsafe act or condition in the workplace.

2.0 SCOPE

This procedure applies to all APTIM employees, contractors, subcontractors, vendors, and site visitors associated with an APTIM site.

3.0 RESPONSIBILITIES

The following personnel have responsibilities defined in this procedure.

- APTIM Managers
- APTIM Supervisors
- APTIM Employees
- APTIM Contractors
- APTIM Subcontractors
- APTIM Vendors
- APTIM Site Visitors

4.0 PROCEDURE

4.1 As an APTIM representative, employees have the responsibility and the authority, without fear of reprimand or retaliation, to immediately stop any work activity that presents a danger to themselves, co-workers, clients, the public, or the environment.

4.2 It is each employee's responsibility to get involved by questioning and rectifying any situation that is an at-risk behavior or condition. If the employee does not feel the issue is addressed adequately, the employee has the responsibility to raise it to a higher level.

4.3 No work will resume until all stop work issues and concerns have been adequately addressed.

4.4 Any form of retribution or intimidation directed at any individual or company for exercising their authority as outlined in this program will not be tolerated.

4.5 Follow the three steps identified on the Stop Work Authority (SWA) Card (Attachment 8.1)

4.5.1 Recognize the hazard that could bring harm to you, fellow employees or the environment.

When a person identifies a perceived unsafe condition, act, error, omission, or lack of understanding that could result in an undesirable event, a "stop work intervention shall be immediately initiated with the person(s) potentially at risk.

4.5.2 Stop the task before an incident happens. This may be the most difficult part, but it is a responsibility and an expectation. Remember, every employee has the authority to do so.

4.5.2.1 If the supervisor is readily available and the affected person(s) are not in immediate risk, the "stop work action" should be coordinated through the supervisor.

4.5.2.2 If the supervisor is not readily available or the affected person(s) are in immediate risk, the "stop work" intervention should be initiated directly with those at risk.

4.5.2.3 "Stop work" interventions should be initiated in a positive manner by briefly introducing yourself and clarifying the intent and set expectations of the Stop Work events.

4.5.2.4 Notify all affected personnel and supervision of the stop work issue. If necessary, stop associated work activities, remove person(s) from the area, stabilize the situation and make the area as safe as possible.

4.5.3 Discuss the hazardous condition or behavior and share the information with others to help avoid similar situations. Develop a plan to eliminate or mitigate the hazard.

4.5.3.1 All parties shall discuss and gain agreement on the stop work issue.

4.5.3.2 If determined and agreed that the task or operation is okay to proceed as is (i.e., the stop work initiator was unaware of certain facts or procedures), the affected persons should thank the initiator for their concern and proceed with the work.

4.5.3.3 If determined and agreed that the stop work issue is valid, then every attempt should be made to resolve the issue to all affected person's satisfaction prior to the commencement of work.

4.5.3.4 If the stop work issue cannot be resolved immediately, work shall be suspended until proper resolution is achieved. When opinions differ regarding the validity of the stop work issue or adequacy of the resolution actions, the location's "person in charge" shall make the final determination.

4.5.3.5 Positive feedback should be given to all affected employees regarding resolution of the stop work issue. Under no circumstances should retribution be directed at any person(s) who exercise in good faith their stop work authority as detailed in this program.

4.5.3.6 All stop work interventions and associated detail shall be documented and reported via the behavior-based safety observation processes.

4.5.3.7 Stop Work reports shall be reviewed by a supervisor or manager in order to measure participation, determine quality of interventions and follow-up, trend common issues, identify opportunities for improvement, and facilitate sharing of lessons learned.

4.5.3.8 It is the desired outcome of any Stop Work Intervention that the identified safety concern(s) have been addressed to the satisfaction of all involved persons prior to the resumption of work. Most issues can be adequately resolved in a timely manner at the job site, occasionally additional investigation and corrective actions may be required to identify and address root causes.

4.6 Training

4.6.1 All employees and contractors shall be trained in the use of Stop Work Authority during APTIM HSE Induction.

4.6.2 Upon completion of training, employees and contractors shall be issued a SWA card.

5.0 REFERENCES

None

6.0 TERMINOLOGY

Term	***Definition***
Site	Any location, facility, or project where APTIM is performing work. Sites may include, but are not limited to, laboratories, offices, shops, owned or leased facilities, and/or project sites.

Supervisor	Person in control of the work and the personnel conducting the work (foreman, general foreman, superintendent)

7.0 EXHIBITS

Exhibit 7.1	AMS-720-01-FM-00020 – Business Glossary
Exhibit 7.2	AMS-720-01-FM-00021 – Technical Glossary

8.0 ATTACHMENTS

Attachment 8.1	Stop Work Authority Card

STOP WORK AUTHORITY

APTIM

I will **IDENTIFY** hazards that could cause harm to me, my fellow employees, others in the surrounding area, or to the environment.

I will **STOP** the task before a harmful event might occur. While this can be difficult or uncomfortable, I commit to using my authority to stop work in a respectful and timely manner.

I will **DISCUSS** the hazardous condition or behavior, share information with others to help avoid similar situations, and help develop a plan to eliminate or mitigate the hazard.

APTIM Ethics Line 1-800-461-9330

APTIM is dedicated to performing work in a quality manner and in compliance with applicable regulations, policies, and ethics. As an APTIM employee, you are responsible for reporting safety and quality issues that could cause harm to you, others around you, the public, or the environment.

Stopping work to discuss a hazard can be done without fear of retaliation or reprimand, and must be done as soon as work is put into safe condition. If you do not feel the safety/quality issue is being addressed, it is your responsibility to raise the issue to a higher level or use an alternate method to report your issue.

No other company policy may supersede, limit, or otherwise discourage your responsibility to raise a safety or quality concern.

Gary Baughman, CEO

PROCEDURE

Procedure Title:	**Hazardous Waste Operations**	**AMS Number:**	**AMS-710-04-PR-00300**
Procedure Owner:	**HSE**	**Issuing Authority:**	**APTIM Quality Management**

HAZARDOUS WASTE OPERATIONS

INT	Issued for Interim Use	M. Hadacek & S. Lachney	7/30/2017
Rev	**Changes**	**Approved**	**Date**

1.0 PURPOSE

The purpose of this procedure is to establish the minimum requirements for developing and implementing a written health and safety program for APTIM employees involved in hazardous waste operations conducted at treatment, storage, and disposal (TSD) facilities.

2.0 SCOPE

This procedure applies to personnel who develop and implement written HSE Programs for employees involved in hazardous waste operations.

3.0 RESPONSIBILITIES

The following personnel have responsibilities defined in this procedure:

- APTIM Managers
- APTIM Supervisors
- APTIM Employees

4.0 PROCEDURE

4.1 General

The Site HSE Manager shall develop and implement a written safety and health program for employees involved in hazardous waste operations (AMS-710-04-WI-00301 Health and Safety Plans for Hazardous Waste Operations Sites). The program shall be designed to identify, evaluate, and control safety and health hazards in the facility for the purpose of employee protection. The program shall provide for emergency response and shall address, as appropriate, site analysis, engineering controls, maximum exposure limits, hazardous waste handling procedures, and the use of new technologies (AMS-710-04-WI-00302 Emergency Response at Hazardous Waste Sites).

4.2 Hazard Communication

The safety and health program shall contain a hazard communication program. Refer to AMS-710-01-PR-00400 Hazard Communication.

4.3 Emergency response

The safety and health program shall contain Emergency Response requirements or shall reference the Emergency Preparedness Plan (AMS-710-03-PR-00400).

4.4 Medical Surveillance

A medical surveillance program shall be developed and implemented. All employees who are or may be exposed to health hazards or hazardous substances at or above the permissible exposure limits or, if there is no permissible exposure limit, above the published exposure levels without regard to the use of respirators for thirty (30) days or more in a calendar year shall be included in the program at no cost to the employee.

4.5 Decontamination

4.5.1 A decontamination program shall be developed, communicated to employees, and implemented before any employees or equipment enters an area on site where potential exposure to hazardous substance(s) exists (AMS-710-04-WI-00305 Hazardous Waste Decontamination).

4.5.2 All employees leaving a contaminated area shall be appropriately decontaminated. All contaminated clothing and equipment leaving a contaminated area shall be appropriately disposed of or decontaminated (AMS-710-04-PR-04113 Waste Characterization).

4.5.3 Decontamination shall be performed in geographical areas that will minimize cross contamination or the exposure of uncontaminated employees or equipment.

4.5.4 The Site HSE Manager shall monitor all methods of decontamination and determine their effectiveness. If methods are found to be ineffective, appropriate steps will be taken to correct the deficiencies.

4.5.5 Regular showers and changing rooms shall be provided outside the contaminated area.

4.6 New Technology

A program shall be developed and implemented to introduce new and innovative equipment for employee protection into the work place.

4.7 Material Handling

Where employees handle drums or containers, AMS-710-02-PR-00300 Material Storage and Handling shall be implemented prior to starting such work.

4.8 Engineering Controls

Engineering controls work practices, personal protective equipment, or a combination of these shall be implemented in accordance with 29 CFR 1910.120 (g) to protect employees from exposure to hazardous substances and safety and health hazards.

4.9 Monitoring

4.9.1 General

Monitoring shall be performed in accordance with 29 CFR 1910.120 (h) to prevent employee exposure to hazardous concentrations of hazardous substances and to assure proper selection of engineering controls, work practices, and personal protective equipment (AMS-710-04-WI-00304 Hazardous Waste Site Control).

4.9.2 Air Monitoring

Air monitoring shall be used to identify and quantify airborne levels of hazardous substances and safety and health hazards in order to determine the appropriate level of employee protection.

4.9.3 Initial Entry

Upon initial entry, representative air monitoring shall be conducted to identify any immediately dangerous to life and health (IDLH) condition, exposure over Permissible Exposure Limits (PELs) or if other dangerous condition(s) exist (i.e., the presence of flammable atmosphere or oxygen deficient environments).

4.9.4 Periodic Monitoring

Periodic monitoring shall be conducted when the possibility of an IDLH condition or flammable atmosphere has developed, or when there is indication that exposure may have risen over PELs. Periodic monitoring shall be considered when the PELs have risen and one or more of the following scenarios occur:

- Beginning of new work on a different portion of the site
- Contaminates other than those previously identified are being handled
- When a different type of operation is initiated
- When obvious liquid contamination is present

4.10 Training

All employees working on sites or at treatment, storage, and disposal (TSD) operations where they may be exposed to health hazards or hazardous substances must receive training to enable the employees to perform their assigned duties and functions in a safe and healthful manner so as not to endanger themselves or other employees (AMS-710-04-WI-00303 Hazardous Waste Operations Training).

4.10.1 New Employees

Employees engaged in hazardous substance removal or other activities, which expose or potentially expose them to hazardous substances and health hazards shall receive initial training which consists of a minimum of 40 hours of instruction off-site and three days of field experience, under direct supervision of a trained, experienced supervisor as described in 29 CFR 1910.120.

4.10.2 Current Employees

Current employees whose previous work experience and/or training are equivalent to the initial training requirement shall be considered as having met the initial training requirements. The Training Manager or his/her designee shall make the determination of equivalency. Current employees shall receive 8 hours of refresher training annually as described in 29 CFR 1910.120.

4.10.3 Trainers

Trainers shall be qualified to instruct employees on the subject matter presented in training. Such trainers shall have satisfactorily completed a training program for teaching their subjects, or they shall have the academic credentials and instructional experience necessary to teach as described in 29 CFR 1910.120.

4.11 Project Manager shall:

4.11.1 Verify compliance with the appropriate regulatory standard(s)

4.11.2 Ensure project-specific Health and Safety Program (HASP) documents are applicable health and safety requirements

4.12 HSE Representative shall:

4.12.1 Verify compliance with the appropriate regulatory standard(s) (AMS-710-04-WP-00001 Implement Environmental Management System (EMS)).

4.12.2 Ensure project-specific Health and Safety Program (HASP) documents are applicable health and safety requirements

4.12.3 Ensure medical and exposure records are handled correctly (AMS-710-01-PR-03500)

5.0 REFERENCES

29 CFR 1910.1200	Hazard Communication
29 CFR 1910.141	Sanitation
AMS-710-01-PR-00400	Hazard Communication
AMS-710-03-PR-00400	Emergency Preparedness Plan
AMS-710-01-PR-03500	Medical and Exposure Records
AMS-710-02-PR-00300	Material Storage and Handling
AMS-710-04-PR-04113	Waste Characterization
AMS-710-04-WI-00301	Health and Safety Plans for Hazardous Waste Operations Sites
AMS-710-04-WI-00302	Emergency Response at Hazardous Waste Sites
AMS-710-04-WI-00303	Hazardous Waste Operations Training

AMS-710-04-WI-00304	Hazardous Waste Site Control
AMS-710-04-WI-00305	Hazardous Waste Decontamination
AMS-710-04-WP-00001	Implement Environmental Management System (EMS)

6.0 TERMINOLOGY

Term	***Definition***
Buddy System	A system of organizing employees into work groups in such a manner that each employee of the work group is designated to be observed by at least one other employee in the work group. The purpose of the buddy system is to provide rapid assistance to employees in case of an emergency.
Clean-up Operation	An operation where hazardous substances are removed, contained, incinerated, neutralized, cleared-up, or in any manner processed or handled with ultimate goal of making the site safer for people or the environment.
Decontamination	The removal of hazardous substances from employees and their equipment to the extent necessary to preclude the occurrence of foreseeable adverse health effects.
Emergency Response or Responding to Emergencies	A response effort by employees from outside the immediate release area or by designated responders to an occurrence which results, or is likely to result, in an uncontrolled release of a hazardous substance. Responses to incidental releases of hazardous substances where the substance can be absorbed, neutralized or otherwise controlled at the time of release by employees in the immediate release area, or by maintenance personnel are not considered emergency responses. Responses to releases of hazardous substances where there is no potential safety or health hazard are not considered to be emergency responses.
Facility	Any building, structure, installation, equipment, pipe or pipeline, well, pit, pond, lagoon, impoundment, ditch, storage container, motor vehicle, rolling stock, or aircraft, or any site or area where a hazardous substance has been deposited, stored, disposed of, or placed, or otherwise come to be located; but does not include any consumer product in consumer use or any water-borne vessel.
Hazardous Substance	A substance which results or may result in adverse effects on the health or safety of employees.
Health Hazard	A chemical, mixture of chemicals, or a pathogen for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. Health hazards include: chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system and agents which damage the lungs, skin, eyes, or mucous membranes.

7.0 EXHIBITS

AMS-720-01-FM-00020	Business Glossary

AMS-720-01-FM-00021 Technical Glossary

8.0 ATTACHMENTS

None

PROCEDURE

Procedure Title:	**Work Area Hazard Assessment**	**AMS Number:**	**AMS-710-05-PR-01700**
Procedure Owner:	**HSE**	**Issuing Authority:**	**APTIM Quality Management**

WORK AREA HAZARD ASSESSMENT

INT	Issued for Interim Use	M. Hadacek & S. Lachney	7/30/2017
Rev	**Changes**	**Approved**	**Date**

1.0 PURPOSE

The purpose of this Procedure is to establish the minimum requirements for Work Area Hazard Assessment on APTIM sites.

2.0 SCOPE

This procedure applies to all APTIM employees, contractors, subcontractors, and visitors associated with a APTIM site.

3.0 RESPONSIBILITIES

The following personnel have responsibilities defined in this procedure:

- APTIM Managers
- APTIM Supervisors
- APTIM Employees
- APTIM Contractors
- APTIM Subcontractors

4.0 PROCEDURE

4.1 Work Area Hazard/Recognition Process Philosophy

4.1.1 It is The Work Area Hazard/Recognition Process Philosophy that a hazard's risk potential is the product of the Level of Focus and the Level of Distraction. The Level of Focus and the Level of Distraction have an inverse relationship. An increase in focus shall decrease the distraction resulting in less risk potential for an incident to occur at the actual work front. An increase in distraction shall have a decrease in focus resulting in a greater risk potential for an incident to occur at the actual work front. This philosophy is applicable at all levels, phases, and stages of work activity.

4.1.2 Varied types of work hazard analyses are to be conducted to mitigate hazard risk potential with the Level of Focus increasing and the Level of Distraction decreasing as the hazard analysis becomes nearer to the actual work activity.

4.1.3 The result from the completion of every hazard analysis/recognition process becomes the basis from which to begin the next level of hazard analysis/recognition study. This process is visually displayed in the Pyramid of Work Area Hazard Recognition/ Assessment (Figure 4-1).

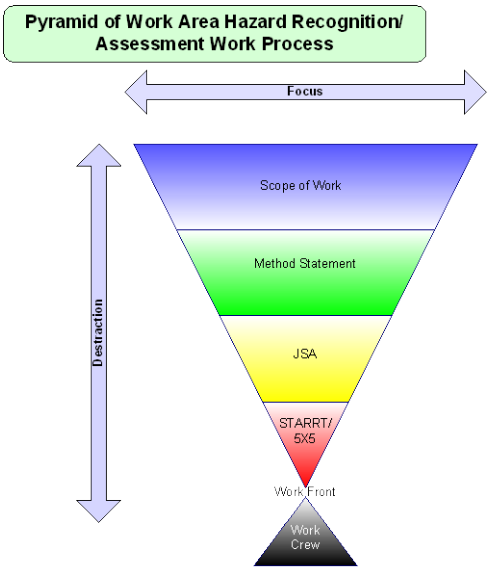


Figure 4-1

4.1.4 If during the Work Area Hazard/Recognition Process it is discovered that a previous step failed to identify a potential risk or hazard, then the previous step shall be repeated or revisited to incorporate the new findings.

4.1.5 Work shall not proceed to the next level or step of the Work Area Hazard Analysis Process prior to the completion of the previous step.

4.2 Work Area Hazard Assessment Flow

4.2.1 The basic work flow process is depicted in Attachment 8.1. Utilizing this methodology each site shall develop a Work Area Hazard Assessment Process specific to their needs. Performing a method statement is a best management practice to tie steps one (1) and three (3) together, but is not required

4.2.2 The location specific Work Area Hazard Assessment Process shall minimally include a means of engaging the supervision in developing an assessment prior to the start of work and a method of engaging their respective work crews in the assessment process. The location specific Work Area Hazard Assessment Process shall, minimally, have a means of ensuring each worker has the opportunity to conduct a 360° review of their specific work task, as well as documenting that review.

4.2.3 Scope of Work (Step One)

4.2.3.1 The first step in the Work Hazard Analysis/Recognition Process begins with the process of defining the Scope of Work. The Scope of Work is a definition of the work to be performed. The objective is to establish an understanding of the work to be performed.

4.2.3.2 The Scope of Work shall define the major elements of work to be executed (e.g., civil, structural, mechanical, or electrical).

4.2.3.3 Within the Scope of Work each of the major disciplines shall be defined to include elements such as:

- Painting and coating
- Instrumentation and electrical
- Structural
- Civil

4.2.3.4 The major disciplines identified in the Scope of Work review shall serve as the basis for development of the method statements

4.2.4 Method Statement (Step Two)

4.2.4.1 The second step in the Work Hazard Analysis/Recognition Process entails the development of a Work Method Statement or equivalent document (e.g., Job Hazard Assessment). A Work Method Statement shall provide specific instructions on the work to be performed, outline hazards involved, and identify key safety measures to be implemented during the work activity. The Method Statement shall also detail which control measures have been introduced to ensure the safety of anyone who is affected by the task or process.

4.2.4.2 For each discipline of work identified under the site scope of work the Site Manager shall prepare Method Statements, using AMS-710-05-FM-01702—Sample Method Statement 2.

4.2.4.3 The site HSE Manager/Supervisor shall maintain a copy of the site method statements and shall submit copies to Business Unit/Operating Group HSE Director or designee for business sector, area, district and/or global application.

4.2.4.4 Within the Method Statement the following minimum information shall be included:

- Sequence of key activities
- Identification of the craft required, including necessary skill/certification
- Identification of the tools and equipment required
- A clear statement of responsible persons, i.e., who is in charge of the work, who has specific responsibilities, e.g., flagmen, riggers.
- Identification of what materials are required for execution of the activity

- Identification of what services are required and how they shall be provided
- Reference to emergency procedures, including contact telephone numbers, reference to emergency provisions such as spill kits.
- Key activities identified in the Method Statement(s) (or equivalent document(s)) shall serve as the basis for the development of an activity specific Job Safety Analysis (JSA).

4.2.5 Job Safety Analysis (Step Three)

4.2.5.1 The third step in the Work Area Hazard Analysis/Recognition Process is to develop a JSA for each key activity to be performed, during the shift. A JSA shall document each step of the activities, identify potential hazards associated with each step, and list the control measure(s) to be used to mitigate the potential hazard(s).

4.2.5.1 A new JSA shall be completed at the work location every day, before commencement of any work activity and updated in the event of changing conditions. If conditions that a work crew encounters during a work period (inclement weather, another contractor began work in area change), the JSA shall be modified to address the new hazards. The JSA shall be changed to reflect new conditions in the task being performed or new hazards not identified previously.

4.2.5.2 Utilize the hierarchy of control measures to develop safe job procedures to eliminate or mitigate the hazards and prevent potential accidents:

1. Eliminate the hazard if possible
2. Use engineering controls to mitigate the hazard
3. Use administrative controls to minimize exposure
4. Use PPE

4.2.5.3 For each key activity identified under the site method statement supervision shall prepare a JSA. Supervision should use one of the following to prepare the JSA:

- AMS-710-05-FM-01704—Sample JSA 1
- AMS-710-05-FM-01705—Sample JSA 2
- AMS-710-05-FM-01708—Sample JSA 3

4.2.5.4 Supervision shall review the prepared JSA prior to work and ensure all appropriate elements are addressed in the JSA and that it is specific to their planned work activities.

4.2.5.5 The supervisor shall review the completed JSA with their respective work crews prior to starting the work activity.

4.2.5.6 Periodic reviews shall be conducted by the site HSE Manager and Senior Level Site Manager to ensure the integrity of the JSA process.

4.2.5.7 JSA's are to remain with the work crew(s) until the task(s) are completed at which time they shall be submitted to the site HSE Manager for inclusion in the site HSE files.

4.2.5.8 These steps identified in the JSA shall serve as the basis for development of job step specific worker completed assessments.

4.2.6 5 x 5 Analysis/STARRT (Step Four)

4.2.6.1 The fourth step in the Work Hazard Analysis/Recognition Process is to develop a 5 X 5 Analysis/Safety Task Analysis and Risk Reduction Talk (STARRT) Card or equivalent form) just prior to the performance of the work. The job or task specific analysis is performed by the individual who is to

perform the work. This is the individual's opportunity to confirm that he has everything needed to perform the work in a safe manner.

4.2.6.2 The individual shall prepare job step specific analysis, using one of the following

- AMS-710-05-FM-01706—Sample 5x5 Analysis
- AMS-710-05-FM-01707—Sample STARRT Card
- Or an equivalent form

4.2.6.3 The work crew shall be actively involved in conducting a 360° review of their specific work area, identifying hazards of their work and the hazards of work activities that surround them. The work crew lead and the work crew shall collectively review the means of mitigation and ensure proper controls and measures are in place.

4.2.6.4 The job or task specific analysis is a tool for the individual to identify any unaccounted hazards that one may encounter associated with the tasks they shall actually be performing.

5.0 REFERENCES

None

6.0 TERMINOLOGY

Term	***Definition***
Hazard	A condition, practice, behavior or situation, or a combination of these, that can cause injury or illness in people, or damage to the environment or property.
JSA	Job Safety Analysis, technique that focuses on job tasks as a way to identify hazards before they occur
Site	Any location, facility or project where APTIM is performing work. Sites may include, but are not limited to, laboratories, offices, shops, owned facilities, leased facilities and/or project sites.
Work Area Hazard Assessment	Evaluation of a work place condition, practice, behavior or situation that an employee may encounter while performing a job/task that has the potential for risks/hazards.

7.0 EXHIBITS

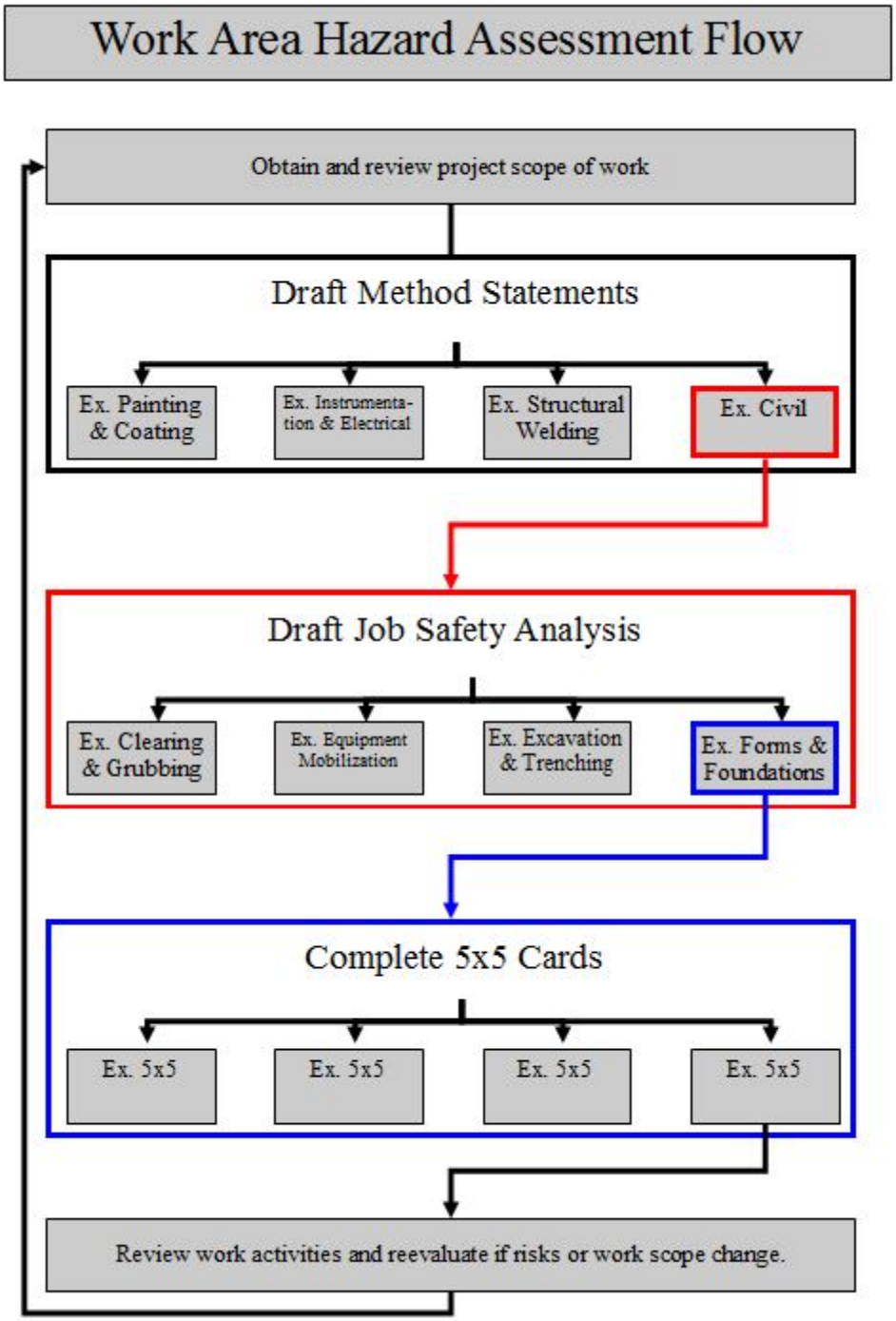
Exhibit 7.2	AMS-710-05-FM-01702—Sample Method Statement 2
Exhibit 7.3	AMS-710-05-FM-01704—Sample JSA 1
Exhibit 7.4	AMS-710-05-FM-01705—Sample JSA 2
Exhibit 7.5	AMS-710-05-FM-01706—Sample 5x5 Card
Exhibit 7.6	AMS-710-05-FM-01707—Sample STARRT Card
Exhibit 7.7	AMS-710-05-FM-01708---Sample JSA 3
Exhibit 7.8	AMS-720-01-FM-00020---Business Glossary
Exhibit 7.9	AMS-720-01-FM-00021---Technical Glossary

8.0 ATTCHMENTS

Attachment 8.1 Work Area Hazard Assessment Process Flow

AMS Number:	Revision:	Approval Date:
AMS-710-05-PR-01700	INT	7/30/2017

Attachment 8.1 Work Area Hazard Assessment Process Flow



PROCEDURE

Procedure Title:	**Personal Protective Equipment**	**AMS Number:**	**AMS-710-02-PR-03000**
Procedure Owner:	**HSE**	**Issuing Authority:**	**APTIM Quality Management**

PERSONAL PROTECTIVE EQUIPMENT

INT	Issued for Interim Use	M. Hadacek & S. Lachney	7/30/2017
Rev	**Changes**	**Approved**	**Date**

AMS Number:	Revision:	Approval Date:
AMS-710-02-PR-03000	INT	7/30/2017

1.0 PURPOSE

The purpose of this Procedure is to establish the minimum requirements for the use of Personal Protective Equipment (PPE) on APTIM sites.

2.0 SCOPE

This procedure applies to all employees of APTIM, contractors, subcontractors and visitors associated with a APTIM site.

3.0 RESPONSIBILITIES

The following personnel have responsibilities defined in this procedure:

- APTIM Managers
- APTIM Supervisors
- APTIM Employees
- APTIM Contractors
- APTIM Subcontractors
- APTIM Visitors

4.0 PROCEDURE

4.1 Requirements

4.1.1 PPE is the last line of defense against hazards and shall not be used as a substitute for engineering, work practice, and/or administrative controls. PPE shall be used in conjunction with these controls to ensure employee safety and health. PPE includes all clothing or other work accessories designed to create a barrier against work place hazards. Employees must be made aware that PPE does not eliminate the hazard. If PPE fails, hazard exposure will occur.

4.1.2 Every attempt shall be made to prevent the possibility of incidents when employees perform work activities by providing them with the appropriate PPE, through compliance with safety regulations and training of employees to properly use, inspect and wear the required PPE and through employee involvement in safe work activities.

4.1.3 The Company reserves the right to select and/or approve all PPE to be issued and used by its employees, visitors, and/or subcontractors. Only such equipment issued or approved will be allowed on its jobsites. Failure to comply with this procedure will result in disciplinary action up to and including termination in accordance with AMS-710-05-PR-00200.

4.1.4 The Site Manager shall ensure that the Site HSE Manager has assessed the workplace to determine if hazards are present or likely to be present. This assessment shall be documented in writing. The documentation shall identify the work place, the person(s) evaluating the work place, the dates of the assessment, and the hazards if any. The Site Manager shall approve the hazard assessment as accurate and complete. If hazards are present, controls shall be implemented to eliminate or reduce the hazard. If controls are not available and/or the hazard is not eliminated, the requisite PPE shall be used. APTIM Management shall:

4.1.4.1 Select and have each affected employee use the types of PPE chosen.

4.1.4.2 Communicate appropriate selection of PPE to employees. (Training).

4.1.4.3 Ensure that employees have PPE that properly fits them.

4.1.4.4 Ensure that employees understand the proper usage of the required PPE.

4.1.5 Workers must report any damaged or defective PPE and the defective or damaged PPE shall be removed from service and shall not be reused.

4.1.6 APTIM shall ensure that each employee who is required to wear PPE is trained in the following:

4.1.6.1 When PPE is necessary.

4.1.6.2 What PPE is necessary.

4.1.6.3 How to put on, take off, adjust, and wear the PPE.

4.1.6.4 The limits of the PPE.

4.1.6.5 The proper care, maintenance, useful life, inspection and disposal of the PPE.

4.1.6.6 The proper practices for keeping the PPE clean and hygienic.

4.1.6.7 The proper use to ensure the PPE is not misused or damaged.

4.1.7 Each affected employee shall demonstrate an understanding of the training and the ability to use PPE properly, before being allowed to perform work requiring the use of PPE.

4.1.8 When there is reason to believe that any affected employee who has already been trained does not have the understanding and skill required, the employee shall be retrained. Circumstances where retraining is required include, but are not limited to, the following:

4.1.8.1 Changes in the workplace which renders previous training obsolete.

4.1.8.2 Changes in the type of PPE to be used which renders previous training obsolete.

4.1.8.3 Inadequacies in an affected employee's knowledge or use of assigned PPE.

4.2 The Site HSE Manager along with Site Management will authorize the purchase of appropriate types and models of PPE.

4.3 The company will provide all PPE to the employee at no cost to the employee with exception of items deemed to be personal in nature to include, but not limited to:

4.3.1 Prescription Safety Eyewear

4.3.2 Thermal undergarments

4.3.3 Safety Toed Protective Footwear

4.3.4 Sites may, at their discretion, accept the cost of these personal in nature items as well.

4.4 The site shall document each affected employee has been trained using the Personal Protective Equipment Training Record form, AMS-710-01-FM-03001. The written documentation shall include the name of each employee trained, the dates of the training, and the subject of the training.

4.5 Employee-owned Equipment

4.5.1 Each employee shall be issued a hard hat (AMS-710-02-PR-03100), protective eyewear (AMS-710-02-PR-03200), hearing protection (AMS-710-01-PR-00900), hand protection (AMS-710-02-PR-03400) and/or respiratory protection (AMS-710-02-PR-03500), fall protection (AMS-710-02-PR-00900), personal flotation devices (AMS-710-02-PR-03700) and flagmen and traffic vests (AMS-710-02-PR-03600) if required. An employee wishing to utilize their own PPE must be able to demonstrate it meets APTIM requirements and must pass inspection by the Site HSE Manager.

4.5.2 Employees are responsible to provide their own work clothes (AMS-710-02-PR-03800) and sturdy safety-toed work boots (AMS-710-02-PR-03300) that meet APTIM's PPE requirements. Should an employee report for work with unsatisfactory PPE, the employee will not be permitted to work until APTIM's requirements are met.

4.6 Miscellaneous

4.6.1 Sweat Pads

4.6.1.1 When weather or working conditions cause perspiration, sponge pads can be worn on the forehead to prevent perspiration from seeping into eyes or fogging safety goggles.

4.6.2 Sunscreen

4.6.2.1 Clothing, hats and shade are the best method for protecting skin from ultraviolet (UV) rays. Any remaining exposed skin may be protected by applying sunscreen with approval from the Site HSE Manager. In active facilities approval for use of sunscreen must be obtained from the client.

5.0 REFERENCES

AMS-710-02-PR-03100	Head Protection
AMS-710-02-PR-03200	Eye Protection
AMS-710-02-PR-03300	Foot Protection
AMS-710-02-PR-03400	Hand Protection
AMS-710-02-PR-03500	Respiratory Protection
AMS-710-02-PR-03600	Flagmen and Traffic Vests
AMS-710-02-PR-03700	Personal Floatation Devices
AMS-710-02-PR-03800	Basic Work Clothing
AMS-710-02-PR-00900	Fall Protection
AMS-710-01-PR-00900	Noise Control and Hearing Conservation

6.0 TERMINOLOGY

Term	***Definition***
PPE	Personal Protective Equipment
Site	Any location, facility or project where APTIM is performing work. Sites may include, but are not limited to, laboratories, offices, shops, owned facilities, leased facilities and/or project sites.

7.0 EXHIBITS

Exhibit 7.1	AMS-710-02-FM-03001 – Personal Protective Equipment Training Record
Exhibit 7.2	AMS-710-02-FM-03002 – Global Approved PPE Listing
Exhibit 7.3	AMS-720-01-FM-00020 – Business Glossary
Exhibit 7.4	AMS-720-01-FM-00021 – Technical Glossary

8.0 ATTACHMENTS

None

PROCEDURE

Procedure Title:	**Respiratory Protection**	**AMS Number:**	**AMS-710-02-PR-03500**
Procedure Owner:	**HSE**	**Issuing Authority:**	**APTIM Quality Management**

RESPIRATORY PROTECTION

INT	Issued for Interim Use	M. Hadacek & S. Lachney	7/30/2017
Rev	**Changes**	**Approved**	**Date**

1.0 PURPOSE

The purpose of this Procedure is to establish the minimum requirements for Respiratory Protection on APTIM projects and at office, warehouse, or shop locations.

2.0 SCOPE

This procedure applies to all APTIM employees, contractors, subcontractors and visitors associated with a APTIM project, office, warehouse, or shop locations.

3.0 RESPONSIBILITIES

The following personnel have responsibilities defined in this procedure:

- APTIM Managers
- APTIM Supervisors
- APTIM Employees
- APTIM Contractors
- APTIM Subcontractors
- APTIM Visitors

4.0 PROCEDURE

Each project, shop, warehouse or facility shall follow this procedure and use it as the minimum guidelines to develop their site specific procedure for Respiratory Protection.

4.1 General

4.1.1 Every consideration will be given to the use of effective engineering controls to eliminate or reduce exposure to respiratory hazards to the point where respirators are not required. However, when feasible engineering controls are not effective in controlling toxic substances, the company, at no charge, will provide appropriate respiratory protective equipment to the employee.

4.1.2 Employees required to use respiratory protective devices because of exposure to toxic substances will do so as a condition of employment. Employees required to use respirators will be properly fitted, appropriately tested, medically screened, and thoroughly trained in their use.

4.2 Written Plan

4.2.1 A written Respiratory Protection Plan will be developed for the specific respiratory hazards of the location based upon a location/task risk assessment. The written Plan will also include information that is to be included in training, the provisions for controlling the distribution of respirators, the method to be used for cleaning and maintenance of respirators, and how the requirements of this Procedure will be met at the location level.

4.2.2 The Location HSE Manager is responsible for the development and implementation of the location-specific respiratory protection program.

4.2.3 The Location HSE Manager will develop a respiratory hazard assessment specific to their risks using AMS-710-02-FM-03507. This hazard assessment will be reviewed, minimally, on an annual basis or as changing conditions warrant.

4.3 Respirator Selection and Use

4.3.1 If a question exists concerning the type of respirator required Corporate HSE shall be consulted.

4.3.2 The Location HSE Manager will select respirators to be used on site, based on the hazards to which workers are exposed. The Location HSE Manager will conduct a hazard evaluation for each operation, process, or work area where airborne

contaminants may be present in routine operations or during an emergency. The hazard evaluation will include:

4.3.2.1 Identification and development of a list of hazardous substances used in the workplace, by department, or work process.

4.3.2.2 Review of work processes to determine where potential exposures to these hazardous substances may occur. This review shall be conducted by surveying the workplace, reviewing process records, and talking with employees and supervisors.

4.3.2.3 Exposure monitoring to quantify potential hazardous exposures.

4.3.3 Issuing Respirators

4.3.3.1 Respirators will not be fit tested or issued to individuals who have facial hair (including stubble) or any other condition, which interferes with the sealing surface of the respirator.

4.3.3.2 Respirators will not be fit tested nor issued to individuals who have not received appropriate respirator training in addition to fit testing and a medical clearance.

4.3.3.3 Employee owned respirators shall not be used.

4.3.4 General Use Procedures:

4.3.4.1 Employees will use their respirators under conditions specified by this program, and in accordance with the training they receive on the use of each particular model. In addition, the respirator shall not be used in a manner for which it is not certified by NIOSH or by its manufacturer.

4.3.4.2 All employees shall conduct user seal checks each time that they wear their respirator. Employees shall use either the positive or negative pressure check (depending on which test works best for them) specified in Appendix B-1 of the Respiratory Protection Standard.

4.3.4.3 All employees shall be permitted to leave the work area to go to the locker room to maintain their respirator for the following reasons: to clean their respirator if the respirator is impeding their ability to work, change filters or cartridges, replace parts, or to inspect respirator if it stops functioning as intended. Employees should notify their supervisor before leaving the area.

4.3.4.4 Employees are not permitted to wear tight-fitting respirators if they have any condition, such as facial scars, facial hair, or missing dentures, that prevents them from achieving a good seal. Employees are not permitted to wear headphones, jewelry, or other articles that may interfere with the face piece-to-face seal.

4.3.4.5 Once the type of respirator that is applicable and suitable for the purpose intended has been selected, the selection process should give consideration to the fit and comfort of the respirator.

4.3.5 Emergency Procedures:

4.3.5.1 When an alarm sounds, employees in the affected department must immediately don their emergency escape respirator, shut down their process equipment, and exit the work area. All other employees must immediately evacuate the building. The location specific Emergency Preparedness Plan describes these procedures (including proper evacuation routes and rally points) in greater detail.

4.3.6 Respirator Malfunction

4.3.6.1 For any malfunction of an APR (e.g., such as breakthrough, facepiece leakage, or improperly working valve), the respirator wearer should inform his or her supervisor that the respirator no longer functions as intended, and go to the designated safe area to maintain the respirator. The supervisor must ensure that the employee receives the needed parts to repair the respirator, or is provided with a new respirator.

4.3.6.2 All workers wearing atmosphere-supplying respirators will work with a "buddy".

4.3.6.3 If a worker experiences a malfunction of an SAR, he or she should signal to the "buddy" that he or she has had a respirator malfunction. The buddy shall don an emergency escape respirator and aid the worker in immediately exiting the spray booth.

4.4 Breathing Air Quality and Use

4.4.1 The Location HSE Manager shall ensure that compressed air, compressed oxygen, liquid air, and liquid oxygen used for respiration accords with the following specifications:

4.4.2 Compressed and liquid oxygen shall meet the United States Pharmacopoeia requirements for medical or breathing oxygen; and

4.4.3 Compressed breathing air shall meet at least the requirements for Grade D breathing air described in ANSI/Compressed Gas Association Commodity Specification for Air, G-7.1-1989, to include:

4.4.3.1 Oxygen content (v/v) of 19.5-23.5%;

4.4.3.2 Hydrocarbon (condensed) content of 5 milligrams per cubic meter of air or less;

4.4.3.3 Carbon monoxide (CO) content of 10 ppm or less;

4.4.3.4 Carbon dioxide content of 1,000 ppm or less; and

4.4.3.5 Lack of noticeable odor.

4.4.4 The Location HSE Manager shall ensure that compressed oxygen is not used in atmosphere-supplying respirators that have previously used compressed air.

4.4.5 The Location HSE Manager shall ensure that oxygen concentrations greater than 23.5% are used only in equipment designed for oxygen service or distribution.

4.4.6 For supplied-air respirators, only Grade D breathing air shall be used in the cylinders. The Location HSE Manager will coordinate deliveries of compressed air with the company's vendor, Compressed Air Inc., and require Compressed Air Inc. to certify that the air in the cylinders meets the specifications of Grade D breathing air.

4.4.7 The Location HSE Manager will maintain a minimum air supply of one fully charged replacement cylinder for each SAR unit. In addition, cylinders may be recharged as necessary from the breathing air cascade system located near the respirator storage area.

4.4.8 For all IDLH atmospheres, the location shall ensure that:

4.4.8.1 One employee or, when needed, more than one employee is located outside the IDLH atmosphere;

4.4.8.2 Visual, voice, or signal line communication is maintained between the employee(s) in the IDLH atmosphere and the employee(s) located outside the IDLH atmosphere;

4.4.8.3 The employee(s) located outside the IDLH atmosphere are trained and equipped to provide effective emergency rescue;

4.4.8.4 The Location HSE Manager shall be notified before the employee(s) located outside the IDLH atmosphere enter the IDLH atmosphere to provide emergency rescue;

4.4.8.5 The Location Area HSE Manager shall review the JSA and approve all respiratory protection to be used in potentially IDLH Environments.

4.4.8.6 Equivalent means for rescue where retrieval equipment is not required.

4.5 Medical Evaluation

4.5.1 Employees who are either required to wear respirators, or who choose to wear an APR voluntarily, must successfully complete a medical evaluation before being permitted to wear a respirator on the job.

4.5.2 Employees are not permitted to wear respirators until a physician has determined that they are medically able to do so. Any employee refusing the medical evaluation will not be allowed to work in an area requiring respirator use.

4.5.3 A licensed and company approved physician will provide the medical evaluations. Medical evaluation procedures are as follows:

4.5.3.1 The medical evaluation will be conducted using AMS-710-02-FM-03501. The Location HSE Manager will provide a copy of this questionnaire to all employees requiring medical evaluations. To the extent feasible, the company will assist employees who are unable to read the questionnaire (by providing help in reading the questionnaire). When this is not possible, the employee will be sent directly to the physician for medical evaluation.

4.5.3.2 All affected employees will be given a copy of the medical questionnaire to fill out, along with a stamped and addressed envelope for mailing the questionnaire to the company physician. Employees will be permitted to fill out the questionnaire on company time.

4.5.3.3 Follow-up medical exams will be granted to employees as required by the standard, and/or as deemed necessary by the company approved physician.

4.5.3.4 All employees will be granted the opportunity to speak with the physician about their medical evaluation, if they so request.

4.5.3.5 The Location HSE Manager has provided the company approved physician with a copy of this program, a copy of the Respiratory Protection standard, the list of hazardous substances by work area, and for each employee requiring evaluation:

- His or her work area or job title
- Proposed respirator type and weight
- Length of time required to wear respirator
- Expected physical work load (light, moderate, or heavy)
- Potential temperature and humidity extremes
- Any additional protective clothing required

4.5.3.6 Any employee required for medical reasons to wear a positive pressure air purifying respirator will be provided with a powered air purifying respirator.

4.5.3.7 After an employee has received clearance and begun to wear his or her respirator, additional medical evaluations will be provided under the following circumstances:

- Employee reports signs and/or symptoms related to their ability to use a respirator, such as shortness of breath, dizziness, chest pains, or wheezing.

- The company approved physician or supervisor informs the Location HSE Manager that the employee needs to be reevaluated;
- Information from this program, including observations made during fit testing and program evaluation, indicates a need for reevaluation;
- A change occurs in workplace conditions that may result in an increased physiological burden on the employee.

4.5.4 The Location HSE Manager will maintain a list of employees currently included in the respiratory protection program and having successfully completed the medical evaluation requirements of this procedure.

4.5.5 All examinations and questionnaires are to remain confidential between the employee and the physician.

4.5.6 Medical Forms

4.5.6.1 When conducting the initial medical evaluation, the Medical Questionnaire for Respirator Use (AMS-710-02-FM-03501) must be used.

4.5.6.2 In addition to the standardized questionnaire, the physician must also be furnished with a copy of the latest OSHA Standard governing the type of exposure to which the employee will be subjected. A description of the employee's duties as they relate to the exposure, the anticipated exposure level, a description of the respiratory protective equipment to be used, and any available information from previous medical evaluations of the employee must also be furnished to the physician on the Request for Medical Evaluation for Respirator Use (AMS-710-02-FM-03502).

4.5.6.3 At the conclusion of the evaluation, the physician will submit a written opinion to the Company on the bottom of AMS-710-02-FM-03502. This will contain the results of the evaluation and any recommendations from the physician regarding the employee's limitations.

4.5.6.4 The Company must furnish a copy of the physician’s opinion to the employee, within thirty (30) days of its receipt by the Company.

4.6 Fit-Testing Requirements

4.6.1 Employees who are required to wear half-facepiece APRs will be fit tested:

4.6.1.1 Prior to being allowed to wear any respirator with a tight fitting facepiece.

4.6.1.2 Annually.

4.6.1.3 When there are changes in the employee’s physical condition that could affect respiratory fit (e.g., obvious change in body weight, facial scarring, etc.).

4.6.2 Employees will be fit tested with the make, model, and size of respirator that they will actually wear. Employees will be provided with several models and sizes of respirators so that they may find an optimal fit. Fit testing of PAPRs is to be conducted in the negative pressure mode.

4.6.3 Respirators will be fitted properly and be tested for their face piece-to-face seal.

4.6.4 There are two acceptable methods for conducting these tests:

- Qualitative
- Quantitative

4.6.5 The fit test is valid only for respirators of the same model and size tested.

4.6.6 Qualitative fit testing is based on the wearer's subjective response to a challenge atmosphere, of which three popular tests are: the irritant smoke test, the saccharin solution test, and the odorous vapor test.

4.6.7 Irritant Smoke Test:

4.6.7.1 Directing an irritant smoke from a smoke tube towards the respirator being worn performs the Irritant Smoke Test. If the wearer does not detect the irritant smoke, a satisfactory fit is assumed to be achieved.

4.6.7.2 Since this type of test provokes an involuntary response from the employee, it is the preferred testing method when available.

4.6.8 Saccharin Solution Test:

4.6.8.1 This test relies on the wearer's ability to taste a saccharin solution sprayed around the outside of the respirator. The test is performed by placing an enclosure over the respirator wearer's head and shoulders and administering the solution from a nebulizer. If the wearer does not react to the chemical, then a satisfactory fit is assumed to be achieved.

NOTE: This test is dependent on the wearer's honest indication of taste. There is not an involuntary response.

4.6.8.2 The saccharin solution aerosol protocol is the only currently available, validated test protocol for use with disposable particulate respirators not equipped with high-efficiency filters.

4.6.9 Odorous Vapor Test:

The odorous vapor test relies on the respirator wearer's ability to detect an odorous material, usually isoamyl acetate (banana oil) inside the respirator. The test is performed by placing an isoamyl acetate saturated material near the respirator. If the wearer is unable to smell the chemical, then a satisfactory fit is assumed to be achieved.

4.6.10 Fit Test Card

4.6.10.1 The respirator wearer shall be issued an employee fit test card (AMS-710-02-FM-03504) with the following information:

- Name
- Date of fit test
- Manufacturer, model, and size of each successfully tested respirator
- Name and signature of the person that conducted the test
- Fit test challenge agent used
- Fit factor if a quantitative fit test was performed

4.6.11 Semi-annual Testing

The qualitative fit test should be repeated at least once every 12 months for routine use.

4.6.12 Fit Checks

There are two tests that are used in the field to check the seal of the respirator. These are known as the positive and negative fit checks. Each of these two tests must be performed every time an employee puts on a respirator and prior to entering a contaminated area.

4.7 Purchase of Approved Equipment

These requirements apply to all NIOSH/MSHA approved respirators used on APTIM locations. Non-approved “Dust Masks” with one strap shall not be used on APTIM projects.

4.8 Cleaning, Care, Maintenance, and Storage

4.8.1 Cleaning

4.8.1.1 Respirators shall be cleaned, disinfected, or sanitized as frequently as necessary recommended weekly to ensure that proper protection is provided to the user. Each worker shall be briefed on the cleaning procedure and be

assured that they will always receive a clean and disinfected/sanitized respirator. Such assurances are very important when respirators are not individually assigned to workers. Respirators maintained for emergency or general use shall be cleaned and disinfected/sanitized after each use.

4.8.1.2 The following procedure is recommended for cleaning and disinfecting/sanitizing respirators:

- Remove any filters, cartridges, canisters, speaking diaphragms or valve assemblies.
- Wash facepiece and breathing tube in cleaner-disinfectant or detergent solution (43°C or 110°F maximum temperature). Use a soft hand brush to help in removal of dirt and grime.
- Rinse completely in clean water (43°C or 110°F maximum temperature).
- Air dry in clean area or wipe dry with clean rags.
- Clean other respirator parts as recommended by the manufacturer.
- Inspect valves, headstraps, and other parts. Replace with new parts if defective.
- Insert new filters, cartridges, or canisters, and make sure seal is tight.
- After completely dry, place in a plastic zip-lock baggie or other suitable container for storage.

4.8.1.3 Cleaner-disinfectant solutions are available that effectively clean the respirator and contain a bactericidal agent.

4.8.1.4 Alternately, respirators may be washed in a liquid detergent solution, and then wiped with a clean piece of paper toweling, which has been dipped into a disinfecting/ sanitizing solution or a solution of rubbing alcohol. The respirator must then be rinsed in fresh water and air dried.

4.8.1.5 Respirators must be cleaned and disinfected after each day's use.

4.8.1.6 Respirator-freshening wipes are not an adequate substitute for this cleaning and disinfecting process.

4.8.1.7 The location shall assign specific individuals to be responsible for the cleaning and disinfecting of respirators.

4.8.1.8 A log shall be maintained which will include a record of date of cleaning and the cleaning attendant.

4.8.2 Storing the Respirator

4.8.2.1 When respirators are not being used, they shall be individually sealed in plastic bags and stored at locations established by location management in order to protect them against dust, sunlight, extreme temperatures, excessive moisture, or damaging chemicals. Respirators should not be stored (thrown) in toolboxes or gang boxes. They shall be stored in such a way that the face piece and exhalation valve are not distorted.

4.8.2.2 Atmosphere supplying respirators will be stored in the storage cabinet outside of the Location HSE Manager’s office.

4.8.3 Inspecting the Respirator

4.8.3.1 All respirators shall be inspected by the individual before and after each use, and at least monthly by the user's supervisor to ensure that they are in satisfactory working condition. These maintenance inspections will be documented by the supervisor using AMS-710-02-FM-03509.

4.8.4 Maintenance

4.8.4.1 Personnel involved in respirator maintenance shall be thoroughly trained. Substitution of parts from different brands or types of respirators invalidates approval of the device. Repairs and adjustments should never be made beyond the manufacturer's recommendations.

4.8.4.2 Respirators are to be properly maintained at all times in order to ensure that they function properly and adequately protect the employee. Maintenance involves a thorough visual inspection for cleanliness and defects. Worn or deteriorated parts will be replaced prior to use.

4.8.4.3 No components will be replaced or repairs made beyond those recommended by the manufacturer. Repairs to regulators or alarms of atmosphere-supplying respirators will be conducted by the manufacturer.

4.8.4.4 The following checklist will be used when inspecting respirators

- Facepiece:
  - cracks, tears, or holes
  - facemask distortion
  - cracked or loose lenses/faceshield
- Headstraps:
  - breaks or tears
  - broken buckles
- Valves:
  - residue or dirt
  - cracks or tears in valve material
- Filters/Cartridges:
  - approval designation
  - gaskets
  - cracks or dents in housing
  - proper cartridge for hazard
- Air Supply Systems:
  - breathing air quality/grade
  - condition of supply hoses
  - hose connections
  - settings on regulators and valves

4.8.4.5 Employees are permitted to leave their work area to perform limited maintenance on their respirator in a designated area that is free of respiratory hazards. Situations when this is permitted include to wash their face and respirator facepiece to prevent any eye or skin irritation, to replace the filter, cartridge or canister, and if they detect vapor or gas breakthrough or leakage in the facepiece or if they detect any other damage to the respirator or its components.

4.8.5 Defective Respirators

4.8.5.1 Respirators that are defective or have defective parts shall be taken out of service immediately.

4.8.5.2 If, during an inspection, an employee discovers a defect in a respirator, he/she is to bring the defect to the attention of his or her supervisor. Supervisors will give all defective respirators to the Location HSE Manager. The Location HSE Manager will decide whether to:

- Temporarily take the respirator out of service until it can be repaired.
- Perform a simple fix on the spot such as replacing a headstrap.
- Dispose of the respirator due to an irreparable problem or defect.

4.8.5.3 When a respirator is taken out of service for an extended period of time, the respirator will be tagged out of service, and the employee will be given a replacement of similar make, model, and size. All tagged out respirators will be kept in the storage cabinet inside the Location HSE Manager's office.

4.9 Training

4.9.1 All personnel shall be trained in the proper use of respirators prior to wearing one in the field.

4.9.2 The Location HSE Manager will provide training to respirator users and their supervisors on the contents of the Respiratory Protection Program and their responsibilities. Workers will be trained prior to using a respirator in the workplace. Supervisors will also be trained prior to using a respirator in the workplace or prior to supervising employees that must wear respirators.

4.9.3 The training course will cover the following topics:

- The location specific Respiratory Protection Program
- The OSHA Respiratory Protection standard
- Respiratory hazards encountered at the location and their health effects
- Proper selection and use of respirators
- Limitations of respirators
- Respirator donning and user seal (fit) checks
- Fit testing
- Emergency use procedures
- Maintenance and storage
- Medical signs and symptoms limiting the effective use of respirators

4.9.4 Employees will be retrained annually or as needed (e.g., if they change departments and need to use a different respirator). Employees must demonstrate their understanding of the topics covered in the training through hands-on exercises and a written test. Respirator training will be documented by the Location HSE Manager and the documentation will include the type, model, and size of respirator for which each employee has been trained and fit tested.

4.10 Program Evaluation

The Location Manager shall ensure that the Program is periodically evaluated to determine the effectiveness of the Program during all phases of operation in which respirators are being used. Frequent walk-through inspections during these activities shall be conducted to monitor and document supervisor and worker compliance with the requirements of the program. In addition to general assessment of the overall Respiratory Protection Program, specific evaluations of the respirator cleaning, inspection, maintenance, repair, storage, and use practices shall be conducted and documented weekly to ensure that the desired results of these operations are consistently achieved.

4.11 6.0 Documentation and Recordkeeping

4.11.1 A written copy of this program will be maintained in the Location HSE Manager's office and is available to all employees who wish to review it.

4.11.2 Also maintained in the Location HSE Manager's office are copies of training and fit test records.

4.11.3 These records will be updated as new employees are trained, as existing employees receive refresher training, and as new fit tests are conducted.

4.11.4 The Location HSE Manager will also maintain copies of the medical records for all employees covered under the respirator program. The completed medical questionnaire and the physician's documented findings are confidential and will remain at the company

approved medical provider. The company will only retain the physician's written recommendation regarding each employee's ability to wear a respirator.

5.0 REFERENCES

Title 30, Part II of the Code of Federal Regulations - NIOSH/MSHA Approvals for Respirators

Title 29 CFR (Code of Federal Regulation) 1926.103 Respiratory Protection

Title 29 CFR (Code of Federal Regulation) 1910.134 Respiratory Protection

Title 29 CFR (Code of Federal Regulation) 1910.1020 Hazardous waste operations and emergency response.

Title 30, Part II of the Code of Federal Regulations - NIOSH/MSHA Approvals for Respirators

American National Standards Institute - Practices for Respiratory protection Z88.2-1992

American National Standards Institute - Practices for Respiratory protection Z88.2-1992

6.0 TERMINOLOGY

Term	***Definition***
Approved	Tested and listed as satisfactory jointly by the Mine Safety and Health Administration (MSHA) of the U. S. Department of Labor and the National Institute for Occupational Safety and Health (NIOSH) of the U. S. Department of Health and Human Services.

7.0 EXHIBITS

Exhibit 7.1	AMS-710-02-FM-03501 – Medical Questionnaire for Respirator Use
Exhibit 7.2	AMS-710-02-FM-03502 – Request for Medical Evaluation for Respirator Use
Exhibit 7.3	AMS-710-02-FM-03503 – Respirator Training and Fit Test Record
Exhibit 7.4	AMS-710-02-FM-03504 – Employee Fit Test Card
Exhibit 7.5	AMS-710-02-FM-03505 – Selection Table for Respiratory Protection
Exhibit 7.6	AMS-710-02-FM-03506 – Respiratory Protection Training Program Certificate
Exhibit 7.7	AMS-710-02-FM-03507 – Location Specific Respiratory Hazard Evaluation Form
Exhibit 7.8	AMS-710-02-FM-03508 – Location Specific Voluntary and Mandatory Respirator Use
Exhibit 7.9	AMS-710-02-FM-03509 – Monthly Maintenance Checklist for Respirators
Exhibit 7.10	AMS-720-01-FM-00020 – Business Glossary

Exhibit 7.11 AMS-720-01-FM-00021 – Technical Glossary

8.0 ATTACHMENTS

None

PROCEDURE

Procedure Title:	**Permit to Work**	**AMS Number:**	**AMS-710-02-PR-06400**
Procedure Owner:	**HSE**	**Issuing Authority:**	**APTIM Quality Management**

PERMIT TO WORK

INT	Issued for Interim Use	M. Hadacek & S. Lachney	7/30/2017
Rev	**Changes**	**Approved**	**Date**

1.0 PURPOSE

The purpose of this Procedure is to establish the minimum requirements for a permit to work system on APTIM sites.

2.0 SCOPE

This procedure applies to all APTIM employees, contractors, subcontractors, and visitors associated with a APTIM site.

3.0 RESPONSIBILITIES

The following personnel have responsibilities defined in this procedure:

- APTIM Managers
- APTIM Supervisors
- APTIM Employees
- APTIM Contractors
- APTIM Subcontractors
- APTIM Visitors

4.0 PROCEDURE

Each site shall make every attempt to prevent the possibility of incidents and accidents to employees when performing work activities through implementation, as determined by the Site HSE Manager and the Site Manager, of this non-mandatory permit to work system.

4.1 General

4.1.1 The intent of this procedure is to describe the APTIM Permit to Work System (PTW), which is used to provide the controls necessary during construction and commissioning activities in ensuring the safe performance of potentially hazardous tasks which cannot be adequately controlled under standard work practices, procedures, or method statements.

4.1.2 This procedure specifically applies to all site activities under the control of APTIM and as determined by the Site HSE Manager and the Site Manager.

4.1.3 This procedure may be superseded by Client mandated PTW.

4.1.4 This PTW is not required to be implemented during routine/normal construction activities. Activities where PTW shall be implemented may include:

4.1.4.1 Where a task is deemed hazardous and/or specific control measures are required above and beyond standard work practices e.g.,

- Excavations.
- Hotwork.
- Confined space entry (including activities that may generate hazardous atmospheres)
- Energised systems.
- Radiography (surveys using radioactive source).
- Heavy and/or Critical Lifts

4.1.4.2 In special cases when the APTIM Site HSE Manager and/or Site Manager deems it necessary to keep adequate control of hazards on site or area construction

4.1.5 This procedure shall be applied to all APTIM and subcontractor construction activities including construction or maintenance activities.

4.1.6 Any work or activity not falling under the category of a permitted activity or type of activity as listed in 4.1.3 shall be controlled by the "Work Area Hazard Assessment Process" (AMS-710-05-PR-01700).

4.2 Key Personnel and Associated Activities

4.2.1 The Issuer (The Party who Approves the Permit)

4.2.1.1 The Issuer has the sole authority to issue and approve the permit.

4.2.1.2 The Issuer shall be fully aware of Site conditions, the type of work to be carried out, and all the requirements stated in the permit.

4.2.1.3 The Issuer shall consult with the APTIM HSE Department to ensure all required safety precautionary measures are stated in the permit.

4.2.1.4 Prior to approving a permit, the Issuer shall conduct an onsite inspection jointly together with the Executor to ensure that Site conditions are safe to work, that there are no interferences either to or from other work groups, and ensure that all requirements stated in the permit are implemented.

4.2.1.5 The Issuer shall withhold approval of the permit if the requirements are not met, or Site conditions are not safe for the work to be carried out.

4.2.1.6 The Issuer shall, if noticing the presence of any other potential hazards that may jeopardize the safety of the workers, tools, or equipment, stop the work and then advise the Executor of appropriate countermeasures to be taken before approving the permit.

4.2.1.7 The Issuer shall ensure that all required safety-monitoring measurements are properly completed prior to the approval of the permit and so stated in the permit, e.g., gas tests, isolation of potential energy releases.

4.2.1.8 Once informed that the work is complete, the Issuer shall visit the Site jointly with the Executor to ensure that the work has been completed and the site is duly reinstated and proper job site clean up is complete.

4.2.2 The Executor (Receiver of the Permit)

4.2.2.1 The Executor must be able to speak, read, and write at a level sufficient to understand the requirements of the permit.

4.2.2.2 The Executor shall accept all requirements stated in the permit and comply with them at all times.

4.2.2.3 The Executor shall ensure that his work crew fully understand requirements stated in the permit and that the pre-task safety toolbox meeting attendance is completed for every permit.

4.2.2.4 The Executor shall ensure the requirements specified in the permit are implemented prior to the commencement of the work. He shall remain at the workplace to supervise the work at all times while the work is in progress, as defined in the PTW. In the event that the supervisor must leave the workplace for any reason, he must either arrange for an alternate, competent person as a stand in or the work must cease until such a person is provided. This change over must be recorded in writing and accepted by the Issuer.

4.2.2.5 The Executor shall under no circumstances, either by his own discretion or that of his work crew, change the original scope of the work, which is described in the permit.

4.2.2.6 The Executor shall request a new permit in the event a change in the scope of the work becomes necessary.

4.2.2.7 Whenever Site conditions are drastically changed such as to create a hazard, the Executor shall immediately stop the work and inform the Issuer of the change and await further instruction from him/her.

4.2.2.8 Upon the occurrence of an emergency, the Executor shall immediately stop the work and follow emergency procedure. Upon resolution of the emergency, the Executor shall have the PTW revalidated before resuming work.

4.2.2.9 The Executor shall report the completion of the work or the expiration of the validity of the permit to the Issuer and on completion of the work ensure that the site is duly reinstated without any remaining risks.

4.2.3 Authorized Gas Testers (AGT)

4.2.3.1 All Authorized Gas Testers must undergo the AGT course which is presented by APTIM and annual training thereafter.

4.2.3.2 APTIM will maintain a register of personnel who have undertaken this course. This course will cover issues such as the physical and chemical properties of gases, the reasons for testing, and the method of testing. In addition to the classroom based course a competent person will assess the AGT in the field.

4.2.3.3 All gas detectors shall be bump tested in accordance with the manufacturer's guidelines. The bump test and reading will be documented.

4.2.3.4 All gas detectors must be calibrated by a third party at a frequency stated by the manufacturer as a minimum or when it fails a bump test. APTIM will maintain a register of records of calibration for all of their detectors.

4.2.3.5 The AGT must ensure that the gas meter in use is fully functional and has an in-date calibration certificate.

4.2.3.6 The Authorized Gas Testers approved by APTIM shall conduct any required gas testing prior to the commencement of the work and validation of the PTW.

4.2.3.7 In case the concentration of any gas is detected outside of the permissible level of concentration (H_2S, 0ppm, LEL >2%, O_2 19.5-23%) the AGT shall withhold the permit and immediately inform the Issuer and conduct retesting. Should the re-test also show levels in excess of these concentrations then additional means of ventilation shall be employed, such as fans, air movers, etc., prior to allowing work to commence.

4.2.3.8 Gas tests shall be carried out before any entry into a Confined Space and before validation of any Hot Work Permit. The AGT will use appropriate PPE, (SCBA, SABA), while testing an unknown atmosphere in a confined space where the AGT has to enter the confined space to take the readings.

4.2.3.9 AGT's may be required, depending upon the work, to carry out further gas tests throughout the working day. Should any gas concentration exceed those stated above, then the work shall be immediately stopped and APTIM informed.

4.2.4 The APTIM Permit Coordinator

4.2.4.1 The designated Permit Coordinator reports to the APTIM Construction Manager and is responsible for daily coordination of the work permits, including maintenance of a log showing the status of all PTW's. In addition, he/she shall maintain a copy of all PTW's Job Safety Analysis and Method Statements in sequential order.

4.2.4.2 He/she is responsible for full clerical control of the permit to work system including retention of the closed out Work Permits until the end of the Site.

4.2.4.3 He/she is responsible for displaying all planned, open, and suspended work permits on visual display in the permit to work office.

4.3 Permit to Work (PTW) System Components

4.3.1 Under this procedure, individual Permit to Work Forms are issued for works as described in section 4.1.4.

4.3.2 A set of PTW Forms, applicable Certificates, Documents, and authorized Permit signatories is called a PTW System. The components of the PTW are described below.

4.3.3 Permit to Work

4.3.3.1 A Permit to Work (PTW) is an official document with which APTIM authorizes activities to be carried out under specific safe working conditions. It is a signed declaration by the Issuing Party that the worksite conditions are safe to perform the specified task within a specified period. The work shall be done in accordance with the requirements of the PTW.

4.3.3.2 Each PTW shall be uniquely and individually numbered for identification purposes with sufficient copies made for all parties involved.

4.3.3.3 Every application for a PTW must have attached to it as a minimum the following supporting documentation:

- Job Safety Analysis (JSA)
- Material Safety Data Sheet (MSDS) where applicable
- Other items that may be required include:

1. Marked up Drawings
2. Isolation details, LO/TO
3. Crane Inspection Certificate, including load test
4. Rigging Certificates
5. Competent Person Certificates.
6. Rigging/Lifting Plan

4.4 Types of Work Requiring a Permit to Work

Any work falling into the following categories may require a specific PTW issued by APTIM. The APTIM Site HSE Manager and Site Manager may designate any other works as work requiring a permit in addition to the above when deemed necessary.

4.4.1 Excavation/Ground Disturbance

The definition of an excavation shall be consistent with AMS-710-02-PR-01600. For the purposes of the PTW the definition of excavation/ground disturbance may also include, but not be limited to:

- Any excavation involving the removal of soil deeper than thirty (30) cm or driving of a peg below this depth in areas known to have underground piping/utilities
- Cutting into of ground or floors below surrounding level where there is the risk of damage to existing services or harm to personnel
- Cutting into or drilling into walls or ceilings where existing services are known to run

4.4.2 Hot Work

All work involving ignition sources performed within fifteen meters (15m) of equipment containing flammable/combustible liquids or work performed within ten meters (10m) of large quantities of ordinary combustible materials (e.g., cardboard, wood).

4.4.3 Electrical Work

Any work requiring de-energizing or isolation of electrical System and/or its associated component parts including any work on any item or piece of equipment capable of being electrically charged or activated, energized or pressurized.

4.4.4 Confined Space Entry

Any entry into an area which is not designed for human occupancy has restricted access/egress or where the presence of toxic or flammable gases or deficiency/enrichment in oxygen possibly exists, as defined in AMS-710-02-PR-01700.

4.4.5 Heavy and/or Critical Lifts

The following lifts will require a Permit to Work:

- Lifts over live Equipment or Plant
- Lifts equal to or exceeding eighty percent (80%) of crane's rated capacity.
- Lifts of > 25 tons
- Lifts requiring more than one crane.

4.4.6 Radiation Work

Any work requiring the use of radioactive sources or x-ray machines for NDE works.

4.5 Validity of the Permit

Validity of the permit shall be restricted to the number of hours or days as specified in the permit, to a maximum of seven (7) days. No works shall be carried out after the validity has expired unless the permit has been duly extended or a new permit has been obtained from the Issuer.

4.6 Revalidation of the Permit

If the validity of the permit extends across more than one working day/shift then the permit shall be re-validated by the Executor at the start of the oncoming shift.

4.7 Closure of the Permit

4.7.1 On completion of the work, the Executor shall signify that the work is complete and that they wish to close the permit by signing in the correct space on the permit and returning the permit to the Issuer.

4.7.2 The permit is only considered closed when signed by the Issuer and after the Issuer has visited the Site and confirmed that the worksite has been left in a safe condition.

4.8 Training and Authorization

4.8.1 All Permits to Work Executors are required to attend the APTIM Permit to Work Training course and must pass an accompanying written examination.

4.8.2 All Executors must be sufficiently conversant, written and verbal, to enable them to understand the requirements that the PTW places on them and their workers.

4.8.3 In the event of any incident involving non-compliance with a PTW then the relevant Executor must undergo refresher training before he is allowed to sign further permits.

4.8.4 No Executor will be permitted to undergo more than two (2) refresher courses before he/she is removed from the authorized list permanently.

4.9 Operational Procedures for the APTIM PTW System

4.9.1 Under this procedure, there are three-sheet PTW Forms.

4.9.2 Original Form of PTW shall stay at the worksite with the Executor, the subcontractor task supervisor/engineer responsible for the work as stated in the PTW. The PTW must be displayed on a stand located at the workplace; the stand should be clearly

marked and placed in a prominent location within the work area. The first copy remains with the Issuer of the permit. The second copy is held by the PTW Coordinator.

4.9.3 The description of the work shall be a precise statement of the planned activity and the location of the work by identification of the area or equipment to be worked upon. Broad scopes of work of a general nature are not acceptable.

4.9.4 Job Safety Analyses will be produced and shall be attached to form part of the permit. Such additional documents shall be attached to the original of the Permit.

4.9.5 The Executor shall submit the permits to the Issuer by 08:00 hours the day before the actual commencement of the work.

4.9.6 The Issuer shall distribute the permits to the APTIM PTW Coordinator for HSE review and verification by 11:00 hours the day before work commences.

4.9.7 The APTIM Permit Coordinator shall submit the permits to the Site Construction Manager or his designee who shall verify that all HSE requirements specified in the permits are appropriate and return the verified permits to the Permit Coordinator.

4.9.8 The APTIM Permit Coordinator shall produce all verified permits to the Issuer the evening before work is due to commence.

4.9.9 The Issuer shall review the permit to ensure that all required safety precautionary measures are stated and that concurrence has been received from all appropriate parties for authorization of the permits.

4.9.10 On the day of the work, the Issuer or his nominees together with the Executor shall go to the Site to ensure that all requirements in the permit are met and hand over the permit to the Executor. Issuance of the permit to the Executor in the office shall not take place.

4.9.11 Upon receipt of the permit from the Issuer, the Executor can commence the work after the HSE requirements of the permit have been discussed with the personnel performing the work. (JSA and 5 X 5 Pre-Task Safety Talk)

4.9.12 When the work is completed, or when no further work is to take place under a permit, the Executor shall sign in the permit and return the permit to the Issuer or his nominees to indicate he has completed the work satisfactorily.

4.9.13 Upon receipt of the permit, the Issuer and the Executor shall inspect the work Site to ensure that the work Site is duly reinstated with all waste material removed and no remaining risks. When satisfied that the site has been left in a safe condition the Executor shall sign the permit as closed.

4.9.14 The Issuer shall return the completed permit to the APTIM Permit Coordinator for file.

4.9.15 The APTIM permit coordinator shall attach the original of the closed permit to his file copy to verify closure. Copies of closed permits are to be kept for the life of the site; remaining copies may be disposed of.

4.10 Emergency and Changing Conditions

4.10.1 In the event of an emergency, the Executor shall immediately stop all works and shut down all equipment before moving to the appropriate Muster Point.

4.10.2 All permits shall be nullified and no work shall be resumed unless the permit has been revalidated or a new permit has been issued out by the Issuer.

4.10.3 Prior to the revalidation or issuance of a new permit, the Issuer shall visit the work Site to ensure that there is no imminent hazard/risk present and that the Work Site is safe to work.

4.10.4 All workers have the right to stop work should they find an unsafe condition after inspection of the Work Site and work methods that the conditions listed in the permit are not being followed.

4.10.5 Should the work conditions change significantly, e.g., underground services being found where not expected, a positive gas reading in excess of the levels mentioned above, or other such circumstances, the work must be immediately stopped and the Issuer informed. In such cases, the permit will be reviewed and if necessary cancelled and a new PTW issued taking account of new circumstances.

5.0 REFERENCES

AMS-710-05-PR-01700	Work Area Hazard Assessment Process
AMS-710-02-PR-01600	Excavation and Trenching
AMS-710-02-PR-01700	Confined Space Entry

6.0 TERMINOLOGY

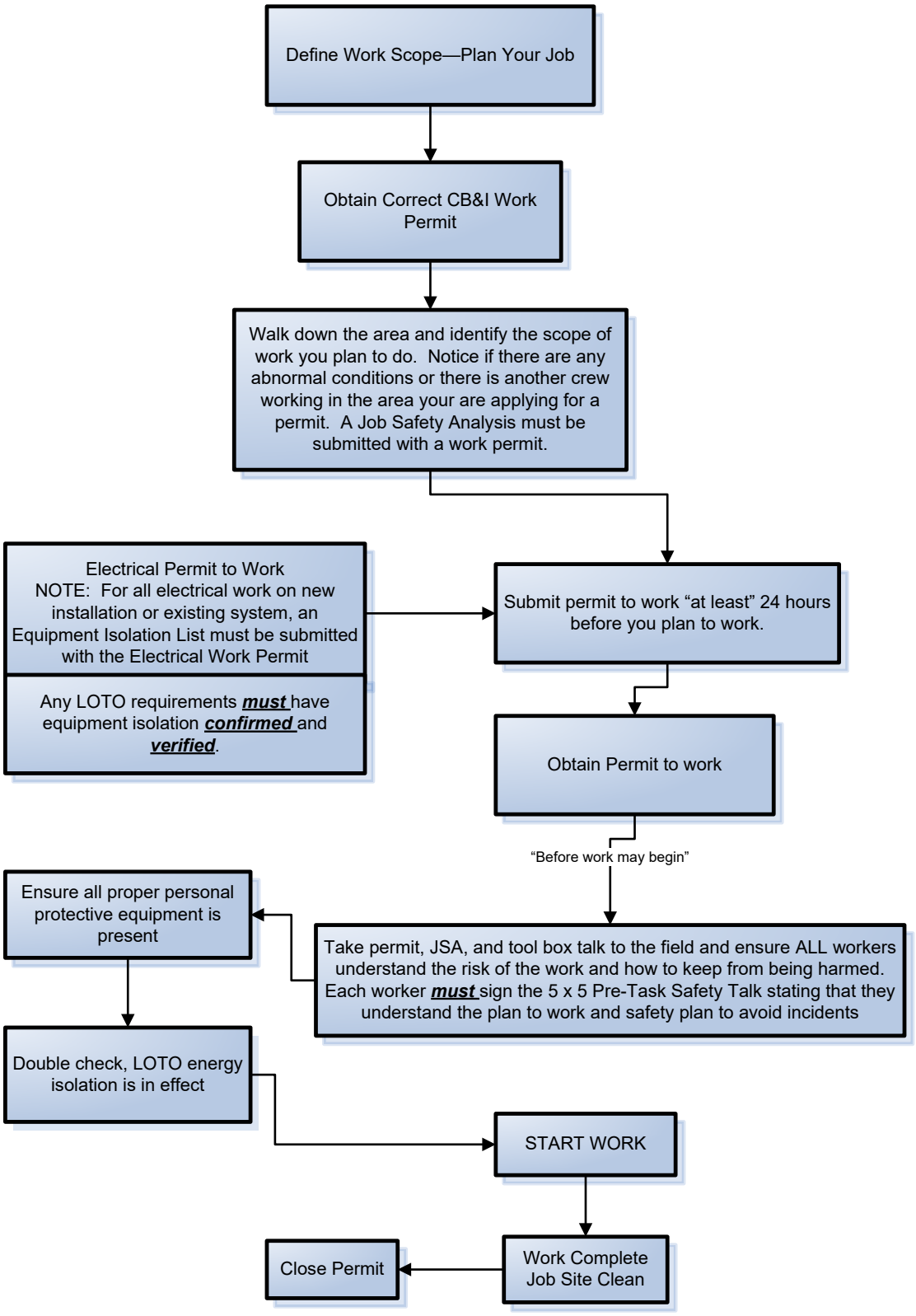
Term	***Definition***
Executor	• This is the person responsible for initiating the PTW and supervising the work specified in the PTW. • The Executor may be APTIM or subcontractor.
Issuer	• For activities taking place within the site, the Issuer will always be APTIM or supervisors nominated by the Site Construction Manager and Site HSE Manager to approve the permits. • APTIM will develop and maintain a list of positions authorized to issue permits, including nominated personnel allowed to sign.
Site	Any location, facility, or project where APTIM is performing work. Sites may include, but are not limited to, laboratories, offices, shops, owned facilities, leased facilities and/or project sites.
The Authorized Gas Testers (AGT)	• The only personnel authorized to perform initial gas tests required for permit validation. Authorized Gas testers must pass the AGT training course provided by APTIM. • Initial gas tests for the validation of PTW' s may only be carried out by AGT' s from APTIM, follow up testing during the working day may then be performed by AGT' s from the subcontractor.

7.0 EXHIBITS

Exhibit 7.1	PTW Flow Chart
Exhibit 7.2	AMS-720-01-FM-00020 – Business Glossary
Exhibit 7.3	AMS-720-01-FM-00021 – Technical glossary

8.0 ATTACHMENTS

None


Define Work Scope—Plan Your Job
Obtain Correct CB&I Work Permit
Walk down the area and identify the scope of work you plan to do. Notice if there are any abnormal conditions or there is another crew working in the area your are applying for a permit. A Job Safety Analysis must be submitted with a work permit.
Electrical Permit to Work
NOTE: For all electrical work on new installation or existing system, an Equipment Isolation List must be submitted with the Electrical Work Permit
Any LOTO requirements must have equipment isolation confirmed and verified.
Submit permit to work "at least" 24 hours before you plan to work.
Obtain Permit to work
"Before work may begin"
Ensure all proper personal protective equipment is present
Take permit, JSA, and tool box talk to the field and ensure ALL workers understand the risk of the work and how to keep from being harmed. Each worker must sign the 5 x 5 Pre-Task Safety Talk stating that they understand the plan to work and safety plan to avoid incidents
Double check, LOTO energy isolation is in effect
START WORK
Work Complete Job Site Clean
Close Permit

PROCEDURE

Procedure Title:	**Medical Surveillance Program**	**AMS Number:**	**AMS-710-01-PR-05000**
Procedure Owner:	**HSE**	**Issuing Authority:**	**APTIM Quality Management**

MEDICAL SURVEILLANCE PROGRAM

INT	Issued for Interim Use	M. Hadacek & S. Lachney	7/30/2017
Rev	**Changes**	**Approved**	**Date**

1.0 PURPOSE

The purpose of this Procedure is to establish the minimum requirements for the implementation and management of the Medical Surveillance Program.

2.0 SCOPE

This procedure applies to all APTIM employees and temporary employees associated with a APTIM site.

Subcontractors and lower tier subcontractors (a lower tier subcontractor is any subcontractor at any level working on any company project whether directly with APTIM or through a third party) are required to provide documentation that they maintain, at a minimum, a medical surveillance program equal to this procedure.

3.0 RESPONSIBILITIES

The following personnel have responsibilities defined in this procedure.

- APTIM Managers
- APTIM Supervisors
- APTIM Employees
- APTIM Contractors
- APTIM Subcontractors
- APTIM Vendors
- APTIM Site Visitors

4.0 PROCEDURE

4.1 Medical screening and medical surveillance are two fundamental necessities for ensuring the health and safety of employees when used in conjunction with AMS-710-01-PR-02300 Occupational Health Plan. Medical screening is, in essence, only one component of a comprehensive medical surveillance program. Occupational health regulations concerning “medical surveillance” requirements are generally a combination of medical screening and medical surveillance and are clinically focused with information obtained from the clinical processes used in the monitoring and analysis of results.

4.2 The company’s Medical Surveillance Program consists of various examination protocols which vary based upon each employee’s essential job functions, site specific requirements, and jurisdictional regulatory requirements.

4.3 General

4.3.1 APTIM reserves the right to modify this procedure at any time consistent with changes in medical procedures, technologies, laws, or APTIM's operational needs. This procedure shall not, in any event, alter the basic "at will" status of any employee, nor shall it create any expressed or implied contractual rights relative to employment with APTIM.

4.3.2 This procedure is subject to the regulations, laws, and customs of the jurisdictions in which the work will occur; therefore, each APTIM site will use this procedure as a template to create a site specific medical surveillance procedure.

4.3.3 This procedure is intended to set forth the minimum medical surveillance program standards for APTIM. In accordance with the applicable authority matrices, business groups or projects may implement more stringent requirements as needed to satisfy any specific industry concerns, additional contractual, legal, and/or regulatory obligations that may be applicable.

4.3.4 Medical surveillance exams and consultations will be performed by or under the direct supervision of a licensed physician and all medical test analyses should be performed

by a laboratory that has demonstrated satisfactory performance in an established inter-laboratory testing program and meets the minimum requirements for certification in the jurisdiction in which it is located.

4.3.5 APTIM will provide medical surveillance exams at a reasonable time and location, at no cost to the employee and without loss of pay.

4.3.6 The licensed physician providing written opinion may review the result of any associated drug screen against the medical questionnaire when evaluating the final opinion. Failure to disclose any medical condition or the use of any prescribed medication capable of affecting the employee's mental and/or physical ability to perform the essential functions of the job on the medical questionnaire is a violation of this procedure and is grounds for disciplinary action up to and including termination.

4.4 Baseline Medical Protocols

4.4.1 Employees will be subject to pre-employment and pre-placement baseline examination based on the essential functions of the job, site-specific requirements, and the regulatory requirements of the jurisdiction. Baseline examinations are performed on a conditional post offer basis, and when potential hazardous exposures are identified by the project site's hazardous risk assessment.

4.4.1.1 All baseline examinations are conducted strictly upon a post-offer of employment and/or pre-placement basis. The individual responsible for scheduling the examinations must verify that a formal offer of employment has been made and the offer accepted prior to arranging the exam.

4.4.1.2 Following an employment offer and prior to becoming an active employee, the prospective employee will be tested for alcohol and illegal drugs. No prospective employee will begin work on any project or at any subcontractor location without submitting to and successfully passing an approved pre-employment drug test pursuant to the requirements set forth in the Substance Abuse Program procedure AMS-710-01-PR-03600.

4.4.1.3 Offer letters must be provisioned that the receipt of a negative drug/alcohol screen result and physician written opinion (PWO) noting that an individual is medically fit to perform the specific job assignment is required prior to proceeding with employment.

4.4.2 All employees whose job functions involve potential exposure at or above action levels are subject to periodic/annual examinations as required by the occupational health laws of the jurisdiction.

4.4.3 Employees who participate in the asbestos medical surveillance program must follow the requirements set forth in AMS-710-01-PR-02500 Asbestos on the Job.

4.5 Periodic/Annual Medical Protocols

The frequency and content of examinations will vary based on the essential functions of the job, site-specific requirements, and the regulatory requirements of the jurisdiction. More frequent examinations may be necessary, depending on the extent of potential or actual exposure, the type of chemicals involved, the duration of the work assignment, and the individual worker's profile.

4.6 Exit Protocols

At the end of employment, all personnel in the medical surveillance program should complete an Exit Examination Acceptance/Declination form. Exit examinations are required for all employees leaving the company unless their most recent exam is less than six months old.

4.7 Medical Surveillance Protocols – Baseline, Periodic/Annual, and Exit, as applicable, includes but is not limited to:

1. 1,2-dibromo-3-chloropropane

2. 1,3-Butadiene
3. Acrylonitrile
4. Arsenic (Inorganic) (AMS-710-01-PR-02900)
5. Asbestos (Construction and Shipyards)
6. Asbestos (General Industry)
7. Benzene (AMS-710-01-PR-03000)
8. Bloodborne Pathogens (AMS-710-01-PR-00300)
9. Cadmium
10. Carcinogens (Suspect)
11. Chromium(VI), Hexavalent Chromium (AMS-710-01-PR-03800)
12. Coke Oven Emissions
13. Compressed Air Environments
14. Crane Operator Exam
15. Designated Qualified Operator Exam (DQO)
16. Diver Exam
17. Diver Medical Exam
18. DOT Exam (Department of Transportation)
19. Ethylene Oxide
20. Fit for Duty Exam – Craft, Professional/Salary, and Clean Construction (Union/Non-Union) (AMS-710-01-PR-01100)
21. Fit for Duty Exam – Field Labor (AMS-710-01-PR-01100)
22. Formaldehyde
23. Functional Assessment Exam
24. GE Hudson Exam
25. HAZWOPER Field Exposure
26. Knoll's Atomic Power Laboratory (KAPL)
27. Laboratory - Hazardous Chemicals
28. Lead (AMS-710-01-PR-02700)
29. Medical Surveillance Exams – Baseline, Periodic/Annual, and Exit (AMS-710-01-PR-03500)
30. Methylene Chloride
31. Methylenedianiline
32. Noise (AMS-710-01-PR-00900)
33. Pre-Placement General Labor Exam
34. Quantitative/ Qualitative Respirator Fit Test
35. Respirator Certification Exam (AMS-710-02-PR-03500)
36. U.S. Army Corp of Engineers (USACE)
37. Vaccinations (Business Travel and Potential Exposure)
38. Vinyl Chloride

4.8 Physician Written Opinions (PWO)

4.8.1 It is important to note that physician written opinions (PWO) are not considered confidential medical records. The physician written opinion (PWO) is designed and intended to communicate employee medical clearances, restrictions, and disqualifications to management and the employee. A physician written opinion (PWO) that notes restrictions will be signed by both the employee and the employee's manager.

4.8.2 The physician written opinion (PWO) must include:

a. Name of the individual
b. Date of the exam
c. Employee number or personal identification numbers
d. Name of the specific regulation upon which the medical opinion was based (if applicable)

e. If any detected medical conditions would place the employee at increased risk of material impairment of the employee's health while working in the specific job position

f. Recommended limitations/restrictions upon the employee's assigned work

g. If the employee is unable to perform his or her job duties with or without accommodations

h. If the employee has been informed of the examination results

i. Any medical recommendations for respirator use such as:

- No limitations,
- Medically not able to wear a respirator,
- May wear a respirator for escape only,
- Any specific limitations that have been placed on the use of the respirator, and
- If the document has been provided to the employee.

j. Date, printed name, and signature of the licensed physician providing the opinion

4.8.3 Whenever a restricted medical clearance is issued, the HSE manager, Human Resource manager, and hiring manager will be notified and will determine if the medical restriction will have an impact on the employee's ability to perform the essential duties of the intended job.

Specifically, all persons must be able to perform the essential functions of their job, with or without reasonable accommodations, and without posing a direct threat to the health and safety of themselves or others.

4.9 Re-Hiring Former Employees

4.9.1 When a former employee is being re-hired, if the most current company medical examination is less than six months old and the HSE manager can confirm that the individual was not subject to hazardous exposures during non-company employment, the HSE manager may choose to waive a new baseline examination. Periodic/Annual examinations will be based on the most recent examination date rather than a new date of hire.

4.9.2 Returning former employees shall be subject to post offer/pre-employment drug and alcohol testing at the time of re-hire unless the break in service has been less than 30 days, as permitted under the laws and customs of the jurisdiction in which the employee is employed.

5.0 REFERENCES

AMS-710-01-PR-02900	Arsenic Exposure Control Program
AMS-710-01-PR-02500	Asbestos on the Job
AMS-710-01-PR-00300	Bloodborne Pathogens
AMS-710-01-PR-03000	APTIM Benzene Safety Program
AMS-710-01-PR-02700	Construction Lead Hazard Abatement Program
AMS-710-01-PR-01100	Fitness for Duty Program
AMS-710-01-PR-03800	Hexavalent Chrome
AMS-710-01-PR-03500	Medical and Exposure Records
AMS-710-01-PR-00900	Noise Control and Hearing Conservation
AMS-710-01-PR-02300	Occupational Health Plan

AMS-710-02-PR-03500	Respiratory Protection
AMS-710-01-PR-03600	Substance Abuse Program

6.0 TERMINOLOGY

Term	***Definition***
Fitness for Duty	The employees' physical, mental, and medical qualifications to perform their job duties
Toxic Substance or Harmful Physical Agent	Any chemical substance, biological agent (bacteria, virus, fungus, etc.), or physical stress (noise, heat, cold, vibration, repetitive motion, ionizing and non-ionizing radiation, hypo-hyperbaric pressure, etc.) which: (1) be listed in the latest edition of the NIOSH Registry of Toxic Effects of Chemical Substances, (2) have yielded positive evidence of an acute or chronic health hazard in testing conducted by or known to the employer, or (3) be the subject of a material safety data sheet (MSDS) kept by or known to the employer indicating that the material may pose a hazard to human health.

7.0 EXHIBITS

Exhibit 7.1	AMS-720-01-FM-00020 – Business Glossary
Exhibit 7.2	AMS-720-01-FM-00021 – Technical Glossary

8.0 ATTACHMENTS

None

PROCEDURE

Procedure Title:	**Sanitation and Potable Water**	**AMS Number:**	**AMS-710-01-PR-01000**
Procedure Owner:	**HSE**	**Issuing Authority:**	**APTIM Quality Management**

SANITATION AND POTABLE WATER

INT	Issued for Interim Use	M. Hadacek & S. Lachney	7/30/2017
Rev	**Changes**	**Approved**	**Date**

AMS Number:	Revision:	Approval Date:
AMS-710-01-PR-01000	INT	7/30/2017

1.0 PURPOSE

The purpose of this Procedure is to establish the minimum requirements for Sanitation and Potable Water on APTIM sites.

2.0 SCOPE

This procedure applies to all APTIM employees, contractors, subcontractors and visitors associated with an APTIM site.

3.0 RESPONSIBILITIES

The following personnel have responsibilities defined in this procedure:

- APTIM Managers
- APTIM Supervisors
- APTIM Employees
- APTIM Contractors
- APTIM Subcontractors
- APTIM Visitors

4.0 PROCEDURE

APTIM sites shall ensure they follow the Sanitation and Potable Water requirements in this procedure.

4.1 Potable Water

4.1.1 An adequate supply of potable water shall be provided in all places of employment.

4.1.2 Portable containers used to dispense drinking water shall be capable of being tightly closed, sealed, and equipped with a tap. Water shall not be dipped from containers.

4.1.3 Any container used to distribute drinking water shall be clearly marked as to the nature of its contents and the current fill date, and shall not be used for any other purpose.

4.1.4 A common drinking cup shall not be used for potable water facilities.

4.1.5 Where single service cups (disposable) are supplied, both a sanitary container for the unused cups and a receptacle for disposing of the used cups shall be provided.

4.1.6 Drinking Water containers shall be cleaned and sanitized on a daily basis according to the following steps:

4.1.6.1 The individual assigned to the task of cleaning the containers shall wash their hands with soap and water and put on disposable or rubber gloves.

4.1.6.2 The outside of the container shall be rinsed off prior to opening the container.

4.1.6.3 Containers are to be washed with a detergent daily. Hot water shall be used when available. Dishwashing liquid and a scrub brush or sponge shall be used to clean the containers.

4.1.6.4 Containers are to be rinsed with clean water to remove all soap residues.

4.1.6.5 Containers are to be sanitized using the following method:

- Rinse containers in a solution of 2 tablespoons of chlorine bleach in one gallon of water.
- Rinse containers in clean water.
- When a location is available, the containers shall be allowed to air dry prior to refilling.

- Containers should be cleaned on an elevated or grated, platform to keep them from being subjected to dirt and grime.

4.1.6.6 Potable water shall be sampled periodically and records maintained of the sample results or appropriate documentation verifying the water meets the quality standards prescribed in the U.S. Public Health Service Drinking Water Standards, published in 42 CFR Part 72, or water which is approved for drinking purposes by the State or local authority having jurisdiction.

4.2 Non-potable Water

4.2.1 Outlets for non-potable water, such as water for industrial or fire fighting purposes only, shall be identified by signs to indicate clearly that the water is unsafe and is not to be used for drinking, washing or cooking purposes.

4.2.2 There shall be no open or potential cross-connection between a potable water system and a non-potable water system.

4.3 Toilets at Construction Projects

4.3.1 Temporary toilets shall be maintained in accordance with Federal, State, or Local ordinances.

4.3.2 Toilets shall be constructed to shield the occupants from view and protect against weather and falling objects.

4.3.3 Toilets shall be ventilated and all windows and vents screened.

4.3.4 All toilet facilities shall be cleaned and emptied on a regular basis and an adequate supply of tissue shall be made available according to project needs.

4.3.5 All toilet facilities shall be located on the project so that clear access is provided for cleaning and servicing.

4.3.6 Toilets shall be placed where users do not exit into roadways.

4.3.7 The following table provides the minimum number of toilet facilities to be provided for employees:

Number of employees	Minimum number of facilities
20 or less	1
20 or more	1 toilet seat and 1 urinal per 40 workers
200 or more	1 toilet seat and 1 urinal per 50 workers

4.4 Washing Facilities

4.4.1 Lavatories shall be made available in all places of employment.

4.4.2 The washing facilities shall be maintained in a sanitary condition.

4.4.3 Each lavatory shall be provided with running, potable water.

4.4.4 Hand soap or similar cleansing agents shall be provided.

4.4.5 Individual hand towels or sections thereof, of cloth or paper, warm air blowers or clean individual sections of continuous cloth toweling, convenient to the lavatories shall be provided.

4.4.6 Whenever showers are required by a particular standard, the showers shall meet the following requirements:

4.4.6.1 One shower shall be provided for each 10 employees of each sex, or numerical fraction thereof, who are required to shower during the same shift.

4.4.6.2 Body soap or other appropriate cleansing agents shall be provided.

4.4.6.3 Showers shall be provided with hot and cold water feeding a common discharge line.

4.4.6.4 Employees who use showers shall be provided with individual clean towels.

4.5 Eating and drinking areas

4.5.1 No employees shall be allowed to consume food or beverages in a toilet room or in any area exposed to a toxic material.

4.5.2 Eating and drinking will be allowed only in designated areas.

4.6 Vermin Control

Every enclosed workplace shall be so constructed, equipped, and maintained so far as reasonable to prevent the entrance or harbouring of rodents, insects, and other vermin. A continuous, effective extermination program shall be instituted where their presence is detected.

4.7 Change rooms

Whenever employees are required by a particular standard to wear protective clothing because of the possibility of contamination with toxic materials, change rooms equipped with storage facilities for street clothes and separate storage facilities for the protective clothing shall be provided.

5.0 REFERENCES

Title 29 CFR (Code of Federal Regulation) 1926.27	Sanitation
Title 29 CFR (Code of Federal Regulation) 1926.51	Sanitation
American National Standards Institute (ANSI) Z4.1	Sanitation in Places of Employment-Minimum Requirements
ANSI Z4.3	Sanitation-Non-sewered Waste-Disposal Systems – Minimum Requirements
ANSI Z4.4	Sanitation in Fields and Temporary Labor Camps – Minimum Requirements
Title 42 Code of Federal Regulations (CFR) Part 72	Occupational Injury and Illness Recording and Reporting
ANSI Z4.4	Sanitation in Fields and Temporary Labor Camps – Minimum Requirements

6.0 TERMINOLOGY

Term	***Definition***
Potable Water	Water that meets the quality standards prescribed in the US Public Health Service Drinking Water Standards, published in 42 CFR Part 72, or water that is approved for drinking purposes by the State or local authority having jurisdiction.
Site	Any location, facility or project where APTIM is performing work. Sites may include, but are not limited to, laboratories, offices,

shops, owned facilities, leased facilities and/or project sites.

7.0 EXHIBITS

Exhibit 7.1	AMS-720-01-FM-00020 – Business Glossary
Exhibit 7.2	AMS-720-01-FM-00021 – Technical Glossary

8.0 ATTACHMENTS

None

PROCEDURE

Procedure Title:	**Excavation and Trenching**	**AMS Number:**	**AMS-710-02-PR-01600**
Procedure Owner:	**HSE**	**Issuing Authority:**	**APTIM Quality Management**

EXCAVATION AND TRENCHING

INT	Issued for Interim Use	M. Hadacek & S. Lachney	7/30/2017
Rev	**Changes**	**Approved**	**Date**

1.0 PURPOSE

This procedure establishes the minimum requirements for Excavation and Trenching activities on APTIM sites.

The following deliverables are defined within this procedure:

- Excavation Permit (AMS-710-02-FM-01601)
- Daily Excavation Inspection Form (Short) (AMS-710-02-FM-01602)
- Daily Excavation Inspection Form (long) (AMS-710-02-FM-01603)
- Soil Classification Worksheet (AMS-710-02-FM-01604)
- Excavation and Trenching Awareness training for affected employees

2.0 SCOPE

This procedure is to be utilized for all excavation and trenching activities on APTIM sites.

3.0 RESPONSIBILITIES

The following personnel have responsibilities defined in this procedure:

- APTIM Managers
- APTIM Superintendent
- APTIM Supervisors
- APTIM Employees
- APTIM Contractors
- APTIM Subcontractors
- APTIM Visitors

4.0 PROCEDURE

This procedure establishes the minimum requirements for work, activities, inspections, and training, required for work in and around excavation and trenching operations on APTIM sites. This procedure will also apply to all APTIM subcontractors.

4.1 General

4.1.1 A designated Competent Person shall be onsite at all times when excavation activities are conducted.

4.1.2 APTIM Supervisors shall ensure employees, contractors, subcontractors, and visitors meet the requirements listed in this procedure when conduction excavation and trenching work.

4.1.3 Before any excavation can be started, an Excavation Permit (AMS-710-02-FM-01601) must be completed by the responsible Superintendent or equivalent with input from the Authorized Person for underground testing (utility identification) and the Excavation Competent Person. Appropriate Client approval and use of Client Excavation permit is also necessary where required by Client regulations. Client and/or utility company representatives shall be notified 24 hours prior to beginning excavations.

4.1.4 Underground Storage Tank (UST) Removal

AMS-710-02-WI-01601 contains specific instructions for trenches and excavations relating to UST removal.

4.1.5 Underground Utilities

4.1.5.1 Utility locating personnel shall locate and mark all known underground utilities within excavation area using utility locating equipment and

techniques. The utilities shall be marked with paint or flags. For more guidance, please refer to AMS-710-02-PR-01610 (Identifying Underground Installations).

4.1.5.2 At least 3 feet (0.9144 m) of clearance between any underground utility and the cutting edge or point of powered excavation equipment will be maintained until the precise location of the utility is determined. Initial excavation within this 3 foot area will be conducted manually.

4.1.5.3 All utilities exposed during an excavation will be protected from accidental damage. Machine excavation within 3 feet (0.9 m) of a located utility requires a spotter.

4.1.5.4 The underground utilities information obtained shall be provided to affected personnel via the job safety analysis (JSA). Underground utilities information, in relation to proposed excavation work, means the following information about underground essential services that may be affected by the excavation:

- The utilities that may be affected
- The location, including the depth, of any pipes, cables or other plant associated with the affected essential services
- Any conditions on the proposed excavation work.

4.1.5.5 Any essential services information obtained must be readily available for inspection. The information must be available:

- For at least two (2) years after the incident occurs
- In every other case, until the excavation work is completed.

4.1.5.6 When working on a pressurized liquid system (i.e., site service water, processed cooling water, pumped sanitary system) with piping 1” or more in diameter in an excavation 4 foot or greater in depth where an engulfment hazard exists must:

- De-energize and drain the system
- Lockout/Tagout
- All persons entering the excavation, whether working on the system or not shall apply safety locks and danger tags to the system in accordance with AMS-710-02-PR-01500, Control of Hazardous Energy.
- No personnel shall be allowed in the excavation during pressure/leak testing.

4.1.6 The work area around a excavation over 4 feet (1.2 m) deep shall be, so far is reasonably practicable, secured from unauthorized access (including inadvertent entry).

4.1.7 When mobile equipment is operated adjacent to an excavation, and the operator does not have a clear and direct view of the edge of the excavation, a warning system shall be utilized such as barricades, hand or mechanical signals, or stop logs.

4.1.8 Soil classification shall be made by the Competent Person or a registered Professional Engineer trained in soil classification. Based on the results of tests described in Exhibit 7.4, “Soil Classification Worksheet,” the competent person will classify each soil/rock deposit as stable rock, Type A, Type B, or Type C. When layers of soil/rock exist, the weakest layer will be classified; however, each layer may be classified individually when a more stable layer lies under a less stable layer. If the properties or conditions of a soil/rock deposit change in any way, re-evaluation will be required. Unclassified soil shall be assumed to be Class “C” and will be sloped 1½:1 or shored when the excavation exceeds 4 feet (1.2 m) in depth.

4.1.9 Each employee in an excavation shall be protected from cave-ins. Excavations over 4 feet (1.2 m) deep shall be shored, sloped, or benched as required. Excavations and the

work scheduled to be performed in the excavation shall be evaluated by the Competent Person to determine if the shoring, sloping, or benching needs to begin at a depth less than 4 feet (1.2 m).

4.1.10 Shoring for excavations over 20 feet deep (6 m) shall be designed by a registered Professional Engineer and shoring installed shall be approved and signed off by a registered Professional Engineer.

4.1.11 Spoils must be placed a minimum of 3 feet (0.9 m) from the edge of the excavation. Loose soil or rocks shall be removed from the sides of excavation walls.

4.1.12 Excavations 4 feet (1.2 m) in depth or greater, shall have a stairway, ladder, ramp, or other safe means of egress within 25 feet (7.6 m) of any employee. Excavations that are less than 4 feet (1.2 m) in depth shall have safe access and egress for all employees with a maximum break in elevation of 19 inches (48.3 cm).

4.1.13 Structural ramps that are used solely by employees as a means of access or egress from excavations shall be designed by a competent person.

4.1.14 Structural ramps used for access or egress of equipment shall be designed by a competent person qualified in structural design, and shall be constructed in accordance with the design.

4.1.15 Excavations shall be inspected by a Competent Person and the results recorded on either AMS-710-02-FM-01602 or AMS-710-02-FM-01603:

4.1.15.1 Prior to entry

4.1.15.2 After rain or snowfall

4.1.15.3 After freezing and/or thawing temperatures occur

4.1.15.4 After any condition that can change the integrity of the soil

4.1.16 During rainy weather, work in excavations shall cease until the Competent Person has evaluated the excavation and the effect of the rain on the excavation. The Competent Person will maintain a regular inspection schedule to ensure the excavation stability and condition during rain events if employees continue to work in the excavation. Depending on the amount of rainfall, the duration of the rainfall and the soil type, the Competent Person may need to maintain continuous observation of the excavation conditions.

4.1.17 For excavations that have the potential for oxygen deficiency or to contain hazardous atmosphere, an atmosphere evaluation shall be performed. This test will be performed by the Construction HSE Manager or their designee. Indications of the potential for a hazardous atmosphere include, but are not limited to: gas lines, sewer lines, areas with hydrocarbons, and proximity to emissions sources for H_2S, SO_2, CO, CO_2 and other gases that are heavier than air. Excavations with hazardous atmospheres should be treated as a confined space.

4.1.18 Excavations shall be evaluated for hazards in addition to cave-in potential and atmospheric hazards. Electrical sources, energized (pressurized) pipes, underground tanks, etc. may also present a hazard to employees who are required to enter an excavation.

4.1.19 The Competent Person responsible for the crew working in the excavation shall inspect the excavation throughout the work period, record the observations on AMS-710-02-FM-01602, and stop operations when unsafe conditions exist.

4.1.20 Water shall not be allowed to accumulate in excavations at any time. Pumps, drains, or other means shall be used to remove water constantly.

4.1.21 Where the stability of adjoining buildings, walls, or other structures is endangered by excavation operations, support systems shall be provided, such as shoring, bracing, or underpinning to ensure the stability of such structures. Excavation below the level of the

base or footing of any foundation or retaining wall that could be reasonably expected to pose a hazard to employees shall not be done unless:

- A support system, such as underpinning, is provided to ensure the safety of employees and the stability of the structure;
- The excavation is in stable rock;
- A registered professional engineer has determined that the structure is sufficiently removed from the excavation so that it will be unaffected by the excavation activity; or
- A registered professional engineer has determined that such excavation work will not pose a hazard to employees.

4.1.22 Sidewalks, pavements and appurtenant structures shall not be undermined unless a support system or another method of protection is provided to protect employees from the possible collapse of such structures. The support system shall be capable of withstanding a minimum live load of 125 lb/ft.

4.1.23 Emergency rescue plans shall be developed and rescue equipment shall be readily available.

4.1.24 Employees will not be permitted to work under loads or near digging equipment. Employees shall be required to stand away from any vehicle being loaded or unloaded to avoid being struck by spillage or falling materials. Operators may remain in the cabs of vehicles being loaded or unloaded provided the vehicles are equipped with a cab shield and/or canopy adequate to protect the operator from shifting or falling materials.

4.1.25 Employees exposed to falls by excavation crossings and walkways will be provided with fall protection in accordance with Procedure AMS-710-02-PR-00900 - Fall Protection.

4.2 Training

4.2.1 Employee Training

4.2.1.1 Each employee who works in or around an excavation shall be trained to recognize potential hazards associated with excavations: cave-in potential, fall hazards, safe entry and exit, proximity to excavating equipment, air quality, back-filling and compacting activities, protective systems, etc. This training shall be documented in accordance with AMS-710-05-PR-01900 (HSE Education and Training) and records maintained in the Site HSE files

4.2.1.2 Each individual assigned as an Excavation Competent Person shall have documented training (see 4.2.1.1) or shall send documentation of experience and qualifications in excavation activities to the Global HSE Education and Training Director for review.

5.0 REFERENCES

AMS-710-02-PR-00900	Fall Protection
AMS-710-02-WI-01601	Underground Storage Tank Removal
AMS-710-02-PR-01500	Control of Hazardous Energy
AMS-710-02-PR-01610	Identifying Underground Installations
AMS-710-05-PR-01900	HSE Education and Training

6.0 TERMINOLOGY

Term	***Definition***
Accepted Engineering Practices	Those requirements that are compatible with standards of practice required by a registered professional engineer.

Angle of Repose	The greatest angle above the horizontal plane at which a material will lie without sliding.
Authorized Person for Underground Testing	The person(s) designated by the Construction Manager to identify underground utilities using a combination of blue prints and underground testing equipment. This individual shall coordinate excavation activities with the Client (as applicable) and outside utility companies. Several individuals (such as the Piping Superintendent, Electrical Superintendent, Equipment Superintendent, and Field Engineer) may serve as Authorized Persons as necessary.
Benching (Benching system)	A method of protecting employees from cave-ins by excavating the sides of an excavation to form one or a series of horizontal levels or steps, usually with vertical or near-vertical surfaces between levels.
Cave-In	The separation of a mass of soil or rock material from the side of an excavation, or the loss of soil from under a trench shield or support system, and its sudden movement into the excavation, either by falling or sliding, in sufficient quantity so that it could entrap, bury, or other wise injure and immobilize a person.
Competent Person	One who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.
Excavation	Any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal.
Excavation Competent Person	A person capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them. The Construction Manager and Construction HSE Manager shall designate the Competent Person in writing and their qualifications shall be documented.
Hazardous Atmosphere	An atmosphere which by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen deficient, toxic, or otherwise harmful, may cause death, illness, or injury.
Protective System	A method of protecting employees from cave-ins, from material that could fall or roll from an excavation face, into an excavation, or from the collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, shield systems, and other systems that provide the necessary protection.
Ramp	An inclined walking or working surface that is used to gain access to one point from another, and is constructed from earth or from structural materials such as steel or wood.
Registered Professional Engineer	A person who is registered as a professional engineer in the state where the work is to be performed. However, a professional engineer, registered in any state is deemed to be a “registered professional engineer” within the meaning of this standard when approving designs for "manufactured protective systems" or “tabulated data” to be used in interstate commerce.

Sheeting	Members of a shoring system that retain the earth in position and in turn are supported by other members of the shoring system.
Shield	A structure that is able to withstand the forces imposed on it by a cave-in and thereby protect employees within the structure. Shields can be permanent structures or can be designed to be portable and moved along as work progresses. Shields may be pre-manufactured or job-built in accordance with 29 CFR 1926.652(c)(3) or (c)(4). Shields used in trenches are usually referred to as "trench boxes" or "trench shields."
Shoring (Shoring System)	A structure such as a metal hydraulic, mechanical or timber shoring system that supports the sides of an excavation and which is designed to prevent cave-ins.
Site	Any location, facility or project where APTIM is performing work. Sites may include, but are not limited to, laboratories, offices, shops, owned facilities, leased facilities and/or project sites.
Sloping (Sloping System)	A method of protecting employees from cave-ins by excavating to form sides of an excavation that are inclined away from the excavation so as to prevent cave-ins. The angle of incline required to prevent a cave-in varies with differences in such factors as the soil type, environmental conditions of exposure, and application of surcharge loads.
Stable Rock	Natural solid mineral material that can be excavated with vertical sides and will remain intact while exposed. Unstable rock is considered to be stable when the rock material on the side or sides of the excavation is secured against caving-in or movement by rock bolts or by another protective system that has been designed by a registered professional engineer.
Structural Ramp	A ramp built of steel or wood, usually used for vehicle access. Ramps made of soil or rock is not considered structural ramps.
Support System	A structure such as underpinning, bracing, or shoring that provides support to an adjacent structure, underground installation, or the sides of an excavation.
Tabulated Data	Tables and charts approved by a registered professional engineer and used to design and construct a protective system.
Trench (Trench Excavation)	A narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than 15 feet (4.6 m). If forms or other structures are installed or constructed in an excavation so as to reduce the dimension measured from the forms or structure to the side of the excavation to 15 feet (4.6 m) or less (measured at the bottom of the excavation), the excavation is also considered to be a trench.
Type A Soil	Cohesive soils with an unconfined compressive strength of 1.5 ton per square foot (tsf) (144kPa) or greater. Examples of cohesive soils are clay, silty clay, sandy clay, clay loam and, in some cases, silty clay loam and sandy clay loam. Cemented soils such as caliche and hardpan are also considered Type A. However, soil is not Type A if: – Soil is fissured

- Soil is subject to vibration from heavy traffic, pile driving, or similar effects
- Soil has been previously disturbed
- Soil is part of a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical (4H:1V) or greater
- Material is subjected to other factors that would require it to be classified as a less stable material

Type B Soil

This classification refers to:

- Cohesive soil with an unconfined compressive strength greater than 0.5 tsf (48 kPa) but less than 1.5 tsf (144 kPa)
- Granular cohesionless soils including angular gravel (similar to crushed rock), silt, silt loam, sandy loam, and, in some cases, silty clay loam and sandy clay loam
- Previously disturbed soils except those which would otherwise be classified Type C soil
- Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured or subjected to vibration
- Dry rock that is not stable

Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than four horizontal to one vertical (4H:1V), but only if the material would otherwise be classified as Type B

Type C Soil

This classification refers to:

- Cohesive soil with an unconfined compressive strength of 0.5 tsf (48 kPa) or less
- Granular soils including gravel, sand, and loamy sand
- Submerged soil or soil from which water is freely seeping
- Submerged rock that is not stable
- Material in a sloped, layered system where the layers dip into the excavation or a slope of four horizontal to one vertical (4H:1V) or steeper

7.0 EXHIBITS

Exhibit 7.1	AMS-710-02-FM-01601 – Excavation Permit
Exhibit 7.2	AMS-710-02-FM-01602 – Daily Excavation Inspection Form (Short)
Exhibit 7.3	AMS-710-02-FM-01603 – Daily Excavation Inspection Form (long)

Exhibit 7.4	AMS-710-02-FM-01604 – Soil Classification Worksheet
Exhibit 7.5	AMS-720-01-FM-00020 – Business Glossary
Exhibit 7.6	AMS-720-01-FM-00021 – Technical Glossary

8.0 ATTACHMENTS

None

CORONA VIRUS CONTROL PLAN

COVID-19 CONTROL PLAN

1.0 GENERAL

Coronavirus Disease 2019 (COVID-19) is a respiratory disease caused by the SARS-CoV-2 virus. The COVID-19 pandemic is impacting all aspects of daily life, including travel, trade, tourism, food supplies, and financial markets. This plan defines location-specific efforts regarding:

- Awareness and Education
- Screening Methods
- Contamination Prevention and Sanitation
- Reporting and Illness/Exposure Management

This COVID-19 Control Program (CCP) is applicable to all APTIM employees at Redstone Arsenal (RSA). APTIM expects subcontractors/visitors/vendors to protect their employees through compliance with APTIM's CCP or through the development and implementation of a COVID-19 control plan specific to their risks. APTIM leadership must approve subcontractor plans, as applicable before implementation at RSA.

These requirements are in effect at least for the duration of the pandemic. The COVID-19 Management Team will amend these requirements or suspend their operation when no longer necessary.

2.0 CONTROLS

2.1 Awareness and Education

A continual assessment of hazards is required to maintain a current awareness of exposures and the effectiveness of current controls. These methods will ensure employees have access to current information on how the pandemic is progressing, known site-specific exposures, site-specific controls and how to effectively implement them, and reporting requirements.

- At a minimum, COVID-19 training shall be provided through internal communications, new hire orientation, daily toolbox talks, risk assessment tools including JSA's, TARGET observation program, Near Miss/Great Catch reporting, findings from inspections, informational postings and informal discussions with supervision or employees.
- All employees reporting to work in an office location must complete the APTIM COVID-19 training available on-line through assignment in Talent Connection.
- On-going assessment of local, state and federal guidelines from organizations such as the Centers for Disease Control (CDC) and Occupational Safety Health Administration (OSHA), are required by all leadership employees to maintain an accurate understanding of the current hazards.
- The APTIM Corporate COVID-19 Management Team meets regularly to evaluate APTIM's pandemic efforts and implement appropriate responses.

- APTIM maintains a Corporate COVID-19 resource page providing guidance from the CDC, World Health Organization (WHO), as well as APTIM-specific information. This page is located on the company intranet and is available to all employees with a company email address.
- Signage: HSE, working with Facilities, will ensure that CDC-recommended signage reminding employees about social distancing, handwashing, and staying home when sick is posted in common areas (restrooms, bulletin boards, lobby, etc.).

2.2 Screening Methods

Employees can be exposed to the virus either at the work location or away from work. Fever, coughing, and shortness of breath are primary symptoms that may be present between two and fourteen days from exposure to the virus. It is critical to remind employees to identify any of these symptoms and to quickly isolate employees who are symptomatic from other employees.

- Employees are reminded to continually evaluate themselves for the onset of any symptoms, particularly tfever, coughing or shortness of breath.
- If the location requires a screening tool at arrival, APTIM will use the screening questionnaire in Appendix 1. [Client-required questionnaires may be used in lieu of Appendix 1 where applicable.]
- If the screening tool in Appendix 1 is used, APTIM may separate individuals and send individuals home or away, as warranted, depending on the answers to questions in the tool, read in accordance with current guidance from the CDC or other applicable health organization.
- Contactless thermometers will be deployed as available and as necessary to assess all individuals for potential fevers prior to entering the workspace.
    - A temperature measured as greater than 100.4 ºF is considered a fever.
        - Individuals registering a fever may sit isolated for no more than 10 minutes before being rechecked to confirm the fever. If a temperature of 100.4 ºF or greater is registered after the second reading, the individual will not be allowed into the workspace and will be turned away/sent home.
- Any employee experiencing symptoms of illness will be isolated from the workforce and turned away/sent home.
- An employee who notices a co-worker exhibiting or complaining of symptoms of acute respiratory illness (fever, coughing, shortness of breath) has Stop Work Authority if they are concerned about another's health. The immediate supervisor should be notified and HSE contacted to evaluate how to proceed and limit further exposure.
    - NOTE: Employees are expected to treat each other with respect and dignity in keeping with APTIM's policies and collaborative culture. **Harassment, bullying or other mistreatment of employees because of a suspicion of symptoms is grounds for discipline, up to and including termination of employment.**

- APTIM may require employees to complete fitness for duty evaluations as needed to respond to an objective concern for the health or safety of an employee and co-workers. A manager/supervisor must discuss a request for a fitness for duty evaluation with HR and HSE in advance; HSE will coordinate the fitness for duty process.

2.3 Contamination Prevention and Sanitation

Current medical understanding is that the virus is primarily transmitted via respiratory droplets when an infected person coughs, sneezes or talks. It may be possible that a person can get COVID-19 by touching a surface or object that has the virus on it and then touching their own mouth, nose or eyes. The virus can potentially survive on varying surfaces from hours to multiple days. Primary routes of entry include the mouth, eyes and nose.

2.3.1 Sick Employees Stay Home

- Any employee who is experiencing symptoms of acute respiratory illness (fever, cough, shortness of breath) shall notify the employee's supervisor and not report to work.

- Employees who are well but who have a sick family member at home with COVID-19 should notify their supervisor and follow CDC recommended precautions.

2.3.2 Social Distancing Practices:

- Whenever possible, everyone is to maintain a minimum 6ft. distance from other people. This practice insulates individuals from potential exposure to respiratory droplets. If situations require close contact, time within 6ft. should be minimized. Employees are also to not touch other employees unless absolutely necessary to complete a task. Any touching should be followed by appropriate disinfecting as soon as possible. Please don't shake hands with other employees; a wave or a nod is a better practice to greet others during this pandemic.
- APTIM supports remote working where it is an efficient and effective option to complete assigned work. APTIM encourages managers to consider carefully before determining that employees who are temporarily working remotely should return to the office environment. APTIM's strong preference during the pandemic is to continue efficient, effective remote working assignments instead of returning employees to office environments. Think carefully about who needs to be in the office and who can still work from home.
- Workspaces, conference rooms, etc. shall be reconfigured, to provide at least 6ft. of distancing. Please do not rearrange, place chairs closer together, or bring in additional seating.
- Avoid congregating in common areas such as lobbies, kitchens, and restrooms and always maintain 6 ft distance. Allow a person to complete their task such as using the microwave and exit the space before entering.
- Visitors, sales representatives, and others whose presence at the location is not business critical are restricted from visiting the location until further notice. The Project Manager must approve any deviation request in advance. All visitors will be required to be met by staff in the lobby where they will be asked to complete the APTIM COVID-19 Questionnaire. [Once

cleared to enter the visitor will be escorted to the temperature monitoring station. Visitors with temperatures above 100.4 degrees will not be allowed to enter and asked to leave.]

- Break times, including lunch times, have been staggered to minimize interactions with others.
- Whenever possible, meetings are to be conducted via teleconference rather than in person. In-person meetings or gatherings must not exceed 10 people and proper social distancing must be enforced.
- Other site-specific measure to maintain distance are captured on the COVID-19 Job Site Practices Activity Hazard Analysis (AHA).
- For project office facilities
    - Employees should not enter another's office until invited. Whenever possible, conduct conversation from the doorway. If privacy/confidentiality is required, the office occupant should invite the other party in, and the parties should don face masks and remain 6-foot distance throughout the discussion.
    - Employees assigned to cubicle workspaces are already limited in their ability to maintain 6-foot distance, and no employee should enter another's cubicle unless necessary and invited. Communication should be conducted via email, phone and Teams/Chat whenever possible. If a discussion is necessary, the parties should locate an available larger space such as a conference room. If the discussion requires the cubicle equipment (such as to discuss and revise a drawing) both parties shall don face masks throughout the interaction.
- Site-specific restroom use is included on the COVID-19 Job Site Practices AHA.

2.3.3 Sanitation Measures:

- Employees should not cover any cough or sneeze with their hands but should use a tissue or their elbow to contain the cough or sneeze. This process reduces contamination on their hands and in the air. Employees must properly wash their hands following any cough or sneeze.
- At a minimum, all employees shall conduct adequate hand washing prior to eating, before and after preparing food, following use of the restroom, following sneezing or coughing, and following touching of the face, especially the mouth, eyes or nose.
    – Adequate hand washing is achieved by following these five steps:
    1. Wet your hands with clean, running water (warm or cold); turn off the tap, and apply soap.
    2. Lather your hands by rubbing them together with the soap. Lather the backs of your hands, between your fingers, and under your nails.
    3. Scrub your hands for at least 20 seconds. Need a timer? Hum the "Happy Birthday" song from beginning to end twice.
    4. Rinse your hands well under clean, running water.
    5. Dry your hands using a clean towel or air dry them.

- An adequate supply of soap must be available to maintain the ability for effective hand washing. **If there is no soap available, hand sanitizing liquid/gel may be utilized as a substitute. If neither option is available, the office/location will be closed unless it is deemed to be "critical" by senior leadership and/or government entities.**
- Do not touch your eyes, nose or mouth. Sores should also stay covered and protected. These measures are to prevent routes of entry.
- Face Masks: Wherever possible, APTIM is working to ensure that employees can work at least 6' away from other individuals, in order to maintain the recommended social distance in this pandemic. Employees working in an area where they can avoid prolonged interaction with others can choose to use a cloth mask (as recommended by the CDC). Please see Appendix 2 for information from the CDC about making cloth masks, directions on how to don and doff these masks, and instructions for properly laundering the masks. The site has a small for use by employees in unexpected/planned close-contact situations that do not have a mask with them.
- HSE will work with employees who are working on tasks that require working within 6' feet of others for a prolonged period to help plan steps to minimize this close contact work and to ensure that, where required, employees have adequate respiratory protection suited to the job task (such as NIOSH-approved, particulate filtering masks). Cloth masks are not a good substitute in these situations.
- [for office locations]: Masks requirements:
    - Employees are not required to wear a mask when;
        - Alone or in an office/cubicle with no interaction with others closer than 6-foot distance
        - In the break room while eating or drinking. During the pandemic employees should confine break/lunchroom time to eating/drinking and avoid lingering or congregating. Stay 6' away from others.
    - Employees must wear masks;
        - Whenever engaged in an interaction/conversation within 6-foot distance
        - When engaged in a conversation inside an office; all parties should don masks upon invitation to enter by the occupant
        - In all common spaces, including conference rooms, elevators, hallways, breakrooms, restrooms, etc.
- Site-specific hand-washing solutions are included on the COVID-19 Job Site Practices AHA
- If means for handwashing are not immediately available, employees should use hand sanitizer containing at least 60% alcohol. Hand sanitizer should not be used in lieu of handwashing if hands are visibly soiled. Hand sanitizer shall be made readily available for employees to frequently disinfect their hands throughout the jobsite.
    - Use hand sanitizer in the following manner:

- Apply the gel product to the palm of one hand. (Read the label to learn the correct amount).
- Rub your hands together.
- Rub the gel over all the surfaces of your hands and fingers until your hands are dry. This process should take around 20 seconds.

- Hand sanitizer should be placed and maintained in strategic locations throughout the workspace.
- Site-specific solutions to janitorial service issues are included on the COVID-19 Job Site Practices AHA.
- Site-specific solutions to restroom cleaning are included on the COVID-19 Job Site Practices AHA.
- [for office locations:] Disinfectant wipes are also available in the printer/copier areas and the kitchens and employees are encouraged to use them to wipe/sanitize touch surfaces as desired. Employees are also encouraged to wipe/disinfect their desks, phones, and keyboards as desired and at least once a day using the wipes provided.
- The procurement and ongoing availability of materials such as soap, disinfectant, PPE, etc. is the responsibility of the site Director/Manager. HSE and Procurement are continually evaluating availability of these products and may assist in this process if requested.
- Some business processes are heavily reliant on the shared handling of paper or other office products. The site must assess and implement measures to minimize exposure to paper, limit interactions among employees, discontinue use of shared pens, use personal protective measures (such as gloves) and disinfect following handling.
- Commonly touched surfaces and items should be identified for cleaning, as well as the frequency required based on the exposure. The CDC recommends that these surfaces be cleaned at least weekly.

2.3.4 Travel Limitations:

- APTIM has suspended all non-essential business travel. Essential business travel must be approved by APTIM Executive Leadership. Anyone approved to travel will be screened prior to reporting back to the jobsite.
- Employees traveling domestically or internationally may be subject to a self-quarantine period and should be familiar with the federal, state and local orders prior to traveling.

2.4 Reporting and Illness Management

2.4.1 General

2.4.1.1 To ensure both prompt medical evaluation and prevention of any potential contamination to the jobsite, APTIM requires employees to immediately report any symptoms (fever, cough, or difficulty breathing), no matter how slight, to their manager, HSE and HR.

2.4.1.2 APTIM will communicate appropriate notifications in accordance with established protocols and in keeping with applicable privacy laws.

2.4.1.3 Employees experiencing symptoms of any illnesses are to stay home and not report to work until symptom and fever-free for at least 24 hours, without the assistance of fever reducing medications. Employees experiencing symptoms consistent with COVID-19 who should stay home and not report to work until the protocols for return to work are met (test based, or symptom based). See below. Please take the necessary steps for your health and safety and the health and safety of your co-workers. Notification to supervision is required.

2.4.1.4 HSE, working with site Leadership and HR, maintains a confidential log of information related to employees who are symptomatic, who test positive for COVID-19, or who were potentially exposed outside of work. The log should include the name of the affected employees, the potential exposure or test date, date of onset and description of symptoms (if symptomatic), information about the exposure event, dates of expected quarantine, and status. HSE, working with site Leadership, also maintains a confidential log of any employees assigned to the jobsite potentially exposed by "close contact" to another COVID-19 positive (test, diagnosed or suspected) employee, including the potential exposure date, any testing information, a description of the potential exposure, the dates of any quarantine period, and a status update.

2.4.1.5 Site Leadership is responsible to notify HSE and HR of any COVID-19 positive (test, diagnosis or suspicion).

2.4.1.6 If an employee's illness appears to be personal and non-emergent, APTIM will direct the employee to see his or her personal health care provider.

2.4.1.7 Cases believed to be emergent in nature without regard to work-relatedness will be handled by following this AMS.

2.4.1.8 Cases potentially work-related will be evaluated at:

Crestwood Workers Care Madison Clinic, 2236 Madison Blvd, Huntsville, AL
Crestwood Family Practice Clinic, 1868 Sparkman Dr. NW, Huntsville, AL
Huntsville Hospital, 878 Madison St. SE, Huntsville, AL

For potentially work-related cases, consideration should be given to allowing the affected employee to self-transport to seek medical care in order to maintain social distancing of 6ft. or greater. Vehicles offering adequate distance, such as passenger vans may also be used. Vehicles used for transport will be disinfected following the trip.

2.4.1.9 Return to Work Protocol

APTIM follows current CDC recommendations for returning employees to work after COVID-19 diagnosis or exposure. Please see Appendix 3 for a flow chart setting forth these criteria. Information about return to work protocols is also contained in the next sections.

A. Person with COVID-19 (tested, diagnosed, or suspected due to symptoms) can return to work after meeting one of the following protocols:

   – Symptom Based Strategy: At least 10 days have passed since symptoms first appeared;
   – At least 24 hours have passed since resolution of fever without the use of fever-reducing medications; and
   – Other symptoms* of COVID-19 have improved.
   – (*Note that loss of taste and smell may persist for weeks or months after recovery and need not delay the end of isolation.
   – Most people do not require testing to decide when they can be around others. However, APTIM employees should follow the advice of their healthcare provider regarding when it is safe for the employee to return to work.

B. People who have not had COVID-19 Symptoms but Tested Positive for COVID-19 can return to work after:

   - At least 10 days have passed since the date of their first positive COVID-19 diagnostic test (assuming they have not developed symptoms.)
   - If symptoms develop, then follow symptom-based or test-based strategy for the return-to work protocol.

C. People who are severely immunocompromised or who were severely ill with COVID-19Test Based Strategy: May need to stay home longer than 10 days and up to 20 days after symptoms first appeared and may require testing to determine when it is appropriate to return to work. These individuals will need a release from their healthcare provider before returning to work.

2.4.2 Potential or Known Exposure to COVID-19 or Employees with Symptoms:

2.4.2.1 Symptomatic employees

If an employee is experiencing symptoms of acute respiratory illness and a fever (greater than 100.4 degrees Fahrenheit, or 37.8 degrees Celsius), the employee must not come to work. The employee must alert his or her supervisor that he or she is symptomatic and is staying away from work. Supervisors should alert HSE immediately once they receive information that an employee is staying home with acute respiratory illness symptoms. Please see Potential Workplace Exposure section below for the required analysis of potential exposure to symptomatic employees. Please see Return to Work Protocol for persons who are positive for COVID-19 with symptoms, above.

2.4.2.2 Diagnosed Employees

Employees testing positive for COVID-19 are required to follow their health care provider's orders and will not be allowed to return to work until cleared by the health care provider to return to work. Recognizing strains on the medical system during this pandemic, APTIM will work with employees to

balance the need for information on the employee's fitness to work with the availability of a health care provider. We will follow CDC guidelines for return to work criteria for employees who test positive or are presumed positive for COVID-19. Please see Return to Work Protocol above.

Please see Potential Workplace Exposure section below for the required analysis of potential exposure to symptomatic employees.

2.4.2.3 Potentially exposed but asymptomatic employees

If an employee has been exposed to:

a. a household member or intimate partner or
b. has provided care in a household without using recommended infection control precautions, or
c. has had "close contact" (< 6 feet) for a "prolonged" period of time

to a person with symptomatic COVID-19 (can be a laboratory-confirmed disease or a clinically compatible illness) but the employee does not have symptoms, the employee may also need to stay home and not come to work or may be able to continue work, subject to workplace protections being in place, if the employee is working in a critical infrastructure position. (see section below).

The potential exposure period is the 48-hour period before the person with symptomatic COVID-19 began experiencing symptoms.

Please note the following definitions of "close contact" and "prolonged" (from CDC guidance):

Factors to consider when defining close contact include proximity, the duration of exposure (e.g., longer exposure time likely increases exposure risk), whether the individual has symptoms (e.g., coughing likely increases exposure risk) and whether the individual was wearing a facemask (which can efficiently block respiratory secretions from contaminating others and the environment).

Prolonged exposure varies on the length of time of exposure from 10 minutes or more to 30 minutes or more. Brief interactions are less likely to result in transmission; however, symptoms and the type of interaction (e.g., did the person cough directly into the face of the individual) remain important.

The potentially exposed employee must alert the employee's supervisor and HSE will work with the employee to determine whether, following CDC guidelines, the employee must remain self-quarantined and return to work for 14 days from the last exposure to the confirmed or suspected COVID-19 individual.

Asymptomatic Employees Working in Critical Infrastructure Positions:

Potentially exposed but asymptomatic employees who are working in "Critical Infrastructure" positions whose presence is critical to the ongoing progress of the project may continue to work with the following required protective measures in place:

- Prescreen: A temperature screening to confirm the absence of a fever (100.4 ºF) and a symptom assessment is required prior to entering the workplace.

- Regular Monitoring: Ongoing self-monitoring with assistance from HSE to ensure the employee remains asymptomatic and fever-free.
- Wear a Mask: The employee should wear a face mask at all times while in the workplace for 14 days after last exposure. Employee-supplied face masks are acceptable (see Appendix 2), or a site can issue a face mask (where supplies are adequate).
- Social Distance: The employee should maintain social distancing of at least 6ft. from other individuals. Any encroaching of 6ft. requires additional controls, such as adequate respiratory protection. (Contact HSE for support)
- Disinfect and Clean: The jobsite must clean and disinfect all areas such as offices, bathrooms, common areas, and shared equipment routinely.

If the employee becomes sick during the day, the employee should be sent home immediately. Surfaces in their workspace should be cleaned and disinfected. Information on persons who had contact with the ill employee during the time the employee had symptoms and 2 days prior to symptoms should be compiled. Others at the facility with close contact within 6 feet of the employee during this time would be considered exposed.

2.4.2.4 Potential Workplace Exposure

APTIM will inform employees of a potential workplace exposure while maintaining confidentiality (i.e., without revealing the infected individual's name unless otherwise directed by the CDC, applicable public health authority, or specifically required by applicable written government directive).

APTIM will analyze whether any other employees were potentially exposed to an employee diagnosed with COVID-19 through "close contact" with the diagnosed employee during the 48-hour period before the diagnosed employee started experiencing symptoms. Following CDC recommendations and directives, APTIM will direct potentially exposed asymptomatic employees to self-quarantine and remove them from the workplace for a 14-day period from the date of the employee's last exposure to the confirmed or suspected positive individual.

Please see above for information about potentially exposed, but asymptomatic, employees working in critical infrastructure. These employees can continue to work as long as they remain asymptomatic and the workplace protections set forth above are in place.

Employees are eligible to continue receiving per diem (if the employee is otherwise eligible for per diem) during the time the employee is not able to work because the employee is experiencing symptom of acute respiratory illness (fever, cough, shortness of breath) or is quarantined and away from home. The employee may need to provide medical documentation in order to be considered for continued per diem while they are not at work.

2.5 Roles and Responsibilities

2.5.1 Project Manager

- Responsible for oversight and coordination of the CCP implementation to ensure consistency in program content and efficient use of resources.
- Responsible for ensuring that all employees adhere to the procedures, including training and awareness of CCP issues.
- Responsible to ensure communication of project/office expectations regarding the CCP.
- Support and endorse the Project HSE Management System and CCP.
- Ensure compliance to the CCP by all employees, subcontractors, and vendors.
- Provide the resources necessary for implementation of the CCP.
- Ensure that adequate Emergency Response Procedures are in place for the evacuation of employees.
- Communicate with Facilities department regarding office closure and re-opening (to include return to work plans).

2.5.2 Project Manager Designee]

- Assists the Project Manager in ensuring that all employees adhere to the procedures, including training and awareness of CCP issues.
- Assists the Project Manager in ensuring communication of project expectations in regard to the CCP.
- Actively support the CCP.

2.5.3 HSE Manager

- Review and analyze new data on COVID-19 risk, prevention, and management.
- Identify and provide training and awareness materials.
- Provide leadership with health risk assessment efforts for each area of the project.
- Identify and communicate program expectations (i.e., diagnosis, treatment and notification) to preferred medical providers.
- Review COVID-19 incident data.

2.5.4 Employees

- Adhere to all program requirements regarding prevention and mitigation measures.
- Participate actively and vocally in the awareness program.
- Report any suspected symptoms of acute respiratory illness (fever, coughing, shortness of breath) immediately to supervision.
- Stay home when sick.

- Provide regular updates to leadership regarding anticipated return to work if the employee is required to stay home due to quarantine or illness.

2.5.5 Preferred Occupational Medical Provider

- Use rapid diagnosis method to test for COVID-19.
- Report confirmed or unconfirmed cases of COVID-19 to APTIM HSE Manager.
- Communicate with HSE Manager related to COVID-19 diagnosis and treatment as needed.
- Ensure clinic staff understands COVID-19 requirements for diagnostics and treatment.

3.0 RESOURCES:

Public Health Recommendations for Community-Related Exposure, https://www.cdc.gov/coronavirus/2019-ncov/php/public-health-recommendations.html

CDC RECOMMENDATIONS FOR MASK - https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/about-face-coverings.html

IMPLEMENTING SAFETY PRACTICES FOR CRITICAL INFRASTRUCTURE WORKERS WHO MAY HAVE HAD EXPOSURE TO A PERSON WITH SUSPECTED OR CONFIRMED COVID-19, https://www.cdc.gov/coronavirus/2019-ncov/community/critical-workers/implementing-safety-practices.html

DISCONTINUATION OF ISOLATION FOR PERSONS WITH COVID-19 NOT IN HEALTHCARE SETTINGS (INTERIM GUIDANCE) **HTTPS://WWW.CDC.GOV/CORONAVIRUS/2019-NCOV/HCP/DISPOSITION-IN-HOME-PATIENTS.HTML**

WHEN YOU CAN BE AROUND OTHERS: https://www.cdc.gov/coronavirus/2019-ncov/if-you-are-sick/end-home-isolation.html ENDING HOME ISOLATION: https://www.cdc.gov/coronavirus/2019-ncov/hcp/disposition-in-home-patients.html

APPENDIX 1
COVID-19 QUESTIONNAIRE

CORONA VIRUS CONTROL PLAN

APPENDIX 1 – COVID-19 QUESTIONNAIRE

Name:	
Contact Number/Cell:	
Date:	
Department:	
Supervisor:	
For use with On-Site temperature check: Verified that temp is less than 100.4?	Yes/No
Self-Fever Check – did you check your temperature today? Is it less than 100.4 F? If you have a fever of greater than 100.4, stay home and do not report to this work site.	Yes/No
Have you read the Covid-19 Safety Plan applicable to our location, and do you understand the safety measures we are asking you to take while working at this jobsite?	
Do you understand that you are required to wear a mask (in accordance with CDC recommendations) when working within a 6ft. proximity of coworkers?	
Do you understand that when possible you are to maintain 6ft. social distancing if you are not able to wear a mask?	
Within the last 14 days, have you had close contact (less than 6' for 15 minutes or more) with a person with COVID-19 (diagnosed with test or symptoms)?	Yes/No
Are you currently experiencing (now or in the last 24 hours) any symptoms of Covid-19? (symptoms can include some or all of the following: fever, chills, cough, shortness of breath, difficulty breathing, fatigue, muscle or body ache, headache, new loss of taste or smell, sore throat, congestion or runny nose, nausea, vomiting, diarrhea)?	Yes/No
Are you currently diagnosed with COVID-19 or are you waiting for test results?	Yes/No
Do you understand that if you are running a fever or exhibiting any signs of illness you are not to come into work?	Yes/No

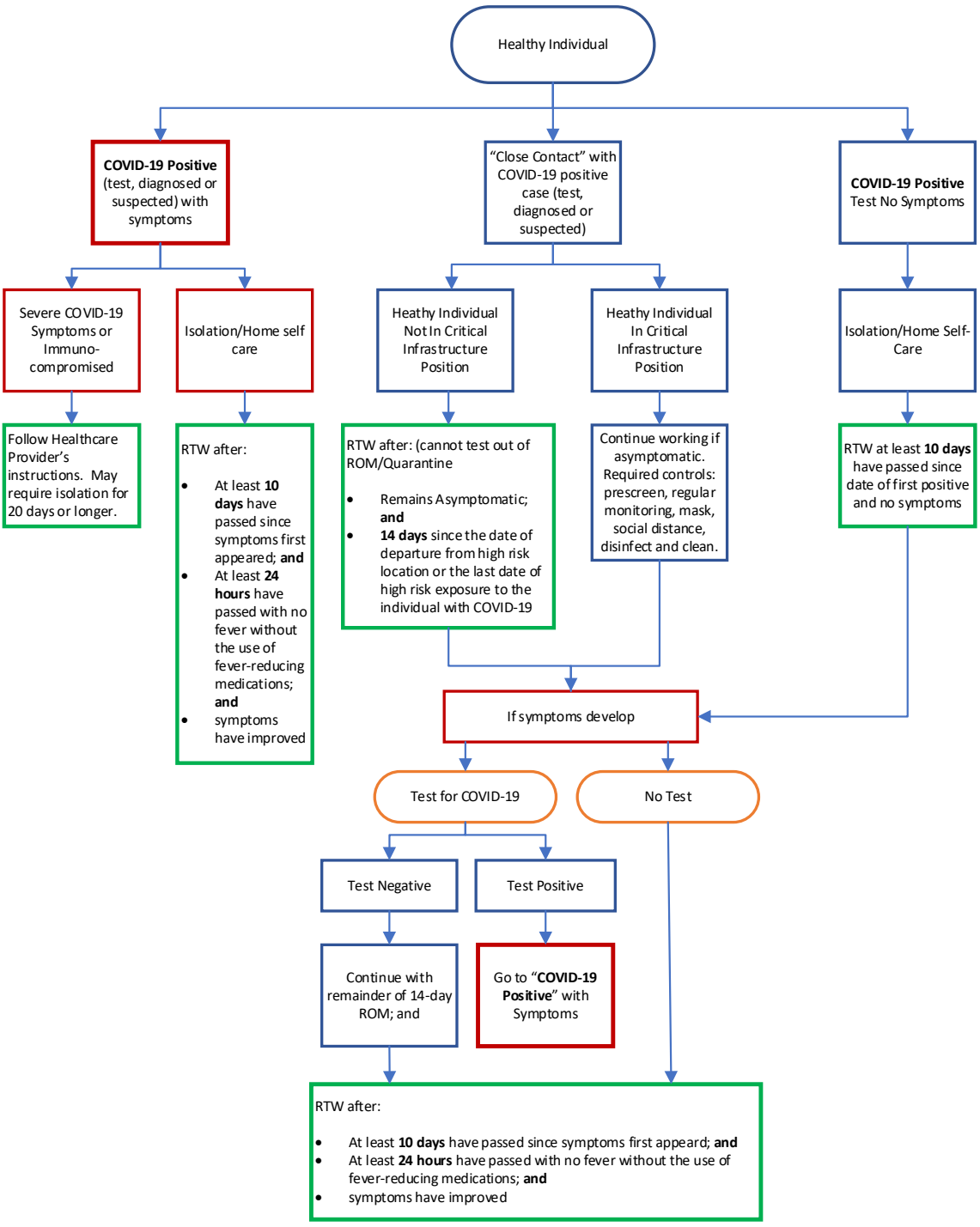
APPENDIX 2
INSTRUCTIONS RELATED TO CLOTH MASKS

DIY CLOTH FACE COVERING INSTRUCTIONS

APPENDIX 3
RETURN TO WORK PROTOCOL

CORONA VIRUS CONTROL PLAN

RETURN TO WORK (RTW) FLOWCHART
COVID-19



MECHANIZED AND MARINE EQUIPMENT INSPECTION REPORT

Inspector's Name Printed:	Date:
Equipment Description:	Equipment Number:

Item Inspected	Good	Fair	Poor	N/A	Comments
Brakes & Steering					
Broken, Missing, Damaged Parts					
Chains/Digging Boom (Trenchers)					
Controls Functioning Properly					
Deflectors & Blades (Mowers)					
Engine Oil/Water/Battery					
Falling Object Prot. Structure					
Fire Extinguisher					
Gauges					
Guards/Shields					
Horn and Back Up Alarm					
Hydraulic Fluid Level/Leaks/Hoses					
Lights					
Mirrors					
Operator Presence/Seat Interlock					
Other Interlock Switches					
Roll Over Protective Structure					
Seat Belt					
Signs/Placards					
Tires					
Windshield/Glass/Wipers					

Comments: _____

_____

_____

Inspector's Signature: _____

Copies:

HSE Manager's File
Equipment Managers

PROCEDURE

Procedure Number:

AMS-710-01-PR-00600

Revision:

1

Procedure Owner:

HSE

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VP HSE

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3/16/2020

HEAT STRESS PREVENTION AND CONTROL

Rev	Changes	Approved	Date
1	Transferred information to new APTIM procedure template, updated reference and attachment sections, created attachments from reference forms Heat Stress Index and Urine Color Test Chart, removed reference to Evaporative Cooling Index, added reference in section 4.2.4.1 to Urine Color Test Chart	M. Karr	3/16/2020
0	Added section 4.3.2	M. Hetzler	12/20/2017
INT	Issued for Interim Use	M. Hadacek & S. Lachney	7/30/2017

Parent Document: N/A

HEAT STRESS PREVENTION AND CONTROL

1.0 PURPOSE

The purpose of this procedure is to establish the minimum requirements for Heat Stress Prevention and Control on APTIM sites.

2.0 SCOPE

This procedure applies to all APTIM employees, contractors, subcontractors and visitors associated with an APTIM site.

3.0 RESPONSIBILITIES

The following personnel have responsibilities defined in this procedure:

- APTIM Managers
- APTIM Supervisors
- APTIM Employees
- APTIM Contractors
- APTIM Subcontractors

4.0 PROCEDURE

APTIM sites shall use this procedure to establish the minimum guidelines to create the site-specific procedure for heat stress prevention and control.

4.1 Heat Stress

Heat stress is the result of the combination of several factors. The following factors should be evaluated to determine the potential for heat stress:

- Ambient temperature
- Humidity
- Radiant heat source
- Direct sun exposure
- Air movement
- Contact with hot objects
- Type of work required - heavy, moderate or light work
- Required work clothing - the potential for heat stress increases as the impermeability of the work clothing increases
- Employee conditioning and/or acclimatization
- Previous project experience or history

- Whenever it is determined that a heat stress environment exists heat stress preventive measures shall be implemented.

4.2 Preventative Measures

4.2.1 Heat stress is the combination of environmental and physical work factors that constitute the total heat load imposed on the body. One of the best ways to reduce heat stress on workers is to minimize the amount of heat in the workplace. However, there are some work environments where heat production is difficult to control, such as active steam lines, high ambient temperature processes, humid work areas, or radiant heat from the sun or a furnace. However, most heat related health problems can be prevented or the risk of developing them reduced. When unacceptable levels of heat stress can potentially occur, there are generally five approaches to a solution:

4.2.1.1 Modify the environment;

4.2.1.2 Modify the clothing or equipment;

4.2.1.3 Modify the work practices;

4.2.1.4 Modify the worker by heat acclimatization;

4.2.1.5 Modify production with a work/rest regiment.

4.2.2 Wearing Personal Protective Equipment (PPE) can place workers at considerable risk of developing heat stress. Health effects range from transient heat fatigue to serious illness or death. Regular monitoring and other preventive precautions shall be employed. For workers wearing semi-permeable or impermeable encapsulating ensembles, workers shall be monitored when the temperature in the work area is above 70ºF (21ºC).

4.2.3 Engineering Controls

4.2.3.1 A variety of engineering controls, including ventilation and spot cooling at points of high heat production, may be helpful. Shielding or insulation may be required as protection from radiant heat sources. Evaporative cooling and mechanical refrigeration are other ways to reduce heat by engineering controls. The use of extra air moving can be added to increase the turnover rate of interior air and remove heat inside enclosures. Cooling fans can increase air velocity and promote evaporation in hot conditions. Shutting down hot process or feed lines is most effective, but equipment modifications, such as using mechanical equipment over manual labor also reduce the exposure.

4.2.3.2 Auxiliary cooling systems can range from simple ice vests, pre-frozen and worn under the clothing, to more complex systems; however, cost of operation and maintenance vary considerably in all of these systems. Four auxiliary cooling systems presently available are:

- Water-cooled garments, such as water-cooled vest, undergarments, hoods, etc., which require a circulating pump, liquid container, and battery;

- Air-cooled garments, such as suits and hoods, that require a vortex tube, connecting hose and a constant source of compressed air;
- Ice pack vest, which although frozen before worn, do not provide continuous regulated cooling and require the use of backup frozen units every 2 to 3 hours; and
- Wetted over-garments, which can be as simple as wet cotton terry cloth coveralls worn over protective clothing; the wetted over garment works best when there is air blowing across the wet garment to increase evaporation.

4.2.4 Work Practices

4.2.4.1 Work practices can help reduce the risk of heat disorders. Making plenty of drinking water (including ice and cool water as appropriate) available at the workplace and urging workers to drink often shall be standard practice in all situations of potential heat stress. In high heat stress environments, an employee can lose as much as one quart of liquid per hour. Attachment 7.2, Urine Color Test Chart is a good resource to for employees to use to gauge their level of hydration. When possible and especially during acclimatization, products that have been formulated to replace electrolytes and match the weight of the body fluids lost by the sweating process should be used. This is necessary to enable the body to quickly absorb replacement minerals. Do not use salt tablets.

4.2.4.2

4.2.4.3 Training supervisors to recognize and be able to correctly treat heat stress disorders is essential. Prospective workers physical conditions should also be considered when determining their fitness for working in a hot environment. Older workers, obese workers, and those workers taking some type of medication are usually at a greater risk.

4.2.5 Acclimatization

Acclimatization to heat through short exposures followed by longer periods of work in the hot environment can reduce heat stress. New employees and workers returning from an absence of two weeks or more should have a five-day period of acclimatization. This period should begin with a less than normal workload and time exposure on the first day and gradually build up to normal workload and exposure on the fifth day.

4.2.6 Work/Rest Regiment

4.2.6.1 There are many times when engineering and other controls are not sufficient, and administrative controls must be instituted for worker protection. One effective administrative control is the work/rest regimen that limits the time worked in the hot environment according to the type of work, environmental conditions, and clothing requirements. Work/rest periods are generally conservative because they are:

- Based on calculated approximations of heat stress and

- Designed to protect most workers. As a result, many acclimatized workers can work longer than the allotted time period.

4.2.6.2 Alternating work and rest periods with longer rest periods in a cool area (77°F. or less) can help workers avoid heat strain. Keep in mind that poor physical condition and/or medication will also impair the ability to work in a hot environment. Older, over-weight individuals or those in poor health may not be able to follow average work/rest regimens. Supervisors shall permit employees to take additional rest breaks as needed in potential heat stress conditions.

4.2.6.3 The APTIM HSE Department should be contacted for assistance in instituting work/rest schedules for the site.

4.3 Employee Training

4.3.1 For both employees and supervisory personnel, heat stress training is the key to avoiding problems. Employees must understand the reasons for using appropriate work practices in order for the program to succeed. A heat stress training program for employees shall cover the following:

4.3.1.1 Heat stress, its components and effects,

4.3.1.2 Signs and symptoms of heat disorders,

4.3.1.3 First-aid Practices for and potential health effects of heat stress,

4.3.1.4 Pre-disposing factors to heat stress; drug use, (including therapeutic) and alcohol in a hot work environment,

4.3.1.5 Protective clothing, equipment and its impact in hot environments,

4.3.1.6 Environmental and medical surveillance programs,

4.3.1.7 Importance of maintaining body fluids at normal levels,

4.3.1.8 Various engineering controls to reduce the impact of hot environments,

4.3.1.9 Administrative measures such as work/rest regimens in use to prevent heat stress,

4.3.1.10 Acclimatization; how it is achieved and its limitations, and

4.3.1.11 The components of the heat stress prevention program.

4.3.2 Supervisors must be trained in heat related illness prior to supervision of employees working in the heat

4.4 Flagging System

4.4.1 The status of the Heat Stress and Control plan will be communicated to the work force using a flagging system to correlate with the categories in section 4.5.

4.4.2 As the Heat Index category (color) changes, an SMS and email will go out to the Project team, including field HSE Supervisors or Representatives.

4.4.3 The field HSE Supervisors or Representatives are responsible for changing out the flag to the correct color so the crew can easily identify what category and precautions are in effect.

4.4.4 Flags should be placed in locations which are readily viewable from most areas such as established water, rest, or cooling areas.

4.5 Heat Stress Categories

4.5.1 The severity of heat exposure is determined by the calculated heat index.

4.5.2 The heat index is broken down into five (5) separate level designated by a color code.

The five (5) levels are green, yellow, orange, red and black. The significance of these colors is discussed in section 4.3.

4.5.3 The heat index is determined by either of three (3) methods:

4.5.3.1 Direct reading instrument such as a weather station, anemometer with built in heat index function, etc.

4.5.3.2 It is recommended for each project to have a direct reading hand held instrument for determining the heat stress, during the summer months. The Kestrel 3000 or equivalent Pocket Weather Meter is a commonly used instrument that is readily available providing a wide range of functions, including accurate relative humidity measurements. A picture of the Kestrel 3000 is shown below in figure 1.

Figure 1

4.5.3.3 Alternatively, calculating the heat index can be accomplished by measuring the ambient temperature and humidity separately to find the corresponding heat index (Attachment 7.1 Heat Stress Index).

4.5.3.4 Lastly, obtain the temperature and humidity from a reliable local weather/news source and utilize Attachment 7.1 Heat Stress Index to determine the heat index.

4.5.4 Category precautions and water intake are captured in Attachment 7.1 Heat Stress Index as a guide to be issued to field personnel.

4.6 Category GREEN – Caution

The initial or least severe category is GREEN. Heat indexes in GREEN are 37°C (98.6ºF) or less. When heat indexes fall within this category, the following conditions apply:

- Heat Syndrome – Fatigue possible with prolonged exposure and physical activity. No significant risk of heat related illnesses.
- Resting Times – Normal / scheduled break are sufficient during this period.
- Water Needed – 250 ml (8.5 oz) every 20 – 30 minutes
- Ensure Adequate Medical Services are available
- Encourage workers to wear sunscreen

4.7 Category YELLOW – Extreme Caution

The next higher severity category is YELLOW. Heat indexes in YELLOW range between 38°C and 45°C (98.7ºF and 113ºF). When the heat index falls within this category, the following conditions apply:

- Review Heat related illness topics with workers: how to recognize heat related illnesses, how to prevent it, and what to do if someone gets sick. Monitor workers closely
- Heat Syndrome – Heat Cramps or Heat Exhaustion possible with prolonged exposure and physical activities.
- Acclimatize workers
- Resting Time – 5 minutes per each hour
- Water Needed – 250ml (8.5 oz) every 20 minutes (average)

4.8 Category ORANGE – Danger

The next higher severity category is ORANGE. Heat indexes in ORANGE range between 46°C and 54°C (114.8ºF and 129.2ºF). When heat indexes fall within this category, the following conditions apply:

- Limit Physical exertion
- Adjust work activities
- Use cooling techniques

- Watch/communicate with workers at all times
- Ensure Adequate Medical Services are available
- Encourage workers to wear sunscreen
- Heat Syndrome – Heat Cramps or Heat Exhaustion likely. Heat Stroke possible with prolonged exposure and physical activity.
- Resting Time – 10 minutes per each hour
- Water Needed – 250 ml (8.5 oz) every 10 minutes (average)

4.9 Category RED – Extreme Danger

4.9.1 The next higher severity category is RED. Heat indexes in RED range between 55°C and 59°C (129.3ºF and 138.2ºF). When heat indexes fall within this category, the following conditions apply:

- Stop work if essential control methods are inadequate or unavailable.
- Limit Physical exertion
- Adjust work activities
- Use cooling techniques
- Watch/communicate with workers at all times
- Ensure Adequate Medical Services are available
- Encourage workers to wear sunscreen
- Heat Syndrome – Heat Stroke imminent with following rest and water intake requirements.
- Resting Time – 15 minutes per each hour
- Water Needed – 250 ml (8.5 oz) every 10 minutes (average)

4.9.2 During Category RED conditions, the following additional precautions should be implemented:

- Supervision should be on active alert to monitor their crew for signs and symptoms of heat stress. Maximum supervision should be present, during category RED conditions to monitor the employees and ensure proper rest and water breaks are being followed.
- Employees who are fasting for whatever reason (i.e. dieting regimen, religious obligations, etc.) are not permitted to work during RED flag conditions. There is a significant health risk associated with fasting in RED flag conditions that can quickly progress into Heat Exhaustion or Heat Stroke.
- Project First Aiders and Nurses should be put on alert in case an employee begins to exhibit heat stress symptoms.

- Ear type thermometers with disposable covers should be available for monitoring an employee's core body temperature. Employees with core temperatures at or above 38°C (100.4°F) should remain out of the heat, until their temperature is reduced and stabilized.
- Cold, wet towels must be available for first aid to assist in the cooling of someone experiencing heat stress symptoms. Cold towels applied to the inside of the forearms and neck serves as effective thermal receptors to cool the body's core temperature.
- Air-conditioned shelters are to be made available for anyone experiencing heat stress symptoms.
- Electrolyte replenishment drink (i.e. Isostar, Pocari Sweat, etc.) should be available to first aiders for anyone exhibiting serious signs of heat stress symptoms and / or dehydration.
- Work involving considerable and / or repetitive climbing should be kept to a minimum.
- A rescue plan should be in place to retrieve anyone who is not capable of removing themselves, under their own power.

4.10 Category BLACK

4.10.1 All work shall stop when heat index exceeds 59°C (138.3ºF). If the ambient temperature is below 35C (95ºF), regardless of humidity, there will be no BLACK flag.

4.10.2 Dispensation for critical activities can be allowed if approved by Supt, HSE Manager and Project Manager

4.10.3 Any work allowed in BLACK flag conditions must have a specific JSA detailing the precaution to be taken for the activity.

4.11 Technical Assistance

In some situations, we will accept work in extremely hot environments that cannot be controlled or mitigated. When faced with this type of situation, the APTIM Safety Department shall be notified for assistance.

5.0 TERMINOLOGY

Term	Definition
Heat Rash	Heat rash, also known as prickly heat, may occur in hot, humid environments where sweat is not easily removed from the surface of the skin by evaporation. This is common when using protective equipment especially impermeable clothing. Heat rash can become uncomfortable when extensive or complicated by infection.

Heat Cramps	Heat cramps, which are painful muscle spasms, are caused when workers fail to replace the body's salt loss that occurs during excessive perspiration (especially with non-acclimatized workers).
Heat Exhaustion	Heat exhaustion results from excessive loss of salt and/or water through sweating. The worker with heat exhaustion still sweats, but experiences extreme fatigue, weakness, giddiness, nausea or headache. The skin is clammy and moist, the complexion pale or flushed and the body temperature normal or slightly higher.
Heat Stroke	Heat stroke, the most serious health problem for workers in hot environments, is caused by the failure of the body's internal mechanism to regulate its core temperature. Sweating stops and the body can no longer rid itself of excess heat. Signs include: mental confusion, delirium, loss of consciousness, convulsions or coma, a body temperature of 105 degrees or higher and hot dry skin which may be red and flushed. Victims of heat stroke may die unless treated promptly and correctly.
Site	Any location, facility or project where APTIM is performing work. Sites may include, but are not limited to, laboratories, offices, shops, owned facilities, leased facilities and/or project sites.

6.0 REFERENCES

6.1 Required Forms/Checklists

None	

6.2 Other Internal References

None	

6.3 Other External References

None

7.0 ATTACHMENTS

Attachment	Attachment Title
Attachment 7.1	Heat Stress Index
Attachment 7.2	Urine Color Test Chart

ATTACHMENT 7.1
HEAT INDEX

HEAT STRESS PREVENTION AND CONTROL

RELATIVE HUMIDITY – FAHRENHEIT

Temp	Relative Humidity																				
	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
123.8																					
122																					
120.2	120	120	120	122	131	138															
118.4	118	118	118	120	127	135															
116.6	117	117	117	117	124	131	138														
114.8	115	115	115	115	120	127	135														
113	113	113	113	113	117	124	129	136													
111.2	111	111	111	111	115	118	126	133													
109.4	109	109	109	109	111	117	120	127	135												
107.6	108	108	108	108	108	113	117	122	129	136											
105.8	106	106	106	106	106	109	113	118	124	129	136										
104	104	104	104	104	104	106	109	113	118	124	129	136									
102.2	102	102	102	102	102	104	106	109	115	120	126	131	138								
100.4	100	100	100	100	100	100	102	106	109	115	120	126	131	138							
98.6	98.6	98.6	98.6	98.6	98.6	98.6	100	102	106	109	115	118	124	131	136						
96.8	96.8	96.8	96.8	96.8	96.8	96.8	96.8	100	102	106	109	115	118	124	129	136					
95	95	95	95	95	95	95	95	96.8	98.6	102	106	109	113	118	122	127	135				
93.2	93.2	93.2	93.2	93.2	93.2	93.2	93.2	93.2	95	98.6	100	104	108	111	117	120	126	131	136	144	
91.4	91.4	91.4	91.4	91.4	91.4	91.4	91.4	91.4	93.2	95	96.8	100	104	108	111	115	118	124	129	135	140
89.6	89.6	89.6	89.6	89.6	89.6	91.4	91.4	91.4	91.4	91.4	93.2	96.8	98.6	102	104	108	111	117	120	126	129
87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8	89.6	91.4	93.2	95	96.8	100	102	106	109	113	117	120
86	86	86	86	86	86	86	86	86	86	86	87.8	89.6	91.4	93.2	95	96.8	100	102	106	108	111

HEAT STRESS PREVENTION AND CONTROL

RELATIVE HUMIDITY - CELSIUS

	Relative Humidity																				
Temp	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
51						----------				STOP ALL WORK				----------							
50																					
49	48.9	48.9	48.9	50	55	58.9															
48	47.8	47.8	47.8	48.9	52.8	57.2															
47	47.2	47.2	47.2	47.2	51.1	55	58.9														
46	46.1	46.1	46.1	46.1	48.9	52.8	57.2														
45	45	45	45	45	47.2	51.1	53.9	57.8													
44	43.9	43.9	43.9	43.9	46.1	47.8	52.2	56.1													
43	42.8	42.8	42.8	42.8	43.9	47.2	48.9	52.8	57.2												
42	42.2	42.2	42.2	42.2	42.2	45	47.2	50	53.9	57.8											
41	41.1	41.1	41.1	41.1	41.1	42.8	45	47.8	51.1	53.9	57.8										
40	40	40	40	40	40	41.1	42.8	45	47.8	51.1	53.9	57.8									
39	38.9	38.9	38.9	38.9	38.9	40	41.1	42.8	46.1	48.9	52.2	55	58.9								
38	37.8	37.8	37.8	37.8	37.8	37.8	38.9	41.1	42.8	46.1	48.9	52.2	55	58.9							
37	37	37	37	37	37	37	37.8	38.9	41.1	42.8	46.1	47.8	51.1	55	58						
36	36	36	36	36	36	36	36	37.8	38.9	41.1	42.8	46.1	47.8	51.1	54	57.8					
35	35	35	35	35	35	35	35	36	37	38.9	41.1	42.8	45	47.8	50	52.8	57				
34	34	34	34	34	34	34	34	34	35	37	37.8	40	42.2	43.9	47	48.9	52	55	58	62	-18
33	33	33	33	33	33	33	33	33	34	35	36	37.8	40	42.2	44	46.1	48	51	54	57	60
32	32	32	32	32	32	33	33	33	33	33	34	36	37	38.9	40	42.2	44	47	49	52	54
31	31	31	31	31	31	31	31	31	31	32	33	34	35	36	38	38.9	41	43	45	47	49
30	30	30	30	30	30	30	30	30	30	30	31	32	33	34	35	36	38	39	41	42	44

HEAT STRESS PREVENTION AND CONTROL

APTIM Heat Stress Guideline					
Heat Stress Index					
Danger Category	Heat Index		Heat Syndrome	Resting Time	Water Needed
	°C	°F			
Extreme Danger	55-59	129.3-138.2	Sun stroke imminent without following rest and water intake requirements	15 minutes / hour	250 ml (8.5 oz) / 10 minutes
Danger	46-54	114.8-129.2	Heat Cramps or Heat Exhaustion likely. Heat Stroke possible with prolonged exposure and physical activity.	10 minutes / hour	250 ml (8.5 oz) / 10 minutes
Extreme Caution	38-45	98.7-113	Heat Cramps or Heat Exhaustion possible with prolonged exposure and physical activity.	5 minutes / hour	250 ml (8.5 oz) / 20 minutes
Caution	<37	<98.6	Fatigue possible with prolonged exposure and physical activity.	Normal / Scheduled	250 ml (85 oz) / 30 minutes
Do not drink more than 1.5 liters (33.8 oz) per hour (maximum water absorption rate of human body)					

ATTACHMENT 7.2
URINE COLOR TEST CHART

HEAT STRESS PREVENTION AND CONTROL

Are You Hydrated?
Take the Urine Color Test

Urine Color Chart*

HYDRATED

OPTIMAL

WELL HYDRATED

DEHYDRATED

DEHYDRATED:
You need to drink more water

SEEK MEDICAL AID:
May indicate blood in urine or kidney disease

*This color chart is not for clinical use.

Water Consumption Table

Heat Category	WBGT Index, °F	Easy Work	Moderate Work	Hard Work
		Water Intake (Quart/Hour)	*Water Intake (Quart/Hour)*	*Water Intake (Quart/Hour)*
1	78° - 81.9°	½	¾	¾
2	82° - 84.9°	½	¾	1
3	85° - 87.9°	¾	¾	1
4	88° - 89.9°	¾	¾	1
5	> 90°	1	1	1
Body Armor = +5°		Easy Work – walking on a hard surface at less than 2 mph with less than a 30 pound load, weapon maintenance, marksmanship training; drill and ceremony	Moderate Work – patrolling, walking in the sand at 2.5 mph with no load, calisthenics; patrolling; individual movement techniques (ie high/low crawl)	Hard Work – walking in the sand at 2.5 MPH with a load, field assaults
MOPP 4 = +10°				
Rest - sitting or standing in the shade if possible				

The fluid replacement volumes will sustain performance and hydration for at least 4 HOURS of work in the specified heat category. Fluid needs can vary based on individual differences and exposure to full sun or full shade.

CAUTION: Hourly fluid intake should not exceed 1.5 quarts. Daily fluid intake should not exceed 12 quarts.

Purpose

- With normal kidney function, your level of hydration is indicated by the color of your urine. Some vitamins and supplements may cause a darkening of the urine unrelated to dehydration.
- Since heat-related illness often follows dehydration, this simple test will help protect your health.
- Dehydration also increases your risk for kidney stones.

How does it work?

- Match your urine color to closest color in the chart and read the hydration level on the chart.
- Watch the urine stream not the toilet water, as the water in the toilet will dilute your urine color.
- In response to dehydration, the kidneys conserve water and excrete more concentrated urine; the more concentrated the urine the darker the color.

Prevent Dehydration

- No amount of training or acclimatization can reduce the body's requirement for water.
- Follow the water consumption guidelines in the water consumption table.

http://usachppm.apgea.army.mil

CP-070-0408 (Also available as a tip card.)

USACHPPM

ATTACHMENT 3

INCIDENT REPORTING FORMS

US Army Corps of Engineers

USACE PRIME CONTRACTOR
Monthly Record of Work-Related Injuries/Illnesses & Exposure

Month _____
Year _____

In accordance with the provisions of EM 385-1-1, Section 01 Program Management, Paragraph 01.D Mishap Reporting and Investigation, sub-paragraphs 01.D.05, you (APTIM) shall provide a monthly record of all exposure and accident experience incidental to the work (this includes exposure and accident experience of APTIM and its sub-contractor(s). As a minimum , these records shall include exposure work hours and a record of occupational injuries and illnesses that include the data elements listed below. Definitional criteria for each data element is found in 29 CFR Part 1904. If the maintenance of OSHA 300 Logs are required by OSHA, most of this information can be obtained from those logs. If data on log provided below is revised after it is submitted to USACE, APTIM shall provide a revised report to the GDA. You must complete the USACE ENG Form 3394, Report of Accident Investigation Report for all recordable accidents. If you're not sure whether a case is recordable, call your local Safety and Occupational Health Office for help.

USACE Command
Contractor Name
Contract Number
Project Title
City State
USACE Office Overseeing Work

Identify the person							Describe The Case		Classify the case													
(A)		(B1)	(B2)	(B3)	(C)	(D)	(E)	(F)	Using these categories, check ONLY the most serious result for each case:				Enter the number of days the injured or ill worker was:		Check the "injury" column or choose one type of illness:							
															(M)							
Company Name	Prime or Sub (P or S)	Age	Gender	Date Employee Began Work on Job Covered by Contract	Job Title (e.g., Welder)	Date of injury or onset of illness (mo./day)	Where the event occurred (e.g. Loading dock north end)	Describe injury or illness, parts of body affected, and object/substance that directly injured or made person ill (e.g. Second degree burns on right forearm from acetylene torch)	Death	Days away from work	Remained at work		On job transfer or restriction (days)	Away from work (days)	Injury	Skin Disorder	Respiratory Condition	Poisoning	Hearing Loss	All other Illnesses
											Job transfer or restriction	Other record-able cases									
									(G)	(H)	(I)	(J)	(K)	(L)	(1)	(2)	(3)	(4)	(5)	(6)
									0	0	0	0	0	0	0	0	0	0	0	0

For Government Use Only

TYPE OF WORK ACTIVITY (Choose One):

Construction		Environmental Remed.	
Opn & Main.		Superfund	
Eng. Services		FUDS	
Dredging		IRP	
Rsch. & Dev.		FUSRAP	
Emerg. Opns.		Ordinance/Expl. Cleanup	
Other		Environmental Other	

Type of Contract (Choose One):

Civil Works	
Military Programs	
Other	

Exposure Hours	
Month	
Year to Date	

Certification of Record	
Name of Person Submit. Record	
Signature	
Date	

USACE Summary of Contractor Work-Related Injuries and Illnesses

Month Submitted _____ **Year** _____

US Army Corps of Engineers

Review the Record and verify that the entries are complete & accurate before completing this summary.

Using the Record, count the individual entries you made for each category. Then write the totals below, making sure you've added the entries from every page of the record. If you had no cases write "0". This summary is a cumulative record of the injury/illness experience for the year

Number of Cases

Total number of deaths	Total number of cases with days away from work	Total number of cases with job transfer or restriction	Total number of other recordable cases
0	0	0	0
(G)	(H)	(I)	(J)

Number of Days

Total days of job transfer or restriction	Total days away from work
0	0
(K)	(L)

Injury and Illness Types

Total number of…

	(M)		
(1) Injury	0	(4) Poisoning	0
(2) Skin Disorder	0	(5) Hearing Loss	0
(3) Respiratory Condition	0	(6) All other illnesses	0

Establishment information

Establishment name

Street

City State Zip

Industry description (e.g., Manufacture of motor truck trailers)

Standard Industrial Classification (SIC), if known (e.g., SIC 3715)

or

North American Industrial Classification (NAICS) if known (e.g. 336212)

Employment information

Annual average number of employees

Total hours worked by all employees last year

Aptim Federal Services, LLC Incident Notification, Reporting, and Management Procedure

Directions, Notes, and Reminders

- **Follow this procedure step-by-step for all incidents.**
- **This procedure has limited application to subcontractors. Assist subcontractors with medical emergencies (as applicable) and then immediately notify the Program H&S Manager for guidance.**
- **Periodically review this procedure in order to be familiar with the steps - prior to an incident occurring.**
- **For injuries and vehicle accidents, secure the scene to prevent additional injury/incident, administer on-site first aid, and arrange for emergency assistance prior to making any other notifications.**
- **The Site Supervisor is responsible for making all other notifications to:**
  - **CORE Health Networks (must be notified while employee is en route to medical care facility): 877-347-7429**
  - **Help Desk / Hot Line: 800-537-9540**
  - **Project Manager: Don Burton 865-207-1394 (cell)**
  - **Marcia Musgrave: 419-429-5520 or 419-819-7848**
- **The Site Supervisor (or SSHO) is responsible for notifying the Program H&S Manager or Alternate H&S Manager by telephone prior to making any other notifications (other than calling 911 and CORE).**
- **The Site Supervisor or SSHO shall accompany all injured personnel to the CORE clinic or to the hospital emergency room.**
- **The Project Manager shall notify the Program Manager in person or by telephone no later than two hours after the incident and the U.S. Army Garrison Chief, Installation Restoration Branch (256) 842-3702.**
- **All incident reports shall be completed by typing (when feasible and applicable).**
- **All incident reports shall be submitted (email or fax) to the Program H&S Manager or Alternate H&S Manager for review and distribution.**
- **Complete all the blanks on the INCIDENT NOTIFICATION AND COMMUNICATION CONTACT LIST (page 6) and post near all site telephones.**

Aptim **Federal Services**, **LLC Incident Notification, Reporting, and Management Procedure**

Action	Who / When	Under what circumstances	How	Notes
1. Notify Site Supervisor for all incidents (no matter how minor)	Injured person, first person recognizing incident, driver/passenger, or employee causing damage *Immediately*	All incidents no matter how minor (including minor cuts, scratches, minor strains/sprains, and insect bites)	In person or by telephone	Site Supervisor to make note of very minor incidents (such as band-aid over scratch) in field logbook
2. For ***life-threatening injuries / illnesses*** - make scene safe, contact local emergency personnel For ***non life-threatening injuries / illnesses*** - make scene safe, transport injured person to doctor at an occupational medical facility See Clinic Route Maps and Directions For ***vehicle accidents*** – make scene safe, notify police, aid injured parties For ***equipment / property damage*** - make scene safe, prevent further damage or injuries	Site Supervisor *Immediately (concurrently with next step if injury or illness)* Site Supervisor *Immediately (concurrently with next step if injury or illness)* Driver/passenger *Immediately* Employee causing damage *Immediately*	In case of serious injury or illness requiring off-site medical care	Via ambulance Via vehicle	Site Supervisor or Site Safety Officer must immediately go to emergency care facility. Follow AMS-710-01-PR-03600 post accident alcohol and drug testing procedure. Site Supervisor or Site Safety and Health Officer must transport and stay with injured person until released from care. Make medical personnel aware of "restricted work will be provided" and "no prescriptions if possible" policies. CORE clinics are the preferred urgent care facilities when possible, unless injury is severe and victim is transported by ambulance.
3. Notify CORE Health Networks (for injuries / illnesses to APTIM employees only)	Site Supervisor *Immediately, prior to transporting the injured employee, unless injuries are life threatening*	• Serious injury requiring off-site medical care • If employee states that he/she has been exposed to any chemical or biological substance • If illness is work related	CORE Medical 877-347-7429 Note: Outside Continental US call: 225-614-9561	Not required for temporary agency and subcontractor labor Provide name of injured employee, name and phone # of treating medical facility, description of the incident CORE will help with medical facility coordination and follow-up care
4. Notify Program H&S Manager (if unsure, see contact list) Notify Alternate H&S Manager if Program H&S Manager cannot be contacted. (if unsure, see contact list)	Site Supervisor *Immediately (concurrently with providing transportation to occupational medical facility or EMS transport to hospital)*	All incidents except on-site first aid cases	See Incident Notification and Communication Contact List (attached)	Program H&S Manager will notify H&S Director

Action	Who / *When*	Under what circumstances	How	Notes
5. Notify APTIM Notification Hotline / Help Desk	Site Supervisor *As soon as possible. Prior to sending an individual for medical treatment*	• Illness and/or injury (doctors cases and above) • Any utility damage • Property damage (damage > $5,000) • Vehicle accidents (All) • Criminal activity (i.e. bomb threat, theft) • Natural disaster (all) • Explosion and/or fires • Environmental spills/releases (incidents that requires regulatory notification or have an offsite impact) • Regulatory agency visit • Fatalities	APTIM Notification Hotline / Help Desk Phone Number: 800-537-9540 Note - Outside the Continental US call: 225-215-5056	Request name of Hotline / Help Desk operator for future reference and note date/time of notification
6. Complete forms: **I*njuries and illnesses*:** • Authorization for Release of Protected Medical Information • Authorization for Treatment of Occupational Injury/Illness • Return-To-Work Examination Form ***and*** fax to CORE ***and*** email or fax to Program H&S Manager	Injured employee and medical facility personnel (Site Supervisor or Site Safety and Health Officer is responsible for verifying forms are completed) *Prior to leaving medical facility*	• Serious injury requiring off-site medical care • If employee states that he/she has been exposed to any chemical or biological substance	Fax to CORE: 225.292.8986 Email or fax to Program H&S Manager	Site Supervisor or Site Safety and Health Officer must take these forms (Contained in 710-01-PR-02100, AMS-710-05-PR-02200, and AMS-710-05-PR-02300)
7. Call Project Manager and notify of incident (Remind Project Manager of notification responsibilities to Program Manager)	Site Supervisor *As soon as reasonably possible*	If Hot Line / Help Desk notification is required (see # 5 above)	See Incident Notification and Communication Contact List	Project Manager will verbally report incident to upper level of Operations/Business Line Management *As soon as reasonably possible*
8. Notify Marcia Musgrave	Site Supervisor	All incidents involving personnel (injuries, illnesses, vehicle accidents)	419-429-5520	

Action	Who / When	Under what circumstances	How	Notes
9. Call back Program H&S Manager to report on status of *injured / ill employee*	Site Supervisor *Prior to employee leaving medical facility*	All injuries and illnesses requiring off-site medical care	See Incident Notification and Communication Contact List (attached)	
10. Complete forms (typed electronically): *OSHA Recordable Cases* • Supervisor's Employee Injury/Illness Report Form • Injured Employee Statement • Witness Statement Form(s) *First Aid Cases (Doctor's)* • Supervisor's Employee Injury/Illness Report • Injured Employee Statement • Witness Statement Form(s) Email or Fax completed forms to Program H&S Manager and CORE	• Site Supervisor • Witnesses *As soon as possible – no later than 24 hours*	All injuries, illnesses, and first aide cases	Email or fax to Program H&S Manager See Incident Notification and Communication Contact List (attached) Fax to CORE 225.292.8986	Site Supervisor should have these forms with him/her at all times (Contained in 710-01-PR-02100, AMS-710-05-PR-02200, and AMS-710-05-PR-02300)
11. Complete forms (typed electronically): *Chargeable Vehicle Accidents* • Vehicle Accident Report • Witness Statement Form(s) • Driving Record Certification (Procedure HS800) *Non-Chargeable Vehicle Accidents* • Vehicle Accident Report • Witness Statement Form(s) *Equipment, Property Damage and General Liability Incidents* • Equipment, Property Damage and General Liability Loss Report • Witness Statement Form(s) Email or Fax completed forms to Program H&S Manager	• Site Supervisor • Witnesses *As soon as possible – no later than 24 hours*	All vehicle accidents and /or all property damage	Email or fax to Program H&S Manager Health See Incident Notification and Communication Contact List (attached)	Supervisor should have these forms with him/her at all times (Contained in 710-01-PR-02100, AMS-710-05-PR-02200, and AMS-710-05-PR-02300)

Action	Who / When	Under what circumstances	How	Notes
12. Complete these additional forms (typed electronically): ***OSHA Recordable Cases*** • Incident Investigation Report ***First Aid Cases (Doctor's)*** • Incident Investigation Report ***Chargeable Vehicle Accidents*** • Incident Investigation Report ***Non-Chargeable Vehicle Accidents*** • Incident Investigation Report ***Equipment, Property Damage and General Liability Incidents*** • Incident Investigation Report ***Near Miss*** • Incident Investigation Report • SharePoint electronic Near Miss Report Email or Fax completed forms to Program H&S Manager	Site Supervisor *As soon as possible – no later than 72 hours of incident* *As soon as possible – no later than 96 hours of incident*	Near Misses All other Near Misses	Email or fax to Program H&S Manager See Incident Notification and Communication Contact List (attached) Contact Program H&S Manager	Supervisor should have these forms with him/her at all times Contact Program H&S Manager for blank electronic forms or access: Do not include any employee or project identification information – *these reports are anonymous*
13. Perform "Incident Review Board" (ARB) - Coordinate through Program H&S Manager Perform "Incident Review Board" (IRB) to extract lessons learned - Coordinate through Program H&S Manager	Program H&S Manager *Within 10 days of incident*	OSHA Recordable Cases Chargeable Vehicle Accidents Doctor's First Aid Cases Utility damage or significant property damage		An IRB is outside of the AMS requirements for an ARB.

Aptim Federal Services, LLC Incident Notification and Communication Contact List

Project Number: 501388 Project/Office Name/Location: RSA DO W912DY 19F1116 / Redstone Arsenal, Huntsville, AL

Name	Phone Number(s)	Fax Number	E-mail
Federal Services Notification Hotline/Helpdesk	800-537-9540	N/A	N/A
CORE (Must be notified prior to or during transport to medical treatment center)	877-347-7429	225-292-8986	N/A
Medical Services Administrative Manager Marcia Musgrave	419-429-5520 (office) 419-819-7848 (mobile)	419-429-5526	marcia.musgrave@aptim.com
APTIM H&S Manager: Doug Russell	865-560-7918 (office) 865-414-9545 (cell))		winston.russell@aptim.com
APTIM Program Manager: Steven Moran	865-560-7905 (office) 865-607-91484 (cell)	865-560-7956	Steve.g.moran@aptim.com
APTIM Project Manager: Don Burton	865-207-1394 (cell)		don.burton@aptim.com
APTIM CIH – Larry Verdier	513-378-8021 (cell)		larry.verdier@aptim.com

WORK SHEET FOR GOVT & CONTRACTOR PRELIMINARY ACCIDENT NOTIFICATION

This work sheet is a field tool to assist the collection of information about an accident and facilitate the completion of a Preliminary Accident Notification. For Member of the Public Recreation Visitor accidents use the Initial Notification of Public Recreation Mishap Work Sheet

General Information:		
1. Project Name:	2. HNC Project Office Symbol:	3. Date Worksheet completed:
4. Person Name Completing Worksheet:	5. Phone Number:	6. Contract Number:
7. Date of Mishap:	8. Time of Mishap	
9. Prime Contractor:	10. Subcontractor:	

Location and Mishap Information:	
1. Exact Location of Mishap:	
2. Number of Persons involved:	3. Number of Properties involved:

Personnel Classification:				
Government Civilian: ☐	Military: ☐	Government Direct Contractor: ☐	Foreign National: ☐	
Volunteer: ☐	Prime Contractor: ☐	Subcontractor: ☐	Public: ☐	Other:

Type of Mishap:				
Fatality: ☐	Injury / Illness: ☐	Property Damage: ☐	Fire: ☐	Driving: ☐

Personal Data: (Note: If more than 2 persons involved provide their personal data on a separate sheet)			
1. Name: Last: First: Middle Initial:	2. Age:	3. Gender:	
4. Job Series & Title:		5. Grade:	
6. Duty Status: On Duty: ☐ Off Duty: ☐ TDY: ☐	7. Time Work Began:		
8. Unit and Station Assignment:	9. Office Symbol:	10. Date Hired:	
11. What was Person doing before the mishap occurred?			

Injury Information: N/A ☐		
1. Nature of Injury:	2. Primary Body Part Affected:	2.a. Secondary:
3. Type of Injury:	4. Source of Injury:	
5. Severity of Injury: Fatality: ☐ Permanent Total Disability: ☐ Permanent Partial Disability: ☐ Other: ☐ If Other Describe:		
6. Estimated Days Away:	7. Estimated Days Restricted/Transferred:	
8. Primary Language Spoken:	9. English Literate: Yes: ☐ No: ☐	
10. Does this person wish to remain anonymous: Yes: ☐ No: ☐		
11. Was injured person hospitalized? Yes: ☐ No: ☐		
12. Name of Physician/Health Care Professional:		
13. Medical Treatment Facility Name:	14. Phone #:	
15. Facility Address:		

Summary of Mishap

Remarks

Describe Any Information Released to the Public

Nature of Injury

Amputation
Abrasion
Back Strain
Burn
Contusion/Bruise
Concussion
Dislocation of joint
Drowning
Fracture
Hearing Loss
Hernia
Laceration/Cut
Puncture
Strain
Stroke
Traumatic Food Poisoning
Traumatic Heart Condition
Traumatic Mental Disorder
Traumatic Respiratory
Traumatic Skin Disease
Tuberculosis
Traumatic Virological/Infective
Parasitic Disease
Other

Type of Injury

Struck by/against
Fell/slipped/tripped
Caught on/in/between
Punctured/lacerated
Stung/bit by
Contact with/by
Exerted
Exposed
Inhaled
Ingested
Absorbed
Traveling In

Severity of Injury

Injury
Illness
Fatality
Permanent Disability

Source of Injury

Environmental Condition
Building or other Area
Walking surface
Electricity
Temperature Extreme
Weather
Fire
Water
Mechanical Equipment
Guard/Shield
Video Display Terminal
Heating
Motor Vehicle/Cycle
Boat
Bicycle/Other non-motorized vehicle
Noise
Radiation
Light
Ventilation
Smoke
Stress
Confined Space
Carbon Monoxide
Inanimate Object
Animal Insect
Human (Violence)
Diving Equipment
Parachute

Body Parts

Arm or Wrist
Breast
Testicle
Abdomen
Chest
Lower Back
Penis
Side
Upper Back
Waist
Trunk Other
Ear
Eye
Brain
Cranial Bones
Teeth
Jaw
Throat/Larynx
Mouth
Nose
Tongue
Head Other External
Elbow
Finger
Thumb
Toe
Face
Scalp
Knee
Leg
Hip
Ankle
Buttock
Hand
Feet
Collar Bone
Shoulder Blade
Rib
Sternum
Vertebrae
Trunk Bones other
Shoulder
Lung
Kidney
Heart
Liver
Reproductive Organs
Stomach
Intestines
Trunk/internal

U.S. Army Corps of Engineers (USACE)

MISHAP NOTIFICATION AND INVESTIGATION

For use of this form, see instructions in the attachments and USACE ER 385-1-99; the proponent agency is CESO.

Requirement Control Symbol

RCS-CESO-21-0001

DATA REQUIRED BY THE PRIVACY ACT OF 1974

Authority 10 U.S.C. 7013, Secretary of the Army; 5 U.S.C. 7902, Safety Programs; Public Law 91-596, Occupational Safety and Health Act of 1970; DoD Instruction 6055.1, DoD Safety and Occupational Health Program; Army Regulations 385-10, Army Safety Program; DoD Instruction 6055 .07, Mishap Notification, Investigation, Reporting, and Record Keeping; and E.O. 9397 (SSN), as amended.

Principal Purpose Information collected is to provide the USACE leaders, soldiers, families and civilians in injury, illness, and loss data to effectively manage its safety and occupational health program.

Routine Uses In addition to those disclosures generally permitted under 5 U.S.C. 552a(b) of the Privacy Act of 1974, these records or information contained therein may specifically be disclosed outside the DoD as a routine use pursuant to 5 U.S.C. 552a(b) as follows: To the Department of Labor, the Federal Aviation Agency, the National Transportation Safety Board, and to Federal, State, and local agencies and applicable civilian organizations, such as the National Safety Council, for use in a combined effort of accident prevention. In some cases, data must also be disclosed to an employee's representative under the provisions of 29 CFR 1960.29. Records will be made available consistent with applicable laws and regulations. Information will be withheld from the public only if authorized by 5 U.S.C. Section 552 (Freedom of Information Act (FOIA), 5 U.S.C. 552a (Privacy Act)), or other statutory or regulatory authority.

Disclosure Failure to provide all the required information on the report may result in the rejection of report submission.

1. WHO IS REPORTING MISHAP

a. Name:	b. Phone number:
c. Email address:	d. Signature:

e. Report type:	☐ 1. Near Miss Report. *(No injury/illness, or property damage. Complete all fields with underlined text.)*	Date:
	☐ 2. Initial Accident Report. (*For accident notification within 24 hrs, Complete all fields with underlined text.*)	Date:
	☐ 3. Final Accident Report. *(For reporting findings from accident investigation, complete full form.)*	Date:

f. Mishap Type. *(Check all that apply)*

☐ Fatality	☐ Injury/Illness	☐ Property Damage	☐ Near Miss

g. Were any of the following items associated with the mishap ? ☐ Yes ☐ No *(If yes, check all that apply)*

☐ Electrical and/or Hazardous Energy	☐ Working at Heights	☐ Diving	☐ Load Handling Equipment or Rigging	☐ Occupational Health Exposure

2. WHO WAS INVOLVED IN THIS MISHAP?

a. Name:		
b. Personnel Classification:	c. Time employee began work:	
d. Gender:	e. Date of birth (for Government personnel only):	f. Age:
g. Date hired:	h. Primary language:	
i. Is individual a supervisor? ☐ Yes ☐ No	j. Duty status at time of mishap:	k. Years experience in job:

l. What was individual doing when mishap occurred? (*Select activity from the drop downs below.*)

1. General activities:	2. Vehicle/Equipment/Vessel:
3. Sports/Recreation:	4. Other not listed:

m. Did individual utilize all OSHA/EM 385-1-1 required Personal Protective Equipment (PPE) for activity? ☐ Yes ☐ No ☐ N/A

If no, identify missing PPE:

n. Was a Personal Flotation Device used? ☐ Yes ☐ No ☐ N/A	o. Was a seat belt used? ☐ Yes ☐ No ☐ N/A

p. **Government personnel only:**

1. Job series:	2. Rank:	3. Grade:
4. Center/Division/Lab:		5. District:

q. **Contractor personnel only:**

1. Employer/Contractor name:		
2. Individual's occupation/trade:		Other not listed:

r. If mishap occurred on a contractor site, provide the following:

1. Prime Contractor name:		
2. Contract number:	3. Contract type:	4. Funding type:

3. WHAT TYPE OF INJURY/ILLNESS OCCURRED?

a. Severity of injury/illness?	b. Type of Injury/Illness:
c. Identify body part(s) affected by injury/illness:	
Primary body part affected:	Secondary body part affected:
d. Identify cause and source of injury/illness:	
Cause of injury/illness:	Source of injury/illness:

e. Was employee treated by a physician or health care professional provider? ☐ Yes ☐ No

If yes, provide name of physician or health care professional provider?

f. Was treatment given away from work site? ☐ Yes ☐ No	g. Was employee treated in an emergency room ? ☐ Yes ☐ No ☐ N/A

h. If treatment was given away from the work-site, where was it given? (For Government Personnel Only)

Treatment facility name:

Address:

City: State: Zip: Country:

i. Was employee hospitalized as an in-patient? ☐ Yes ☐ No	If yes, how many nights?	Was OSHA notified? ☐ Yes ☐ No

Note: OSHA requires reporting all work-related fatalities within 8 hours and in-patient hospitalizations, amputations and loss of an eye within 24 hours to OSHA.

j. Estimated days away from work:	k. Estimated days of restricted/transferred duty:

4. WHAT HAPPENED?

a. What was the primary activity occurring at the time of the mishap?

Other, not listed:

b. What happened? Provide a detailed description of the mishap. (Do not include any personally identifiable information (name, etc.).)

Note: Provide supporting photos, charts, diagrams, etc. with this report.

c. What other organizations or agencies have been notified about this mishap?

5. WHAT TYPE OF PROPERTY/MATERIAL WAS INVOLVED?

a. List all property/material involved in the mishap. (Include damaged and undamaged property.)

	Item A	*Item B*	*Item C*
i. Type of item:			
Other not listed:			
ii. Name of item(s):			
iii. Collision type:			
Other not listed:			
iv. Ownership of item:			
v. Dollar cost of damage:			

6. WHEN DID THE MISHAP OCCUR?

a. Date the mishap occurred:	b. Time mishap occurred:
c. What day did mishap occur on?	d. What period of day did mishap occur?

7. WHERE DID THE MISHAP OCCUR?

a. Did the mishap occur on a military Base/Post? ☐ Yes ☐ No

b. USACE Office/Program/Project name:

c. Select the location type most closely associated with the mishap:

d. Identify exact location where mishap occurred:

Address:

City: State: Zip: Country:

e. Latitude:	f. Longitude:

8. WHY DID THE MISHAP OCCUR? (*Recommend completing this section for Near Misses.*)

A. Performance Causal Factors

1. Did a problem with performance contribute to this mishap occurring? ☐ Yes ☐ No

If yes, select the error that contributed most to the mishap:

2. Describe action(s) taken, anticipated or recommended to eliminate cause(s):

B. Support Causal Factors

1. Did a problem with resources contribute to this mishap occurring? ☐ Yes ☐ No

If yes, select the error that contributed most to the mishap:

2. Describe action(s) taken, anticipated or recommended to eliminate cause(s):

C. Standards/Policy/Planning Causal Factors

1. Did an organizational standard/policy/or plan contribute to this mishap occurring? ☐ Yes ☐ No

If yes, select the error that contributed most to the mishap:

2. Was a written Activity Hazard Analysis (AHA) or equivalent completed and accepted by Government Designated Authority (GDA) for task(s) being performed at time of mishap? (If yes, attach a copy to this report) ☐ Yes ☐ No

If yes, was the AHA available and used by worker? ☐ Yes ☐ No

3. Was a written work plan (critical lift plan, fall protection plan, etc.) required, completed and accepted by the GDA for task(s) being performed at time of mishap? ☐ Yes ☐ No

If yes, was the plan available and used by worker? ☐ Yes ☐ No

4. Describe action(s) taken, anticipated or recommended to eliminate cause(s):

D. Training Causal Factors

1. Did a problem with training contribute to this mishap occurring? ☐ Yes ☐ No

If yes, select the error that contributed most to the mishap:

2. Was individual trained to perform the activity/task? ☐ Yes ☐ No

If yes, select type of training: ☐ Classroom ☐ Certification/License ☐ On the job

☐ Other, describe:

What was date of most recent training?

3. Describe action(s) taken, anticipated or recommended to eliminate cause(s):

E. Leader/Supervisor Causal Factors

1. Did any leader/supervisory mistake/task error contribute to this mishap occurring? ☐ Yes ☐ No

If yes, select the error that contributed most to the mishap:

2. Did the safety climate/culture contribute to the mishap? ☐ Yes ☐ No

3. Did challenges with teamwork contribute to the mishap? ☐ Yes ☐ No

4. Describe action(s) taken, anticipated or recommended to eliminate cause(s):

F. Individual Causal Factors

1. Did any individual mistakes/task errors contribute to this mishap occurring? ☐ Yes ☐ No

If yes, select the error that contributed most to the mishap:

2. Describe action(s) taken, anticipated or recommended to eliminate cause(s):

G. Physical Environment Causal Factors

1. Did any physical environment contribute to this mishap occurring? ☐ Yes ☐ No

If yes, select the error that contributed most to the mishap:

2. Describe action(s) taken, anticipated or recommended to eliminate cause(s):

H. Material Causal Factors

1. Did any material failure contribute to this mishap occurring? ☐ Yes ☐ No

If yes, select the error that contributed most to the mishap:

2. Which failure is most closely associated with the material failure/malfunction?

3. Describe action(s) taken, anticipated or recommended to eliminate cause(s):

I. Environmental Causal Factors

1. Did any environmental condition contribute to this mishap occurring? ☐ Yes ☐ No

If yes, select the factor that contributed most to the mishap:

2. Describe action(s) taken, anticipated or recommended to eliminate cause(s):

J. Facility/Building Design
1. Did the design of the facility/building contribute to the mishap? ☐ Yes ☐ No
If yes, describe:
2. Describe action(s) taken, anticipated or recommended to eliminate hazard:
K. Existing Hazard
1. Did a hazard(s) contribute to the mishap? ☐ Yes ☐ No
If yes, describe the hazard(s):
2. Describe action(s) taken, anticipated or recommended to eliminate hazard(s):
9. Corrective Action plan
a. Have all corrective action(s) to prevent mishap recurrence been completed? ☐ Yes ☐ No
b. Who is responsible for the corrective action plan?
c. What date will/have all corrective action(s) be/been completed by:
d. Additional information:
10. Additional Information

OSHA's Form 300A (Rev. 01/2004)

Summary of Work-Related Injuries and Illnesses

Year 2020

U.S. Department of Labor
Occupational Safety and Health Administration

Form approved OMB no. 1218-0176

All establishments covered by Part 1904 must complete this Summary page, even if no injuries or illnesses occurred during the year. Remember to review the Log to verify that the entries are complete

Using the Log, count the individual entries you made for each category. Then write the totals below, making sure you've added the entries from every page of the log. If you had no cases write "0."

Employees former employees, and their representatives have the right to review the OSHA Form 300 in its entirety. They also have limited access to the OSHA Form 301 or its equivalent. See 29 CFR 1904.35, in OSHA's Recordkeeping rule, for further details on the access provisions for these forms.

Number of Cases

Total number of deaths	Total number of cases with days away from work	Total number of cases with job transfer or restriction	Total number of other recordable cases
0	2	1	10
(G)	(H)	(I)	(J)

Number of Days

Total number of days away from work	Total number of days of job transfer or restriction
30	181
(K)	(L)

Injury and Illness Types

Total number of…	(M)		
(1) Injury	13	(4) Poisoning	0
(2) Skin Disorder	0	(5) Hearing Loss	0
(3) Respiratory Condition	0	(6) All Other Illnesses	0

Establishment information

Your establishment name: APTIM Government

Street: 4171 Essen Lane

City: Baton Rouge State: LA Zip: 70809

Industry description (e.g., Manufacture of motor truck trailers)
Other Heavy and Civil Engineering Construction

Standard Industrial Classification (SIC), if known (e.g., SIC 3715)

OR North American Industrial Classification (NAICS), if known (e.g., 336212)
2 3 7 9 9 0

Employment information

Annual average number of employees: 1,811

Total hours worked by all employees last year: 3,766,393

Sign here Alan B. Weakley

Knowingly falsifying this document may result in a fine.

I certify that I have examined this document and that to the best of my knowledge the entries are true, accurate, and complete.

Alan Weakley
Company executive

President
Title

865-560-7936
Phone

1/28/2021
Date

Post this Summary page from February 1 to April 30 of the year following the year covered by the form

ATTACHMENT 4

SSHO RESUME AND TRAINING CERTIFICATIONS

Talent Shaw Connection™
Building Careers For Growth, Leadership, and Opportunity

This certificate is awarded to

Brian Rhodes

for the successful completion of the course

40-Hour HAZWOPER Training

Hours: 40 Hours 0 Min Credits:

Completion Date: 11/9/1998

Virgil Barton, Sr. Vice President
Quality, EHS, Regulatory Compliance,
Process Improvement

Talent Shaw Connection™
Building Careers For Growth, Leadership, and Opportunity

This certificate is awarded to

Brian Rhodes

for the successful completion of the course

OSHA 30 Hour Construction Safety

Hours: 30 Hours 0 Min Credits: 0

Completion Date: 1/28/2010

Virgil Barton, Sr. Vice President
Quality, EHS, Regulatory Compliance,
Process Improvement

Talent Shaw Connection™
Building Careers For Growth, Leadership, and Opportunity

This certificate is awarded to

Brian Rhodes

for the successful completion of the course

8-Hour HAZWOPER Supervisor Training

Hours: 8 Hours 0 Min Credits: 0

Completion Date: 4/24/2003

Virgil Barton, Sr. Vice President
Quality, EHS, Regulatory Compliance,
Process Improvement

Talent Shaw Connection™
Building Careers For Growth, Leadership, and Opportunity

This certificate is awarded to

Brian Rhodes

for the successful completion of the course

8-Hour HAZWOPER Refresher

Hours: 8 Hours 0 Min Credits: 0

Completion Date: 11/28/2012

Virgil Barton, Sr. Vice President
Quality, EHS, Regulatory Compliance,
Process Improvement

Compliance Solutions
"Today's Training...Tomorrow's Solution"

Certificate Number: Online

Certificate of Completion

This is to certify that

Brian Rhodes

has been tested and successfully meets the training requirments for

8-Hour HAZWOPER Annual Refresher

29 CFR 1910(e) & Title 8CCR 5192(e)(3)(A}

Presented this:

Wednesday, November 21, 2018

Compliance Solutions Occupational Trainers, Inc.

Neval Gupta
Vice President

Jeffrey Kline
President/CEO

Student Affiliation:
APTIM
4433

Compliance Solutions
"Today's Training...Tomorrow's Solution"

3980 Quebec St., 2nd Floor, Denver CO 80207-1633 800-711-2706

Certificate of Completion

Brian Rhodes

has successfully completed training and passed all testing requirements for

8-Hour HAZWOPER Annual Refresher
as per 29 CFR 1910.120(e)

Presented this
Wednesday, November 27, 2019

Certificate Number: 754982334

Compliance Solutions Occupational Trainers, Inc.

Jeffrey E. Kline
President/CEO

American Red Cross
Training Services

Certificate of Completion

Brian Rhodes

has successfully completed requirements for

Adult and Pediatric First Aid/CPR/AED

Date Completed: 4/1/2020
Validity Period: 2 - Years

Conducted by: American Red Cross

To verify certificate, scan code or visit redcross.org/digitalcertificate and enter ID.

Learn and be inspired at LifesavingAwards.org

008FUE7

Brian Rhodes

(256) 714-4200 | 205 Yonex Drive Madison, AL 35756 | brianrhodes24@yahoo.com

Senior Environmental Scientist

Accomplished geologist with 20 years of environmental site investigation experience and 15+ years management experience. Experienced project geologist, waste specialist, and site manager. Expert in the collection and interpretation/evaluation of soil/groundwater samples. Adept at project management and problem-solving in hydrogeologic studies, water resources, environmental site assessments, remedial actions, soil & groundwater contamination studies, stormwater management, geotechnical investigations, land use planning, heavy metal remediation, and more.

EDUCATION

Bachelor of Science Degree in Geology (1997)
University of Alabama | *Tuscaloosa, AL*
Associate of Science (1991)
Calhoun Community College | *Decatur, AL*

CERTIFICATIONS

40-Hour HAZWOPER as per 29 CFR 1910.120(e)
Hazmat Transportation Security Awareness as per 49 CFR 172.704
H&S Program Management for Project Managers and Supervisors
Construction Quality Management for Contractors (Army Corps of Engineers)
OSHA 10-Hour Construction Safety
IATA Dangerous Goods Transportation as per DOT CFR 172.704(a), (1), (2) and (4)
DOT Hazardous Materials Transportation as per 49 CFR 172.704(a), (1) and (3)
OSHA 30-Hour Construction Safety
50-Hour Site Safety Officer
Level I Antiterrorism Awareness Training
OPSEC Awareness for Military Members, DOD employees and Contractors
Military Munitions Response Program (MMRP) 101 Workshop (Army Corps of Engineers)
Munitions Response Site Prioritization Protocol (Army Corps of Engineers)

PROFESSIONAL EXPERIENCE

APTIM (Sep 2013–Present)
Shaw Group (Sep 2010–Sep 2013)

Manage environmental site investigations in the following capacities under the Army's Program Management Contract:

Quality Control Site Manager (QCSM), Environmental Site Investigations

★ Oversee and maintain quality control for several sites, ensuring contracts are followed and subcontractors followed due diligence, resulting in 100% completion and approval by state and national regulators

- Manage on-site and off-site QC program, including field sampling and characterization, construction, and consulting engineering activities
- Ensure overall project quality and that deliverables meet corporate quality standards; evaluate quality-related status, procedures, and non-conformances in coordination with the project QA
- Monitor all subcontractors; prepare daily QC reports; work closely with the QA/QC Manager on any adverse conditions that couldn't be resolved at the project level
- Assist with training and orientation of field staff; conduct random performance and systems inspections to verify all personnel are following implemented work plan procedures; identify and report any nonconforming items or activities

Project Geologist, Environmental Site Investigations

★ Achieved 125+ milestones the PMC contract team, including 85 sites with approved RCRA Facility Investigations (RFIs), 53 sites with No Further Actions (NFAs), and 22 sites with approved Corrective Measures Implementation Work Plans (CMIPs)
★ Managed 12 remediation projects of off-site shipment of contaminated soils, working directly with subcontractors during soil excavations, which resulted in meeting cleanup goals
★ Managed the construction of 2 on-site landfills, which required consolidating waste and soil and capping them with a geosynthetic clay liner, while taking precautions for contaminants including DDT, DDE, and PAHs

- Oversee all on-site geological activities, supervise subcontracted drilling, subsurface investigations, remediation, and groundwater sampling crews; conduct all geological field documentation forms and boring/drilling logs
- Manage subcontractor investigations and provide technical guidance; generate daily QC reports

- Develop technical approaches, work plans, and statements of work; evaluate, select, and oversee subcontractors; ensure contracts are properly implemented, establish safety procedures, maintain schedule and budget

Aptim Federal Services (formerly CB & I Federal Services) (Jul 2017–**Present**)
CB&I Federal Services (formerly Shaw Group) (Sep 2013–Jul 2017)

Site Safety and Health Officer

★ Evaluated the Health and Safety aspects of the on-site tasks to ensure that activities are performed in a safe manner
★ Coordinated with Task Managers to complete Health and Safety Work Plan agenda and worked with on-site personnel to achieve compliance with applicable Health and Safety Plans

★ Conducted site orientation training with all new onsite personnel to insure all general site hazards, project safety rules, chain of command and emergency procedures are provided

★ Worked closely with Senior Health and Safety officers and Task Managers to develop and implement Activity Hazard Analysis for any anticipated hazards for all associated tasks to include the following

- Activity Hazard Analysis includes all chemical and physical hazards that may be encountered for each task. These control measures include work practice controls, engineering controls, health and safety policy reference and use of appropriate personal protective equipment (PPE).
- Implementation of Job Safety Analysis (JSA) which is a checklist of daily hazards along with any change conditions encountered during a work period
- Daily safety hazards to be analyzed may include the following
    - Mobilization/Demobilization of heavy equipment
    - Slips, Trips and Falls
    - Heavy Lifting, Strains and Sprains
    - Use of Heavy Equipment
    - Heat Stress and Cold Stress
    - Noise Prevention
    - Spill Prevention
    - Personal Protective Equipment (PPE)
    - Air Monitoring

Waste Specialist

★ Successfully made off-site shipments of 5200+ drums of waste, 300,000+ gallons of liquid, and 200,000+ cubic yards of contaminated soil through the successful management of non-hazardous and hazardous waste
★ Developed a drum tracking system to address issues with drum labeling and tracking, which resulted in the proper disposal of 100% of drums generated

- Manage waste stream from approx. 300 environmental sites on RSA, ensuring all containers undergo a receipt inspection to verify proper requirements have been met
- Established and maintain a waste tracking system which tracks waste containers from “cradle to grave”
- Conduct weekly inspections on one year and 90 day hazardous waste storage areas to ensure hazardous waste are properly stored, labeled, packaged, characterized and documented in accordance with the Waste Management Plan (WMP)
- Ensure all storage areas are in compliance with RCRA standards which include proper labeling, spill containment kits and proper PPE
- Work directly with government and regulatory personnel on waste disposal, ensuring documentation is properly prepared, executed, and retained for official records; ensure all waste shipments meet the U.S. Department of Transportation (DOT) requirements
- Coordinate with Army and regulatory personnel for the off-site shipment of non-hazardous and hazardous waste streams
- Ensure all hazardous/non-hazardous waste is properly containerized in accordance with Department of Transportation, 49 CFR

Sample Coordinator

- ★ Managed numerous soil and groundwater sampling events and ensured that they were successful
- ★ Resolved chemical agent contamination of multiple sites by successfully managing field sampling efforts during intrusive investigation activities, including:
    - Coordinating and tracking sample status for chemical analysis (CA) screening and analyses
    - Working with several investigation teams including, Chemical, Biological, Radiological, Nuclear, and High Yield Explosives and Remediation Activity (CARA), Edgewood, Chemical and Biological Center (ECBC) and multiple laboratories to ensure that CA screening and analyses did not negatively impact analytical holding times
    - Implementing recovery plans to ensure that HTRW laboratories received CA clearance in time so that analytical holding times were met
    - Manage laboratory and facilitation of sample and documentation transfers, forwarding discrepancies to the Field Sampling Lead, the Project Chemist, and the Laboratory PM for resolution
    - Ensure all analytical samples are collected, documented, packaged, and shipped using project-specific plans and IW QAPP; assist in identifying and resolving any technical or quality issues regarding sample collection and analysis; resolve any non-conformances or quality issues

Shaw Group (Aug 2003–Sep 2010)

Site Manager

- Managed the coordination of work activities, quality, schedule, budget, and subcontractors; ensured compliance of the scope of work and environmental activities
- Ensured field activities are completed and meet project objectives in accordance with Redstone Arsenal and the Army Corps of Engineers; ensure all site personnel are trained in procedures, that the procedures are adhered to, and that all activities are documented
- Tracked and maintained inventory of all Government Furnished Equipment (GFE) per FAR Part 45 as by instructed by United States government.

International Technology (Nov 1998–Jan 2002)

Project Geologist

- Implemented and maintained a site-wide surface water monitoring system that synthesized available and newly acquired data to develop a site-wide understanding of surface water flow and discharge
- Provided field oversight to HTW drilling sites, including hollow stem auger and sonic drilling methods for the installation of monitoring wells for site investigations
- Analyzed and reported geological materials, completed field document boring and drilling logs, collected soil and groundwater samples

APPENDIX F

INVESTIGATION-DERIVED WASTE
STANDARD OPERATING PROCEDURE 4.0

Subject: INVESTIGATION-DERIVED WASTE

1.0 PURPOSE AND SUMMARY

This Standard Operating Procedure (SOP) establishes specific management practices for the in-process handling and subsequent disposition of environmental media generated as a result of investigation and removal actions at Redstone Arsenal (RSA), Madison County, Alabama. Investigation-derived waste (IDW) will be handled in accordance with the most recent versions of Alabama Environmental Investigation and Remediation Guidance and Alabama Administrative Code (AAC) 335-14. This SOP serves as an update to IDW plans previously submitted to comply with Alabama Department of Environmental Management (ADEM) Consent Order No. 97-203-CHW for the management of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) IDW.

In support of RSA's Installation Restoration Program under the Federal Facilities Compliance Act of 1992 and CERCLA and to meet the requirements of RSA's Resource Conservation and Recovery Act (RCRA) permit, RSA is conducting investigation and removal activities which generate environmental media. The media typically consist of drill cuttings and fluids, monitoring well purge and development water, spent personal protective equipment (PPE), and other inert materials (i.e., plastic, rope, tape, paper, etc.) generated during operations, well installation and sampling activities, remedial actions, and associated site activities. When accumulated, the media must be managed appropriately to minimize the exposure to human health and the environment while adhering to applicable regulatory requirements.

2.0 TABLE OF CONTENTS

3.0 RESPONSIBILITIES

3.1 Quality Control Site Manager

The Quality Control Site Manager (QCSM) is responsible for ensuring that field activities are completed to meet the project objectives, that they are conducted in accordance with the project plans and requirements, and that all activities are performed according to their respective procedures. The QCSM is responsible for ensuring that all site personnel are trained in the procedures, that the procedures are adhered to, and that all activities are documented.

3.2 Field Team

All members of the field team (samplers, technicians, field geologists, engineers, etc.) are responsible for understanding and implementing this field procedure as well as ensuring that all team members also perform work in accordance with this SOP.

3.3 Quality Assurance/Quality Control Manager

The Quality Assurance/Quality Control Manager is responsible for ensuring that this SOP is correctly implemented and that the quantity and quality of field- measurable physical characteristic samples collected meet the requirements of the Site-Specific Field Sampling Plans (SFSP).

4.0 DEFINITIONS

None.

5.0 TEXT

5.1 Required Records and Forms

For a description of required forms, refer to SOP No. 1.0, *Field Documentation*.

- Sample Collection Log (SCL)
- Field Activity Daily Log

- Sample tags/labels and the appropriate forms/documentation for sample shipment
- Material Safety Data Sheets (MSDS)
- SFSP.

5.2 Required Materials, Equipment, or Supplies

- Indelible black ink pens and markers
- Appropriate sample containers
- Insulated cooler and waterproof sealing tape
- Nitrile or latex gloves
- Decontamination equipment and supplies, including rinse bottles and deionized water
- Personal protective equipment (PPE)
- Socket wrench or bung wrench to access drums
- Appropriate equipment and meters for obtaining field measurements as specified in the SFSP (i.e., photoionization detector/flame ionization detector).

5.3 Procedures

5.3.1 Preparation

The following steps must be followed when preparing for management activities of IDW:

- Verify that all personnel have read and understand the approved Site-Specific Health and Safety Plan and have the proper training and certifications required under the Occupational Safety and Health Administration.
- Don the appropriate PPE as dictated by the Site-Specific Health and Safety Plan.
- Document the sampling events, recording the information on the SCL or equivalent form as specified. Document any and all deviations from standard operating procedures on the Field Activity Daily Log and include rationale for changes.

5.3.2 Specific Preparation

The following paragraphs detail the planned methodologies for dealing with environmental media generated during site activities. For the purpose of this document, a site, an area of contamination (AOC), and a solid waste management unit (SWMU) are all synonymous.

5.3.2.1 Initial Handling Requirements

All environmental media will be managed in an effort to minimize exposure to human health and the environment. Typically, the media will be generated as a result of these

major activities: drilling soil borings; installation and development of monitoring wells; and groundwater sampling activities.

In instances where soil borings are advanced, either to retrieve soil samples or to allow for the retrieval of a groundwater sample via a hydropunch or similar sampling device (including obtaining a sample from an open borehole), the following handling protocols for IDW soil will be used:

- All soil cuttings will be placed adjacent to the borehole on plastic or other suitable material capable of preventing contact with the ground surface.
- All cuttings will be covered daily or during rainfall events to prevent contact with moisture.
- Upon completion of the downhole activity (i.e., drilling, groundwater sampling, etc.), the soil cuttings will be placed in open topped 55-gallon drums, labeled, sampled, and properly stored.

In cases where a soil test boring is advanced for the purposes of installing a monitoring well, all environmental media accumulated will be containerized to allow for characterization upon generation and situated at or near the point of generation. As solids are generated, they will first be placed into open-topped 55-gallon drums or other approved containers pending further characterization. Solids may be bulked into larger approved containers situated within the AOC. Liquids may be bulked upon generation unless directed otherwise. All solids and liquids will be separated prior to disposal.

Liquids may be held on site at the AOC or SWMU and are not required to be moved to a separate 90-day storage area. However, either the satellite accumulation restrictions regulating storage of less than 55 gallons or 90-day storage rules would apply to hazardous liquids that remain on the SWMU/AOC. Section 5.3.2.3 further discusses storage requirements. If hazardous liquids are stored on site, the satellite accumulation area or the temporary less-than-90-day storage area must meet ADEM requirements for secondary containment standards as noted in Section 5.3.2.3.

5.3.2.2 Labeling

After each container (i.e., drum, roll-off box, etc.) has been filled, the container and lid, if appropriate, will be labeled with a description of the media (i.e., soil, purge water, decon water, PPE), origin of media (i.e., Soil Boring A- 1, Monitor Well RS-0 1 2, etc.), date the media were placed in the container, site identification (i.e., SWMU or AOC number), date container was sealed and sampled, and a short statement stating that the contents are on hold waiting analytical test results. If the analytical results determine that the container contents are hazardous, a standard hazardous waste label will be placed on each container. The accumulation start date will be the same as the date recorded on the initial drum. A copy of correspondence (email) from ADEM clarifying their position on handling of potentially hazardous wastewater at RSA is provided as an attachment to this SOP. Nonhazardous waste containers may be labeled using a paint pen or other indelible

marker that will not fade when exposed to weather. Hazardous waste containers will be marked with labels and information pursuant 40 Code of Federal Regulations (CFR) 262.34. A record of the number of containers, their contents, and the regulatory status of the waste will be completed at each generation site and will be included in the Field Activity Daily Log before leaving each site.

5.3.2.3 Storage

At the end of each day and/or field activity, all containers will be sealed or covered in such a way to prevent the introduction of rain water or surface runoff. Nonhazardous IDW will either be moved to a central IDW storage area, or, if feasible and in the best interest of operations, nonhazardous IDW will remain in the SWMU/AOC from where it was generated until final disposition is selected.

Within 72 hours of being generated, hazardous solid IDW will be moved to an RSA-approved Satellite Accumulation Area, a temporary 90-day storage area, or a fully permitted waste storage area. Wastewater IDW may be held at the AOC or SWMU in a temporary less-than-90-day storage area or it may be moved to a central 90-day storage area. Any temporary 90-day storage area established on an AOC or SWMU will meet ADEM's secondary containment standards. Wastewater or solid hazardous IDW will be labeled during storage as discussed in Section 5.3.2.2.

Waste may be transported between storage areas when required or in preparation of disposal activities without specific regulatory concurrence (i.e., RSA is not required to obtain specific regulatory approval to transport wastes within the confines of RSA). Drums of hazardous wastewater will be removed from the AOC or SWMU in less than 90 days. All hazardous IDW will be shipped off site or properly treated and managed on site within 90 days of its accumulation start date.

5.4 Characterization of Media

The characterization of the media will be determined by a combination of generator knowledge and use of analytical data obtained during the activity from which the materials were generated. As stated, it is anticipated that specific generation activities will include soil borings, monitoring well installations, and monitoring well purge and development actions. Water obtained from specific monitoring well sampling points (i.e., purge and development water) will be characterized using groundwater sampling data taken from the specific well site from which the water was obtained. Analytical data obtained from a particular borehole reflecting soil contaminant levels will be used to characterize solids generated from that borehole. Other solids (such as rock) will be characterized for disposal based on the analytical results of the soil and water sampled at the specific location where the solids were generated. When appropriate, analytical data will be extrapolated to reflect toxicity characteristic leaching procedure (TCLP) values (i.e., 20x divisor rule for soils). Generator knowledge may be used to evaluate the media potential for toxicity, corrosivity, ignitability, reactivity, and listed waste scenarios.

In the event generator knowledge and data associated with previous site investigations are inadequate to accurately and thoroughly characterize the IDW, waste will be managed as hazardous waste. A representative sample will be retrieved from each waste stream warranting further characterization. In addition, representative samples will be collected from all IDW determined to be nonhazardous based on generator knowledge. These samples will be taken directly from containers after the waste has been generated. The suite of analyses to be run will be determined based on suspected contaminants and any information gleaned from previously available data. Hazardous versus nonhazardous determinations will be made utilizing those parameters outlined in AAC R. 335-14-2-.02, *Criteria for Identifying the Characteristics of Hazardous Wastes and for Listing Hazardous Waste*. More specifically, hazardous characteristics will be determined utilizing the requirements of AAC R. 335-14-2-.02 (1) and 335-14-2-.03. Where listed wastes are expected or where the potential exists, specific analytes (i.e., totals as opposed to TCLP) for the listed compounds will be tested in addition to determining any hazardous characteristics. All sampling and analytical testing protocols will be consistent with ADEM/U.S. Environmental Protection Agency (EPA) requirements and methodologies.

5.5 Management and Disposition

Once adequately characterized, the containers will be labeled as described. U.S. Department of Transportation-approved labels will be used if transportation outside of RSA boundaries is required or anticipated. The media may also be bulked on site (within the staging area) with like waste streams possessing compatible nonreacting characteristics.

5.6 Wastewater

In general, all wastewater generated during the described site activities will most likely be disposed either at an RSA-approved treatment facility or at the wastewater treatment facility currently operated at RSA.

5.6.1 Nonhazardous Wastewater

Upon proper characterization and approval from RSA representatives, wastewater determined to be nonhazardous (Section 40 CFR Part 261) but possessing some level of contaminants can be disposed directly into RSA's sanitary sewer system, where it will ultimately be treated at the RSA wastewater treatment plant (WWTP). The RSA representative will request waste characterization data, approximate volume, and the location of disposal in making the determination to accept sewer discharge. The nonhazardous water will typically be discharged at a manhole(s) located near the generation site.

All discharges will be in accordance with provisions outlined in Division 6, *Water Quality Program*, of the AAC. More specifically, the discharge will not be greater than 5 percent of the average dry weather capacity of the WWTP, greater than 5 percent of the

design capacity of the WWTP, or subject to Section 403.6 of the Federal Water Pollution Control Act. No disposal permit is required as long as the wastewater is discharged in quantities of less than 25,000 gallons per day and the water is nonhazardous (40 CFR 261).

Wastewater generated during site activities and for which analytical tests showed no level of contamination present above approved detection limits will be considered nonregulated. The disposal means and methods of nonregulated waste water are at the discretion of RSA representatives (e.g., storm water system, open ditch, etc.) and do not require regulatory consultation or concurrence.

On a quarterly basis, RSA will submit documentation of all discharges (regulated and nonregulated) to ADEM. The documentation will contain pertinent information regarding the discharge, including, date, time, volumes, analytical data (if available), site, action, etc**.** All discharges to the sanitary sewer system will be coordinated in advance.

5.6.2 Hazardous Wastewater

Hazardous wastewater will be transported, when required, and treated at an off-site wastewater treatment facility when the following conditions are met:

1. The treatment facility meets the definition of a wastewater treatment unit as defined in AAC R. 335-14-1-.02.
2. The treatment facility is capable of (a) rendering characteristically hazardous wastes (AAC R. 335-14-2-.03) nonhazardous or (b) removing listed wastes (AAC R. 335-14-2-.04) from the contaminated media so that the media no longer contain the listed waste for which the media were originally considered hazardous. If after treatment, analytical tests show the listed waste is not present above laboratory detection limits, then the contaminated media will be considered to no longer contain the listed waste and will no longer be considered hazardous.
3. The wastewater treatment facility has been constructed at RSA in conjunction with a removal, interim remedial action, or remedial action at an AOC.

At no time will liquids that possess hazardous characteristics or meet the definition of a listed waste be disposed into the sanitary sewer system, unless the waste is specifically exempt under RCRA, CERCLA, or its applicable or relevant and appropriate requirement without applicable ADEM authorization.

Wastewater determined to be hazardous may be transported between AOCs and within RSA boundaries for treatment/disposition in accordance with the previously outlined provisions without specific regulatory concurrence.

On a quarterly basis, RSA will submit documentation of discharges to ADEM. The documentation will contain pertinent information regarding the discharge including date, time, volumes, analytical (if available), site, action, etc.

All discharges to the sanitary sewer system will be coordinated prior to any discharge.

In the event that RSA does not have a facility on line capable of treating the hazardous wastewater at or around the time of generation, and the water is expected to remain on site for a prolonged period of time (but not to exceed 90 days), the water will be stored in an area with an adequate secondary containment system until an approved treatment system is on line.

Unless specifically mandated by ADEM and EPA, the treatment and disposal of hazardous and nonhazardous wastewater will be performed as previously described. The wastes will be treated and disposed in a timely manner so as to expedite site activities and to ensure the protection of human health and the environment. Except where noted, specific written concurrence from ADEM and EPA prior to those actions previously described is not required.

5.7 Solids

Solids may include soil cuttings, rock, grout, spent PPE, plastic sheeting, rope, unused monitoring well construction materials, and other environmental media generated during field activities. All solids will be containerized at or near the point of generation and staged as described in Section 5.3.2.1. Other specific management practices are described in Sections 5.7.1 and 5.7.2.

5.7.1 Nonhazardous Solids

Soil cuttings and rock determined to be nonhazardous will be staged within the confines of the AOC from which they were generated or stored properly in an RSA-approved storage area. After characterizations (hazardous versus nonhazardous) are finalized and depending upon site conditions, nonhazardous cuttings will be removed from containers and replaced “at or near” the location from which they were derived. “At or near” infers media will be placed as near to their point of origin as is practical. Examples would be placing monitoring well cuttings around the monitoring well from which they originated as opposed to within it. However, when not practical, the media may be centrally located within the confines of the originating AOC in an area of minimal traffic and where the media could be managed in a manner protective of human health and the environment. At no time will contaminated media originating from one AOC be transported to another AOC for placement without prior written concurrence from ADEM and EPA.

In the event that site conditions are not conducive to the replacement of the materials (i.e., restricted space, confined area, etc.), soils and rock determined to be nonhazardous may be disposed into RSA's Solid Waste Disposal Facility-Construction/Demolition Landfill (ADEM Permit No. 45-03) or an approved off-site non-hazardous solid waste disposal facility as long as the following conditions are met:

1. Soils exhibiting contaminant levels below analytical detection limits are considered nonregulated and will be disposed at the discretion of RSA representatives.

2. The soil analytes do not exceed 50 percent of the TCLP analysis for any given compound. A disposal report is submitted within 45 days of disposal that includes a signed copy of ADEM's Solid/Hazardous Waste Determination form and any applicable analytical results.

Other nonhazardous solids such as spent PPE, plastic sheeting, rope, unused monitoring well construction materials, and other environmental media generated during field activities that have been determined to be nonhazardous will be emptied into dumpsters or roll-offs for disposal off site at a permitted solid waste disposal facility.

5.7.2 Hazardous Solids

Hazardous IDW solids can be segregated into two categories for purposes of waste management. The first is strictly IDW soils. Hazardous IDW soils will be immediately handled and stored as hazardous waste while on RSA. The waste soils will be analyzed, profiled, and managed off site at a permitted transportation, storage, and disposal facility for its characteristic and/or listed waste status. The second hazardous IDW solid category is essentially all non-soil-like media, generally anticipated to be in the form of debris and PPE. The soil versus nonsoil differentiation is necessary in order to select the correct treatment and disposal technology. Hazardous nonsoil and debris media can present different analytical and treatment strategies than contaminated soils.

6.0 EXCEPTION PROVISION

None.

7.0 CROSS REFERENCES AND OTHER SOURCES OF INFORMATION

This SOP will be used in conjunction with the following cross references where applicable.

SOP No. 1.0 – Field Documentation

SOP No. 11.0 – Field Generated Records Management

Alabama Department of Environmental Management (ADEM), 2009, Division 14 - Hazardous Waste Program, Revised Effective March.

Alabama Department of Environmental Management (ADEM), 2005, **Alabama Environmental Investigation and Remediation Guidance**, September.

McCoy and Associates, 1995, **RCRA Regulations and Keyword Index**, Elsevier, 1995.

U. S. Environmental Protection Agency (EPA), 1992a, **Guide to Management of Investigative-Derived Wastes**, Office of Solid Waste and Emergency Response, Publication 9345.3-03FS, April 1992.

U. S. Environmental Protection Agency (EPA), 1992b, **Management of Contaminated Media**, Region IV EPA, Guidance Number TSC-92-02, December 28, 1992.

U. S. Environmental Protection Agency (EPA), 1991, **Management of lnvestigative-**

Derived Wastes During Site Inspections, Office of Research and Development, Publication, EPA/540/G-91/009, May 1991.

8.0 ATTACHMENTS

- Attachment 1, ADEM Email Addressing IDW.

ATTACHMENT 1

ADEM EMAIL ADDRESSING IDW

Attachment I
ADEM Email Addressing IDW
RSA IWSAP SOPP 4.0

Kurth, Randy

Subject: FW: Response to ADEM original comments on the IDW discussion {Update}

Importance: High

From: Morrissette, Krishna M [mailto:KMorrissette@adem.state.al.us]
Sent: Wednesday, November 17, 2010 2:54 PM
To: Kurth, Randy
Cc: Davis, Emily; Burton, Don; Hodges, Barry A Mr CIV USA USACE; Shell, Ronald T; Wilson, J Jason; Reese, Dennis
Subject: RE: Response to ADEM original comments on the IDW discussion {Update}
Importance: High

Randy,

Sorry for the confusion on the 90-day storage issue. Here are some comments to further clarify ADEM position on the handling/ staging of potentially hazardous wastewater at RSA:

1. Wastewater can be held at the AOC or SWMU site and does not have to be immediately moved to another < 90 day storage area. The holding area must meet secondary containment standards.
2. It is OK to initially label the wastewater filled drums with the following information.
   - Description of the drum contents (e.g. wastewater from RSA-XXX)
   - Accumulation start date (the date the drum was filled)
   - A short statement that states that the contents are on hold awaiting analytical test results
3. If the analytical results come back noting the drum contents are hazardous, a standard hazardous waste label must be put on the drum noting all required information. The accumulation start date for the standard HW label should be the same date as recorded on the initial drum label.
4. Drums of hazardous wastewater must be removed from the AOC or SWMU in less than 90 days.

Remember that the generator must meet the < 90 day storage rules and regulations (e.g. weekly inspections, training, secondary containment, etc.) while holding the hazardous wastewater drums at the AOC or SWMU site.

As for your response to the example IDW information needed to support generator knowledge determination, it is adequate for our on-site visits. Since it is late in the afternoon for you (EST), I will try to call you to confirm the information presented in this email. Thanks again for your help in this matter, Randy!

Sincerely Yours,

Krishna "Kel" Morrissette
ADEM - Land Division: Facilities Engineering Section
Work: (334) 394-4335
Fax: (334) 279-3050
email: kmorrissette@adem.state.al.us

APPENDIX G

CONSTRUCTION BEST MANAGEMENT PRACTICES PLAN AND NOTICE OF INTENT

Appendix G

Construction Best Management Practices Plan and Notice of Intent RSA-013, Unlined Inactive Open Burn Pad Operable Unit 14

U.S. Army Garrison-Redstone
Madison County, Alabama
EPA ID No. AL7 210 020 742

Prepared for:

U.S. Army Engineering and Support Center
Huntsville Engineering and Support Center
ATTN: CEHNC-OEC
5021 Bradford Drive East
Huntsville, Alabama 35805

Prepared by:

Aptim Federal Services, LLC
11400 Parkside Drive, Suite 400
Knoxville, TN 37934

Contract No. W912DY-17-D-0003
APTIM Project Number 501388
Delivery Order W912DY19F1116

November 2021

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List of Attachments

G1.0 Introduction

Aptim Federal Services, LLC, on behalf of the U.S. Army Garrison-Redstone, has prepared this Construction Best Management Practices (BMP) Plan pursuant to National Pollutant Discharge Elimination System General Permit Number ALR100000, *Waste Discharge Requirements for Discharge of Stormwater Runoff Associated with Construction Activity*, which is also known as the Construction Stormwater General Permit (CSWGP).

In accordance with this plan and Section 4.2.9 of the corrective measures implementation (CMI) work plan, the Remediation Contractor shall implement and maintain appropriate structural and nonstructural BMPs for the prevention and control of nonpoint sources of pollutants, e.g., sediment, oil and grease, chemicals, etc., during project construction. In doing so, the Remediation Contractor shall abide by the regulations given in the Alabama Department of Environmental Management (ADEM) Administrative Code applicable to construction stormwater and the National Pollutant Discharge Elimination System General Permit; a copy of the CSWGP is provided as Attachment G-1.

Coverage under and compliance with the CSWGP is required if stormwater is discharged to waters of the United States from construction projects that result in a total land disturbance of 1 acre or greater and sites less than 1 acre but part of a common plan of development. The excavation of contaminated soil during CMI activities at RSA-013, covering approximately 5 acres, will result in more than 1 acre of soil disturbance from which discharges of stormwater to waters of the United States may occur. Ground elevations within RSA-013 slope gently to the east, ranging from approximately 560 to 578 feet above mean sea level. With the exception of the berms, the site lies within the 100-year floodplain, generally defined as the 565-foot elevation contour. There are no surface water bodies located within the RSA-013 site boundary. An embayment to the Tennessee River is located approximately 200 feet north of the site; the Tennessee River is located approximately 800 feet west of RSA-013. Wetlands are located to the north and west of RSA-013

To obtain coverage under the CSWGP, a Notice of Intent must be submitted to ADEM prior to initiation of construction activities. A copy of the Notice of Intent Form is provided in Attachment G-2. Compliance with the conditions of the CSWGP must be maintained throughout the project and a Notice of Termination must be submitted when construction activities are completed. A copy of the sample Notice of Termination is also provided in Attachment G-2.

G2.0 Project Description

RSA-013 consists of an area containing two formerly used unlined (earthen) burn pads. The former burn pads were used from the 1950s until 1986 for the thermal treatment (burning) of explosives and explosives-contaminated material and reactive waste, primarily propellant (CB&I Federal Services LLC [CB&I], 2017). The pads, each approximately 200 feet square, were bare ground surrounded by grass fields and crescent-shaped earthen berms on the north, west, and south sides of each pad. Operations were discontinued and investigations were initiated following an ADEM inspection during which burning on unprotected ground was observed, which resulted in ADEM issuing a Notice of Violation in January 1986. No buildings are located within the site boundary.

A Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) was performed at the surface media site designated as RSA-013, Unlined Inactive Open Burn Pad, to evaluate potential environmental impacts from historical activities conducted at the site by the United States Army (CB&I, 2017). Surface media are defined as surface soil, subsurface soil, surface water, and sediment, as applicable. Based on available information collected during historical and recent investigation activities, the RFI report concluded that the Army's historical operations at RSA-013 have resulted in concentrations of site-related constituents (perchlorate and RDX) in surface media which pose a leaching threat to groundwater. Corrective measures are, therefore, warranted for surface media as part of RSA-013. Corrective measures are also required for groundwater beneath RSA-013. The Army intends to perform corrective measures for groundwater as part of the RSA-151 groundwater unit.

The corrective measures to be implemented at RSA-013 involve excavation and off-site disposal of perchlorate- and RDX-contaminated soil. The projected excavation area covers approximately 2 acres. The depth of excavation is expected to be approximately 8 feet, the average depth to groundwater. The volume of material to be excavated from RSA-013 is estimated to be 24,200 cubic yards. The scope of work for this project is detailed in the CMI work plan for RSA-013 to which this construction best management practices plan is an appendix.

G3.0 Responsibility and Authority

Activities at the project site will be conducted under the supervision of the Project Manager. Throughout the duration of the construction activities, periodic inspections will be conducted to verify that stormwater controls are in place and effective. These inspections will ensure the following:

- Scouring and excessive sediment displacement has not occurred.
- Erosion has not damaged berms or ditches.
- Surface water is not ponding on the site.
- Sediment has not blocked silt fences, straw waddles, culverts, or plugged outlets.
- Off-site surface water migration is minimized.

Inspections will be conducted weekly during operation activities. In addition, the site will be inspected before (if possible) and immediately after (within 24 hours) each qualifying rain event. A qualifying rain event is defined as a storm that has a measurable rainfall depth of 0.75 inch or greater in any 24-hour period.

All maintenance work done on the site surface water management or erosion control systems will be recorded in the inspection log.

G4.0 Best Management Practices and Measures

The following BMPs and measures will be followed in order to minimize the effects of runoff from the site in accordance with the *Alabama Handbook for Erosion Control, Sediment Control, and Stormwater Management on Construction Sites and Urban Areas* (Alabama Soil and Water Conservation Committee, 2018).

Site Preparation

A. Construction Exit Pad – Aggregate base construction pads will be constructed at vehicle entrances and exits to reduce the tracking of mud and caked soil from the site onto roadways.

B. Land Grading – Land grading, including soil stockpiling, will be utilized to as part of excavation activities and to manage runoff and erosion, as well as reduce ponding. Following construction, backfilled excavations will also be graded in keeping with BMPs.

Surface Stabilization

C. Dust Control – Dust at the site will be controlled with water using a water truck with hose and sprayers and mulch such as straw, as necessary.

D. Erosion Control Blanket – Erosion control blanket may be used to control erosion for areas with steep slopes.

E. Mulching – Straw mulch will be used to control runoff and erosion on disturbed land and reduce moisture loss to facilitate revegetation.

F. Permanent Seeding – Permanent seeding will be used to revegetate the excavation areas, and other areas affected by construction activities.

G. Preservation of Vegetation – Care will be taken to avoid disturbing land outside the excavation and work areas to maintain the vegetative cover surrounding the work site.

H. Temporary Seeding – Similar to permanent seeding, fast-growing temporary seeding will be used to revegetate the excavation areas and other areas affected by construction activities during seasons or under conditions where establishing vegetation is required.

Runoff Conveyance

I. Check Dam – Check dams may be used in conjunction with grass swales and diversions to slow the velocity of flow and reduce erosion.

J. Diversion – Diversions may be used to convey runoff away from construction areas or other key locations.

K. Grass Swale – Grass swales may also be used to convey runoff, especially in areas where runoff velocity and erosion are concerns.

Sediment Control

L. Filter Strip – Filter strips may be used to provide infiltration, intercept sediment, and reduce stormwater flow and velocity. Preservation of existing vegetation will be used, when possible, to serve as filter strips.

M. Sediment Barrier – Sediment barriers (i.e., silt fence) will be used to reduce the amount of sediment washed away from construction areas. Any perimeter of the excavation area that does not typically have water encroachment will have silt fence installed. In revegetated areas, the silt fence will remain in place until after the vegetation is established. Once the silt fence is removed, the posts will be cut off at ground surface and the remaining disturbed area will be reseeded.

N. Sediment Trap – Straw bales may be used for trapping sediment in minor drainage swales.

Excerpts from the handbook describing the BMPs and measures in fuller detail, as well as related log sheets, are included in Attachments G-3 and G-4, respectively. The locations of stormwater management BMPs and measures are presented on Figure 4-1 of the CMI work plan.

G5.0 References

Alabama Soil and Water Conservation Committee, 2018, ***Alabama Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Areas,*** July.

CB&I Federal Services LLC (CB&I), 2017, ***Revision 1 RCRA Facility Investigation Report, RSA-013, Unlined Inactive Open Burn Pad, RSA-132, Dismantled Popping Furnace, RSA-133, Inactive Rocket Washrack/Sump, Operable Unit 14, U.S. Army Garrison-Redstone, Madison County, Alabama***, February.

ATTACHMENT G-1

ADEM CONSTRUCTION STORMWATER GENERAL PERMIT
(Permit No. ALR100000)

ADEM
Alabama Department of Environmental Management

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM GENERAL PERMIT

DISCHARGE AUTHORIZED: DISCHARGES FROM CONSTRUCTION ACTIVITIES THAT RESULT IN A TOTAL LAND DISTURBANCE OF ONE ACRE OR GREATER AND SITES LESS THAN ONE ACRE BUT ARE PART OF A COMMON PLAN OF DEVELOPMENT OR SALE

AREA OF COVERAGE: THE STATE OF ALABAMA

PERMIT NUMBER: ALR100000

RECEIVING WATERS: ALL WATERS OF THE STATE OF ALABAMA

In accordance with and subject to the provisions of the Federal Water Pollution Control Act, as amended, 33 U.S.C. §§1251-1378 (the "FWPCA'J, the Alabama Water Pollution Control Act, as amended, Code of Alabama 1975, §§ 22-22-1 to 22-22-14 (the "AWPCA'J , the Alabama Environmental Management Act, as amended, Code of Alabama 1975, §§22-22A-1 to 22-22A-15, and rules and regulations adopted thereunder, and subject further to the terms and conditions set forth in this permit, the Permittee is hereby authorized to discharge into the above-named receiving waters.

ISSUANCE DATE: March 12, 2021

EFFECTIVE DATE: April 1, 2021

EXPIRATION DATE: March 31, 2026

Jeffery W. Kitchen
Alabama Department of Environmental Management

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PART I: Coverage Under This General Permit

A. Permit Coverage

This permit authorizes, subject to the conditions of this permit, discharges associated with construction activity that will result in land disturbance equal to or greater than one (1) acre or from construction activities involving less than one (1) acre and which are part of a common plan of development or sale equal to or greater than one (1) acre occurring on or before, and continuing after the effective date of this permit, except for discharges identified under Part I.C. of the permit.

B. Eligibility

1. Allowable Stormwater Discharges

   This permit authorizes the following stormwater discharges:

   (a) Stormwater associated with construction activities defined in Part I.A. of this permit;

   (b) The following stormwater discharges have been determined by the Director to require coverage under this permit:

      (i) Sites, irrespective of size, whose stormwater discharges have a reasonable potential to be a significant contributor of pollutants to a water of the State, as determined by the Department;

      (ii) Sites, irrespective of size, whose stormwater discharges have a reasonable potential to cause or contribute to a violation of an applicable Alabama water quality standard as determined by the Department.

   (c) Discharges from construction support activities provided:

      (i) The support activity is solely related to the construction site covered under this permit;

      (ii) The support activity is not an operation serving multiple unrelated construction projects and does not operate beyond the completion of the construction activity at the construction project it supports;

      (iii) The support activity is located in close proximity (two-mile radius) to the construction site covered under this permit, or as otherwise approved by the Department;

      (iv) Stormwater controls are implemented in accordance with Part III for discharges from the support activity area; and

      (v) Pollutant discharges from support activity areas are minimized to the maximum extent practicable and do not pose a reasonable potential to exceed applicable water quality standards.

2. Allowable Non-Stormwater Discharges

   This permit authorizes the following non-stormwater discharges provided the non-stormwater component of the discharge is in compliance with Part III.D.:

   (a) Discharges from fire-fighting activities;

   (b) Fire hydrant flushings;

   (c) Water used to wash vehicles and equipment where detergents are not used;

   (d) Water used to control dust;

   (e) Potable water including uncontaminated water line flushings not associated with hydrostatic testing;

   (f) Routine external building wash down associated with construction that does not use detergents;

   (g) Pavement wash waters where spills or leaks of toxic or hazardous materials have not occurred (unless all spilled material has been removed) and where detergents are not used. The operator is prohibited from directing pavement wash waters directly into any surface water, storm drain inlet, or stormwater conveyance, unless the conveyance is connected to a sediment basin, sediment trap, or similarly effective control;

   (h) Uncontaminated air conditioning or compressor condensate associated with temporary office trailers and other similar buildings;

   (i) Uncontaminated, non-turbid discharges of ground water or spring water;

   (j) Foundation or footing drains where flows are not contaminated with process materials such as solvents; and

   (k) Landscape irrigation.

C. Exempt Discharges

1. Coverage under this permit is not required for the following:
   (a) Animal feeding operation (AFO) or concentrated animal feeding operation (CAFO) construction activity that has been granted NPDES registration coverage pursuant to Chapter 335-6-7;
   (b) Normal agricultural; and
   (c) Silvicultural activities.
2. Coverage under this permit is not required for discharges associated with minor land disturbing activities such as the following:
   (a) Home gardens or individual home landscaping;
   (b) Home repairs and/or maintenance;
   (c) Fence installation or maintenance;
   (d) Directional boring, hand hole digging; and
   (e) Guardrail, shoulder, and minor improvements associated with roadway pavement resurfacing.

D. Prohibited Discharges

The following discharges associated with construction are not authorized by this permit:

1. Stormwater discharges that are mixed with sources of non-stormwater unless such stormwater discharges are:
   (a) In compliance with a separate NPDES permit, or
   (b) Determined by the Department not to be a contributor of pollutants to waters of the State.
2. Stormwater discharges currently covered under another NPDES permit;
3. Discharges from coal/metallic mining, dry processing, wet processing, and areas associated with these activities;
4. Wastewater from washout of concrete, unless managed by an appropriate control (Wastewater from Concrete Batch Plants are prohibited unless such discharges are authorized by and in compliance with a separate NPDES permit);
5. Wastewater from washout and cleanout of stucco, paint, form release oils, curing compounds, and other construction materials;
6. Fuels, oils, or other pollutants used in vehicle and equipment operation and maintenance;
7. Soaps or solvents used in vehicle and equipment washing;
8. Discharges from dewatering activities, including discharges of ground water or accumulated stormwater from dewatering of trenches, excavations, foundations, vaults, or other similar points of accumulation, unless managed by appropriate controls;
9. Discharges to surface waters from sediment basins or impoundments, unless an outlet structure that withdraws water from the surface, unless infeasible, is utilized;
10. Discharges where the turbidity of such discharge will cause or contribute to a substantial visible contrast with the natural appearance of the receiving water;
11. Discharges where the turbidity of such discharge will cause or contribute to an increase in the turbidity of the receiving water by more than 50 NTUs above background. For the purposes of determining compliance with this limitation, background will be interpreted as the natural condition of the receiving water without the influence of man-made or man-induced causes. Turbidity levels caused by natural runoff will be included in establishing background levels;
12. Discharges of any pollutant into any water for which a total maximum daily load (TMDL) has been finalized or approved by EPA unless the discharge is consistent with the TMDL;
13. Discharges to waters listed on the most recently approved 303(d) list of impaired streams unless the discharge will not cause or contribute to the listed impairment; and
14. Toxic or hazardous substances from a spill or release.

PART II: Notice of Intent (NOI) Requirements

A. Deadlines for Notices of Intent

Any person wishing to obtain coverage under this general permit shall submit an NOI in accordance with the following schedule:

1. Any person wishing to be permitted to discharge under this general permit shall submit a complete NOI and appropriate fee prior to the initiation of construction activity;
2. Any Permittee authorized to discharge under the 2016 NPDES Construction General Permit, who wishes to continue to discharge upon the expiration of that permit, shall submit a complete NOI to be covered by this reissued General Permit. Such NOI shall be submitted at least 30 days prior to the expiration date of the 2021 NPDES Construction General Permit; and
3. Failure of the Permittee to submit a complete NOI for reauthorization under this permit at least 30 days prior to the previous permit's expiration will void the automatic continuation of the authorization to discharge under that permit as provided by ADEM Admin. Code r. 335-6-6-.06. Should the permit not be reissued for any reason prior to its expiration date, Permittees who failed to meet the 30-day submittal deadline will be illegally discharging without a permit after the expiration date of the 2016 NPDES Construction General Permit.

B. Continuation of the Expired General Permit

If this permit is not reissued or replaced prior to the expiration date, it will be administratively continued in accordance with the ADEM Administrative Code Chapter 335-6-6 and remain in force and in effect if the Permittee submits an updated and complete NOI meeting the requirements of Part II.C. at least 30 days prior to the expiration of this permit. Any Permittee who was granted permit coverage prior to the expiration date will automatically remain covered by the continued permit until the earlier of:

1. Reissuance or replacement of this permit, at which time the Permittee must comply with the Notice of Intent conditions of the new permit to maintain authorization to discharge; or
2. Issuance of an individual permit; or
3. A formal permit decision by the Department not to reissue this general permit, at which time the Permittee must seek coverage under an alternative general permit or an individual permit.

C. Contents of the Notice of Intent (NOI)

1. The NOI shall include:
   (a) The correct fee pursuant to ADEM Admin. Code R. 335-1, Fee Schedule D;
   (b) A general description of the construction activity for which coverage is desired, which shall be in sufficient detail to allow the Department to determine that the stormwater and non-stormwater discharges are included in the authorized discharges category of this general permit;
   (c) The latitude and longitude, to the nearest second, for the entrance to the construction site, each outfall for which coverage under this general permit is desired. For the purposes of this requirement the entrance to the construction site will be identified as the primary point of access by normal vehicle traffic. For linear projects, the latitude and longitude, to the nearest second, should be provided for the starting and ending point of the project boundaries;
   (d) Identification of the waterbodies receiving discharges for which coverage under this general permit is desired;
   (e) A portion or copy of a recent map or series of maps (e.g., USGS quadrangle map or LIDAR contour map) at an appropriate contour interval, including perennial, intermittent, and ephemeral streams/lakes/springs/wetlands. Several maps/pages may be necessary depending on the size and scope of the project;
   (f) The map(s) at a minimum must include the following, which should be clearly identified (please include a key for symbols and a scale) on the map(s):
      (i) Site/project boundaries;
      (ii) Proposed permit boundaries;
      (iii) Property boundaries (non-linear project only);
      (iv) Area(s) of disturbance;
      (v) One (1) mile radius;
      (vi) Entrance(s)/Exit(s);

(vii) Outfall(s);

(viii) Receiving stream(s); and

(ix) Begin and End Project Locations (Linear project only).

(g) A current plat map for subdivisions and/or common plans of development or sale;

(h) A facility contact person, address, and phone number for the site to be covered under the general permit.

(i) For priority construction sites, the NOI must be accompanied by a copy of the CBMPP prepared and certified by a Qualified Credentialed Professional (QCP) as required by Part III.E.

(j) The number of estimated disturbed acres and total site acreage.

(k) The estimated start and completion dates of project.

(l) Provide a list of all treatment chemicals anticipated to be used at the site, including the most recent published Safety Data Sheets (SDS) and the dosage(s) to be used and the location(s) where these materials will be applied. If this information is not known at the time of the NOI submittal, the information shall be submitted to the Department through an information update as timely as possible and update the CBMPP as required by Part III.E.5.

2. The NOI shall be signed by a person meeting the requirements for signatories under ADEM Admin. Code r. 335-6-6-.09, and the person signing the NOI shall make the certification required for submission of documents under ADEM Admin Code r. 335-6-6-.09(4).

3. The NOI shall be signed by a QCP and shall have the following certification statement: "I certify under penalty of law that a comprehensive Construction Best Management Practices Plan (CBMPP) for the prevention and minimization of all sources of pollution in stormwater and authorized related process wastewater runoff has been prepared under my supervision for this site/activity, and associated regulated areas/activities. The CBMPP meets the requirements of this permit and if properly implemented and maintained by the operator, discharges of pollutants in stormwater runoff can reasonably be expected to be effectively minimized to the maximum extent practicable according to the requirements of ADEM Administrative Code r. 335-6-6-.23 and this Permit. The CBMPP describes the erosion and sediment control measures that must be fully implemented and regularly maintained as needed at the permitted site in accordance with sound sediment and erosion control practices to ensure the protection of water quality."

D. Submittal of Documents

The Permittee must complete and submit the NOI electronically, using the Department's Alabama Environmental Permitting and Compliance System (AEPACS), unless the Permittee submits in writing valid justification as to why the electronic submittal process cannot be utilized and the Department approves in writing the utilization of hard copy submittals. The AEPACS can be accessed at the following link: http://adem.alabama.gov/AEPACS. Permit requests for initial issuance and modifications of the existing permit should all be submitted through the AEPACS system.

E. Additional Permittees (Co-Permittee) Under a Single NOI

Multiple operators conducting regulated land disturbances in a common plan of development may jointly submit an NOI. An NOI covering multiple operators must include a site plan clearly describing each operator's areas of operational control.

F. Authorization to Discharge

1. Except as otherwise limited by Part II.F.2 or II.F.3, the operator is authorized to discharge in accordance with the requirements of this permit upon the Department's receipt of a complete and timely NOI which meets the requirements of this permit and ADEM Admin. Code r. 335-6-6-.23.

2. Coverage under this permit is conditionally granted, and the requirement to submit an NOI is suspended for governmental agencies and utilities for construction activity associated with immediate and effective emergency repairs and response to natural disasters, human health or environmental emergencies, or to avert/avoid imminent, probable, or irreparable harm to the environment or severe property damage. The operator or controlling/participating federal, State, or local government agencies/entities conducting emergency construction activity shall document the emergency condition, ensure compliance with the requirements of this permit to the extent possible, and shall notify the Department as promptly as possible regarding the occurrence of the emergency construction disturbance and measures that have been implemented and are being implemented to protect water quality. Unless the requirement to obtain a permit pursuant to the requirements of this permit are suspended or voided by the Director on a categorical or individual emergency basis, the operator shall submit the appropriate project information, NOI, and the required application fee for construction or reconstruction activity after emergency repairs have been accomplished, according to a schedule acceptable to the Department.

3. For priority construction sites, the operator is authorized to discharge thirty (30) days from the Department's receipt of a complete and technically adequate NOI and CBMPP meeting the requirements of Parts II.C. and III.E, unless, within thirty (30) days from the Department's receipt of the NOI, the Department notifies the operator that additional time is needed to review the NOI and CBMPP. Where the operator receives such notification from the Department, that operator may not discharge until the Department formally acknowledges receipt of a complete and technically adequate NOI and CBMPP.

PART III: Stormwater Pollution Prevention Requirements

The stormwater control requirements in this Part are the technology-based, non-numeric effluent limitations and conditions that apply to all discharges from construction projects eligible for coverage under this permit. These requirements apply the national effluent limitations guidelines and new source performance standards found at 40 CFR Part 450.

Where the requirements in this Part are stricter than any corresponding federal, State, or local requirements, the requirements in this permit take precedence.

A. Erosion Controls and Sediment Controls

The Permittee shall design, install, and maintain effective stormwater controls, erosion controls, and sediment controls appropriate for site conditions. To meet this requirement, the following factors shall be accounted for in designing controls:

1. The nature of stormwater runoff and run-on at the site, including factors such as expected flow from impervious surfaces, slopes, and site drainage features;
2. Control stormwater volume and velocity within the site to minimize soil erosion;
3. Control stormwater discharges, including both peak flowrates and total stormwater volume, to minimize channel and streambank erosion and scour in the immediate vicinity of points of discharge;
4. The soil series and range of soil particle sizes expected to be present on the site;
5. Complete installation of stormwater controls by the time each phase of construction activities has begun;
   (a) By the time construction activity in any given portion of the site begins, install and make operational any downgradient sediment controls (e.g., buffers, perimeter controls, storm drain inlet protection, etc.) that control discharges from the initial site clearing, grading, excavating, and other earth-disturbing activities; and
   (b) Following the installation of these initial controls, install and make operational all stormwater controls needed to control discharges prior to subsequent earth-disturbing activities.
   (c) The requirement to install stormwater controls prior to each phase of construction activities for the site does not apply to the earth disturbance associated with the actual installation of these controls. Operators should take all reasonable actions to minimize the discharges of pollutants during the installation of stormwater controls.
6. Ensure that all stormwater controls are properly implemented, maintained, and remain in effective operating condition during permit coverage and are protected from activities that would reduce their effectiveness;
7. Minimize the amount of soil exposed and the duration of exposure during construction activity through the use of project phasing, sequence of construction, or other appropriate techniques;
8. Provide and maintain a 25-foot natural riparian buffer around surface waters as discussed in detail in Part III.B.;
9. Implement measures or requirements to achieve the pollutant reductions consistent with a TMDL finalized or approved by EPA. Applicable TMDLs are located and/or can be accessed at the following link: http://adem.alabama.gov/programs/water/approvedTMDLs.htm
10. Minimize the disturbance of steep slopes;
11. Minimize sediment discharges from the site;
12. Minimize the generation of dust through the appropriate application of water or other dust suppression techniques;
13. Minimize all stream crossings;
14. Minimize sediment track-out:
   (a) Use appropriate stabilization techniques at all construction entrances and exits onto paved roads;
   (b) Restrict vehicle use to properly designated entrances and exits;
   (c) Implement and maintain additional track-out controls as necessary to ensure that sediment removal occurs prior to vehicle exit; and
   (d) Sediment that has been tracked-out from site onto paved roads, sidewalks, or other paved areas outside of site boundaries should be removed by the end of the same business day and/or normal operating hours. Removal shall be by sweeping, shoveling, or vacuuming the surfaces. Removal by hosing or sweeping tracked out sediment into any stormwater conveyance, storm drain inlet, or water of the State is prohibited.

15. Protect storm drain inlets, where applicable:

    (a) Install storm drain inlet protection measures that remove coarse sediment particles from discharges prior to entry into any storm drain inlet that routes stormwater flow from the site and/or to a water of the State to further prevent sediment discharges; and

    (b) Clean, remove, and replace protection measures as sediment accumulates as often as is necessary to ensure full effectiveness of protection measures and/or that performance is not compromised.

16. Direct stormwater to vegetated areas to increase sediment removal and maximize stormwater infiltration, unless infeasible;

17. Minimize soil compaction.

18. Preserve and protect topsoil for use in vegetation establishment;

19. Manage stockpiles or land clearing debris composed, in whole or in part, of sediment and/or soil:

    (a) Locate the stockpiles outside of any natural buffers established under Part III.B., and away from any stormwater conveyances, storm drain inlets, and areas where stormwater flow is concentrated;

    (b) Install a sediment barrier along all downgradient areas;

    (c) Stockpiles that will not be used for 13 days or more, provide cover or appropriate temporary stabilization;

20. Sediment basin, impoundments, or detention/retention basins used as a sediment basin during construction shall be installed and stabilized prior to commencement of other construction activities:

    (a) Locate the basin or impoundment outside of any water of the State;

    (b) Design basin or impoundment to provide appropriate storage for 3,600 cubic feet per acre drained;

    (c) Utilize outlet structures that withdraw water from the surface of the sediment basin or impoundment;

    (d) Use erosion controls and velocity dissipation devices to prevent erosion at inlets and outlets; and

    (e) Remove accumulated sediment to maintain at least one-half of the design capacity and conduct all other appropriate maintenance to ensure basin or impoundment remains in effective operating condition.

21. Treatment chemicals (e.g. polymers, flocculants, coagulants):

    (a) Use conventional erosion and sediment controls before and after the application of treatment chemicals. Treatment chemicals may only be applied where treated stormwater is directed to a sediment control practice (e.g., sediment basin, perimeter control) that allows for on-site particle settlement before final discharge;

    (b) Select appropriate treatment chemicals. Chemicals must be appropriately suited to the soil likely to be exposed during construction and present in the discharges being treated (i.e., the expected turbidity, pH, and flow rate of the stormwater flowing into the chemical treatment system or area);

    (c) Ensure proper chemical storage of all treatment chemicals, such as in leak-proof containers, spill proof pallets, covered storage, or in secondary containment designed and maintained to minimize the potential discharge of treatment chemicals in stormwater or by any other means; and

    (d) Use chemicals in accordance with good engineering practices and specification of the chemical provider/supplier. Use treatment chemicals and chemical treatment systems in accordance with dosing specifications and sediment removal design specification provided by the provider/supplier of the applicable chemicals.

22. Additional Design Requirements

    (a) Sediment control measures, erosion control measures, and other site management practices must be properly selected based on site-specific conditions and must meet or exceed the technical guidance outlined in the Alabama Handbook and the site-specific CBMPP prepared in accordance with Part III.E;

    (b) Unless specified otherwise by the Alabama Handbook, sediment control measures, erosion control measures, and other site management practices shall be designed and maintained to minimize erosion and maximize sediment removal resulting from a 2-year, 24-hour storm event.; and

    (c) The Permittee is encouraged to design the site, the erosion prevention measures, sediment control measures, and other site management practices with consideration of minimizing stormwater runoff, both during and following construction, including facilitating the use of low-impact development (LID) and green infrastructure. The Alabama Low Impact Development Handbook for the State of Alabama (LID Handbook) can be found at the following link: http://adem.alabama.gov/programs/water/waterforms/LIDHandbook.pdf

B. Provide Natural Riparian Buffers or Equivalent Sediment Controls

Natural riparian buffer requirements apply to all waters of the State adjacent to construction sites or contained within their overall project boundary. A 25-foot natural riparian buffer zone adjacent to all waters of the State at the construction site shall be preserved, to the maximum extent practicable, during construction activities at the site. The natural riparian buffer should be preserved between the top of stream bank and the disturbed construction area. The water quality buffer zone aids in the protection of waters of the State (e.g., perennial and intermittent streams, rivers, lakes, wetlands) located within or immediately adjacent to the boundaries of the project. Natural riparian buffers are not primary sediment control measures and should not be relied on as such. The natural riparian buffer requirement applies to new construction sites, or new additional acreage not previously covered by the initial permit.

1. Compliance Alternatives
   (a) Provide and maintain a 25-foot undisturbed natural riparian buffer;
      (i) If land disturbances are located 25 feet or farther from surface water, then compliance with this alternative has been achieved.
      (ii) Rehabilitation and enhancement of a natural riparian buffer is allowed, if necessary, for improvement for its effectiveness of protection of the waters of the State.
      (iii) Any preexisting structures (e.g., buildings, parking lots, roadways, utility lines, structures, impervious surfaces) are allowed in the natural riparian buffer; provided the Permittee retains and protects from disturbance any additional natural buffer area contained within the natural riparian buffer but outside the preexisting structures footprint.
   (b) Provide and maintain an undisturbed natural riparian buffer that is less than 25 feet and is supplemented by additional erosion and sediment controls, which in combination achieves the sediment load reduction equivalent to a 25-foot undisturbed natural riparian buffer;
   (c) If it is infeasible to provide and maintain an undisturbed natural riparian buffer of any size, the Permittee must implement erosion and sediment controls that achieve the sediment load reduction equivalent to a 25-foot undisturbed natural riparian buffer;
   (d) All discharges from the area of earth disturbance to the natural riparian buffer must first be treated by erosion and sediment control on the site. Velocity dissipation devices should be used if necessary to prevent erosion caused by stormwater within the natural riparian buffer;
   (e) All compliance alternatives must be documented in the CBMPP and comply with all requirements. The natural riparian buffer boundary should be indicated on the site plan;
   (f) Compliance alternatives must be maintained throughout the duration of permit coverage; and
   (g) All natural riparian buffer areas should be delineated and clearly marked off with flags, tape, or similar marking device.
2. If there is no discharge of stormwater to waters of the State through the areas between the construction site and any waters of the State located within 25 feet of the construction site, compliance with this requirement is achieved;
3. Where no natural riparian buffer exists due to preexisting development disturbances (e.g., buildings, parking lots, roadways, utility lines, structures, impervious surfaces) that occurred prior to the initiation of planning for the current development of the site, the Permittee is not required to comply with the requirements in this section, unless portions of the preexisting development will be removed;
4. Where some natural riparian buffer exists but portions of the area within 25 feet of the waters of the State are occupied by preexisting development disturbances (e.g., buildings, parking lots, roadways, utility lines, structures, and impervious surfaces), the Permittee is required to comply with the requirements in this section. Only the portion of the buffer zone that contains the footprint of the existing "structure" is exempt from the natural riparian buffer. Activities necessary to maintain uses are allowed provided that no additional vegetation is removed from the natural riparian buffer;
5. For "linear construction projects" the Permittee is not required to comply with the requirements in this section if site constraints (e.g., limited right-of-way) prevent the Permittee from meeting any of the compliance alternatives provided that, to the extent practicable, disturbances within 25 feet of the water of the State are limited and/or supplemental erosion and sediment controls to treat stormwater discharges from earth disturbances within 25 feet of the waters of the State are provided. It must be documented in the CBMPP as to why compliance with this section is infeasible and describe any buffer width retained and/or supplemental erosion and sediment controls installed; and

6. The following disturbances within 25 feet of a water of the State are exempt from the requirements in this Part:
   (a) Construction approved under a CWA Section 404 permit; or
   (b) Construction of a water-dependent structure or water access area (e.g., pier, boat ramp, seawall, bridge, drainage structure, trail, etc.)

C. Soil Stabilization

The Permittee should minimize, as feasible, the area disturbed to maintain the natural soil cover for stability. The Permittee must stabilize the exposed bare soil portions of the site:

1. Implement and maintain stabilization measures (e.g., seeding protected by erosion controls until vegetation is established, sodding, mulching, erosion control blankets, hydromulch, gravel) that minimize erosion from exposed portions of the site.
2. Temporary stabilization of disturbed areas must be initiated immediately whenever work toward project completion and final stabilization of any portion of the site has temporarily ceased on any portion of the site and will not resume for a period exceeding thirteen (13) calendar days.
3. Final stabilization of disturbed areas must, at a minimum, be initiated immediately whenever any clearing, grading, excavating, or other earth disturbing activities have permanently ceased on any portion of the site.
4. The requirement to initiate stabilization immediately is triggered as soon as you know that construction work on a portion of the site is temporarily ceased and will not resume for more than thirteen (13) calendar days, or as soon as you know that construction work has permanently ceased. In the context of this provision, "immediately" means as soon as practicable, but no later than the end of the next business day, following the day when the construction activities have temporarily or permanently ceased.
5. Both temporary and permanent vegetation shall be completed as provided by the guidance in the Alabama Handbook.

D. Pollution Prevention Measures

The Permittee must design, install, implement, and maintain effective pollution prevention measures to minimize the discharge of pollutants. At a minimum, such measures must be designed, installed, implemented, and maintained to:

1. Provide an effective means of minimizing the discharge of pollutants from equipment and vehicle washing, wheel wash water, concrete washout, washing applicators and/or containers used for stucco, paint, concrete, or other compounds/materials and other wash waters;
   (a) Wash waters must be treated in a sediment basin or alternative control (e.g., sediment trap, filtration device, filter bags, or similar effective controls) that provides equivalent or better treatment prior to discharge;
   (b) Liquid waste shall not be directly discharged into storm sewers;
   (c) Washout and cleanout activities should be located as far away as possible from surface waters, natural buffer areas, stormwater inlets, and conveyances; and
   (d) For storage of soaps, detergents, or solvents, provide either (1) cover (e.g., plastic sheeting or temporary roofs) to minimize exposure of these detergents to precipitation and to stormwater or (2) a similarly effective means designed to minimize the discharge of pollutants from these areas.
2. Provide an effective means of minimizing the exposure of building materials, building products, construction wastes, trash, landscape materials, fertilizers, pesticides, herbicides, detergents, sanitary waste, and other materials present on the site to precipitation and to stormwater;
   (a) Provide either (1) cover (e.g., plastic sheeting or temporary roofs) to minimize exposure of these detergents to precipitation and to stormwater or (2) a similarly effective means designed to minimize the discharge of pollutants from these areas;
   (b) Provide waste containers (e.g., dumpster, trash receptacle) of sufficient size and number to contain construction wastes;
   (c) Locate waste containers as far away as possible from waters of the State and stormwater inlets or conveyances so that stormwater coming into contact with these activities cannot reach water of the State;
   (d) For sanitary waste, position portable toilets so that they are on level ground and are located as far away as possible from waters of the State and stormwater inlets or conveyances; and
   (e) Comply with all application and disposal requirements included on the fertilizer, pesticide, herbicide, or detergent label.

3. Provide an effective means of minimizing the discharge of pollutants caused by spills and leaks from, including but not limited to, vehicles, mechanical equipment, chemical storage, and refueling activities;

   (a) Locating activities away from waters of the State and stormwater inlets or conveyances so that stormwater coming into contact with these activities cannot reach water of the State;

   (b) Providing secondary containment and cover where appropriate;

   (c) Ensure adequate supplies are available at all times to handle spills, leaks, and disposal of used liquids. Have a spill kit available on site and ensure personnel are available and trained to respond expeditiously in the event of a leak or spill; and

   (d) Clean up spills or contaminated surfaces immediately (do not clean contaminated surfaces by hosing the area down) and eliminate the source of the spill to prevent a discharge or a continuation of an ongoing discharge.

4. Apply treatment chemicals at the site only where treated stormwater is directed to a sediment control (e.g., sediment basin, perimeter control) that allows for on-site particle settlement before final discharge.

E. Construction Best Management Practices Plan (CBMPP)

1. Except as provided by Part II.F.2, construction activity may not commence until a CBMPP has been prepared in a format acceptable to the Department and certified by a QCP as adequate to meet the requirements of this permit;

2. The NOI and CBMPP must be prepared in accordance with the requirements of this permit by the QCP prior to commencing construction at a new construction site or prior to continued construction at an existing construction site, or as otherwise required by the Director;

3. The Permittee shall properly implement and regularly maintain the controls, practices, devices, and measures specified in the CBMPP;

4. The CBMPP shall include:

   (a) A general description of the construction site activity, including:

      (i) The function of the construction site activity (e.g. residential subdivision, shopping mall, highway, etc.); and

      (ii) Identification of all known operators of the construction site and the areas of the site over which each operator has control.

   (b) A description of the intended sequence of major activities which disturb soils, including but not limited to, grubbing, excavation, and/or grading. The sequence shall be accomplished in a manner which minimizes the area disturbed at any one time and minimizes the duration that the areas are disturbed;

   (c) Estimates of the total area expected to be disturbed by grubbing, excavation, and/or grading, including offsite borrow and fill areas (if areas are to be included in permit coverage);

   (d) A detailed description (including but not limited to site specific dimensions, storage capacity, and drainage calculations are required for engineered BMPs) of the erosion controls, sediment controls, and management practices to be implemented at the site during each sequence of activity in accordance with Part III.A;

   (e) A clear outline and identification of the 25-foot natural riparian buffer for all sites that discharge directly to waters of the State and where a water of the State lies within the boundaries of the project;

   (f) A detailed description of controls needed to meet State water quality standards, waste load allocations, or other measures necessary for consistency with applicable TMDLs finalized or approved by EPA;

      (i) Provide a calculation based on the control measures to be implemented for the pollutant of concern to confirm the controls as designed in the CBMPP meet the required percent reduction for the applicable TMDL;

      (ii) Reduction capabilities shall assume the control measures have been appropriately installed and maintained. See Part III.L.2.

   (g) A detailed description of BMPs needed to prevent or eliminate discharges of sediment and other pollutants of concern from priority construction sites;

   (h) A description of temporary and permanent stabilization practices, including a schedule and/or sequence for implementation;

   (i) A description of energy or flow velocity dissipation devices at discharge locations and along the length of any outfall channel;

(j) Identification of all allowable sources of non-stormwater discharges listed in Part I.B.2, except for flows from firefighting activities that are or may be combined with stormwater discharges associated with construction activity at the site;

(k) A description of the pollution prevention measures used to manage non-stormwater discharges;

(l) A description of the best management practices to be installed during site construction and operated and maintained following final stabilization at sites where the post-construction volumes or velocities of stormwater runoff are significantly different from conditions existing prior to the construction activity;

(m) A listing of all treatment chemicals to be used at the site, including Safety Data Sheets (SDS), the dosage(s) to be used and the location(s) where these materials will be used;

(n) The most recent site topographic map (e.g. USGS quadrangle map or LIDAR contour map) at an appropriate contour interval, clearly showing:

(i) Sufficient detail to identify the location of the construction site;

(ii) Existing topography and drainage patterns and features, existing structures proposed roads, utilities, rights-of-way (ROWs), and waterbodies;

(iii) Drainage patterns and approximate slopes anticipated after major grading activities;

(iv) The external and internal (if subdivided) property boundaries of the project;

(v) Areas to be disturbed by excavation, grading, or other activities;

(vi) Identification of sediment control measures, erosion control measures, planned stabilization measures, and other site management practices;

(vii) Locations of all waters of the State within a one (1) mile radius of the site;

(viii) Locations of wetlands and riparian zones; and

(ix) Locations of all outfalls.

(o) A description of procedures for:

(i) Sweeping or removal and proper disposal or utilization of sediment and other debris that has been tracked from the site or deposited from the site onto streets and other paved surfaces;

(ii) Removal and proper disposal or utilization of sediment or other pollutants that have accumulated in or near any sediment control measures, stormwater conveyance channels, storm drain inlets, or water course conveyance within or immediately outside of the construction site; and

(iii) Removal and proper disposal or utilization of accumulated sediment that has been trapped by sediment control measures at the site, in accordance with applicable maintenance requirements covered under this permit;

(p) A description of the procedures for handling and disposing of wastes generated at the site, including, but not limited to, clearing and demolition debris, sediment removed from the site, construction and domestic waste, hazardous or toxic waste, and sanitary waste.

5. Maintain an Updated CBMPP

(a) The CBMPP shall be updated as necessary to address changes in the construction activity, site weather patterns, new TMDLs finalized or approved by EPA, new 303(d) listings approved by EPA, or manufacturer specifications for specific control technologies;

(b) The CBMPP shall be amended if inspections or investigations by site staff or by local, state, or federal officials determine that the existing sediment control measures, erosion control measures, or other site management practices are ineffective or do not meet the requirements of this permit. All necessary modifications to the CBMPP shall be made within seven (7) calendar days following notification of the inspection unless granted an extension of time by the Department;

(c) If existing sediment control measures, erosion control measures, or other site management practices prove ineffective in protecting water quality or need to be modified; or if additional sediment control measures, erosion control measures, or other site management practices are necessary to meet the requirements of this permit, implementation shall be completed as soon as possible, but not to exceed five (5) days of the observation or site inspection unless prevented by unsafe weather conditions. If unsafe weather conditions are present, they should be documented. If implementation before the next storm event is impracticable, then new land disturbance activities must cease until the modified or additional controls can be implemented; and

(d) A copy of the CBMPP shall be maintained at the site during normal operating hours as defined by Part V of this permit when regulated land disturbing activities are occurring.

F. Spill Prevention, Control, and Management

1. The Permittee shall prepare, implement, and maintain a Spill Prevention, Control and Countermeasures (SPCC) Plan in accordance with 40 CFR Part 112 and ADEM Admin Code r.335-6-6-.12(r) for all applicable onsite petroleum storage tanks;

2. The Permittee shall prepare, implement, and maintain a SPCC Plan in accordance with ADEM Admin Code r.335-6-6-.12(r) for any stored pollutant(s) that may, if spilled, be reasonably expected to enter a water of the state or the collection system for a publicly or privately owned treatment works;

   (a) The SPCC Plan(s) shall be maintained as a separate document or as part of the CBMPP Plan required in Part III.E. above;

   (b) The Permittee shall implement appropriate structural and/or non-structural spill prevention, control, and/or management sufficient to prevent any spills of pollutants from entering a water of the State or a publicly or privately owned treatment works. The plan(s) must be consistent with the requirements of 40 CFR Part 112 and/or ADEM Admin Code r.335-6-6-.12(r). Any containment system used to implement this requirement shall be constructed of materials compatible with the substance(s) contained and of materials which shall prevent the contamination of groundwater and shall be capable of retaining 110 percent of the volume of the largest container of pollutants for which the containment system is provided;

   (c) The Permittee shall maintain onsite or have readily available sufficient oil & grease absorbing material and flotation booms to contain and clean-up fuel or chemical spills and leaks; and

   (d) Soil contaminated by paint or chemical spills, oil spills, etc. must be immediately cleaned up, remediated, or be removed and disposed of in a Department approved manner.

3. Discharges of toxic or hazardous substances from a spill to other release or prohibited, consistent with Part I.D.

   (a) Where a leak, spill, or other release containing a hazardous substance or oil in an amount equal to or in excess of a reportable quantity established under either 40 CFR 110, 40 CFR 117, or 40 CFR 302 occurs during a 24-hour period, the National Response Center (NRC) must be notified at (800) 424-8802, in accordance with the requirements of 40 CFR 110, 40 CFR 117, or 40 CFR 302 as soon as the Permittee has knowledge of the release; and

   (b) Within five (5) calendar days of knowledge of the release, the Permittee must provide a description of the release, the circumstances leading to the release, and the date of the release.

G. Training

Unless the Permittee has employed or contracted with a QCP that performs duties as required by this permit, and the QCP is readily available and able to be present onsite as often as is necessary to ensure full compliance with the requirements of this permit, the Permittee shall ensure that:

1. At least one onsite employee shall be certified as a Qualified Credentialed Inspector (QCI) by completing an initial training and annual refresher training course through an ADEM-approved Qualified Credentialed Inspector Program (QCIP) conducted by a cooperating training entity;

2. The QCIP must be approved by the Department prior to use and provide training in the following areas:

   (a) The applicable requirements of the Alabama NPDES rules;

   (b) The requirements of this permit;

   (c) The evaluation of construction sites to ensure that erosion controls and sediment controls designed and certified by a QCP detailed in a site-specific CBMPP are effectively implemented and maintained;

   (d) The evaluation of conveyance structures, receiving waters, and adjacent impacted offsite areas to ensure the protection of water quality and compliance with the requirements of this permit; and

   (e) The general operation of a turbidity meter or similar device intended for the measurement of turbidity.

3. Each individual holding a QCI Certification need not be on-site continuously and they may conduct site inspections at multiple sites permitted by them or their employer;

4. Each individual holding QCI certification shall obtain annual certification of satisfactory completion of formal refresher education or training regarding general erosion controls and sediment controls, the requirements of this permit, and the general operation of a turbidity meter or similar device intended for the measurement of turbidity. The refresher training

requirements, including but not limited to, appropriate curricula, course content, course length, and any participant testing, shall be subject to acceptance by the Director prior to use.

H. Inspection Requirements

1. Pre-Construction Observations

   (a) A pre-construction site inspection shall be conducted prior the placement of any BMPs, or the commencement of land disturbing activities.

   (b) Pre-construction site inspection shall consist of a complete and comprehensive inspection of the entire proposed construction site including all proposed areas of land disturbance, proposed areas used for storage of materials that may be exposed to precipitation, affected ditches, and other stormwater conveyances, as well as all proposed outfalls, receiving waters and stream banks to determine if there are pre-existing areas of concern.

   (c) Pre-construction inspections shall be conducted by the QCP, or by a qualified person under the direct supervision of a QCP;

   (d) The inspection shall be documented and made available to the Department upon request;

   (e) Pre-construction inspection shall include dated electronic photographic documentation of all areas described in paragraph (b) above; and

   (f) The Permittee shall maintain record of the pre-construction site inspection pursuant to Part IV.K.

2. Daily Observations

   (a) Each day there is activity at the site, the Permittee shall visually observe that portion of the construction project where active disturbance, work, or construction occurred to note any rainfall measurements occurring since the previous observation and any apparent BMP deficiencies in the area of active disturbance;

   (b) Such daily observations may be performed by appropriate site personnel; and

   (c) The Permittee shall maintain a log of all daily observations and record in such log any rainfall measurements and BMP deficiencies observed.

3. Site Inspections

   (a) Site inspections shall be performed by a QCI, QCP, or a qualified person under the direct supervision of a QCP;

   (b) A site inspection shall consist of a complete and comprehensive observation of the entire construction site including all areas of land disturbance, areas used for storage of materials that are exposed to precipitation, equipment storage and maintenance areas, affected ditches and other stormwater conveyances, as well as all outfalls, receiving waters, and stream banks to determine if, and ensure that:

      (i) Effective erosion controls and sediment controls have been fully implemented and maintained in accordance with this permit, the site CBMPP, and the Alabama Handbook;

      (ii) Pollutant discharges are being prevented/minimized; and

      (iii) Discharges do not result in a contravention of applicable State water quality standards for the receiving stream(s) or other waters impacted or affected by the Permittee.

   (c) For non-linear projects, a site inspection shall be performed once each month and after any qualifying precipitation event since the last inspection, commencing as promptly as possible, but no later than 24-hours after resuming or continuing active construction or disturbance and completed no later than 72-hours following the qualifying precipitation event;

   (d) For linear projects, a site inspection shall be performed at least once a month and after any qualifying precipitation event since the last inspection, beginning as promptly as possible, but no later than 24-hours after resuming or continuing active construction or disturbance and completed no later than five (5) days after the qualifying precipitation event, on areas of active construction and/or where perennial vegetation has not been fully established, or meeting the definition of final stabilization;

   (e) A site inspection shall also be performed as often as is necessary until any poorly functioning erosion controls or sediment controls, non-compliant discharges, or any other deficiencies observed during a prior inspection are corrected and documented as being in compliance with the requirements of this permit;

   (f) On all active disturbance, dredging, excavation, or construction undertaken or located within the banks of a waterbody, including but not limited to, equipment/vehicle crossings, pipelines, or other transmission line installation, conveyor structure installation, and waterbody relocation, streambank stabilization, or other alterations, a site inspection shall

be performed at least once a week and as often as is necessary until the disturbance/activity impacting the waterbody is complete and reclamation or effective stormwater quality remediation is achieved;

(g) The inspection shall be recorded in a written format acceptable to the Department. The inspection record shall include:

(i) The site name and location, date and entry/exit time, outfall identification(s), date, time and exact place of any turbidity sampling performed;

(ii) The name(s) of person(s) who performed the inspection and/or obtained any turbidity samples or measurements;

(iii) The analytical results of any samples or measurements performed;

(iv) A description of any sampling and analytical techniques or methods used, including source of method and method number;

(v) Weather conditions at the time of the inspection;

(vi) Description of any discharges of sediment or other pollutants from the site;

(vii) Locations of discharges of sediment or other pollutants from the site;

(viii) Locations of BMPs that need repair, replacement and/or maintenance;

(ix) Locations of BMPs that failed to operate as designed;

(x) Locations where BMPs required by the CBMPP are not installed or installed in a manner inconsistent with the CBMPP; and

(xi) Locations where additional BMPs are needed that did not exist at the time of the inspection. This requirement is applicable only to site inspections performed by a QCP or qualified persons under the direct supervision of a QCP.

(h) Results of all required inspections shall be available for inspection no later than 15 days following the date of the inspection, monitoring, or sampling; and

(i) Reports shall be legible and bear an original signature or in the case of electronic reports, an electronic signature.

4. CBMPP Evaluations

(a) The QCP shall perform an onsite evaluation of all erosion and sediment controls being implemented for adequacy and consistency with site conditions;

(b) The CBMPP evaluation shall be performed as often as necessary until poorly functioning or damaged erosion controls or sediment controls are corrected and, at a minimum, once every three (3) months for a priority construction site or once every six (6) months for non-priority construction site;

(c) If, based on the CBMPP evaluation, the QCP identifies any needed modifications or additions to erosion and sediment controls, the CBMPP shall be updated in accordance with Part III.E.4; and

(d) The Permittee shall maintain appropriate documentation of the CBMPP evaluation.

I. Corrective Action

1. Any poorly functioning erosion controls or sediment controls, non-compliant discharges, or any other deficiencies observed during daily observations or site inspections required under Part III.H, shall be corrected as soon as possible, but not to exceed five (5) days of the observation or site inspection unless prevented by unsafe weather conditions. If unsafe weather conditions are present, they should be documented.

2. In the event of a breach of a sediment basin/pond temporary containment measures shall be taken within 24 hours after the inspection. Permanent corrective measures shall be implemented within five (5) days of the inspection. However, if permanent corrective measures cannot be implemented within the timeframes provided herein the Permittee shall notify the Department; and

3. The operator shall promptly take all reasonable steps to remove, to the maximum extent practical, pollutants deposited offsite or in any waterbody or stormwater conveyance structure.

J. Suspension of Monitoring

Suspension of applicable monitoring and inspection requirements for phased projects or developments may be granted provided:

1. The Department is notified in writing at least thirty (30) days prior to the requested suspension;

2. The Permittee and the QCP certify in the request that all disturbance has been graded, stabilized, and/or fully vegetated or otherwise permanently covered, and that appropriate, effective steps have been and will be taken by the Permittee to ensure compliance with the requirements of this permit and commit that these measures will remain continually effective until the permit is properly terminated;

3. The request should be accompanied by a construction stormwater inspection report confirming permanent stabilization of all previously disturbed areas, including material storage areas, and associated support activities. In addition, photo documentation may be submitted for confirmation purposes; and

4. The Permittee notifies the Department in writing within fifteen (15) days prior to resumption of disturbance or commencement of the next phase of development and the Permittee complies with the requirements of this Permit prior to commencement of additional disturbance.

K. Precipitation Measurement

1. The Permittee shall measure and record all precipitation occurring at the construction site (including rainfall and snowfall). Precipitation measurements must be representative of the Permittee's site. Records shall be maintained and available for inspection.

2. Precipitation measurements should be read and recorded during normal operating hours, even if no precipitation occurs. To facilitate determination of a qualifying precipitation event, the measuring device or method should have a scale that is readable to 0.5 inches or smaller unit.

3. Recording of rainfall outside of normal operating hours may be read and recorded on the next business day and noted as "accumulated." If the outside of normal operating hours accumulation is greater than 0.75 inches, a qualifying rainfall event inspection must occur regardless of whether that accumulation occurred over 24 hours, as described in Part III.H.

4. Precipitation measurements shall be taken using one or more of the following:

   (a) Continuous recorders,

   (b) Daily readings of an onsite rain gauge,

   (c) Daily readings of an offsite precipitation gauge located adjacent to or in close proximity (for non-linear projects a maximum one (1) mile distance) to the facility, or

   (d) Other measurement devices acceptable to the Department (e.g., online resources).

L. Impaired Waters and Total Maximum Daily Load (TMDL) Waters

1. Permittees discharging from construction sites into waters included on the latest EPA Approved §303(d) List or designated by the Department as impaired.

   (a) The Permittee must determine whether the discharge from any part of the construction site contributes directly or indirectly to a waterbody that is included on the latest EPA Approved §303(d) List or designated by the Department as impaired.

   (b) If the construction site discharges either directly or indirectly to a waterbody included on the latest EPA Approved §303(d) List or designated by the Department as impaired, then the CBMPP must detail the BMPs that are being utilized to control discharges of pollutants of concern associated with the impairment of the waterbody.

   (c) The Permittee must demonstrate the discharges, as controlled by the Permittee, and in conjunction with the implementation of the CBMPP, do not cause or contribute to the impairment of the waterbody.

   (d) If during this permit cycle a new EPA Approved §303(d) List is published, or Department designation, includes any waterbody into which the construction site discharges, the Permittee and QCP must review the CBMPP and the site to determine if existing BMPs are sufficient and discharges do not cause or contribute to the impairment of the waterbody. If existing BMPs are not sufficient to achieve this demonstration, the Permittee must, within sixty (60) days following the publication of the latest final §303(d) List, Department designation, or the effective date of this permit, submit a revised CBMPP detailing new or modified BMPs. The CBMPP must be revised as directed by the Department and the new or modified BMPs must be implemented within ninety (90) days from the publication of the latest final §303(d) list or Department designation.

2. Permittees discharging from construction sites into waters with EPA-Approved TMDLs and/or EPA-Established TMDLs

   (a) The Permittee must determine whether its construction site discharges to a waterbody for which a TMDL has been established or approved by EPA.

   (b) If a construction site discharges into a water body with an EPA approved or established TMDL, then the CBMPP must include BMPs targeted to control the discharges of pollutants of concern and to meet the assumptions and requirements

of the TMDL. If additional BMPs will be necessary to meet the requirements of the TMDL, the CBMPP must include a schedule for installation and/or implementation of such BMPs.

(c) If, during this permit cycle, a TMDL is approved by EPA or a TMDL is established by EPA for any waterbody into which a construction site discharges, the Permittee must review the applicable TMDL to see if it includes requirements for control of storm water discharges from the construction site.

(d) If it is found that the Permittee must implement specific allocations of the TMDL, it must assess whether the assumptions and requirements of the TMDL are being met through implementation of existing BMPs or if additional BMPs are necessary. The CBMPP must include BMPs targeted to meet the assumptions and requirements of the TMDL. If existing BMPs are not sufficient, the Permittee must, within sixty (6o) days following the approval or establishment of the TMDL by EPA, submit a revised CBMPP detailing new or modified BMPs to be utilized along with a schedule of installation and/or implementation of such BMPs. Any new or modified BMPs must be implemented within ninety (90) days, unless an alternate date is approved by the Department, from the establishment or approval of the TMDL by EPA.

PART IV: Standard and General Permit Conditions

A. Duty to Comply

1. The Permittee must comply with all terms and conditions of this permit. Any permit noncompliance constitutes a violation of the AWPCA and the FWPCA and is grounds for: enforcement action, termination, or suspension of coverage under this permit; denial of a NOI for renewal; a requirement that the Permittee submit an application for an individual NPDES permit.
2. For any violation(s) of this Permit, the Permittee may be subject to a civil penalty as authorized by the AWPCA, the FWPCA, and Code of Alabama 1975, §§22-22A-1 et. seq., as amended, and/or a criminal penalty as authorized by Code of Alabama 1975, §22-22-1 et. seq., as amended.
3. The discharge of a pollutant from a source not specifically identified in the NOI to be covered under this Permit and not specifically included in the description of an outfall (where applicable) in this permit is not authorized and shall constitute noncompliance with this permit.
4. Nothing in this Permit shall be construed to preclude or negate the Permittee's responsibility or liability to apply for, obtain, or comply with other ADEM, federal, state, or local government permits, certifications, licenses, or other approvals.

B. Duty to Reapply

1. The Permittee authorized to discharge under this General Permit, who wishes to continue to discharge upon the expiration of this permit, shall submit a NOI to be covered by the reissued General Permit. Such NOI shall be submitted at least 30 days prior to the expiration date of this General Permit.
2. Failure of the Permittee to submit a complete NOI for reauthorization under this permit at least 30 days prior to the permit's expiration will void the automatic continuation of the authorization to discharge under this permit as provided by ADEM Admin. Code r. 335-6-6-.06. Should the permit not be reissued for any reason prior to its expiration date, Permittees who failed to meet the 30-day submittal deadline will be illegally discharging without a permit after the expiration date of the permit.

C. Need to Halt or Reduce Activity Not a Defense

It shall not be a defense for the Permittee in an enforcement action that it would have been necessary to halt or reduce construction activities in order to maintain compliance with the conditions of the permit.

D. Duty to Mitigate

The Permittee shall take all reasonable steps to mitigate or prevent any violation of the permit or to minimize or prevent any adverse impact of any permit violation.

E. Proper Operation and Maintenance

The Permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the Permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of backup or auxiliary facilities only when necessary to achieve compliance with the conditions of this permit.

F. Permit Modification, Revocation and Reissuance, Suspension, and Termination

1. During the term of this General Permit the Director may, for cause, and subject to the public notice procedure of ADEM Administrative Code r. 335-6-6-21, modify or revoke and reissue this General Permit. The causes for this action include the causes listed below:
   (a) When the Director receives any information that was not available at the time of permit issuance and that would have justified the application of different permit conditions at the time of issuance;
   (b) When the standards or regulations on which the permit was based have been changed by promulgation of amended standards or regulations or by judicial decision after the permit was issued;
   (c) Upon failure of the state to notify, as required by Section 402(b)(3) of the FWPCA, another state whose waters may be affected by a discharge;
   (d) When the level of discharge of any pollutant which is not limited in the permit exceeds the level which can be achieved by the technology based treatment requirements appropriate to the discharge under 40 CFR 125.3(c)(1994);

(e) To correct technical mistakes, such as errors in calculations, or mistaken interpretations of the law made in determining permit conditions;

(f) When the permit limitations are found not to be protective of water quality standards; or

(g) For any applicable cause set forth in 40 CFR Sections 122.61, 122.62, 122.63, and 122.64 (1994).

2. Subject to the public notice procedures of rule 335-6-.6-21, the Director may terminate this General Permit during its term for any of the causes for modification listed in ADEM Admin Code r. 335-6-6-.23(7)(a).

3. The Director may terminate coverage of a discharge under this general permit for cause. Cause shall include, but not be limited to, noncompliance with Department rules; or a finding that the general permit does not control with wastewater discharge sufficiently to protect water quality or comply with treatment-based limits applicable to the discharge.

4. Any person may petition the Director for withdrawal of this General Permit authority from a discharger. The Director shall consider the information submitted by the petitioner and any other information he may be aware of and may obtain additional information from the discharger and through inspections by Department staff and shall decide if coverage should be withdrawn. The petitioner shall be informed of the Director's decision and shall be provided a summary of the information considered.

G. Property Rights

This permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to persons or property or invasion of other private rights, or any infringement of federal, state, or local laws or regulations, nor does it authorize or approve the construction of any physical structures or facilities or the undertaking of any work in any waters of the State or of the United States.

H. Duty to Provide Information

1. The Permittee shall furnish to the Director, within a reasonable time, any information which the Director may request to determine whether cause exists for modifying, revoking and re-issuing, suspending, or terminating this permit or to determine compliance with this Permit. The Permittee shall also furnish to the Director upon request, copies of records required to be kept by this Permit.

2. The Permittee shall inform the Director in writing of any change in the Permittee's mailing address or telephone number or in the Permittee's designation of a facility contact or officer having the authority and responsibility to prevent and abate violations of the AWPCA, the Department's rules and the terms and conditions of this permit no later than ten (10) days after such change. Upon request of the Director, the Permittee shall furnish an update of any information provided in the NOI.

3. If the Permittee becomes aware that it failed to submit any relevant facts in the NOI; or submitted incorrect information in the NOI; or in any report to the Director, it shall promptly submit such facts or information with a written explanation for the mistake and/or omission.

4. All information and/or documents required to be submitted to the Department by this general permit shall be submitted via the AEPACS, which can be accessed at the following link, http://adem.alabama.gov/AEPACS, or delivered to the following address: Alabama Department of Environmental Management Water Division, Stormwater Management Branch, Post Office Box 301463, Montgomery, Alabama 36130-1463, or 1400 Coliseum Boulevard, 36110-2400, Montgomery, Alabama.

I. Inspection and Entry

The Permittee shall allow the Director, or an authorized representative, upon the presentation of credentials and other documents as may be required by law to:

1. Enter upon the Permittee's premises where a regulated activity is located or conducted, or where records must be kept under the conditions of this Permit;

2. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this Permit;

3. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this Permit; and

4. Sample or monitor at reasonable times, for the purposes of assuring permit compliance or as otherwise authorized by the AWPCA, any activities, substances or parameters at any location.

J. Noncompliance Notification

1. The Permittee must notify the Department if, for any reason, the Permittee's discharge:
   (a) Potentially threatens human health or welfare;
   (b) Threatens fish or aquatic life;
   (c) Causes an in-stream water quality criterion as stated in ADEM. Admin. Code Ch. 335-6-10 to be exceeded;
   (d) Does not comply with an applicable toxic pollutant effluent standard or prohibition established under Section 307(a) of the FWPCA, 33 U.S.C. §1317(a); or
   (e) Contains a quantity of a hazardous substance which has been determined may be harmful to the public health or welfare under Section 311(b)(4) of the FWPCA, 33 U.S.C. §1321(b)(4).
2. The Permittee shall orally report the occurrences, describing the circumstances and potential effects of such discharge to the Director no later than 24-hours after the Permittee becomes aware of the occurrence of such discharge. In addition to the oral report, the Permittee shall submit to the Director a written report as provided in Part IV.J.3 below, no later than five (5) days after becoming aware of the occurrence of such discharge.
3. The written report shall be in a format acceptable to the Department and shall include:
   (a) A description of the noncompliant event, its cause, if known, and location;
   (b) The period of noncompliance, including exact dates and times or, if not corrected, the anticipated time the noncompliance is expected to continue; and
   (c) A description of the steps taken and/or being taken to reduce or eliminate the noncomplying discharge and to prevent its recurrence.

K. Retention of Records

1. The Permittee shall retain records of all inspection records, monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by the permit, and records of all data used to complete such reports, for a period of at least three (3) years from the date of the inspection, sample measurement, or report. This period may be extended by request of the Director at any time. If litigation or other enforcement action, under the AWPCA and/or the FWPCA, is ongoing which involves any of these records, the records shall be kept until the litigation is resolved.
2. All records required to be kept for a period of three (3) years shall be kept at the permitted facility or an alternate location identified to the Department in writing and shall be available for inspection upon request.

L. Signatory Requirements

The NOI and all reports or information submitted to the Director shall be signed and certified according to the requirement of ADEM Admin Code r. 335-6-6-.09. Where required by this Permit, documents will also be signed by a QCP or QCI.

M. Transfers

This Permit may not be transferred without notice to the Director and subsequent modification or revocation and reissuance of this Permit. In the case of a change in name, ownership, or control of the Permittee’s premises, a request for permit modification in a format acceptable to the Director is required within fifteen (15) days of the change occurring.

N. Bypass

Any bypass of erosion controls, sediment controls, or any other stormwater management/treatment controls specified in the CBMPP is prohibited except as provided by ADEM Admin Code r. 335-6-6-.12(m).

O. Upset

1. Effect of an Upset. An upset constitutes an affirmative defense to an action brought for noncompliance with technology-based permit limitation if the requirements of subparagraph 335-6-6-.12(n)2. are met.
2. Conditions Necessary for Demonstration of an Upset. A Permittee who wishes to establish the affirmative defense of an upset shall demonstrate through properly signed, contemporaneous operating logs, or other relevant evidence that:
   (a) An upset occurred and that the Permittee can identify the specific cause(s) of the upset;
   (b) The treatment facility was at the time being properly operated;
   (c) The Permittee submitted notice of the upset as required in subparagraph 335-6-6-.12(l)6.; and

(d) The Permittee complied with any remedial measures required under paragraph 335-6-6-.12(d).

3. Burden of Proof. In any enforcement proceeding the Permittee seeking to establish the occurrence of an upset has the burden of proof.

P. Severability

The provisions of this permit are severable, and if any provision of this permit or the application of any provision of this permit to any circumstance is held invalid, the application of such provision to other circumstances, and the remainder of this permit shall not be affected thereby.

Q. Issuance of an Individual Permit

The Director may require the Permittee to obtain an individual permit for discharges covered by this permit in accordance with ADEM Admin. Code r. 335-6-6-.23(9).

R. Request for Individual Permit by General Permit Holder

1. Any person covered by this General Permit may apply for termination of coverage by applying for an individual NPDES permit.

2. A permit application submitted voluntarily or at the direction of the Director for the purpose of termination of coverage by this General Permit shall be processed in accordance with the rules found in ADEM Admin. Code Ch. 335-6-6 applicable to individual permits.

S. Termination of Coverage

1. The Director may suspend or terminate coverage under this permit for cause without the consent of the Permittee. Cause shall include, but not be limited to, noncompliance with this permit or the applicable requirements of Department rules, or a finding that this permit does not control the stormwater discharge sufficiently to protect water quality.

2. Voluntary Notice of Termination – Initiated by Permittee

   The Permittee must submit a Notice of Termination (NOT) request electronically, using the Department's AEPACS at http://adem.alabama.gov/AEPACS , within thirty (30) days of one of the following conditions:

   (a) Final stabilization as defined in Part V has been achieved on all portions of the site;

   (b) Another operator has assumed control over all areas of the site that have not achieved final stabilization and the new operator has submitted an NOI for coverage under this permit; or

   (c) Coverage under an individual permit or alternative general permit has been obtained.

3. Content of the Voluntary Notice of Termination

   (a) The Permittee name, permit number, and location of the site;

   (b) Certification by the Permittee and the QCP that all construction activity covered by this permit has been completed, all temporary BMPs have been removed and final stabilization has been achieved; or

   (c) Identification, including complete contact information, of the person that has assumed legal or operational control over the construction site.

      (i) Loss of operational control does not relieve the operator from liability and responsibility for compliance with the provisions of this permit until the complete and correct request for termination is received by the Department.

      (ii) Sale or transfer of operational responsibility for the site by the operator prior to the succeeding operator obtaining permit coverage required by this chapter does not relieve the operator from the responsibility to comply with the requirements of this permit.

T. Facility Identification

The Permittee shall post and maintain sign(s) at the front gate/entrance, and if utility installation, where project crosses paved county, State, or federal highways/roads, and/or at other easily accessible location(s) to adequately identify the site prior to commencement of and during NPDES construction until permit coverage is properly terminated. Such sign shall be legible and display the name of the Permittee, "ADEM NPDES ALR10" followed by the four-digit NPDES permit number, facility or project name, and other descriptive information deemed appropriate by the Permittee.

U. Schedule of Compliance

The Permittee shall achieve compliance with the requirements of this permit on the effective date of coverage under this permit.

V. Discharge of Wastewater Generated by Others

The discharge of wastewater generated by any process, facility, or by any other means not under the operational control of the Permittee or not identified in the application for this permit or not identified specifically in the description of an outfall in this permit is not authorized by this permit except as allowed by Part I.

W. Compliance with Water Quality Standards and Other Provisions

1. On the basis of the Permittee's application, plans, or other available information, the Department has determined that compliance with the terms and conditions of this Permit will assure compliance with applicable water quality standards. However, this Permit does not relieve the Permittee from compliance with applicable State water quality standards established in ADEM Admin. Code Ch. 335-6-10, and does not preclude the Department from taking action as appropriate to address the potential for contravention of applicable State water quality standards which could result from discharges of pollutants from the permitted facility.
2. Compliance with Permit terms and conditions notwithstanding, if the Permittee's discharge(s) cause(s) or contribute(s) to a condition in contravention of State water quality standards, the Department may require abatement action to be taken by the Permittee, modify the Permit pursuant to the Department's rules and regulations, or both.
3. If the Department determines, on the basis of any investigation, inspection, or sampling, that a modification of this Permit is necessary to assure maintenance of water quality standards or compliance with other provisions of the AWPCA or FWPCA, the Department may require such modification and, in cases of emergency, the Director may prohibit the noticed act until the Permit has been modified.

X. Civil and Criminal Liability

1. Tampering: Any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained or performed under this Permit shall, upon conviction, be subject to penalties and/or imprisonment as provided by the AWPCA and/or the AEMA.
2. False Statements: Any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this Permit, including monitoring reports or reports of compliance or noncompliance shall, upon conviction, be punished as provided by applicable State and federal law.
3. Permit Enforcement: This NPDES Permit is a Permit for the purpose of the AWPCA, the AEMA, and the FWPCA, and as such all terms, conditions, or limitations of this Permit are enforceable under State and federal law.
4. Relief From Liability: Except as provided in Part IV.M. (Bypass) and Part IV.N. (Upset), nothing in this Permit shall be construed to relieve the Permittee of civil or criminal liability under the AWPCA, AEMA, or FWPCA for noncompliance with any term or condition of this Permit.

Y. Oil and Hazardous Substance Liability

Nothing in this Permit shall be construed to preclude the institution of any legal action or relieve the Permittee from any responsibilities, liabilities, or penalties to which the Permittee is or may be subject to under Section 311 of the FWPCA, 33 U.S.C. §1321.

Z. Availability of Reports

Except for data determined to be confidential under Code of Alabama 1975, §22-22-9(c), all reports prepared and submitted in accordance with the terms of this Permit shall be available for public inspection at the offices of the Department or the Department’s electronic filing system (eFile) at http://app.adem.alabama.gov/eFile/. Effluent data shall not be considered confidential. Knowingly making any false statement in any such report may result in the imposition of criminal penalties as provided for in Section 309 of the FWPCA, 33 U.S.C. §1319, and Code of Alabama 1975, §22-22-14.

AA. Coastal Zone Management for Baldwin and Mobile Counties

1. Except for those activities described in Part IV.AA.2 below, this permit is conditionally consistent with the Alabama Coastal Area Management Plan (ACAMP) upon continued compliance with the ACAMP.
2. The Permittee shall obtain, as appropriate, a coastal permit or coastal consistency determination from the Department if any activity constitutes a use as described in ADEM Admin. Code r. 335-8-1-.08, 335-8-1-.09, 335-8-1-.10 or 335-8-1-.11.

BB. Removed Substances

Solids, sludges, or any other pollutants or other wastes removed in the course of treatment or control of stormwater shall be disposed of in a manner that complies with all applicable Department rules and regulations.

CC. Compliance with Statutes and Rules

3. This permit has been issued under ADEM Admin. Code Ch. 335-6-6. All provisions of this chapter, that are applicable to this permit, are hereby made a part of this permit. A copy of this chapter can be found on the ADEM website at: http://adem.alabama.gov/alEnviroRegLaws/files/Division6Vol1.pdf

4. This permit does not authorize the noncompliance with or violation of any Laws of the State of Alabama or the United States of America or any regulations or rules implementing such laws. FWPCA, 33 U.S.C. Section 1319, and Code of Alabama 1975, Section 22-22-14.

PART V: Definitions

2-year, 24-hour storm event means the maximum 24-hour precipitation event with a probable recurrence interval of once in two years as defined by the National Weather Service and Technical Paper No. 40, "Rainfall Frequency Atlas of the U.S.," May 1961, or equivalent regional or rainfall probability information developed there from.

24-hour precipitation event means that amount of precipitation which occurs within any 24-hour period.

AEMA means the Alabama Environmental Management Act, Code of Alabama 1975, §§ 22-22A-1, et seq.

Alabama Handbook means the current edition of the Alabama Handbook for Erosion Control, Sediment Control, and Stormwater Management on Constructions Sites and Urban Areas, published by the Alabama Soil and Water Conservation Committee (ASWCC) at the time permit coverage is obtained.

ADEM means the Alabama Department of Environmental Management.

Agricultural Practices means practices commensurate with the size of the farming operation that are implemented in a manner that meet or exceed Natural Resources Conservation Service technical standards and guidelines, including but not limited to, farm ponds that are constructed for the primary purpose of irrigation and/or watering of livestock, terraces, grassed waterways, vegetative filter strips, cropland grade stabilization measures, drainage tiles, underground outlets, land leveling, dike/diversion structures, and other grade stabilization structures.

AWPCA means the Alabama Water Pollution Control Act.

Best Management Practices or BMPs means implementation and continued maintenance of appropriate structural and non- structural practices and management strategies to prevent and minimize the introduction of pollutants to stormwater and to treat stormwater to remove pollutants prior to discharge.

Borrow Area "Pit" means the activity of removing material (soil, gravel, sand) from one area to use in another area. For the purposes of this permit, this activity is solely in conjunction with the project requesting permit coverage and the material is not to be sold for profit. The borrow area and associated activity shall be located within a two-mile radius of the project requesting permit coverage to be considered as part of the project and will open and close with the project requesting permit coverage.

Chronic and Catastrophic Precipitation means precipitation events which may result in failure of the properly designed, located, implemented, and maintained BMPs or other structure/practices required by this permit. Catastrophic precipitation conditions means any single event of significant total volume, or of increased intensity and shortened duration, that exceeds normally expected or predicted precipitation over the time period that the disturbance is planned or is ongoing, as determined by the Department. Catastrophic conditions could also include tornadoes, hurricanes, or other climatic conditions which could cause failure due to winds or mechanical damage. Chronic precipitation is also that series of wet-weather conditions over a limited time-period which does not provide any opportunity for emergency maintenance, reinstallation, and corrective actions and which equals or exceeds the volume of normally expected or predicted precipitation for the time period that the disturbance is planned or is ongoing.

Common Plan of Development or Sale means any announcement or piece of documentation (e.g., sign, public notice, or hearing, sales pitch, advertisement, drawing, permit application, zoning request, computer design, etc.) or physical demarcation (e.g., boundary signs, lot stakes, surveyor markings, etc.) indicating construction activities may occur on a specific plot.

Construction means any land disturbance or discharges of pollutants associated with, or the result of building, excavation, land clearing, grubbing, placement of fill, grading, blasting, reclamation, areas in which construction materials are stored in association with a land disturbance or handled above ground and other associated areas including, but not limited to, construction site vehicle parking, equipment or supply storage areas, material stockpiles, temporary office areas, and access roads. Construction also means significant pre-construction land disturbance activities performed in support or in advance of construction activity including, but not limited to, land clearing, excavation, removal of existing buildings, dewatering, and geological testing. For the purposes of this Permit, any activity related to mining operations is excluded.

Construction Activity means the disturbance of soils associated with clearing, grading, excavating, filling of land, or other similar activities which may result in soil erosion. For the purposes of this Permit, construction activity does not include mining operations, agricultural and silvicultural practices. However, construction activity does include the construction of agricultural buildings.

Construction Best Management Practices Plan (CBMPP) means any research, planning considerations, systems, procedures, processes, activities, and practices implemented for the prevention and/or minimization of pollutants in stormwater to the maximum extent practicable, and collection, storage, treatment, handling, transport, distribution, land application, or disposal of construction stormwater and onsite management of construction waste generated by the construction activity, and to comply with the requirements of this permit. The CBMPP shall be prepared and certified, and when necessary updated by a qualified credentialed professional (QCP) in accordance with the requirements of this permit.

Construction Site means any site regardless of size where construction or construction associated activity has commenced, or is continuing, and associated areas, including sites where active work is suspended or has ceased, until the activity is completed and effective reclamation and/or stormwater quality remediation has been achieved.

Construction Support Activity a construction-related activity that specifically supports the construction activity solely related to the construction site covered under this permit and involves earth disturbance or pollutant-generating activities of its own, and may include activities including but not limited to equipment staging yards, materials storage areas, excavated material disposal areas, and temporary borrow areas.

Construction Waste means construction and land disturbance generated materials, including but not limited to, waste chemicals, sediment, trash, debris, litter, garbage, construction demolition debris, land clearing and logging slash, or other materials or pollutants located or buried at the site prior to disturbance activity or that is generated at a construction site.

Control Measure refers to any Best Management Practice or other method used to prevent or reduce the discharge of pollutants to waters of the State.

CWA or The Act means the Clean Water Act (formerly referred to as the Federal Water Pollution Control Act or Federal Water Pollution Control Act Amendments of 1972) Pub.L. 92-500, as amended Pub. L. 95-217, Pub. L. 95-576, Pub. L. 96-483 and Pub. L. 97-117, 33 U.S.C. 1251 et.seq.

Department means the Alabama Department of Environmental Management or an authorized representative.

Director means the Director of the Department or his designee.

Discharge, "[t]he addition, introduction, leaking, spilling or emitting of any sewage, industrial waste, pollutant or other waste into waters of the State." Code of Alabama 1975, §22-22-1(b)(8).

EPA refers to the U.S. Environmental Protection Agency.

Ephemeral Stream means a stream or portion of a stream which flows briefly in direct response to precipitation in the immediate vicinity and whose channel is at all times above the ground-water reservoir.

Facility see the definition for construction site

Final Stabilization means the application and establishment of the permanent ground cover (vegetative, pavements of erosion resistant hard or soft material, or impervious structures) planned for the site to permanently eliminate soil erosion to the maximum extent practicable. Established vegetation will be considered final if 100% of the soil surface is uniformly covered in permanent vegetation with a density of 85% or greater. Permanent vegetation shall consist of planted trees, shrubs, perennial vines; and/or an agricultural or a perennial crop of vegetation appropriate for the region and accomplished according to the Alabama Handbook. Final stabilization applies to each phase of construction.

FWPCA means the Federal Water Pollution Control Act

Green Infrastructure refers to systems and practices that use or mimic natural processes to infiltrate, evapotranspirate (the return of water to the atmosphere either through evaporation or by plants), or reuse storm water or runoff on the site where it is generated.

Intermittent Stream means a stream where portions flow continuously only at certain times of the year. At low flow there may be dry segments alternating with flowing segments.

Linear Project means land disturbing activities conducted by an underground /overhead utility or highway department, including, but not limited to any cable line or wire for the transmission of electrical energy; any conveyance pipeline for transportation of gaseous or liquid substance; any cable line or wire for utility communications; or any other energy resource transmission ROW or utility infrastructure, e.g., roads and highways. Activities include the construction and installation of these utilities within a corridor. Linear project activities also include the construction of access roads, staging areas, and borrow/spoil sites associated with the linear project.

Low Impact Development or LID is an approach to the maintenance of predevelopment hydrology in land development (or re- development) that works with nature to manage storm water as close to its source as possible. LID employs principles such as preserving and recreating natural landscape features, minimizing effective imperviousness to create functional and appealing site drainage that treat storm water as a resource rather than a waste product.

Maximum extent practicable (MEP) means full implementation and regular maintenance of available industry standard technology and effective management practices, such as those contained in the Alabama Handbook and site-specific CBMPP, designed to prevent and/or minimize discharges of pollutants and ensure protection of groundwater and surface water quality.

Mining Operations shall mean all or any part of the process of recovering coal, lignite, iron, clay, sand, bauxite, gravel, ores, gold, marble or any other material or mineral by removal of such mineral from the surface or by removal or displacement of the strata or material which overlies such mineral deposits in its natural condition, and shall include but not be limited to the open-pit or open-cut method, the auger method, and the highwall mining method. For the purposes of this permit, mining operations are commercial operations that do not meet the definition of a construction support activity. Additionally, this permit does not cover pre-mining construction and land preparation, including but not limited to, clearing, grubbing, testing, and advanced prospecting in advance of mining activity/operations.

Minor Land Disturbing Activities means activities which will result in minor soil erosion such as home gardens or individual home landscaping, repairs, maintenance work, fences, routine maintenance and other related activities.

National Pollutant Discharge Elimination System "NPDES" means the national program for issuing, modifying, revoking, and reissuing, terminating, monitoring, and enforcing permits for the discharge of pollutants into waters of the State.

Natural Buffer (Riparian buffer) means a strip of dense undisturbed perennial native vegetation, either original or re-established, that borders streams and rivers, ponds and lakes, and wetlands. Buffer zones are established for the purposes of slowing water runoff, enhancing water infiltration, and minimizing the risk of any potential nutrients or pollutants from leaving the upland area and reaching surface waters. Natural buffers help stabilize streambanks and therefore are important in minimizing production of sediment from bank erosion. The importance increases in relation to the size of the stream. Buffer zones are most effective when stormwater runoff is flowing into and through the buffer zone as shallow sheet flow, rather than in concentrated form such as in channels, gullies, or wet weather conveyances.

Nephelometric Turbidity Unit or NTU means a numerical unit of measure based upon photometric analytical techniques for measuring the light scattered by fine particles of a substance in suspension.

New Construction Site means any initial construction or construction activity covered under this General Permit where the disturbance begins after the effective date of this permit. This includes subsequent phases of a previously permitted development.

Non-stormwater Discharges means discharges that do not originate from storm events. They can include, but are not limited to, discharges of process water, air conditioner condensate, non-contact cooling water, vehicle wash water, sanitary wastes, concrete washout water, paint wash water, irrigation water, or pipe testing water.

Normal Operating Hours means from 6:00 a.m. to 6:00 p.m., Monday through Friday, excluding federal holidays established pursuant to 5 U.S.C. § 6103. Normal operating hours also include any time when workers are present or when construction activity is occurring, regardless of the particular day or time of day.

NOI means Notice of Intent.

Operator means any person or other entity that owns, operates, directs, conducts, controls, authorizes, approves, determines, or otherwise has responsibility for, or exerts financial control over the commencement, continuation, or daily operation of activity regulated by this permit. An operator includes any person who treats and discharges stormwater, or in the absence of treatment, the person who generates and/or discharges stormwater, or pollutants. An operator may include but may not be limited to, property owners, agents, general partners, LLP partners, LLC members, leaseholders, developers, builders, contractors, or other responsible or controlling entities.

Outfall means the location where stormwater in a discernible, confined and discrete conveyance leaves a facility or construction site prior to discharging into the receiving water.

Perennial Stream means a stream or portion of a stream that flows year-round, is considered a permanent stream, and for which base flow is maintained by ground-water discharge to the streambed due to the ground-water elevation adjacent to the stream typically being higher than the elevation of the streambed.

Permittee means a person to whom a permit has been issued.

Plan or Sale as included in the phrase "larger common plan of development or sale" is broadly defined to mean any announcement or documentation, sales program, permit application, presentation, zoning request, physical demarcation, surveying marks, etc., associated with or indicating construction activities may occur in an area.

Pollutant of concern refers to sediment, turbidity, and any other pollutant known or reasonably expected to be found in untreated discharges associated with the construction site.

Post-construction refers to any phase of construction where final stabilization has been achieved and all but minor construction activities have been completed. The term post-construction is not affected by the final operational status of the site or whether the site has been placed into operation according to its final intended use.

Priority construction site means any site that discharges to a waterbody which is listed on the most recently EPA approved 303(d) list of impaired waters for turbidity, siltation, or sedimentation, any waterbody for which a TMDL has been finalized or approved by EPA for turbidity, siltation, or sedimentation, any waterbody assigned the Outstanding Alabama Water use classification in accordance with ADEM Admin. Code r. 335-6-10-.09, and any waterbody assigned a special designation in accordance with ADEM Admin. Code r. 335-6-10-.10.

Qualified Credentialed Inspector or QCI means a permittee, permittee employee, or permittee designated qualified person who has successfully completed initial training and annual refresher Qualified Credentialed Inspection Program (QCIP) training, and holds a valid certification from a Department approved cooperating training entity. A QCI is familiar with current industry standards for erosion and sediment controls and able to inspect and assure that BMPs or other pollution control devices (silt fences, erosion control fabric, rock check devices, etc.) and erosion control efforts (grading, mulching, seeding, growth management, etc.) or management strategies have been properly implemented and regularly maintained. Such individual may not certify the CBMPP or modifications to the CBMPP.

Qualified Credentialed Inspector Program or QCIP means a Department approved program conducted by a cooperating training entity. Approved programs provide training in the requirements of the Alabama NPDES rules and regulations to ensure that QCP designed and certified BMPs detailed in a CBMPP are effectively implemented and maintained, and evaluation of conveyance structures, receiving waters and adjacent impacted offsite areas to ensure the protection of water quality and compliance with the requirements of this Permit.

Qualified Credentialed Professional or QCP means a licensed (in the State of Alabama) professional engineer (PE) or a Certified Professional in Erosion and Sediment Control (CPESC) as determined by EnviroCert International. Other registered or certified professionals eligible to be classified as a QCP include registered landscape architect, licensed land surveyor, registered geologist, registered forester, Registered Environmental Manager as determined by the National Registry of Environmental Professionals (NREP), or Certified Professional and Soil Scientist (CPSS) as determined by the Soil Science Society of America. The QCP shall be in good standing with the authority granting the registration or designation. The design and implementation of certain structural BMPs may involve the practice of engineering and require the certification of a professional engineer pursuant to Alabama law.

A qualified person under the direct supervision of a QCP refers to an individual who is an employee of the QCP or the QCP's firm, and is familiar with current industry standards for erosion and sediment controls. This individual is able to inspect and assure that BMPs or other pollution control devices (silt fences, erosion control fabric, rock check devices, etc.) and erosion control efforts (grading, mulching, seeding, growth management, etc.) or management strategies have been properly implemented and regularly maintained. Such individual may not certify the CBMPP or modifications to the CBMPP.

Qualifying precipitation event refers to any precipitation of 0.75 inches or greater in any 24-hour period.

Receiving Stream means the "waters" receiving a "discharge" from a construction site.

Severe property damage means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

Silvicultural Operations:

> ***Non-point source Silvicutural activities*** means activities such as nursery operations, site preparation, reforestations, and subsequent cultural treatment, thinning, prescribed burning, pest and fire control, harvesting operations, surface drainage, or road construction and maintenance from which there is natural runoff.

Point source Silvicultural activities means any discernable, confined and discrete conveyance related to rock crushing, gravel washing, log sorting, or log storage facilities which are operated in conjunction with silvicultural activities and from which pollutants are discharged into waters of the State. Silvicultural point sources, excluding mining operations regulated pursuant to ADEM Administrative Code rule 335-6-9; 40 CFR Part 122.27 (1994).

Site means the land or water area where any facility or activity for which coverage under this permit is required is physically located or conducted, including adjacent land use in connection with the facility or activity. See also the definition of Construction Site.

State water quality standards refer to numeric and narrative standards set forth at ADEM Admin Code chaps. 335-6-10 and 335-6-11.

Steep Slope means a slope of 15% or greater.

Stormwater means runoff, accumulated precipitation, process water, and other wastewater generated directly or indirectly as a result of construction activity, the operation of a construction material management site, including but not limited to, precipitation, upgradient or offsite water that cannot be diverted away from the site, and wash down water associated with normal construction activities. Stormwater does not mean discharges authorized by the Department via other permits or regulations.

Stormwater control refers to any BMP or other method used to prevent or reduce the discharge of pollutants to waters of the State.

Surface water means a water of the State of Alabama as defined in ADEM Admin. Code R. 335-6-10-.02.

Temporary Stabilization means the application and establishment of temporary ground cover (vegetative, pavements of erosion resistant hard or soft materials, or impervious structures) for the purpose of temporarily reducing raindrop impact and sheet erosion in areas where final stabilization cannot be established due to project phasing, seasonal limitations, or other project related restrictions.

Total Maximum Daily Load or TMDL means the calculated maximum permissible pollutant loading to a waterbody at which water quality standards can be maintained. The sum of waste load allocations (WLAs) and load allocations (LAs) for any given pollutant.

Treatment Chemicals refers to polymers, coagulants, flocculants, or other chemicals used to reduce turbidity in stormwater. For the purposes of this permit, treatment chemicals are used to control erosion on soil or to enhance the sediment removal capabilities of sediment traps or basins. Common construction site polymers include polyacrylamide (PAM) and chitosan.

Treatment facility and treatment system means all structures which contain, convey, and as necessary, chemically or physically treat stormwater. This includes all pipes, channels, ponds, tanks, and all other equipment serving such structures.

TSS means the pollutant parameter Total Suspended Solids.

Turbidity means a condition of water quality characterized by the presence of suspended solids and/or organic material. Sources of turbidity include soil erosion, waste discharge, urban runoff, eroding streambanks, and excessive algal growth.

Upset means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limitations because of factors beyond the reasonable control of the Permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventative maintenance, or careless or improper operation. For purposes of this definition, Chronic and Catastrophic Precipitation constitutes an exceptional incident.

Waters of the State means "[a]ll waters of any river, stream, watercourse, pond, lake, coastal, ground or surface water, wholly or partially within the State, natural or artificial. This does not include waters which are entirely confined and retained completely upon the property of a single individual, partnership, or corporation unless such waters are used in interstate commerce." Code of Alabama 1975, §22-22-1(b)(2). "Waters" include all "navigable waters" as defined in §502(7) of the FWPCA, 33 U.S.C. §1362(7), which are within the State of Alabama.

Week means the period beginning at twelve midnight Saturday and ending at twelve midnight the following Saturday.

ATTACHMENT G-2

NOTICE OF INTENT AND TERMINATION REQUEST (GENERAL PERMIT NO. ALR100000)

NOTICE OF INTENT – GENERAL PERMIT NUMBER ALR100000

NPDES PERMIT NUMBER ALR100000 IS A GENERAL PERMIT AUTHORIZING DISCHARGES ASSOCIATED WITH CONSTRUCTION ACTIVITIES THAT RESULT IN A TOTAL LAND DISTURBANCE OF ONE ACRE OR GREATER AND SITES LESS THAN ONE ACRE BUT ARE PART OF A LARGER COMMON PLAN OF DEVELOPMENT OR SALE

Mail to: Alabama Department of Environmental Management
Water Division
Stormwater Management Branch
Post Office Box 301463
Montgomery, Alabama 36130-1463

PLEASE COMPLETE ALL QUESTIONS. INCOMPLETE OR INCORRECT ANSWERS, OR MISSING SIGNATURES WILL DELAY PROCESSING. IF SPACE IS INSUFFICIENT, CONTINUE ON AN ATTACHED SHEET(S) AS NECESSARY. ATTACH CBMPP AND OTHER INFORMATION AS NEEDED. PLEASE TYPE OR PRINT LEGIBLY IN INK.

I. PERMITTEE INFORMATION Initial: ■ Modification: ☐ Transfer: ☐ Renewal: ☐ Previous ALR10 _____

Permittee Name (Legal Name) U.S. Army Garrison - Redstone	Responsible Official Phone Number 256-842-3702
Responsible Owner/Operator or Official, and Title Clint Howard, Acting Chief, Environmental Management Division	Responsible Official E-Mail Address Joseph.c.howard1.civ@mail.mil
Responsible Official (RO) Street/Physical Address 4488 Martin Road, Room A-336	City, State, and Zip Code Redstone Arsenal, AL 35898
Responsible Official (RO) Mailing Address same as above	City, State, and Zip Code same as above
☐ Corporation ☐ Individual ☐Sole Proprietorship ☐ Partnership ☐ LLC ☐ LLP ■ Government Agency ☐ Other _____	

II. FACILITY INFORMATION

Facility/Site Name Redstone Arsenal, RSA-013	Facility Contact and Title Kenneth Hurley, P.E.
Facility Street Address or Location Description RSA-013, Unlined Inactive Burn Pad	Facility Contact Company Name APTIM
City / Zip Code / County(s) Redstone Arsenal 35898 Madison	Facility Contact Phone Number 865-560-7831
Facility Front Gate Latitude and Longitude (For linear projects, please include coordinates for both the beginning and ending points of the project.) 34º 34'03" N, 86º 39' 57" W	Facility Contact e-Mail Address: kenneth.hurley@aptim.com
Detailed Directions to the Site	

III. ACTIVITY DESCRIPTION

Brief Description of Construction / Land disturbance activity(s): Excavation of contaminated soil	
(For Modifications Only) Brief description of the action/change that has resulted in the request for permit modification:	
Primary SIC Code:	Primary NAICS Code:

IV. PROPOSED SCHEDULE

Anticipated Activity schedule:	Commencement date:	Completion date:
Area of the Registered site:	Total site area in acres:	Total disturbed area in acres:

V. PRIORITY CONSTRUCTION SITE

Is this a Priority Construction Site as defined by Part V of the construction stormwater general permit? Yes ☐ No ☐ If yes, attach/submit a copy of the CBMPP that meets or exceeds the requirements of Parts III A. and E. of the construction stormwater general permit.

VI. TOPOGRAPHIC MAP SUBMITTAL

Please attach a recent 7.5 minute series USGS topographic map(s) no larger than 11 by 17 inches (several pages may be necessary), showing the location of the Facility including site boundaries, area of disturbance, a 1 mile radius, perennial, intermittent, and ephemeral streams, lakes/springs/wells/wetlands and contour lines. The map should also show the point(s) at which stormwater runoff will exit (outfall) the facility and the point(s) where stormwater runoff from the site will enter the receiving water.

VII. RECEIVING WATERS

Are there any surface waters within 25 feet of your project's earth disturbances? YES ☐ NO ■

List name of receiving water(s), latitude & longitude (decimal or deg, min, sec) of location(s) that run-off enters the receiving water, and the waterbody classification. Please refer to ADEM Admin. Code 335-6-11 for a detailed list of water use classifications. (Attach a separate list if necessary)

Receiving Water	Latitude	Longitude	Waterbody Classification

VIII. GENERAL INFORMATION

Will flocculants or other chemical stabilization products be used on site? Yes ☐ No ☐

IX. QUALIFIED CREDENTIALED PROFESSIONAL (QCP) CERTIFICATION

"I certify under penalty of law that a comprehensive Construction Best Management Practices Plan (CBMPP) for the prevention and minimization of all sources of pollution in stormwater and authorized related process wastewater runoff has been prepared under my supervision for this site/activity, and associated regulated areas/activities. The CBMPP meets the requirements of this permit and if properly implemented and maintained by the operator, discharges of pollutants in stormwater runoff can reasonably be expected to be effectively minimized to the maximum extent practicable according to the requirements of ADEM Administrative Code Chapter 335-6-6-.23 and this Permit. The CBMPP describes the erosion and sediment control measures that must be fully implemented and regularly maintained as needed at the permitted site in accordance with sound sediment and erosion control practices to ensure the protection of water quality."

QCP Designation/Description: _____

Address _____ Registration / Certification: _____

Name and Title (type or Print) _____ Phone Number _____

Signature _____ Date Signed _____

X. OPERATOR - RESPONSIBLE OFFICIAL SIGNATURE

Pursuant to ADEM Administrative Code Rule 335-6-6-.09, this NOI must be signed by a Responsible Official of the permittee who is the operator, owner, the sole proprietor of a sole proprietorship, a general/controlling member or partner, a ranking elected official or other duly authorized representative for a unit of government; or an executive officer of at least the level of vice-president for a corporation, having overall responsibility and decision making for the site/activity. "I certify under penalty of law that this form, the CBMPP, and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the qualified credentialed professional (QCP) and other person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, correct, and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine or imprisonment for knowing violations. I certify that this form has not been altered, and if copied or reproduced, is consistent in format and identical in content to the ADEM approved form. I further certify that the proposed discharges described in this registration have been evaluated for the presence of any non-construction and/or coal/mineral mining stormwater, or process wastewaters have been fully identified."

Name and Title (type or Print) Kenneth J. Hurley, P.E. Official Title Project Engineer

Signature _____ Date Signed _____

Print Form

TERMINATION REQUEST – GENERAL PERMIT NUMBER ALR100000

NPDES PERMIT NUMBER ALR100000 IS A GENERAL PERMIT AUTHORIZING DISCHARGES ASSOCIATED WITH CONSTRUCTION ACTIVITIES THAT RESULT IN A TOTAL LAND DISTURBANCE OF ONE ACRE OR GREATER AND SITES LESS THAN ONE ACRE BUT ARE PART OF A LARGER COMMON PLAN OR DEVELOPMENT OR SALE

Mail to: Alabama Department of Environmental Management
Water Division
Post Office Box 301463
Montgomery, Alabama 36130-1463

PLEASE COMPLETE ALL QUESTIONS. RESPOND WITH "N/A" AS APPROPRIATE. INCOMPLETE OR INCORRECT ANSWERS, OR MISSING SIGNATURES WILL DELAY PROCESSING. IF SPACE IS INSUFFICIENT, CONTINUE ON AN ATTACHED SHEET(S) AS NECESSARY. ATTACH CBMPP AND OTHER INFORMATION AS NEEDED. PLEASE TYPE OR PRINT LEGIBLY IN INK.

Item I.

Permittee Name	Facility/Site Name
NPDES Permit Number ALR10	Facility Street Address or Location Description
County(s)	City, State, and Zip Code

Item II.

1. ☐ Yes ☐ No Has all regulated activity authorized by this Permit at this facility been completed? (i.e. construction/industrial effects removed; solid waste/debris properly disposed; all disturbed areas have been fully reclaimed, permanently stabilized, or perennial vegetative cover established; and stormwater discharges do not represent an adverse impact to water quality.)

2. ☐ Yes ☐ No Has the Permittee lost operational control of the facility/site?

3. ☐ Yes ☐ No Has the Permittee lost legal responsibility for the facility/site?

If "Yes" to any or all of questions 2 or 3, in order for this termination request to be granted, the Name, Phone Number, and Address of the succeeding responsible permittee/operator(s) must be listed and the succeeding responsible operator must obtain coverage:

_____

"I understand that discharging pollutants in storm water associated with regulated activity to waters of the State that is not authorized by NPDES permit coverage is a violation of State law. I also understand that the submittal of this request for termination does not release the operator from liability for any violations of this permit, ADEM Administrative Code Chapter 335-6-6, or other ADEM rules until a complete and correct request for termination of the permit is received by the Department. I understand that the permittee, operator, owner, developer, contractors, home builder(s), property owners association, etc., separately or collectively, must retain permit coverage for subdivision developments or other phased developments until all disturbance activity, including individual home construction, is substantially complete. I understand that should an inspection or complaint reveal significant noncompliance with ADEM rules, an environmental problem related to the discharge of stormwater from the site or that incorrect information has inadvertently been provided, implementation of remedial measures may be required, to include resubmittal of the NOI in order to correct any deficiencies, comply with federal stormwater permitting requirements, and provide for the protection of water quality. "I certify under penalty of law that this form, the CBMPP, and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the qualified credentialed professional (QCP) and other person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, correct, and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine or imprisonment for knowing violations.

Name & Designation of QCP	Signature	Date

Name & Title of Responsible Official	Signature	Date

ATTACHMENT G-3

STORMWATER BEST MANAGEMENT PRACTICES

(Alabama Soil and Water Conservation Committee, 2018)

Site Preparation

A. Construction Exit Pad (CEP)
B. Land Grading (LG)

Surface Stabilization

C. Dust Control (DC)
D. Erosion Control Blanket (ECB)
E. Mulching (MU)
F. Permanent Seeding (PS)
G. Preservation of Vegetation (PV)
H. Temporary Seeding (TS)

Runoff Conveyance

I. Check Dam (CD)
J. Diversion (DV)
K. Grass Swale (GS)

Sediment Control

L. Filter Strip (FS)
M. Sediment Barrier (SB)
N. Sediment Trap (ST)

Construction Exit Pad (CEP)

Practice Description

A construction pad is a stone base pad or manufactured product designed to provide a buffer area where mud and caked soil can be removed from the tires of construction vehicles to avoid transporting it onto public roads. This practice applies anywhere traffic will be leaving a construction site and moving directly onto a public road or street.

Planning Considerations

Roads and streets adjacent to construction sites should be kept clean for the general safety and welfare of the public. A construction exit pad (Figure CEP-1) should be provided where mud can be removed from construction vehicle tires before they enter a public road.

Where possible the construction exit pad should be located and constructed at a site where surface runoff from the pad will not transport sediment from the pad off the site. If the pad slope toward the road exceeds 2%, a diversion ridge 6” to 8” high with 3:1 side slopes should be constructed across the foundation approximately 15 feet from the entrance. This diversion ridge should divert surface runoff from the pad away from the road and into a sediment trap or basin.

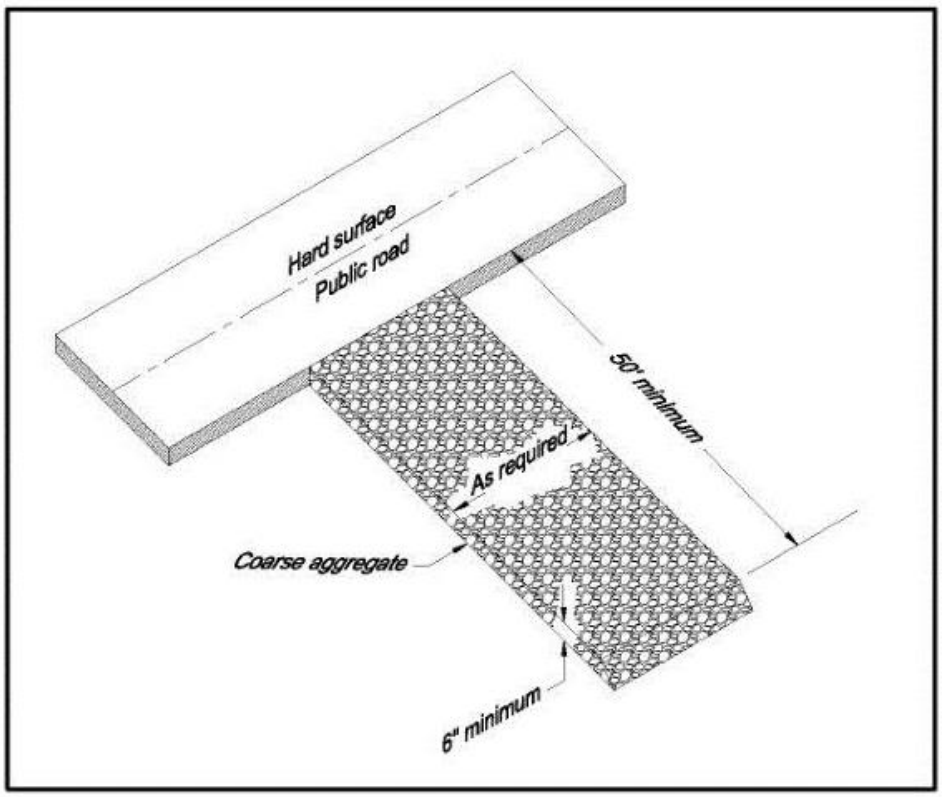

Figure CEP-1 Gravel Construction Exit

If the action of the vehicle traveling over the gravel pad does not sufficiently remove the mud or if the site is in a particularly sensitive area, a washing facility should be included with the pad (Figure CEP-2). When a washing facility is required all wash water shall be diverted to a sediment trap or basin.

If the construction exit pad is located in an area with soils that will not support traffic when wet, an underliner of geotextile will be required to provide stability to the pad.

Construction of stabilized roads throughout the development site should be considered to lessen the amount of mud transported by vehicular traffic. The construction exit pad should be located to provide for maximum use by construction vehicles.

Consideration should be given to limiting construction vehicles to only one ingress and egress point. Measures may be necessary to make existing traffic use the construction exit pad.

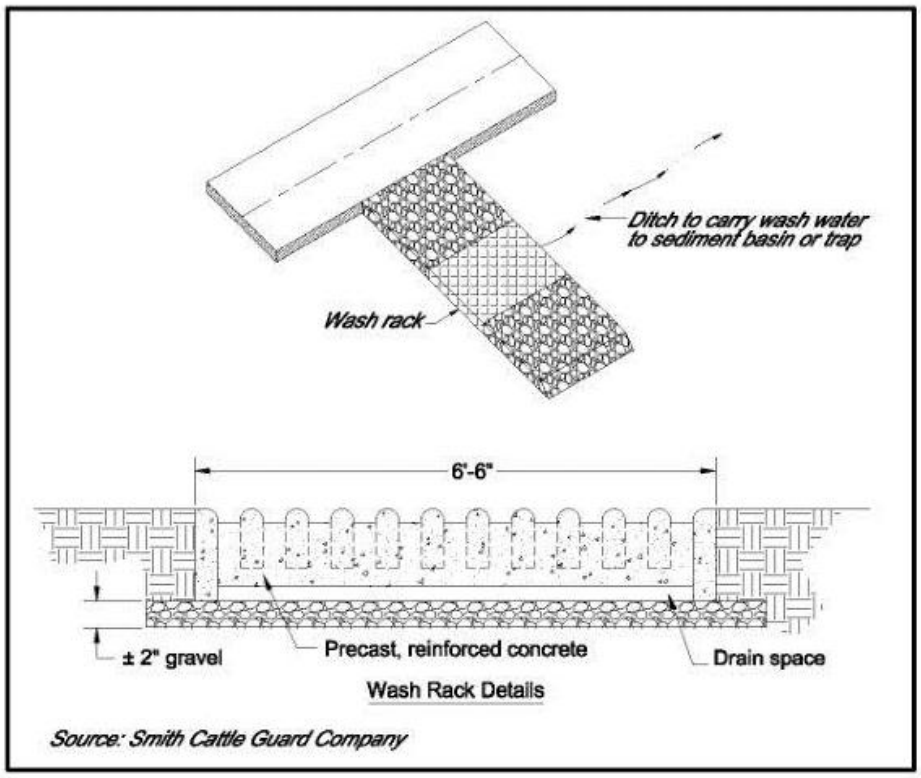

Figure CEP-2 Construction Exit with Wash Rack

Design Criteria

Aggregate size

Aggregate should be Alabama Highway Department coarse aggregate gradation No.1.

Pad Thickness

The exit pad shall have a minimum aggregate thickness of 6”.

Geotextiles

A non-woven geotextile shall be placed underneath the aggregate. The geotextile shall be of the strength and durability required for the project to ensure the aggregate and soil base are stable. Generally, the non-woven geotextile should meet the requirements for a Class 2 geotextile used for separation that is found in the current version of AASHTO M288.

Pad Length

The exit pad should provide for entering and parking the longest anticipated construction vehicles. A pad is typically 50 feet long but the required length may be longer or shorter.

Pad Width

The exit pad width is typically 20 feet but may be narrower or wider to equal the full width of the vehicular egress.

Washing

A washing facility shall be provided if necessary to prevent mud and caked soil from being transported to public streets and highways. It shall be constructed of concrete, stone, and/or other durable materials. Provisions shall be provided for the mud and other material to be carried away from the washing facility to a sediment trap or basin to allow for settlement of the sediment from the runoff before it is released from the site.

Land Grading (LG)

Practice Description

Land grading is reshaping of the ground surface to provide suitable topography for buildings, facilities and other land uses, to control surface runoff, and to minimize soil erosion and sedimentation both during and after construction. This practice applies to sites where the existing topography must be modified to prepare for another land use, or where adapting proposed development to the existing landscape can reduce the erosion potential of the site and the cost of installing erosion and sediment control measures. In some instances, other practices such as diversions or benches can be used to reduce the length of continuous slopes and reduce erosion potential.

Planning Considerations

A detailed plan should be developed by a qualified design professional for all land grading activities at the project site. The plan should show all areas to be disturbed, the areas of cut, areas of fill, and the finished elevation for all graded areas. Areas that will be mowed after the site is developed should have slopes planned that are not too steep for the type of mowing equipment that will be used for regular maintenance.

The grading plan should be designed to protect existing vegetation where possible, especially around natural drainageways. Grading activities should be scheduled to minimize the area disturbed at any one time during the construction process. The plan should include provisions for stabilizing disturbed areas immediately after final grading is completed. Provisions should also be made to protect existing

underground utilities. Finally, topsoil should be removed and stockpiled for use in revegetating the site.

The grading plan should also include necessary practices for controlling sediment and erosion at the site. These practices could include stable outlets and slope breaks such as diversions or benches.

Design Criteria

Site Preparation

A detailed survey of the construction site should be performed by a qualified surveyor prior to grading plan development. This survey should include existing topographic information at the site including existing elevations, existing drainage patterns, locations of existing overhead and underground utilities, and construction limit boundaries.

The grading plan should require that the existing topsoil at sites to be graded be removed as the first step in the grading process. The plan should include a location on the construction site where topsoil will be stockpiled. Stockpiled topsoil should be protected by temporary vegetation (see Temporary Vegetation practice) or other appropriate temporary cover, such as plastic, until it is used to cover disturbed areas in advance of permanent vegetation of the site.

The grading plan should include a schedule of disturbance activities that minimizes the area disturbed at any point in time using sequencing and staging concepts. In areas where clearing of existing vegetation is planned, the area should be cleared and grubbed by removing trees, vegetation, roots and other debris such as trash. In areas to be filled all loose or weak soil and oversized rocks should be removed from the area. The foundation of the area to be filled should consist of soil or rock material of adequate strength to support the proposed fill material and the structures to be built at the site. The exact depth of material to be removed should be determined by a qualified geotechnical professional according to accepted engineering standards.

Grading

A plan for placement of fill should be developed by a qualified geotechnical professional. The plan should specify the source of fill materials, which should be obtained on site if possible. Materials used for fill, when placed according to the plans and specifications, should provide sufficient strength to support structures planned for construction at the location.

Loose fill material should be placed in layers not exceeding 9” in thickness. The materials should be compacted to a moisture content and to a dry density that will produce the design bearing strength required for structures planned at the site. A qualified geotechnical engineer should provide fill placement specifications using standard accepted engineering practices.
Long and/or steep slope lengths can result in rill and gully erosion on slopes. Erosion on these type slopes can be minimized by breaking the slope with

diversions or benches (see Diversion practice). Diversion widths should be compatible with the expected maintenance equipment. Care is needed in locating outlets that will be stable and not cause gully erosion. The following table gives general guidance on the horizontal spacing of slope breaks:

Table LG-1 Guidelines for Spacing Slope Breaks [1]

Slope (H:V)	Horizontal Spacing (Ft)
1:1	20
2:1	40
3:1	60
4:1 and 5:1	80
6:1 to 9:1	120
10:1 or flatter	200

[1] Adjustments in spacing may be made to account for soil and site conditions and professional experience of the site designer.

In areas where seepage and ground water are present subsurface drains should be installed to improve slope stability or soil bearing capacity (see Subsurface Drain practice).

Steep slopes should be avoided if possible. Slopes that are to be vegetated should be 2 horizontal to 1 vertical or flatter. If the slope is to be maintained by tractor or other equipment the slope should be 3 horizontal to 1 vertical or flatter. Slopes should be designed to blend with surrounding topography as much as possible.

Erosion Control

The grading plan should include provisions for stabilization of graded areas immediately after final grading is completed. On areas that will have no additional disturbance, permanent vegetation should be applied immediately to the site (see Permanent Seeding practice) if grading is finished during the planting season. If grading is finished outside of the recommended planting dates a temporary cover should be installed using a Temporary Seeding or other appropriate cover and the Permanent Seeding planned for the next planting period. On areas where work is to be interrupted or delayed for 14 calendar days or longer, such as topsoil stockpiles, the area should be stabilized using mulch or temporary seeding (see Mulching or Temporary Seeding practice). Other stabilization measures such as hydraulic mulch or erosion control blankets should be used in extreme conditions, such as steep slopes and channels.

Where practical, runoff from undisturbed off-site areas should be diverted around the construction site to prevent erosion on the disturbed areas (see Diversion practice).

Sediment Control

Required sediment control practices should be installed before the land disturbance activities in the drainage area of the sediment control practices. Until disturbed

areas can be stabilized, appropriate sediment control measures will be maintained to minimize sediment delivery off-site. Measures should include as a minimum:

- Sediment Barriers – Placed along toes of slopes (see Sediment Barrier practice).

- Sediment Basins – Divert sediment laden runoff to basins as needed to minimize off-site sedimentation (see Sediment Basin practice).

- Inlet Protection – Where sediment-laden runoff is diverted to on-site stormwater drain inlets, the inlets should be protected with an appropriate sediment control practice.

- Stabilized Outlets – All runoff from the site should be conveyed in stabilized channels (see Grassed Swale, Lined Swale, Rip-rap Lined Swale, or other appropriate channel stabilization).

Dust Control (DC)

Practice Description

Dust control includes a wide range of techniques that prevent or reduce movement of wind-borne soil particles (dust) during land disturbing activities. This practice applies to construction routes and other disturbed areas where on-site and off-site damage or hazards may occur if dust is not controlled.

Planning Considerations

Construction activities that disturb soil can be a significant source of air pollution. Large quantities of dust can be generated, especially in “heavy” construction activities such as land grading for road construction and commercial, industrial or subdivision development.

The scheduling of construction operations so that the least amount of area is disturbed at one time is important in planning for dust control.

The greatest dust problems occur during dry periods. Therefore, to the extent practicable do not expose large areas of bare soil during drought conditions.

Where wind erosion is a potential cause of dust problems, preserving vegetation should be considered as a passive measure. Leave undisturbed buffer areas between graded areas wherever possible.

Installing temporary or permanent surface stabilization measures immediately after completing land grading will minimize dust problems.

Design Criteria

Permanent Methods

Vegetative Cover

For disturbed areas not subject to traffic, vegetation provides the most practical method of dust control. Establish vegetative cover according to the Permanent Seeding or Temporary Seeding practice.

Topsoiling

This entails covering the surface with less erosive soil material. See Topsoiling practice for guidance.

Stone

Stone used to stabilize construction roads can also be effective for dust control. Stone should be spread a minimum of 6” thick over construction roads in the disturbed area. For heavily traveled roads or roads subjected to heavy loads the stone thickness should be 8” to 10”. A non-woven geotextile meeting the minimum requirements of AASHTO M288 for a Class 2 separation geotextile should be used under the stone.

Temporary Methods

Mulches

Mulch offers a fast, effective means of controlling dust when properly applied. See Mulching practice for guidelines for planning and installing the practice.

Temporary Vegetative Cover

For disturbed areas where no activity is anticipated for 14 days or longer, temporary seeding can effectively control dust. Establish vegetative cover according to Temporary Seeding practice guidelines.

Calcium Chloride

Calcium chloride may be applied by mechanical spreader as loose, dry granules or flakes at a rate that keeps the surface moist but not so high as to cause water pollution or plant damage. Sites may need to be retreated because the product degrades over time.

Spray-on Adhesives

Spray-on adhesives may be used on mineral soils for dust control. Traffic must be kept off treated areas to prevent the product from becoming ineffective. Examples of spray-on adhesives for use in dust control are listed in Table DC-1.

Table DC-1 Spray-on Adhesives for Dust Control on Mineral Soil

Material	Water Dilution	Type of Nozzle	Apply Gal/Ac
Anionic Asphalt Emulsion	7:1	Coarse Spray	1,200
Latex Emulsion	12.5:1	Fine Spray	235
Resin in Water	4:1	Fine Spray	300

Chemical Stabilization (CHS)

Chemical products are available for use on mineral soils for dust control. Traffic must be often kept off treated areas to prevent the product from becoming ineffective. The manufacturer or supplier shall provide written application methods. The application method shall ensure uniform coverage to the target and avoid drift to non-target areas including waters of the State. The manufacturer or supplier shall also provide written instructions to ensure proper safety, storage, and mixing of the product. Refer to the Planning Considerations for the Chemical Stabilization practice for planning consideration before deciding to use these type products.

Sprinkling or Irrigation

Sprinkling is especially effective for dust control on haul roads and other traffic routes. Sprinkle the site until the surface is wet. Repeat as needed. Also, bare areas may be kept wet with irrigation to control dust as an emergency treatment.

Tillage

Tillage is used to roughen the site and bring clods and moist soil to the surface. This is a temporary emergency measure that can be used on large open disturbed areas as soon as soil blowing starts. Begin tilling on the windward edge of the site. The depth of tillage is determined by the depth to moist soil and the amount of moist soil desired at the surface. In sandy soils, the depth to moist soil may make tillage impractical.

Barriers

A board fence, wind fence, sediment fence, hay bales, or similar barriers can control air currents and blowing soil. Place barriers perpendicular to prevailing air currents at intervals about 15 times the barrier height.

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Erosion Control Blanket (ECB)

Photo courtesy of Sunshine Supplies, Inc.

Practice Description

To aid in controlling erosion on critical areas by providing a protective cover made of straw, jute, wood or other plant fibers; plastic, nylon, paper or cotton. This practice is best utilized on slopes and channels where the erosion hazard is high, and plant growth is likely to be too slow to provide adequate protective cover. Erosion control blankets are typically used as an alternative to mulching but can also be used to provide structural erosion protection. Some important factors in the choice of a blanket are: soil conditions, steepness of slope, length of slope, type and duration of protection required to establish desired vegetation, and probable sheer stress.

Planning Considerations

Care must be taken to choose the type of blanket that is most appropriate for the specific project needs. Eighteen types of erosion control blankets are included in this practice and the type names and related information are from the materials developed by the Erosion Control Technology Council (ECTC). Manufacturer's instructions and recommendations, as well as a site visit by the qualified design professional and site plan reviewer are highly recommended to determine a product's appropriateness.

Note: The Alabama Department of Transportation (ALDOT) identifies Rolled and Hydraulic Erosion Control Products based on performance. Description of ALDOT types can be found in Section 659 of their Standard Specifications for Highway Construction. ALDOT recognizes some Hydraulic Erosion Control Products equal in performance to Rolled Products.

Temporary Erosion Control Blankets

Benefits of using temporary erosion control blankets include the following:

- Protection of the seed and soil from raindrop impact and subsequent displacement.
- Thermal consistency and moisture retention for the seedbed area.
- Stronger and faster germination of grasses and legumes.
- Spreading stormwater runoff to prevent rill erosion of slopes.
- Prevention of sloughing of topsoil added to steeper slopes.

Because temporary blankets will deteriorate in a short period of time, they provide no enduring reduction in erosion potential.

Permanent Erosion Control Blankets

Permanent erosion control blankets are also known as permanent soil reinforcing mats or turf reinforcement mats (TRMs). Roots penetrate and become entangled in the matrix, forming a continuous anchorage for surface growth and promoting enhanced energy dissipation.

Benefits of using permanent erosion control blankets, in addition to the benefits gained from using a temporary blanket include the following:

- Sediment from stormwater flows is deposited in the matrix providing a fine soil growth medium for the development of roots.
- In stormwater channels, blankets and the vegetative root system form an erosion resistant cover which resists hydraulic uplift and shear forces of channel flows.

Design Criteria

General

All blankets shall be nontoxic to vegetation and to the germination of seed and shall not be injurious to the unprotected skin of humans. Erosion control products shall be of sufficient strength to hold the prepared ground and, if applicable, cover material (mulch, sod, etc.) in place until an acceptable growth of natural or planted material is established. Erosion control products shall be identified by a type designation (Type 1.A, 2.B, 3.A, etc.) where the type is based on the functional longevity and physical properties of the product. Type 1 products have a 3-month functional longevity, Type 2 a 12-month, Type 3 a 24-month, Type 4 a 36-month, and Type 5 are Turf Reinforcement Mats for long-term erosion protection.

Tables ECB-1 and ECB-2 give typical applications of the different types of erosion control blankets. ECTC's recommended installation guide and standard specifications can be found on their website and at the following link:

https://www.ectc.org/assets/docs/ectc_july2017_recpspecification%20final.pdf

Table ECB-1 Temporary Erosion Control Blanket Types and Applications

Functional Longevity	Type	Application
3-Month	1.A	A Netting / Open Weave Textile for use on a maximum slope steepness of 5:1 and provides a shear stress of at least 1.0 lbs/ft^2.
3-Month	1.B	A Netless Rolled Erosion Control Blanket for use on a maximum slope steepness of 3:1 and provides a shear stress of at least 1.0 lbs/ft^2.
3-Month	1.C	A Single-Net Erosion Control Blanket for use on a maximum slope steepness of 3:1 and provides a shear stress of at least 1.5 lbs/ft^2.
3-Month	1.D	A Double-Net Erosion Control Blanket for use on a maximum slope steepness of 2:1 and provides a shear stress of at least 1.75 lbs/ft^2.
12-Month	2.A	A Netting / Open Weave Textile for use on a maximum slope steepness of 5:1 and provides a shear stress of at least 1.0 lbs/ft^2.
12-Month	2.B	A Netless Rolled Erosion Control Blanket for use on a maximum slope steepness of 3:1 and provides a shear stress of at least 1.0 lbs/ft^2.
12-Month	2.C	A Single-Net Erosion Control Blanket for use on a maximum slope steepness of 3:1 and provides a shear stress of at least 1.5 lbs/ft^2.
12-Month	2.D	A Double-Net Erosion Control Blanket for use on a maximum slope steepness of 2:1 and provides a shear stress of at least 1.75 lbs/ft^2.
24-Month	3.A	An Open Weave Textile for use on a maximum slope steepness of 2:1 and provides a shear stress of at least 2.0 lbs/ft^2.
24-Month	3.B	An Erosion Control Blanket for use on a maximum slope steepness of 1.5:1 and provides a shear stress of at least 2.0 lbs/ft^2.
36-Month	4.A	An Open Weave Textile for use on a maximum slope steepness of 1:1 and provides a shear stress of at least 2.25 lbs/ft^2.
36-Month	4.B	An Erosion Control Blanket for use on a maximum slope steepness of 1:1 and provides a shear stress of at least 2.25 lbs/ft^2.

Table ECB-2 Turf Reinforcement Mats (TRMs) Types and Applications

Type	Application
5.A	A TRM designed for use on geotechnically stable slopes up to 1:1, provide an unvegetated shear stress of at least 2.0 lbs/ft^2, and a vegetated shear stress of at least 6.0 lbs/ft^2.
5.B	A TRM designed for use on geotechnically stable slopes up to 1:1, provide an unvegetated shear stress of at least 2.0 lbs/ft^2, and a vegetated shear stress of at least 8.0 lbs/ft^2.
5.C	A TRM designed for use on geotechnically stable slopes up to 0.5:1, provide an unvegetated shear stress of at least 2.0 lbs/ft^2, and a vegetated shear stress of at least 10.0 lbs/ft^2.
5.D	A TRM designed for use on geotechnically stable slopes up to 0.5:1, provide an unvegetated shear stress of at least 2.0 lbs/ft^2, and a vegetated shear stress of at least 12.0 lbs/ft^2.
5.E	A TRM designed for use on geotechnically stable slopes up to 0.5:1, provide an unvegetated shear stress of at least 2.0 lbs/ft^2, and a vegetated shear stress of at least 12.0 lbs/ft^2.
5.F	A High Performance TRM designed for use on geotechnically stable slopes up to 1:1, provide an unvegetated shear stress of at least 2.0 lbs/ft^2, and a vegetated shear stress of at least 14.0 lbs/ft^2.

Type Designations and Materials

Erosion control products shall be composed of the materials shown in Tables ECB-3 and ECB-4.

Table ECB-3 Material Composition of Temporary Erosion Control Blankets

Type	Material Composition
1.A	A photodegradable synthetic mesh or woven biodegradable natural fiber netting.
1.B	Natural and/or polymer fibers mechanically interlocked and/or chemically adhered together to form an RECP.
1.C	Processed degradable natural and/or polymer fibers mechanically bound together by a single rapidly degrading, synthetic or natural fiber netting.
1.D	Processed degradable natural and/or polymer fibers mechanically bound together between two rapidly degrading, synthetic or natural fiber nettings.
2.A	A photodegradable synthetic mesh or woven biodegradable natural fiber netting.
2.B	Natural and/or polymer fibers mechanically interlocked and/or chemically adhered together to form an RECP.
2.C	Processed degradable natural and/or polymer fibers mechanically bound together by a single degrading, synthetic or natural fiber netting.
2.D	Processed degradable natural and/or polymer fibers mechanically bound together between two degradable, synthetic or natural fiber nettings.
3.A	An open weave textile composed of processed slow degrading natural or polymer yarns or twines woven into a continuous matrix.
3.B	An erosion control blanket composed of processed slow degrading natural or polymer fibers mechanically bound together between two slow degrading synthetic or natural fiber nettings to form a continuous matrix.
4.A	An open weave textile composed of processed slow degrading natural or polymer yarns or twines woven into a continuous matrix.
4.B	An erosion control blanket composed of processed slow degrading natural or polymer fibers mechanically bound together between two slow degrading synthetic or natural fiber nettings to form a continuous matrix.

Table ECB-4 Material Composition of Turf Reinforcement Mats

Type	Material Composition
5.A 5.B 5.C 5.D 5.E	A product composed of UV-stabilized non-degradable synthetic fibers, filaments, nets, wire mesh and/or other elements, processed into a permanent, three- dimensional matrix which may be supplemented with degradable components.
5.F	A product composed of UV-stabilized, non-degradable, synthetic fibers, filaments, nets, wire mesh and/or other elements, processed into a permanent, three- dimensional matrix for highest performance.

Materials Physical Requirements

A properly designed erosion control blanket installation requires selection of a product manufactured with physical properties to withstand the stresses the product will be subjected to for the design life of the product. Refer to the ECTC standard specifications for the minimum physical requirements for each type of blanket.

Product Placement

General. Refer to the ECTC Installation Guide for the general guidelines for the installation of rolled erosion control products (RECPs); however, the ECTC guidelines do not supersede the manufacturer's installation guidelines.

Prior to installation of a RECP, the surface on which it is to be placed must be properly prepared. The surface should be stable and firm, the top soil should be evenly spread if specified, and the soil amendments added. The soil pH in the root zone and soil compaction MUST be addressed for long-term vegetal success. Fertilizer and lime applications per soil test recommendations should always be incorporated into the soil surface whenever possible. Some RECPs may require an application of mulch prior to placement of the blanket. Some TRMs may require soil or hydraulically-applied matrix in-filling after placement of the blanket. For soil in-filling, some of the soil amendment and the seed should be applied to the soil in-fill and lightly brushed or raked in to cover the seed.

Blankets shall be rolled out in the direction of flow to reduce rill erosion. The RECP should always have intimate contact with the soil surface over the entire installation. Do not stretch the RECP over surface irregularities.

For temporary blankets, staples should be U-shaped wire with an 11-gauge thickness or greater. Staples should be of sufficient thickness for soil penetration without undue distortion. The legs of the staples shall be at least 6" long with a crown of 1". Appropriate biodegradable staples can be used in lieu of wire staples.

Permanent blankets shall be anchored in one of two ways. Blankets can be anchored using sound wood stakes, 1" by 3" stock sawn in a triangular shape. The length of the stakes shall be from 12" to 18" depending upon the soil compaction at the site. Stakes shall be installed on 4 feet centers along each edge of the blanket. Blankets can also be anchored using U shaped staples of 11-gauge steel or greater with a minimum leg length of 8" and a 2" crown.

Upslope Anchor. The upslope portion of the RECP should be properly anchored. There are several different techniques that can be used. Always refer to the manufacturer's or the ECTC installation guidelines for the proper technique.

Seams. Edges of the RECP should be properly secured to adjacent blankets. There are several different techniques used to prevent seam or abutted rolls from separating. Always refer to the manufacturer's or the ECTC installation guidelines for the proper technique.

Terminal Ends. RECP should be securely fastened at the terminal end of the blanket. Always refer to the manufacturer's or the ECTC installation guidelines for the proper technique

Slopes. RECP should be securely fastened to the soil by installing stakes/staples at a minimum rate of 1.3/yd^2 within the body of the blanket. Always refer to the manufacturer's or the ECTC installation guidelines for the proper technique

Channels. Always follow manufacturer's or ECTC guidelines for anchor trenches or stake/staple check slots, seaming, and terminal end anchoring. Unroll RECPs down the center of the channel in the primary water flow direction. Securely fasten all RECPs to the soil by installing stakes/stapes at a minimum rate of 1.7/yd^2. Significantly higher anchor rates and longer stakes/stapes may be necessary in sandy, loose, or wet soil and in severe applications. Always refer to the manufacturer's or the ECTC installation guidelines for the proper technique for staking/stapling.

Photo courtesy of John Slupecki.

Figure ECB-1 RECP Slope Installation.

Figure ECB-2 Topsoil “In-Fill” Being Placed in TRM.

Figure ECB-3 TRM in the Middle of a Swale.

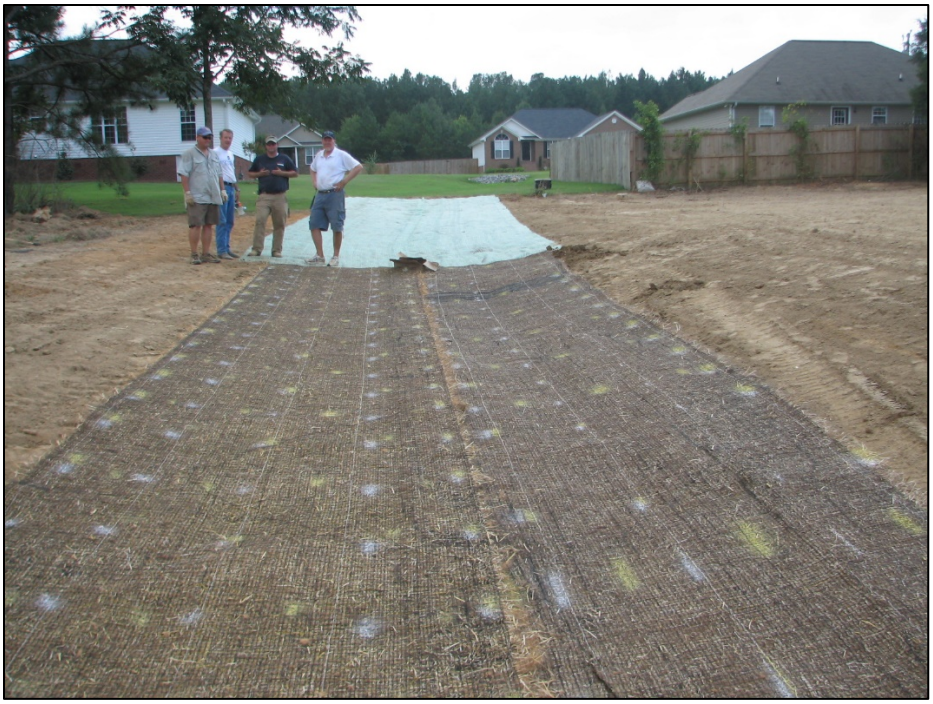

Figure ECB-4 TRM with Pre-Marked Stapling Pattern.

Mulching (MU)

Practice Description

Mulching is the application of plant residues such as straw or other suitable fibrous materials to the soil surface. Mulch protects the soil surface from the erosive force of raindrop impact and reduces the velocity of overland flow. It helps seedlings germinate and grow by conserving moisture, protecting against temperature extremes and controlling weeds. Mulch also maintains the infiltration capacity of the soil. Mulch can be applied to seeded areas to help establish plant cover. It can also be used in unseeded areas to protect against erosion over the winter or until final grading and shaping can be accomplished except in areas with concentrated flow.

Planning Considerations

Surface mulch is the most effective, practical means of controlling runoff and erosion on disturbed land prior to vegetation establishment. Mulch absorbs the energy associated with raindrops and thereby minimizes soil particle detachment, which is the initiation step of erosion.

Mulch also reduces soil moisture loss by evaporation, prevents crusting and sealing of the soil surface, moderates soil temperatures, and provides a suitable microclimate for seed germination.

Organic mulches such as straw, wood chips and shredded bark have been found to be very effective mulch materials. Materials containing weed and grass seeds which may compete with establishing vegetation should not be used. Also, decomposition of some wood products can tie up significant amounts of soil nitrogen, making it necessary to modify fertilization rates or add fertilizer with the mulch.

Hydraulic Erosion Control Products (HECPs) as defined by the Erosion Control Technology Council (ECTC) can also be used as effective mulch applications. HECPs are designated as 5 different types based on product characteristics and performance. Information from the ECTC table dated April 2014 is provided as Table MU-1. To ensure that you use the most valid information refer to the latest HECP specifications provided by the ECTC or the manufacturer's recommendation. The Alabama Department of Transportation (ALDOT) characterizes mulches based on performance levels identified in Sections 656 and 659 of their Standard Specifications for Highway Construction.

The choice of materials for mulching should be based on soil conditions, season, type of vegetation to establish, and size of the area. Properly applied and tacked mulch is always beneficial. Mulching is especially important when conditions of germination are not optimum, such as midsummer and early winter, and on difficult sites such as cut slopes, fill slopes and droughty soils.

Straw has traditionally been the most commonly used mulching material in conjunction with seeding. Wheat straw is the mostly commonly used straw, and can be spread by hand or with a mulch blower. If the site is susceptible to blowing wind, the straw should be tacked down with a tackifier, or a crimper to prevent loss.

Wood chips are suitable for areas that will not be closely mowed, and around ornamental plantings. Chips do not require tacking. Because they decompose slowly they must be treated with 12 pounds of nitrogen per ton to prevent nutrient deficiency in plants. They can be an inexpensive mulch if the chips are obtained from trees cleared on the site.

Compost, peanut hulls, and pine straw are organic materials that potentially make excellent mulches but may only be available locally or seasonally. Creative use of these materials may reduce costs.

Jute mesh or the various types of netting is very effective in holding mulch in place on waterways and slopes before grasses become established.

Erosion control blankets promote seedling growth in the same way as organic mulches and are suited for use in areas with concentrated flows (see Erosion Control Blanket practice).

Table MU-1 Hydraulic Erosion Control Products (HECP) Specification Chart [1]

Hydraulic Erosion Control							
Type HECP[2]	Term	Functional Longevity[3]	Typical Application Rates Lbs/acre (kg/ha)	Typical Maximum Slope Gradient (H:V)	Maximum Uninterrupted Slope Length (ft)	Maximum C Factor[4, 5] (3:1 test)	Minimum Vegetation Establishment[6]
1	Ultra Short Term	1 month	1500—2500 (1700—2800)	≤ 5:1	20	0.3	150 %
2	Short Term	2 month	2000—3000 (2250—3400)	≤ 4:1	25	0.2	150 %
3	Moderate Term	3 month	2000—3500 (2250—3900)	≤ 3:1	50	0.1	200 %
4	Extended Term	6 month	2500—4000 (2800—4500)	≤ 2:1	75	0.05	300 %
5	Long Term	12 month	3000—4500 (3400—5100)	≤ 2:1	100	0.02	300 %

[1] This table is for general guidelines only. Refer to manufacturer for application rates, instructions, gradients, maximum continuous slope lengths and other site-specific recommendations.

[2] These categories are independent of rolled erosion control products (RECPs) categories, despite the identical names.

[3] A manufacturer's estimated time period, based upon field observations, that a material can be anticipated to provide erosion control as influenced by it composition and site-specific conditions.

[4] "C" Factor calculated as ratio of soil loss from HECP protected slope (tested at specified or greater gradient, h:v) to ratio of soil loss from unprotected (control) plot based on large-scale testing.

[5] Acceptable large-scale test methods may include ASTM D 6459, or other independent testing deemed acceptable by the engineer.

[6] Minimum vegetation establishment is calculated as outlined in ASTM D 7322 being a percentage by dividing the plant mass per area of the protected plot by the plant mass per area of the control plot.

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(Source: Erosion Control Technology Council, April 2014)

Design Criteria

Site Preparation

Before mulching, complete the required site preparation. Site preparation includes grading, if needed, and seedbed preparation and fertilizing, liming and seeding if a planting is being made by means other than hydroseeding.

Spreading the Mulch

Select a mulch material based on the site and practice requirements, availability of material, and availability of labor and equipment. Table MU-2 lists commonly used mulches.

Table MU-2 Mulching Materials and Application Rates

Material	Rate Per Acre and (Per 1000 ft.^{2})	Notes
Straw with Seed	1 ½-2 tons (70 lbs-90 lbs)	Spread by hand or machine to attain 75% groundcover; anchor when subject to blowing.
Straw Alone (no seed)	2 ½-3 tons (115 lbs-160 lbs)	Spread by hand or machine; anchor when subject to blowing.
Wood Chips	5-6 tons (225 lbs-270 lbs)	Treat with 12 lbs. nitrogen/ton.
Bark	35 cubic yards (0.8 cubic yard)	Can apply with mulch blower.
Pine Straw	1-2 tons (45 lbs-90 lbs)	Spread by hand or machine; will not blow like straw.
Peanut Hulls	10-20 tons (450 lbs-900 lbs)	Will wash off slopes. Treat with 12 lbs. nitrogen/ton.
HECPs	0.75 – 2.25 tons (35 lbs – 103 lbs)	Refer to ECTC or Manufacturer's Specifications.

Uniformly spread organic mulches by hand or with a mulch blower at a rate which provides about 75% ground cover. Spread HECPs utilizing appropriate equipment and at rates as specified When spreading straw mulch by hand, divide the area to be mulched into sections of approximately 1000 sq. ft. and place 70-90 pounds of straw (1 ½ to 2 bales) in each section to facilitate uniform distribution. Caution, an over-application of wheat straw will reduce stand success – do not over-apply wheat straw when mulching a seeding!

When straw mulch is subject to be blown away by wind, it must be anchored immediately after spreading. It is best anchored with a mulch anchoring tool.

Application of a commercial tackifier through a hydroseeder is often practical for steep slopes and can be effective on most sites. Binders (tackifiers) may be applied after mulch is spread or may be sprayed into the mulch as it is being blown onto the soil. Applying straw and binder together is the most effective

method. Liquid binders include an array of commercially available synthetic binders and organic tackifiers.

In high wind situations like roadways, crimping the mulch is the best alternative as the use of mulch binders may still result in the mulch being rolled up on the edge.

Straw mulch may also be anchored with lightweight plastic, cotton, jute, wire or paper netting which is stapled over the mulch. The manufacturer's recommendations on stapling netting should be followed.

Maintenance

Inspect all mulches periodically, and after rainstorms to check for rill erosion, dislocation, or failure. Where erosion is observed, apply additional mulch or if washout has occurred, repair the slope grade, reseed, and reinstall mulch. Continue inspections until vegetation is firmly established.

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Permanent Seeding (PS)

Practice Description

Permanent seeding is the establishment of perennial vegetation on disturbed areas from seed. Permanent vegetation provides economical long-term erosion control and helps prevent sediment from leaving the site. This practice is used when vegetation is desired and appropriate to permanently stabilize the soil.

Planning Considerations

The advantages of seeding over other means of establishing plants include the smaller initial cost, lower labor input, and greater flexibility of method.

Disadvantages of seeding include potential for erosion during the establishment stage, seasonal limitations on suitable seeding dates, and weather-related problems such as droughts.

The probability of successful plant establishment can be maximized through good planning. The selection of plants for permanent vegetation must be site specific. Factors that should be considered are type of soils, climate, establishment rate, and management requirements of the vegetation. Other factors that may be important are wear, mowing tolerance, and salt tolerance of vegetation.

Plant selection for permanent vegetation should be based on plant characteristics, site and soil conditions, time of year of planting, method of planting, and the intended use of the vegetated area. Climate factors can vary widely in Alabama. Important plant attributes are discussed in Vegetation Establishment for Erosion and Sediment Control in Chapter 2.

Plant selection may include companion plants to provide quick cover on difficult sites, late seedings, or where the desired permanent cover may be slow to establish. Annuals are usually used for companion plants and should be selected carefully to prevent using a species that provide so much competition that it prevents the establishment of the desired species.

Seeding properly carried out within the optimum dates has a higher probability of success. It is also possible to have satisfactory establishment when seeding outside these dates. However, as plantings are deviated from the optimum dates, the probability of failure increases rapidly. Seeding dates should be taken into account in scheduling land-disturbing activities.

Site quality impacts both short-term and long-term plant success. Sites that have compacted soils, soils that are shallow to rock or have textures that are too clayey or too sandy should be modified whenever practical to improve the potential for plant growth and long-term cover success.

The operation of equipment is restricted on slopes steeper than 3:1, severely limiting the quality of the seedbed that can be prepared. Provisions for establishment of vegetation on steep slopes can be made during final grading. In construction of fill slopes, for example, the last 4-6” might not be compacted. A loose, rough seedbed with irregularities that hold seeds and lime and fertilizer is essential for hydroseeding. Cut slopes should be roughened (see Land Grading practice).

Proper mulching is critical to protect against erosion on steep slopes. When using straw, anchor with netting or asphalt. On slopes steeper than 2:1, jute, excelsior, or synthetic matting may be required.

The use of irrigation (temporary or permanent) will greatly improve the success of vegetation establishment.

Design Criteria

Plant Selection

Select plants that can be expected to meet planting objectives. To simplify plant selection, use Figure PS-1 Geographical Areas for Species Adaptation and Seeding Dates and Table PS-1, Commonly Used Plants for Permanent Cover. Mixtures commonly specified by the Alabama Department of Transportation are an appropriate alternative for plantings on rights-of-ways. Additional information related to plants commonly used in Alabama is found in Chapter 2 under the section Vegetation for Erosion and Sediment Control.

The plants used for temporary vegetation may be used for companion plants provided the seeding rate of the annual species is reduced by one half. See the Temporary Seeding practice for additional information on establishing temporary vegetation. **Ryegrass or other highly competitive plants should not be used as a companion plant with a permanent seeding**.

Figure PS-1 Geographical Areas for Species Adaptation and Seeding Dates

Note: Site conditions related to soils and aspect in counties adjacent to or close to county boundaries may justify adjustments in planting dates by qualified design professionals.

Table PS-1 Commonly Used Plants for Permanent Cover with Seeding Rates and Dates

Species	Seeding Rates/Ac PLS	North	Central	South
		Seeding Dates		
Bahiagrass, Pensacola	40 lbs	--	Mar 1-July 1	Feb 1-Nov 1
Bermudagrass, Common	10 lbs	Apr 1-July 1	Mar 15-July 15	Mar 1-July 15
Bahiagrass, Pensacola Bermudagrass, Common	30 lbs 5 lbs	--	Mar 1-July 1	Mar 1-July 15
Bermudagrass, Hybrid (Lawn Types)	Solid Sod	Anytime	Anytime	Anytime
Bermudagrass, Hybrid (Lawn Types)	Sprigs 1/sq ft	Mar 1-Aug 1	Mar 1-Aug 1	Feb 15-Sep 1
Fescue, Tall	40-50 lbs	Sep 1-Nov 1	Sep 1-Nov 1	--
Sericea	40-60 lbs	Mar 15-July 15	Mar 1-July 15	Feb 15-July 15
Sericea & Common Bermudagrass	40lbs 10 lbs	Mar 15-July 15	Mar 1-July 15	Feb 15-July 15
Switchgrass, Alamo	4 Lbs	Apr 1-Jun 15	Mar 15-Jun 15	Mar 15-Jun15

PLS means pure live seed and is used to adjust seeding rates. For example, to plant 10 lbs PLS of a species with germination of 80% and purity of 90%, PLS= 0.8X 0.9 = 72%. 10 lbs PLS = 10/0.72 = 13.9 lbs of the species to be planted.

Seedbed Requirements

Establishment of vegetation should not be attempted on sites that are unsuitable due to compaction or inappropriate soil texture, poor drainage, concentrated overland flow, or steepness of slope until measures have been completed to correct these problems. To maintain a good stand of vegetation, the soil must meet certain minimum requirements as a growth medium. A good growth medium should have these attributes:

- Sufficient pore space to permit root penetration.
- Enough fine-grained soil material (silt and clay) to maintain adequate moisture and nutrient supply.
- Sufficient depth of soil to provide an adequate root zone. The depth to rock or impermeable layers such as hardpans should be 12” or more, except on slopes steeper than 2:1 where topsoiling is not feasible.
- A favorable pH range for plant growth, usually 6.0-6.5.

- Sufficient nutrients (nitrogen, phosphorus and potassium) for initial plant establishment.

- Freedom from large roots, branches, stones, or large clods. Clods and stones may be left on slopes steeper than 3:1 if they are to be hydroseeded.

If any of the above attributes are not met: i.e., if the existing soil is too dense, coarse, shallow or acidic to foster vegetation – chiseling, topsoil, or special amendments should be used to improve soil conditions. The soil conditioners described below may be beneficial or topsoil may be applied (for guidance on topsoiling see Topsoiling practice). These amendments should only be necessary where soils have limitations that make them poor for plant growth or for turf establishment.

- Peat-appropriate types are sphagnum moss peat, reed-sedge peat, or peat humus, all from fresh-water sources. Peat should be shredded and conditioned in storage piles for at least 6 months after excavation.

- Sand-should be clean and free of toxic materials.

- Vermiculite-use horticultural grade.

- Rotted manure-use stable or cattle manure not containing undue amounts of straw or other bedding materials.

- Thoroughly rotted sawdust-should be free of stones and debris. Add 6 lbs of nitrogen to each cubic yard.

Soil Amendments

Liming Materials

Lime (Agricultural limestone) should have a neutralizing value of not less than 90 percent calcium carbonate equivalent and 90 percent will pass through a 10-mesh sieve and 50 percent will pass through a 60-mesh sieve.

Selma chalk should have a neutralizing value of not less than 80 percent calcium carbonate equivalent and 90 percent will pass through a 10-mesh sieve.

Other liming materials that may be selected should be provided in amounts that provide equal value to the criteria listed for agricultural lime or be used in combination with agricultural limestone or Selma chalk to provide equivalent values to agricultural limestone.

Plant Nutrients

Commercial grade fertilizers that comply with current Alabama Fertilizer Laws should be used to supply nutrients required to establish vegetation.

Lime and fertilizer needs should be determined by soil tests. Soil testing is performed by the Auburn University Soil Testing Laboratory and provides recommendations based on field tests on Alabama soils. The local county Cooperative Extension Service can provide information on obtaining soil tests. Commercial laboratories that make recommendations based on soil analysis may be used.

When soil tests are not available, use the following rates for application of soil amendments.

Sandy soils: Use 1 ton/acre (exception on sandy soils – if the cover will be tall fescue and clover) use 2 tons/acre.
Clayey soils: 2 tons/acre.
(Do not apply lime to alkaline soils).

Grasses alone: Use 400 lbs/acre of 8-24-24 or the equivalent. Apply 30 lbs of additional nitrogen when grass has emerged and begun growth (approximately 0.8lbs/1000 ft^2).
Grass-legume mixtures: Use 800 to 1200 lbs/acre of 5-10-10 or the equivalent.
Legumes Alone: Use 400 to 600 lbs/acre of 0-20-20 or the equivalent.

Note: Fertilizer can be blended to meet exact fertilizer recommendations. Take soil test recommendations to local fertilizer dealer for bulk fertilizer blends. This may be more economical than bagged fertilizer.

Application of Soil Amendments

Apply lime and fertilizer evenly and incorporate into the top 6” of soil by disking, chiseling or other suitable means during seedbed preparation. Operate machinery on the contour. On sites too steep for seedbed preparation, fertilizer and lime can be applied with a hydroseeder.

Seedbed Preparation

If needed, grade and shape to provide a surface on which equipment can safely and efficiently be used for seedbed preparation and seeding.

Install necessary sediment control practices before seedbed preparation and complete grading according to the approved plan.

Prepare a friable seedbed with tillage to a depth of at least 6”. Break up large clods, alleviate compaction, and smooth and firm the soil into a uniform surface. Fill in or level depressions that can collect water.

Planting Methods

Seeding

Use certified seed for permanent seeding whenever possible. Certified seed is inspected by the Alabama Crop Improvement Association to meet high quality standards and will be tagged with a “Certified Seed” tag. (Note: all seed sold in

Alabama is required by law to be tagged to identify seed purity, germination, and presence of weed seeds. Seed must meet state standards for content of noxious weeds.)

Seeding dates are determined using Figure PS-1 and Table PS-1.

Inoculate legume seed with the Rhizobium bacteria appropriate to the species of legume. Details of legume inoculation are located in Chapter 2 in the part on Vegetation for Erosion and Sediment Control under Inoculation of Legumes.

Plant seed uniformly with a cyclone seeder, a drill seeder, a cultipacker seeder, or by hand on a fresh, firm, friable seedbed. If the seedbed has been sealed by rainfall, it should be disked so the seed will be sown into a freshly prepared seedbed.

When using broadcast-seeding methods, subdivide the area into workable sections and determine the amount of seed needed for each section. Apply one-half the seed while moving back and forth across the area, making a uniform pattern; then apply the second half in the same way, but moving at right angles to the first pass.

Cover broadcast seed by raking or chain dragging; then firm the surface with a roller or cultipacker to provide good seed contact. Small grains should be planted no more than 1" deep and grasses and legume seed no more than ½" deep.

Hydroseeding

Surface roughening is particularly important when hydroseeding, as a roughened slope will provide some natural coverage for lime, fertilizer, and seed. The surface should not be compacted or smooth. Fine seedbed preparation is not necessary for hydroseeding operations; large clods, stones, and irregularities provide cavities in which seeds can lodge.

Mix seed, inoculant if required, and a seed carrier with water and apply as a slurry uniformly over the area to be treated. The seed carrier should be a cellulose fiber, natural wood fiber or other approved fiber mulch material which is dyed an appropriate color to facilitate uniform application of seed. Use the correct legume inoculant at 4 times the recommended rate when adding inoculant to a hydroseeder slurry. The mixture should be applied within one hour after mixing to reduce damage to seed.

Fertilizer should not be mixed with the seed-inoculant mixture because fertilizer salts may damage seed and reduce germination and seedling vigor.

Fertilizer may be applied with a hydroseeder as a separate operation after seedlings are established.

Lime is not normally applied with a hydraulic seeder because it is abrasive but if necessary it can be added to the seed slurry and applied at seeding or it may be applied with the fertilizer mixture. Also, lime can be blown onto steeper slopes in dry form.

Sprigging

Hybrid bermudagrass cannot be grown from seed and must be planted vegetatively. Vegetative methods of establishing common and hybrid bermudagrass, centipedegrass and zoysia include sodding, plugging and sprigging (see Sodding practice).

When sprigs are planted with a sprigging machine, furrows should be 4-6" deep and 2 feet apart. Place sprigs no farther than 2 feet apart in the row and so that at least one rooting node is in the furrow.

When broadcasting is used for sprig planting, broadcast sprigs at the specified rate (Table PS-1). Press into the top ½" to 2" of soil with a cultipacker or with a disk set nearly straight so that the sprigs are not brought back to the surface. A mulch tacking machine may be used to press sprigs into the soil.

Mulching

The use of mulch provides instant cover and helps ensure establishment of vegetation under normal conditions and is essential to seeding success under harsh site conditions (see Mulching practice). Harsh site conditions include: slopes steeper than 3:1 and adverse soils (shallow, rocky, or high in clay or sand). Areas with concentrated flow should be treated differently and require sod, a hydromulch formulated for channels or an appropriate erosion control blanket.

Irrigation

Moisture is essential for seed germination and vegetation establishment. Supplemental irrigation can be very helpful in assuring adequate stands in dry seasons or to speed development of full cover. It is a requirement for establishment of vegetation from sod and sprigs and should be used elsewhere when feasible. However, irrigation is rarely critical for low-maintenance vegetation planted at the appropriate time of the year.

Water application rates must be carefully controlled to prevent runoff. Inadequate or excessive amounts of water can be more harmful than no supplemental water.

Maintenance

Generally, a stand of vegetation cannot be determined to be fully established until soil cover has been maintained for 1 full year from planting. Inspect vegetated areas for failure and make necessary repairs and vegetate as soon as possible.

If a stand has inadequate cover, reevaluate choice of plant materials and quantities of lime and fertilizer. Re-establish the stand after seedbed preparation or over-seed the stand. Consider a temporary seeding if the time of year is not appropriate for establishment of permanent vegetation (see Temporary Seeding practice).

If vegetation fails to grow, a soil test should be made to determine if soil acidity or nutrient imbalance is responsible.

To attain complete establishment, fertilization is usually required in the second growing season. Turf grasses require annual maintenance fertilization. Use soil tests if possible or follow the guidelines given for the specific seeding mixtures.

Protect vegetation during its establishing period from traffic that will be harmful. If appropriate, use either temporary fences or barriers to protect areas that may be damaged by excessive traffic.

Preservation of Vegetation (PV)

Practice Description

Preservation of vegetation is the avoidance of an area during land disturbing and construction activity to prevent mechanical and other injury to desirable plants in the planned landscape. The practice provides erosion and sediment control and is applicable where vegetative cover is desired and the existing plant community is compatible with the planned landscape.

Planning Considerations

Preservation of vegetation requires good site management to minimize the impact of construction activities on existing vegetation.

Plants to save should be identified prior to any construction activity.

Proper maintenance, especially during construction, is important to ensure healthy vegetation that can control erosion.

Different species, soil types, and climatic conditions will require different maintenance activities.

Design Criteria

Mark Plant Area for Retention

Groups of plants and individual trees to be retained should be located on a plan map. Limits of clearing should be planned outside the drip line of groups or individual trees to be saved. The clearing should never be closer than 5 feet to the trunk of a tree.

Flagging or other appropriate means of marking the site of the groups of plants and individual trees to be retained should be required before construction begins Individual trees to be retained should be marked with a highly visible paint or surveyor's ribbon in a band circling the tree at a height visible to equipment operators.

Plant Protection

Restrict construction equipment, vehicular traffic, stockpiles of construction materials, topsoil etc., from the areas where plants are retained and restrict these activities from occurring within the drip line of any tree to be retained. Trees being removed shall not be pushed into trees to be retained. Equipment operators shall not clean any of their equipment by slamming it against trees to be retained.

Restrict burning of debris within 100 feet of the plants being preserved. Fires shall be limited in size to prevent damage to any nearby trees.

Toxic material shall not be stored any closer than 100 feet to the drip line of any trees to be retained. Toxic materials shall be managed and disposed of according to state laws.

Fencing and Armoring

Groups of plants and trees should be protected by fencing or armoring where necessary (See Figure PV-l). The following types of fencing or armoring may be used:

- Board Fence-Board fence may be constructed with 4" square posts set securely in the ground and protruding at least 4 feet above the ground. A minimum of 2 horizontal boards should be placed between the posts. The fence should be placed at the limits of the clearing around the drip line of the tree. If it is not practical to erect a fence at the drip line, construct a triangular fence near the trunk. The limits of clearing will still be the drip line as the root zone within the drip line will still require protection.

- Cord Fence-Posts at least 2" square or 2" in diameter set securely in the ground and protruding at least 4 feet above the ground shall be placed at the limits of clearing with 2 rows of cord ¼" or thicker at least 2 feet apart running between posts with strips of surveyor's tape tied securely to the string at intervals of 3 feet or less.

- Earth Berms-Temporary earth berms may be constructed. The base of the berm on the tree side should be located along the limits of clearing. Earth berms may not be used for this purpose if their presence will create drainage patterns that cause erosion.

- Additional Trees-Additional trees may be left standing as protection between the trees to be retained and the limits of clearing. However, for this alternative to be used, trees in the buffer must be no more than 6 feet apart to prevent passage of equipment and material through the buffer.

- Plan for these additional trees to be evaluated prior to the completion of construction and either given sufficient treatment to ensure survival or be removed.

- Trunk Armoring-As a last resort, a tree may be armored with burlap wrapping and 2” studs wired vertically no more than 2” apart to a height of 5 feet. The armoring should encircle the tree trunk. Nothing should ever be nailed to a tree. The root zone within the drip line will still require protection.

- Fencing and armoring devices should be in place before any construction work is done and should be kept in good condition for the duration of construction activities. Fencing and armoring should not be removed until the completion of the construction project.

Raising the Grade

When the ground level must be raised around an existing tree or group of trees several methods may be used to insure survival.

A well may be created around a group of trees or an individual tree slightly beyond the drip line to retain the natural soil around the feeder roots (see Figure PV-2). When the well alternative is not practical or desirable, remove vegetation and organic matter from beneath the tree or trees for 3 feet beyond the drip line and loosen the surface soil to a depth of approximately 3” without damaging the roots.

Apply fertilizer in the root area of the tree to be retained. A soil test is the best way to determine what type of fertilizer to use. In the absence of a soil test, fertilizer should be applied at the rate of 1 to 2 pounds of 10-8-6 or 10-6-4 per inch of diameter at breast height (dbh) for trees under 6” dbh and at the rate of 2 to 4 pounds of 10-8-6 or 10-6-4 per inch of dbh for trees over 6” dbh.

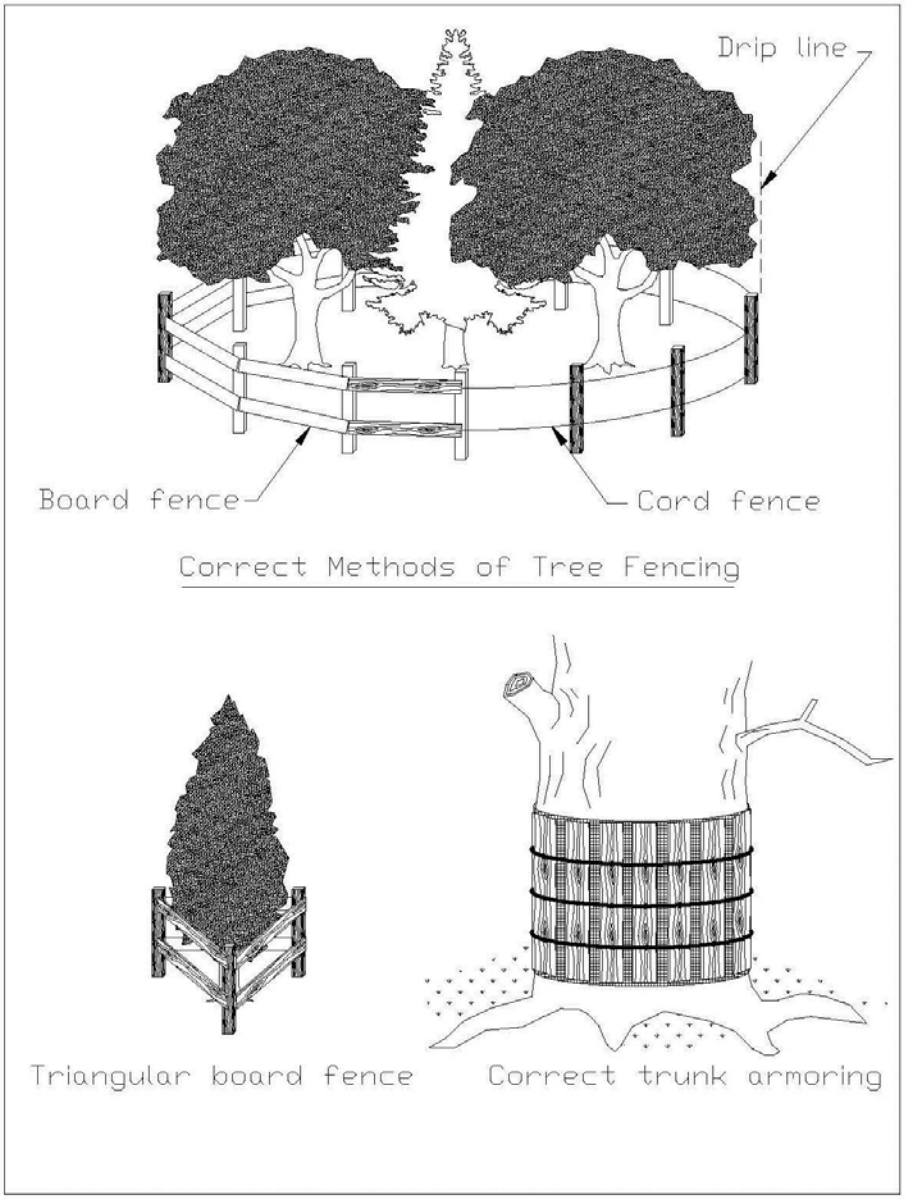


Figure PV-1 Fencing and Armoring

A dry well shall be constructed to allow for tree trunk diameter growth (see Figure PV-3). A space of at least 1 foot between the tree trunk and the well wall is adequate for old, slow growing trees. Clearance for younger trees shall be at least 2 feet. The well shall be high enough to bring the top just above the level of the proposed fill. The well wall shall taper slightly away from the tree trunk at a rate of 1” per foot of wall height.

The well wall shall be constructed of large stones, brick, building tile, concrete blocks, or cinder blocks. Openings should be left through the wall of the well to allow for free movement of air and water. Mortar shall only be used near the top of the well and only above the porous fill.

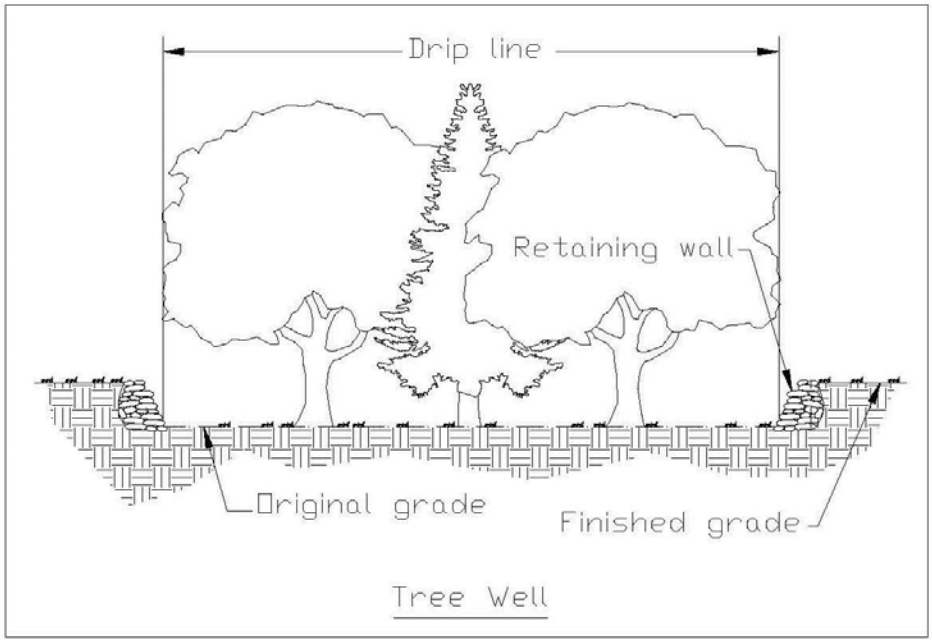


Figure PV-2 Tree Well

Drain lines composed of 4" high quality drain tiles shall begin at the lowest point inside the well and extend outward from the tree trunk in a wheel and spoke pattern with the trunk as the hub. Radial drain lines shall slope away from the well at a rate of ⅛" per foot. The circumference line of tiles should be located beneath the drip line of the trees. Vertical tiles or pipes shall be placed over the intersections of the two tile systems if a fill of more than 2 feet is contemplated. Vertical tiles shall be held in place with stone fill. Tile joints shall be tight. A few radial tiles shall extend beyond each intersection and shall slope sharply downward to insure good drainage. Tar paper or its approved equivalent shall be placed over the tile and/or pipe joints to prevent clogging and large stone shall be placed around and over drain tiles and/or pipes for protection.

A layer of 2" to 6" of stone shall be placed over the entire area under the tree from the well outward at least as far as the drip line. For fills up to 2 feet deep, a layer of stone 8" to 12" thick should be adequate.

A thick layer of this stone not to exceed 30" will be needed for deeper fills. A layer of ¾" to 1" stone covered by straw, fiberglass mat or a manufactured filter fabric shall be used to prevent soil from clogging the space between stones. Cinders shall not be used as fill material. Filling shall be completed with porous soil such as topsoil until the desired grade is reached. This soil shall be suitable to sustain specified vegetation.

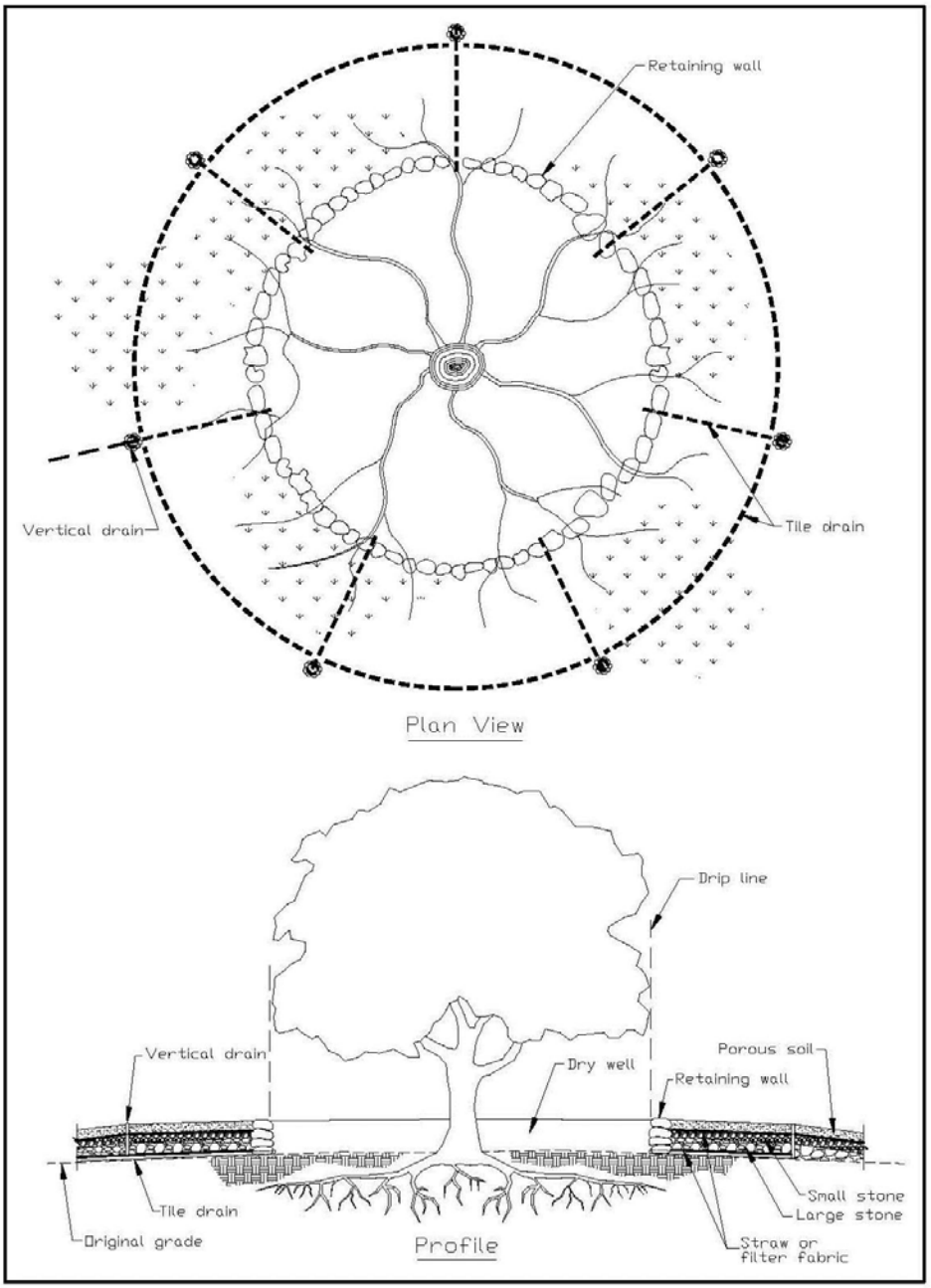


Figure PV-3 Tree Well Detail

Crushed stone shall be placed inside the dry well over the openings of the radial tiles to prevent clogging. The area between the trunk and the well wall shall either be covered by an iron grate or filled with a 50-50 mixture of crushed charcoal and sand to prevent anyone from falling into the dry well.

Where water drainage through the soil is not a problem, coarse gravel in the fill may be substituted for the tile. This material has sufficient porosity to ensure air drainage. Instead of the vertical tiles or pipes in the system, stones, crushed rock and gravel may be added so that the upper level of these porous materials slants toward the surface in the vicinity below the drip line.

Raising the grade on only one side of a tree or group of trees may be accomplished by constructing only half of one of these systems.

Lowering the Grade

Shrubs and trees shall be protected from the harmful grade cuts by the construction of a tree wall (see Figure PV-4). Following excavation, all tree roots that are exposed and/or damaged shall be trimmed cleanly and covered with moist peat moss, burlap or other suitable material to keep them from drying out.

The wall shall be constructed of large stones, brick, building tile, concrete block or cinder block. The wall should be backfilled with topsoil, peat moss, or other organic matter to retain moisture and aid in root development. Apply fertilizer and water thoroughly. The tree plants should be pruned to reduce the leaf surface in proportion to the amount of root loss. Drainage should be provided through the wall so water will not accumulate behind the wall. Lowering the grade on one side of the tree or group of trees can be accomplished by constructing only half of this system.

Trenching and Tunneling

Trenching should be done as far away from the trunks of trees as possible, preferably outside the branches or crown spreads of trees, to reduce the amount of root area damaged or killed by trenching activities. When possible, trenches should avoid large roots or root concentrations. This can be accomplished by curving the trench or by tunneling under large roots and areas of heavy root concentration. Tunneling under a species that does not have a large tap root may be preferable to trenching beside it as it has less impact on root systems (see Figure PV-5).

Roots should not be left exposed to the air but should be covered with soil as soon as possible or protected and kept moist with burlap or peat moss until the trench or tunnel can be filled. The ends of damaged and cut roots shall be cut off smoothly and moist peat moss, burlap or topsoil should be placed over the exposed area.

Trenches and tunnels shall be filled as soon as possible. Care should be taken to ensure that air spaces are not left in the soil. Peat moss or other organic matter shall be added to the fill material as an aid to inducing and developing root growth. The tree should be fertilized and mulched to stimulate new root growth and enhance general tree vigor. If a large part of the root system has been damaged the crown leaf surface area should be reduced in proportion to the root damage. This may be accomplished by pruning 20-30 percent of the crown foliage. If the roots are damaged during the winter the crown should be pruned before the next growing season. If roots are cut during the growing season, pruning should be done immediately.

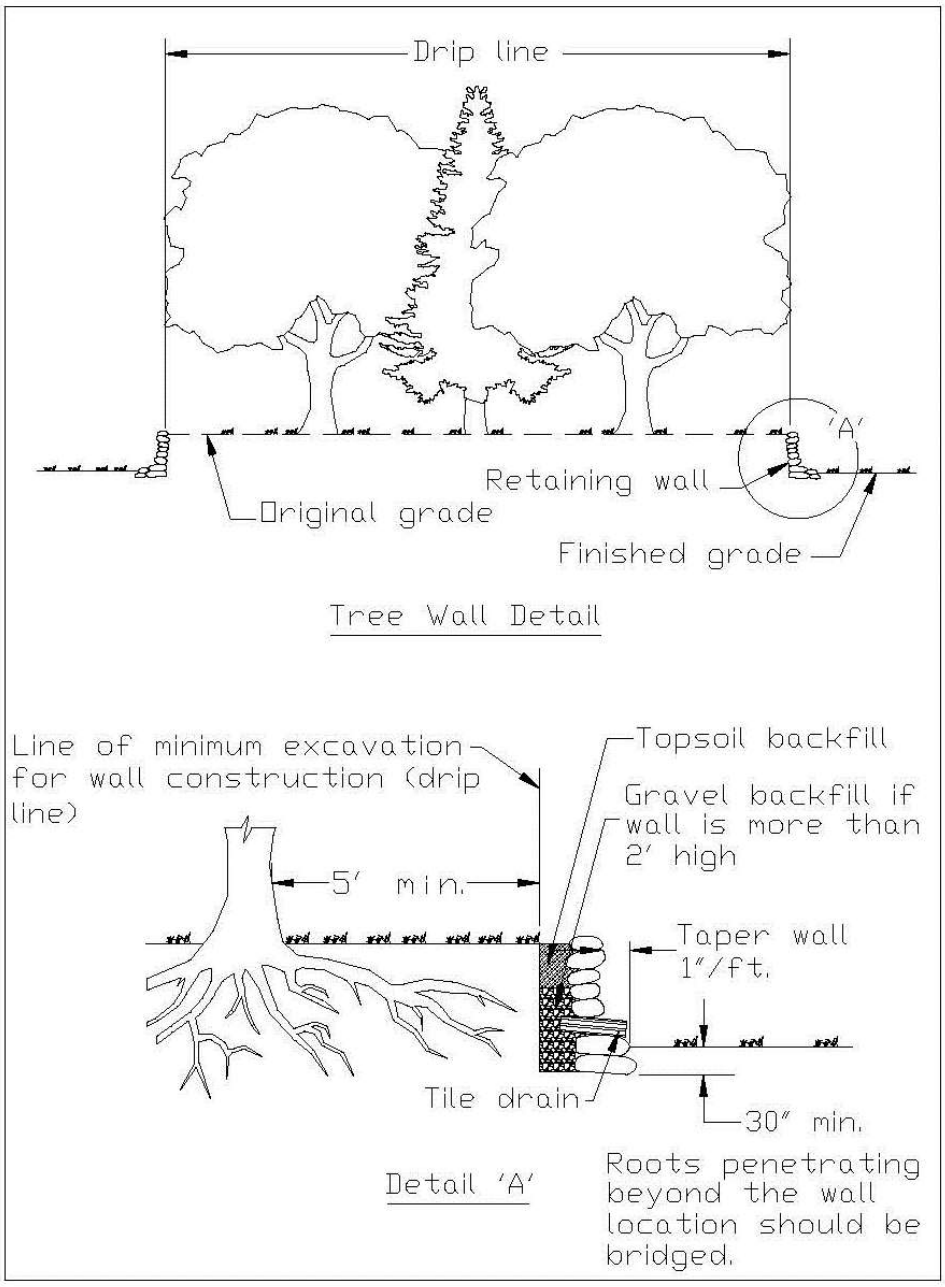


Figure PV-4 Tree Wall Detail

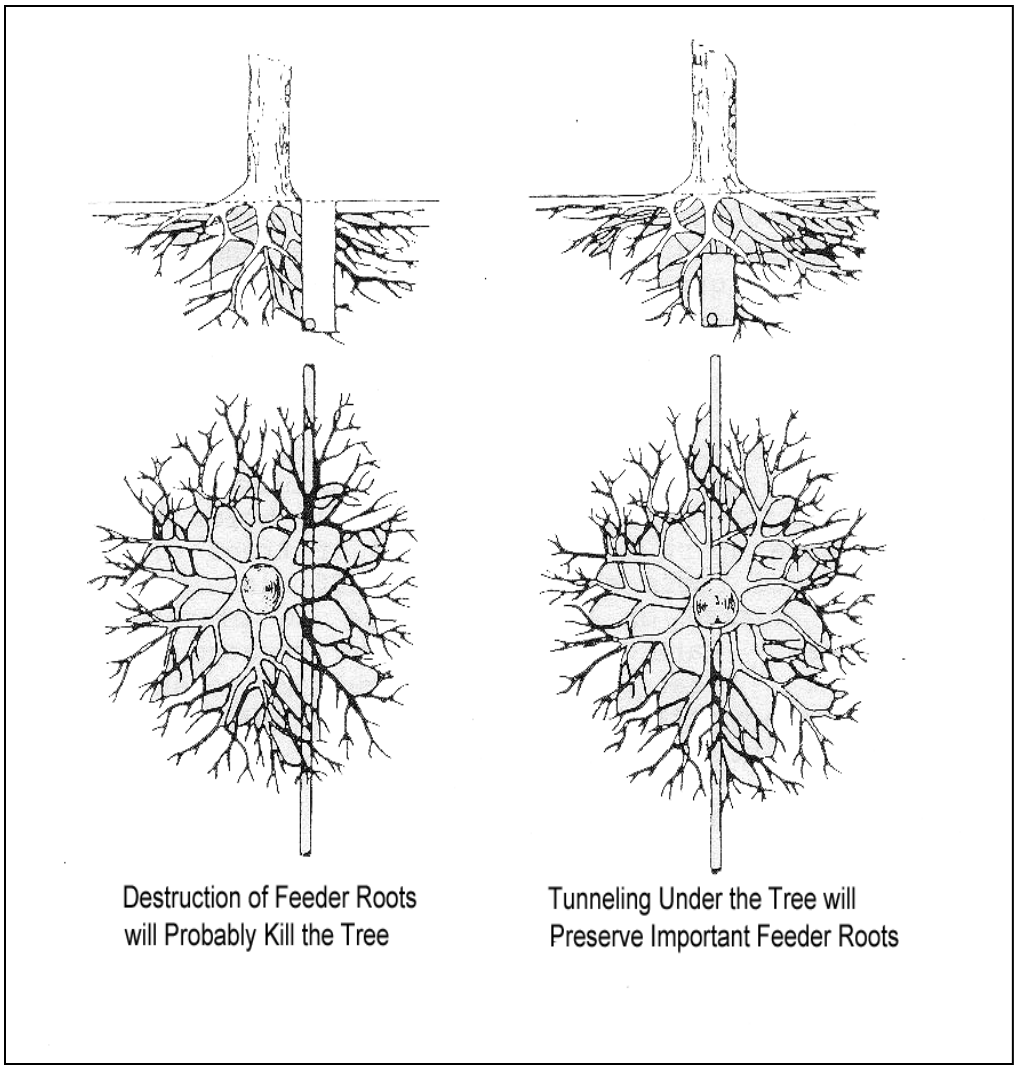


Figure PV-5 Trenching vs Tunneling

Treating Damaged Trees

When trees are damaged during construction activities certain maintenance practices can be applied to protect the health of the tree.

Soil aeration may be needed if the soil has been compacted. The soil around trees can be aerated by punching holes 1 foot deep and 18" apart under the crown of trees with an iron pipe.

Damaged roots should be cut off cleanly and moist peat moss, burlap or topsoil should be placed over the exposed area. Bark damage should be treated by removing loose bark.

Tree limbs damaged during construction or removed for any other reason shall be cut off above the collar at the branch junction.

Trees that have been stressed or damaged should be fertilized to aid their recovery.

Trees should be fertilized in the spring or fall. Fall applications are preferred.

Fertilizer should be applied to the soil over the feeder roots. In no case should it be applied closer than 3 feet to the trunk. Root systems of trees extend some distance beyond the drip line. The area to be fertilized should be increased by ¼ the area of the crown. A soil test is the best way to determine what type of fertilizer to use. In the absence of a soil test, fertilizer should be applied at the rate of 1 to 2 pounds of 10-8-6 or 10-6-4 per inch of dbh for trees under 6” dbh and at the rate of 2 to 4 pounds of 10-8-6 or 10-6-4 per inch of dbh for trees over 6” dbh.

A ground cover or organic mulch layer should be maintained around trees to prevent erosion, protect roots and to conserve water.

Temporary Seeding (TS)

Practice Description

Temporary seeding is the establishment of fast-growing annual vegetation from seed on disturbed areas. Temporary vegetation provides economical erosion control for up to a year and reduces the amount of sediment moving off the site.

This practice applies where short-lived vegetation can be established before final grading or in a season not suitable for planting the desired permanent species. It helps prevent costly maintenance operations on other practices such as sediment basins and sediment barriers. In addition, it reduces problems of mud and dust production from bare soil surfaces during construction. Temporary or permanent seeding is necessary to protect earthen structures such as dikes, diversions, grass-lined channels and the banks and dams of sediment basins.

Planning Considerations

Temporary vegetative cover can provide significant short-term erosion and sediment reduction before establishing perennial vegetation.

Temporary vegetation will reduce the amount of maintenance associated with sediment basins.

Temporary vegetation is used to provide cover for no more than 1 year. Permanent vegetation should be established at the proper planting time for permanent vegetative cover.

Certain plants species used for temporary vegetation will produce large quantities of residue which can provide mulch for establishment of the permanent vegetation.

Proper seedbed preparation and selection of appropriate species are important with this practice. Failure to follow establishment guidelines and recommendations carefully may result in an inadequate or short-lived stand of vegetation that will not control erosion.

The selection of plants for temporary vegetation must be site specific. Factors that should be considered are type of soils, climate, establishment rate, and management requirements of the vegetation. Other factors that may be important are wear, mowing tolerance, and salt tolerance of vegetation.

Seeding properly carried out within the optimum dates has a higher probability of success. It is also possible to have satisfactory establishment when seeding outside these dates. However, as plantings are deviated from the optimum dates, the probability of failure increases rapidly. Seeding dates should be taken into account in scheduling land-disturbing activities.

Site quality impacts both short-term and long-term plant success. Sites that have compacted soils should be modified whenever practical to improve the potential for plant growth.

The operation of equipment is restricted on slopes steeper than 3:1, severely limiting the quality of the seedbed that can be prepared. Provisions for establishment of vegetation on steep slopes can be made during final grading. In construction of fill slopes, for example, the last 4-6” might not be compacted. A loose, rough seedbed with irregularities that hold seeds and fertilizer is essential for hydroseeding. Cut slopes should be roughened (see practice Land Grading).

Good mulching practices are critical to protect against erosion on steep slopes. When using straw, anchor with netting or asphalt. On slopes steeper than 2:1, either hydraulic mulch or erosion control blanket is more appropriate than straw to protect the slope.

The use of irrigation (temporary or permanent) will greatly improve the success of vegetation establishment.

Design Criteria

Plant Selection

Select plants that can be expected to meet planting objectives. To simplify plant selection, use Table TS-1, Commonly Used Plants for Temporary Cover and Figure TS-1, Geographical Areas for Species Adaptation and Seeding Dates. Seeding mixtures commonly specified by the Alabama Department of Transportation are an appropriate alternative for plantings on rights-of-ways. Additional information related to plantings in Alabama is found in Chapter 2 in the section Non-Woody Vegetation for Erosion and Sediment Control.

Figure TS-1 Geographical Areas for Species Adaptation and Seeding Dates

Note: Site conditions related to soils and aspect in counties adjacent to or close to county boundaries may justify adjustments in planting dates by qualified design professionals.

Table TS-l Commonly Used Plants for Temporary Cover

Species	Seeding Rate/AC PLS	North	Central	South
		Seeding Dates		
Millet, Browntop or German	40 lbs	Apr1-Aug 1	Apr1- Aug 15	Apr 1-Aug 15
Rye	3 bu	Sep I-Nov 15	Sep 15-Nov 15	Sep 15-Nov 15
Ryegrass	30 lbs	Aug l-Sep 15	Sep l-Oct 15	Sep 1-Oct 15
Sorghum-Sudan Hybrids	40 lbs	May l-Aug 1	Apr 15-Aug 1	Apr l-Aug 15
Sudangrass	40 lbs	May l-Aug I	Apr 15-Aug	Apr l-Aug 15
Wheat	3 bu	Sep I-Nov 1	Sep 15-Nov 15	Sep 15-Nov 15
Common Bermudagrass	10 lbs	Apr 1-July 1	Mar 15-July 15	Mar 1-July 15
Crimson Clover	10lbs	Sept 1-Nov 1	Sept 1-Nov 1	Sept 1-Nov 1

PLS means pure live seed and is used to adjust seeding rates. For example, to plant 10 lbs PLS of a species with germination of 80% and purity of 90%, PLS= 0.8X 0.9 = 72%. 10 lbs PLS = 10/0.72 = 13.9 lbs of the species to be planted.

Site Preparation and Soil Amendments

Complete grading and shaping before applying soil amendments if needed to provide a surface on which equipment can safely and efficiently be used to apply soil amendments and accomplish seedbed preparation and seeding.

Lime

Apply lime according to soil test recommendations. If a soil test is not available, use 1 ton of agricultural limestone or equivalent per acre on coarse textured soils and 2 tons per acre on fine textured soils. Do not apply lime to alkaline soils or to areas which have been limed during the preceding 2 years. Other liming materials that may be selected should be provided in amounts that provide equal value to the criteria listed for agricultural lime or be used in combination with agricultural limestone or Selma chalk to provide equivalent values to agricultural limestone.

Fertilizer

Apply fertilizer according to soil test results. If a soil test is not available, apply 8-24-24 fertilizer.

When vegetation has emerged to a stand and is growing, 30 to 40 lbs/acre (approximately 0.8 lbs/1000 ft^2) of additional nitrogen fertilizer should be applied.

Note: Fertilizer can be blended to meet exact fertilizer recommendations. Take soil test recommendations to local fertilizer dealer for bulk fertilizer blends. This may be more economical than bagged fertilizer.

Application of Soil Amendments

Incorporate lime and fertilizer into the top 6” of soil during seedbed preparation.

Seedbed Preparation

Good seedbed preparation is essential to successful plant establishment. A good seedbed is well pulverized, loose, and smooth. If soils become compacted during grading, loosen them to a depth of 6” to 8” using a ripper or chisel plow.

If rainfall has caused the surface to become sealed or crusted, loosen it just prior to seeding by disking, raking, harrowing, or other suitable methods. When hydroseeding methods are used, the surface should be left with a more irregular surface of clods.

Planting Methods

Seeding

Evenly apply seed using a cyclone seeder (broadcast), drill seeder, cultipacker seeder, or hydroseeder. Broadcast seeding and hydroseeding are appropriate for steep slopes where equipment cannot operate safely. Small grains should be planted no more than 1” deep, and grasses and legumes no more than ½” deep. Seed that are broadcast must be covered by raking or chain dragging, and then lightly firmed with a roller or cultipacker.

Hydroseeding

Surface roughening is particularly important when hydroseeding, as a roughened slope will provide some natural coverage for lime, fertilizer, and seed. The surface should not be compacted or smooth. Fine seedbed preparation is not necessary for hydroseeding operations; large clods, stones, and irregularities provide cavities in which seeds can lodge.

Mix seed, inoculant if required, and a seed carrier with water and apply as slurry uniformly over the area to be treated. The seed carrier should be a cellulose fiber, natural wood fiber or other approved fiber mulch material which is dyed an appropriate color to facilitate uniform application of seed. Use the correct legume inoculant at 4 times the recommended rate when adding inoculant to hydroseeder slurry. The mixture should be applied within one hour after mixing to reduce damage to seed.

Fertilizer should not be mixed with the seed-inoculant mixture because fertilizer salts may damage seed and reduce germination and seedling vigor. Fertilizer may be applied with a hydro seeder as a separate operation after seedlings are established.

Mulching

The use of appropriate mulch provides instant cover and helps ensure establishment of vegetative cover under normal conditions and is essential to seeding success

under harsh site conditions (see the Mulching practice for guidance). Harsh site conditions include the following: slopes steeper than 3:1 and adverse soils (soils that are shallow to rock, rocky, or high in clay or sand). Areas with concentrated flow should be treated differently and require a practice appropriate for channel flow. (refer to Chapter 5 Runoff Conveyance for guidance).

Check Dam (CD)

Practice Description

A check dam (also referred to as a “ditch check”) is a small barrier or dam constructed across a swale, drainage ditch or other area of concentrated flow for the purpose of reducing channel erosion. Channel erosion is reduced because check dams flatten the gradient of the flow channel and slow the velocity of channel flow. Check dams do not reduce turbidity of runoff. Check dams can be constructed of rock, wattles (sometimes referred to as tubes or rolls), sand bags, or other materials that may be acceptable to the design professional. Unless installed correctly, check dams will not capture a significant amount of sediment. When installed correctly, most check dams can capture the coarser grained material, which can be significant for sandy soils. Sediment capture increases as velocity in the channel decreases by creating impoundments with the check dams. This impoundment pool creates the flattening of the gradient, greatly reducing channel erosion.

This practice applies in small open channels and drainageways, including temporary and permanent swales. Check dams are not to be used in a live stream. Situations of use include areas in need of protection during establishment of grass and areas that cannot receive a temporary or permanent non-erodible lining for an extended period.

Planning Considerations

Check dams are used in concentrated flow areas to provide temporary channel stabilization with minimal sediment retention during rainfall runoff periods on construction sites. Check dams may be constructed of rock, wattles, sand bags, or other suitable material, including manufactured products. Water flowing over a check dam creates turbulent erosive forces (super critical flow) that must be addressed to prevent erosion downstream of the check dam. Inevitably water will likely flow under check dams due to limitation with ground contact. Therefore, it is of upmost importance to ensure the performance of the check dam that erosion and scour under the check dam be minimized. This is best achieved using an underlay such as an 8-oz. nonwoven filter fabric. If the underlay is extended downstream, it will also protect the channel from super critical flows from water flowing over and under the dam.

Check dams should be planned to be compatible with the other features such as streets, walkways, trails, sediment basins and rights-of-way or property lines. Check dams are installed with the center overflow area lower in elevation than the ends to ensure flow goes over the check dam and not around. Check dams are normally constructed in series and the dams should be located at a normal interval from other grade controls such as culverts or sediment basins.

Check dams are generally used as a temporary BMP that is removed following construction to allow for final long-term stabilization of the channel. Provisions should be made to establish permanent channel linings as early as possible.

Check dams can also be used for other purposes such as the capture of sediment upstream of other practices or flocculent dosing upstream of a sediment basin.

Extensive research has been conducted by The Auburn University Erosion and Sediment Control Test Facility. The research recommendations are incorporated in the following planning considerations:

Rock Check Dams

Many check dams are constructed of rock. Rock may not be acceptable in some installations and alternative types of check dams need to be considered. Rock check dams (Figures CD-1 and CD-2) are usually installed with mechanical equipment but hand labor is likely needed to complete most installations to the quality needed. The availability and cost of commercially produced rock should be considered. The use of rock should be considered carefully in areas to be mowed. Some rock may be washed downstream and should be removed before each mowing operation. The use of geotextile can be used on the upstream face of the rock check dam to increase the sediment trapping efficiency of the rock check dam. Measures must be taken to prevent undermining of the check dam and erosion below the check dam. A non-woven geotextile underlayment should be used to prevent this from happening. The geotextile meeting AASHTO M 288 requirement for separation Class II (minimum 8-oz. fabric) should extend approximately 3 ft. upstream and downstream, and pinned securely with the upstream edge buried.

Measures to prevent downstream erosion associated with a rock check dam include placing larger rock on the downstream face of a rock dam, and providing erosion protection material just downstream of the dam.

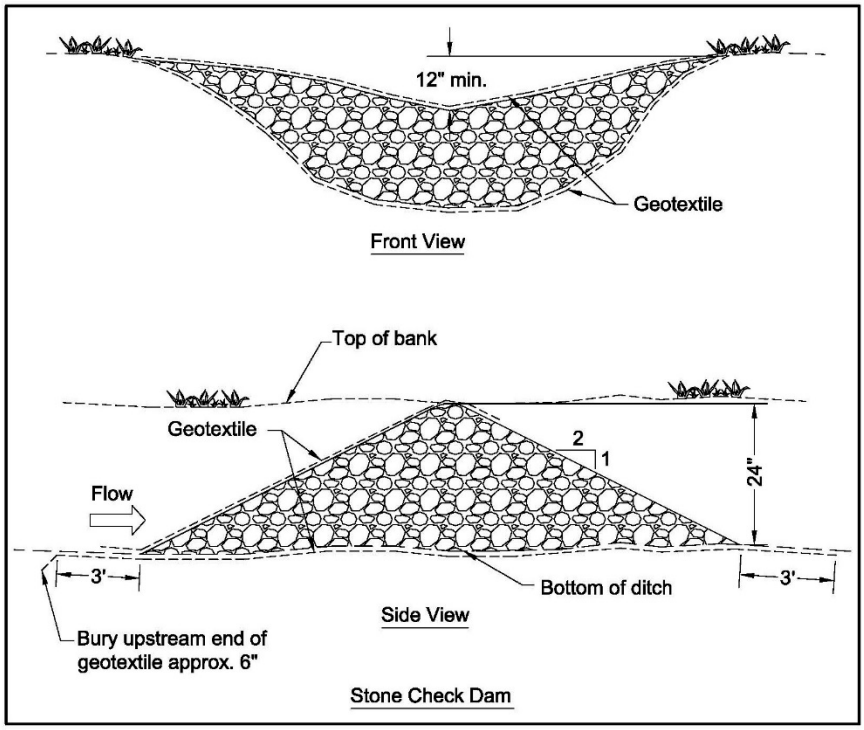


Figure CD-1 Profile and Cross-Section of Typical Rock Check Dams

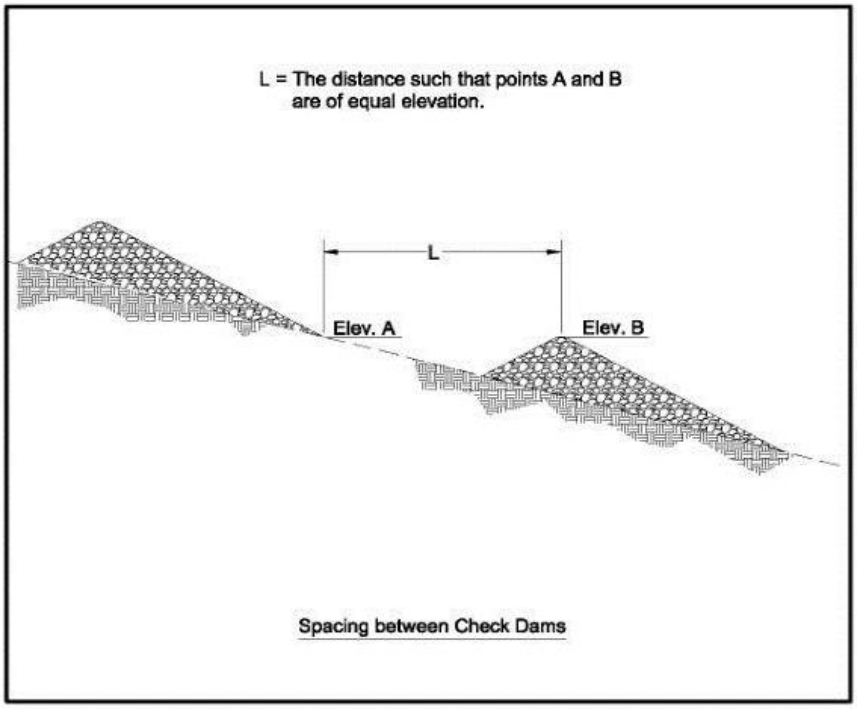


Figure CD-2 Profile of Typical Rock Check Dams

Wattle Check Dams

Wattles have been found to be best installed without trenching and on top of stapled geotextile underlayment that extends a minimum 3 ft. up and downstream from the wattle. Wattles must be properly stapled with sod staples on 10-inch centers on each side of the wattle to prevent flotation, and staked over the top using non-destructive tee-pee type staking. Wattles that provide less “flow through” create more ponding of water that increases the trapping of sediment (see Figures CD-3 and CD-4).

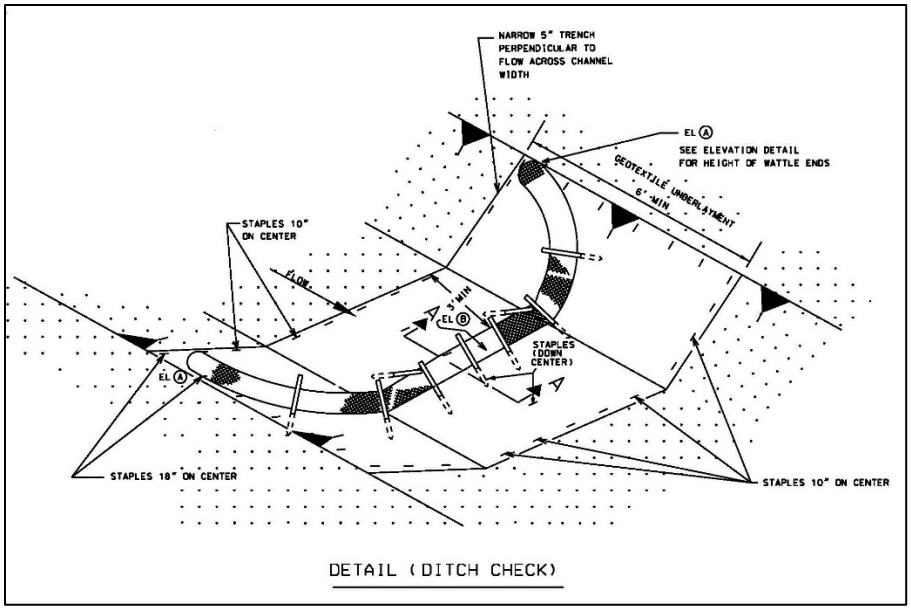


Figure CD-3 Wattle Check Dam (ditch check)

Figure CD-4 Wattle Check Dam (ditch check)
(Photo courtesy of Auburn University Erosion and Sediment Control Test Facility)

Silt Fence Check Dam

When properly designed and installed, typical silt fence materials can be utilized to construct a check dam. Geotextile underlayment should be used and the fence notched as needed to ensure the maximum depth of flow is no greater than the depth of the channel. Figures CD-5 and CD-6 show the recommended details.

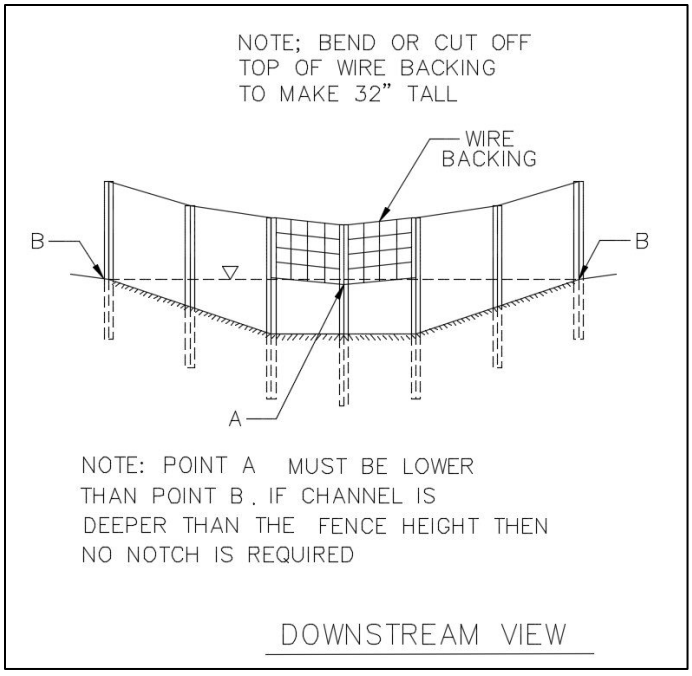


Figure CD-5 Silt Fence Check Dam Cross-Section

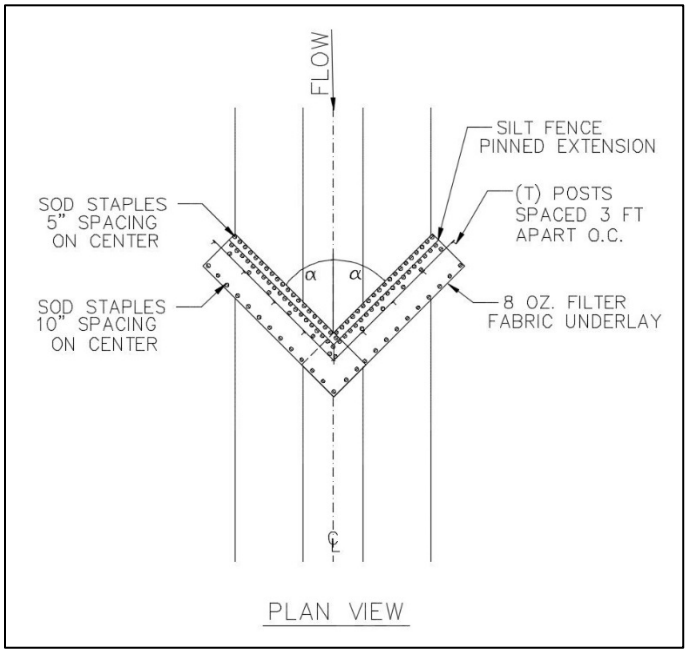


Figure CD-6 Silt Fence Check Dam Plan View

Figure CD-7 Silt Fence Check Dam
(Photo courtesy of Auburn University Erosion and Sediment Control Test Facility)

Sand Bag Check Dam

Sand bags have also been proven to be effective as check dams but only when the bags are properly oriented (See Figures CD-8 and CD-9). A geotextile underlayment that extends approximately 3 ft. upstream and downstream should also be used in earth channel situations to prevent undermining and scour.

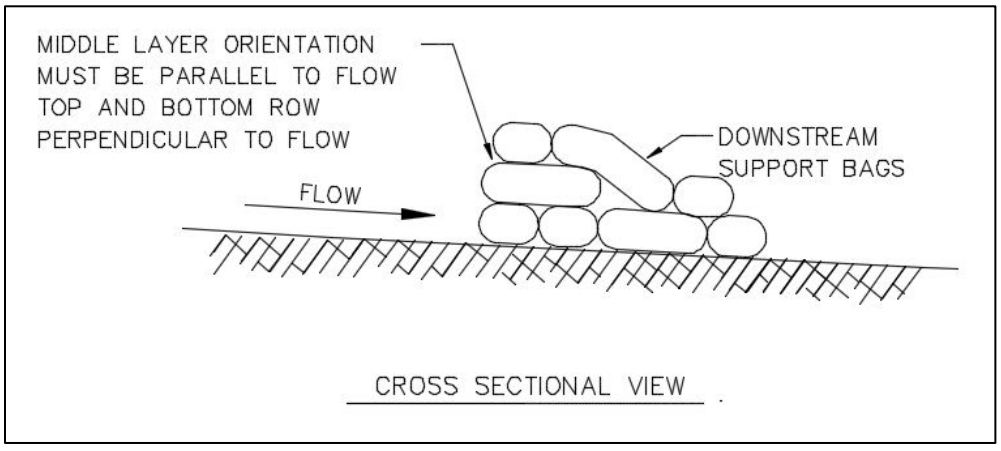


Figure CD-8 Sand Bag Check Dam Cross-Section

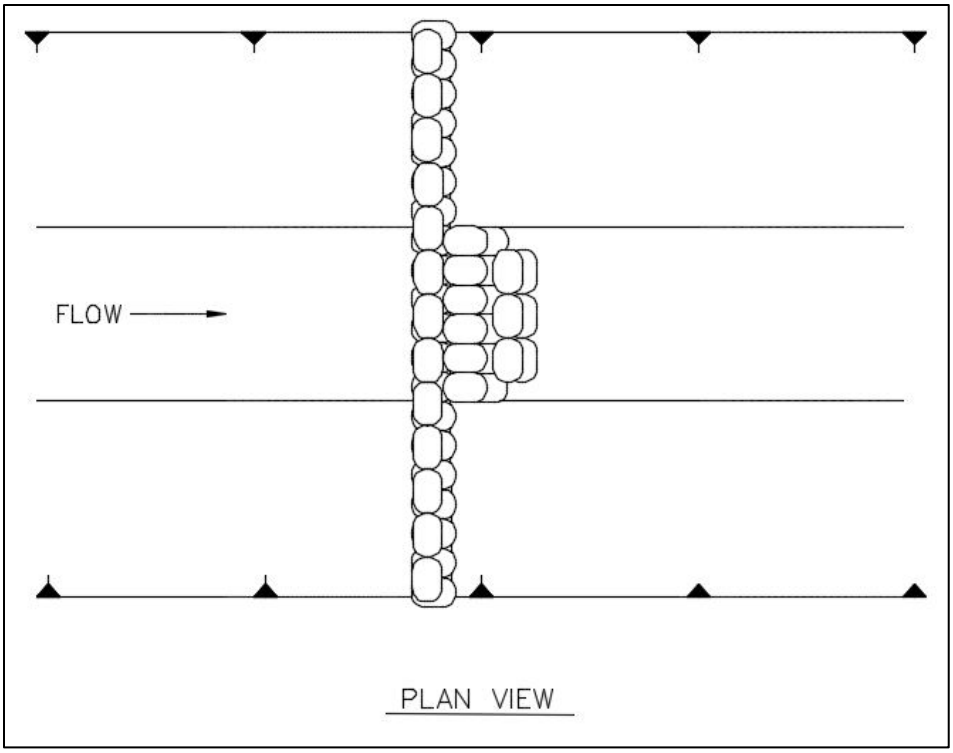


Figure CD-9 Sand Bag Check Dam Plan View

Design Criteria

Formal design is not required. The following factors should be considered when designing check dams.

Drainage Area

Generally, one acre or less.

Maximum Height

Check dam height is a function of channel geometry. Most check dams are 3 feet or less in height.

Depth of Flow

Depth of flow over a check dam is a function of the cross-section and porosity of the check dam. Generally, flows over a check dam are less than 1 foot.

The center of the dam should be constructed lower than the ends. The elevation of the center of the dam should be lower than the ends by the depth of design flow.

Side Slopes

2:1 or flatter (rock check dam).

Spacing

The elevation of the toe of the upstream dam should be at or below the elevation of crest of the downstream dam (Figure CD-2).

For example, if the channel is 3% grade, and the check dam height is 2 feet, The check dam spacing should be 67 feet:

Spacing (ft) = dam height (ft) / channel grade

Spacing = 2 ft / 0.03 = 67 feet

Geotextile

Generally, the non-woven geotextile should meet the requirements found in AASHTO M 288 Class II used for separation.

Diversion (DV)

Practice Description

A diversion is a watercourse constructed across a slope consisting of an excavated channel, a compacted ridge or a combination of both. Most diversions are constructed by excavating a channel and using the excavated material to construct a ridge on the downslope side of the channel. Right-of-way diversions and temporary diversions are sometimes constructed by making a ridge, often called a berm, from fill material.

This practice applies to sites where stormwater runoff can be redirected to permanently protect structures or areas downslope from erosion, sediment, and excessive wetness or localized flooding. Diversions may be used to temporarily divert stormwater runoff to protect disturbed areas and slopes or to retain sediment on-site during construction.

Perimeter protection is sometimes used to describe both permanent and temporary diversions used at either the upslope or downslope side of a construction area.

Right-of-way diversions, sometimes referred to as water bars, are used to shorten the flow length on a sloping right-of-way and reduce the erosion potential of the stormwater runoff.

Planning Considerations

Diversions are designed to intercept and carry excess water to a stable outlet.

Diversions can be useful tools for managing surface water flows and preventing soil erosion. On moderately sloping areas, they may be placed at intervals to trap and divert sheet flow before it has a chance to concentrate and cause rill and gully erosion.

Diversions may be placed at the top of cut or fill slopes to keep runoff from upgradient drainage areas off the slope. The following picture illustrates the placement of a diversion near the top of the slope. Diversions are sometimes built at the base of steeper slopes to protect flatter developed areas which cannot withstand runoff water from outside areas. Also, they can be used to protect structures, parking lots, adjacent properties, and other special areas from flooding.

Figure DV-1 Diversion near the top of a slope

Diversions are preferable to other types of man-made stormwater conveyance systems because they more closely simulate natural flow patterns and characteristics. Flow velocities are generally kept to a minimum. When properly coordinated into the landscape design of a site, diversions can he visually pleasing as well as functional.

As with any earthen structure, it is very important to establish adequate vegetation as soon as possible after installation. It is usually important to stabilize the drainage area above the diversion so that sediment will not enter and accumulate in the diversion channel.

Design Criteria

Location

Diversion location should be determined by considering outlet conditions, topography, land use, soil type, length of slope, seepage (where seepage is a problem) and the development layout. Outlets must be stable after the diversion empties stormwater flow into it; therefore, care should be exercised in selecting the location of the diversion and its outlet.

Capacity

The diversion channel must have a minimum capacity to carry the runoff expected from a storm frequency meeting the requirements of Table DV-l with a freeboard of at least 0.3 foot (Figure DV-1).

The storm frequency should be used to determine the required channel capacity, Q (peak rate of runoff). The peak rate of runoff should be determined using the Natural Resources Conservation Service runoff curve no. (RCN) method or other equivalent methods.

Table DV-1 Design Frequency

Diversion Type	Typical Area of Protection	24-Hour Design Storm Frequency
Temporary	Construction Areas	2-year
	Building Sites	5-year
Permanent	Agricultural Land	10-year
	Mined Reclamation Area	10-year
	Recreation Areas	10-year
	Isolated Buildings	25-year
	Urban areas, Residential, School, Industrial Areas, etc.	50-year

Diversions designed to protect homes, schools, industrial buildings, roads, parking lots, and comparable high-risk areas, and those designed to function in connection with other structures, should have sufficient capacity to carry peak runoff expected from a storm frequency consistent with the hazard involved.

Velocities

Diversions should be designed so that the design velocities will be safe for the planned type of protective vegetation and the expected maintenance. Maximum permissible velocities are dependent upon the erosion resistance of the soil (Table DV-2) and the quality of the vegetation maintained.

Table DV-2 Permissible Velocities

Soil Texture	Velocity in Feet/Second		
	Conditions of Vegetation		
	Poor	Fair	Good
Sand, Silt, Sandy Loam, Silt Loam	1.5	2.0	3.0
Silty Clay Loam, Sandy Clay Loam	2.5	3.0	4.0
Clay	3.0	4.0	5.0

Channel Design

The diversion channel may be parabolic, trapezoidal or v-shaped as shown in Figure DV-2 and should be designed in accordance with the procedure provided in the Diversion Design section. Land slope must be considered when choosing channel dimensions. On steeper slopes, narrow and deep channels may be required. On more gentle slopes, broad, shallow channels can be used to facilitate maintenance.

Ridge Design

The supporting ridge cross section should meet the configuration and requirements of Figure DV-2.

The side slopes should be no steeper than 2:1. Side slopes should be flatter, 5:1 to 10:1, when the diversion is to be permanent with mowing and other maintenance activities performed on or around it.

The width of the ridge at the design water elevation should be a minimum of 4 feet.

The minimum freeboard should be 0.3 foot.

The design should include a 10% settlement factor.

Outlet

Diversions should have adequate outlets which will convey concentrated runoff without erosion. Acceptable outlets include practices such as Grassed Swale, Lined Swale, Drop Structure, Sediment Basin, and Stormwater Detention Basins.

Stabilization

Unless otherwise stabilized, the ridge and channel should be seeded within 13 days of installation in accordance with the applicable seeding practice, Permanent Seeding or Temporary Seeding.

Disturbed areas draining into the diversion should be seeded and mulched prior to or at the time the diversion is constructed in accordance with the Permanent Seeding or Temporary Seeding (whichever is applicable) practices.

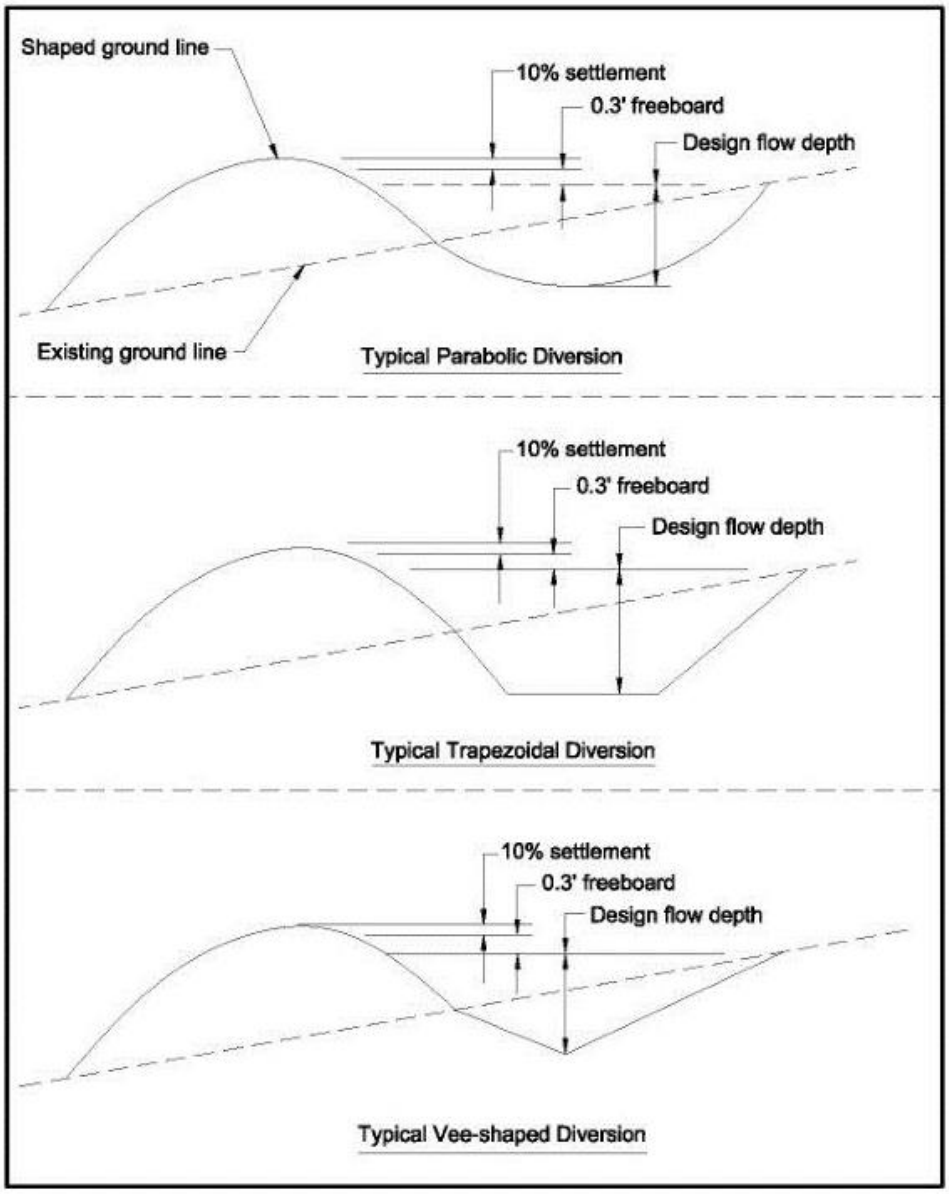


Figure DV-2 Typical Diversions Detail

Diversion Design

Note: This design example uses the Permissible Velocity approach. Diversion design using the Tractive Stress approach can also be used but is not discussed in this document.

Table DV-l through DV-16 may be used to facilitate the design of grass-lined diversions with parabolic cross sections. These tables are based on a retardance of "D" (vegetation newly cut) to determine V1 for stability considerations. To determine channel capacity, choose a retardance of "C" when proper maintenance is expected; otherwise, design channel capacity based on retardance "B". Refer to Table DV-2 for maximum permissible velocities. The permissible velocities guide the selection of V1 and should not be exceeded. It is good practice to use a value for V1 that is significantly less than the maximum allowable when choosing a design cross section. When velocities approach the maximum allowable, flatter grades should be evaluated or a more erosion resistant liner such as erosion control blanket or riprap should be considered. After the diversion dimensions are selected in the design tables, the top width should be increased by 4 feet. and the depth by 0.3 foot. for freeboard.

Example Problem

Given

Q: 30 cfs
Grade: 1%
Soil: Sandy clay loam
Condition of vegetation expected: fair
Maintenance: low; will be cut only twice a year.
Site will allow a top width of 26 feet.

Find

Diversion top width and depth that will be stable and fit site conditions.

Solution

From Table DV-2 use maximum permissible velocity of 3.0 ft./sec.

Since maintenance will be low use "B" retardance for capacity.

From Table DV-4 use retardance "D" and "B";
Grade 1.00 Percent. Top width = 21.0 feet + 4 feet = 25.0 feet.

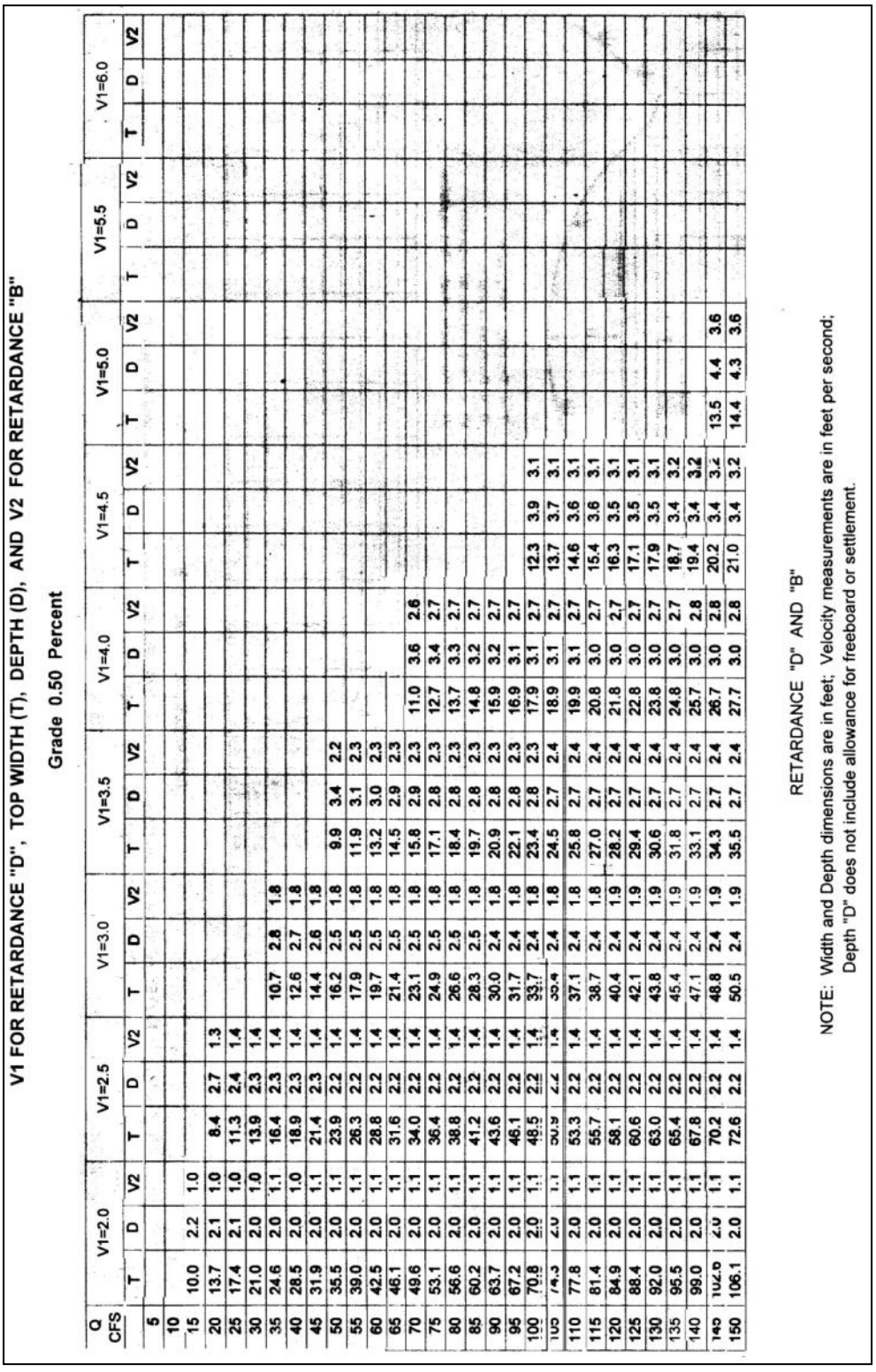
Depth = 1.6 feet + 0.3 foot = 1.9 feet.

V_2 = 1.3 ft./sec.

Note: V_1 < 3.0 ft./sec.; Top width < 26 feet, design O.K.

Note: It is good practice to select a cross section that will give a velocity, V_1, well below the maximum allowable whenever site conditions permit. Wide, shallow cross sections are more stable and require less maintenance. It is always prudent to evaluate flatter design grades to best fit diversions to the site and keep velocities well below maximum allowable.

Table DV-3 Parabolic Diversion Design Chart (Retardance “D” and “B”, Grade 0.50%)



V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH (D), AND V2 FOR RETARDANCE "B"

Grade 0.50 Percent

Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5																											
10																											
15	10.0	2.2	1.0																								
20	13.7	2.1	1.0	8.4	2.7	1.3																					
25	17.4	2.1	1.0	11.3	2.4	1.4																					
30	21.0	2.0	1.0	13.9	2.3	1.4																					
35	24.6	2.0	1.1	16.4	2.3	1.4	10.7	2.8	1.8																		
40	28.5	2.0	1.0	18.9	2.3	1.4	12.6	2.7	1.8																		
45	31.9	2.0	1.1	21.4	2.3	1.4	14.4	2.6	1.8																		
50	35.5	2.0	1.1	23.9	2.2	1.4	16.2	2.5	1.8	9.9	3.4	2.2															
55	39.0	2.0	1.1	26.3	2.2	1.4	17.9	2.5	1.8	11.9	3.1	2.3															
60	42.5	2.0	1.1	28.8	2.2	1.4	19.7	2.5	1.8	13.2	3.0	2.3															
65	46.1	2.0	1.1	31.6	2.2	1.4	21.4	2.5	1.8	14.5	2.9	2.3															
70	49.6	2.0	1.1	34.0	2.2	1.4	23.1	2.5	1.8	15.8	2.9	2.3	11.0	3.6	2.6												
75	53.1	2.0	1.1	36.4	2.2	1.4	24.9	2.5	1.8	17.1	2.8	2.3	12.7	3.4	2.7												
80	56.6	2.0	1.1	38.8	2.2	1.4	26.6	2.5	1.8	18.4	2.8	2.3	13.7	3.3	2.7												
85	60.2	2.0	1.1	41.2	2.2	1.4	28.3	2.5	1.8	19.7	2.8	2.3	14.8	3.2	2.7												
90	63.7	2.0	1.1	43.6	2.2	1.4	30.0	2.4	1.8	20.9	2.8	2.3	15.9	3.2	2.7												
95	67.2	2.0	1.1	46.1	2.2	1.4	31.7	2.4	1.8	22.1	2.8	2.3	16.9	3.1	2.7												
100	70.8	2.0	1.1	48.5	2.2	1.4	33.7	2.4	1.8	23.4	2.8	2.3	17.9	3.1	2.7	12.3	3.9	3.1									
105	74.3	2.0	1.1	50.9	2.2	1.4	35.4	2.4	1.8	24.5	2.7	2.4	18.9	3.1	2.7	13.7	3.7	3.1									
110	77.8	2.0	1.1	53.3	2.2	1.4	37.1	2.4	1.8	25.8	2.7	2.4	19.9	3.1	2.7	14.6	3.6	3.1									
115	81.4	2.0	1.1	55.7	2.2	1.4	38.7	2.4	1.8	27.0	2.7	2.4	20.8	3.0	2.7	15.4	3.6	3.1									
120	84.9	2.0	1.1	58.1	2.2	1.4	40.4	2.4	1.9	28.2	2.7	2.4	21.8	3.0	2.7	16.3	3.5	3.1									
125	88.4	2.0	1.1	60.6	2.2	1.4	42.1	2.4	1.9	29.4	2.7	2.4	22.8	3.0	2.7	17.1	3.5	3.1									
130	92.0	2.0	1.1	63.0	2.2	1.4	43.8	2.4	1.9	30.6	2.7	2.4	23.8	3.0	2.7	17.9	3.5	3.1									
135	95.5	2.0	1.1	65.4	2.2	1.4	45.4	2.4	1.9	31.8	2.7	2.4	24.8	3.0	2.7	18.7	3.4	3.2									
140	99.0	2.0	1.1	67.8	2.2	1.4	47.1	2.4	1.9	33.1	2.7	2.4	25.7	3.0	2.8	19.4	3.4	3.2									
145	102.6	2.0	1.1	70.2	2.2	1.4	48.8	2.4	1.9	34.3	2.7	2.4	26.7	3.0	2.8	20.2	3.4	3.2	13.5	4.4	3.6						
150	106.1	2.0	1.1	72.6	2.2	1.4	50.5	2.4	1.9	35.5	2.7	2.4	27.7	3.0	2.8	21.0	3.4	3.2	14.4	4.3	3.6						

RETARDANCE "D" AND "B"

NOTE: Width and Depth dimensions are in feet; Velocity measurements are in feet per second;
Depth "D" does not include allowance for freeboard or settlement.

Table DV-4 Parabolic Diversion Design Chart (Retardance “D” and “B”, Grade 1.00%)

V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH (D), AND V2 FOR RETARDANCE "B"

Grade 1.00 Percent

Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5																											
10	9.7	1.6	1.0	6.2	2.0	1.2																					
15	14.8	1.5	1.0	10.2	1.7	1.3	6.5	2.2	1.5																		
20	20.2	1.5	1.0	13.8	1.7	1.3	9.6	1.9	1.6																		
25	25.1	1.5	1.0	17.4	1.7	1.3	12.2	1.9	1.6	8.5	2.2	2.0															
30	30.1	1.5	1.0	21.0	1.6	1.3	14.9	1.8	1.7	10.6	2.1	2.1															
35	35.1	1.5	1.0	24.7	1.6	1.3	17.5	1.8	1.7	12.6	2.0	2.1	8.9	2.4	2.5												
40	40.1	1.5	1.0	28.2	1.6	1.3	20.0	1.8	1.7	14.5	2.0	2.1	10.5	2.3	2.5												
45	45.1	1.5	1.0	31.7	1.6	1.3	22.5	1.8	1.7	16.4	2.0	2.1	12.1	2.2	2.5	8.2	2.8	2.9									
50	50.2	1.5	1.0	35.2	1.6	1.3	25.4	1.8	1.7	18.3	2.0	2.1	13.6	2.2	2.5	10.0	2.6	2.9									
55	55.2	1.5	1.0	38.8	1.6	1.3	27.9	1.8	1.7	20.3	1.9	2.1	15.1	2.2	2.5	11.2	2.5	3.0									
60	60.2	1.5	1.0	42.3	1.6	1.3	30.4	1.8	1.7	22.2	1.9	2.1	16.6	2.1	2.5	12.4	2.4	3.0									
65	65.2	1.5	1.0	45.8	1.6	1.3	32.9	1.8	1.7	24.0	1.9	2.1	18.0	2.1	2.5	13.6	2.4	3.0	8.9	3.1	3.5						
70	70.2	1.5	1.0	49.3	1.6	1.3	35.5	1.8	1.7	25.9	1.9	2.1	19.5	2.1	2.6	14.8	2.4	3.0	10.6	2.8	3.5						
75	75.2	1.5	1.0	52.8	1.6	1.3	38.0	1.8	1.7	28.2	1.9	2.1	20.9	2.1	2.6	16.0	2.3	3.0	11.5	2.8	3.5						
80	80.2	1.5	1.0	56.3	1.6	1.3	40.5	1.8	1.7	30.0	1.9	2.1	22.3	2.1	2.6	17.1	2.3	3.0	12.5	2.7	3.5						
85	85.2	1.5	1.0	59.8	1.6	1.3	43.0	1.8	1.7	31.9	1.9	2.1	23.7	2.1	2.6	18.3	2.3	3.0	13.5	2.7	3.6	9.8	3.3	3.9			
90	90.2	1.5	1.0	63.3	1.6	1.3	45.6	1.8	1.7	33.6	1.9	2.1	25.2	2.1	2.6	19.4	2.3	3.1	14.4	2.6	3.6	10.9	3.1	3.9			
95	95.2	1.5	1.0	66.9	1.6	1.3	48.1	1.8	1.7	35.5	1.9	2.1	26.6	2.1	2.6	20.5	2.3	3.1	15.3	2.6	3.6	12.0	3.0	3.9			
100	100.2	1.5	1.0	70.4	1.6	1.3	50.6	1.8	1.7	37.4	1.9	2.1	28.0	2.1	2.6	21.6	2.3	3.1	16.2	2.6	3.6	12.9	2.9	4.0			
105	105.3	1.5	1.0	73.9	1.6	1.3	53.1	1.8	1.7	39.2	1.9	2.1	29.8	2.1	2.6	22.8	2.3	3.1	17.1	2.6	3.6	13.7	2.9	4.0	10.8	3.4	4.3
110	110.3	1.5	1.0	77.4	1.6	1.3	55.7	1.8	1.7	41.1	1.9	2.1	31.3	2.1	2.6	23.9	2.3	3.1	18.0	2.6	3.6	14.4	2.9	4.0	12.0	3.2	4.3
115	115.3	1.5	1.0	80.9	1.6	1.3	58.2	1.8	1.7	42.9	1.9	2.1	32.7	2.1	2.6	25.0	2.3	3.1	18.9	2.5	3.6	15.2	2.8	4.0	12.7	3.2	4.3
120	120.3	1.5	1.0	84.4	1.6	1.3	60.7	1.8	1.7	44.8	1.9	2.1	34.1	2.1	2.6	26.1	2.2	3.1	19.7	2.5	3.6	16.0	2.8	4.0	13.4	3.1	4.3
125	125.3	1.5	1.0	88.0	1.6	1.3	63.2	1.8	1.7	46.7	1.9	2.1	35.5	2.1	2.6	27.2	2.2	3.1	20.6	2.5	3.6	16.8	2.8	4.0	14.1	3.1	4.3
130	130.3	1.5	1.0	91.5	1.6	1.3	65.8	1.8	1.7	48.5	1.9	2.1	36.9	2.1	2.6	28.4	2.2	3.1	21.5	2.5	3.6	17.4	2.8	4.0	14.8	3.1	4.3
135	135.3	1.5	1.0	95.0	1.6	1.3	68.3	1.8	1.7	50.4	1.9	2.1	38.3	2.1	2.6	29.5	2.2	3.1	22.4	2.5	3.6	18.2	2.8	4.0	15.5	3.0	4.3
140	140.3	1.5	1.0	98.5	1.6	1.3	70.8	1.8	1.7	52.2	1.9	2.1	39.7	2.0	2.6	30.6	2.2	3.1	23.2	2.5	3.6	18.9	2.7	4.0	16.1	3.0	4.4
145	145.3	1.5	1.0	102.0	1.6	1.3	73.3	1.8	1.7	54.1	1.9	2.1	41.1	2.0	2.6	32.1	2.2	3.0	24.1	2.5	3.6	19.7	2.7	4.0	16.8	3.0	4.4
150	150.3	1.5	1.0	105.5	1.6	1.3	75.9	1.8	1.7	56.0	1.9	2.1	42.5	2.0	2.6	33.2	2.2	3.0	25.0	2.5	3.6	20.4	2.7	4.1	17.5	2.9	4.4

RETARDANCE "D" AND "B"

NOTE: Width and Depth dimensions are in feet; Velocity measurements are in feet per second;
Depth "D" does not include allowance for freeboard or settlement.

Table DV-5 Parabolic Diversion Design Chart (Retardance “D” and “B”, Grade 2.00%)

V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH (D), AND V2 FOR RETARDANCE "B"

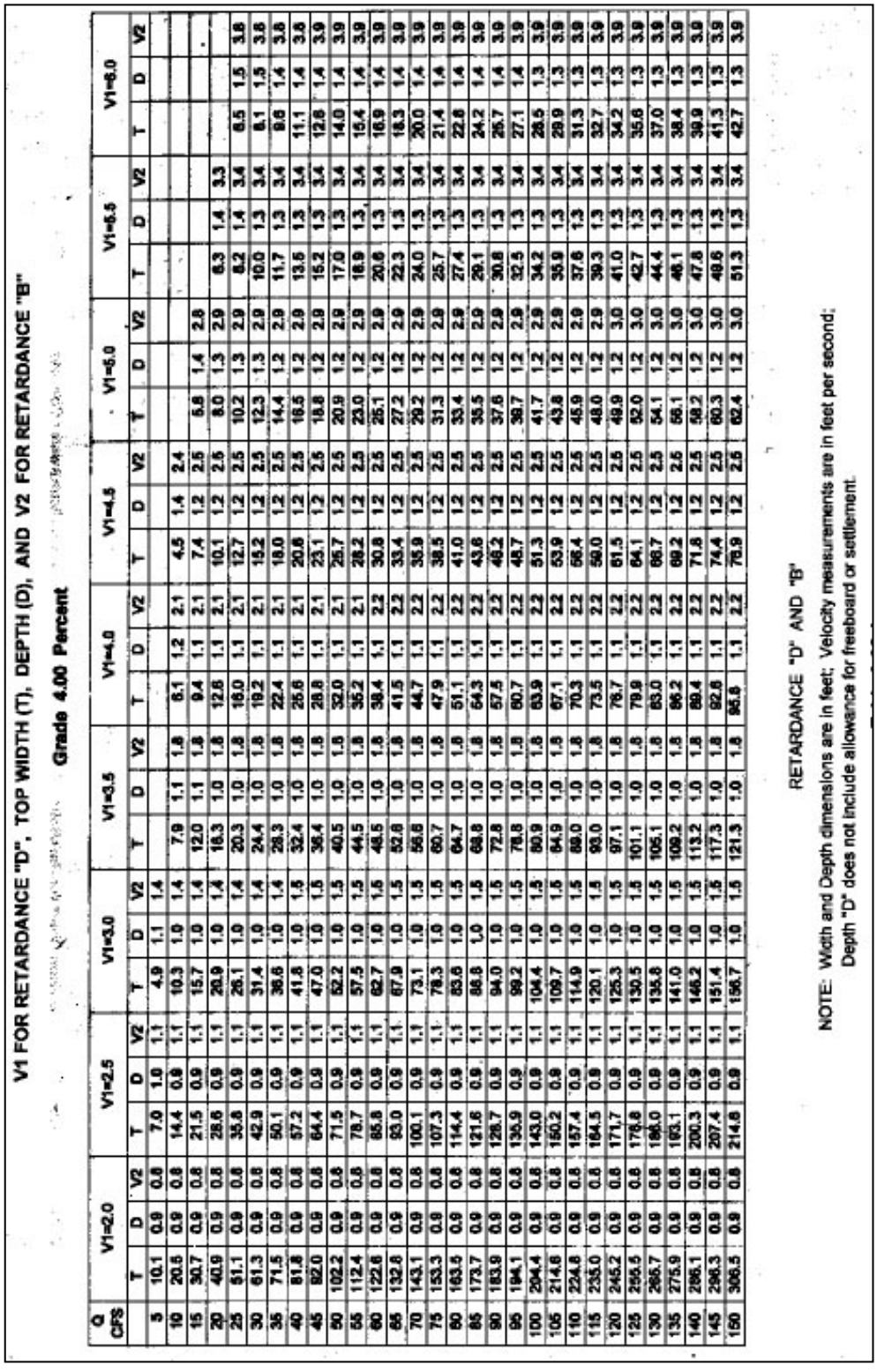
Grade 2.00 Percent

Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5	7.1	1.2	0.9																								
10	14.7	1.2	0.9	9.5	1.3	1.2	7.0	1.4	1.5																		
15	22.0	1.2	0.9	14.5	1.3	1.2	10.8	1.4	1.5	8.0	1.5	1.9	5.5	1.9	2.1												
20	29.3	1.2	0.9	19.6	1.2	1.2	14.6	1.3	1.5	10.9	1.5	1.9	8.1	1.8	2.3	5.5	2.1	2.6									
25	36.6	1.2	0.9	24.4	1.2	1.2	18.5	1.3	1.5	13.6	1.4	1.9	10.4	1.8	2.3	7.9	1.8	2.7									
30	43.9	1.2	0.9	29.3	1.2	1.2	22.2	1.3	1.6	16.6	1.4	1.9	12.7	1.5	2.3	9.7	1.7	2.7	7.3	2.0	3.1						
35	51.2	1.2	0.9	34.2	1.2	1.2	25.8	1.3	1.6	19.6	1.4	1.9	14.9	1.5	2.3	11.5	1.7	2.7	8.9	1.8	3.2						
40	58.5	1.2	0.9	39.0	1.2	1.2	29.5	1.3	1.6	22.4	1.4	1.9	17.1	1.5	2.3	13.3	1.6	2.8	10.4	1.8	3.2	8.0	2.1	3.6			
45	65.8	1.2	0.9	43.9	1.2	1.2	33.2	1.3	1.6	25.2	1.4	1.9	19.3	1.5	2.3	15.0	1.6	2.8	11.8	1.8	3.2	9.2	2.0	3.7			
50	73.1	1.2	0.9	48.8	1.2	1.2	36.8	1.3	1.6	28.0	1.4	1.9	21.7	1.5	2.3	16.7	1.6	2.8	13.2	1.8	3.2	10.5	1.9	3.7	7.9	2.3	4.1
55	80.4	1.2	0.9	53.6	1.2	1.2	40.5	1.3	1.6	30.7	1.4	1.9	23.9	1.5	2.3	18.5	1.6	2.8	14.6	1.7	3.2	11.7	1.9	3.7	9.2	2.2	4.1
60	87.7	1.2	0.9	58.5	1.2	1.2	44.2	1.3	1.6	33.5	1.4	1.9	26.0	1.5	2.3	20.2	1.6	2.8	16.0	1.7	3.2	12.8	1.9	3.7	10.2	2.1	4.1
65	95.0	1.2	0.9	63.4	1.2	1.2	47.9	1.3	1.6	36.3	1.4	1.9	28.2	1.5	2.3	22.1	1.6	2.8	17.4	1.7	3.3	14.0	1.9	3.7	11.3	2.1	4.2
70	102.3	1.2	0.9	68.2	1.2	1.2	51.6	1.3	1.6	39.1	1.4	1.9	30.3	1.5	2.3	23.8	1.6	2.8	18.8	1.7	3.3	15.2	1.9	3.7	12.3	2.1	4.2
75	109.6	1.2	0.9	73.1	1.2	1.2	55.2	1.3	1.6	41.9	1.4	1.9	32.5	1.5	2.3	25.5	1.6	2.8	20.1	1.7	3.3	16.2	1.8	3.7	13.2	2.0	4.2
80	116.9	1.2	0.9	78.0	1.2	1.2	58.9	1.3	1.6	44.7	1.4	1.9	34.6	1.5	2.3	27.2	1.6	2.8	21.5	1.7	3.3	17.4	1.8	3.6	14.2	2.0	4.2
85	124.2	1.2	0.9	82.9	1.2	1.2	62.6	1.3	1.6	47.4	1.4	1.9	36.8	1.5	2.3	28.9	1.6	2.8	22.9	1.7	3.3	18.5	1.8	3.8	16.1	2.0	4.2
90	131.5	1.2	0.9	87.7	1.2	1.2	66.3	1.3	1.6	50.2	1.4	1.9	39.0	1.5	2.3	30.6	1.6	2.8	24.6	1.7	3.2	19.6	1.8	3.8	18.1	2.0	4.2
95	138.8	1.2	0.9	92.6	1.2	1.2	69.9	1.3	1.6	53.0	1.4	1.9	41.1	1.5	2.3	32.3	1.6	2.8	25.9	1.7	3.3	20.8	1.8	3.8	17.0	2.0	4.2
100	146.1	1.2	0.9	97.5	1.2	1.2	73.6	1.3	1.6	55.8	1.4	1.9	43.3	1.5	2.3	34.0	1.6	2.8	27.3	1.7	3.3	21.9	1.8	3.8	18.0	2.0	4.2
105	153.4	1.2	0.9	102.3	1.2	1.2	77.3	1.3	1.6	58.6	1.4	1.9	45.4	1.5	2.3	35.7	1.6	2.8	28.6	1.7	3.3	23.0	1.8	3.8	18.9	2.0	4.2
110	160.7	1.2	0.9	107.2	1.2	1.2	81.0	1.3	1.6	61.4	1.4	1.9	47.6	1.5	2.3	37.3	1.6	2.8	30.0	1.7	3.3	24.1	1.8	3.8	19.8	2.0	4.2
115	168.0	1.2	0.9	112.1	1.2	1.2	84.7	1.3	1.6	64.2	1.4	1.9	49.8	1.5	2.3	39.0	1.6	2.8	31.3	1.7	3.3	25.3	1.8	3.8	20.8	2.0	4.2
120	175.3	1.2	0.9	117.0	1.2	1.2	88.3	1.3	1.6	67.0	1.4	1.9	51.9	1.5	2.3	40.7	1.6	2.8	32.7	1.7	3.3	26.7	1.8	3.7	21.7	2.0	4.2
125	182.6	1.2	0.9	121.8	1.2	1.2	92.0	1.3	1.6	69.7	1.4	1.9	54.1	1.5	2.3	42.4	1.6	2.8	34.1	1.7	3.3	27.8	1.8	3.7	22.6	1.9	4.3
130	189.9	1.2	0.9	126.7	1.2	1.2	95.7	1.3	1.6	72.5	1.4	1.9	56.2	1.5	2.3	44.1	1.6	2.8	35.4	1.7	3.3	28.9	1.8	3.7	23.6	1.9	4.3
135	197.3	1.2	0.9	131.6	1.2	1.2	99.4	1.3	1.6	75.3	1.4	1.9	58.4	1.5	2.3	45.8	1.6	2.8	36.8	1.7	3.3	30.0	1.8	3.7	24.5	1.9	4.3
140	204.6	1.2	0.9	136.5	1.2	1.2	103.1	1.3	1.6	78.1	1.4	1.9	60.6	1.5	2.3	47.5	1.6	2.8	38.1	1.7	3.3	31.1	1.8	3.7	25.4	1.9	4.3
145	211.9	1.2	0.9	141.3	1.2	1.2	106.7	1.3	1.6	80.9	1.4	1.9	62.7	1.5	2.3	49.2	1.6	2.8	39.5	1.7	3.3	32.3	1.8	3.7	26.4	1.9	4.3
150	219.2	1.2	0.9	146.2	1.2	1.2	110.4	1.3	1.6	83.7	1.4	1.9	64.9	1.5	2.3	50.9	1.6	2.8	40.8	1.7	3.3	33.4	1.8	3.7	27.3	1.9	4.3

RETARDANCE "D" AND "B"

NOTE: Width and Depth dimensions are in feet; Velocity measurements are in feet per second;
Depth "D" does not include allowance for freeboard or settlement.

Table DV-6 Parabolic Diversion Design Chart (Retardance “D” and “B”, Grade 4.00%)



V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH (D), AND V2 FOR RETARDANCE "B"

Grade 4.00 Percent

Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5	10.1	0.9	0.8	7.0	1.0	1.1	4.9	1.1	1.4																		
10	20.5	0.9	0.8	14.4	0.8	1.1	10.3	1.0	1.4	7.9	1.1	1.8	6.1	1.2	2.1	4.5	1.4	2.4									
15	30.7	0.9	0.8	21.5	0.9	1.1	15.7	1.0	1.4	12.0	1.1	1.8	9.4	1.1	2.1	7.4	1.2	2.5	5.8	1.4	2.8						
20	40.9	0.9	0.8	28.6	0.9	1.1	20.9	1.0	1.4	16.3	1.0	1.8	12.6	1.1	2.1	10.1	1.2	2.5	8.0	1.3	2.9	6.3	1.4	3.3			
25	51.1	0.9	0.8	35.8	0.9	1.1	26.1	1.0	1.4	20.3	1.0	1.8	16.0	1.1	2.1	12.7	1.2	2.5	10.2	1.3	2.9	8.2	1.4	3.4	6.5	1.5	3.8
30	61.3	0.9	0.8	42.9	0.9	1.1	31.4	1.0	1.4	24.4	1.0	1.8	19.2	1.1	2.1	15.2	1.2	2.5	12.3	1.3	2.9	10.0	1.3	3.4	8.1	1.5	3.8
35	71.5	0.9	0.8	50.1	0.9	1.1	36.6	1.0	1.4	28.3	1.0	1.8	22.4	1.1	2.1	18.0	1.2	2.5	14.4	1.2	2.9	11.7	1.3	3.4	9.6	1.4	3.8
40	81.8	0.9	0.8	57.2	0.9	1.1	41.8	1.0	1.5	32.4	1.0	1.8	25.6	1.1	2.1	20.6	1.2	2.5	16.5	1.2	2.9	13.5	1.3	3.4	11.1	1.4	3.8
45	92.0	0.9	0.8	64.4	0.9	1.1	47.0	1.0	1.5	36.4	1.0	1.8	28.8	1.1	2.1	23.1	1.2	2.5	18.6	1.2	2.9	15.2	1.3	3.4	12.6	1.4	3.9
50	102.2	0.9	0.8	71.5	0.9	1.1	52.2	1.0	1.5	40.5	1.0	1.8	32.0	1.1	2.1	25.7	1.2	2.5	20.9	1.2	2.9	17.0	1.3	3.4	14.0	1.4	3.9
55	112.4	0.9	0.8	78.7	0.9	1.1	57.5	1.0	1.5	44.5	1.0	1.8	35.2	1.1	2.1	28.2	1.2	2.5	23.0	1.2	2.9	18.9	1.3	3.4	15.4	1.4	3.9
60	122.6	0.9	0.8	85.8	0.9	1.1	62.7	1.0	1.5	48.5	1.0	1.8	38.4	1.1	2.2	30.8	1.2	2.5	25.1	1.2	2.9	20.6	1.3	3.4	16.9	1.4	3.9
65	132.8	0.9	0.8	93.0	0.9	1.1	67.9	1.0	1.5	52.8	1.0	1.8	41.5	1.1	2.2	33.4	1.2	2.5	27.2	1.2	2.9	22.3	1.3	3.4	18.3	1.4	3.9
70	143.1	0.9	0.8	100.1	0.9	1.1	73.1	1.0	1.5	56.8	1.0	1.8	44.7	1.1	2.2	35.9	1.2	2.5	29.2	1.2	2.9	24.0	1.3	3.4	20.0	1.4	3.9
75	153.3	0.8	0.8	107.3	0.9	1.1	78.3	1.0	1.5	60.7	1.0	1.8	47.9	1.1	2.2	38.5	1.2	2.5	31.3	1.2	2.9	25.7	1.3	3.4	21.4	1.4	3.9
80	163.6	0.9	0.8	114.4	0.9	1.1	83.6	1.0	1.5	64.7	1.0	1.8	51.1	1.1	2.2	41.0	1.2	2.5	33.4	1.2	2.9	27.4	1.3	3.4	22.8	1.4	3.9
85	173.7	0.9	0.8	121.6	0.9	1.1	88.8	1.0	1.5	68.8	1.0	1.8	54.3	1.1	2.2	43.6	1.2	2.5	35.5	1.2	2.9	29.1	1.3	3.4	24.2	1.4	3.9
90	183.9	0.9	0.8	128.7	0.9	1.1	94.0	1.0	1.5	72.8	1.0	1.8	57.5	1.1	2.2	46.2	1.2	2.5	37.6	1.2	2.9	30.8	1.3	3.4	25.7	1.4	3.9
95	194.1	0.9	0.8	135.9	0.9	1.1	99.2	1.0	1.5	76.8	1.0	1.8	60.7	1.1	2.2	48.7	1.2	2.5	39.7	1.2	2.9	32.5	1.3	3.4	27.1	1.4	3.9
100	204.4	0.9	0.8	143.0	0.9	1.1	104.4	1.0	1.5	80.9	1.0	1.8	63.9	1.1	2.2	51.3	1.2	2.5	41.7	1.2	2.9	34.2	1.3	3.4	28.5	1.3	3.9
105	214.6	0.9	0.8	150.2	0.9	1.1	109.7	1.0	1.5	84.9	1.0	1.8	67.1	1.1	2.2	53.9	1.2	2.5	43.8	1.2	2.9	35.9	1.3	3.4	29.9	1.3	3.9
110	224.8	0.9	0.8	157.4	0.9	1.1	114.9	1.0	1.5	88.9	1.0	1.8	70.3	1.1	2.2	56.4	1.2	2.5	45.9	1.2	2.9	37.6	1.3	3.4	31.3	1.3	3.9
115	235.0	0.9	0.8	164.5	0.9	1.1	120.1	1.0	1.5	93.0	1.0	1.8	73.5	1.1	2.2	59.0	1.2	2.5	48.0	1.2	2.9	39.3	1.3	3.4	32.7	1.3	3.9
120	245.2	0.9	0.8	171.7	0.9	1.1	125.3	1.0	1.5	97.1	1.0	1.8	76.7	1.1	2.2	61.5	1.2	2.5	49.9	1.2	3.0	41.0	1.3	3.4	34.2	1.3	3.9
125	255.5	0.9	0.8	178.8	0.9	1.1	130.5	1.0	1.5	101.1	1.0	1.8	79.9	1.1	2.2	64.1	1.2	2.5	52.0	1.2	3.0	42.7	1.3	3.4	35.6	1.3	3.9
130	265.7	0.9	0.8	186.0	0.9	1.1	135.8	1.0	1.5	105.1	1.0	1.8	83.0	1.1	2.2	66.7	1.2	2.5	54.1	1.2	3.0	44.4	1.3	3.4	37.0	1.3	3.9
135	275.9	0.9	0.8	193.1	0.9	1.1	141.0	1.0	1.5	109.2	1.0	1.8	86.2	1.1	2.2	69.2	1.2	2.5	56.1	1.2	3.0	46.1	1.3	3.4	38.4	1.3	3.9
140	286.1	0.9	0.8	200.3	0.9	1.1	146.2	1.0	1.5	113.2	1.0	1.8	89.4	1.1	2.2	71.8	1.2	2.5	58.2	1.2	3.0	47.8	1.3	3.4	39.9	1.3	3.9
145	296.3	0.9	0.8	207.4	0.9	1.1	151.4	1.0	1.5	117.3	1.0	1.8	92.6	1.1	2.2	74.4	1.2	2.5	60.3	1.2	3.0	49.6	1.3	3.4	41.3	1.3	3.9
150	306.5	0.9	0.8	214.6	0.9	1.1	156.7	1.0	1.5	121.3	1.0	1.8	95.8	1.1	2.2	76.9	1.2	2.5	62.4	1.2	3.0	51.3	1.3	3.4	42.7	1.3	3.9

RETARDANCE "D" AND "B"

NOTE: Width and Depth dimensions are in feet; Velocity measurements are in feet per second;
Depth "D" does not include allowance for freeboard or settlement.

Table DV-7 Parabolic Diversion Design Chart (Retardance “D” and “B”, Grade 6.00%)

V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH (D), AND V2 FOR RETARDANCE "B"

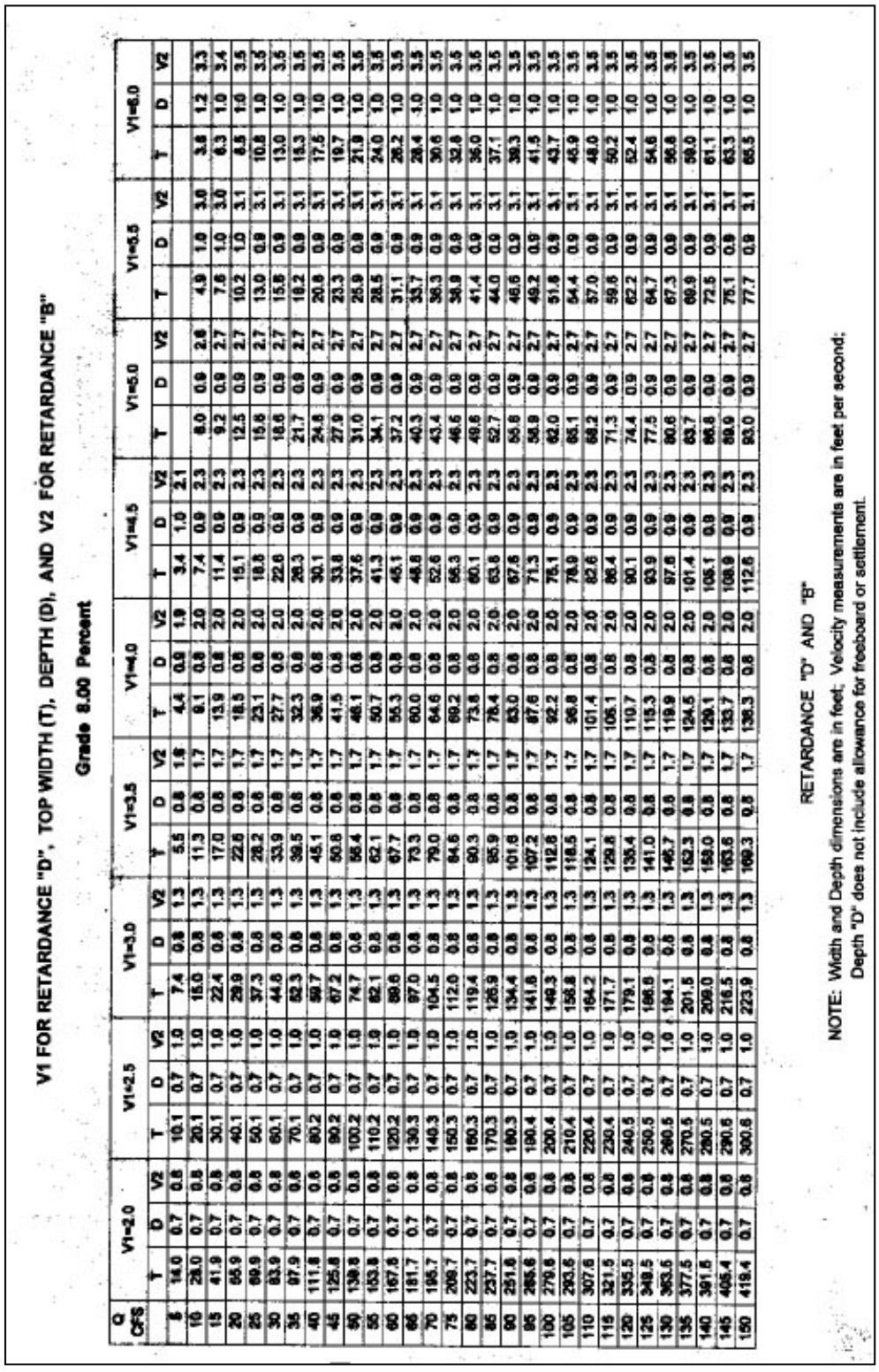
Grade 6.00 Percent

Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5	12.4	0.7	0.8	8.7	0.8	1.0	6.2	0.9	1.4	4.7	1.0	1.8	3.5	1.2	1.9												
10	24.7	0.7	0.8	17.6	0.8	1.0	12.6	0.9	1.4	9.8	0.9	1.7	7.8	1.0	2.0	6.2	1.0	2.3	4.8	1.1	2.7						
15	37.1	0.7	0.8	26.4	0.8	1.1	19.2	0.8	1.4	15.0	0.9	1.7	11.8	0.9	2.0	9.5	1.0	2.4	7.7	1.1	2.7	6.2	1.2	3.1	5.0	1.3	3.5
20	49.4	0.7	0.8	35.1	0.8	1.1	25.6	0.8	1.4	19.9	0.9	1.7	16.0	0.9	2.0	12.9	1.0	2.4	10.4	1.0	2.8	8.5	1.1	3.2	7.0	1.2	3.6
25	61.8	0.7	0.8	43.9	0.8	1.1	32.0	0.8	1.4	24.9	0.9	1.7	19.9	0.9	2.0	16.1	1.0	2.4	13.1	1.0	2.8	10.8	1.1	3.2	8.9	1.2	3.6
30	74.1	0.7	0.8	52.7	0.8	1.1	38.4	0.8	1.4	29.9	0.9	1.7	23.8	0.9	2.1	19.3	1.0	2.4	15.9	1.0	2.8	13.0	1.1	3.2	10.8	1.1	3.6
35	86.5	0.7	0.8	61.5	0.8	1.1	44.8	0.8	1.4	34.8	0.9	1.7	27.8	0.9	2.1	22.5	1.0	2.4	18.5	1.0	2.8	15.4	1.1	3.2	12.7	1.1	3.6
40	98.9	0.7	0.8	70.2	0.8	1.1	51.2	0.8	1.4	39.8	0.9	1.7	31.8	0.9	2.1	25.7	1.0	2.4	21.2	1.0	2.8	17.8	1.1	3.2	14.5	1.1	3.6
45	111.2	0.7	0.8	79.0	0.8	1.1	57.6	0.8	1.4	44.8	0.9	1.7	38.7	0.9	2.1	29.0	1.0	2.4	23.8	1.0	2.8	19.8	1.1	3.2	16.6	1.1	3.6
50	123.6	0.7	0.8	87.8	0.8	1.1	64.0	0.8	1.4	49.7	0.9	1.7	39.7	0.9	2.1	32.2	1.0	2.4	26.4	1.0	2.8	22.0	1.1	3.2	18.4	1.1	3.6
55	136.0	0.7	0.8	96.6	0.8	1.1	70.4	0.8	1.4	54.7	0.9	1.7	43.6	0.9	2.1	35.4	1.0	2.4	29.1	1.0	2.8	24.2	1.1	3.2	20.2	1.1	3.7
60	148.3	0.7	0.8	105.3	0.8	1.1	76.8	0.8	1.4	58.7	0.9	1.7	47.6	0.9	2.1	38.6	1.0	2.4	31.7	1.0	2.8	26.3	1.1	3.2	22.0	1.1	3.7
65	160.6	0.7	0.8	114.1	0.8	1.1	83.2	0.8	1.4	64.7	0.9	1.7	51.6	0.9	2.1	41.8	1.0	2.4	34.3	1.0	2.8	28.5	1.1	3.2	23.8	1.1	3.7
70	173.0	0.7	0.8	122.9	0.8	1.1	89.6	0.8	1.4	69.6	0.9	1.7	55.5	0.9	2.1	45.0	1.0	2.4	37.0	1.0	2.8	30.7	1.1	3.2	25.6	1.1	3.7
75	185.4	0.7	0.8	131.7	0.8	1.1	96.0	0.8	1.4	74.6	0.9	1.7	59.6	0.9	2.1	48.2	1.0	2.4	39.6	1.0	2.8	32.9	1.1	3.2	27.4	1.1	3.7
80	197.7	0.7	0.8	140.4	0.8	1.1	102.3	0.8	1.4	79.6	0.9	1.7	63.5	0.9	2.1	51.4	1.0	2.4	42.2	1.0	2.8	35.1	1.1	3.2	29.3	1.1	3.7
85	210.1	0.7	0.8	149.2	0.8	1.1	108.7	0.8	1.4	84.5	0.9	1.7	67.4	0.9	2.1	54.7	1.0	2.4	44.9	1.0	2.8	37.3	1.1	3.2	31.1	1.1	3.7
90	222.4	0.7	0.8	158.0	0.8	1.1	115.1	0.8	1.4	89.5	0.9	1.7	71.4	0.9	2.1	57.9	1.0	2.4	47.5	1.0	2.8	39.5	1.1	3.2	32.9	1.1	3.7
95	234.8	0.7	0.8	166.8	0.8	1.1	121.5	0.8	1.4	94.5	0.9	1.7	75.4	0.9	2.1	61.1	1.0	2.4	50.2	1.0	2.8	41.7	1.1	3.2	34.7	1.1	3.7
100	247.1	0.7	0.8	175.5	0.8	1.1	127.9	0.8	1.4	99.5	0.9	1.7	79.3	0.9	2.1	64.3	1.0	2.4	52.8	1.0	2.8	43.9	1.1	3.2	36.6	1.1	3.7
105	259.5	0.7	0.8	184.3	0.8	1.1	134.3	0.8	1.4	104.4	0.9	1.7	83.3	0.9	2.1	67.5	1.0	2.4	55.4	1.0	2.8	46.1	1.1	3.2	38.4	1.1	3.7
110	271.8	0.7	0.8	193.1	0.8	1.1	140.7	0.8	1.4	109.4	0.9	1.7	87.3	0.9	2.1	70.7	1.0	2.4	58.1	1.0	2.8	48.2	1.1	3.2	40.2	1.1	3.7
115	284.2	0.7	0.8	201.9	0.8	1.1	147.1	0.8	1.4	114.4	0.9	1.7	91.2	0.9	2.1	73.9	1.0	2.4	60.7	1.0	2.8	50.4	1.1	3.2	42.0	1.1	3.7
120	296.6	0.7	0.8	210.7	0.8	1.1	153.5	0.8	1.4	119.3	0.9	1.7	95.2	0.9	2.1	77.2	1.0	2.4	63.3	1.0	2.8	52.6	1.1	3.2	43.9	1.1	3.7
125	308.9	0.7	0.8	219.4	0.8	1.1	159.8	0.8	1.4	124.3	0.9	1.7	99.2	0.9	2.1	80.4	1.0	2.4	66.0	1.0	2.8	54.8	1.1	3.2	45.7	1.1	3.7
130	321.3	0.7	0.8	228.2	0.8	1.1	166.3	0.8	1.4	129.3	0.9	1.7	103.1	0.9	2.1	83.6	1.0	2.4	68.6	1.0	2.8	57.0	1.1	3.2	47.5	1.1	3.7
135	333.6	0.7	0.8	237.0	0.8	1.1	172.7	0.8	1.4	134.3	0.9	1.7	107.1	0.9	2.1	86.8	1.0	2.4	71.3	1.0	2.8	59.2	1.1	3.2	49.3	1.1	3.7
140	346.0	0.7	0.8	245.8	0.8	1.1	179.1	0.8	1.4	139.2	0.9	1.7	111.0	0.9	2.1	90.0	1.0	2.4	73.9	1.0	2.8	61.4	1.1	3.2	51.2	1.1	3.7
145	358.3	0.7	0.8	254.5	0.8	1.1	185.5	0.8	1.4	144.2	0.9	1.7	115.0	0.9	2.1	93.2	1.0	2.4	76.5	1.0	2.8	63.6	1.1	3.2	53.0	1.1	3.7
150	370.7	0.7	0.8	263.3	0.8	1.1	191.9	0.8	1.4	149.2	0.9	1.7	119.0	0.9	2.1	96.4	1.0	2.4	79.2	1.0	2.8	66.8	1.1	3.2	54.8	1.1	3.7

RETARDANCE "D" AND "B"

NOTE: Width and Depth dimensions are in feet; Velocity measurements are in feet per second;
Depth "D" does not include allowance for freeboard or settlement.

Table DV-8 Parabolic Diversion Design Chart (Retardance “D” and “B”, Grade 8.00%)



V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH (D), AND V2 FOR RETARDANCE "B"

Grade 8.00 Percent

Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5	14.0	0.7	0.8	10.1	0.7	1.0	7.4	0.8	1.3	5.5	0.8	1.6	4.4	0.8	1.9	3.4	1.0	2.1									
10	28.0	0.7	0.8	20.1	0.7	1.0	15.0	0.8	1.3	11.3	0.8	1.7	9.1	0.8	2.0	7.4	0.9	2.3	8.0	0.9	2.6	4.9	1.0	3.0	3.6	1.2	3.3
15	41.9	0.7	0.8	30.1	0.7	1.0	22.4	0.8	1.3	17.0	0.8	1.7	13.9	0.8	2.0	11.4	0.9	2.3	9.2	0.9	2.7	7.6	1.0	3.0	6.3	1.0	3.4
20	55.9	0.7	0.8	40.1	0.7	1.0	29.9	0.8	1.3	22.6	0.8	1.7	18.5	0.8	2.0	15.1	0.9	2.3	12.5	0.9	2.7	10.2	1.0	3.1	8.5	1.0	3.5
25	69.9	0.7	0.8	50.1	0.7	1.0	37.3	0.8	1.3	28.2	0.8	1.7	23.1	0.8	2.0	18.8	0.9	2.3	15.6	0.9	2.7	13.0	0.9	3.1	10.8	1.0	3.5
30	83.9	0.7	0.8	60.1	0.7	1.0	44.8	0.8	1.3	33.9	0.8	1.7	27.7	0.8	2.0	22.6	0.8	2.3	18.8	0.9	2.7	15.8	0.9	3.1	13.0	1.0	3.5
35	97.9	0.7	0.8	70.1	0.7	1.0	52.3	0.8	1.3	39.5	0.8	1.7	32.3	0.8	2.0	26.3	0.9	2.3	21.7	0.9	2.7	18.2	0.9	3.1	15.3	1.0	3.5
40	111.8	0.7	0.8	80.2	0.7	1.0	59.7	0.8	1.3	45.1	0.8	1.7	36.9	0.8	2.0	30.1	0.9	2.3	24.8	0.9	2.7	20.8	0.9	3.1	17.5	1.0	3.5
45	125.8	0.7	0.8	90.2	0.7	1.0	67.2	0.8	1.3	50.8	0.8	1.7	41.5	0.8	2.0	33.8	0.9	2.3	27.9	0.9	2.7	23.3	0.9	3.1	19.7	1.0	3.5
50	139.8	0.7	0.8	100.2	0.7	1.0	74.7	0.8	1.3	56.4	0.8	1.7	46.1	0.8	2.0	37.6	0.9	2.3	31.0	0.9	2.7	25.9	0.9	3.1	21.9	1.0	3.5
55	153.8	0.7	0.8	110.2	0.7	1.0	82.1	0.8	1.3	62.1	0.8	1.7	50.7	0.8	2.0	41.3	0.9	2.3	34.1	0.9	2.7	28.5	0.9	3.1	24.0	1.0	3.5
60	167.8	0.7	0.8	120.2	0.7	1.0	89.6	0.8	1.3	67.7	0.8	1.7	55.3	0.8	2.0	45.1	0.9	2.3	37.2	0.9	2.7	31.1	0.9	3.1	26.2	1.0	3.5
65	181.7	0.7	0.8	130.3	0.7	1.0	97.0	0.8	1.3	73.3	0.8	1.7	60.0	0.8	2.0	48.8	0.9	2.3	40.3	0.9	2.7	33.7	0.9	3.1	28.4	1.0	3.5
70	195.7	0.7	0.8	140.3	0.7	1.0	104.5	0.8	1.3	79.0	0.8	1.7	64.6	0.8	2.0	52.6	0.9	2.3	43.4	0.9	2.7	36.3	0.9	3.1	30.6	1.0	3.5
75	209.7	0.7	0.8	150.3	0.7	1.0	112.0	0.8	1.3	84.6	0.8	1.7	69.2	0.8	2.0	56.3	0.9	2.3	46.6	0.9	2.7	38.9	0.9	3.1	32.8	1.0	3.5
80	223.7	0.7	0.8	160.3	0.7	1.0	119.4	0.8	1.3	90.3	0.8	1.7	73.8	0.8	2.0	60.1	0.9	2.3	49.8	0.9	2.7	41.4	0.9	3.1	35.0	1.0	3.5
85	237.7	0.7	0.8	170.3	0.7	1.0	126.9	0.8	1.3	95.9	0.8	1.7	78.4	0.8	2.0	63.8	0.9	2.3	52.7	0.9	2.7	44.0	0.9	3.1	37.1	1.0	3.5
90	251.6	0.7	0.8	180.3	0.7	1.0	134.4	0.8	1.3	101.8	0.8	1.7	83.0	0.8	2.0	67.6	0.9	2.3	55.8	0.9	2.7	46.6	0.9	3.1	39.3	1.0	3.5
95	265.6	0.7	0.8	190.4	0.7	1.0	141.8	0.8	1.3	107.2	0.8	1.7	87.6	0.8	2.0	71.3	0.9	2.3	58.9	0.9	2.7	49.2	0.9	3.1	41.5	1.0	3.5
100	279.6	0.7	0.8	200.4	0.7	1.0	149.3	0.8	1.3	112.8	0.8	1.7	92.2	0.8	2.0	75.1	0.9	2.3	62.0	0.9	2.7	51.8	0.9	3.1	43.7	1.0	3.5
105	293.6	0.7	0.8	210.4	0.7	1.0	156.8	0.8	1.3	118.5	0.8	1.7	96.8	0.8	2.0	78.9	0.9	2.3	65.1	0.9	2.7	54.4	0.9	3.1	45.9	1.0	3.5
110	307.6	0.7	0.8	220.4	0.7	1.0	164.2	0.8	1.3	124.1	0.8	1.7	101.4	0.8	2.0	82.6	0.9	2.3	68.2	0.9	2.7	57.0	0.9	3.1	48.0	1.0	3.5
115	321.6	0.7	0.8	230.4	0.7	1.0	171.7	0.8	1.3	129.8	0.8	1.7	106.1	0.8	2.0	86.4	0.9	2.3	71.3	0.9	2.7	59.6	0.9	3.1	50.2	1.0	3.5
120	335.5	0.7	0.8	240.5	0.7	1.0	179.1	0.8	1.3	135.4	0.8	1.7	110.7	0.8	2.0	90.1	0.9	2.3	74.4	0.9	2.7	62.2	0.9	3.1	52.4	1.0	3.5
125	349.5	0.7	0.8	250.5	0.7	1.0	186.6	0.8	1.3	141.0	0.8	1.7	115.3	0.8	2.0	93.9	0.9	2.3	77.5	0.9	2.7	64.7	0.9	3.1	54.6	1.0	3.5
130	363.5	0.7	0.8	260.5	0.7	1.0	194.1	0.8	1.3	146.7	0.8	1.7	119.9	0.8	2.0	97.6	0.9	2.3	80.6	0.9	2.7	67.3	0.9	3.1	56.8	1.0	3.5
135	377.5	0.7	0.8	270.5	0.7	1.0	201.6	0.8	1.3	152.3	0.8	1.7	124.5	0.8	2.0	101.4	0.9	2.3	83.7	0.9	2.7	69.9	0.9	3.1	59.0	1.0	3.5
140	391.5	0.7	0.8	280.5	0.7	1.0	209.0	0.8	1.3	158.0	0.8	1.7	129.1	0.8	2.0	105.1	0.9	2.3	86.8	0.9	2.7	72.5	0.9	3.1	61.1	1.0	3.5
145	405.4	0.7	0.8	290.6	0.7	1.0	216.5	0.8	1.3	163.6	0.8	1.7	133.7	0.8	2.0	108.9	0.9	2.3	89.9	0.9	2.7	75.1	0.9	3.1	63.3	1.0	3.5
150	419.4	0.7	0.8	300.6	0.7	1.0	223.9	0.8	1.3	169.3	0.8	1.7	138.3	0.8	2.0	112.6	0.9	2.3	93.0	0.9	2.7	77.7	0.9	3.1	65.5	1.0	3.5

RETARDANCE "D" AND "B"

NOTE: Width and Depth dimensions are in feet; Velocity measurements are in feet per second;
Depth "D" does not include allowance for freeboard or settlement.

Table DV-9 Parabolic Diversion Design Chart (Retardance “D” and “B”, Grade 10.00%)

V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH (D), AND V2 FOR RETARDANCE "B"

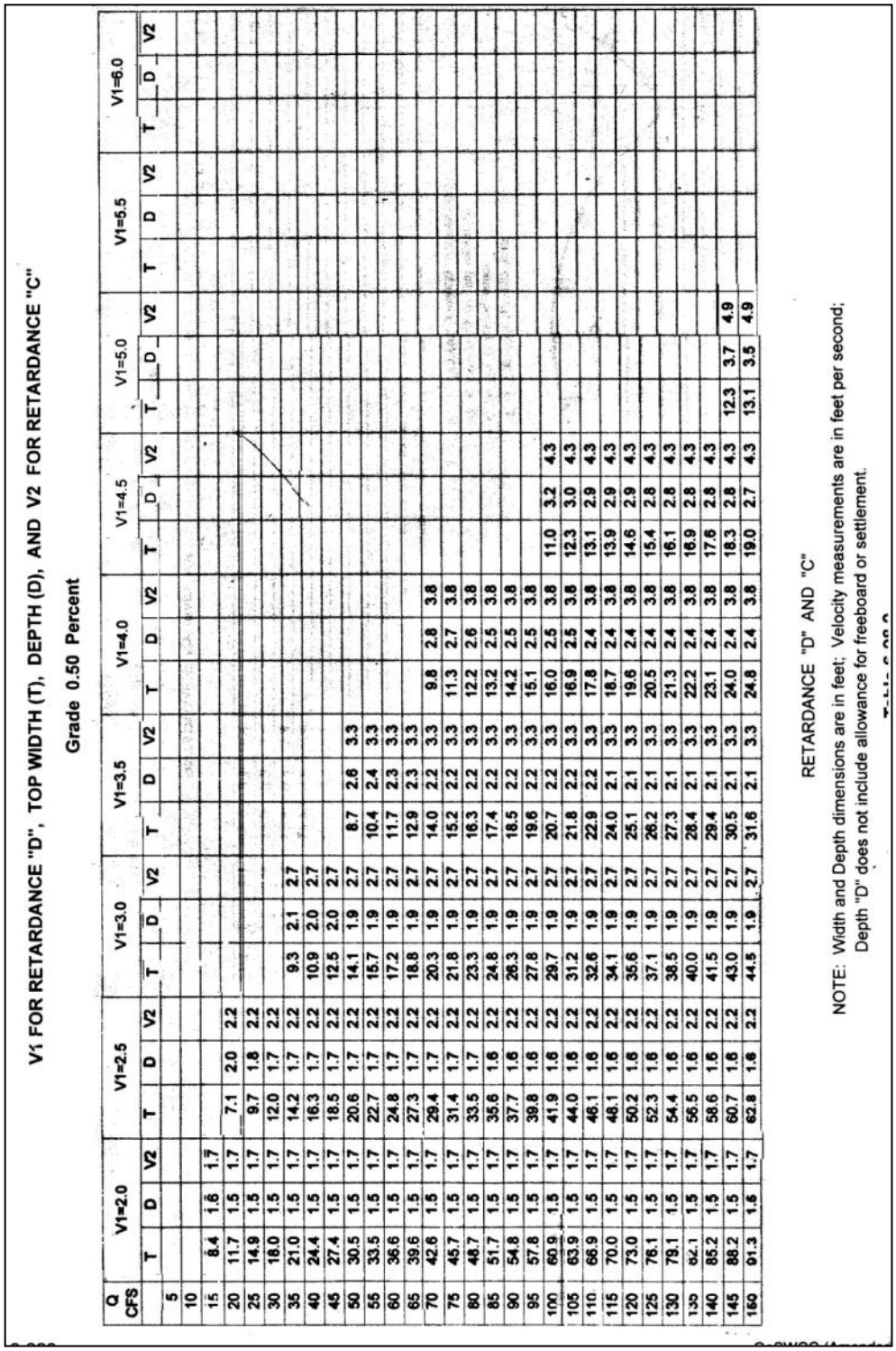
Grade 10.00 Percent

Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5	15.3	0.6	0.8	11.1	0.7	1.0	8.1	0.7	1.3	6.3	0.7	1.6	4.8	0.8	1.9	4.0	0.9	2.2	3.1	1.0	2.4						
10	30.6	0.6	0.8	22.1	0.7	1.0	16.5	0.7	1.3	12.8	0.7	1.6	10.0	0.8	2.0	8.4	0.8	2.2	6.9	0.8	2.6	5.7	0.9	2.8	4.7	1.0	3.3
15	45.9	0.6	0.8	33.2	0.7	1.0	24.7	0.7	1.3	19.2	0.7	1.6	15.0	0.8	2.0	12.7	0.8	2.2	10.5	0.8	2.6	8.7	0.9	3.0	7.3	0.9	3.3
20	61.2	0.6	0.8	44.2	0.7	1.0	32.9	0.7	1.3	25.6	0.7	1.6	20.0	0.8	2.0	17.0	0.8	2.2	14.1	0.8	2.6	11.8	0.9	3.0	9.8	0.9	3.4
25	76.5	0.6	0.8	55.3	0.7	1.0	41.1	0.7	1.3	32.0	0.7	1.6	25.0	0.8	2.0	21.2	0.8	2.3	17.6	0.8	2.6	14.7	0.9	3.0	12.5	0.9	3.4
30	91.8	0.6	0.8	66.3	0.7	1.0	49.3	0.7	1.3	38.3	0.7	1.6	29.9	0.8	2.0	25.4	0.8	2.3	21.1	0.8	2.6	17.7	0.8	3.0	15.0	0.9	3.3
35	107.1	0.6	0.8	77.4	0.7	1.0	57.5	0.7	1.3	44.7	0.7	1.6	34.8	0.8	2.0	29.7	0.8	2.3	24.6	0.8	2.6	20.6	0.8	3.0	17.5	0.9	3.4
40	122.4	0.6	0.8	88.4	0.7	1.0	65.7	0.7	1.3	51.1	0.7	1.6	39.9	0.8	2.0	33.9	0.8	2.3	28.1	0.8	2.6	23.5	0.8	3.0	20.0	0.9	3.4
45	137.8	0.6	0.8	99.5	0.7	1.0	73.9	0.7	1.3	57.5	0.7	1.6	44.9	0.8	2.0	38.0	0.8	2.3	31.6	0.8	2.6	26.5	0.8	3.0	22.5	0.9	3.4
50	153.1	0.6	0.8	110.6	0.7	1.0	82.1	0.7	1.3	63.9	0.7	1.6	49.9	0.8	2.0	42.2	0.8	2.3	35.1	0.8	2.6	29.4	0.8	3.0	25.0	0.9	3.4
55	168.4	0.6	0.8	121.6	0.7	1.0	90.3	0.7	1.3	70.3	0.7	1.6	54.9	0.8	2.0	46.4	0.8	2.3	38.6	0.8	2.6	32.3	0.8	3.0	27.5	0.9	3.4
60	183.7	0.6	0.8	132.7	0.7	1.0	98.6	0.7	1.3	76.7	0.7	1.6	59.9	0.8	2.0	50.7	0.8	2.3	42.1	0.8	2.6	35.3	0.8	3.0	30.0	0.9	3.4
65	199.0	0.6	0.8	143.7	0.7	1.0	106.7	0.7	1.3	83.1	0.7	1.6	64.8	0.8	2.0	54.9	0.8	2.3	45.6	0.8	2.6	38.2	0.8	3.0	32.5	0.9	3.4
70	214.3	0.6	0.8	154.8	0.7	1.0	115.0	0.7	1.3	89.4	0.7	1.6	69.8	0.8	2.0	59.1	0.8	2.3	49.1	0.8	2.6	41.2	0.8	3.0	35.0	0.9	3.4
75	229.6	0.6	0.8	165.8	0.7	1.0	123.2	0.7	1.3	95.8	0.7	1.6	74.8	0.8	2.0	63.3	0.8	2.3	52.6	0.8	2.6	44.1	0.8	3.0	37.4	0.9	3.4
80	244.9	0.6	0.8	176.9	0.7	1.0	131.4	0.7	1.3	102.2	0.7	1.6	79.8	0.8	2.0	67.6	0.8	2.3	56.1	0.8	2.6	47.0	0.8	3.0	39.8	0.9	3.4
85	260.2	0.6	0.8	187.9	0.7	1.0	139.6	0.7	1.3	108.6	0.7	1.6	84.8	0.8	2.0	71.8	0.8	2.3	59.6	0.8	2.6	50.0	0.8	3.0	42.3	0.9	3.4
90	275.5	0.6	0.8	199.0	0.7	1.0	147.8	0.7	1.3	115.0	0.7	1.6	89.8	0.8	2.0	76.0	0.8	2.3	63.1	0.8	2.6	52.9	0.8	3.0	44.6	0.9	3.4
95	290.8	0.6	0.8	210.0	0.7	1.0	156.0	0.7	1.3	121.4	0.7	1.6	94.8	0.8	2.0	80.2	0.8	2.3	66.6	0.8	2.6	55.8	0.8	3.0	47.3	0.9	3.4
100	306.1	0.6	0.8	221.1	0.7	1.0	164.2	0.7	1.3	127.8	0.7	1.6	99.8	0.8	2.0	84.4	0.8	2.3	70.1	0.8	2.6	58.8	0.8	3.0	49.7	0.9	3.4
105	321.4	0.6	0.8	232.2	0.7	1.0	172.4	0.7	1.3	134.2	0.7	1.6	104.7	0.8	2.0	88.7	0.8	2.3	73.6	0.8	2.6	61.7	0.8	3.0	52.2	0.9	3.4
110	336.7	0.6	0.8	243.2	0.7	1.0	180.6	0.7	1.3	140.5	0.7	1.6	109.7	0.8	2.0	92.9	0.8	2.3	77.1	0.8	2.6	64.7	0.8	3.0	54.7	0.9	3.4
115	352.0	0.6	0.8	254.3	0.7	1.0	188.8	0.7	1.3	146.9	0.7	1.6	114.7	0.8	2.0	97.1	0.8	2.3	80.6	0.8	2.6	67.6	0.8	3.0	57.2	0.9	3.4
120	367.3	0.6	0.8	265.3	0.7	1.0	197.1	0.7	1.3	153.3	0.7	1.6	119.7	0.8	2.0	101.3	0.8	2.3	84.1	0.8	2.6	70.5	0.8	3.0	59.7	0.9	3.4
125	382.6	0.8	0.8	276.4	0.7	1.0	205.3	0.7	1.3	159.7	0.7	1.6	124.7	0.8	2.0	105.5	0.8	2.3	87.6	0.8	2.6	73.5	0.8	3.0	62.2	0.9	3.4
130	397.9	0.6	0.8	287.4	0.7	1.0	213.5	0.7	1.3	166.1	0.7	1.6	129.7	0.8	2.0	109.8	0.8	2.3	91.1	0.8	2.6	76.4	0.8	3.0	64.7	0.9	3.4
135	413.2	0.6	0.8	298.5	0.7	1.0	221.7	0.7	1.3	172.5	0.7	1.6	134.7	0.8	2.0	114.0	0.8	2.3	94.6	0.8	2.6	79.3	0.8	3.0	67.2	0.9	3.4
140	428.6	0.6	0.8	309.6	0.7	1.0	229.9	0.7	1.3	178.9	0.7	1.6	139.7	0.8	2.0	118.2	0.8	2.3	98.1	0.8	2.6	82.3	0.8	3.0	69.6	0.9	3.4
145	443.9	0.6	0.8	320.6	0.7	1.0	238.1	0.7	1.3	185.3	0.7	1.6	144.6	0.8	2.0	122.4	0.8	2.3	101.7	0.8	2.6	85.2	0.8	3.0	72.1	0.9	3.4
150	459.2	0.6	0.8	331.7	0.7	1.0	246.3	0.7	1.3	191.6	0.7	1.6	149.6	0.8	2.0	126.7	0.8	2.3	105.2	0.8	2.6	88.2	0.9	3.0	74.6	0.9	3.4

RETARDANCE "D" AND "B"

NOTE: Width and Depth dimensions are in feet; Velocity measurements are in feet per second;
Depth "D" does not include allowance for freeboard or settlement.

Table DV-10 Parabolic Diversion Design Chart (Retardance “D” and “C”, Grade .50%)



V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH (D), AND V2 FOR RETARDANCE "C"

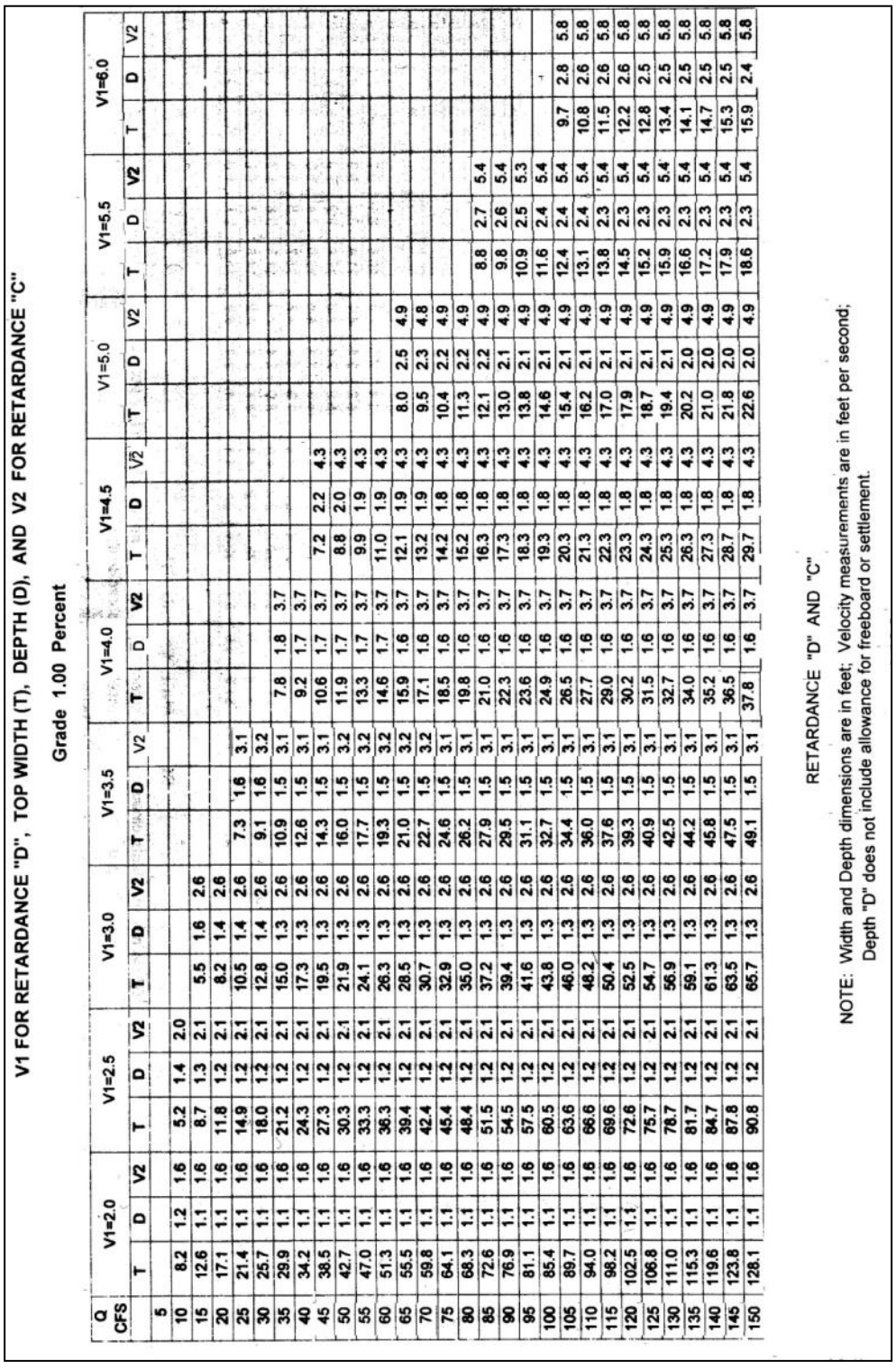
Grade 0.50 Percent

Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5																											
10																											
15	8.4	1.6	1.7																								
20	11.7	1.5	1.7	7.1	2.0	2.2																					
25	14.9	1.5	1.7	9.7	1.8	2.2																					
30	18.0	1.5	1.7	12.0	1.7	2.2																					
35	21.0	1.5	1.7	14.2	1.7	2.2	9.3	2.1	2.7																		
40	24.4	1.5	1.7	16.3	1.7	2.2	10.9	2.0	2.7																		
45	27.4	1.5	1.7	18.5	1.7	2.2	12.5	2.0	2.7																		
50	30.5	1.5	1.7	20.6	1.7	2.2	14.1	1.9	2.7	8.7	2.6	3.3															
55	33.5	1.5	1.7	22.7	1.7	2.2	15.7	1.9	2.7	10.4	2.4	3.3															
60	36.6	1.5	1.7	24.8	1.7	2.2	17.2	1.9	2.7	11.7	2.3	3.3															
65	39.6	1.5	1.7	27.3	1.7	2.2	18.8	1.9	2.7	12.9	2.3	3.3															
70	42.6	1.5	1.7	29.4	1.7	2.2	20.3	1.9	2.7	14.0	2.2	3.3	9.8	2.8	3.8												
75	45.7	1.5	1.7	31.4	1.7	2.2	21.8	1.9	2.7	15.2	2.2	3.3	11.3	2.7	3.8												
80	48.7	1.5	1.7	33.5	1.7	2.2	23.3	1.9	2.7	16.3	2.2	3.3	12.2	2.6	3.8												
85	51.7	1.5	1.7	35.6	1.6	2.2	24.8	1.9	2.7	17.4	2.2	3.3	13.2	2.5	3.8												
90	54.8	1.5	1.7	37.7	1.6	2.2	26.3	1.9	2.7	18.5	2.2	3.3	14.2	2.5	3.8												
95	57.8	1.5	1.7	39.8	1.6	2.2	27.8	1.9	2.7	19.6	2.2	3.3	15.1	2.5	3.8												
100	60.9	1.5	1.7	41.9	1.6	2.2	29.7	1.9	2.7	20.7	2.2	3.3	16.0	2.5	3.8	11.0	3.2	4.3									
105	63.9	1.5	1.7	44.0	1.6	2.2	31.2	1.9	2.7	21.8	2.2	3.3	16.9	2.5	3.8	12.3	3.0	4.3									
110	66.9	1.5	1.7	46.1	1.6	2.2	32.6	1.9	2.7	22.9	2.2	3.3	17.8	2.4	3.8	13.1	2.9	4.3									
115	70.0	1.5	1.7	48.1	1.6	2.2	34.1	1.9	2.7	24.0	2.1	3.3	18.7	2.4	3.8	13.9	2.9	4.3									
120	73.0	1.5	1.7	50.2	1.6	2.2	35.6	1.9	2.7	25.1	2.1	3.3	19.6	2.4	3.8	14.6	2.9	4.3									
125	76.1	1.5	1.7	52.3	1.6	2.2	37.1	1.9	2.7	26.2	2.1	3.3	20.5	2.4	3.8	15.4	2.8	4.3									
130	79.1	1.5	1.7	54.4	1.6	2.2	38.5	1.9	2.7	27.3	2.1	3.3	21.3	2.4	3.8	16.1	2.8	4.3									
135	82.1	1.5	1.7	56.5	1.6	2.2	40.0	1.9	2.7	28.4	2.1	3.3	22.2	2.4	3.8	16.9	2.8	4.3									
140	85.2	1.5	1.7	58.6	1.6	2.2	41.5	1.9	2.7	29.4	2.1	3.3	23.1	2.4	3.8	17.6	2.8	4.3									
145	88.2	1.5	1.7	60.7	1.6	2.2	43.0	1.9	2.7	30.5	2.1	3.3	24.0	2.4	3.8	18.3	2.8	4.3	12.3	3.7	4.9						
150	91.3	1.6	1.7	62.8	1.6	2.2	44.5	1.9	2.7	31.6	2.1	3.3	24.8	2.4	3.8	19.0	2.7	4.3	13.1	3.5	4.9						

RETARDANCE "D" AND "C"

NOTE: Width and Depth dimensions are in feet; Velocity measurements are in feet per second;
Depth "D" does not include allowance for freeboard or settlement.

Table DV-11 Parabolic Diversion Design Chart (Retardance “D” and “C”, Grade 1.00%)



V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH (D), AND V2 FOR RETARDANCE "C"

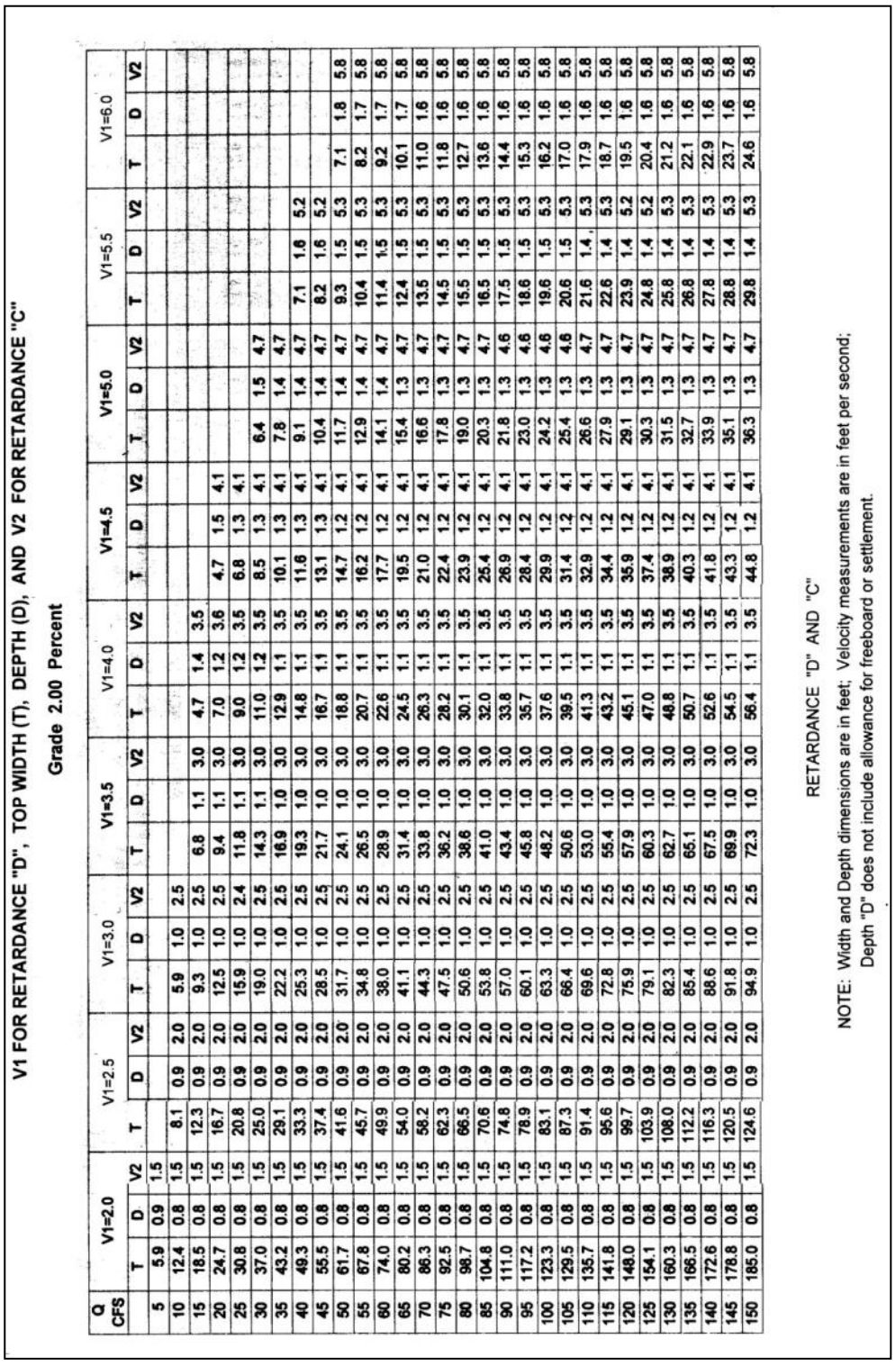
Grade 1.00 Percent

Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5																											
10	8.2	1.2	1.6	5.2	1.4	2.0																					
15	12.6	1.1	1.6	8.7	1.3	2.1	5.5	1.6	2.6																		
20	17.1	1.1	1.6	11.8	1.2	2.1	8.2	1.4	2.6																		
25	21.4	1.1	1.6	14.9	1.2	2.1	10.5	1.4	2.6	7.3	1.6	3.1															
30	25.7	1.1	1.6	18.0	1.2	2.1	12.8	1.4	2.6	9.1	1.6	3.2															
35	29.9	1.1	1.6	21.2	1.2	2.1	15.0	1.3	2.6	10.9	1.5	3.1	7.8	1.8	3.7												
40	34.2	1.1	1.6	24.3	1.2	2.1	17.3	1.3	2.6	12.6	1.5	3.1	9.2	1.7	3.7												
45	38.5	1.1	1.6	27.3	1.2	2.1	19.5	1.3	2.6	14.3	1.5	3.1	10.6	1.7	3.7	7.2	2.2	4.3									
50	42.7	1.1	1.6	30.3	1.2	2.1	21.9	1.3	2.6	16.0	1.5	3.2	11.9	1.7	3.7	8.8	2.0	4.3									
55	47.0	1.1	1.6	33.3	1.2	2.1	24.1	1.3	2.6	17.7	1.5	3.2	13.3	1.7	3.7	9.9	1.9	4.3									
60	51.3	1.1	1.6	36.3	1.2	2.1	26.3	1.3	2.6	19.3	1.5	3.2	14.6	1.7	3.7	11.0	1.9	4.3									
65	55.5	1.1	1.6	39.4	1.2	2.1	28.5	1.3	2.6	21.0	1.5	3.2	15.9	1.6	3.7	12.1	1.9	4.3	8.0	2.5	4.9						
70	59.8	1.1	1.6	42.4	1.2	2.1	30.7	1.3	2.6	22.7	1.5	3.2	17.1	1.6	3.7	13.2	1.9	4.3	9.5	2.3	4.8						
75	64.1	1.1	1.6	45.4	1.2	2.1	32.9	1.3	2.6	24.6	1.5	3.1	18.5	1.6	3.7	14.2	1.8	4.3	10.4	2.2	4.9						
80	68.3	1.1	1.6	48.4	1.2	2.1	35.0	1.3	2.6	26.2	1.5	3.1	19.8	1.6	3.7	15.2	1.8	4.3	11.3	2.2	4.9						
85	72.6	1.1	1.6	51.5	1.2	2.1	37.2	1.3	2.6	27.9	1.5	3.1	21.0	1.6	3.7	16.3	1.8	4.3	12.1	2.2	4.9	8.8	2.7	5.4			
90	76.9	1.1	1.6	54.5	1.2	2.1	39.4	1.3	2.6	29.5	1.5	3.1	22.3	1.6	3.7	17.3	1.8	4.3	13.0	2.1	4.9	9.8	2.6	5.4			
95	81.1	1.1	1.6	57.5	1.2	2.1	41.6	1.3	2.6	31.1	1.5	3.1	23.6	1.6	3.7	18.3	1.8	4.3	13.8	2.1	4.9	10.9	2.5	5.3			
100	85.4	1.1	1.6	60.5	1.2	2.1	43.8	1.3	2.6	32.7	1.5	3.1	24.9	1.6	3.7	19.3	1.8	4.3	14.6	2.1	4.9	11.6	2.4	5.4			
105	89.7	1.1	1.6	63.6	1.2	2.1	46.0	1.3	2.6	34.4	1.5	3.1	26.5	1.6	3.7	20.3	1.8	4.3	15.4	2.1	4.9	12.4	2.4	5.4	9.7	2.8	5.8
110	94.0	1.1	1.6	66.6	1.2	2.1	48.2	1.3	2.6	36.0	1.5	3.1	27.7	1.6	3.7	21.3	1.8	4.3	16.2	2.1	4.9	13.1	2.4	5.4	10.8	2.6	5.8
115	98.2	1.1	1.6	69.6	1.2	2.1	50.4	1.3	2.6	37.6	1.5	3.1	29.0	1.6	3.7	22.3	1.8	4.3	17.0	2.1	4.9	13.8	2.3	5.4	11.5	2.6	5.8
120	102.5	1.1	1.6	72.6	1.2	2.1	52.5	1.3	2.6	39.3	1.5	3.1	30.2	1.6	3.7	23.3	1.8	4.3	17.9	2.1	4.9	14.5	2.3	5.4	12.2	2.6	5.8
125	106.8	1.1	1.6	75.7	1.2	2.1	54.7	1.3	2.6	40.9	1.5	3.1	31.5	1.6	3.7	24.3	1.8	4.3	18.7	2.1	4.9	15.2	2.3	5.4	12.8	2.5	5.8
130	111.0	1.1	1.6	78.7	1.2	2.1	56.9	1.3	2.6	42.5	1.5	3.1	32.7	1.6	3.7	25.3	1.8	4.3	19.4	2.1	4.9	15.9	2.3	5.4	13.4	2.5	5.8
135	115.3	1.1	1.6	81.7	1.2	2.1	59.1	1.3	2.6	44.2	1.5	3.1	34.0	1.6	3.7	26.3	1.8	4.3	20.2	2.0	4.9	16.6	2.3	5.4	14.1	2.5	5.8
140	119.6	1.1	1.6	84.7	1.2	2.1	61.3	1.3	2.6	45.8	1.5	3.1	35.2	1.6	3.7	27.3	1.8	4.3	21.0	2.0	4.9	17.2	2.3	5.4	14.7	2.5	5.8
145	123.8	1.1	1.6	87.8	1.2	2.1	63.5	1.3	2.6	47.5	1.5	3.1	36.5	1.6	3.7	28.7	1.8	4.3	21.8	2.0	4.9	17.9	2.3	5.4	15.3	2.5	5.8
150	128.1	1.1	1.6	90.8	1.2	2.1	65.7	1.3	2.6	49.1	1.5	3.1	37.8	1.6	3.7	29.7	1.8	4.3	22.6	2.0	4.9	18.6	2.3	5.4	15.9	2.4	5.8

RETARDANCE "D" AND "C"

NOTE: Width and Depth dimensions are in feet; Velocity measurements are in feet per second;
Depth "D" does not include allowance for freeboard or settlement.

Table DV-12 Parabolic Diversion Design Chart (Retardance “D” and “C”, Grade 2.00%)



V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH (D), AND V2 FOR RETARDANCE "C"

Grade 2.00 Percent

Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5	5.9	0.9	1.5																								
10	12.4	0.8	1.5	8.1	0.9	2.0	5.9	1.0	2.5																		
15	18.5	0.8	1.5	12.3	0.9	2.0	9.3	1.0	2.5	6.8	1.1	3.0	4.7	1.4	3.5												
20	24.7	0.8	1.5	16.7	0.9	2.0	12.5	1.0	2.5	9.4	1.1	3.0	7.0	1.2	3.6	4.7	1.5	4.1									
25	30.8	0.8	1.5	20.8	0.9	2.0	15.9	1.0	2.4	11.8	1.1	3.0	9.0	1.2	3.5	6.8	1.3	4.1									
30	37.0	0.8	1.5	25.0	0.9	2.0	19.0	1.0	2.5	14.3	1.1	3.0	11.0	1.2	3.5	8.5	1.3	4.1	6.4	1.5	4.7						
35	43.2	0.8	1.5	29.1	0.9	2.0	22.2	1.0	2.5	16.9	1.0	3.0	12.9	1.1	3.5	10.1	1.3	4.1	7.8	1.4	4.7						
40	49.3	0.8	1.5	33.3	0.9	2.0	25.3	1.0	2.5	19.3	1.0	3.0	14.8	1.1	3.5	11.6	1.3	4.1	9.1	1.4	4.7	7.1	1.6	5.2			
45	55.5	0.8	1.5	37.4	0.9	2.0	28.5	1.0	2.5	21.7	1.0	3.0	16.7	1.1	3.5	13.1	1.3	4.1	10.4	1.4	4.7	8.2	1.6	5.2			
50	61.7	0.8	1.5	41.6	0.9	2.0	31.7	1.0	2.5	24.1	1.0	3.0	18.8	1.1	3.5	14.7	1.2	4.1	11.7	1.4	4.7	9.3	1.5	5.3	7.1	1.8	5.8
55	67.8	0.8	1.5	45.7	0.9	2.0	34.8	1.0	2.5	26.5	1.0	3.0	20.7	1.1	3.5	16.2	1.2	4.1	12.9	1.4	4.7	10.4	1.5	5.3	8.2	1.7	5.8
60	74.0	0.8	1.5	49.9	0.9	2.0	38.0	1.0	2.5	28.9	1.0	3.0	22.6	1.1	3.5	17.7	1.2	4.1	14.1	1.4	4.7	11.4	1.5	5.3	9.2	1.7	5.8
65	80.2	0.8	1.5	54.0	0.9	2.0	41.1	1.0	2.5	31.4	1.0	3.0	24.5	1.1	3.5	19.5	1.2	4.1	15.4	1.3	4.7	12.4	1.5	5.3	10.1	1.7	5.8
70	86.3	0.8	1.5	58.2	0.9	2.0	44.3	1.0	2.5	33.8	1.0	3.0	26.3	1.1	3.5	21.0	1.2	4.1	16.6	1.3	4.7	13.5	1.5	5.3	11.0	1.6	5.8
75	92.5	0.8	1.5	62.3	0.9	2.0	47.5	1.0	2.5	36.2	1.0	3.0	28.2	1.1	3.5	22.4	1.2	4.1	17.8	1.3	4.7	14.5	1.5	5.3	11.8	1.6	5.8
80	98.7	0.8	1.5	66.5	0.9	2.0	50.6	1.0	2.5	38.6	1.0	3.0	30.1	1.1	3.5	23.9	1.2	4.1	19.0	1.3	4.7	15.5	1.5	5.3	12.7	1.6	5.8
85	104.8	0.8	1.5	70.6	0.9	2.0	53.8	1.0	2.5	41.0	1.0	3.0	32.0	1.1	3.5	25.4	1.2	4.1	20.3	1.3	4.7	16.5	1.5	5.3	13.6	1.6	5.8
90	111.0	0.8	1.5	74.8	0.9	2.0	57.0	1.0	2.5	43.4	1.0	3.0	33.8	1.1	3.5	26.9	1.2	4.1	21.8	1.3	4.6	17.5	1.5	5.3	14.4	1.6	5.8
95	117.2	0.8	1.5	78.9	0.9	2.0	60.1	1.0	2.5	45.8	1.0	3.0	35.7	1.1	3.5	28.4	1.2	4.1	23.0	1.3	4.6	18.6	1.5	5.3	15.3	1.6	5.8
100	123.3	0.8	1.5	83.1	0.9	2.0	63.3	1.0	2.5	48.2	1.0	3.0	37.6	1.1	3.5	29.9	1.2	4.1	24.2	1.3	4.6	19.6	1.5	5.3	16.2	1.6	5.8
105	129.5	0.8	1.5	87.3	0.9	2.0	66.4	1.0	2.5	50.6	1.0	3.0	39.5	1.1	3.5	31.4	1.2	4.1	25.4	1.3	4.6	20.6	1.5	5.3	17.0	1.6	5.8
110	135.7	0.8	1.5	91.4	0.9	2.0	69.6	1.0	2.5	53.0	1.0	3.0	41.3	1.1	3.5	32.9	1.2	4.1	26.6	1.3	4.7	21.6	1.4	5.3	17.9	1.6	5.8
115	141.8	0.8	1.5	95.6	0.9	2.0	72.8	1.0	2.5	55.4	1.0	3.0	43.2	1.1	3.5	34.4	1.2	4.1	27.9	1.3	4.7	22.6	1.4	5.3	18.7	1.6	5.8
120	148.0	0.8	1.5	99.7	0.9	2.0	75.9	1.0	2.5	57.9	1.0	3.0	45.1	1.1	3.5	35.9	1.2	4.1	29.1	1.3	4.7	23.9	1.4	5.2	19.5	1.6	5.8
125	154.1	0.8	1.5	103.9	0.9	2.0	79.1	1.0	2.5	60.3	1.0	3.0	47.0	1.1	3.5	37.4	1.2	4.1	30.3	1.3	4.7	24.8	1.4	5.2	20.4	1.6	5.8
130	160.3	0.8	1.5	108.0	0.9	2.0	82.3	1.0	2.5	62.7	1.0	3.0	48.8	1.1	3.5	38.9	1.2	4.1	31.5	1.3	4.7	25.8	1.4	5.3	21.2	1.6	5.8
135	166.5	0.8	1.5	112.2	0.9	2.0	85.4	1.0	2.5	65.1	1.0	3.0	50.7	1.1	3.5	40.3	1.2	4.1	32.7	1.3	4.7	26.8	1.4	5.3	22.1	1.6	5.8
140	172.6	0.8	1.5	116.3	0.9	2.0	88.6	1.0	2.5	67.5	1.0	3.0	52.6	1.1	3.5	41.8	1.2	4.1	33.9	1.3	4.7	27.8	1.4	5.3	22.9	1.6	5.8
145	178.8	0.8	1.5	120.5	0.9	2.0	91.8	1.0	2.5	69.9	1.0	3.0	54.5	1.1	3.5	43.3	1.2	4.1	35.1	1.3	4.7	28.8	1.4	5.3	23.7	1.6	5.8
150	185.0	0.8	1.5	124.6	0.9	2.0	94.9	1.0	2.5	72.3	1.0	3.0	56.4	1.1	3.5	44.8	1.2	4.1	36.3	1.3	4.7	29.8	1.4	5.3	24.6	1.6	5.8

RETARDANCE "D" AND "C"

NOTE: Width and Depth dimensions are in feet; Velocity measurements are in feet per second;
Depth "D" does not include allowance for freeboard or settlement.

Table DV-13 Parabolic Diversion Design Chart (Retardance “D” and “C”, Grade 4.00%)

V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH (D), AND V2 FOR RETARDANCE "C"

Grade 4.00 Percent

Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5	8.5	0.6	1.4	5.9	0.7	1.8	4.1	0.8	2.3																		
10	17.2	0.6	1.4	12.1	0.7	1.8	8.8	0.7	2.3	6.7	0.8	2.8	5.2	0.9	3.3	3.8	1.0	3.9									
15	25.8	0.6	1.4	18.1	0.7	1.8	13.4	0.7	2.3	10.3	0.8	2.8	8.1	0.8	3.4	6.4	0.9	3.9	4.9	1.0	4.5						
20	34.4	0.6	1.4	24.2	0.7	1.8	17.8	0.7	2.3	13.9	0.8	2.8	10.9	0.8	3.4	8.7	0.9	3.9	6.9	1.0	4.5	5.5	1.1	5.0			
25	43.0	0.6	1.4	30.2	0.7	1.9	22.3	0.7	2.3	17.4	0.8	2.8	13.8	0.8	3.3	10.9	0.9	3.9	8.6	1.0	4.5	7.1	1.0	5.1	5.7	1.2	5.6
30	51.6	0.6	1.4	36.3	0.7	1.9	26.7	0.7	2.3	20.8	0.8	2.8	16.5	0.8	3.3	13.2	0.9	3.9	10.7	0.9	4.5	8.7	1.0	5.1	7.1	1.1	5.6
35	60.2	0.6	1.4	42.3	0.7	1.9	31.1	0.7	2.3	24.3	0.8	2.8	19.3	0.8	3.4	15.6	0.9	3.9	12.5	0.9	4.5	10.3	1.0	5.0	8.4	1.1	5.6
40	68.8	0.6	1.4	48.3	0.7	1.9	35.6	0.7	2.3	27.8	0.8	2.8	22.0	0.8	3.4	17.8	0.9	3.9	14.4	0.9	4.5	11.8	1.0	5.0	9.8	1.1	5.7
45	77.4	0.6	1.4	54.4	0.7	1.9	40.0	0.7	2.4	31.2	0.8	2.8	24.8	0.8	3.4	20.0	0.9	3.9	16.4	0.9	4.4	13.3	1.0	5.0	11.1	1.1	5.7
50	86.0	0.6	1.4	60.4	0.7	1.9	44.5	0.7	2.4	34.7	0.8	2.8	27.5	0.8	3.4	22.2	0.9	3.9	18.2	0.9	4.4	14.9	1.0	5.0	12.3	1.1	5.7
55	94.6	0.6	1.4	66.5	0.7	1.9	48.9	0.7	2.4	38.2	0.8	2.8	30.3	0.8	3.4	24.4	0.9	3.9	20.0	0.9	4.4	16.6	1.0	5.0	13.6	1.1	5.7
60	103.2	0.6	1.4	72.5	0.7	1.9	53.4	0.7	2.4	41.7	0.8	2.8	33.0	0.8	3.4	26.6	0.9	3.9	21.8	0.9	4.5	18.1	1.0	5.0	14.9	1.1	5.7
65	111.8	0.6	1.4	78.5	0.7	1.9	57.8	0.7	2.4	45.1	0.8	2.8	35.8	0.8	3.4	28.9	0.9	3.9	23.6	0.9	4.5	19.6	1.0	5.0	16.2	1.1	5.7
70	120.4	0.6	1.4	84.6	0.7	1.9	62.3	0.7	2.4	48.6	0.8	2.8	38.6	0.8	3.4	31.1	0.9	3.9	25.4	0.9	4.5	21.1	1.0	5.0	17.7	1.1	5.6
75	129.0	0.6	1.4	90.6	0.7	1.9	66.7	0.7	2.4	52.1	0.8	2.8	41.3	0.8	3.4	33.3	0.9	3.9	27.2	0.9	4.5	22.6	1.0	5.0	19.0	1.1	5.6
80	137.6	0.6	1.4	96.7	0.7	1.9	71.2	0.7	2.4	55.5	0.8	2.8	44.1	0.8	3.4	35.5	0.9	3.9	29.1	0.9	4.5	24.1	1.0	5.0	20.2	1.1	5.6
85	146.2	0.6	1.4	102.7	0.7	1.9	75.6	0.7	2.4	59.0	0.8	2.8	46.8	0.8	3.4	37.7	0.9	3.9	30.9	0.9	4.5	25.6	1.0	5.0	21.5	1.1	5.6
90	154.8	0.6	1.4	108.7	0.7	1.9	80.0	0.7	2.4	62.5	0.8	2.8	49.6	0.8	3.4	39.9	0.9	3.9	32.7	0.9	4.5	27.1	1.0	5.0	22.8	1.1	5.6
95	163.4	0.6	1.4	114.8	0.7	1.9	84.5	0.7	2.4	65.9	0.8	2.8	52.3	0.8	3.4	42.2	0.9	3.9	34.5	0.9	4.5	28.6	1.0	5.0	24.0	1.1	5.6
100	172.0	0.6	1.4	120.8	0.7	1.9	88.9	0.7	2.4	69.4	0.8	2.8	55.1	0.8	3.4	44.4	0.9	3.9	36.3	0.9	4.5	30.1	1.0	5.0	25.3	1.1	5.6
105	180.6	0.6	1.4	126.9	0.7	1.9	93.4	0.7	2.4	72.9	0.8	2.8	57.8	0.8	3.4	46.6	0.9	3.9	38.1	0.9	4.5	31.6	1.0	5.0	26.5	1.1	5.6
110	189.2	0.6	1.4	132.9	0.7	1.9	97.8	0.7	2.4	76.3	0.8	2.8	60.6	0.8	3.4	48.8	0.9	3.9	39.9	0.9	4.5	33.1	1.0	5.0	27.8	1.1	5.6
115	197.8	0.6	1.4	138.9	0.7	1.9	102.3	0.7	2.4	79.8	0.8	2.8	63.3	0.8	3.4	51.0	0.9	3.9	41.7	0.9	4.5	34.6	1.0	5.0	29.0	1.1	5.6
120	206.4	0.6	1.4	145.0	0.7	1.9	106.7	0.7	2.4	83.3	0.8	2.8	66.1	0.8	3.4	53.3	0.9	3.9	43.6	0.9	4.5	36.1	1.0	5.0	30.2	1.1	5.7
125	215.0	0.6	1.4	151.0	0.7	1.9	111.2	0.7	2.4	86.8	0.8	2.8	68.8	0.8	3.4	55.5	0.9	3.9	45.4	0.9	4.5	37.6	1.0	5.0	31.5	1.1	5.7
130	223.7	0.6	1.4	157.1	0.7	1.9	115.6	0.7	2.4	90.2	0.8	2.8	71.6	0.8	3.4	57.7	0.9	3.9	47.2	0.9	4.5	39.1	1.0	5.0	32.7	1.1	5.7
135	232.3	0.6	1.4	163.1	0.7	1.9	120.1	0.7	2.4	93.7	0.8	2.8	74.3	0.8	3.4	59.9	0.9	3.9	49.0	0.9	4.5	40.6	1.0	5.0	34.0	1.1	5.7
140	240.9	0.6	1.4	169.1	0.7	1.9	124.5	0.7	2.4	97.2	0.8	2.8	77.1	0.8	3.4	62.1	0.9	3.9	50.8	0.9	4.5	42.1	1.0	5.0	35.2	1.1	5.7
145	249.5	0.6	1.4	175.2	0.7	1.9	129.0	0.7	2.4	100.6	0.8	2.8	79.8	0.8	3.4	64.3	0.9	3.9	52.6	0.9	4.5	43.6	1.0	5.0	36.5	1.1	5.7
150	258.1	0.6	1.4	181.2	0.7	1.9	133.4	0.7	2.4	104.1	0.8	2.8	82.6	0.8	3.4	66.6	0.9	3.9	54.4	0.9	4.5	45.1	1.0	5.0	37.8	1.1	5.7

RETARDANCE "D" AND "C"

NOTE: Width and Depth dimensions are in feet; Velocity measurements are in feet per second;
Depth "D" does not include allowance for freeboard or settlement.

Table DV-14 Parabolic Diversion Design Chart (Retardance “D” and “C”, Grade 6.00%)

V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH (D), AND V2 FOR RETARDANCE "C"

Grade 6.00 Percent

Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5	10.6	0.5	1.3	7.3	0.6	1.8	5.3	0.6	2.3	4.0	0.7	2.8	2.9	0.8	3.2												
10	21.1	0.5	1.3	14.7	0.6	1.8	10.9	0.6	2.3	8.4	0.7	2.8	6.6	0.7	3.2	5.3	0.8	3.8	4.2	0.8	4.3						
15	31.6	0.5	1.3	22.1	0.6	1.8	16.3	0.6	2.3	12.7	0.6	2.7	10.1	0.7	3.3	8.2	0.7	3.8	6.6	0.8	4.3	5.4	0.9	4.9	4.3	1.0	5.5
20	42.1	0.5	1.3	29.5	0.6	1.8	21.7	0.6	2.3	17.0	0.6	2.7	13.6	0.7	3.2	11.1	0.7	3.7	9.0	0.8	4.3	7.4	0.8	4.9	6.1	0.9	5.5
25	52.7	0.5	1.3	36.8	0.6	1.8	27.1	0.6	2.3	21.2	0.6	2.8	17.0	0.7	3.2	13.9	0.7	3.8	11.3	0.8	4.3	9.3	0.8	4.9	7.8	0.9	5.5
30	63.2	0.5	1.3	44.2	0.6	1.8	32.5	0.6	2.3	25.4	0.6	2.8	20.4	0.7	3.2	16.6	0.7	3.8	13.7	0.8	4.3	11.3	0.8	4.9	9.4	0.9	5.5
35	73.7	0.5	1.3	51.6	0.6	1.8	38.0	0.6	2.3	29.7	0.6	2.8	23.8	0.7	3.2	19.4	0.7	3.8	16.0	0.8	4.3	13.4	0.8	4.9	11.1	0.9	5.5
40	84.2	0.5	1.3	58.9	0.6	1.8	43.4	0.6	2.3	33.9	0.6	2.8	27.2	0.7	3.3	22.2	0.7	3.8	18.3	0.8	4.3	15.3	0.8	4.9	12.7	0.9	5.5
45	94.8	0.5	1.3	66.3	0.6	1.8	48.8	0.6	2.3	38.2	0.6	2.8	30.7	0.7	3.3	24.9	0.7	3.8	20.6	0.8	4.3	17.2	0.8	4.9	14.5	0.9	5.4
50	105.3	0.5	1.3	73.6	0.6	1.8	54.2	0.6	2.3	42.4	0.6	2.8	34.1	0.7	3.3	27.7	0.7	3.8	22.8	0.8	4.3	19.1	0.8	4.9	16.1	0.9	5.4
55	115.8	0.5	1.3	81.0	0.6	1.8	59.7	0.6	2.3	46.6	0.6	2.8	37.5	0.7	3.3	30.5	0.7	3.8	25.1	0.8	4.3	21.0	0.8	4.9	17.7	0.9	5.4
60	126.4	0.5	1.3	88.4	0.6	1.8	65.1	0.6	2.3	50.9	0.6	2.8	40.9	0.7	3.3	33.3	0.7	3.8	27.4	0.8	4.3	22.9	0.8	4.9	19.3	0.9	5.4
65	136.9	0.5	1.3	95.7	0.6	1.8	70.5	0.6	2.3	55.1	0.6	2.8	44.3	0.7	3.3	36.0	0.7	3.8	29.7	0.8	4.3	24.8	0.8	4.9	20.9	0.9	5.4
70	147.4	0.5	1.3	103.1	0.6	1.8	75.9	0.6	2.3	59.3	0.6	2.8	47.7	0.7	3.3	38.8	0.7	3.8	32.0	0.8	4.3	26.7	0.8	4.9	22.5	0.9	5.4
75	158.0	0.5	1.3	110.5	0.6	1.8	81.3	0.6	2.3	63.6	0.6	2.8	51.1	0.7	3.3	41.6	0.7	3.8	34.3	0.8	4.3	28.6	0.8	4.9	24.1	0.9	5.4
80	168.5	0.5	1.3	117.8	0.6	1.8	86.8	0.6	2.3	67.8	0.6	2.8	54.5	0.7	3.3	44.3	0.7	3.8	36.5	0.8	4.3	30.5	0.8	4.9	25.7	0.9	5.5
85	179.0	0.5	1.3	125.2	0.6	1.8	92.2	0.6	2.3	72.0	0.6	2.8	57.9	0.7	3.3	47.1	0.7	3.8	38.8	0.8	4.3	32.4	0.8	4.9	27.3	0.9	5.5
90	189.6	0.5	1.3	132.6	0.6	1.8	97.6	0.6	2.3	76.3	0.6	2.8	61.3	0.7	3.3	49.9	0.7	3.8	41.1	0.8	4.3	34.3	0.8	4.9	28.9	0.9	5.5
95	200.1	0.5	1.3	139.9	0.6	1.8	103.0	0.6	2.3	80.5	0.6	2.8	64.7	0.7	3.3	52.6	0.7	3.8	43.4	0.8	4.3	36.2	0.8	4.9	30.5	0.9	5.5
100	210.6	0.5	1.3	147.3	0.6	1.8	108.5	0.6	2.3	84.8	0.6	2.8	68.1	0.7	3.3	55.4	0.7	3.8	45.7	0.8	4.3	38.1	0.8	4.9	32.1	0.9	5.5
105	221.1	0.5	1.3	154.6	0.6	1.8	113.9	0.6	2.3	89.0	0.6	2.8	71.5	0.7	3.3	58.2	0.7	3.8	47.9	0.8	4.3	40.0	0.8	4.9	33.7	0.9	5.5
110	231.7	0.5	1.3	162.0	0.6	1.8	119.3	0.6	2.3	93.2	0.6	2.8	74.9	0.7	3.3	60.9	0.7	3.8	50.2	0.8	4.3	41.9	0.8	4.9	35.3	0.9	5.5
115	242.2	0.5	1.3	169.4	0.6	1.8	124.7	0.6	2.3	97.5	0.6	2.8	78.3	0.7	3.3	63.7	0.7	3.8	52.5	0.8	4.3	43.8	0.8	4.9	36.9	0.9	5.5
120	252.7	0.5	1.3	176.7	0.6	1.8	130.2	0.6	2.3	101.7	0.6	2.8	81.7	0.7	3.3	66.5	0.7	3.8	54.8	0.8	4.3	45.7	0.8	4.9	38.5	0.9	5.5
125	263.3	0.5	1.3	184.1	0.6	1.8	135.6	0.6	2.3	106.0	0.6	2.8	85.1	0.7	3.3	69.3	0.7	3.8	57.1	0.8	4.3	47.6	0.8	4.9	40.1	0.9	5.5
130	273.8	0.5	1.3	191.5	0.6	1.8	141.0	0.6	2.3	110.2	0.6	2.8	88.5	0.7	3.3	72.0	0.7	3.8	59.4	0.8	4.3	49.5	0.8	4.9	41.7	0.9	5.5
135	284.3	0.5	1.3	198.8	0.6	1.8	146.4	0.6	2.3	114.4	0.6	2.8	91.9	0.7	3.3	74.8	0.7	3.8	61.6	0.8	4.3	51.4	0.8	4.9	43.3	0.9	5.5
140	294.9	0.5	1.3	206.2	0.6	1.8	151.8	0.6	2.3	118.7	0.6	2.8	95.3	0.7	3.3	77.6	0.7	3.8	63.9	0.8	4.3	53.3	0.8	4.9	44.9	0.9	5.5
145	305.4	0.5	1.3	213.6	0.6	1.8	157.3	0.6	2.3	122.9	0.6	2.8	98.7	0.7	3.3	80.3	0.7	3.8	66.2	0.8	4.3	55.2	0.8	4.9	46.5	0.9	5.5
150	315.9	0.5	1.3	220.9	0.6	1.8	162.7	0.6	2.3	127.1	0.6	2.8	102.1	0.7	3.3	83.1	0.7	3.8	68.5	0.8	4.3	57.1	0.8	4.9	48.1	0.9	5.5

RETARDANCE "D" AND "C"

NOTE: Width and Depth dimensions are in feet; Velocity measurements are in feet per second.
Depth "D" does not include allowance for freeboard or settlement.

Table DV-15 Parabolic Diversion Design Chart (Retardance “D” and “C”, Grade 8.00%)

V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH (D), AND V2 FOR RETARDANCE "C"

Grade 8.00 Percent

Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5	12.0	0.5	1.3	8.5	0.5	1.7	6.2	0.5	2.2	4.6	0.6	2.7	3.7	0.6	3.2	2.9	0.7	3.6									
10	24.1	0.5	1.3	16.9	0.5	1.7	12.6	0.5	2.2	9.6	0.6	2.7	7.8	0.6	3.2	6.3	0.6	3.7	5.1	0.7	4.2	4.2	0.8	4.8	3.2	0.9	5.3
15	36.1	0.5	1.3	25.3	0.5	1.7	18.9	0.5	2.2	14.4	0.6	2.7	11.8	0.6	3.2	9.7	0.6	3.7	7.9	0.7	4.2	6.5	0.7	4.8	5.4	0.8	5.3
20	48.1	0.5	1.3	33.8	0.5	1.7	25.2	0.5	2.2	19.2	0.6	2.7	15.8	0.6	3.2	12.9	0.6	3.7	10.7	0.7	4.2	8.8	0.7	4.8	7.4	0.8	5.3
25	60.1	0.5	1.3	42.2	0.5	1.7	31.5	0.5	2.2	24.0	0.6	2.7	19.7	0.6	3.2	16.2	0.6	3.7	13.4	0.7	4.2	11.2	0.7	4.7	9.3	0.8	5.3
30	72.1	0.5	1.3	50.6	0.5	1.7	37.8	0.5	2.2	28.8	0.6	2.7	23.6	0.6	3.2	19.4	0.6	3.7	16.1	0.7	4.2	13.5	0.7	4.8	11.3	0.7	5.3
35	84.1	0.5	1.3	59.1	0.5	1.7	44.1	0.5	2.2	33.6	0.6	2.7	27.6	0.6	3.2	22.6	0.6	3.7	18.7	0.7	4.2	15.7	0.7	4.8	13.3	0.7	5.3
40	96.2	0.5	1.3	67.5	0.5	1.7	50.4	0.5	2.2	38.4	0.6	2.7	31.5	0.6	3.2	25.8	0.6	3.7	21.4	0.7	4.2	17.9	0.7	4.8	15.2	0.7	5.3
45	108.2	0.5	1.3	76.0	0.5	1.7	56.7	0.5	2.2	43.2	0.6	2.7	35.4	0.6	3.2	29.0	0.6	3.7	24.1	0.7	4.2	20.2	0.7	4.8	17.1	0.7	5.3
50	120.2	0.5	1.3	84.4	0.5	1.7	63.0	0.5	2.2	48.0	0.6	2.7	39.4	0.6	3.2	32.3	0.6	3.7	26.8	0.7	4.2	22.4	0.7	4.8	19.0	0.7	5.3
55	132.2	0.5	1.3	92.8	0.5	1.7	69.3	0.5	2.2	52.8	0.6	2.7	43.3	0.6	3.2	35.5	0.6	3.7	29.4	0.7	4.2	24.7	0.7	4.8	20.9	0.7	5.3
60	144.2	0.5	1.3	101.3	0.5	1.7	75.6	0.5	2.2	57.6	0.6	2.7	47.2	0.6	3.2	38.7	0.6	3.7	32.1	0.7	4.2	26.9	0.7	4.8	22.8	0.7	5.3
65	156.3	0.5	1.3	109.7	0.5	1.7	81.8	0.5	2.2	62.4	0.6	2.7	51.2	0.6	3.2	41.9	0.6	3.7	34.8	0.7	4.2	29.1	0.7	4.8	24.7	0.7	5.3
70	168.3	0.5	1.3	118.2	0.5	1.7	88.1	0.5	2.2	67.2	0.6	2.7	55.1	0.6	3.2	45.2	0.6	3.7	37.5	0.7	4.2	31.4	0.7	4.8	26.6	0.7	5.3
75	180.3	0.5	1.3	126.6	0.5	1.7	94.4	0.5	2.2	72.0	0.6	2.7	59.0	0.6	3.2	48.4	0.6	3.7	40.1	0.7	4.2	33.6	0.7	4.8	28.5	0.7	5.3
80	192.3	0.5	1.3	135.0	0.5	1.7	100.7	0.5	2.2	76.8	0.6	2.7	63.0	0.6	3.2	51.6	0.6	3.7	42.8	0.7	4.2	35.9	0.7	4.8	30.3	0.7	5.3
85	204.3	0.5	1.3	143.5	0.5	1.7	107.0	0.5	2.2	81.6	0.6	2.7	66.9	0.6	3.2	54.9	0.6	3.7	45.5	0.7	4.2	38.1	0.7	4.8	32.2	0.7	5.3
90	216.4	0.5	1.3	151.9	0.5	1.7	113.3	0.5	2.2	86.4	0.6	2.7	70.8	0.6	3.2	58.1	0.6	3.7	48.1	0.7	4.2	40.3	0.7	4.8	34.1	0.7	5.3
95	228.4	0.5	1.3	160.3	0.5	1.7	119.6	0.5	2.2	91.2	0.6	2.7	74.8	0.6	3.2	61.3	0.6	3.7	50.8	0.7	4.2	42.6	0.7	4.8	36.0	0.7	5.3
100	240.4	0.5	1.3	168.8	0.5	1.7	125.9	0.5	2.2	96.0	0.6	2.7	78.7	0.6	3.2	64.5	0.6	3.7	53.5	0.7	4.2	44.8	0.7	4.8	37.9	0.7	5.3
105	252.4	0.5	1.3	177.2	0.5	1.7	132.2	0.5	2.2	100.8	0.6	2.7	82.6	0.6	3.2	67.8	0.6	3.7	56.2	0.7	4.2	47.1	0.7	4.8	39.8	0.7	5.3
110	264.4	0.5	1.3	185.7	0.5	1.7	138.5	0.5	2.2	105.6	0.6	2.7	86.6	0.6	3.2	71.0	0.6	3.7	58.8	0.7	4.2	49.3	0.7	4.8	41.7	0.7	5.3
115	276.5	0.5	1.3	194.1	0.5	1.7	144.8	0.5	2.2	110.4	0.6	2.7	90.5	0.6	3.2	74.2	0.6	3.7	61.5	0.7	4.2	51.5	0.7	4.8	43.6	0.7	5.3
120	288.5	0.5	1.3	202.5	0.5	1.7	151.1	0.5	2.2	115.2	0.6	2.7	94.4	0.6	3.2	77.4	0.6	3.7	64.2	0.7	4.2	53.8	0.7	4.8	45.5	0.7	5.3
125	300.5	0.5	1.3	211.0	0.5	1.7	157.4	0.5	2.2	120.0	0.6	2.7	98.4	0.6	3.2	80.7	0.6	3.7	66.9	0.7	4.2	56.0	0.7	4.8	47.4	0.7	5.3
130	312.5	0.5	1.3	219.4	0.5	1.7	163.7	0.5	2.2	124.8	0.6	2.7	102.3	0.6	3.2	83.9	0.6	3.7	69.5	0.7	4.2	58.3	0.7	4.8	49.3	0.7	5.3
135	324.5	0.5	1.3	227.9	0.5	1.7	170.0	0.5	2.2	129.6	0.6	2.7	106.2	0.6	3.2	87.1	0.6	3.7	72.2	0.7	4.2	60.5	0.7	4.8	51.2	0.7	5.3
140	336.6	0.5	1.3	236.3	0.5	1.7	176.3	0.5	2.2	134.4	0.6	2.7	110.2	0.6	3.2	90.3	0.6	3.7	74.9	0.7	4.2	62.7	0.7	4.8	53.1	0.7	5.3
145	348.6	0.5	1.3	244.7	0.5	1.7	182.6	0.5	2.2	139.2	0.6	2.7	114.1	0.6	3.2	93.6	0.6	3.7	77.6	0.7	4.2	65.0	0.7	4.8	55.0	0.7	5.3
150	360.6	0.5	1.3	253.2	0.5	1.7	188.9	0.5	2.2	144.0	0.6	2.7	118.0	0.6	3.2	96.8	0.6	3.7	80.2	0.7	4.2	67.2	0.7	4.8	56.9	0.7	5.3

RETARDANCE "D" AND "C"

NOTE: Width and Depth dimensions are in feet; Velocity measurements are in feet per second
Depth "D" does not include allowance for freeboard or settlement

Table DV-16 Parabolic Diversion Design Chart (Retardance “D” and “C”, Grade 10.00%)

V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH (D), AND V2 FOR RETARDANCE "C"

Grade 10.00 Percent

Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5	13.3	0.4	1.3	9.4	0.5	1.7	6.8	0.5	2.2	5.3	0.5	2.6	4.1	0.6	3.2	3.4	0.6	3.6	2.6	0.7	4.1						
10	26.6	0.4	1.3	18.7	0.5	1.7	13.8	0.5	2.2	10.9	0.5	2.6	8.5	0.6	3.2	7.1	0.6	3.6	5.9	0.6	4.1	4.9	0.7	4.7	4.0	0.7	5.3
15	39.9	0.4	1.3	28.0	0.5	1.7	20.7	0.5	2.2	16.3	0.5	2.6	12.8	0.6	3.2	10.9	0.6	3.6	9.0	0.6	4.1	7.5	0.6	4.7	6.3	0.7	5.2
20	53.2	0.4	1.3	37.4	0.5	1.7	27.6	0.5	2.2	21.7	0.5	2.7	17.0	0.6	3.2	14.5	0.6	3.6	12.1	0.6	4.1	10.2	0.8	4.6	8.5	0.7	5.2
25	66.5	0.4	1.3	46.7	0.5	1.7	34.5	0.5	2.2	27.1	0.5	2.7	21.3	0.6	3.2	18.1	0.6	3.6	15.1	0.6	4.1	12.7	0.6	4.7	10.8	0.7	5.2
30	79.8	0.4	1.3	56.1	0.5	1.7	41.4	0.5	2.2	32.5	0.5	2.7	25.5	0.6	3.2	21.7	0.6	3.6	18.1	0.6	4.1	15.2	0.6	4.7	12.9	0.7	5.2
35	93.1	0.4	1.3	65.4	0.5	1.7	48.3	0.5	2.2	37.9	0.5	2.7	29.8	0.6	3.2	25.3	0.6	3.6	21.1	0.6	4.1	17.8	0.6	4.7	15.1	0.7	5.2
40	106.4	0.4	1.3	74.7	0.5	1.7	55.2	0.5	2.2	43.3	0.5	2.7	34.0	0.6	3.2	29.0	0.6	3.6	24.1	0.6	4.1	20.3	0.6	4.7	17.2	0.7	5.2
45	119.7	0.4	1.3	84.1	0.5	1.7	62.1	0.5	2.2	48.8	0.5	2.7	38.3	0.6	3.2	32.6	0.6	3.6	27.2	0.6	4.1	22.8	0.6	4.7	19.4	0.7	5.2
50	133.0	0.4	1.3	93.4	0.5	1.7	69.0	0.5	2.2	54.2	0.5	2.7	42.5	0.6	3.2	36.2	0.6	3.6	30.2	0.6	4.1	25.4	0.6	4.7	21.5	0.7	5.2
55	146.3	0.4	1.3	102.8	0.5	1.7	75.9	0.5	2.2	59.6	0.5	2.7	46.8	0.6	3.2	39.8	0.6	3.6	33.2	0.6	4.1	27.9	0.6	4.7	23.7	0.7	5.2
60	159.6	0.4	1.3	112.1	0.5	1.7	82.8	0.5	2.2	65.0	0.5	2.7	51.0	0.6	3.2	43.4	0.6	3.6	36.2	0.6	4.1	30.5	0.6	4.7	25.9	0.7	5.2
65	172.9	0.4	1.3	121.4	0.5	1.7	89.7	0.5	2.2	70.4	0.5	2.7	55.3	0.6	3.2	47.1	0.6	3.6	39.2	0.6	4.1	33.0	0.6	4.7	28.0	0.7	5.2
70	186.2	0.4	1.3	130.8	0.5	1.7	96.6	0.5	2.2	75.8	0.5	2.7	59.5	0.6	3.2	50.7	0.6	3.6	42.2	0.6	4.1	35.5	0.6	4.7	30.2	0.7	5.2
75	199.5	0.4	1.3	140.1	0.5	1.7	103.5	0.5	2.2	81.2	0.5	2.7	63.8	0.6	3.2	54.3	0.6	3.6	45.2	0.6	4.1	38.1	0.6	4.7	32.3	0.7	5.2
80	212.8	0.4	1.3	149.5	0.5	1.7	110.5	0.5	2.2	86.7	0.5	2.7	68.0	0.6	3.2	57.9	0.6	3.6	48.3	0.6	4.1	40.6	0.6	4.7	34.5	0.7	5.2
85	226.1	0.4	1.3	158.8	0.5	1.7	117.4	0.5	2.2	92.1	0.5	2.7	72.3	0.6	3.2	61.5	0.6	3.6	51.3	0.6	4.1	43.1	0.6	4.7	36.6	0.7	5.2
90	239.4	0.4	1.3	168.1	0.5	1.7	124.3	0.5	2.2	97.5	0.5	2.7	76.5	0.6	3.2	65.2	0.6	3.6	54.3	0.6	4.1	45.7	0.6	4.7	38.8	0.7	5.2
95	252.7	0.4	1.3	177.5	0.5	1.7	131.2	0.5	2.2	102.9	0.5	2.7	80.8	0.6	3.2	68.8	0.6	3.6	57.3	0.6	4.1	48.2	0.6	4.7	40.9	0.7	5.2
100	266.0	0.4	1.3	186.8	0.5	1.7	138.1	0.5	2.2	108.3	0.5	2.7	85.0	0.6	3.2	72.4	0.6	3.6	60.3	0.6	4.1	50.7	0.6	4.7	43.1	0.7	5.2
105	279.3	0.4	1.3	196.2	0.5	1.7	145.0	0.5	2.2	113.7	0.5	2.7	89.3	0.6	3.2	76.0	0.6	3.6	63.3	0.6	4.1	53.3	0.6	4.7	45.2	0.7	5.2
110	292.6	0.4	1.3	205.5	0.5	1.7	151.9	0.5	2.2	119.2	0.5	2.7	93.5	0.6	3.2	79.6	0.6	3.6	66.4	0.6	4.1	55.8	0.6	4.7	47.4	0.7	5.2
115	305.9	0.4	1.3	214.9	0.5	1.7	158.8	0.5	2.2	124.8	0.5	2.7	97.8	0.6	3.2	83.3	0.6	3.6	69.4	0.6	4.1	58.3	0.6	4.7	49.5	0.7	5.3
120	319.2	0.4	1.3	224.2	0.5	1.7	165.7	0.5	2.2	130.0	0.5	2.7	102.0	0.6	3.2	86.9	0.6	3.6	72.4	0.6	4.1	60.9	0.6	4.7	51.7	0.7	5.3
125	332.5	0.4	1.3	233.5	0.5	1.7	172.6	0.5	2.2	135.4	0.5	2.7	106.3	0.6	3.2	90.5	0.6	3.6	75.4	0.6	4.1	63.4	0.6	4.7	53.8	0.7	5.3
130	345.8	0.4	1.3	242.9	0.5	1.7	179.5	0.5	2.2	140.8	0.5	2.7	110.5	0.6	3.2	94.1	0.6	3.6	78.4	0.6	4.1	66.0	0.6	4.7	56.0	0.7	5.3
135	359.1	0.4	1.3	252.2	0.5	1.7	186.4	0.5	2.2	146.2	0.5	2.7	114.8	0.6	3.2	97.7	0.6	3.6	81.4	0.6	4.1	68.5	0.6	4.7	58.1	0.7	5.3
140	372.4	0.4	1.3	261.6	0.5	1.7	193.3	0.5	2.2	151.7	0.5	2.7	119.0	0.6	3.2	101.3	0.6	3.6	84.4	0.6	4.1	71.0	0.6	4.7	60.3	0.7	5.3
145	385.7	0.4	1.3	270.9	0.5	1.7	200.2	0.5	2.2	157.1	0.5	2.7	123.3	0.6	3.2	105.0	0.6	3.6	87.5	0.6	4.1	73.6	0.6	4.7	62.5	0.7	5.3
150	399.0	0.4	1.3	280.2	0.5	1.7	207.1	0.5	2.2	162.5	0.5	2.7	127.5	0.6	3.2	108.6	0.6	3.6	90.5	0.6	4.1	76.1	0.6	4.7	64.6	0.7	5.3

RETARDANCE "D" AND "C"

NOTE: Width and Depth dimensions are in feet; Velocity measurements are in feet per second;
Depth "D" does not include allowance for freeboard or settlement.

Grass Swale (GS)

Practice Description

A grass swale is a natural or constructed channel that is shaped or graded to required dimensions and established in suitable vegetation for the stable conveyance of runoff without causing damage to the channel by erosion. This practice applies to sites where concentrated runoff will cause erosion damage, a vegetative lining provides sufficient stability for the channel as designed, and space is available for a relatively large cross section. Typical situations where concentrated flow areas are addressed with a grass swale include roadside ditches, channels at property boundaries, outlets for diversions and other concentrated flow areas subject to channel erosion. Grassed swales are generally considered permanent structures but may be used as a temporary measure.

Planning Considerations

Grass swales should be carefully built to the design cross section, shape and dimensions. Swales are hydraulic structures and as such depend upon the hydraulic parameters to function satisfactorily. Vegetated swales should be well established before large flows are permitted in the channel.

The design of a channel cross section and lining is based primarily upon the volume and velocity of flow expected in the channel. This practice covers grassed swales with low velocity flows (generally less than 5 ft/sec). Where high velocities are anticipated lined swales should be used (see Lined Swale practice or Riprap-lined Swale practice). Lined swales should also be used where there is continuous flow in the swale, which would prevent establishment of vegetation within the flow area.

Besides the primary design considerations of capacity and velocity, a number of other important factors should be taken into account when selecting a cross section (Figure GS-1). These factors include land availability, compatibility with land use and surrounding environment, safety, maintenance requirements outlet conditions, etc.

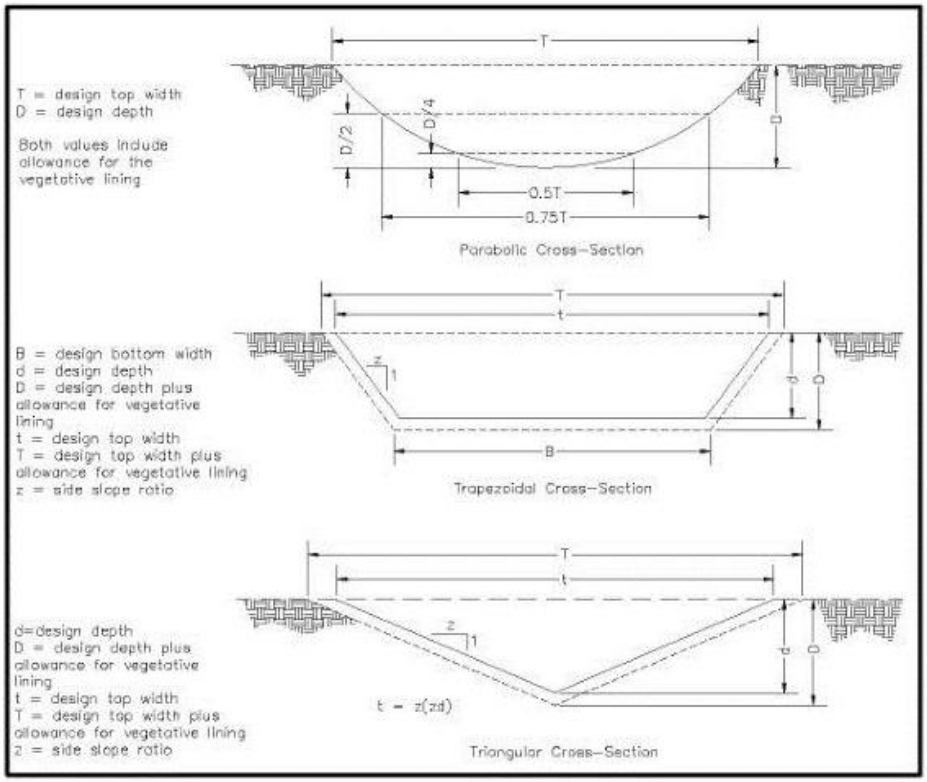


Figure GS-1 Typical Grass Swale Cross section

Triangular Shaped Ditches

Triangular shaped ditches are generally used where the quantity of water to be handled is relatively small, such as along roadsides. A triangular grass swale will suffice where velocities in the ditch are low.

Parabolic Channels

Parabolic channels are often used where the quantity of water to be handled is larger and where space is available for a wide, shallow channel with low velocity flow.

Trapezoidal Channels

Trapezoidal channels are often used where the quantity of water to be carried is large and conditions require that it be carried at a relatively high velocity. Trapezoidal ditches lined with concrete, riprap, or others similar materials are considered lined swales or riprap lined swales. In some cases, erosion control

blankets (see Erosion Control Blanket practice) and high end hydraulic mulch (see Mulching practice) can be used to establish vegetation.

Other Considerations

Outlet conditions for all channels should be considered. Appropriate measures must be taken to dissipate the energy of the flow to prevent scour at the outlet of the swale.

Grass swales should be protected from erosion by concentrated flows. The methods of protecting grass swales would include, but not be limited to the following:

- Vegetation.
- Biodegradable linings and vegetation.

The type and intensity of the protective linings will determine the design of the grass swale.

If velocities exceed stable velocities, for vegetated swales or vegetation with biodegradable linings, then other linings should be used (see Lined Swale or Riprap-lined Swale practice).

The time of the year should be considered when planning grass swales. Grass swales that are seeded to establish vegetation should not be planned for construction during late fall, winter or early spring. Grass swales constructed during mid-summer to early fall may need temporary seeding followed by permanent seeding at the recommended times. The vegetation species should be recommended for the area of the state that it is planned.

Design Criteria

Capacity

Note: This design example uses the Permissible Velocity approach. Grass swale design using the Tractive Stress approach can also be used but is not discussed in this document.

Grass swales shall be designed to convey the peak rate of runoff as shown in Table GS-1. Adjustments should be made for release rates from structures and other drainage facilities. Grass swales shall also be designed to comply with local stormwater ordinances. Grass swales should be designed for greater capacity whenever there is danger of flooding or out of bank flow cannot be tolerated.

Table GS-1 Design Frequency for Grassed Swale

Grass Swale Type	Typical Area of Protection	24 Hour Design Storm Frequency
Temporary Swale	Construction Areas	2-year
	Building Sites	5-year
Permanent Swale	Agricultural Land	10-year
	Reclaimed Mined Land	10-year
	Isolated Buildings	10-year
	Urban areas, Residential, School, Industrial Areas, Recreation Areas, etc.	10-year

Peak rates of runoff values used to determine the capacity requirements should be calculated using accepted engineering methods. Some accepted methods are:

- Natural Resources Conservation Service, National Engineering Handbook Series, Part 650, Engineering Field Handbook, Chapter 2, Estimating Runoff.
- Natural Resources Conservation Service, formerly Soil Conservation Service, Technical Release 55, Urban Hydrology for Small Watersheds.
- Other comparable methods.

Grade of Grass Swale

After selecting a location for the grassed swale that will minimize the impacts to the site and maximize the intended use, the grade in the grass swales should be determined. The grade in feet per 100 feet of length can be determined from a topographic map of the site or from a detailed survey of the planned grassed swale location.

Retardance

The grass species used and the degree of maintenance planned for the vegetation determines the retardance of the swale (see Table GS-2).

Generally, the retardance used for the design of grassed swales should be “D” and “C” to produce a stable velocity and adequate capacity to carry the design storm.

Table GS-2 Retardance for Grassed Swales

Retardance	Species [1]	Cover Condition
A	Reed Canarygrass	Excellent stand, tall (average 36”)
	Yellow Bluestem Ischaemum	Excellent stand, tall (average 36”)
B	Smooth Bromegrass	Good stand, mowed (average 12 to 15”)
	Bermudagrass	Good stand, tall (average 12)
	Native Grass mixture (Little Bluestem, Blue Grama, and other long and short Midwest Grasses)	Good stand, unmowed
	Tall Fescue	Good stand, unmowed (average 18”)
	Lespedeza Sericea	Good stand, not woody, tall (average 19”)
	Grass-Legume mixture-Timothy, smooth Bromegrass, or Orchardgrass	Good stand, uncut (average 20”)
	Reed Canarygrass	Good stand, mowed (average 12 to 15”)
	Tall Fescue, with Bird’s Foot Trefoil or Ladino Clover	Good stand, uncut (average 18”)
	Blue Grama	Good stand, uncut (average 13”)
C	Bahiagrass	Good stand, uncut (average 6 to 8”)
	Bermudagrass	Good stand, mowed (average 6”)
	Redtop	Good stand, headed (15 to 20)
	Grass-legume mixture-summer (Orchardgrass, Redtop, Italian Ryegrass, and Common Lespedeza)	Good stand, uncut (6 to 8”)
	Centipedegrass	Very dense cover (average 6”)
	Kentucky Bluegrass	Good stand, headed (6 to 12”)
D	Bermudagrass	Good stand, cut to 2.5” height
	Red Fescue	Good stand, headed (12 to 18”)
	Buffalograss	Good stand, uncut (3 to 6”)
	Grass-Legume mixture-fall, spring (Orchard Grass, Redtop, Italian Ryegrass, and Common Lespedeza)	Good stand, uncut (4 to 5”)
	Lespedeza Sericea	After cutting to 2” height. Very good stand before cutting
E	Bermudagrass	Good stand, cut to 1.5” height.
	Bermudagrass	Burned stubble

1/ Species to establish should be selected based on suitability of soil and expected management.

Velocities

Classify the soil where the swale is to be constructed into erosion resistant cohesive (clayey) fine and coarse-grained soils or easily eroded noncohesive silt, clays and sands.

Determine the type of vegetative cover to be established in the swale.

Use the swale grade, cover and soil erodibility to determine permissible velocity using Table GS-3.

Table GS-3 Permissible Velocities in Grassed Swales

Cover	Slope Range[2]	Permissible Velocity[1] Erosion Resistant Soils[3] (clayey)	Permissible Velocity[1] Easily Eroded Soils[4] (sandy)
	percent	ft/sec	ft/sec
Bermudagrass	< 5	8	6
	5-10	7	4
	over 10	6	3
Bahiagrass	<5	7	5
Tall Fescue	5-10	6	4
	over 10	5	3
Sericea Lespedeza **Weeping Lovegrass**	<5[5]	3.5	2.5

[1]Use velocities exceeding (5ft/sec) only where good covers and proper maintenance can be obtained.
[2]Do not use on slopes steeper than 10 percent except for vegetated side slopes in combination with a stone, concrete, or highly resistant vegetative center section.
[3]Cohesive (clayey) fine-grain soils and coarse-grain soils with cohesive fines with a plasticity index of 10 to 40 (CL, CH, SC, and CG).
[4] Soils that do not meet requirements for erosion-resistant soils.
[5] Do not use on slopes steeper than 5 percent except for vegetated side slopes in combination with a stone, concrete, or highly resistant vegetative center section.

Swale Dimensions

The swale may be triangular shaped, parabolic or trapezoidal as discussed in the planning considerations of this standard and shown in Figure GS-1.

Using the peak discharge, swale grade, permissible velocity and retardance, parabolic dimensions can be determined using Table GS-4, Sheets 1 through 14.

Design dimensions for triangular shaped and trapezoidal shaped swales can be determined using Manning's equation or other accepted engineering designs.

The design water surface elevation of a channel receiving water from other tributary sources shall be equal to or less than the design water surface elevation of the contributing source. The design water surface elevation of contributing and receiving waters should be the same, whenever practical.

A minimum depth may be necessary to provide adequate outlets for subsurface drains and tributary channels.

Drainage

Polyethylene drainage tubing, tile or other suitable subsurface drainage measures shall be provided for sites having high water tables or seepage problems.

Freeboard

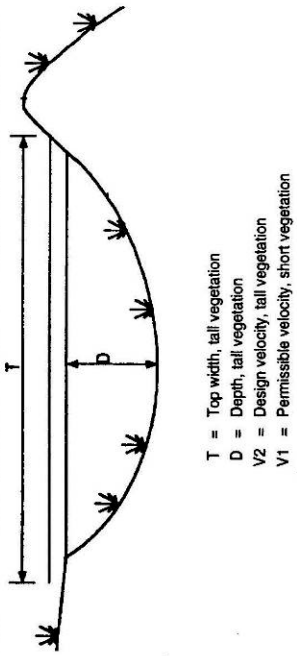
The minimum freeboard is 0.25 feet in depth. Freeboard is not required on grass swales with less than 1% slope and where out-of-bank flow will not be damaging and can be tolerated in the normal operation at the site.

Table GS-4 Parabolic Grass Swale Design Sheet 1 of 14

V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH (D), AND V2 FOR RETARDANCE "C"

Grade 0.25 Percent

Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5																											
10																											
15																											
20																											
25	9.3	2.3	1.7																								
30	11.7	2.2	1.8																								
35	14.1	2.1	1.7																								
40	16.3	2.1	1.8																								
45	18.5	2.1	1.8	10.4	2.8	2.3																					
50	20.7	2.1	1.8	12.3	2.6	2.3																					
55	22.9	2.1	1.8	13.8	2.6	2.3																					
60	25.0	2.0	1.8	15.3	2.5	2.3																					
65	27.2	2.0	1.8	16.8	2.5	2.3	10.4	3.4	2.8																		
70	29.3	2.0	1.8	18.2	2.5	2.3	12.1	3.1	2.8																		
75	31.9	2.0	1.7	19.7	2.4	2.3	13.5	3.0	2.8																		
80	34.0	2.0	1.7	21.1	2.4	2.3	14.7	2.9	2.8																		
85	36.1	2.0	1.7	22.5	2.4	2.3	15.8	2.9	2.8																		
90	38.2	2.0	1.7	23.9	2.4	2.3	16.9	2.8	2.8																		
95	40.3	2.0	1.7	25.3	2.4	2.3	18.0	2.8	2.8																		
100	42.4	2.0	1.7	26.7	2.4	2.3	19.1	2.8	2.8																		
105	44.6	2.0	1.7	28.1	2.4	2.3	20.2	2.8	2.8																		
110	46.7	2.0	1.7	29.5	2.4	2.3	21.3	2.8	2.8	12.9	3.8	3.4															
115	48.8	2.0	1.7	30.8	2.4	2.3	22.3	2.8	2.8	14.0	3.7	3.4															
120	50.9	2.0	1.7	32.2	2.4	2.3	23.4	2.8	2.8	15.3	3.5	3.4															
125	53.0	2.0	1.8	33.6	2.4	2.3	24.4	2.8	2.8	16.1	3.5	3.4															
130	55.1	2.0	1.8	35.0	2.4	2.3	25.5	2.8	2.8	16.9	3.4	3.4															
135	57.3	2.0	1.8	36.4	2.4	2.3	26.5	2.7	2.8	17.7	3.4	3.4															
140	59.4	2.0	1.8	38.3	2.4	2.3	27.6	2.7	2.8	18.5	3.4	3.4															
145	61.5	2.0	1.8	39.7	2.4	2.3	28.6	2.7	2.8	19.3	3.3	3.4															
150	63.6	2.0	1.8	41.1	2.4	2.3	29.6	2.7	2.8	20.1	3.3	3.4															



RETARDANCE "D" AND "C"

NOTE: Width and Depth dimensions are in feet; Velocity measurements are in feet per second;
Depth "D" does not include allowance for freeboard or settlement.

Table GS-4 Parabolic Grass Swale Design Sheet 2 of 14

V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH (D), AND V2 FOR RETARDANCE "C"

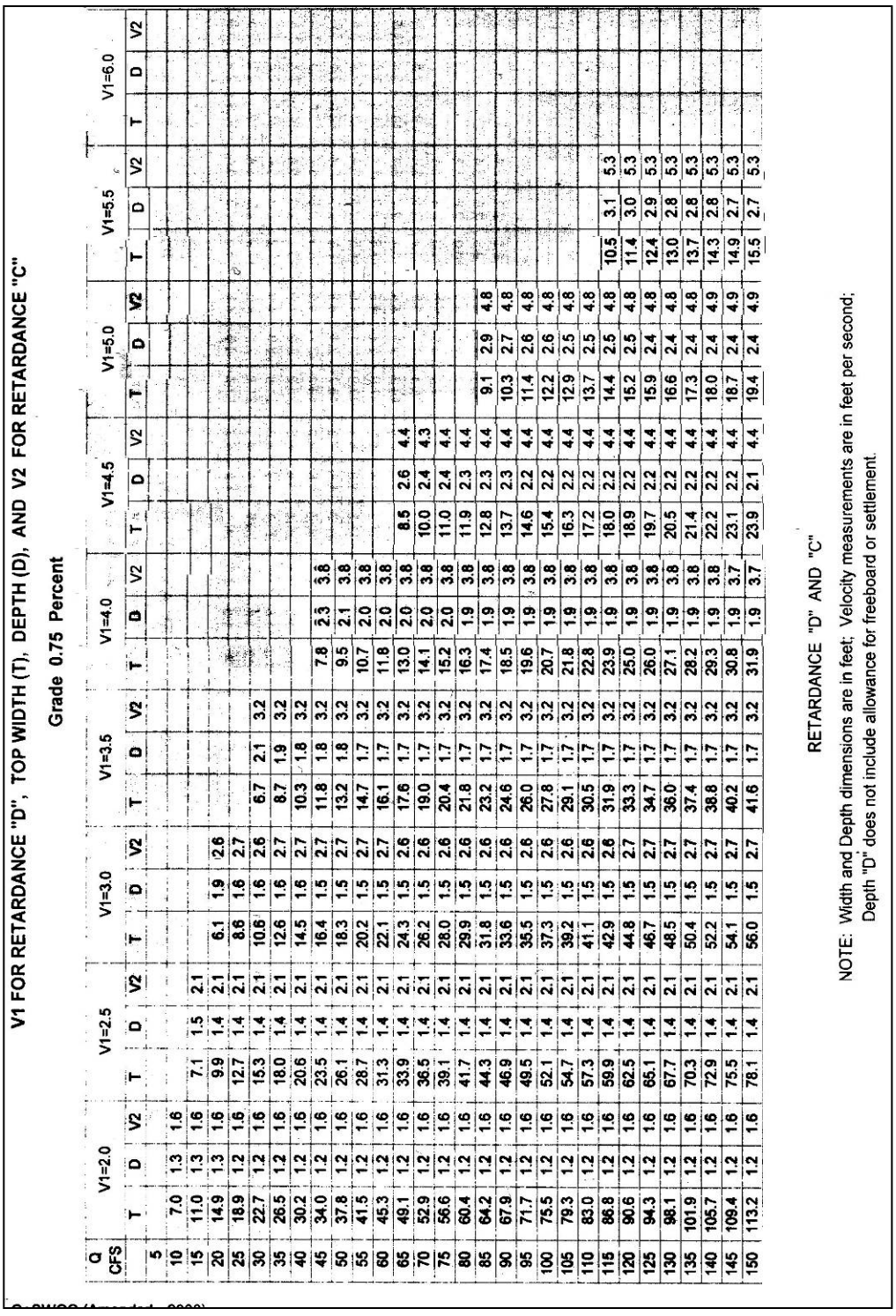
Grade 0.50 Percent

Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5																											
10																											
15	8.4	1.6	1.7																								
20	11.7	1.5	1.7	7.1	2.0	2.2																					
25	14.9	1.5	1.7	9.7	1.8	2.2																					
30	18.0	1.5	1.7	12.0	1.7	2.2																					
35	21.0	1.5	1.7	14.2	1.7	2.2	9.3	2.1	2.7																		
40	24.4	1.5	1.7	16.3	1.7	2.2	10.9	2.0	2.7																		
45	27.4	1.5	1.7	18.5	1.7	2.2	12.5	2.0	2.7																		
50	30.5	1.5	1.7	20.6	1.7	2.2	14.1	1.9	2.7	8.7	2.6	3.3															
55	33.5	1.5	1.7	22.7	1.7	2.2	15.7	1.9	2.7	10.4	2.4	3.3															
60	36.6	1.5	1.7	24.8	1.7	2.2	17.2	1.9	2.7	11.7	2.3	3.3															
65	39.6	1.5	1.7	27.3	1.7	2.2	18.8	1.9	2.7	12.9	2.3	3.3															
70	42.6	1.5	1.7	29.4	1.7	2.2	20.3	1.9	2.7	14.0	2.2	3.3	9.8	2.8	3.8												
75	45.7	1.5	1.7	31.4	1.7	2.2	21.8	1.9	2.7	15.2	2.2	3.3	11.3	2.7	3.8												
80	48.7	1.5	1.7	33.5	1.7	2.2	23.3	1.9	2.7	16.3	2.2	3.3	12.2	2.6	3.8												
85	51.7	1.5	1.7	35.6	1.6	2.2	24.8	1.9	2.7	17.4	2.2	3.3	13.2	2.5	3.8												
90	54.8	1.5	1.7	37.7	1.6	2.2	26.3	1.9	2.7	18.5	2.2	3.3	14.2	2.5	3.8												
95	57.8	1.5	1.7	39.8	1.6	2.2	27.8	1.9	2.7	19.6	2.2	3.3	15.1	2.5	3.8												
100	60.9	1.5	1.7	41.9	1.6	2.2	29.7	1.9	2.7	20.7	2.2	3.3	16.0	2.5	3.8	11.0	3.2	4.3									
105	63.9	1.5	1.7	44.0	1.6	2.2	31.2	1.9	2.7	21.8	2.2	3.3	16.9	2.5	3.8	12.3	3.0	4.3									
110	66.9	1.5	1.7	46.1	1.6	2.2	32.6	1.9	2.7	22.9	2.2	3.3	17.8	2.4	3.8	13.1	2.9	4.3									
115	70.0	1.5	1.7	48.1	1.6	2.2	34.1	1.9	2.7	24.0	2.1	3.3	18.7	2.4	3.8	13.9	2.9	4.3									
120	73.0	1.5	1.7	50.2	1.6	2.2	35.6	1.9	2.7	25.1	2.1	3.3	19.6	2.4	3.8	14.6	2.9	4.3									
125	76.1	1.5	1.7	52.3	1.6	2.2	37.1	1.9	2.7	26.2	2.1	3.3	20.5	2.4	3.8	15.4	2.8	4.3									
130	79.1	1.5	1.7	54.4	1.6	2.2	38.5	1.9	2.7	27.3	2.1	3.3	21.3	2.4	3.8	16.1	2.8	4.3									
135	82.1	1.5	1.7	56.5	1.6	2.2	40.0	1.9	2.7	28.4	2.1	3.3	22.2	2.4	3.8	16.9	2.8	4.3									
140	85.2	1.5	1.7	58.6	1.6	2.2	41.5	1.9	2.7	29.4	2.1	3.3	23.1	2.4	3.8	17.6	2.8	4.3									
145	88.2	1.5	1.7	60.7	1.6	2.2	43.0	1.9	2.7	30.5	2.1	3.3	24.0	2.4	3.8	18.3	2.8	4.3	12.3	3.7	4.9						
150	91.3	1.6	1.7	62.8	1.6	2.2	44.5	1.9	2.7	31.6	2.1	3.3	24.8	2.4	3.8	19.0	2.7	4.3	13.1	3.5	4.9						

RETARDANCE "D" AND "C"

NOTE: Width and Depth dimensions are in feet; Velocity measurements are in feet per second;
Depth "D" does not include allowance for freeboard or settlement.

Table GS-4 Parabolic Grass Swale Design Sheet 3 of 14



V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH (D), AND V2 FOR RETARDANCE "C"

Grade 0.75 Percent

Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5																											
10	7.0	1.3	1.6																								
15	11.0	1.3	1.6	7.1	1.5	2.1																					
20	14.9	1.3	1.6	9.9	1.4	2.1	6.1	1.9	2.6																		
25	18.9	1.2	1.6	12.7	1.4	2.1	8.6	1.6	2.7																		
30	22.7	1.2	1.6	15.3	1.4	2.1	10.6	1.6	2.6	6.7	2.1	3.2															
35	26.5	1.2	1.6	18.0	1.4	2.1	12.6	1.6	2.7	8.7	1.9	3.2															
40	30.2	1.2	1.6	20.6	1.4	2.1	14.5	1.6	2.7	10.3	1.8	3.2															
45	34.0	1.2	1.6	23.5	1.4	2.1	16.4	1.5	2.7	11.8	1.8	3.2	7.8	2.3	3.8												
50	37.8	1.2	1.6	26.1	1.4	2.1	18.3	1.5	2.7	13.2	1.8	3.2	9.5	2.1	3.8												
55	41.5	1.2	1.6	28.7	1.4	2.1	20.2	1.5	2.7	14.7	1.7	3.2	10.7	2.0	3.8												
60	45.3	1.2	1.6	31.3	1.4	2.1	22.1	1.5	2.7	16.1	1.7	3.2	11.8	2.0	3.8												
65	49.1	1.2	1.6	33.9	1.4	2.1	24.3	1.5	2.6	17.6	1.7	3.2	13.0	2.0	3.8	8.5	2.6	4.4									
70	52.9	1.2	1.6	36.5	1.4	2.1	26.2	1.5	2.6	19.0	1.7	3.2	14.1	2.0	3.8	10.0	2.4	4.3									
75	56.6	1.2	1.6	39.1	1.4	2.1	28.0	1.5	2.6	20.4	1.7	3.2	15.2	2.0	3.8	11.0	2.4	4.4									
80	60.4	1.2	1.6	41.7	1.4	2.1	29.9	1.5	2.6	21.8	1.7	3.2	16.3	1.9	3.8	11.9	2.3	4.4									
85	64.2	1.2	1.6	44.3	1.4	2.1	31.8	1.5	2.6	23.2	1.7	3.2	17.4	1.9	3.8	12.8	2.3	4.4	9.1	2.9	4.8						
90	67.9	1.2	1.6	46.9	1.4	2.1	33.6	1.5	2.6	24.6	1.7	3.2	18.5	1.9	3.8	13.7	2.3	4.4	10.3	2.7	4.8						
95	71.7	1.2	1.6	49.5	1.4	2.1	35.5	1.5	2.6	26.0	1.7	3.2	19.6	1.9	3.8	14.6	2.2	4.4	11.4	2.6	4.8						
100	75.5	1.2	1.6	52.1	1.4	2.1	37.3	1.5	2.6	27.8	1.7	3.2	20.7	1.9	3.8	15.4	2.2	4.4	12.2	2.6	4.8						
105	79.3	1.2	1.6	54.7	1.4	2.1	39.2	1.5	2.6	29.1	1.7	3.2	21.8	1.9	3.8	16.3	2.2	4.4	12.9	2.5	4.8						
110	83.0	1.2	1.6	57.3	1.4	2.1	41.1	1.5	2.6	30.5	1.7	3.2	22.8	1.9	3.8	17.2	2.2	4.4	13.7	2.5	4.8						
115	86.8	1.2	1.6	59.9	1.4	2.1	42.9	1.5	2.6	31.9	1.7	3.2	23.9	1.9	3.8	18.0	2.2	4.4	14.4	2.5	4.8	10.5	3.1	5.3			
120	90.6	1.2	1.6	62.5	1.4	2.1	44.8	1.5	2.7	33.3	1.7	3.2	25.0	1.9	3.8	18.9	2.2	4.4	15.2	2.5	4.8	11.4	3.0	5.3			
125	94.3	1.2	1.6	65.1	1.4	2.1	46.7	1.5	2.7	34.7	1.7	3.2	26.0	1.9	3.8	19.7	2.2	4.4	15.9	2.4	4.8	12.4	2.9	5.3			
130	98.1	1.2	1.6	67.7	1.4	2.1	48.5	1.5	2.7	36.0	1.7	3.2	27.1	1.9	3.8	20.5	2.2	4.4	16.6	2.4	4.8	13.0	2.8	5.3			
135	101.9	1.2	1.6	70.3	1.4	2.1	50.4	1.5	2.7	37.4	1.7	3.2	28.2	1.9	3.8	21.4	2.2	4.4	17.3	2.4	4.8	13.7	2.8	5.3			
140	105.7	1.2	1.6	72.9	1.4	2.1	52.2	1.5	2.7	38.8	1.7	3.2	29.3	1.9	3.8	22.2	2.2	4.4	18.0	2.4	4.9	14.3	2.8	5.3			
145	109.4	1.2	1.6	75.5	1.4	2.1	54.1	1.5	2.7	40.2	1.7	3.2	30.8	1.9	3.7	23.1	2.2	4.4	18.7	2.4	4.9	14.9	2.7	5.3			
150	113.2	1.2	1.6	78.1	1.4	2.1	56.0	1.5	2.7	41.6	1.7	3.2	31.9	1.9	3.7	23.9	2.1	4.4	19.4	2.4	4.9	15.5	2.7	5.3			

RETARDANCE "D" AND "C"

NOTE: Width and Depth dimensions are in feet; Velocity measurements are in feet per second;
Depth "D" does not include allowance for freeboard or settlement.

Table GS-4 Parabolic Grass Swale Design Sheet 4 of 14

V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH (D), AND V2 FOR RETARDANCE "C"

Grade 1.00 Percent

Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5																											
10	8.2	1.2	1.6	5.2	1.4	2.0																					
15	12.6	1.1	1.6	8.7	1.3	2.1	5.5	1.6	2.6																		
20	17.1	1.1	1.6	11.8	1.2	2.1	8.2	1.4	2.6																		
25	21.4	1.1	1.6	14.9	1.2	2.1	10.5	1.4	2.6	7.3	1.6	3.1															
30	25.7	1.1	1.6	18.0	1.2	2.1	12.8	1.4	2.6	9.1	1.6	3.2															
35	29.9	1.1	1.6	21.2	1.2	2.1	15.0	1.3	2.6	10.9	1.5	3.1	7.8	1.8	3.7												
40	34.2	1.1	1.6	24.3	1.2	2.1	17.3	1.3	2.6	12.6	1.5	3.1	9.2	1.7	3.7												
45	38.5	1.1	1.6	27.3	1.2	2.1	19.5	1.3	2.6	14.3	1.5	3.1	10.6	1.7	3.7	7.2	2.2	4.3									
50	42.7	1.1	1.6	30.3	1.2	2.1	21.9	1.3	2.6	16.0	1.5	3.2	11.9	1.7	3.7	8.8	2.0	4.3									
55	47.0	1.1	1.6	33.3	1.2	2.1	24.1	1.3	2.6	17.7	1.5	3.2	13.3	1.7	3.7	9.9	1.9	4.3									
60	51.3	1.1	1.6	36.3	1.2	2.1	26.3	1.3	2.6	19.3	1.5	3.2	14.6	1.7	3.7	11.0	1.9	4.3									
65	55.5	1.1	1.6	39.4	1.2	2.1	28.5	1.3	2.6	21.0	1.5	3.2	15.9	1.6	3.7	12.1	1.9	4.3	8.0	2.5	4.9						
70	59.8	1.1	1.6	42.4	1.2	2.1	30.7	1.3	2.6	22.7	1.5	3.2	17.1	1.6	3.7	13.2	1.9	4.3	9.5	2.3	4.8						
75	64.1	1.1	1.6	45.4	1.2	2.1	32.9	1.3	2.6	24.6	1.5	3.1	18.5	1.6	3.7	14.2	1.8	4.3	10.4	2.2	4.9						
80	68.3	1.1	1.6	48.4	1.2	2.1	35.0	1.3	2.6	26.2	1.5	3.1	19.8	1.6	3.7	15.2	1.8	4.3	11.3	2.2	4.9	8.8	2.7	5.4			
85	72.6	1.1	1.6	51.5	1.2	2.1	37.2	1.3	2.6	27.9	1.5	3.1	21.0	1.6	3.7	16.3	1.8	4.3	12.1	2.2	4.9	9.8	2.6	5.4			
90	76.9	1.1	1.6	54.5	1.2	2.1	39.4	1.3	2.6	29.5	1.5	3.1	22.3	1.6	3.7	17.3	1.8	4.3	13.0	2.1	4.9	10.9	2.5	5.3			
95	81.1	1.1	1.6	57.5	1.2	2.1	41.6	1.3	2.6	31.1	1.5	3.1	23.6	1.6	3.7	18.3	1.8	4.3	13.8	2.1	4.9	11.6	2.4	5.4			
100	85.4	1.1	1.6	60.5	1.2	2.1	43.8	1.3	2.6	32.7	1.5	3.1	24.9	1.6	3.7	19.3	1.8	4.3	14.6	2.1	4.9	12.4	2.4	5.4	9.7	2.8	5.8
105	89.7	1.1	1.6	63.6	1.2	2.1	46.0	1.3	2.6	34.4	1.5	3.1	26.5	1.6	3.7	20.3	1.8	4.3	15.4	2.1	4.9	13.1	2.4	5.4	10.8	2.6	5.8
110	94.0	1.1	1.6	66.6	1.2	2.1	48.2	1.3	2.6	36.0	1.5	3.1	27.7	1.6	3.7	21.3	1.8	4.3	16.2	2.1	4.9	13.8	2.3	5.4	11.5	2.6	5.8
115	98.2	1.1	1.6	69.6	1.2	2.1	50.4	1.3	2.6	37.6	1.5	3.1	29.0	1.6	3.7	22.3	1.8	4.3	17.0	2.1	4.9	14.5	2.3	5.4	12.2	2.6	5.8
120	102.5	1.1	1.6	72.6	1.2	2.1	52.5	1.3	2.6	39.3	1.5	3.1	30.2	1.6	3.7	23.3	1.8	4.3	17.9	2.1	4.9	15.2	2.3	5.4	12.8	2.5	5.8
125	106.8	1.1	1.6	75.7	1.2	2.1	54.7	1.3	2.6	40.9	1.5	3.1	31.5	1.6	3.7	24.3	1.8	4.3	18.7	2.1	4.9	15.9	2.3	5.4	13.4	2.5	5.8
130	111.0	1.1	1.6	78.7	1.2	2.1	56.9	1.3	2.6	42.5	1.5	3.1	32.7	1.6	3.7	25.3	1.8	4.3	19.4	2.1	4.9	16.6	2.3	5.4	14.1	2.5	5.8
135	115.3	1.1	1.6	81.7	1.2	2.1	59.1	1.3	2.6	44.2	1.5	3.1	34.0	1.6	3.7	26.3	1.8	4.3	20.2	2.0	4.9	17.2	2.3	5.4	14.7	2.5	5.8
140	119.6	1.1	1.6	84.7	1.2	2.1	61.3	1.3	2.6	45.8	1.5	3.1	35.2	1.6	3.7	27.3	1.8	4.3	21.0	2.0	4.9	17.9	2.3	5.4	15.3	2.5	5.8
145	123.8	1.1	1.6	87.8	1.2	2.1	63.5	1.3	2.6	47.5	1.5	3.1	36.5	1.6	3.7	28.7	1.8	4.3	21.8	2.0	4.9	18.6	2.3	5.4	15.9	2.4	5.8
150	128.1	1.1	1.6	90.8	1.2	2.1	65.7	1.3	2.6	49.1	1.5	3.1	37.8	1.6	3.7	29.7	1.8	4.3	22.6	2.0	4.9						

RETARDANCE "D" AND "C"

NOTE: Width and Depth dimensions are in feet; Velocity measurements are in feet per second;
Depth "D" does not include allowance for freeboard or settlement.

Table GS-4 Parabolic Grass Swale Design Sheet 5 of 14

V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH (D), AND V2 FOR RETARDANCE "C"

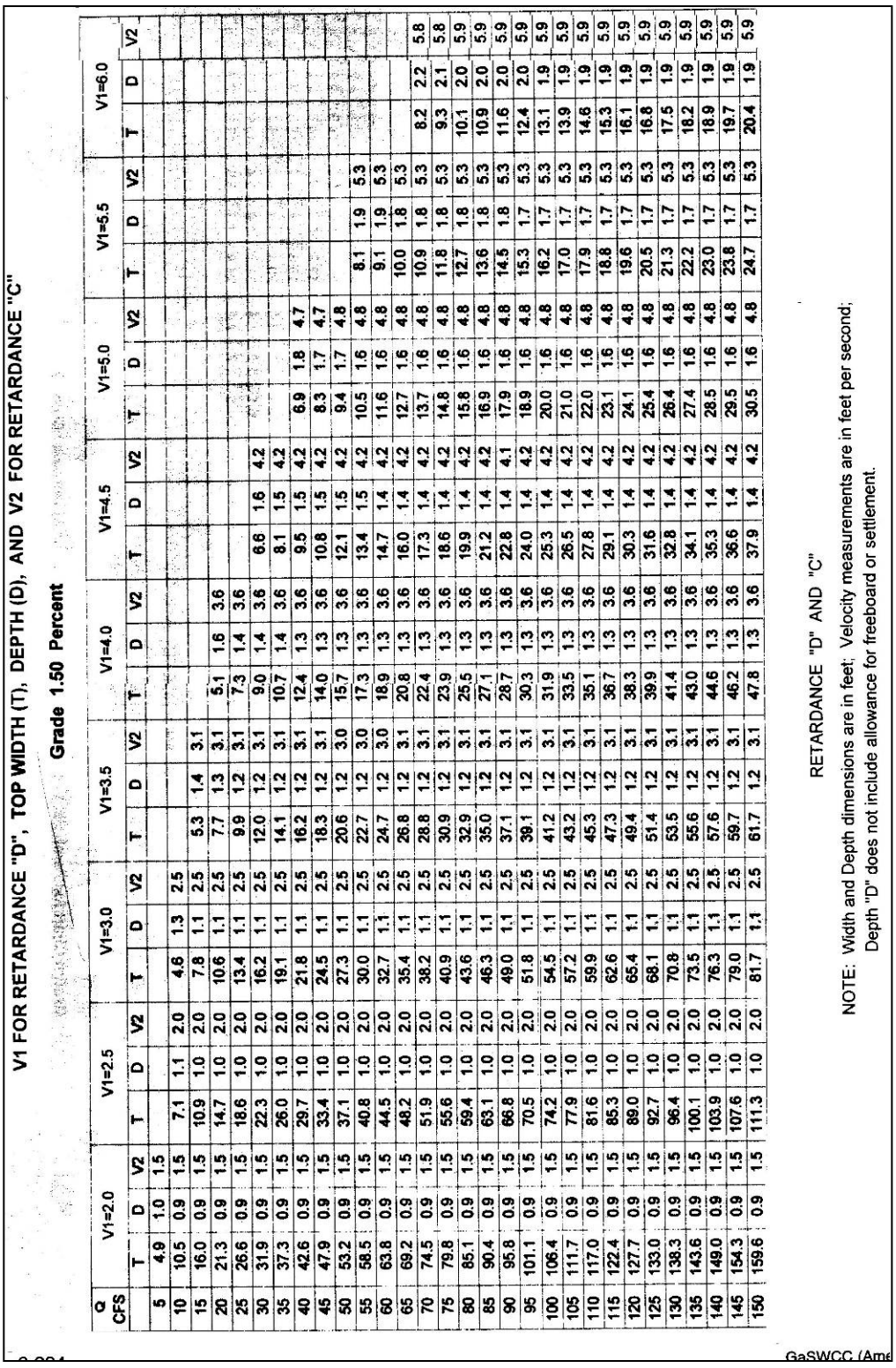
Grade 1.25 Percent

Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5	4.1	1.2	1.5																								
10	9.4	1.0	1.5	6.3	1.2	2.0																					
15	14.3	1.0	1.6	9.9	1.1	2.0	6.8	1.3	2.6																		
20	19.4	1.0	1.5	13.4	1.1	2.0	9.5	1.2	2.6	6.7	1.4	3.1															
25	24.2	1.0	1.5	17.0	1.1	2.0	12.1	1.2	2.6	8.8	1.4	3.1	5.9	1.7	3.6												
30	29.0	1.0	1.6	20.4	1.1	2.0	14.6	1.2	2.6	10.7	1.4	3.1	7.8	1.6	3.7												
35	33.8	1.0	1.6	23.8	1.1	2.0	17.1	1.2	2.6	12.7	1.3	3.1	9.4	1.5	3.7	6.5	1.9	4.2									
40	38.6	1.0	1.6	27.1	1.1	2.0	19.8	1.2	2.5	14.6	1.3	3.1	10.9	1.5	3.7	8.1	1.7	4.2									
45	43.5	1.0	1.6	30.5	1.1	2.0	22.3	1.2	2.5	16.5	1.3	3.1	12.5	1.5	3.7	9.4	1.7	4.2									
50	48.3	1.0	1.6	33.9	1.1	2.0	24.8	1.2	2.5	18.3	1.3	3.1	13.9	1.5	3.7	10.6	1.7	4.2	7.7	2.0	4.8						
55	53.1	1.0	1.6	37.3	1.1	2.0	27.2	1.2	2.6	20.5	1.3	3.1	15.4	1.5	3.7	11.8	1.6	4.3	9.0	1.9	4.8						
60	57.9	1.0	1.6	40.7	1.1	2.0	29.7	1.2	2.6	22.3	1.3	3.1	16.9	1.5	3.7	13.0	1.6	4.3	10.1	1.9	4.8						
65	62.8	1.0	1.6	44.1	1.1	2.0	32.2	1.2	2.6	24.2	1.3	3.1	18.3	1.5	3.7	14.2	1.6	4.3	11.1	1.8	4.8	8.0	2.3	5.3			
70	67.6	1.0	1.6	47.5	1.1	2.0	34.6	1.2	2.6	26.0	1.3	3.1	19.8	1.4	3.7	15.4	1.6	4.3	12.0	1.8	4.8	9.3	2.1	5.3			
75	72.4	1.0	1.6	50.8	1.1	2.0	37.1	1.2	2.6	27.9	1.3	3.1	21.2	1.4	3.7	16.5	1.6	4.3	13.0	1.8	4.8	10.1	2.1	5.3			
80	77.2	1.0	1.6	54.2	1.1	2.0	39.6	1.2	2.6	29.7	1.3	3.1	23.0	1.4	3.6	17.7	1.6	4.3	14.0	1.8	4.8	11.0	2.0	5.3			
85	82.1	1.0	1.6	57.6	1.1	2.0	42.0	1.2	2.6	31.6	1.3	3.1	24.4	1.4	3.6	18.8	1.6	4.3	14.9	1.8	4.8	11.8	2.0	5.3			
90	86.9	1.0	1.6	61.0	1.1	2.0	44.5	1.2	2.6	33.5	1.3	3.1	25.8	1.4	3.6	20.0	1.6	4.3	15.9	1.8	4.8	12.6	2.0	5.3	9.1	2.5	5.9
95	91.7	1.0	1.6	64.4	1.1	2.0	47.0	1.2	2.6	35.3	1.3	3.1	27.3	1.4	3.6	21.1	1.6	4.3	16.8	1.8	4.8	13.4	2.0	5.4	10.2	2.4	5.9
100	96.6	1.0	1.6	67.8	1.1	2.0	49.4	1.2	2.6	37.2	1.3	3.1	28.7	1.4	3.6	22.3	1.6	4.3	17.7	1.8	4.8	14.2	2.0	5.4	10.9	2.3	5.9
105	101.4	1.0	1.6	71.2	1.1	2.0	51.9	1.2	2.6	39.0	1.3	3.1	30.1	1.4	3.6	23.4	1.6	4.3	18.7	1.8	4.8	15.0	2.0	5.4	11.6	2.3	5.9
110	106.2	1.0	1.6	74.6	1.1	2.0	54.4	1.2	2.6	40.9	1.3	3.1	31.6	1.4	3.6	24.6	1.6	4.3	19.6	1.7	4.8	15.8	2.0	5.4	12.3	2.3	5.9
115	111.0	1.0	1.6	78.0	1.1	2.0	56.8	1.2	2.6	42.7	1.3	3.1	33.0	1.4	3.6	26.1	1.6	4.2	20.5	1.7	4.8	16.6	1.9	5.4	13.0	2.2	5.9
120	115.9	1.0	1.6	81.3	1.1	2.0	59.3	1.2	2.6	44.6	1.3	3.1	34.4	1.4	3.6	27.2	1.6	4.2	21.5	1.7	4.8	17.3	1.9	5.4	13.6	2.2	5.9
125	120.7	1.0	1.6	84.7	1.1	2.0	61.8	1.2	2.6	46.4	1.3	3.1	35.9	1.4	3.6	28.3	1.6	4.2	22.4	1.7	4.8	18.1	1.9	5.4	14.3	2.2	5.9
130	125.5	1.0	1.6	88.1	1.1	2.0	64.3	1.2	2.6	48.3	1.3	3.1	37.3	1.4	3.7	29.5	1.6	4.2	23.3	1.7	4.8	18.9	1.9	5.4	14.9	2.2	5.9
135	130.3	1.0	1.6	91.5	1.1	2.0	66.7	1.2	2.6	50.2	1.3	3.1	38.7	1.4	3.7	30.6	1.6	4.2	24.2	1.7	4.8	19.6	1.9	5.4	15.6	2.2	5.9
140	135.2	1.0	1.6	94.9	1.1	2.0	69.2	1.2	2.6	52.0	1.3	3.1	40.2	1.4	3.7	31.7	1.6	4.2	25.1	1.7	4.8	20.4	1.9	5.4	16.2	2.2	5.9
145	140.0	1.0	1.6	98.3	1.1	2.0	71.7	1.2	2.6	53.9	1.3	3.1	41.6	1.4	3.7	32.9	1.6	4.2	26.1	1.7	4.8	21.2	1.9	5.4	16.9	2.2	5.9
150	144.8	1.0	1.6	101.7	1.1	2.0	74.1	1.2	2.6	55.7	1.3	3.1	43.0	1.4	3.7	34.0	1.6	4.2	27.0	1.7	4.8	21.9	1.9	5.4	17.5	2.2	5.9

RETARDANCE "D" AND "C"

NOTE: Width and Depth dimensions are in feet; Velocity measurements are in feet per second
Depth "D" does not include allowance for freeboard or settlement.

Table GS-4 Parabolic Grass Swale Design Sheet 6 of 14



V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH (D), AND V2 FOR RETARDANCE "C"

Grade 1.50 Percent

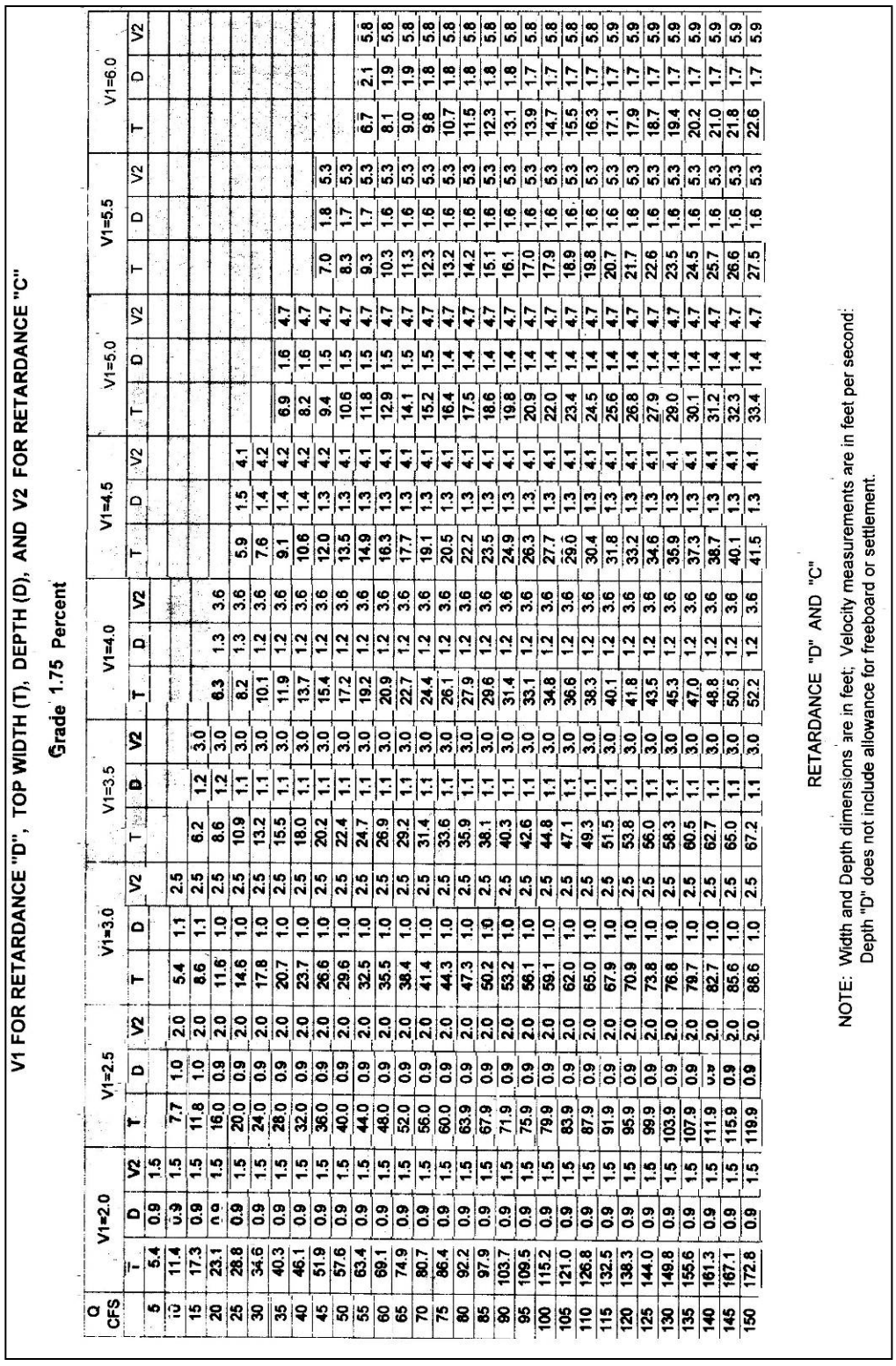
Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5	4.9	1.0	1.5																								
10	10.5	0.9	1.5	7.1	1.1	2.0	4.8	1.3	2.5																		
15	16.0	0.9	1.5	10.9	1.0	2.0	7.8	1.1	2.5	5.3	1.4	3.1															
20	21.3	0.9	1.5	14.7	1.0	2.0	10.6	1.1	2.5	7.7	1.3	3.1	5.1	1.6	3.6												
25	26.6	0.9	1.5	18.6	1.0	2.0	13.4	1.1	2.5	9.9	1.2	3.1	7.3	1.4	3.6												
30	31.9	0.9	1.5	22.3	1.0	2.0	16.2	1.1	2.5	12.0	1.2	3.1	9.0	1.4	3.6	6.6	1.6	4.2									
35	37.3	0.9	1.5	26.0	1.0	2.0	19.1	1.1	2.5	14.1	1.2	3.1	10.7	1.4	3.6	8.1	1.5	4.2									
40	42.6	0.9	1.5	29.7	1.0	2.0	21.8	1.1	2.5	16.2	1.2	3.1	12.4	1.3	3.6	9.5	1.5	4.2	6.9	1.8	4.7						
45	47.9	0.9	1.5	33.4	1.0	2.0	24.5	1.1	2.5	18.3	1.2	3.1	14.0	1.3	3.6	10.8	1.5	4.2	8.3	1.7	4.7						
50	53.2	0.9	1.5	37.1	1.0	2.0	27.3	1.1	2.5	20.6	1.2	3.0	15.7	1.3	3.6	12.1	1.5	4.2	9.4	1.7	4.8						
55	58.5	0.9	1.5	40.8	1.0	2.0	30.0	1.1	2.5	22.7	1.2	3.0	17.3	1.3	3.6	13.4	1.5	4.2	10.5	1.6	4.8	8.1	1.9	5.3			
60	63.8	0.9	1.5	44.5	1.0	2.0	32.7	1.1	2.5	24.7	1.2	3.0	18.9	1.3	3.6	14.7	1.4	4.2	11.6	1.6	4.8	9.1	1.9	5.3			
65	69.2	0.9	1.5	48.2	1.0	2.0	35.4	1.1	2.5	26.8	1.2	3.1	20.8	1.3	3.6	16.0	1.4	4.2	12.7	1.6	4.8	10.0	1.8	5.3			
70	74.5	0.9	1.5	51.9	1.0	2.0	38.2	1.1	2.5	28.8	1.2	3.1	22.4	1.3	3.6	17.3	1.4	4.2	13.7	1.6	4.8	10.9	1.8	5.3	8.2	2.2	5.8
75	79.8	0.9	1.5	55.6	1.0	2.0	40.9	1.1	2.5	30.9	1.2	3.1	23.9	1.3	3.6	18.6	1.4	4.2	14.8	1.6	4.8	11.8	1.8	5.3	9.3	2.1	5.8
80	85.1	0.9	1.5	59.4	1.0	2.0	43.6	1.1	2.5	32.9	1.2	3.1	25.5	1.3	3.6	19.9	1.4	4.2	15.8	1.6	4.8	12.7	1.8	5.3	10.1	2.0	5.9
85	90.4	0.9	1.5	63.1	1.0	2.0	46.3	1.1	2.5	35.0	1.2	3.1	27.1	1.3	3.6	21.2	1.4	4.2	16.9	1.6	4.8	13.6	1.8	5.3	10.9	2.0	5.9
90	95.8	0.9	1.5	66.8	1.0	2.0	49.0	1.1	2.5	37.1	1.2	3.1	28.7	1.3	3.6	22.8	1.4	4.1	17.9	1.6	4.8	14.5	1.8	5.3	11.6	2.0	5.9
95	101.1	0.9	1.5	70.5	1.0	2.0	51.8	1.1	2.5	39.1	1.2	3.1	30.3	1.3	3.6	24.0	1.4	4.2	18.9	1.6	4.8	15.3	1.7	5.3	12.4	2.0	5.9
100	106.4	0.9	1.5	74.2	1.0	2.0	54.5	1.1	2.5	41.2	1.2	3.1	31.9	1.3	3.6	25.3	1.4	4.2	20.0	1.6	4.8	16.2	1.7	5.3	13.1	1.9	5.9
105	111.7	0.9	1.5	77.9	1.0	2.0	57.2	1.1	2.5	43.2	1.2	3.1	33.5	1.3	3.6	26.5	1.4	4.2	21.0	1.6	4.8	17.0	1.7	5.3	13.9	1.9	5.9
110	117.0	0.9	1.5	81.6	1.0	2.0	59.9	1.1	2.5	45.3	1.2	3.1	35.1	1.3	3.6	27.8	1.4	4.2	22.0	1.6	4.8	17.9	1.7	5.3	14.8	1.9	5.9
115	122.4	0.9	1.5	85.3	1.0	2.0	62.6	1.1	2.5	47.3	1.2	3.1	36.7	1.3	3.6	29.1	1.4	4.2	23.1	1.6	4.8	18.8	1.7	5.3	15.3	1.9	5.9
120	127.7	0.9	1.5	89.0	1.0	2.0	65.4	1.1	2.5	49.4	1.2	3.1	38.3	1.3	3.6	30.3	1.4	4.2	24.1	1.6	4.8	19.6	1.7	5.3	16.1	1.9	5.9
125	133.0	0.9	1.5	92.7	1.0	2.0	68.1	1.1	2.5	51.4	1.2	3.1	39.9	1.3	3.6	31.6	1.4	4.2	25.4	1.6	4.8	20.5	1.7	5.3	16.8	1.9	5.9
130	138.3	0.9	1.5	96.4	1.0	2.0	70.8	1.1	2.5	53.5	1.2	3.1	41.4	1.3	3.6	32.8	1.4	4.2	26.4	1.6	4.8	21.3	1.7	5.3	17.5	1.9	5.9
135	143.6	0.9	1.5	100.1	1.0	2.0	73.5	1.1	2.5	55.6	1.2	3.1	43.0	1.3	3.6	34.1	1.4	4.2	27.4	1.6	4.8	22.2	1.7	5.3	18.2	1.9	5.9
140	149.0	0.9	1.5	103.9	1.0	2.0	76.3	1.1	2.5	57.6	1.2	3.1	44.6	1.3	3.6	35.3	1.4	4.2	28.5	1.6	4.8	23.0	1.7	5.3	18.9	1.9	5.9
145	154.3	0.9	1.5	107.6	1.0	2.0	79.0	1.1	2.5	59.7	1.2	3.1	46.2	1.3	3.6	36.6	1.4	4.2	29.5	1.6	4.8	23.8	1.7	5.3	19.7	1.9	5.9
150	159.6	0.9	1.5	111.3	1.0	2.0	81.7	1.1	2.5	61.7	1.2	3.1	47.8	1.3	3.6	37.9	1.4	4.2	30.5	1.6	4.8	24.7	1.7	5.3	20.4	1.9	5.9

RETARDANCE "D" AND "C"

NOTE: Width and Depth dimensions are in feet. Velocity measurements are in feet per second;
Depth "D" does not include allowance for freeboard or settlement.

GaSWCC (Ame

Table GS-4 Parabolic Grass Swale Design Sheet 7 of 14



V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH (D), AND V2 FOR RETARDANCE "C"

Grade 1.75 Percent

Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5	5.4	0.9	1.5																								
10	11.4	0.9	1.5	7.7	1.0	2.0	5.4	1.1	2.5																		
15	17.3	0.9	1.5	11.8	1.0	2.0	8.6	1.1	2.5	6.2	1.2	3.0															
20	23.1	0.9	1.5	16.0	0.9	2.0	11.6	1.0	2.5	8.6	1.2	3.0	6.3	1.3	3.6												
25	28.8	0.9	1.5	20.0	0.9	2.0	14.6	1.0	2.5	10.9	1.1	3.0	8.2	1.3	3.6	5.9	1.5	4.1									
30	34.6	0.9	1.5	24.0	0.9	2.0	17.8	1.0	2.5	13.2	1.1	3.0	10.1	1.2	3.6	7.6	1.4	4.2									
35	40.3	0.9	1.5	28.0	0.9	2.0	20.7	1.0	2.5	15.5	1.1	3.0	11.9	1.2	3.6	9.1	1.4	4.2	6.9	1.6	4.7						
40	46.1	0.9	1.5	32.0	0.9	2.0	23.7	1.0	2.5	18.0	1.1	3.0	13.7	1.2	3.6	10.6	1.4	4.2	8.2	1.6	4.7						
45	51.9	0.9	1.5	36.0	0.9	2.0	26.6	1.0	2.5	20.2	1.1	3.0	15.4	1.2	3.6	12.0	1.3	4.2	9.4	1.5	4.7	7.0	1.8	5.3			
50	57.6	0.9	1.5	40.0	0.9	2.0	29.6	1.0	2.5	22.4	1.1	3.0	17.2	1.2	3.6	13.5	1.3	4.1	10.6	1.5	4.7	8.3	1.7	5.3			
55	63.4	0.9	1.5	44.0	0.9	2.0	32.5	1.0	2.5	24.7	1.1	3.0	19.2	1.2	3.6	14.9	1.3	4.1	11.8	1.5	4.7	9.3	1.7	5.3	6.7	2.1	5.8
60	69.1	0.9	1.5	48.0	0.9	2.0	35.5	1.0	2.5	26.9	1.1	3.0	20.9	1.2	3.6	16.3	1.3	4.1	12.9	1.5	4.7	10.3	1.6	5.3	8.1	1.9	5.8
65	74.9	0.9	1.5	52.0	0.9	2.0	38.4	1.0	2.5	29.2	1.1	3.0	22.7	1.2	3.6	17.7	1.3	4.1	14.1	1.5	4.7	11.3	1.6	5.3	9.0	1.9	5.8
70	80.7	0.9	1.5	56.0	0.9	2.0	41.4	1.0	2.5	31.4	1.1	3.0	24.4	1.2	3.6	19.1	1.3	4.1	15.2	1.5	4.7	12.3	1.6	5.3	9.8	1.8	5.8
75	86.4	0.9	1.5	60.0	0.9	2.0	44.3	1.0	2.5	33.6	1.1	3.0	26.1	1.2	3.6	20.5	1.3	4.1	16.4	1.4	4.7	13.2	1.6	5.3	10.7	1.8	5.8
80	92.2	0.9	1.5	63.9	0.9	2.0	47.3	1.0	2.5	35.9	1.1	3.0	27.9	1.2	3.6	22.2	1.3	4.1	17.5	1.4	4.7	14.2	1.6	5.3	11.5	1.8	5.8
85	97.9	0.9	1.5	67.9	0.9	2.0	50.2	1.0	2.5	38.1	1.1	3.0	29.6	1.2	3.6	23.5	1.3	4.1	18.6	1.4	4.7	15.1	1.6	5.3	12.3	1.8	5.8
90	103.7	0.9	1.5	71.9	0.9	2.0	53.2	1.0	2.5	40.3	1.1	3.0	31.4	1.2	3.6	24.9	1.3	4.1	19.8	1.4	4.7	16.1	1.6	5.3	13.1	1.8	5.8
95	109.5	0.9	1.5	75.9	0.9	2.0	56.1	1.0	2.5	42.6	1.1	3.0	33.1	1.2	3.6	26.3	1.3	4.1	20.9	1.4	4.7	17.0	1.6	5.3	13.9	1.7	5.8
100	115.2	0.9	1.5	79.9	0.9	2.0	59.1	1.0	2.5	44.8	1.1	3.0	34.8	1.2	3.6	27.7	1.3	4.1	22.0	1.4	4.7	17.9	1.6	5.3	14.7	1.7	5.8
105	121.0	0.9	1.5	83.9	0.9	2.0	62.0	1.0	2.5	47.1	1.1	3.0	36.6	1.2	3.6	29.0	1.3	4.1	23.4	1.4	4.7	18.9	1.6	5.3	15.5	1.7	5.8
110	126.8	0.9	1.5	87.9	0.9	2.0	65.0	1.0	2.5	49.3	1.1	3.0	38.3	1.2	3.6	30.4	1.3	4.1	24.5	1.4	4.7	19.8	1.6	5.3	16.3	1.7	5.8
115	132.5	0.9	1.5	91.9	0.9	2.0	67.9	1.0	2.5	51.5	1.1	3.0	40.1	1.2	3.6	31.8	1.3	4.1	25.6	1.4	4.7	20.7	1.6	5.3	17.1	1.7	5.9
120	138.3	0.9	1.5	95.9	0.9	2.0	70.9	1.0	2.5	53.8	1.1	3.0	41.8	1.2	3.6	33.2	1.3	4.1	26.8	1.4	4.7	21.7	1.6	5.3	17.9	1.7	5.9
125	144.0	0.9	1.5	99.9	0.9	2.0	73.8	1.0	2.5	56.0	1.1	3.0	43.5	1.2	3.6	34.6	1.3	4.1	27.9	1.4	4.7	22.6	1.6	5.3	18.7	1.7	5.9
130	149.8	0.9	1.5	103.9	0.9	2.0	76.8	1.0	2.5	58.3	1.1	3.0	45.3	1.2	3.6	35.9	1.3	4.1	28.0	1.4	4.7	23.5	1.6	5.3	19.4	1.7	5.9
135	155.6	0.9	1.5	107.9	0.9	2.0	79.7	1.0	2.5	60.5	1.1	3.0	47.0	1.2	3.6	37.3	1.3	4.1	30.1	1.4	4.7	24.5	1.6	5.3	20.2	1.7	5.9
140	161.3	0.9	1.5	111.9	0.9	2.0	82.7	1.0	2.5	62.7	1.1	3.0	48.8	1.2	3.6	38.7	1.3	4.1	31.2	1.4	4.7	25.7	1.6	5.3	21.0	1.7	5.9
145	167.1	0.9	1.5	115.9	0.9	2.0	85.6	1.0	2.5	65.0	1.1	3.0	50.5	1.2	3.6	40.1	1.3	4.1	32.3	1.4	4.7	26.6	1.6	5.3	21.8	1.7	5.9
150	172.8	0.9	1.5	119.9	0.9	2.0	88.6	1.0	2.5	67.2	1.1	3.0	52.2	1.2	3.6	41.5	1.3	4.1	33.4	1.4	4.7	27.5	1.6	5.3	22.6	1.7	5.9

RETARDANCE "D" AND "C"

NOTE: Width and Depth dimensions are in feet; Velocity measurements are in feet per second.
Depth "D" does not include allowance for freeboard or settlement.

Table GS-4 Parabolic Grass Swale Design Sheet 8 of 14

V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH (D), AND V2 FOR RETARDANCE "C"

Grade 2.00 Percent

Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5	5.9	0.9	1.5																								
10	12.4	0.8	1.5	8.1	0.9	2.0	5.9	1.0	2.5																		
15	18.5	0.8	1.5	12.3	0.9	2.0	9.3	1.0	2.5	6.8	1.1	3.0	4.7	1.4	3.5												
20	24.7	0.8	1.5	16.7	0.9	2.0	12.5	1.0	2.5	9.4	1.1	3.0	7.0	1.2	3.6	4.7	1.5	4.1									
25	30.8	0.8	1.5	20.8	0.9	2.0	15.9	1.0	2.4	11.8	1.1	3.0	9.0	1.2	3.5	6.8	1.3	4.1									
30	37.0	0.8	1.5	25.0	0.9	2.0	19.0	1.0	2.5	14.3	1.1	3.0	11.0	1.2	3.5	8.5	1.3	4.1	6.4	1.5	4.7						
35	43.2	0.8	1.5	29.1	0.9	2.0	22.2	1.0	2.5	16.9	1.0	3.0	12.9	1.1	3.5	10.1	1.3	4.1	7.8	1.4	4.7						
40	49.3	0.8	1.5	33.3	0.9	2.0	25.3	1.0	2.5	19.3	1.0	3.0	14.8	1.1	3.5	11.6	1.3	4.1	9.1	1.4	4.7	7.1	1.6	5.2			
45	55.5	0.8	1.5	37.4	0.9	2.0	28.5	1.0	2.5	21.7	1.0	3.0	16.7	1.1	3.5	13.1	1.3	4.1	10.4	1.4	4.7	8.2	1.8	5.2			
50	61.7	0.8	1.5	41.6	0.9	2.0	31.7	1.0	2.5	24.1	1.0	3.0	18.8	1.1	3.5	14.7	1.2	4.1	11.7	1.4	4.7	9.3	1.5	5.3	7.1	1.6	5.8
55	67.8	0.8	1.5	45.7	0.9	2.0	34.8	1.0	2.5	26.5	1.0	3.0	20.7	1.1	3.5	16.2	1.2	4.1	12.9	1.4	4.7	10.4	1.5	5.3	8.2	1.7	5.8
60	74.0	0.8	1.5	49.9	0.9	2.0	38.0	1.0	2.5	28.9	1.0	3.0	22.6	1.1	3.5	17.7	1.2	4.1	14.1	1.4	4.7	11.4	1.5	5.3	9.2	1.7	5.8
65	80.2	0.8	1.5	54.0	0.9	2.0	41.1	1.0	2.5	31.4	1.0	3.0	24.5	1.1	3.5	19.5	1.2	4.1	15.4	1.3	4.7	12.4	1.5	5.3	10.1	1.7	5.8
70	86.3	0.8	1.5	58.2	0.9	2.0	44.3	1.0	2.5	33.8	1.0	3.0	26.3	1.1	3.5	21.0	1.2	4.1	16.6	1.3	4.7	13.5	1.5	5.3	11.0	1.6	5.8
75	92.5	0.8	1.5	62.3	0.9	2.0	47.5	1.0	2.5	36.2	1.0	3.0	28.2	1.1	3.5	22.4	1.2	4.1	17.8	1.3	4.7	14.5	1.5	5.3	11.8	1.6	5.8
80	98.7	0.8	1.5	66.5	0.9	2.0	50.6	1.0	2.5	38.6	1.0	3.0	30.1	1.1	3.5	23.9	1.2	4.1	19.0	1.3	4.7	15.5	1.5	5.3	12.7	1.6	5.8
85	104.8	0.8	1.5	70.6	0.9	2.0	53.8	1.0	2.5	41.0	1.0	3.0	32.0	1.1	3.5	25.4	1.2	4.1	20.3	1.3	4.7	16.5	1.5	5.3	13.6	1.6	5.8
90	111.0	0.8	1.5	74.8	0.9	2.0	57.0	1.0	2.5	43.4	1.0	3.0	33.8	1.1	3.5	26.9	1.2	4.1	21.8	1.3	4.6	17.5	1.5	5.3	14.4	1.6	5.8
95	117.2	0.8	1.5	78.9	0.9	2.0	60.1	1.0	2.5	45.8	1.0	3.0	35.7	1.1	3.5	28.4	1.2	4.1	23.0	1.3	4.6	18.6	1.5	5.3	15.3	1.6	5.8
100	123.3	0.8	1.5	83.1	0.9	2.0	63.3	1.0	2.5	48.2	1.0	3.0	37.6	1.1	3.5	29.9	1.2	4.1	24.2	1.3	4.6	19.6	1.5	5.3	16.2	1.6	5.8
105	129.5	0.8	1.5	87.3	0.9	2.0	66.4	1.0	2.5	50.6	1.0	3.0	39.5	1.1	3.5	31.4	1.2	4.1	25.4	1.3	4.6	20.6	1.5	5.3	17.0	1.6	5.8
110	135.7	0.8	1.5	91.4	0.9	2.0	69.6	1.0	2.5	53.0	1.0	3.0	41.3	1.1	3.5	32.9	1.2	4.1	26.6	1.3	4.7	21.6	1.4	5.3	17.9	1.6	5.8
115	141.8	0.8	1.5	95.6	0.9	2.0	72.8	1.0	2.5	55.4	1.0	3.0	43.2	1.1	3.5	34.4	1.2	4.1	27.9	1.3	4.7	22.6	1.4	5.3	18.7	1.6	5.8
120	148.0	0.8	1.5	99.7	0.9	2.0	75.9	1.0	2.5	57.9	1.0	3.0	45.1	1.1	3.5	35.9	1.2	4.1	29.1	1.3	4.7	23.9	1.4	5.2	19.5	1.6	5.8
125	154.1	0.8	1.5	103.9	0.9	2.0	79.1	1.0	2.5	60.3	1.0	3.0	47.0	1.1	3.5	37.4	1.2	4.1	30.3	1.3	4.7	24.8	1.4	5.2	20.4	1.6	5.8
130	160.3	0.8	1.5	108.0	0.9	2.0	82.3	1.0	2.5	62.7	1.0	3.0	48.8	1.1	3.5	38.9	1.2	4.1	31.5	1.3	4.7	25.8	1.4	5.3	21.2	1.6	5.8
135	166.5	0.8	1.5	112.2	0.9	2.0	85.4	1.0	2.5	65.1	1.0	3.0	50.7	1.1	3.5	40.3	1.2	4.1	32.7	1.3	4.7	26.8	1.4	5.3	22.1	1.6	5.8
140	172.6	0.8	1.5	116.3	0.9	2.0	88.6	1.0	2.5	67.5	1.0	3.0	52.6	1.1	3.5	41.8	1.2	4.1	33.9	1.3	4.7	27.8	1.4	5.3	22.9	1.6	5.8
145	178.8	0.8	1.5	120.5	0.9	2.0	91.8	1.0	2.5	69.9	1.0	3.0	54.5	1.1	3.5	43.3	1.2	4.1	35.1	1.3	4.7	28.8	1.4	5.3	23.7	1.6	5.8
150	185.0	0.8	1.5	124.6	0.9	2.0	94.9	1.0	2.5	72.3	1.0	3.0	56.4	1.1	3.5	44.8	1.2	4.1	36.3	1.3	4.7	29.8	1.4	5.3	24.6	1.6	5.8

RETARDANCE "D" AND "C"

NOTE: Width and Depth dimensions are in feet; Velocity measurements are in feet per second;
Depth "D" does not include allowance for freeboard or settlement.

Table GS-4 Parabolic Grass Swale Design Sheet 9 of 14

V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH (D), AND V2 FOR RETARDANCE "C"

Grade 3.00 Percent

Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5	7.4	0.7	1.4	4.9	0.8	1.9	3.2	1.0	2.3																		
10	15.1	0.7	1.4	10.2	0.8	1.9	7.6	0.8	2.4	5.7	0.9	2.9	4.0	1.1	3.4												
15	22.6	0.7	1.4	15.6	0.8	1.9	11.5	0.8	2.4	8.8	0.9	2.9	6.7	1.0	3.4	5.1	1.1	4.0									
20	30.1	0.7	1.4	20.7	0.8	1.9	15.5	0.8	2.4	11.8	0.9	2.9	9.2	0.9	3.4	7.2	1.0	4.0	5.5	1.2	4.6						
25	37.6	0.7	1.4	25.9	0.8	1.9	19.4	0.8	2.4	15.0	0.9	2.9	11.6	0.9	3.4	9.2	1.0	4.0	7.2	1.1	4.6	5.6	1.3	5.1			
30	45.1	0.7	1.4	31.1	0.8	1.9	23.3	0.8	2.4	18.0	0.9	2.9	14.0	0.9	3.4	11.1	1.0	4.0	8.9	1.1	4.6	7.1	1.2	5.2	5.3	1.5	5.7
35	52.7	0.7	1.4	36.2	0.8	1.9	27.1	0.8	2.4	21.0	0.9	2.9	16.5	0.9	3.4	13.0	1.0	4.0	10.5	1.1	4.6	8.4	1.2	5.2	6.7	1.4	5.7
40	60.2	0.7	1.4	41.4	0.8	1.9	31.0	0.8	2.4	24.0	0.9	2.9	18.9	0.9	3.4	14.9	1.0	4.0	12.0	1.1	4.6	9.8	1.2	5.2	7.9	1.3	5.7
45	67.7	0.7	1.4	46.6	0.8	1.9	34.9	0.8	2.4	27.0	0.9	2.9	21.2	0.9	3.4	17.0	1.0	4.0	13.6	1.1	4.6	11.1	1.2	5.2	9.1	1.3	5.7
50	75.2	0.7	1.4	51.8	0.8	1.9	38.8	0.8	2.4	29.9	0.9	2.9	23.6	0.9	3.4	18.9	1.0	4.0	15.2	1.1	4.6	12.4	1.2	5.2	10.2	1.3	5.7
55	82.8	0.7	1.4	56.9	0.8	1.9	42.6	0.8	2.4	32.9	0.9	2.9	25.9	0.9	3.4	20.8	1.0	4.0	16.7	1.1	4.6	13.7	1.2	5.2	11.3	1.3	5.7
60	90.3	0.7	1.4	62.1	0.8	1.9	46.5	0.8	2.4	35.9	0.9	2.9	28.3	0.9	3.4	22.7	1.0	4.0	18.5	1.1	4.5	14.9	1.2	5.2	12.4	1.3	5.7
65	97.8	0.7	1.4	67.3	0.8	1.9	50.4	0.8	2.4	38.9	0.9	2.9	30.6	0.9	3.4	24.6	1.0	4.0	20.0	1.1	4.5	16.2	1.2	5.2	13.5	1.3	5.7
70	105.3	0.7	1.4	72.4	0.8	1.9	54.3	0.8	2.4	41.9	0.9	2.9	33.0	0.9	3.4	26.4	1.0	4.0	21.5	1.1	4.5	17.5	1.2	5.2	14.5	1.3	5.7
75	112.8	0.7	1.4	77.6	0.8	1.9	58.1	0.8	2.4	44.9	0.9	2.9	35.3	0.9	3.4	28.3	1.0	4.0	23.1	1.1	4.5	19.1	1.2	5.1	15.6	1.3	5.7
80	120.4	0.7	1.4	82.8	0.8	1.9	62.0	0.8	2.4	47.9	0.9	2.9	37.7	0.9	3.4	30.2	1.0	4.0	24.6	1.1	4.5	20.3	1.2	5.1	16.7	1.3	5.7
85	127.9	0.7	1.4	88.0	0.8	1.9	65.9	0.8	2.4	50.9	0.9	2.9	40.1	0.9	3.4	32.1	1.0	4.0	26.1	1.1	4.5	21.6	1.2	5.1	17.8	1.2	5.7
90	135.4	0.7	1.4	93.1	0.8	1.9	69.8	0.8	2.4	53.9	0.9	2.9	42.4	0.9	3.4	34.0	1.0	4.0	27.7	1.1	4.5	22.9	1.2	5.1	18.9	1.2	5.7
95	142.9	0.7	1.4	98.3	0.8	1.9	73.6	0.8	2.4	56.9	0.9	2.9	44.8	0.9	3.4	35.9	1.0	4.0	29.2	1.1	4.5	24.1	1.2	5.1	20.2	1.2	5.7
100	150.5	0.7	1.4	103.5	0.8	1.9	77.5	0.8	2.4	59.9	0.9	2.9	47.1	0.9	3.4	37.8	1.0	4.0	30.7	1.1	4.5	25.4	1.2	5.1	21.2	1.2	5.7
105	158.0	0.7	1.4	108.7	0.8	1.9	81.4	0.8	2.4	62.8	0.9	2.9	49.5	0.9	3.4	39.6	1.0	4.0	32.3	1.1	4.5	26.7	1.2	5.1	22.3	1.2	5.7
110	165.5	0.7	1.4	113.8	0.8	1.9	85.3	0.8	2.4	65.8	0.9	2.9	51.8	0.9	3.4	41.5	1.0	4.0	33.8	1.1	4.6	27.9	1.2	5.1	23.3	1.2	5.7
115	173.0	0.7	1.4	119.0	0.8	1.9	89.1	0.8	2.4	68.8	0.9	2.9	54.2	0.9	3.4	43.4	1.0	4.0	35.4	1.1	4.6	29.2	1.2	5.1	24.4	1.2	5.7
120	180.5	0.7	1.4	124.2	0.8	1.9	93.0	0.8	2.4	71.8	0.9	2.9	56.5	0.9	3.4	45.3	1.0	4.0	36.9	1.1	4.6	30.5	1.2	5.1	25.5	1.2	5.7
125	188.1	0.7	1.4	129.4	0.8	1.9	96.9	0.8	2.4	74.8	0.9	2.9	58.9	0.9	3.4	47.2	1.0	4.0	38.4	1.1	4.6	31.7	1.2	5.1	26.5	1.2	5.7
130	195.6	0.7	1.4	134.5	0.8	1.9	100.8	0.8	2.4	77.8	0.9	2.9	61.2	0.9	3.4	49.1	1.0	4.0	40.0	1.1	4.6	33.0	1.2	5.1	27.6	1.2	5.7
135	203.1	0.7	1.4	139.7	0.8	1.9	104.6	0.8	2.4	80.8	0.9	2.9	63.6	0.9	3.4	51.0	1.0	4.0	41.5	1.1	4.6	34.3	1.2	5.1	28.6	1.2	5.7
140	210.6	0.7	1.4	144.9	0.8	1.9	108.5	0.8	2.4	83.8	0.9	2.9	66.0	0.9	3.4	52.8	1.0	4.0	43.0	1.1	4.6	35.6	1.2	5.1	29.7	1.2	5.7
145	218.2	0.7	1.4	150.1	0.8	1.9	112.4	0.8	2.4	86.8	0.9	2.9	68.3	0.9	3.4	54.7	1.0	4.0	44.6	1.1	4.6	36.8	1.2	5.1	30.7	1.2	5.7
150	225.7	0.7	1.4	155.2	0.8	1.9	116.3	0.8	2.4	89.8	0.9	2.9	70.7	0.9	3.4	56.6	1.0	4.0	46.1	1.1	4.6	38.1	1.2	5.1	31.8	1.2	5.7

RETARDANCE "D" AND "C"

NOTE: Width and Depth dir sions are in feet; Velocity measurements are in feet per second;
includ lowance for freeboarc settlement.

Table GS-4 Parabolic Grass Swale Design Sheet 10 of 14

V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH (D), AND V2 FOR RETARDANCE "C"

Grade 4.00 Percent

Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5	8.5	0.6	1.4	5.9	0.7	1.8	4.1	0.8	2.3																		
10	17.2	0.6	1.4	12.1	0.7	1.8	8.8	0.7	2.3	6.7	0.8	2.8	5.2	0.9	3.3	3.8	1.0	3.9									
15	25.8	0.6	1.4	18.1	0.7	1.8	13.4	0.7	2.3	10.3	0.8	2.8	8.1	0.8	3.4	6.4	0.9	3.9	4.9	1.0	4.5						
20	34.4	0.6	1.4	24.2	0.7	1.8	17.8	0.7	2.3	13.9	0.8	2.8	10.9	0.8	3.4	8.7	0.9	3.9	6.9	1.0	4.5	5.5	1.1	5.0			
25	43.0	0.6	1.4	30.2	0.7	1.9	22.3	0.7	2.3	17.4	0.8	2.8	13.8	0.8	3.3	10.9	0.9	3.9	8.8	1.0	4.5	7.1	1.0	5.1	5.7	1.2	5.6
30	51.6	0.6	1.4	36.3	0.7	1.9	26.7	0.7	2.3	20.8	0.8	2.8	16.5	0.8	3.3	13.2	0.9	3.9	10.7	0.9	4.5	8.7	1.0	5.1	7.1	1.1	5.6
35	60.2	0.6	1.4	42.3	0.7	1.9	31.1	0.7	2.3	24.3	0.8	2.8	19.3	0.8	3.4	15.6	0.9	3.9	12.5	0.9	4.5	10.3	1.0	5.0	8.4	1.1	5.6
40	68.8	0.6	1.4	48.3	0.7	1.9	35.6	0.7	2.3	27.8	0.8	2.8	22.0	0.8	3.4	17.8	0.9	3.9	14.4	0.9	4.5	11.8	1.0	5.0	9.8	1.1	5.7
45	77.4	0.6	1.4	54.4	0.7	1.9	40.0	0.7	2.4	31.2	0.8	2.8	24.8	0.8	3.4	20.0	0.9	3.9	16.4	0.9	4.4	13.3	1.0	5.0	11.1	1.1	5.7
50	86.0	0.6	1.4	60.4	0.7	1.9	44.5	0.7	2.4	34.7	0.8	2.8	27.5	0.8	3.4	22.2	0.9	3.9	18.2	0.9	4.4	14.9	1.0	5.0	12.3	1.1	5.7
55	94.6	0.6	1.4	66.5	0.7	1.9	48.9	0.7	2.4	38.2	0.8	2.8	30.3	0.8	3.4	24.4	0.9	3.9	20.0	0.9	4.4	16.6	1.0	5.0	13.6	1.1	5.7
60	103.2	0.6	1.4	72.5	0.7	1.9	53.4	0.7	2.4	41.7	0.8	2.8	33.0	0.8	3.4	26.6	0.9	3.9	21.8	0.9	4.5	18.1	1.0	5.0	14.9	1.1	5.7
65	111.8	0.6	1.4	78.5	0.7	1.9	57.8	0.7	2.4	45.1	0.8	2.8	35.8	0.8	3.4	28.9	0.9	3.9	23.6	0.9	4.5	19.6	1.0	5.0	16.2	1.1	5.7
70	120.4	0.6	1.4	84.6	0.7	1.9	62.3	0.7	2.4	48.6	0.8	2.8	38.6	0.8	3.4	31.1	0.9	3.9	25.4	0.9	4.5	21.1	1.0	5.0	17.7	1.1	5.6
75	129.0	0.6	1.4	90.6	0.7	1.9	66.7	0.7	2.4	52.1	0.8	2.8	41.3	0.8	3.4	33.3	0.9	3.9	27.2	0.9	4.5	22.6	1.0	5.0	19.0	1.1	5.6
80	137.6	0.6	1.4	96.7	0.7	1.9	71.2	0.7	2.4	55.5	0.8	2.8	44.1	0.8	3.4	35.5	0.9	3.9	29.1	0.9	4.5	24.1	1.0	5.0	20.2	1.1	5.6
85	146.2	0.6	1.4	102.7	0.7	1.9	75.6	0.7	2.4	59.0	0.8	2.8	46.8	0.8	3.4	37.7	0.9	3.9	30.9	0.9	4.5	25.6	1.0	5.0	21.5	1.1	5.6
90	154.8	0.6	1.4	108.7	0.7	1.9	80.0	0.7	2.4	62.5	0.8	2.8	49.6	0.8	3.4	39.9	0.9	3.9	32.7	0.9	4.5	27.1	1.0	5.0	22.8	1.1	5.6
95	163.4	0.6	1.4	114.8	0.7	1.9	84.5	0.7	2.4	65.9	0.8	2.8	52.3	0.8	3.4	42.2	0.9	3.9	34.5	0.9	4.5	28.6	1.0	5.0	24.0	1.1	5.6
100	172.0	0.6	1.4	120.8	0.7	1.9	88.9	0.7	2.4	69.4	0.8	2.8	55.1	0.8	3.4	44.4	0.9	3.9	36.3	0.9	4.5	30.1	1.0	5.0	25.3	1.1	5.6
105	180.6	0.6	1.4	126.9	0.7	1.9	93.4	0.7	2.4	72.9	0.8	2.8	57.8	0.8	3.4	46.6	0.9	3.9	38.1	0.9	4.5	31.6	1.0	5.0	26.5	1.1	5.6
110	189.2	0.6	1.4	132.9	0.7	1.9	97.8	0.7	2.4	76.3	0.8	2.8	60.6	0.8	3.4	48.8	0.9	3.9	39.9	0.9	4.5	33.1	1.0	5.0	27.8	1.1	5.6
115	197.8	0.6	1.4	138.9	0.7	1.9	102.3	0.7	2.4	79.8	0.8	2.8	63.3	0.8	3.4	51.0	0.9	3.9	41.7	0.9	4.5	34.6	1.0	5.0	29.0	1.1	5.6
120	206.4	0.6	1.4	145.0	0.7	1.9	106.7	0.7	2.4	83.3	0.8	2.8	66.1	0.8	3.4	53.3	0.9	3.9	43.6	0.9	4.5	36.1	1.0	5.0	30.2	1.1	5.7
125	215.0	0.6	1.4	151.0	0.7	1.9	111.2	0.7	2.4	86.8	0.8	2.8	68.8	0.8	3.4	55.5	0.9	3.9	45.4	0.9	4.5	37.6	1.0	5.0	31.5	1.1	5.7
130	223.7	0.6	1.4	157.1	0.7	1.9	115.6	0.7	2.4	90.2	0.8	2.8	71.6	0.8	3.4	57.7	0.9	3.9	47.2	0.9	4.5	39.1	1.0	5.0	32.7	1.1	5.7
135	232.3	0.6	1.4	163.1	0.7	1.9	120.1	0.7	2.4	93.7	0.8	2.8	74.3	0.8	3.4	59.9	0.9	3.9	49.0	0.9	4.5	40.6	1.0	5.0	34.0	1.1	5.7
140	240.9	0.6	1.4	169.1	0.7	1.9	124.5	0.7	2.4	97.2	0.8	2.8	77.1	0.8	3.4	62.1	0.9	3.9	50.8	0.9	4.5	42.1	1.0	5.0	35.2	1.1	5.7
145	249.5	0.6	1.4	175.2	0.7	1.9	129.0	0.7	2.4	100.6	0.8	2.8	79.8	0.8	3.4	64.3	0.9	3.9	52.6	0.9	4.5	43.6	1.0	5.0	36.5	1.1	5.7
150	258.1	0.6	1.4	181.2	0.7	1.9	133.4	0.7	2.4	104.1	0.8	2.8	82.6	0.8	3.4	66.6	0.9	3.9	54.4	0.9	4.5	45.1	1.0	5.0	37.8	1.1	5.7

RETARDANCE "D" AND "C"

NOTE: Width and Depth dimensions are in feet; Velocity measurements are in feet per second;
Depth "D" does not include allowance for freeboard or settlement.

Table GS-4 Parabolic Grass Swale Design Sheet 11 of 14

V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH (D), AND V2 FOR RETARDANCE "C"

Grade 5.00 Percent

Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5	9.5	0.6	1.4	6.7	0.6	1.8	4.7	0.7	2.3	3.5	0.8	2.8															
10	19.0	0.6	1.4	13.7	0.6	1.8	9.7	0.7	2.3	7.6	0.7	2.8	6.0	0.8	3.3	4.7	0.8	3.8	3.4	1.0	4.4						
15	28.5	0.6	1.4	20.5	0.6	1.8	14.8	0.7	2.3	11.7	0.7	2.8	9.2	0.7	3.3	7.3	0.8	3.8	5.9	0.9	4.4	4.7	1.0	5.0			
20	38.0	0.6	1.4	27.3	0.6	1.8	19.7	0.7	2.3	15.5	0.7	2.8	12.4	0.7	3.3	9.9	0.8	3.8	8.0	0.9	4.4	6.5	0.9	4.9	5.3	1.0	5.5
25	47.5	0.6	1.4	34.1	0.6	1.8	24.6	0.7	2.3	19.4	0.7	2.8	15.5	0.7	3.3	12.6	0.8	3.8	10.1	0.8	4.4	8.3	0.9	5.0	6.8	1.0	5.6
30	57.0	0.6	1.4	40.9	0.6	1.8	29.5	0.7	2.3	23.3	0.7	2.8	18.6	0.7	3.3	15.1	0.8	3.8	12.2	0.8	4.4	10.1	0.9	5.0	8.3	1.0	5.6
35	66.5	0.6	1.4	47.7	0.6	1.8	34.4	0.7	2.3	27.2	0.7	2.8	21.7	0.7	3.3	17.6	0.8	3.8	14.5	0.8	4.4	11.8	0.9	5.0	9.8	1.0	5.6
40	76.0	0.6	1.4	54.6	0.6	1.8	39.4	0.7	2.3	31.0	0.7	2.8	24.8	0.7	3.3	20.1	0.8	3.8	16.5	0.8	4.4	13.6	0.9	5.0	11.3	1.0	5.5
45	85.5	0.6	1.4	61.4	0.6	1.8	44.3	0.7	2.3	34.9	0.7	2.8	27.9	0.7	3.3	22.6	0.8	3.8	18.6	0.8	4.4	15.5	0.9	4.9	12.8	1.0	5.5
50	95.0	0.6	1.4	68.2	0.6	1.8	49.2	0.7	2.3	38.8	0.7	2.8	31.0	0.7	3.3	25.1	0.8	3.8	20.6	0.8	4.4	17.2	0.9	4.9	14.3	1.0	5.5
55	104.6	0.6	1.4	75.0	0.6	1.8	54.1	0.7	2.3	42.7	0.7	2.8	34.1	0.7	3.3	27.6	0.8	3.8	22.7	0.8	4.4	18.9	0.9	4.9	15.9	0.9	5.5
60	114.1	0.6	1.4	81.8	0.6	1.8	59.0	0.7	2.3	46.6	0.7	2.8	37.2	0.7	3.3	30.1	0.8	3.8	24.7	0.8	4.4	20.6	0.9	4.9	17.3	0.9	5.5
65	123.6	0.6	1.4	88.6	0.6	1.8	63.9	0.7	2.3	50.4	0.7	2.8	40.3	0.7	3.3	32.6	0.8	3.8	26.8	0.8	4.4	22.3	0.9	4.9	18.8	0.9	5.5
70	133.1	0.6	1.4	95.5	0.6	1.8	68.9	0.7	2.3	54.3	0.7	2.8	43.4	0.7	3.3	35.1	0.8	3.8	28.9	0.8	4.4	24.0	0.9	4.9	20.2	0.9	5.5
75	142.6	0.6	1.4	102.3	0.6	1.8	73.8	0.7	2.3	58.2	0.7	2.8	46.5	0.7	3.3	37.7	0.8	3.8	30.9	0.8	4.4	25.7	0.9	4.9	21.6	0.9	5.5
80	152.1	0.6	1.4	109.1	0.6	1.8	78.7	0.7	2.3	62.1	0.7	2.8	49.6	0.7	3.3	40.2	0.8	3.8	33.0	0.8	4.4	27.4	0.9	4.9	23.1	0.9	5.5
85	161.6	0.6	1.4	115.9	0.6	1.8	83.6	0.7	2.3	65.9	0.7	2.8	52.7	0.7	3.3	42.7	0.8	3.8	35.0	0.8	4.4	29.1	0.9	5.0	24.5	0.9	5.5
90	171.1	0.6	1.4	122.7	0.6	1.8	88.5	0.7	2.3	69.8	0.7	2.8	55.8	0.7	3.3	45.2	0.8	3.8	37.1	0.8	4.4	30.9	0.9	5.0	26.0	0.9	5.5
95	180.6	0.6	1.4	129.6	0.6	1.8	93.4	0.7	2.3	73.7	0.7	2.8	58.9	0.7	3.3	47.7	0.8	3.8	39.2	0.8	4.4	32.6	0.9	5.0	27.4	0.9	5.5
100	190.1	0.6	1.4	136.4	0.6	1.8	98.4	0.7	2.3	77.6	0.7	2.8	62.0	0.7	3.3	50.2	0.8	3.8	41.2	0.8	4.4	34.3	0.9	5.0	28.8	0.9	5.5
105	199.6	0.6	1.4	143.2	0.6	1.8	103.3	0.7	2.3	81.5	0.7	2.8	65.1	0.7	3.3	52.7	0.8	3.8	43.3	0.8	4.4	36.0	0.9	5.0	30.3	0.9	5.5
110	209.1	0.6	1.4	150.0	0.6	1.8	108.2	0.7	2.3	85.3	0.7	2.8	68.2	0.7	3.3	55.2	0.8	3.8	45.3	0.8	4.4	37.7	0.9	5.0	31.7	0.9	5.5
115	218.6	0.6	1.4	156.8	0.6	1.8	113.1	0.7	2.3	89.2	0.7	2.8	71.3	0.7	3.3	57.7	0.8	3.8	47.4	0.8	4.4	39.4	0.9	5.0	33.2	0.9	5.5
120	228.1	0.6	1.4	163.6	0.6	1.8	118.0	0.7	2.3	93.1	0.7	2.8	74.3	0.7	3.3	60.2	0.8	3.8	49.5	0.8	4.4	41.1	0.9	5.0	34.6	0.9	5.5
125	237.6	0.6	1.4	170.5	0.6	1.8	123.0	0.7	2.3	97.0	0.7	2.8	77.4	0.7	3.3	62.7	0.8	3.8	51.5	0.8	4.4	42.8	0.9	5.0	36.0	0.9	5.5
130	247.1	0.6	1.4	177.3	0.6	1.8	127.9	0.7	2.3	100.8	0.7	2.8	80.5	0.7	3.3	65.2	0.8	3.8	53.6	0.8	4.4	44.6	0.9	5.0	37.5	0.9	5.5
135	256.6	0.6	1.4	184.1	0.6	1.8	132.8	0.7	2.3	104.7	0.7	2.8	83.6	0.7	3.3	67.8	0.8	3.8	55.6	0.8	4.4	46.3	0.9	5.0	38.9	0.9	5.5
140	266.1	0.6	1.4	190.9	0.6	1.8	137.7	0.7	2.3	108.6	0.7	2.8	86.7	0.7	3.3	70.3	0.8	3.8	57.7	0.8	4.4	48.0	0.9	5.0	40.4	0.9	5.5
145	275.6	0.6	1.4	197.7	0.6	1.8	142.6	0.7	2.3	112.5	0.7	2.8	89.8	0.7	3.3	72.8	0.8	3.8	59.8	0.8	4.4	49.7	0.9	5.0	41.8	0.9	5.5
150	285.1	0.6	1.4	204.6	0.6	1.8	147.5	0.7	2.3	116.4	0.7	2.8	92.9	0.7	3.3	75.3	0.8	3.8	61.8	0.8	4.4	51.4	0.9	5.0	43.2	0.9	5.5

RETARDANCE "D" AND "C"

NOTE: Width and Depth dimensions are in feet; Velocity measurements are in feet per second:
Depth "D" does not include allowance for freeboard or settlement.

Table GS-4 Parabolic Grass Swale Design Sheet 12 of 14

V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH (D), AND V2 FOR RETARDANCE "C"

Grade 6.00 Percent

Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5	10.6	0.5	1.3	7.3	0.6	1.8	5.3	0.6	2.3	4.0	0.7	2.8	2.9	0.8	3.2												
10	21.1	0.5	1.3	14.7	0.6	1.8	10.9	0.6	2.3	8.4	0.7	2.8	6.6	0.7	3.2	5.3	0.8	3.8	4.2	0.8	4.3						
15	31.6	0.5	1.3	22.1	0.6	1.8	16.3	0.6	2.3	12.7	0.6	2.7	10.1	0.7	3.3	8.2	0.7	3.8	6.6	0.8	4.3	5.4	0.9	4.9	4.3	1.0	5.5
20	42.1	0.5	1.3	29.5	0.6	1.8	21.7	0.6	2.3	17.0	0.6	2.7	13.6	0.7	3.2	11.1	0.7	3.7	9.0	0.8	4.3	7.4	0.8	4.9	6.1	0.9	5.5
25	52.7	0.5	1.3	36.8	0.6	1.8	27.1	0.6	2.3	21.2	0.6	2.8	17.0	0.7	3.2	13.9	0.7	3.8	11.3	0.8	4.3	9.3	0.8	4.9	7.8	0.9	5.5
30	63.2	0.5	1.3	44.2	0.6	1.8	32.5	0.6	2.3	25.4	0.6	2.8	20.4	0.7	3.2	16.6	0.7	3.8	13.7	0.8	4.3	11.3	0.8	4.9	9.4	0.9	5.5
35	73.7	0.5	1.3	51.6	0.6	1.8	38.0	0.6	2.3	29.7	0.6	2.8	23.8	0.7	3.2	19.4	0.7	3.8	16.0	0.8	4.3	13.4	0.8	4.9	11.1	0.9	5.5
40	84.2	0.5	1.3	58.9	0.6	1.8	43.4	0.6	2.3	33.9	0.6	2.8	27.2	0.7	3.3	22.2	0.7	3.8	18.3	0.8	4.3	15.3	0.8	4.9	12.7	0.9	5.5
45	94.8	0.5	1.3	66.3	0.6	1.8	48.8	0.6	2.3	38.2	0.6	2.8	30.7	0.7	3.3	24.9	0.7	3.8	20.6	0.8	4.3	17.2	0.8	4.9	14.5	0.9	5.4
50	105.3	0.5	1.3	73.6	0.6	1.8	54.2	0.6	2.3	42.4	0.6	2.8	34.1	0.7	3.3	27.7	0.7	3.8	22.8	0.8	4.3	19.1	0.8	4.9	16.1	0.9	5.4
55	115.8	0.5	1.3	81.0	0.6	1.8	59.7	0.6	2.3	46.6	0.6	2.8	37.5	0.7	3.3	30.5	0.7	3.8	25.1	0.8	4.3	21.0	0.8	4.9	17.7	0.9	5.4
60	126.4	0.5	1.3	88.4	0.6	1.8	65.1	0.6	2.3	50.9	0.6	2.8	40.9	0.7	3.3	33.3	0.7	3.8	27.4	0.8	4.3	22.9	0.8	4.9	19.3	0.9	5.4
65	136.9	0.5	1.3	95.7	0.6	1.8	70.5	0.6	2.3	55.1	0.6	2.8	44.3	0.7	3.3	36.0	0.7	3.8	29.7	0.8	4.3	24.8	0.8	4.9	20.9	0.9	5.4
70	147.4	0.5	1.3	103.1	0.6	1.8	75.9	0.6	2.3	59.3	0.6	2.8	47.7	0.7	3.3	38.8	0.7	3.8	32.0	0.8	4.3	26.7	0.8	4.9	22.5	0.9	5.4
75	158.0	0.5	1.3	110.5	0.6	1.8	81.3	0.8	2.3	63.6	0.8	2.8	51.1	0.7	3.3	41.6	0.7	3.8	34.3	0.8	4.3	28.6	0.8	4.9	24.1	0.9	5.4
80	168.5	0.5	1.3	117.8	0.6	1.8	86.8	0.6	2.3	67.8	0.6	2.8	54.5	0.7	3.3	44.3	0.7	3.8	36.5	0.8	4.3	30.5	0.8	4.9	25.7	0.9	5.5
85	179.0	0.5	1.3	125.2	0.6	1.8	92.2	0.6	2.3	72.0	0.6	2.8	57.9	0.7	3.3	47.1	0.7	3.8	38.8	0.8	4.3	32.4	0.8	4.9	27.3	0.9	5.5
90	189.6	0.5	1.3	132.6	0.6	1.8	97.6	0.6	2.3	76.3	0.6	2.8	61.3	0.7	3.3	49.9	0.7	3.8	41.1	0.8	4.3	34.3	0.8	4.9	28.9	0.9	5.5
95	200.1	0.5	1.3	139.9	0.6	1.8	103.0	0.6	2.3	80.5	0.6	2.8	64.7	0.7	3.3	52.6	0.7	3.8	43.4	0.8	4.3	36.2	0.8	4.9	30.5	0.9	5.5
100	210.6	0.5	1.3	147.3	0.6	1.8	108.5	0.6	2.3	84.8	0.6	2.8	68.1	0.7	3.3	55.4	0.7	3.8	45.7	0.8	4.3	38.1	0.8	4.9	32.1	0.9	5.5
105	221.1	0.5	1.3	154.6	0.6	1.8	113.9	0.6	2.3	89.0	0.6	2.8	71.5	0.7	3.3	58.2	0.7	3.8	47.9	0.8	4.3	40.0	0.8	4.9	33.7	0.9	5.5
110	231.7	0.5	1.3	162.0	0.6	1.8	119.3	0.6	2.3	93.2	0.6	2.8	74.9	0.7	3.3	60.9	0.7	3.8	50.2	0.8	4.3	41.9	0.8	4.9	35.3	0.9	5.5
115	242.2	0.5	1.3	169.4	0.6	1.8	124.7	0.6	2.3	97.5	0.6	2.8	78.3	0.7	3.3	63.7	0.7	3.8	52.5	0.8	4.3	43.8	0.8	4.9	36.9	0.9	5.5
120	252.7	0.5	1.3	176.7	0.6	1.8	130.2	0.6	2.3	101.7	0.6	2.8	81.7	0.7	3.3	66.5	0.7	3.8	54.8	0.8	4.3	45.7	0.8	4.9	38.5	0.9	5.5
125	263.3	0.5	1.3	184.1	0.6	1.8	135.6	0.6	2.3	106.0	0.6	2.8	85.1	0.7	3.3	69.3	0.7	3.8	57.1	0.8	4.3	47.6	0.8	4.9	40.1	0.9	5.5
130	273.8	0.5	1.3	191.5	0.6	1.8	141.0	0.6	2.3	110.2	0.6	2.8	88.5	0.7	3.3	72.0	0.7	3.8	59.4	0.8	4.3	49.5	0.8	4.9	41.7	0.9	5.5
135	284.3	0.5	1.3	198.8	0.6	1.8	146.4	0.6	2.3	114.4	0.6	2.8	91.9	0.7	3.3	74.8	0.7	3.8	61.6	0.8	4.3	51.4	0.8	4.9	43.3	0.9	5.5
140	294.9	0.5	1.3	206.2	0.6	1.8	151.8	0.6	2.3	118.7	0.6	2.8	95.3	0.7	3.3	77.6	0.7	3.8	63.9	0.8	4.3	53.3	0.8	4.9	44.9	0.9	5.5
145	305.4	0.5	1.3	213.6	0.6	1.8	157.3	0.6	2.3	122.9	0.6	2.8	98.7	0.7	3.3	80.3	0.7	3.8	66.2	0.8	4.3	55.2	0.8	4.9	46.5	0.9	5.5
150	315.9	0.5	1.3	220.9	0.6	1.8	162.7	0.6	2.3	127.1	0.6	2.8	102.1	0.7	3.3	83.1	0.7	3.8	68.5	0.8	4.3	57.1	0.8	4.9	48.1	0.9	5.5

RETARDANCE "D" AND "C"

NOTE: Width and Depth dimensions are in feet; Velocity measurements are in feet per second:
Depth "D" does not include allowance for freeboard or settlement.

Table GS-4 Parabolic Grass Swale Design Sheet 13 of 14

V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH' (D), AND V2 FOR RETARDANCE "C"

Grade 8.00 Percent

Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5	12.0	0.5	1.3	8.5	0.5	1.7	6.2	0.5	2.2	4.6	0.6	2.7	3.7	0.6	3.2	2.9	0.7	3.6									
10	24.1	0.5	1.3	16.9	0.5	1.7	12.6	0.5	2.2	9.6	0.6	2.7	7.8	0.6	3.2	6.3	0.6	3.7	5.1	0.7	4.2	4.2	0.8	4.8	3.2	0.9	5.3
15	36.1	0.5	1.3	25.3	0.5	1.7	18.9	0.5	2.2	14.4	0.6	2.7	11.8	0.6	3.2	9.7	0.6	3.7	7.9	0.7	4.2	6.5	0.7	4.8	5.4	0.8	5.3
20	48.1	0.5	1.3	33.8	0.5	1.7	25.2	0.5	2.2	19.2	0.6	2.7	15.8	0.6	3.2	12.9	0.6	3.7	10.7	0.7	4.2	8.8	0.7	4.8	7.4	0.8	5.3
25	60.1	0.5	1.3	42.2	0.5	1.7	31.5	0.5	2.2	24.0	0.6	2.7	19.7	0.6	3.2	16.2	0.6	3.7	13.4	0.7	4.2	11.2	0.7	4.7	9.3	0.8	5.3
30	72.1	0.5	1.3	50.6	0.5	1.7	37.8	0.5	2.2	28.8	0.6	2.7	23.6	0.6	3.2	19.4	0.6	3.7	16.1	0.7	4.2	13.5	0.7	4.8	11.3	0.7	5.3
35	84.1	0.5	1.3	59.1	0.5	1.7	44.1	0.5	2.2	33.6	0.6	2.7	27.6	0.6	3.2	22.6	0.6	3.7	18.7	0.7	4.2	15.7	0.7	4.8	13.3	0.7	5.3
40	96.2	0.5	1.3	67.5	0.5	1.7	50.4	0.5	2.2	38.4	0.6	2.7	31.5	0.6	3.2	25.8	0.6	3.7	21.4	0.7	4.2	17.9	0.7	4.8	15.2	0.7	5.3
45	108.2	0.5	1.3	76.0	0.5	1.7	56.7	0.5	2.2	43.2	0.6	2.7	35.4	0.6	3.2	29.0	0.6	3.7	24.1	0.7	4.2	20.2	0.7	4.8	17.1	0.7	5.3
50	120.2	0.5	1.3	84.4	0.5	1.7	63.0	0.5	2.2	48.0	0.6	2.7	39.4	0.6	3.2	32.3	0.6	3.7	26.8	0.7	4.2	22.4	0.7	4.8	19.0	0.7	5.3
55	132.2	0.5	1.3	92.8	0.5	1.7	69.3	0.5	2.2	52.8	0.6	2.7	43.3	0.6	3.2	35.5	0.6	3.7	29.4	0.7	4.2	24.7	0.7	4.8	20.9	0.7	5.3
60	144.2	0.5	1.3	101.3	0.5	1.7	75.6	0.5	2.2	57.6	0.6	2.7	47.2	0.6	3.2	38.7	0.6	3.7	32.1	0.7	4.2	26.9	0.7	4.8	22.8	0.7	5.3
65	156.3	0.5	1.3	109.7	0.5	1.7	81.8	0.5	2.2	62.4	0.6	2.7	51.2	0.6	3.2	41.9	0.6	3.7	34.8	0.7	4.2	29.1	0.7	4.8	24.7	0.7	5.3
70	168.3	0.5	1.3	118.2	0.5	1.7	88.1	0.5	2.2	67.2	0.6	2.7	55.1	0.6	3.2	45.2	0.6	3.7	37.5	0.7	4.2	31.4	0.7	4.8	26.6	0.7	5.3
75	180.3	0.5	1.3	126.6	0.5	1.7	94.4	0.5	2.2	72.0	0.6	2.7	59.0	0.6	3.2	48.4	0.6	3.7	40.1	0.7	4.2	33.6	0.7	4.8	28.5	0.7	5.3
80	192.3	0.5	1.3	135.0	0.5	1.7	100.7	0.5	2.2	76.8	0.6	2.7	63.0	0.6	3.2	51.6	0.6	3.7	42.8	0.7	4.2	35.9	0.7	4.8	30.3	0.7	5.3
85	204.3	0.5	1.3	143.5	0.5	1.7	107.0	0.5	2.2	81.6	0.6	2.7	66.9	0.6	3.2	54.9	0.6	3.7	45.5	0.7	4.2	38.1	0.7	4.8	32.2	0.7	5.3
90	216.4	0.5	1.3	151.9	0.5	1.7	113.3	0.5	2.2	86.4	0.6	2.7	70.8	0.6	3.2	58.1	0.6	3.7	48.1	0.7	4.2	40.3	0.7	4.8	34.1	0.7	5.3
95	228.4	0.5	1.3	160.3	0.5	1.7	119.6	0.5	2.2	91.2	0.6	2.7	74.8	0.6	3.2	61.3	0.6	3.7	50.8	0.7	4.2	42.6	0.7	4.8	36.0	0.7	5.3
100	240.4	0.5	1.3	168.8	0.5	1.7	125.9	0.5	2.2	96.0	0.6	2.7	78.7	0.6	3.2	64.5	0.6	3.7	53.5	0.7	4.2	44.8	0.7	4.8	37.9	0.7	5.3
105	252.4	0.5	1.3	177.2	0.5	1.7	132.2	0.5	2.2	100.8	0.6	2.7	82.6	0.6	3.2	67.8	0.6	3.7	56.2	0.7	4.2	47.1	0.7	4.8	39.8	0.7	5.3
110	264.4	0.5	1.3	185.7	0.5	1.7	138.5	0.5	2.2	105.6	0.6	2.7	86.6	0.6	3.2	71.0	0.6	3.7	58.8	0.7	4.2	49.3	0.7	4.8	41.7	0.7	5.3
115	276.5	0.5	1.3	194.1	0.5	1.7	144.8	0.5	2.2	110.4	0.6	2.7	90.5	0.6	3.2	74.2	0.6	3.7	61.5	0.7	4.2	51.5	0.7	4.8	43.6	0.7	5.3
120	288.5	0.5	1.3	202.5	0.5	1.7	151.1	0.5	2.2	115.2	0.6	2.7	94.4	0.6	3.2	77.4	0.6	3.7	64.2	0.7	4.2	53.8	0.7	4.8	45.5	0.7	5.3
125	300.5	0.5	1.3	211.0	0.5	1.7	157.4	0.5	2.2	120.0	0.6	2.7	98.4	0.6	3.2	80.7	0.6	3.7	66.9	0.7	4.2	56.0	0.7	4.8	47.4	0.7	5.3
130	312.5	0.5	1.3	219.4	0.5	1.7	163.7	0.5	2.2	124.8	0.6	2.7	102.3	0.6	3.2	83.9	0.6	3.7	69.5	0.7	4.2	58.3	0.7	4.8	49.3	0.7	5.3
135	324.5	0.5	1.3	227.9	0.5	1.7	170.0	0.5	2.2	129.6	0.6	2.7	106.2	0.6	3.2	87.1	0.6	3.7	72.2	0.7	4.2	60.5	0.7	4.8	51.2	0.7	5.3
140	336.6	0.5	1.3	236.3	0.5	1.7	176.3	0.5	2.2	134.4	0.6	2.7	110.2	0.6	3.2	90.3	0.6	3.7	74.9	0.7	4.2	62.7	0.7	4.8	53.1	0.7	5.3
145	348.6	0.5	1.3	244.7	0.5	1.7	182.6	0.5	2.2	139.2	0.6	2.7	114.1	0.6	3.2	93.6	0.6	3.7	77.6	0.7	4.2	65.0	0.7	4.8	55.0	0.7	5.3
150	360.6	0.5	1.3	253.2	0.5	1.7	188.9	0.5	2.2	144.0	0.6	2.7	118.0	0.6	3.2	96.8	0.6	3.7	80.2	0.7	4.2	67.2	0.7	4.8	56.9	0.7	5.3

RETARDANCE "D" AND "C"

NOTE: Width and Depth dimensions are in feet; Velocity measurements are in feet per second

Depth "D" does not include allowance for freeboard or settlement

Table GS-4 Parabolic Grass Swale Design Sheet 14 of 14

V1 FOR RETARDANCE "D", TOP WIDTH (T), DEPTH (D), AND V2 FOR RETARDANCE "C"

Grade 10.00 Percent

Q CFS	V1=2.0			V1=2.5			V1=3.0			V1=3.5			V1=4.0			V1=4.5			V1=5.0			V1=5.5			V1=6.0		
	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2	T	D	V2
5	13.3	0.4	1.3	9.4	0.5	1.7	6.8	0.5	2.2	5.3	0.5	2.6	4.1	0.6	3.2	3.4	0.6	3.6	2.6	0.7	4.1						
10	26.6	0.4	1.3	18.7	0.5	1.7	13.8	0.5	2.2	10.9	0.5	2.6	8.5	0.6	3.2	7.1	0.6	3.6	5.9	0.6	4.1	4.9	0.7	4.7	4.0	0.7	5.3
15	39.9	0.4	1.3	28.0	0.5	1.7	20.7	0.5	2.2	16.3	0.5	2.6	12.8	0.6	3.2	10.9	0.6	3.6	9.0	0.6	4.1	7.5	0.6	4.7	6.3	0.7	5.2
20	53.2	0.4	1.3	37.4	0.5	1.7	27.6	0.5	2.2	21.7	0.5	2.7	17.0	0.6	3.2	14.5	0.6	3.6	12.1	0.6	4.1	10.2	0.6	4.6	8.5	0.7	5.2
25	66.5	0.4	1.3	46.7	0.5	1.7	34.5	0.5	2.2	27.1	0.5	2.7	21.3	0.6	3.2	18.1	0.6	3.6	15.1	0.6	4.1	12.7	0.6	4.7	10.8	0.7	5.2
30	79.8	0.4	1.3	56.1	0.5	1.7	41.4	0.5	2.2	32.5	0.5	2.7	25.5	0.6	3.2	21.7	0.6	3.6	18.1	0.6	4.1	15.2	0.6	4.7	12.9	0.7	5.2
35	93.1	0.4	1.3	65.4	0.5	1.7	48.3	0.5	2.2	37.9	0.5	2.7	29.8	0.6	3.2	25.3	0.6	3.6	21.1	0.6	4.1	17.8	0.6	4.7	15.1	0.7	5.2
40	106.4	0.4	1.3	74.7	0.5	1.7	55.2	0.5	2.2	43.3	0.5	2.7	34.0	0.6	3.2	29.0	0.6	3.6	24.1	0.6	4.1	20.3	0.6	4.7	17.2	0.7	5.2
45	119.7	0.4	1.3	84.1	0.5	1.7	62.1	0.5	2.2	48.8	0.5	2.7	38.3	0.6	3.2	32.6	0.6	3.6	27.2	0.6	4.1	22.8	0.6	4.7	19.4	0.7	5.2
50	133.0	0.4	1.3	93.4	0.5	1.7	69.0	0.5	2.2	54.2	0.5	2.7	42.5	0.6	3.2	36.2	0.6	3.6	30.2	0.6	4.1	25.4	0.6	4.7	21.5	0.7	5.2
55	146.3	0.4	1.3	102.8	0.5	1.7	75.9	0.5	2.2	59.6	0.5	2.7	46.8	0.6	3.2	39.8	0.6	3.6	33.2	0.6	4.1	27.9	0.6	4.7	23.7	0.7	5.2
60	159.6	0.4	1.3	112.1	0.5	1.7	82.8	0.5	2.2	65.0	0.5	2.7	51.0	0.6	3.2	43.4	0.6	3.6	36.2	0.6	4.1	30.5	0.6	4.7	25.9	0.7	5.2
65	172.9	0.4	1.3	121.4	0.5	1.7	89.7	0.5	2.2	70.4	0.5	2.7	55.3	0.6	3.2	47.1	0.6	3.6	39.2	0.6	4.1	33.0	0.6	4.7	28.0	0.7	5.2
70	186.2	0.4	1.3	130.8	0.5	1.7	96.6	0.5	2.2	75.8	0.5	2.7	59.5	0.6	3.2	50.7	0.6	3.6	42.2	0.6	4.1	35.5	0.6	4.7	30.2	0.7	5.2
75	199.5	0.4	1.3	140.1	0.5	1.7	103.5	0.5	2.2	81.2	0.5	2.7	63.8	0.6	3.2	54.3	0.6	3.6	45.2	0.6	4.1	38.1	0.6	4.7	32.3	0.7	5.2
80	212.8	0.4	1.3	149.5	0.5	1.7	110.5	0.5	2.2	86.7	0.5	2.7	68.0	0.6	3.2	57.9	0.6	3.6	48.3	0.6	4.1	40.6	0.6	4.7	34.5	0.7	5.2
85	226.1	0.4	1.3	158.8	0.5	1.7	117.4	0.5	2.2	92.1	0.5	2.7	72.3	0.6	3.2	61.5	0.6	3.6	51.3	0.6	4.1	43.1	0.6	4.7	36.6	0.7	5.2
90	239.4	0.4	1.3	168.1	0.5	1.7	124.3	0.5	2.2	97.5	0.5	2.7	76.5	0.6	3.2	65.2	0.6	3.6	54.3	0.6	4.1	45.7	0.6	4.7	38.8	0.7	5.2
95	252.7	0.4	1.3	177.5	0.5	1.7	131.2	0.5	2.2	102.9	0.5	2.7	80.8	0.6	3.2	68.8	0.6	3.6	57.3	0.6	4.1	48.2	0.6	4.7	40.9	0.7	5.2
100	266.0	0.4	1.3	186.8	0.5	1.7	138.1	0.5	2.2	108.3	0.5	2.7	85.0	0.6	3.2	72.4	0.6	3.6	60.3	0.6	4.1	50.7	0.6	4.7	43.1	0.7	5.2
105	279.3	0.4	1.3	196.2	0.5	1.7	145.0	0.5	2.2	113.7	0.5	2.7	89.3	0.6	3.2	76.0	0.6	3.6	63.3	0.6	4.1	53.3	0.6	4.7	45.2	0.7	5.2
110	292.6	0.4	1.3	205.5	0.5	1.7	151.9	0.5	2.2	119.2	0.5	2.7	93.5	0.6	3.2	79.6	0.6	3.6	66.4	0.6	4.1	55.8	0.6	4.7	47.4	0.7	5.2
115	305.9	0.4	1.3	214.9	0.5	1.7	158.8	0.5	2.2	124.6	0.5	2.7	97.8	0.6	3.2	83.3	0.6	3.6	69.4	0.6	4.1	58.3	0.6	4.7	49.5	0.7	5.3
120	319.2	0.4	1.3	224.2	0.5	1.7	165.7	0.5	2.2	130.0	0.5	2.7	102.0	0.6	3.2	86.9	0.6	3.6	72.4	0.6	4.1	60.9	0.6	4.7	51.7	0.7	5.3
125	332.5	0.4	1.3	233.5	0.5	1.7	172.6	0.5	2.2	135.4	0.5	2.7	106.3	0.6	3.2	90.5	0.6	3.6	75.4	0.6	4.1	63.4	0.6	4.7	53.8	0.7	5.3
130	345.8	0.4	1.3	242.9	0.5	1.7	179.5	0.5	2.2	140.8	0.5	2.7	110.5	0.6	3.2	94.1	0.6	3.6	78.4	0.6	4.1	66.0	0.6	4.7	56.0	0.7	5.3
135	359.1	0.4	1.3	252.2	0.5	1.7	186.4	0.5	2.2	146.2	0.5	2.7	114.8	0.6	3.2	97.7	0.6	3.6	81.4	0.6	4.1	68.5	0.6	4.7	58.1	0.7	5.3
140	372.4	0.4	1.3	261.6	0.5	1.7	193.3	0.5	2.2	151.7	0.5	2.7	119.0	0.6	3.2	101.3	0.6	3.6	84.4	0.6	4.1	71.0	0.6	4.7	60.3	0.7	5.3
145	385.7	0.4	1.3	270.9	0.5	1.7	200.2	0.5	2.2	157.1	0.5	2.7	123.3	0.6	3.2	105.0	0.6	3.6	87.5	0.6	4.1	73.6	0.6	4.7	62.5	0.7	5.3
150	399.0	0.4	1.3	280.2	0.5	1.7	207.1	0.5	2.2	162.5	0.5	2.7	127.5	0.6	3.2	108.6	0.6	3.6	90.5	0.6	4.1	76.1	0.6	4.7	64.6	0.7	5.3

RETARDANCE "D" AND "C"

NOTE: Width and Depth dimensions are in feet; Velocity measurements are in feet per second;
Depth "D" does not include allowance for freeboard or settlement.

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Filter Strip (FS)

Practice Description

A filter strip is a wide belt of vegetation designed to provide infiltration, intercept sediment and other pollutants, and reduce stormwater flow and velocity. Filter strips are similar to grassed swales except that they are designed to intercept overland sheet flow (not channel flow). They cannot treat high velocity flows. Surface runoff must be evenly distributed across the filter strip. Vegetation may consist of existing cover that is preserved and protected or be planted to establish the strip. Once a concentrated flow channel forms in the filter strip, the filter strip is no longer effective. This practice applies on construction sites and other disturbed areas.

Planning Considerations

Filter strips provide their maximum benefit when established as early as possible after disturbances begin. This concept should receive strong consideration during the scheduling of practices to be installed. In some instances, the existing vegetation may be preserved to serve as a filter strip.

Filter strips should be strategically located on the contour to reduce runoff, and increase infiltration. They should be situated downslope from the disturbed site and where runoff water enters environmentally sensitive areas.

Overland flow entering filter strips should be primarily sheet flow. All concentrated flow should be dispersed prior to entering the filter strip.

Flow length should be based on slope percent and length, predicted amount and particle size distribution of sediment delivered to the filter strip, density and height of the filter strip vegetation, and runoff volume.

The slope of the drainage area above a filter strip should be greater than 1% but less than 10%. The ratio of the drainage area to the filter strip area should be less than 10:1. The minimum width of an effective filter strip is 15 feet.

Existing vegetation may be used if it meets stand density and height requirements and has uniform flow through the existing vegetation. The existing vegetation strip must be on a contour to be effective.

Site preparation for filter strips requires that the filter strip be placed on the contour. Variation in placement on the contour should not exceed a 0.5% longitudinal (perpendicular to the flow length) gradient.

All soil amendments should be applied according to a soil test recommendation for the planned vegetation.

The vegetation for filter strips must be permanent herbaceous vegetation of a single species or a mixture of grasses or legumes, which have stiff stems and a high stem density near the ground surface. Stem density should be such that the stem spacing does not exceed 1".

Design Criteria

Installation (preservation of existing vegetation)

Designate the areas for preserving vegetation on the design plan map.

Indicate in the plan that the designated areas will be fenced or flagged and will not be disturbed. This includes avoiding surface disturbances that affect sheet flow of stormwater runoff and not storing debris from clearing and grubbing, and other construction waste material in the filter strips during construction.

Installation (planting)

Site Preparation
If the upper edge of the filter strip does not have a level edge, remove any obstructions and grade the upper edge of the filter strip so that runoff evenly enters the filter strip.
Fill and smooth any rills and gullies that exist over the filter strip area to ensure that overland flow will discharge across the filter strip along a smooth surface

Seedbed Preparation
Grade and loosen soil to a smooth firm surface to enhance rooting of seedlings and reduce rill erosion. If existing, break up large clods and loosen compacted, hard or crusted soil surfaces with a disk, ripper, chisel, harrow or other tillage equipment. Avoid preparing the seedbed under excessively wet conditions.

For broadcast seeding and drilling, tillage should adequately loosen the soil to a depth of at least 6", alleviate compaction, and smooth and firm the soil for the proper placement of seed.

For no-till drilling, the soil surface does not need to be loosened unless the site has surface compaction. If compaction exists, the area should be chiseled across the slope to a depth of at least 6".

Applying Soil Amendments

Liming
Follow soil test recommendation. If a soil test is not available, use 2 tons/acre of ground agricultural lime on clayey soils (approximately 90 lbs/1000 ft^2) and 1 ton/acre on sandy soils (approximately 45 lbs/1000 ft^2). Exception: If the cover is tall fescue and clover, use the 2 tons/acre rate (90 lbs/1000 ft^2) on both clayey and sandy soils.

Spread the specified amount of lime and incorporate into the top 6" of soil after applying fertilizer.

Fertilizing
Apply fertilizer at rates specified in the soil test recommendation. In the absence of soil tests, use the following as a guide:

Grass alone: 8-24-24 or equivalent - 400 lbs/acre (9.2 lbs/1000 ft^2). When vegetation has emerged to a stand and is growing, 30 to 40 lbs/acre (0.8 lb/1000 ft^2) of additional nitrogen fertilizer should be applied.

Grass-Legume Mixture: 8-24-24 or equivalent-400 lbs/acre (9.2 lbs/1000 ft^2). When vegetation has emerged to a stand and is growing, 30 to 40 lbs (0.8 lb/1000 ft^2) of additional nitrogen fertilizer should be applied.

Legume alone: 0-20-20 or equivalent-500 lbs/acre (11.5 lbs/1000 ft^2).

Incorporate lime and fertilizer to a minimum depth of at least 6" or more by disking or chiseling on slopes of up to 3:1.

Planting

Select adapted species from Figure FS-1 and Table FS-1.

Apply seed uniformly using a cyclone seeder, drill seeder, cultipacker seeder or hydroseeder.

When using a drill seeder, plant grasses and legumes ¼" to ½" deep. Calibrate equipment in the field.

When planting by methods other than a drill seeder or hydroseeder, cover seed by raking, or dragging a chain, brush or mat. Then firm the soil lightly with a roller. Seed can also be covered with hydro-mulched wood fiber and tackifier. Legumes

require inoculation with nitrogen-fixing bacteria to ensure good growth. Purchase inoculum specific for the seed and mix with seed prior to planting.

Table FS-1 Commonly Used Plants for Permanent Cover

Species	Seeding Rates/Ac PLS[1]	North	Central	South
		Seeding Dates		
Bahiagrass, Pensacola	40 lbs	--	Mar 1-July 1	Feb 1-Nov 1[1]
Bermudagrass, Common	10 lbs	Apr 1-July 1	Mar 15-July 15	Mar 1-July 15
Bahiagrass, Pensacola Bermudagrass, Common	30 lbs 5 lbs	--	Mar 1-July 1	Mar 1-July 15
Bermudagrass, Hybrid (Lawn Types)	Solid Sod	Anytime	Anytime	Anytime
Bermudagrass, Hybrid (Lawn Types)	Sprigs 1/sq ft	Mar 1-Aug 1	Mar 1-Aug 1	Feb 15 - Sep 1
Fescue, Tall	40-50 lbs	Sep 1-Nov 1	Sep 1-Nov 1	--
Sericea	40-60 lbs	Mar 15-July 15	Mar 1-July 15	Feb 15 -July 15
Sericea & Common Bermundagrass	40 lbs 10 lbs	Mar 15 -July 15	Mar 1-July 15	Feb 15-July 15
Switchgrass, Alamo	4 lbs	Apr 1-Jun 15	Mar 15-Jun 15	Mar 15-Jun 15

[1] PLS means pure live seed and is used to adjust seeding rates. For example, to plant 10 lbs of a species with germination of 80% and with purity of 90%, PLS = 0.8 x 0.9 = 72%, 10 PLS = 10/0.72 = 13.9 lbs

[2] A late fall planting of Bahiagrass should include 45 lbs./ac. of small grain to provide cover during winter months.

Mulching

Cover approximately 75% of the surface with the specified mulch materials. Crimp, tack or tie down straw mulch with netting. Mulching is extremely important for successful seeding (See Mulching practice for more details).

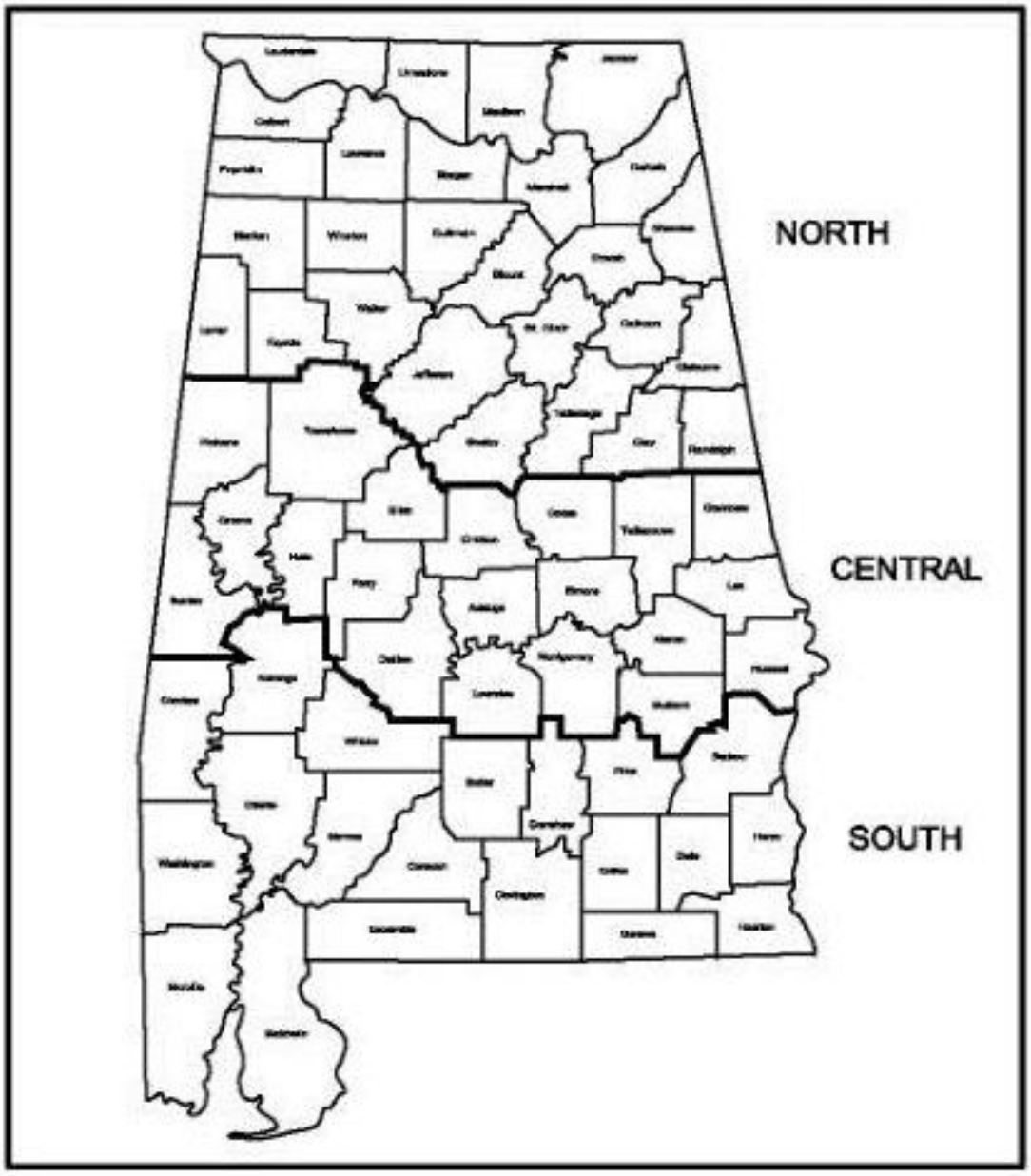

Figure FS-1 Geographical Areas for Species Adaptation and Seeding Dates

Note: Site conditions related to soils and aspect in counties adjacent or close to county boundaries may justify adjustments in planting dates by qualified design professionals.

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Sediment Barrier (SB)

Practice Description

A sediment barrier is a temporary structure used across a landscape mostly on the contour to reduce the quantity of sediment that is moving downslope. The most commonly used barrier is a silt fence (a geotextile fabric that is trenched into the ground and attached to supporting posts and possibly reinforced with a wire fence or polypropylene netting). Other barrier materials could include sand bags, wattles, and various man-made materials and devices that can be used in a similar manner as a silt fence.

This practice applies where sheet and rill erosion occurs on small disturbed areas. Barriers intercept runoff from upslope to form ponds that temporarily store runoff and allow sediment to settle out of the water and remain on the construction site.

Planning Considerations

Sediment barriers may be used on developing sites. It is important that they be installed on the contour so that flow will not concentrate and cause overtopping due to lack of storage capacity. It is also important that the ends of sediment barriers are turned upslope to prevent runoff from bypass around the ends of the barrier. Prevention of scouring, erosion, and undermining at and under sediment barriers is also of upmost importance to ensure maximum impoundment capabilities.

The most commonly used sediment barriers are silt fences and manufactured sediment logs (often referred to as wattles or sediment retention fiber rolls). Manufactured sediment logs should be installed according to manufacturer's recommendations.

The success of silt fences depends on a proper installation (on the contour with each end turned up slope) that causes the fence to develop maximum efficiency of sediment trapping. Silt fences should be carefully installed to meet the intended purpose. Silt fences are effective at trapping coarse sediment but do not effectively reduce turbidity as water passes through the geotextile fabric.

A silt fence is specifically designed to retain sediment transported by sheet flow from disturbed areas, while allowing water to pass through the fence. Water flow through the silt fence often decreases over time as silts and trash "blind" or seal the geotextile fabric. Silt fences should be installed to be stable under the flows expected from the site. Generally, silt fences should not be installed across streams, ditches, waterways, or other concentrated flow areas. When properly designed and installed, silt fence can be used as a Check Dam (See Check Dam).

Silt fences are composed of geotextile (i.e., woven and non-woven) supported between steel or wooden posts. Silt fences are commercially available with geotextile attached to the post and can be rolled out and installed by driving the post into the ground. This type of silt fence is simple to install, but more expensive than some other installations. Silt fences must be trenched in at the bottom to prevent runoff from undermining the fence and developing rills under the fence. Locations with high runoff flows or velocities should use either a wire or polypropylene net reinforcement. In addition, decreasing the spacing between support posts will improve the structural integrity of the silt fence in these areas.

Design professionals should consider specifying an "off-set" trench installation. This involves a conventional 6 in. x 6 in. trench to bury the geotextile with the posts and wire installed 6 in. downslope of the trench. The wire is on top of the ground surface and not in a trench. This installation has proven to have less potential for undermining than any installation tested at the Auburn University Erosion and Sediment Control Test Facility.

A rather recent innovation that is still being tested and refined is referred to as a "sediment retention barrier with flocculant." It is used to introduce flocculant to turbid runoff causing flocculation. A sediment retention barrier should only be used in conjunction with effective erosion and sediment control practices upstream that have removed sediment and turbidity as much as possible without chemical additive. The measure consists of a double row of netting on the contour that allows runoff to easily pass through. Material such as jute is secured to the ground between the rows of netting and adjacent to the downslope row. Loose straw is placed between the rows (see Figure SB-1). An approved flocculant powder is added at a designed rate to all the jute and in layers within the straw. The measure is located upstream of sediment control (sediment basin, sediment trap, or sediment barrier) which will pond, allow for flocs to settle, and capture flocs prior to runoff leaving the site. Design professionals should get details needed to design this measure from a research professional or a qualified industry representative.

Figure SB-1 Sediment Retention Barrier

Design Criteria (for silt fence)

Silt fence installations are normally limited to situations in which only sheet or overland flow is expected because the practice cannot pass the volumes of water generated by channelized flows. Silt fences are normally constructed of synthetic fabric (geotextile) and the life is expected to be the duration of most construction projects. Silt fence geotextile should conform to the property requirements found in AASHTO M288 shown in Table SB-1 as follows:

Table SB-1 Silt Fence Geotextile Fabric Requirements per AASHTO M288

Requirement	Test Methods	Units	Type A supported fence	Type B unsupported fence
Grab Strength	ASTM			
Machine Direction	D4632/D4632M	N	400	550
X-Machine Direction			400	450
Permittivity	ASTM D4491	sec^{-1}	0.05	0.05
Apparent Opening Size	ASTM D4751	mm	0.60 max avg roll value	0.60 max avg roll value
Ultraviolet stability (retained strength)	ASTM D4355/4355M	%	70% after 500 h of exposure	70% after 500 h of exposure

Note: ALDOT has an approved products list for geotextile

The drainage area behind the silt fence should not exceed ¼ acre per 100 linear feet of silt fence for non-reinforced fence and ½ acre per 100 feet of reinforced silt fence. When all runoff from the drainage area is to be stored behind the fence (i.e. there is no stormwater disposal system in place) the maximum slope length behind the fence should not exceed those shown in Table SB-2.

Table SB-2 Slope Limitations for Silt Fence

Land Slope (Percent)	Maximum Slope Length Above Fence (Feet)
<2	100
2 to 5	75
5 to 10	50
10 to 20*	25
>20	15

*In areas where the slope is greater than 10%, a flat area length of 10 feet between the toe of the slope to the fence should be provided.

Type A Silt Fence

Type A fence shall be a minimum of 24" and not more than 32" above ground with wire reinforcements and is used on sites needing the highest degree of protection by a silt fence. The wire reinforcement is necessary because this type of silt fence is used for the highest flow situations and has almost 3 times the flow rate as Type B silt fence. Wire fence should be made of 14-gauge wire with 6 in. x 6 in. openings (Note: ALDOT wire spacing may differ). Type A silt fence should be used where runoff flows or velocities are particularly high or where slopes exceed a vertical height of 10 feet. Staked tie backs on each end of a Type A silt fence may be necessary to prevent overturning. Tie backs should also be used at points of possible concentration and overtopping if site conditions do not allow for the silt fence to be installed on the contour.

Provide a riprap splash pad with a geotextile underlay or other outlet protection device for any point where flow may overtop the silt fence.

The silt fence should be installed as shown in Figure SB-2. Maximum post spacing is 10 ft. In situations where runoff flows parallel with the silt fence when in perimeter control applications, 10 ft. spacing is adequate. J-hooks should also be considered for long parallel flow scenarios to slow flow velocity and create areas of impoundments, thereby reducing scour potential under the silt fence. For the portion of the silt fence that creates the J-hook impoundment area, the post spacing should be reduced to 5 ft. to support the hydrostatic loads. For all installations that intercept flow perpendicularly to the slope causing a concentrated impoundment, the maximum post spacing should be reduced to 5 ft. Materials for posts, post size, and fasteners are shown in Tables SB-3 and SB-4. Do not use "light weight" steel posts commonly found at building supply stores. Details for overlap of Type A silt fence is available from The Alabama Department of Transportation construction drawings.

Geotextile silt fence material should be looped over each post and the top of the wire to prevent sagging. A "hog ring" attachment should be made each 2 feet along the top of the wire.

Table SB-3 Post Size for Silt Fence

	Minimum Length	Type of Post	Size of Post
Type A	5'	Steel "T" Post	1.25 lb./ft. min.
Type B	4'	Soft Wood Oak Steel	3" diameter or 2X4 1.5" X 1.5" 1.25 lb./ft. min.

Table SB-4 Wood Post Fasteners for Silt Fence

	Gauge	Crown	Legs	Staples/Post
Wire Staples	17 min.	¾" wide	½" long	5 min.
	Gauge	**Length**	**Button Heads**	**Nail/Post**
Nails	14 min.	1"	¾" long	4 min.

Type B Silt Fence

This 36" wide geotextile fabric should be used on developments where the life of the project is short (6 months or less) and there is less need for protection from a silt fence.

The silt fence should be installed as shown in Figure SB-3. Post spacing is either 4 ft. or 6 ft. based on geotextile elongation % (see note on Figure SB-3). Materials for posts and fasteners are shown in Tables SB-3 and SB-4. Details for overlap of the silt fence and fastener placement are shown in Figure SB-4.

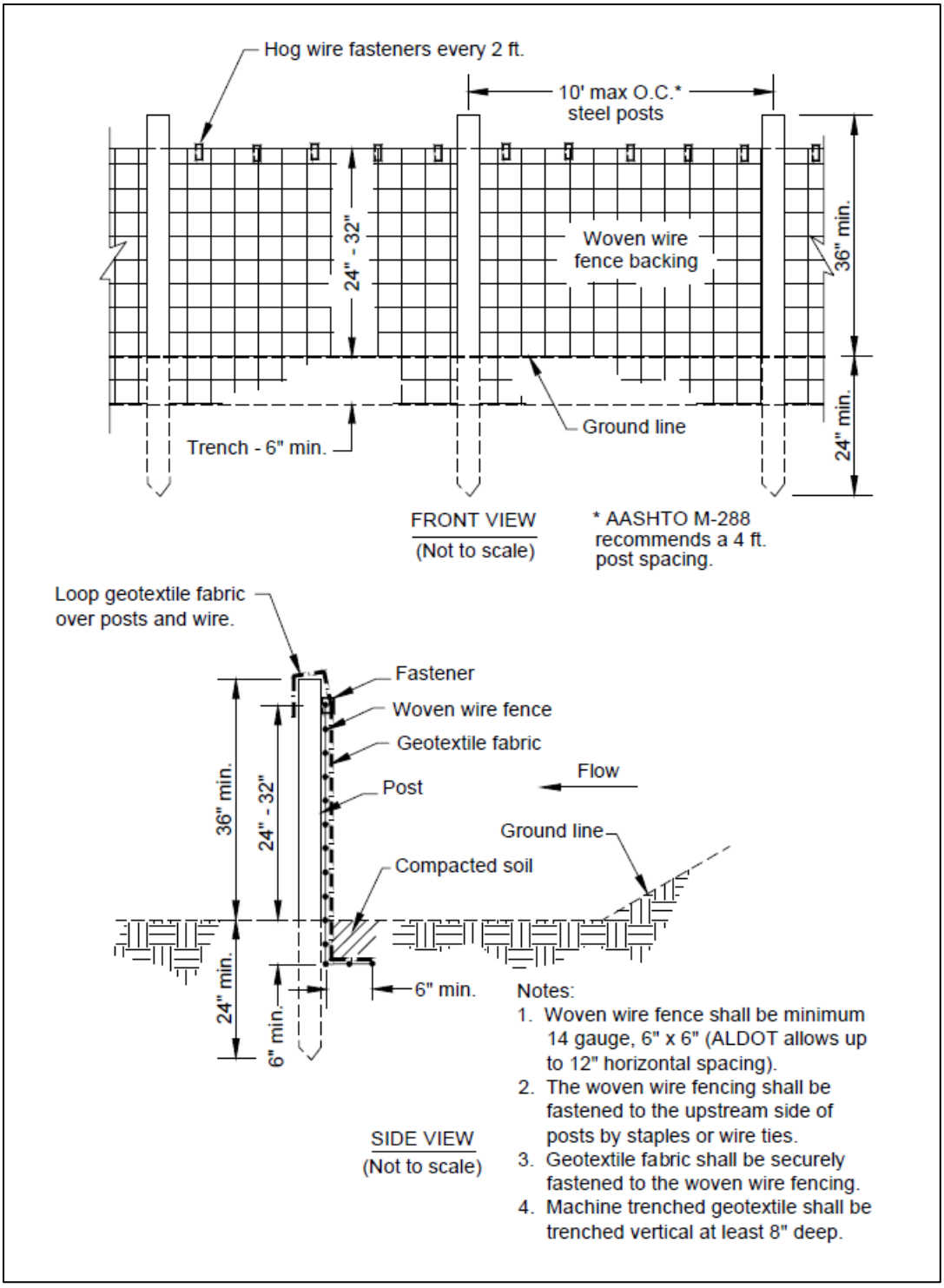

Figure SB-2 Silt Fence-Type A
(For post material requirements see Tables SB-3 and SB-4)

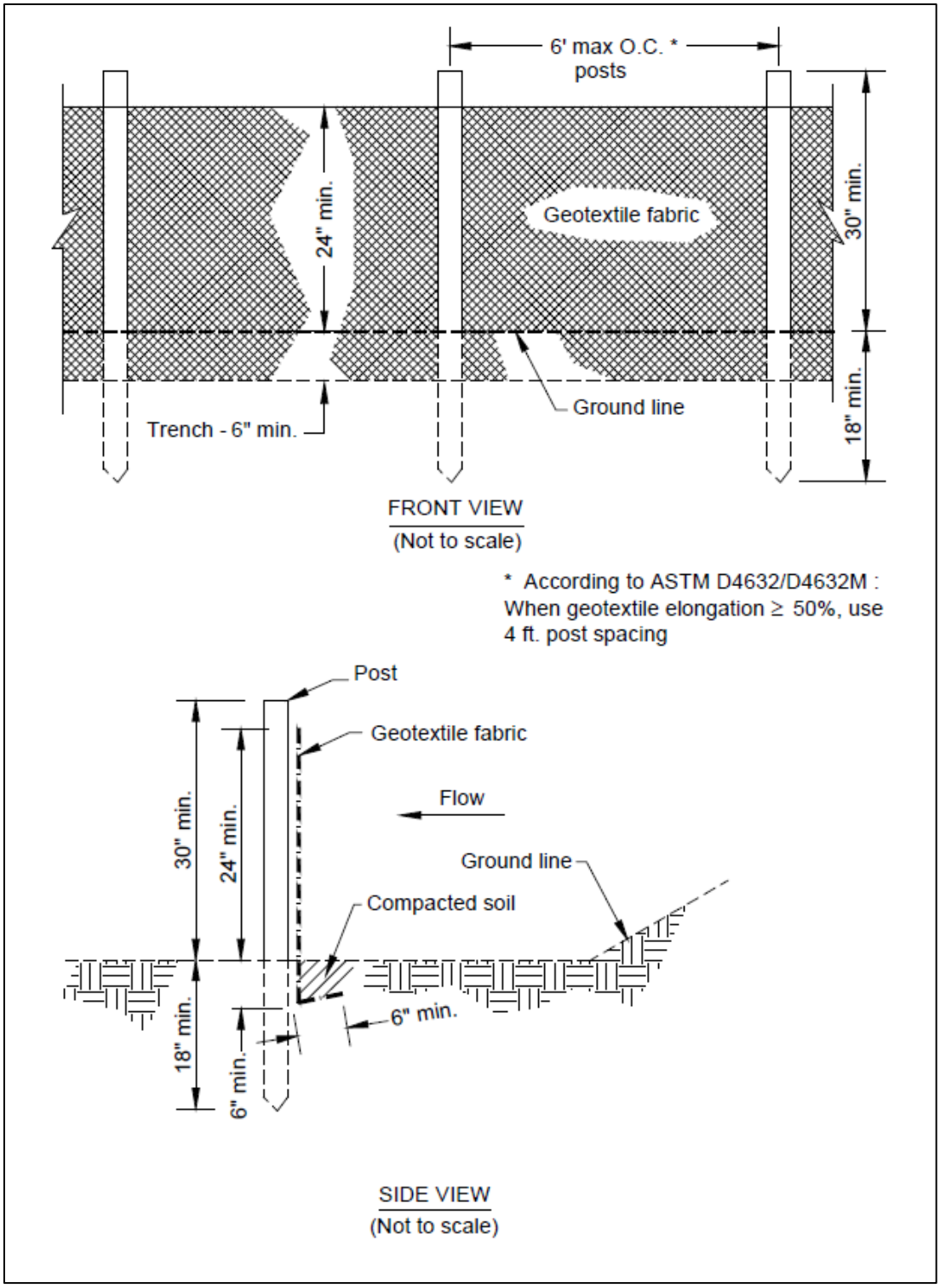

Figure SB-3 Silt Fence - Type B

(1) For post material requirements see Tables SB-3 and SB-4

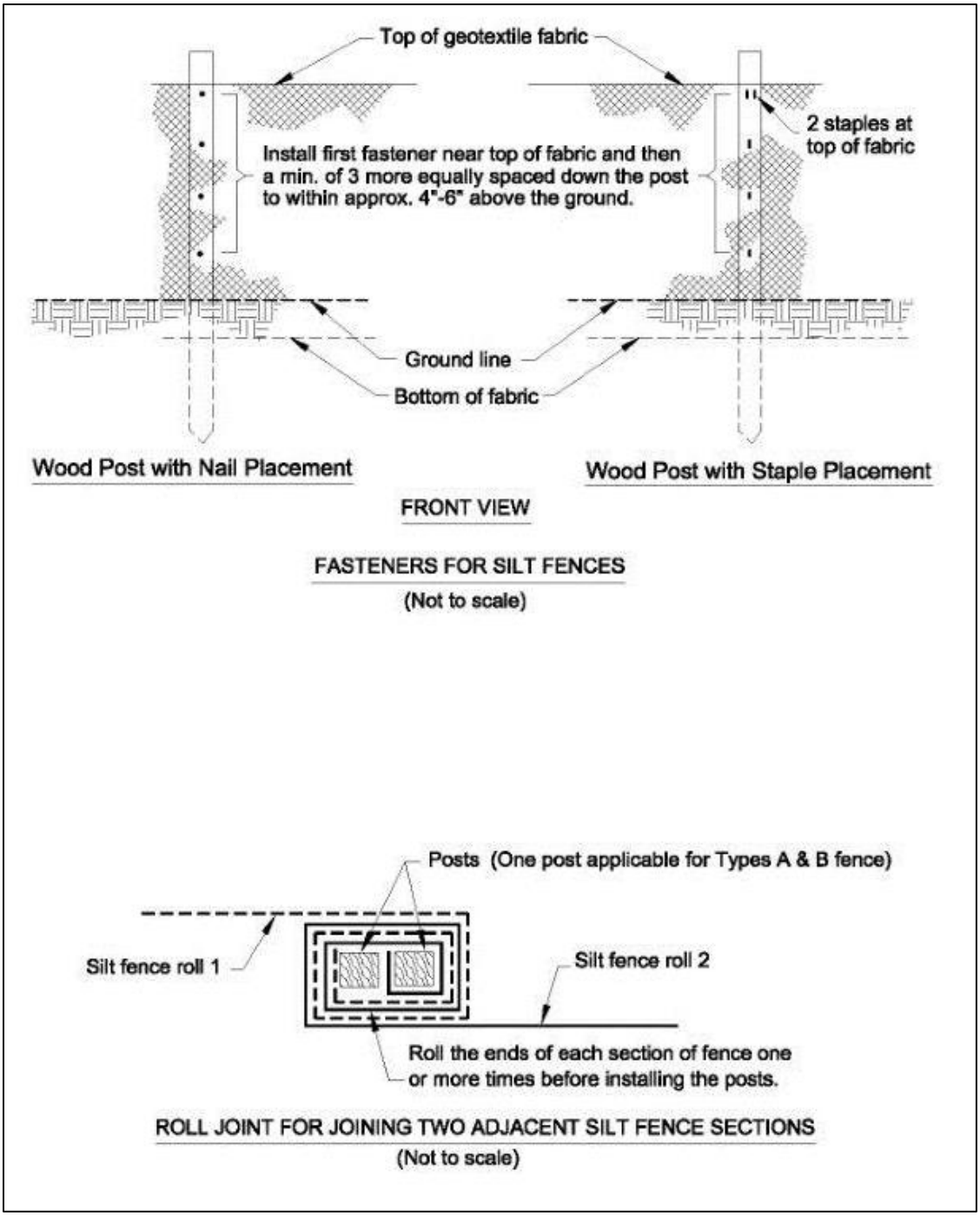

Figure SB-4 Silt Fence Installation Details

Sediment Trap (ST)

Practice Description

A sediment trap is a temporary catch basin used for intercepting and detaining small amounts of sediment to prevent it from leaving the construction site. This practice applies within disturbed areas with very small drainage basins that are subject to sheet erosion or in minor swales. Various materials may be used for sediment traps and include straw bales, sand bags, wattles, and various man-made materials and devices.

Planning Considerations

Note: Straw bales are the only sediment trap material covered in this handbook.

In certain situations, straw bales can be used as an alternative to silt fence for trapping sediment. The practice should only be used to trap sediment for a short duration from very small drainage areas. Straw bales comparatively low flow rate should be considered before choosing to use this practice. Ponding above the bales can occur rapidly due to the low flow rate. Overtopping and bypass of the bales can cause significant damage to the site. Additional measures should be used if turbidity leaving the site served by this practice is an issue.

Design Criteria

Drainage Area

For disturbed areas subject to sheet erosion the drainage area should be restricted to ¼ acre per 100 feet of trap. The slope length behind the trap should be restricted according to Table ST-1.

Table ST-1 Criteria for Straw or Hay Bale Placement

Land Slope (Percent)	Maximum Slope Length Above Bale (Feet)
<2	75
2 to 5	50
5 to 10	35
10 to 20	20
>20	10

Bale Size

Bales should be 14” x 18” x 36”.

Anchors

Two 36” long (minimum) 2” x 2” hardwood stakes should be driven through each bale after the bales are properly entranced. Alternate anchors can be 2 pieces of no.4 steel rebar, 36” long (minimum). See Figure ST-1 for details on proper installation of straw bales.

Effective Life

Straw and hay bales have a relatively short period of usefulness and should not be used if the project duration is expected to exceed 3 months. Bale placement should result in the twine or cord being on the side and not the bottom of the bale.

Location

This practice should be used on nearly level ground and be placed at least 10 feet from the toe of any slope. The barrier should follow the land contour. The practice should never be used in live streams or in swales where there is a possibility of washout. The practice should also not be used in areas where rock or hard surfaces prevent the full and uniform anchoring of the bales.

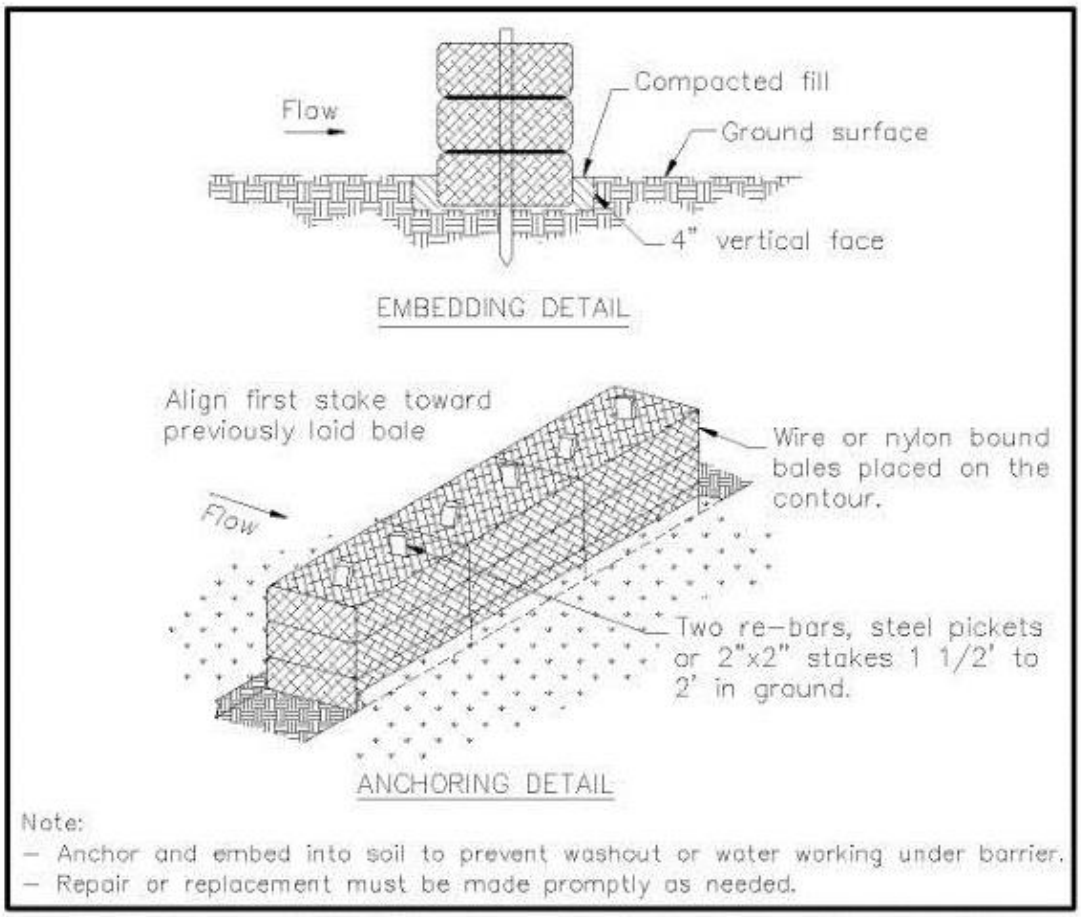

Figure ST-1 Anchoring Technique for Straw Bales

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ATTACHMENT G-4

CONSTRUCTION ACTIVITY LOG SHEETS

- Corrective Action Log
- Construction Best Management Practices Plan Amendment Log
- Grading and Stabilization Activities Log
- Rainfall Documentation and Observations Log
- Construction Stormwater Inspection Report and BMP Certification
- Construction Stormwater Noncompliance Notification Report

Corrective Action Log

Project Name: Corrective Measures Implementation RSA-013, Unlined Inactive Open Burn Pad, Operable Unit 14
CBMPP Contact:

Inspection Date	Inspector Name(s)	Description of BMP Deficiency	Corrective Action Needed (including planned date/responsible person)	Date Action Taken/Responsible person

CBMPP Amendment Log

Project Name: Corrective Measures Implementation RSA-013, Unlined Inactive Open Burn Pad, Operable Unit 14
CBMPP Contact:

Amendment No.	Description of Amendment	Date of Amendment	Amendment Prepared by [Name(s) and Title]

Grading and Stabilization Activities Log

Project Name: Corrective Measures Implementation RSA-013, Unlined Inactive Open Burn Pad, Operable Unit 14
CBMPP Contact:

Date Grading Activity Initiated	Description of Grading Activity	Date Grading Activity Ceased (Indicate Temporary or Permanent)	Date When Stabilization Measures are Initiated	Description of Stabilization Measure(s) and Location(s)

Rainfall Documentation and Observations

Project Name or Description: Corrective Measures Implementation RSA-013, Unlined Inactive Open Burn Pad, Operable Unit 14
Project Location: U.S. Army Garrison - Redstone, Madison County, Alabama
ADEM Permit Number:

Date	Start Time	End Time	Total Depth (to tenth of inch)	Observations (rainfall intense, moderate, etc.)	Initials

Print Form

ADEM NPDES CONSTRUCTION STORMWATER INSPECTION REPORT AND BMP CERTIFICATION

RESPOND WITH "N/A" AS APPROPRIATE. FORMS WITH INCOMPLETE OR INCORRECT ANSWERS, OR MISSING SIGNATURES WILL BE RETURNED AND MAY RESULT IN APPROPRIATE COMPLIANCE ACTION BY THE DEPARTMENT. IF SPACE IS INSUFFICIENT, CONTINUE ON AN ATTACHED SHEET(S) AS NECESSARY. PLEASE TYPE OR PRINT IN INK.

Item I.

Permittee Name:	Facility/Site Name:
Permit Number:	County:
Facility Entrance Latitude & Longitude:	Phone Number:
Facility Street Address or Location Description:	

Item II.

List name of current ultimate receiving water(s) (indicate if through MS4) and the number of disturbed acres which drains through each treatment system or BMP: Add additional sheet(s) if necessary.

Receiving Water	Disturbed Acres	Discharge Point #	Representative Outfall
			☐ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO

Item III.

1. ☐ YES ☐ NO Did discharges of sediment or other pollutants occur from the site? If "Yes", please list a description of the discharge(s) and their location(s):

2. ☐ YES ☐ NO Were BMPs properly implemented and maintained at the time of inspection? If "No", please provide location(s) and descriptions of BMPs that need maintenance:

3. ☐ YES ☐ NO Are BMPs needed in addition to those already present onsite at the time of inspection? If "Yes" please provide a description and location of additional BMPs that are needed:

4. ☐ YES ☐ NO Have any BMPs failed to operate as designed? If "Yes", please provide location(s) and description of BMP(s) that failed:

5. ☐ YES ☐ NO Were there BMPs required by the CBMPP that were not installed or installed in a manner not consistent with the CBMPP? If "Yes", please provide a description and location where the BMPs were not installed or installed incorrectly:

Item IV.

The Permittee shall conduct turbidity monitoring in accordance with Part V of the permit:

1. ☐ YES ☐ NO Is this facility a Priority Construction Site?
2. ☐ YES ☐ NO Has the facility disturbed greater than 10 acres?
3. ☐ YES ☐ NO Was the site discharging at the time of inspection?
4. ☐ YES ☐ NO Samples collected, if "Yes", sampling data must be attached.

Item V.

Weather Conditions:			
Discharge Point #	Date, Time, and Location of Samples Collected	Sample Results	Analytical Method(s)

"Based upon the inspection of (date & time) _____ conducted by the QCP, QCI, or a qualified person (list:_____) under the direct supervision of the QCP identified below. The QCI or QCP identified below certifies that effective structural and non-structural BMPs have been fully implemented and regularly maintained to the maximum extent practicable for the prevention and minimization of all sources of pollution in stormwater and authorized related process wastewater runoff, **except for those deficiencies noted above**, in accordance with the facility's CBMPP, good sediment, erosion, and other pollution control practices, and the requirements of the permit. I certify that discharges have been tested or evaluated for the presence of non-stormwater and non-authorized process wastewaters. I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I certify that this form has not been altered, and if copied or reproduced, is consistent in format and identical in content to the ADEM approved form. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations."

Name & Designation of QCI or QCP	Signature	Date

Name & Title of Permittee Responsible Official	Signature	Date

Print Form

ADEM NPDES CONSTRUCTION STORMWATER NONCOMPLIANCE NOTIFICATION REPORT

RESPOND WITH "N/A" AS APPROPRIATE. FORMS WITH INCOMPLETE OR INCORRECT ANSWERS, OR MISSING SIGNATURES WILL BE RETURNED AND MAY RESULT IN APPROPRIATE COMPLIANCE ACTION BY THE DEPARTMENT. IF SPACE IS INSUFFICIENT, CONTINUE ON AN ATTACHED SHEET(S) AS NECESSARY. PLEASE TYPE OR PRINT IN INK.

Complete this form, attach additional information as necessary, and send report to ADEM.

Item I.

Permittee Name		Facility/Site Name		
NPDES ALR10	County	Facility Contact and Title		
Facility Street Address or Location Description		City	State	Zip
Phone Number	Fax Number	E-Mail Address		

Item II.

DESCRIPTION OF NONCOMPLIANCE OR NONCOMPLIANT DISCHARGE:

Item III.

INSPECTION AND BMP CERTIFICATION REPORT(S), ANY PHOTOGRAPHS, AND ANY SAMPLING RESULTS ARE ATTACHED. IF NOT, PLEASE EXPLAIN:

Item IV.

CAUSE OF NONCOMPLIANCE:

Item V.

PERIOD OF NONCOMPLIANCE: (Include exact date(s) and time(s) or, if not corrected, the anticipated time the noncompliance is expected to continue):

Item VI.

DESCRIPTION OF STEPS TAKEN AND/OR BEING TAKEN (PROPOSED COMPLIANCE SCHEDULE) TO REDUCE AND/OR ELIMINATE THE NONCOMPLYING DISCHARGE, REPAIR/REPLACE/UPGRADE BMPs, AND TO PREVENT ITS RECURRENCE:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I certify that this form has not been altered, and if copied or reproduced, is consistent in format and identical in content to the ADEM approved form. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations."

Name & Designation of QCP	Signature	Date

Name & Title of Permittee Responsible Official	Signature	Date

APPENDIX H

CONSTRUCTION QUALITY ASSURANCE PLAN

Appendix H

Construction Quality Assurance Plan
RSA-013, Unlined Inactive Open Burn Pad
Operable Unit 14
U.S. Army Garrison-Redstone
Madison County, Alabama
EPA ID No. AL7 210 020 742

Prepared for:

U.S. Army Engineering and Support Center
Huntsville Engineering and Support Center
ATTN: CEHNC-OEC
5021 Bradford Drive East
Huntsville, AL 35805

Prepared by:

Aptim Federal Services, LLC
11400 Parkside Drive, Suite 400
Knoxville, TN 37934

Contract No. W912DY-17-D-0003
Delivery Order No. W912DY19F1116

November 2021

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H1.0 Introduction

This construction quality assurance plan (CQAP) presents the overall program for construction quality assurance (CQA) to be implemented during corrective measures implementation (CMI) activities at RSA-013. This document establishes a program to comply with requirements established in the CMI work plan and those of the Alabama Department of Environmental Management (ADEM) and U.S. Environmental Protection Agency. The scope of work for the project is detailed in the CMI work plan for RSA-013 (to which this CQAP is an appendix).

H1.1 Overall Directive

The procedures and practices set forth in the CQAP should be adhered to and specifically applied to all quality-related work on the project. It is the responsibility of all personnel performing work on the project to be familiar with and implement the technical requirements referenced in this CQAP or otherwise specified for the project, as included in the CMI work plan.

Conformance to the requirements of this CQAP will provide results which will verify that the contract, when completed, will conform to the specified requirements and will be documented by defensible evidence that the work performed meets or exceeds the standards set forth for the project.

H1.2 Project Background

RSA-013 is located in the southern portion of RSA, within the boundary of the active open burn (OB)/open detonation (OD) area (Figures 1-1 and 1-2 in the CMI work plan). The OB/OD area is secured by a perimeter chain-link fence and locked gate, limiting access to the site. No buildings are located within the RSA-013 site boundary. The site lies above groundwater unit RSA-151, which covers approximately 572 acres in the southern portion of RSA (Figure 1-1 in the CMI work plan).

Prior to 2009, the footprint for RSA-013 encompassed 4.3 acres and consisted of the area containing two formerly used unlined (earthen) burn pads. The RSA-013 burn pads were used from the 1950s until 1986 for the thermal treatment (burning) of explosives and explosives-contaminated material and reactive waste, primarily propellant. The locations of the burn pads are provided on Figure 1-3 in the CMI work plan. Propellant burned at RSA-013 included waste perchlorate containing relatively high amounts of solvent. The ash, residue, and metal debris left over from burning activities were transported off site and disposed at the RSA-014 trenches, located to the southeast, and at RSA-066, which is located to the north of the embayment (Figure 1-2 in the CMI work plan). The pads, each approximately 200 feet square, were bare ground

surrounded by grass fields and earthen berms on the west, north, and east sides of each pad. The RSA-013 site boundary was expanded from 4.3 acres to 5 acres in 2009 to include two noncontiguous sites: RSA-132, Dismantled Popping Furnace, and RSA-133, Inactive Rocket Washrack/Sump. The RSA-013 RFI report (CB&I Federal Services LLC, 2017) included the data relevant to RSA-132 and RSA-133 and recommended no further action for these two sites. ADEM concurred with the recommendation for no further action for RSA-132 and RSA-133.

Investigations at RSA-013 have concluded that no chemicals of concern requiring action are present in surface media at RSA-013. However, perchlorate- and RDX-contaminated soil poses a continuing leaching threat to groundwater. These soil concentrations are a result of historical releases at RSA-013 and thus corrective measures are required to minimize or eliminate ongoing leaching to groundwater of perchlorate and RDX, thereby reducing the unacceptable risk to human health should groundwater be consumed. The chemicals of concern requiring action in groundwater under RSA-013 will be addressed by the RSA-151 groundwater unit corrective measures.

RSA-013 has a "Low" unexploded ordnance (UXO) probability and an "Unlikely" chemical warfare materiel (CWM) probability. The Army manages the UXO and CWM probabilities for RSA sites under the site access control program (U.S. Army Garrison-Redstone [Army], 2012).

H1.3 Objectives of the Construction Quality Assurance Program

The objective of the CQA program is to provide a system of procedures, practices, guidelines, and controls which, when implemented, will provide the confidence that project activities are accomplished in accordance with the specified contracts, design criteria, plans, drawings, and CMI plan developed during implementation of the corrective measures. This CQAP establishes requirements for developing the overall site-specific construction quality control (CQC) system to be implemented at RSA-013. The CQAP will be implemented during all phases of the project, including preliminary site activities, remediation, and close-out activities.

Aptim Federal Services, LLC (APTIM) has been selected as the contractor to implement corrective measures at RSA-013. The Army Site Manager and/or U.S. Army Engineering and Support Center, Huntsville (CEHNC) Technical Manager will observe the work during its performance by APTIM and subcontractors and approve the work upon acceptable completion. APTIM has prepared a Quality Assurance Surveillance Plan under this contract; this plan sets forth procedures and guidelines that the CEHNC will use in evaluating the technical and safety performance of APTIM and its subcontractors (APTIM, 2019).

The CQAP is also applicable to off-site suppliers of equipment or services to the project, which could affect the quality of the CMI. In particular, the following items must be adhered to during the CQA activities:

- Guidelines and requirements prepared and documented in the CMI work plan
- Construction verification as it is performed, by inspection and verification testing, so that the design features are implemented as intended
- Evaluation of variance to the design that may occur during construction and remediation and its effect upon system performance
- Complete documentation prepared and maintained during and after construction and remediation so that it can be demonstrated that the design has been implemented and that the performance requirements have been met.

H1.4 Presentation of the Construction Quality Assurance Plan

This CQAP is designed so that the CQC activities for all portions of the remediation are executed and managed from a common set of quality objectives and practices as described in the CQC plan and the project-specific quality assurance project plan (QAPP) (CMI Work Plan Appendix D). The CQA and CQC activities, as described herein, serve as the minimum requirements to verify that all work is in compliance with the quality requirements set forth in the CMI work plan and is consistent with the local, state, federal, and other appropriate regulatory agencies for the types of environmental activities performed.

H2.0 Responsibility and Authority

APTIM will perform the CMI for RSA-013. The RSA Site Manager and/or CEHNC Technical Manager or designee will observe the work as it is performed to ensure compliance with the CMI work plan. ADEM personnel may be present during some or all of the corrective measures at RSA-013 as their schedule allows.

It is the responsibility of all project personnel to report activities that could adversely affect the CQC requirements set forth by the contract documents. The dedicated Quality Control Site Manager (QCSM) is responsible for identifying, reporting, and documenting activities affecting quality and for verifying correction of materials and activities that do not conform to the specified contract requirements. The QCSM will maintain a close working relationship with the Project Manager (PM), RSA Site Manager, and CEHNC Technical Manager, keeping them advised of all situations that if not corrected or controlled could affect the resulting quality of the project.

APTIM will designate an authorized representative to be responsible for CQA, referred to as the QCSM. The RSA Site Manager will ultimately be responsible for providing the relevant documentation to the oversight agency (ADEM). APTIM will be responsible for furnishing appropriate documentation (outlined in this CQAP) to RSA and CEHNC for submittal to the oversight agencies, as required.

H2.1 CQA Organization and Key Elements

The APTIM PM will be responsible to ensure the execution of the CQA duties for RSA-013, which will be performed by the QCSM. CEHNC has retained the services of APTIM to perform the required CMI at the site. APTIM, including its subcontractors, will be responsible for field activities and laboratory testing requirements for the project CQC. The responsibility of key personnel involved in the CQA and CQC activities are described Sections H2.1.1 through H2.1.6.

H2.1.1 Project Manager

The PM has the overall responsibility to ensure the execution of the work to be performed by APTIM, including efforts to ensure compliance with the requirements of ADEM. Among other duties, the PM will coordinate all financial and project-required resources (technical as well as administrative) necessary for the implementation of the project. The PM will maintain overall responsibility of the project through coordination activities with APTIM personnel, ADEM, and the Army. The PM will verify that the corrective measures have been implemented in accordance

with the CMI work plan. The PM has the authority to select and dismiss organizations charged with implementation of the corrective measures and is vested with the authority to stop work if conditions adverse to quality are persistent and need to be corrected before proceeding further.

H2.1.2 Oversight Agency (ADEM)

The primary oversight agency for the RSA-013 CMI is ADEM. The oversight agency will provide review and comment on the CQAP to ensure that the proposed CQA program will provide for sufficient confirmation that work is being performed as intended. The oversight agency has the responsibility to review CQA documentation and, upon completion of the corrective measures, confirm that the CQAP has been followed and that the construction/remediation has been performed in accordance with the regulatory requirements.

H2.1.3 Quality Control Site Manager

The QCSM will be responsible for the review and approval of the equipment and materials supplied by APTIM (including its subcontractors). The APTIM QCSM reports directly to the APTIM Corporate Quality Management Director. The work that the QCSM produces is subject to the review and approval of the PM, APTIM Corporate Quality Management Director, and Project Engineer.

A few deviations from the CMI work plan are not uncommon during the implementation of remedial actions. As such, activities may need to be adjusted accordingly during the progress of construction and remediation. The QCSM may be requested to change some aspects of the design and/or CMI work plan if unexpected conditions (e.g., a change in site conditions, unanticipated logistical problems, change in construction or remediation methodology, or lack of availability of certain materials) are encountered during the construction work. Accordingly, the QCSM will be responsible for preparing the appropriate variances and providing necessary feedback to the PM or the APTIM Corporate Quality Management Director.

The QCSM is responsible for coordinating all required field activities and laboratory CQC testing activities, including sample collection and shipment and verification of the test results. The results will be documented on the daily construction log. Additional responsibilities include preparing addenda to the CQAP and formulating corrective actions or variances when required.

H2.1.4 CQC Analytical Laboratory

In accordance with the contract documents, CQC activities will be performed by a subcontracted laboratory for confirmation analysis with the soil excavation. The testing laboratory must have its own internal quality control (QC) procedures to ensure that laboratory analyses conform to the appropriate regulatory requirements and applicable testing standards. The CQC laboratory is

responsible for ensuring that analyses are performed in accordance with applicable test methods and standards for following internal QC procedures, for maintaining sample chain-of-custody records, and for reporting data. In addition, the CQC laboratory must be willing to allow announced or unannounced inspections by authorized project personnel, including representatives from RSA and ADEM in order to observe the sample preparation and analysis procedures. The laboratory must be willing to accommodate such inspection as long as the observer does not interfere with the testing process.

H2.1.5 The Contractor and Subcontractors

APTIM has the overall responsibility for conducting the remediation in accordance with the approved CMI work plan. APTIM, including its subcontractors, must perform CQC tests, as required by the CMI work plan, during project remediation activities and provide CQC documentation as specified and report variances and nonconformances as outlined in this CQAP.

H2.1.6 Construction Quality Control Personnel

Field quality assurance (QA)/QC personnel are individuals designated by APTIM and its subcontractors whose duty it is to ensure products and services are provided to RSA and CEHNC in accordance with the CMI work plan.

H2.2 Qualifications

CQA and CQC activities will be accomplished by appropriately qualified personnel. Each individual will understand and enforce the specified quality requirements and recommend improvements in processes and/or services which, when implemented, could affect the cost, schedule, and quality of the project in a positive manner.

The key personnel involved in the CQA/CQC program and their minimum recommended qualifications are provided in the following table:

Key Personnel in CQA/CQC Organization	Role/Minimum Qualifications Requirements
PM	The specific individual(s) to certify that the construction activities have been completed in accordance with project design CMI Plan.
Project Engineer	The individual who prepared the CMI work plan and designated representative of APTIM with knowledge of the design and contract requirements.
APTIM Corporate Quality Management Director	Independent supervisor of the field QA/QC personnel. Five years of QA/QC project work.
Qualified Credentialed Inspector	The individual responsible for completing the Construction Storm Water Inspections.
Qualified Credentialed Professional	Responsible for updating the Best Management Practices Plan and certifying the plan.

Key Personnel in CQA/CQC Organization	Role/Minimum Qualifications Requirements
QCSM	Responsible for the review and approval of the equipment and materials and coordinating all required field and laboratory CQC testing activities, including record keeping, and sample collection and shipment. Five years project work; college degree in science or technical field.
Field QA/QC Personnel	Designated APTIM and/or subcontractor personnel (or independent third parties) to perform specific CQC testing. Training required when appropriate (moisture-density testing, concrete testing, etc.) for assigned tasks, certifications.

H2.3 Personnel Training

APTIM personnel assigned to the project, including subcontractors, are trained to ensure competence commensurate with the responsibility and qualifications necessary to perform the tasks to which they are assigned. In addition to education and experience, job-specific training may be required to qualify individuals to perform certain activities. The PM and QCSM will review and document the personnel qualifications and training to verify compliance to the subcontract requirements.

All personnel will be trained per Occupational Safety and Health Administration (OSHA) Section 1910.120. Project personnel will receive an orientation to the CMI work plan as appropriate to their responsibilities before participation in project activities.

The PM and QCSM will review the qualifications and training of all personnel assigned to the project. Training and qualification records will be maintained at the project site and available for review. Training of site personnel will be verified and documented as applicable to the work to be performed. The QCSM will monitor the training activities to verify all required training is completed for personnel performing work on the project and verify that the training is documented and that current records are maintained.

Training will include all phases of the work as necessary and will be commensurate with the complexity of the activities being performed. Training methods may include formal classroom, required reading, on-the-job training, or combination of these methods. Training procedures will be reviewed and approved by qualified CMI APTIM project personnel.

Training programs are conducted according to organizational needs and policies so that personnel:

- Have an acceptable understanding of the safety consideration of the work tasks
- Possess knowledge of the processes adequate to perform assigned tasks

- Have a working knowledge of the project or facility basis requirements
- Have an understanding of systems, terminology, reasons for performance of specific control functions and the acceptance and rejection criteria for the work
- Know the consequences of inadequate quality attainment.

The training program will be evaluated to determine the effectiveness of the program and instruction. If it is determined that the program content, instructor capabilities, or other conditions require changes, the program will be updated at that time. At a minimum, the training will be reviewed as part of the management assessment.

APTIM shall maintain qualification and training records for each employee. Training records should include all documents that establish the employee's capabilities, including outside training and training performed by approved training organizations. The QCSM will verify compliance with the project requirements.

H2.4 Communication Within the CQA Organization

Communication between the CQA program participants includes the exchange of information that allows work to proceed and the required reporting so that activities can be reviewed. Communication in the form of construction documents, inspection reports, audit reports, verification test results, and daily CQC reports must be timely so that reviews and evaluations can be performed by all the parties responsible for execution of the work.

CQA personnel, the PM, and the subcontractors must communicate as required and as addressed in this CQAP to maximize the efficiency and effectiveness of the CMI and to minimize variance or nonconformance.

H2.5 CQA Meetings

CQA meetings will be held throughout the progression of construction and remediation activities on an as-needed basis. Progress meetings will be documented in the form of meeting minutes prepared by the QCSM and maintained in the on-site CQA files.

H3.0 Contract Scope of Work

The complete and detailed scope of work for the planned construction/remediation activities are presented in the CMI work plan and the supporting documents therein. Additionally, the CMI work plan provides the proposed schedule and sequencing of the activities. This chapter provides a general overview of the activities and an outline of the CQC testing requirements referenced in the CMI work plan. Subsequent to this chapter, Chapters 4.0 through 10.0 present the necessary supporting aspects of the CQC/CQA program that must be implemented to ensure the overall objectives of the program are met and to provide evidence of compliance with all applicable project and regulatory requirements.

H3.1 Proposed Work Activities

The general scope of work for RSA-013 includes the following:

- Obtain Underground Injection Control (UIC) permit
- Obtain a permit under the General National Pollutant Discharge Elimination System permit coverage for stormwater discharges
- Mobilization/demobilization
- Utility clearance and marking
- Installation of surface water and erosion controls
- Vegetation clearing
- Surveying and marking of the proposed excavation area
- Protection/closure of monitoring wells located in the vicinity of the excavation area
- Excavation of contaminated soil
- Place a carbon source (emulsified vegetable oil [EVO] substrate) at the bottom of the excavation to promote biodegradation of perchlorate in the smear zone and possibly into saturated zone soils
- Confirmation sampling and analysis of the excavated area
- Waste characterization sampling
- Transport and disposal of excavated soils as nonhazardous waste (Subtitle D landfill)
- Site restoration, including application of backfill and topsoil, and revegetation with approved grass mixtures.

H3.2 CQC Requirements and Responsibilities

Sections H3.2.1 through H3.2.4 present a summary of the CQC testing requirements and responsibilities of APTIM's QCSM during implementation of corrective measures at RSA-013. The information presented herein is intended only to provide an overview of the requirements; the complete and full details of the planned work is contained in the CMI work plan and supporting documents.

H3.2.1 Preliminary Activities

Preliminary activities include permitting, mobilization, requirements for base access, dig permits and utility marking, site control, surveying of excavation areas and stockpile areas, and protection of existing site features (e.g., boundary fencing and monitoring wells), and closure of monitoring wells within or adjacent to the proposed excavation boundary.. The dig permit will be obtained from the RSA Directorate of Public Works ([256] 876-9881) prior to commencement of the CMI. During these activities, the QCSM will be responsible for reviewing purchase orders and packing slips to ensure all materials received are in accordance with the CMI specifications. As the excavation at RSA-013 will be greater than 1 acre in size, a construction storm water general permit (CSWGP) issued by the ADEM will be required. To obtain coverage under the CSWGP, a Notice of Intent must be submitted to ADEM prior to initiation of construction activities. Storm water erosion and sediment controls will be implemented in compliance with the *Alabama Handbook for Erosion Control, Sediment Control, and Stormwater Management on Construction Sites and Urban Areas* (Alabama Soil and Water Conservation Committee [ASWCC], 2018). A UIC permit will be obtained through ADEM as required to administer a carbon source (EVO substrate) at the bottom of the excavation to promote biodegradation of perchlorate in the smear zone and possibly into saturated zone soils. Site controls will be enforced in accordance with the site-specific safety and health plan prepared by APTIM. A licensed land surveyor will be subcontracted to delineate the project work boundary and mark the excavation and soil stockpile areas. Temporary roads will be built to access the excavation areas, if deemed necessary.

H3.2.2 Soil Excavation

Soil will be excavated to meet the cleanup goals specified in the CMI work plan. Excavation will be accomplished according to the Safety and Health Regulations for Excavations (OSHA 29 Code of Federal Regulations Part 1926 Subpart P). A licensed land surveyor will be contracted to survey the final excavation limits at each area. Surveying will be conducted in accordance with the Alabama Society of Professional Land Surveyors Standards of Practice for Surveying in Alabama (www.aspls.org).

Contaminated soils will be stockpiled during the excavation at RSA-013. Based on site knowledge and data from similar sites, it is expected that the excavated soils will be managed as a nonhazardous special waste and that the soil will likely be able to be disposed as special waste (nonhazardous) at a Subtitle D landfill. APTIM will employ a licensed transportation and disposal subcontractor to complete these activities. The waste characterization results will be submitted to the landfill for approval. An ADEM waste certification number will be obtained prior to disposal of any excavated soils at a landfill in Alabama.

H3.2.3 Backfill and Revegetation

Upon completion of all soil excavation activities, clean fill material may be brought in from an RSA borrow area or another approved off-site borrow source to supplement backfill from berm soil and excavated soil that is determined usable as backfill (e.g., concentrations of perchlorate and RDX are below cleanup goals). If sampling of the borrow source material has not been conducted, APTIM will sample the material to confirm it is acceptable for use as backfill at the site. The borrow material sampling, if required, will include one 5-point composite sample analyzed for target compound list (TCL) semivolatile organic compounds, TCL pesticides/polychlorinated biphenyls, and target analyte list metals, and one sample analyzed for TCL volatile organic compounds. The backfill material will be placed by the excavator, spread in maximum 12-inch loose lifts, and compacted using the excavator. Any uncontaminated soil removed during excavation activities will also be placed in the excavation. Once the areas have been backfilled and compacted, clean topsoil will be placed over the affected areas.

Soil excavation will disturb/destroy site vegetation. Any vegetated areas that are disturbed or destroyed will be restored following completion of the remediation and removal of all equipment. Restoration will include reseeding and mulching the area. The ASWCC should be consulted to determine the grass species to use. The QCSM will be responsible for verifying the proper fill and revegetation materials are used.

H3.2.4 Final Inspection and Demobilization

When planned remediation activities have been completed, temporary field structures (e.g., fencing and best management practices) will be removed and disposed off site. A final inspection of the project site will then be conducted in accordance with the requirements as outlined in this CQAP.

After the completed work has been accepted by RSA and/or CEHNC, all personnel and equipment will be demobilized from the project site. During these activities, the QCSM will be responsible for the performance or oversight of the following:

- Oversee the removal of temporary field structures.
- Obtain required waste characterization samples as necessary for off-site disposal.
- Coordinate disposal with RSA personnel (including obtaining appropriate RSA signatures on waste manifests or bills of lading) and the subcontracted transportation and disposal vendor.
- Participate in final field inspection and note deficiencies that require corrective action.
- Coordinate implementation of corrective actions and arrange for reinspection.
- Submit final approved inspection report to RSA and CEHNC.
- Oversee demobilization activities.

H3.3 Additional Considerations

The information contained in this chapter only represents an overview of the proposed work activities and is intended to serve as a guide to the complete details of work as included in the contract CMI work plan and other supporting documents. As noted previously, the remaining chapters of this CQAP contain discussions of the additional components included in the overall CQA/CQC program which are implemented to ensure the generation of defensible evidence of compliance with contract and regulatory requirements.

H4.0 Document Control

The CQAP is a controlled document, and measures are included to maintain the currency and the use of the plan so that the CQC functions defined within are in accordance with the latest specified requirements. Distribution of the plan is controlled so that all revisions to the plan are issued to the plan holders and the superseded requirements revised accordingly in the existing plans.

Issuance and distribution of the plan will be controlled by the PM or his/her designee, the document controller. The plan will be transmitted to each plan holder on the distribution list. The transmittal document will reference the assigned document control number, which will appear in the top right corner of the transmittal letter included within each document. The assigned number will be kept on a log and maintained by the PM's designee in the home office. Copies will be maintained at specific locations and available to the individuals performing the work.

Revisions to the plan will be made by sections or by the addition of supplements or amendments and will be noted with change pages or with a new final or revised document. All accepted revisions to the plan will be transmitted to the plan holders according to the distribution list. Individuals or organizations designated as plan holders will be responsible for updating their copies of the plan.

H4.1 Documentation

The PM will provide a document control system to provide measures for the control of issuance, distribution, storage, and maintenance of documents relating to quality, including those from APTIM and its subcontractors and other vendors or suppliers.

Preparation, review, issuance, and revisions to documents affecting construction quality will be controlled so that the specified contract, regulatory, and permitting requirements are clearly defined and made available to the personnel performing the work. Such documents may include but not be limited to the following:

- Correspondence
- Drawings
- Procedures
- Plans
- Reports
- CMI work plan.

The PM or his/her designee will review the documents to verify inclusion of the appropriate QA requirements.

H4.2 Daily Construction Log

CQC reporting will be addressed in the daily construction log, and APTIM will document all project activities as required by the contract. The log will cover conforming and nonconforming work and will include but not be limited to the following:

- Weather conditions
- Site instructions
- Nonconforming conditions
- Results of inspections and tests
- Types of defects or causes for rejection
- Corrective actions - proposed and taken
- On-site personnel and major equipment log
- Delays and causes
- Verbal instructions.

A copy of a typical daily CQC report is included as Table H4-1. RSA and CEHNC will be provided a copy of the daily QC reports throughout the duration of the project.

H4.3 Records

H4.3.1 Evidence of Contract Compliance

Records will be prepared to furnish documented evidence that design, construction, and operation activities, including laboratory analysis, are in compliance with the quality requirements of the contract. The records will be consistent with the applicable sections of the project technical CMI work plan and may include one or more of the following:

- Daily CQC report
- Technical reviews
- Inspection and test reports
- Audit reports
- Monitoring and surveillance activities
- Personnel qualifications
- As-built drawings
- Nonconformance reports and corrective actions
- Design documents
- Laboratory analyses reports
- Other specified documents.

H4.3.2 Storage of Field Records

Copies of field records will be maintained and stored at the project site until turnover as specified by CEHNC. On-site records will be readily retrievable for review and audit purposes by ADEM, RSA, and CEHNC. The records will be controlled so that the possibility of loss, damage, or other detrimental conditions of the records is avoided. The original project documents will be stored at APTIM's home office.

H4.4 Project Submittals

Project submittals include documents generated or revised in the home office or in the field site office at RSA. Project submittals will have tracking numbers issued with each new or revised document. In addition, project submittals specified in the contract documents and CMI work plan will be prepared by APTIM and submitted to the QCSM. The PM is responsible for the preparation and maintenance of the specified submittals for the project.

A master set of as built-drawings, kept on site at APTIM's field office, will be updated periodically with variances from the contract documents, as well as other changes documented on the redline drawings. Two sets of redline drawings will be maintained at the site. Each deviation will be identified with the appropriate modifying documentation. These redline drawings will include buried or concealed structures and utility features revealed during the course of the site work. The redline drawings will be used to produce the final as-built drawings. A copy of the redline drawings and a set of final as-built drawings will be submitted.

H4.4.1 Document Submittal Register

The project submittal register will be maintained by APTIM. Submittals returned unapproved or with comments requiring revisions will be so noted on the submittal register and re-entered as a revision. The Project Engineer or his/her designee will monitor the submittal register to verify submittals are being controlled, scheduled, and tracked, and the status kept in an effective manner. The project submittal register will be updated continuously, as applicable, and reviewed by the Project Engineer or his/her designee to determine the status of the submittals and compliance to the project schedule requirements.

H4.4.2 Submittal Preparation and Transmittal

Submittals will be prepared by the PM or his/her designee. Submittals from subcontractors or vendors will be reviewed by the QCSM prior to transmitting the submittals to the PM and Project Engineer or designees. All appropriate information will be completed prior to transmittal of the submittals. Submittals will be scheduled to coincide with the needed dates and adequate time allowed for review and approval in accordance with the contract requirements. The submittals will be reviewed for conformance to specified requirements, completeness, and accuracy.

Submittals requiring modifications or changes will be returned to the PM or his/her designee for corrective actions and resubmitted for review.

H4.4.3 Resubmittals

Submittals that are not approved by the QCSM or returned with comments that require resubmittal for approval will be processed in the same manner as the original submittals. The submittal number used for the original submittal will be used for each resubmittal followed by a numerical notation indicating the revision. The resubmittals will be re-entered on the project submittal register with the new revision numbers.

H5.0 Nonconformances And Corrective Actions

This chapter addresses the procedure for reporting nonconformances and corrective actions for variance from the contract documents.

H5.1 Nonconformance Report

Work, field testing, laboratory testing, or materials not conforming to the CMI work plan or contract requirements, including noncompliances and deficiencies identified by RSA and CEHNC, will be documented on a nonconformance report (NCR). A sample NCR is shown in Table H5-1. At a minimum, the NCR will detail the nonconforming conditions, recommended corrective action(s), and disposition of the corrective action(s). Noncompliances or deficiencies identified by the QCSM will be immediately corrected. A master log of all NCRs will be kept by the QCSM for review by the PM. All NCRs will remain open until the nonconforming condition has been satisfactorily resolved and verified as acceptable by the APTIM Corporate Quality Management Director.

H5.2 Identification of Nonconforming Items

Items identified as nonconforming will be documented on the NCR, which, as applicable, will include the following:

- Description of nonconforming item or activity
- Detailed description of nonconformance
- Cause of nonconformance
- Referenced criteria
- Recommended disposition
- Disposition and verification of corrective action
- Responsible organization.

H5.3 Nonconformance Tracking Register

Each identified nonconformance will be documented on the sample NCR tracking register (Table H5-2) which, at a minimum, will include the following information:

- NCR tracking number
- Description of nonconformance
- Issue date
- Distribution parties
- Individual or organization assigned responsibility
- NCR closed-out date and initial of party responsible for closure.

The QCSM is responsible for maintaining the NCR tracking register and for the verification that the corrective actions were implemented and verified prior to closing the NCR. RSA and

CEHNC will be notified in advance of verification of the corrective actions to permit their participation in the inspections and acceptance of the results prior to closing the NCR.

H5.4 Control and Segregation

Nonconforming materials or items will be controlled to prevent inadvertent use or further processing which would cause the nonconforming condition to be inaccessible for correction. All items identified as nonconforming will be clearly identified and segregated from acceptable items except where size, installation status, and other conditions would make it impractical to segregate from conforming items. When nonconforming items are not segregated, they will be identified and clearly marked so that they may be easily recognized as nonconforming to prevent further activities prior to the implementation of the corrective action(s).

H5.5 Disposition

The disposition of NCRs will include the necessary actions required to bring the nonconforming condition to an acceptable condition and may include reworking, replacing, retesting, or re-inspecting. Implementation of the disposition will be in accordance with the original procedural requirements, a specific procedure, or other acceptable written instructions by the APTIM Corporate Quality Management Director.

H5.6 Documentation

Notifications of noncompliance and the proposed corrective actions will be documented on an NCR and processed in accordance with the provision described in this section. Corrective actions will be implemented upon receipt of the notification. The NCR will remain open until the noncompliance is resolved.

H5.7 Corrective Actions

In addition to resolving identified nonconforming conditions, corrective actions will address the cause of adverse conditions contributing to the nonconformance and establish methods and controls to preclude the recurrence of the same or similar types of nonconformances.

The QCSM will track corrective actions to identify trends in the causes of the nonconforming conditions and initiate necessary actions to prevent recurrence. Additionally, the QCSM will monitor the corrective actions to verify that corrective actions were properly implemented and accepted and the NCR was closed.

H5.8 Stop Work Notice

Nonconforming conditions that affect the quality of the project, threaten safety, or cause an environmental threat will be stopped through the use of a stop work notice (Table H5-3). Stop work notices may also be issued in the event of insufficient corrective actions resulting in

recurring nonconforming work. The issuance and tracking of stop work notices will be documented on a stop work notice log (Table H5-4) to be maintained by the PM (or his/her designee).

H5.9 Conflict Resolution

Conflicts arising from nonconformance and corrective actions that cannot be resolved at the project management and QC levels will be directed to successive levels of management as necessary to obtain resolution. The levels of management will include the QCSM, APTIM Corporate Quality Management Director, and PM. All conflicts will be resolved within the specified requirements of the contract and the governing regulatory documents.

H6.0 Procurement Control

This chapter addresses the procedure for ensuring that procured items and services meet established requirements and perform as specified within procurement standard operating procedures.

H6.1 Overview

Prospective suppliers will be evaluated and selected on the basis of the specified criteria. APTIM will ensure that approved suppliers can provide acceptable items and services as required by the contract. The Project Engineer will review and approve all materials and supplies that may affect quality of the project. Upon approval of purchase requisitions, the QCSM will receive a copy of the approved purchase requisition. When materials and supplies arrive at the project site, the QCSM will be responsible to ensure the items and services meet the requirements listed in the purchase requisition and that no items are installed prior to approval of applicable submittals.

The procurement details include provisions for the following, as applicable to the scope of work or services:

- ***Scope of Work***. A statement of the scope of work to be performed by the subcontractor will be in the procurement documents.
- ***Technical Requirements.*** Technical requirements will be specified. Where necessary, these requirements will be specified by reference to CMI work plan, codes, regulations, procedures, QA program documents, and statement of work requirements that describe the services to be furnished. The procurement documents will provide for identification of inspection, verification, and acceptance requirements for monitoring and evaluating the supplier's performance.
- ***QA Program Requirements.*** Procurement documents will require that subcontractors have a documented quality system that implements portions or all of the requirements of this plan, as applicable. The extent of the suppliers' quality system will depend on the type and use of the service being procured.
- ***Right of Access.*** At each tier of procurement, the procurement documents will provide for access to supplier's facilities and records for inspection or audit by APTIM or its authorized representative.
- ***Documentation Requirements.*** Procurement documents at each tier of procurement will identify the documentation required to be submitted to APTIM for information, review, or approval and the time of submittal. The retention times and the disposition requirements for specific quality records will be prescribed.

- ***Questionable or Unusable Data.*** The procurement documents will include requirements for reporting and approving disposition of questionable or unusable data.

H6.1.1 Review of Procurement Documents

The QCSM will ensure that site-initiated procurement documents and changes transmitted to the prospective supplier include adequate requirements, performance standards, and quality criteria. The purchase requisition will then go through the proper approval process including the PM, the Project Engineer, and the Procurement Leader.

The review of changes and their effects will be completed prior to transmittal to the prospective supplier. This review will include the considerations that the appropriate requirements are specified, additional or modified performance criteria determined, and analysis of exceptions or changes requested or specified by the supplier.

H6.1.2 Source Evaluation and Selection

The selection of suppliers and subcontractors will be based on an evaluation of their capability to provide items and/or services in accordance with the specified requirements. Measures for evaluating and selecting procurement sources will be documented and may include one or more of the following:

- Evaluation of the supplier's history of providing an identical or similar service, which reflects the current capability
- Supplier's current QA records supported by documented qualitative and quantitative information that can be objectively evaluated
- Supplier's technical and quality capability as determined by a direct evaluation of their facilities and personnel, an evaluation of the effectiveness of their implementation of their quality system, and, in the case of subcontracted analytical data acquisition services, the successful analysis of a set of performance evaluation samples
- Submittals pertaining to the items or services to be provided must be approved prior to use or initiation of the work on the project site.

H6.1.3 Acceptance of Services

The procurement control will include flow-down provisions of the contract and site-specified task order. The acceptance methods used (e.g., source verification, receipt inspection, and technical verification of data produced) will be verified. Confirmation of specific characteristics will be performed at intervals and to a depth consistent with the service's complexity, quantity and frequency of procurement, and statement of work requirements.

H6.1.4 Receipt Inspection and Verification

The QCSM or designee will develop and implement procedures for receipt inspection and verification of purchased items. These controls will provide for the following, as applicable:

- Verification that the items received is in accordance with purchase order requirements
- Inspection for evidence of breakage, damage, or otherwise being unfit for use
- Verification that required documentation is received and acceptable
- Verification that the items conform to the supplier's published requirements that were provided submitted and approved.

H6.1.5 Handling, Storage, Packaging, and Shipping

The handling, storage, cleaning, preservation, packaging, and shipping of items will be controlled to prevent damage or deterioration that would jeopardize the specified performance of the items.

Procurement documents will include the following:

- Requirements for sellers to establish special procedures, when necessary, to ensure cleanliness, identification, and proper handling
- Requirements for the preparation of items for shipment, as necessary, to prevent damage or deterioration of the supplied items
- Requirements for material and equipment storage instructions, when specified, to be available at the site well in advance of the arrival of material or equipment.

H6.2 Subcontractor Quality Control

All subcontractors performing work for a project are responsible for compliance to the requirements of their respective subcontracts. Subcontractors include organizations supplying quality-related items or services to the project. The overall responsibility for conformance to the quality requirements for the subcontracted items and services is retained by APTIM.

The requirements for personnel qualifications, technical performance levels, QC procedures, acceptability levels, and documentation will be included as part of the subcontract documents. The PM or designee will review the subcontract procurement documents to verify that QC requirements are passed on to the subcontractor.

The QCSM is responsible for the implementation of inspections, surveillance, document review, audits, and other QC activities for monitoring the subcontractor to verify compliance with the

contract and subcontract requirements. These activities will be documented on inspection reports, audit reports, field logs, or other forms appropriate to the function performed.

For field operations, the field QA/QC personnel will provide QC checks before, during, and at the completion of the subcontractor's activities to determine that the subcontractor is in compliance with the QC measures set forth by the contract, the applicable subcontract documents, and the subcontractor's approved QC plan, including the following:

- Meeting quality requirements
- Generating, controlling, and maintaining required documentation
- Performing and documenting required inspections and tests
- Identifying, reporting, and correcting nonconforming conditions
- Turnover to APTIM.

H6.3 Analytical Laboratory Services

Analytical testing to ensure that the cleanup objectives are achieved will be performed using analytical laboratories off the project site as specified by the contract documents. The analytical testing requirements and related activities are described in Section 4.0 of the CMI work plan.

H6.3.1 Other Subcontractors

Subcontractors performing work other than laboratory-related activities will be monitored by the QCSM or field QA/QC personnel to verify conformance to the contract and subcontract quality requirements. The monitoring activities will include audits, surveillances, witnessing of inspections and tests, document reviews, and interfacing with the subcontractor's QC or project management. All monitoring activities will be documented on the appropriate form or included in the daily construction log.

H6.3.2 Subcontractor Noncompliance

Work performed by subcontractors that does not comply with the specified requirements will be identified, reported, controlled, tracked, and corrected.

H7.0 Audits

Audits may be performed to verify compliance with aspects of the project documents. Audits will be performed with checklists and include a review of documents and records to determine if the CQAP and supporting procedures are being implemented. A site-specific assessment checklist for RSA-013 is provided as Attachment H-1 of this CQAP. The individual elements of the checklist are based on the site-specific requirements presented in Section 4.0 of the CMI work plan.

An audit will note findings and observations. A finding will be a documented statement of fact concerning a noncompliance or deviation from established requirements. An observation will be a statement of fact regarding the potential for a noncompliance.

Audits will be performed by qualified personnel and include individuals that are technically knowledgeable in the areas to be assessed. Audit results will be documented and sent to the appropriate management.

H7.1 Scheduling and Planning

Audits typically will be performed early in the life of the activity as practical and continue until completion of the activity. The Auditor will provide written notification to the organization to be audited informing them of the scheduled audit date.

Audit schedules may be prioritized based on the importance of the activity, previously identified deficiencies of the activity, and the size or complexity of the activity. The QCSM will develop a schedule for the performance of audits. The audit schedule will be posted and distributed to project staff and managers. Unscheduled audits may be used to supplement scheduled audits when conditions warrant.

H7.2 Internal Performance Audits

Performance audits are conducted on site by an auditor who directly observes specific project activities to determine if these activities are being conducted in accordance with the contract requirements. The Auditor will be technically competent in the activities to be audited and independent of the subject work. The audit of project deliverables will be for the purpose of determining compliance with the procedures set forth in this plan (i.e., technical reviews, documentation of reviews, document control, and other procedures). Checklist items to be examined may include the following:

- Availability and implementation of approved work instructions
- Field documentation and checking
- Subcontractor performance
- Review of personnel training and qualification records
- Review of process controls and associated records to determine compliance with CMI work plan or plans
- Review of work areas for evidence of implementation of procedures and instructions
- Review of documentation indicating compliance with plan, document and design preparation, review, and approval procedures
- Change and nonconformance documentation and disposition.

H7.3 Execution of Audits

Audits will normally be conducted as described below.

H7.3.1 Pre-Audit Meeting

The Auditor will conduct a brief pre-audit meeting with management or supervisory personnel of the organization to be audited to confirm the audit scope, discuss the audit sequence, establish a tentative time for the post-audit meeting, and establish channels of communication.

H7.3.2 Audit

The Auditor will follow checklists, developed prior to the audit, to evaluate existing project records provided by designated project staff and may observe work in progress. If noncompliances are observed or uncovered during the audit, the Auditor will discuss these potential findings with the individuals being audited so that findings are accurate and understood. In addition to identifying noncompliances, the audit results may include observations of notable areas of strength.

H7.3.3 Exit Meeting

Upon completion of the audit, the Auditor will discuss observations and findings with the group or organizations audited and, whenever possible, agree on corrective actions. Minor administrative findings that can be resolved to the satisfaction of the audit team during the audit are not required to be documented as items requiring corrective actions. All findings that are not resolved during the course of the audit and findings affecting quality will be noted on the audit checklists.

H7.3.4 Audit Report

The Auditor will prepare and issue an audit report, which provides the following information at a minimum:

- Unique audit number
- Description of the audit scope
- Audited organization and location
- Persons contacted during the audit activities
- Audit dates
- Summary of audit results, including a statement on the effectiveness of the quality management elements that were audited
- Suggested opportunities for improvement in the form of observations and comments
- Description of each reported audit finding in sufficient detail to enable corrective action to be performed
- Due date for completion of corrective actions and/or audit response (typically 30 days).

Audit results will include findings and observations. Findings are items that require corrective action. Findings will be documented on an audit finding report or equivalent. Observations are nonmandatory recommendations to improve project quality. The Auditor may make recommendations for corrective actions; however, the ultimate responsibility for taking corrective action lies with the auditee. The report will be signed by the Auditor. Checklists do not need to be included with the audit report but should be maintained as records in the project files.

The Auditor will prepare an audit report cover letter or memorandum for signature and issuance by the PM. The audit report will be issued to the management of the audited organization.

H7.4 Response

The response prepared by the auditee will clearly state for each finding the corrective action taken or planned, the cause of the deficiency, and the action to prevent recurrence. For each observation, the response will indicate actions taken or planned for quality improvement. The response will, at a minimum, be sent to the PM and the Auditor.

H7.5 Follow-Up

The QCSM or designee will track all audit findings to assure that all findings are appropriately addressed and to trend audit findings for significant conditions adverse to quality. The QCSM or designee will maintain the status of audit findings for active audits and prepare correspondence relating to overdue audit responses. When responses are overdue, the QCSM or designee notifies the responsible organization by telephone that responses are overdue and prepares a memorandum or letter indicating a new response due date. If a request for extension of response is received, an evaluation will be made and a formal response submitted to the requesting organization.

The PM or designee, upon receipt of responses to audit findings, will coordinate with the Auditor for the evaluation of responses. The responsible evaluator will document the results of the evaluation. Unacceptable responses will be noted together with the specific reason for rejection. The PM or designee will prepare transmittal correspondence to the responsible organization to inform them of a new response due date.

Follow-up actions, possibly including re-audit of deficient areas, will be taken to verify whether corrective action is accomplished as scheduled. The QCSM or designee will assure that verifications of corrective action implementation are accomplished and document the results of verification.

Following acceptance and verification of all corrective actions, an audit closure document will be issued by the Auditor to the same distribution as the audit report. The closure document will indicate that corrective actions have been satisfactorily completed and will contain a statement that the audit is closed.

H7.6 Documentation

The following documents generated before, during, and after the audit process will be maintained in the record file system in accordance with Chapter H4.0 of this plan:

- Audit report
- Audit responses
- Audit closure letter
- Correspondence related to the audit.

H8.0 Construction Inspections

The primary function of inspections is to establish the measures required to verify the quality of work performed and compliance to the specified requirements, including the inspection of materials and workmanship before, during, and after each work element.

H8.1 Preparatory Inspections and Meetings

Along with representatives of RSA and CEHNC, the PM, the QCSM, and the Site Supervisor will conduct preparatory inspections/meetings at RSA-013. Preparatory inspections/meetings will be performed prior to starting definable features of work. Typical definable tasks and related inspection requirements can be modified based on project requirements. When more than one work element is included in one work activity, one preparatory meeting may cover several work elements for the site. Likewise, a number of work activities, where feasible, can be combined into individual preparatory meetings. The preparatory inspection/meeting will be attended by the Army, applicable APTIM personnel and subcontractors involved with the feature of work, and responsible field QA/QC personnel. The QCSM will be notified in advance to coordinate participation in the inspection. The preparatory meeting may include but not be limited to the following:

- Review the basic elements of the work.
- Review documentation and reporting requirements.
- Review pertinent contract requirements.
- Review materials and equipment documentation for required tests, submittals, and approvals.
- Review required QC inspections and test requirements.
- Establish that the preliminary work required to begin the feature of work is complete and conforms to approved drawings and submittal data.
- Establish that the required materials and equipment for commencement of the work are on hand or available for use on the feature of work and that all equipment is properly calibrated and in proper working condition.
- Ensure the securing of utility clearances (“dig permits”).
- Address basic site health and safety considerations.
- Establish hours of operation.

Preparatory inspections will be reported on the daily QC reports. The detailed results of the preparatory inspection will be documented.

Personnel performing work activities affected by a preparatory inspection will be directed in the acceptable level of the workmanship involved for the feature of work covered by the inspection.

H8.2 Initial Inspections

The initial inspection may be conducted at the beginning of the work element. The inspection will be performed when it is determined that a sufficient portion of the work element has been accomplished to evaluate the following criteria:

- Compliance with the CMI work plan, drawings, submittals, and other contract requirements
- Acceptable levels of workmanship
- Quality of materials
- Resolution of differences (when applicable).

Initial inspections will include participation of the responsible personnel, including appropriate subcontractors and the field QA/QC personnel involved with the work element. The Army will be notified in advance of each initial inspection to coordinate participation in the inspection. The initial inspections will be reported on the daily QC reports.

H8.3 Follow-Up Inspections

Follow-up inspections will be performed throughout the course of work. The frequency of the follow-up inspections will be dependent upon the extent of work being performed on each particular work element. Follow-up inspections will be performed on all ongoing work. Follow-up inspections will also be performed on completed work phase prior to starting subsequent phases. Deficiencies identified will be corrected in a timely manner or identified on a punch list that will be used as a tracking method until the work is completed and verified and the punch list item signed off. Deficiencies that would be made inaccessible for correction by subsequent work activities will be corrected and accepted prior to starting the new work.

The follow-up inspections will be reported on the daily QC reports and copies of the inspection forms as applicable.

H8.4 Pre-Final Inspection

Near the completion of the work or increment thereof as established (e.g., completion of the erosion control structures such as silt fencing and construction entrance), the QCSM will conduct

an inspection of the work and develop a punch list of items that do not conform to the approved CMI plan. The list of deficiencies will become a part of the CQC documentation which will include the estimated date by which the deficiencies will be corrected. The QCSM will then make a second inspection to ensure that all deficiencies have been corrected. Once this is completed, APTIM will notify the QCSM that the site is ready for pre-final inspection.

The Army will perform the pre-final inspection to verify that the site work has been satisfactorily completed. A pre-final "punch list" may be developed by the QCSM as a result of this inspection. The QCSM will then make sure that all items on this list have been corrected and so notify the PM so that a final inspection with RSA and CEHNC can be scheduled. Items noted in the pre-final inspection will be completed in a timely manner. These inspections and deficiency corrections will be accomplished within the time frame slated for completion of the project.

H8.5 Final Inspection

The PM, the QCSM, the RSA Site Manager, and the CEHNC Technical Manager will be in attendance at this inspection. The RSA Site Manager or CEHNC Technical Manager will formally schedule the Final Inspection based upon completion of the results of the pre-final inspection. Notice will be given to the Army at least 14 days prior to the final inspection and must include APTIM's assurance that all the specific items previously identified as being unacceptable will be completed by the date scheduled for the final inspection.

APTIM will prepare the punch list. The punch list will identify all nonconforming or incomplete work. Upon completion of the punch list items, a second inspection will be conducted by RSA, CEHNC, and APTIM to verify all of the items conform to the requirements. The APTIM Corporate Quality Management Director will be the final authority to accept all of the punch list items as having been corrected.

H8.6 Inspection Documentation

The QCSM is responsible for the maintenance of the inspection records. Inspection records will be legible and clearly provide all information necessary to verify the items or activities inspected conform to the specified requirements or, in the case of nonconforming conditions, provide evidence that the conditions were brought into conformance or otherwise accepted by the Army.

H9.0 Analytical Testing

The installation-wide quality assurance program plan (HydroGeoLogic, Inc., 2019) establishes the measures for management and control of analytical testing activities affecting the quality of remedial actions. Primary responsibility for control of construction (through performance of analytical QC testing) resides with APTIM (including its subcontractors), and testing will be done in accordance with the CMI work plan, including the site-specific QAPP (Appendix D to the CMI work plan).

Task-specific programs of field controls, consisting of inspections and verification tests, will be utilized to verify that the CMI work plan, including the site-specific QAPP, is adhered to during implementation of the corrective measures at RSA-013, where applicable. However, the installation-wide quality assurance program plan (HydroGeoLogic, Inc., 2019) presents the overall general principles that are employed in any chemical analyses performed as part of the construction.

H10.0 References

Alabama Soil and Water Conservation Committee (ASWCC), 2018, ***Alabama Handbook for Erosion Control, Sediment Control, and Stormwater Management of Construction Sites and Urban Areas***, July.

Aptim Federal Services, LLC (APTIM), 2019, ***Quality Assurance Surveillance Plan for Corrective Measures Implementation at Multiple Sites, U.S. Army Garrison-Redstone, Madison County, Alabama***, Prepared for U.S. Army Engineering & Support Center, Huntsville, Alabama, November.

CB&I Federal Services LLC (CB&I), 2017, ***Revision 1 RCRA Facility Investigation Report, RSA-013, Unlined Inactive Open Burn Pad, RSA-132, Dismantled Popping Furnace, RSA-133, Inactive Rocket Washrack/Sump, Operable Unit 14, U.S. Army Garrison-Redstone, Madison County, Alabama***, February.

HydroGeoLogic, Inc., 2019, ***Final Revision 4 Installation-Wide Quality Assurance Program Plan, U.S. Army Garrison – Redstone, Madison County, Alabama***, December.

U.S. Army Garrison-Redstone (Army), 2012, ***Redstone Army Garrison: Installation Restoration Site Access Control Program, Redstone Arsenal Regulation 200-7,*** September.

TABLES

Table H.4-1

Typical Daily Construction Log
Redstone Arsenal, Madison County, Alabama

Date: _____

Contractor: _____ Project No.: _____

Contract Title: _____ Report No.: _____

Area: _____ Unit: _____ Work: Contract (✓) _____ WO # _____

Shift: _____ Hrs. Wkd: From _____ To _____ Weather _____
Temp. L H

Manpower	No.	Total Hrs.	Major Equipment	No.	Total Hrs.

Description of Work Performed Today:

Remarks by Contractor: (Delays, interruptions, deviations, extra work activities, unusual occurrences, etc., relevant to today's work.)

For Contractor: Title: Date:

USACE Comments and/or Exceptions:

For USACE: Title: Date:

Table H.5-1

Nonconformance Report
Redstone Arsenal, Madison County, Alabama

Linked w/Variance No: Page __of __

Project Name:	Project Number:
Date of Issue:	Report Number:
-- Nonconformance Report --	
I. Description of the Nonconformance, include requirement violated: (by the person identifying the nonconformance) Identified by: Date:	
Root Cause of nonconformance:	
II. Recommended Corrective Action: (by the person identifying the nonconformance and the review committee)	
To Be Performed by:	Date:
To Be Verified by:	Date:
III. Corrective Action Implementation: (by those implementing the corrective action)	
Was Performed by:	Date:
Was Verified by:	Date:
How was the Corrective Action Verified?	
IV. Nonconformance Resolution, include action taken to preclude recurrence: (by the review committee)	
Affected Organization:	**-- Signatures --**
<u>Distribution List:</u>	Requested by: _____ Date: _____ (printed name and date) Signature:
	QC Approved by: _____ Date: _____ (printed name and date) Signature:
	Proj. Mgr. Approval:_____ Date: _____ (printed name and date) Signature:
	Client QA Approval: _____ Date: _____ (printed name and date) Signature:

Table H.5-2

Nonconformance Report Tracking Register
Redstone Arsenal, Madison County, Alabama

PROJECT NO.
CONTRACT NO.
NONCONFORMANCE REPORT TRACKING REGISTER

NCR NO.	DESCRIPTION OF NONCONFORMANCE	DATE ISSUED	DATE CLOSED	COMMENTS

Table H.5-3

Stop Work Notice
Redstone Arsenal, Madison County, Alabama

Project Name/Location: _____ Project No. _____ D.O. No. _____

S.W.O. No. _____ Date: _____ Page 1 of ___

1. Written Notice Issued to: Name: _____ Title: _____ Org.: _____	2. P.O. # or Activity: _____ 3. Location: _____ 4. Issued by (name): _____ Issued by (title): _____
5. Verbal Notice Issued to: Name: _____ Title: _____	Date: _____ Time: _____
6. Associated NCR No.: _____	7. Associated CAR No.: _____
8. Stop Work Order Condition Description:	Attachment _____
9. Remedial Action Required: By Whom: _____ Required Remedial Action Determined by: Project Manager: _____ CQA Director/Field CQA Coordinator: _____	Attachment _____ By When: _____ Date: _____ Date: _____
10. Follow-up of Remedial Action Taken: Verbal Notice to Resume Operations Given to: Name: _____ Title: _____ Stop Work Order Cancellation Authorized by: CQA Director/Field CQA Coordinator: _____	Attachment _____ Date: _____ Time: _____ Date: _____

Table H.5-4

Stop Work Notice Log
Redstone Arsenal, Madison County, Alabama

SWO No.	Action Party/Organization	Subject	Date Issued	Date Closed

ATTACHMENT H-1

FIELD INSPECTION CHECKLIST

	Contract No: W912DY-17-D-0003 **EPA ID No.** AL7 210 020 742	**Controlling Document:** **Corrective Measures Implementation (CMI) Plan**
Location: Redstone Arsenal, Madison County, Alabama		
Inspection Type: Field Inspection Checklist **Subject:** RSA-013 CMI Work Plan	**Inspection Date:**	

Descriptor / Requirements	Comments	Results
4.0 Corrective Measures Implementation		
This section provides an overview of the planned activities to complete corrective measures at RSA-013. Work presented in this section will be completed in accordance with the procedures described in the Corrective Measures Implementation (CMI) Work Plan and other approved documentation as appropriate. RSA-013 CMI Work Plan Chapter 4.0		
4.1 General Scope		
The general scope of work includes the following: • Obtain underground injection control permit • Obtain a permit under the General National Pollutant Discharge Elimination System (NPDES) for stormwater discharges • Mobilization/demobilization • Surveying and marking the proposed excavation areas • Utility clearance and marking • Protection of existing monitoring wells and closure of wells within excavation boundary • Installation of surface water and erosion controls • Vegetation clearance • Excavation of contaminated soil • Confirmation sampling and analysis of the excavated areas • In situ enhanced bioremediation (ISEB) • Waste characterization sampling • Transport and disposal of excavated soils contaminated with perchlorate and RDX as nonhazardous waste (Subtitle D landfill) • Install replacement monitoring wells, if needed • Site restoration, including application of backfill and topsoil, and revegetation with approved grass mixture. RSA-013 CMI Work Plan Chapter 4.0		

Location: Redstone Arsenal, Madison County, Alabama		
Inspection Type: Field Inspection Checklist **Subject:** RSA-013 CMI Work Plan		
Descriptor / Requirements	**Comments**	**Results**
The stage of the Tennessee River and precipitation events directly impact aquifer water levels. Excavation activities at RSA-013 will be scheduled to be performed during periods when groundwater levels are expected to be lower, if possible. RSA-013 CMI Work Plan Chapter 4.0		
The schedule for implementation of the CMI activities at RSA-013 is constrained by OB/OD operational periods. If needed, weekend and/or night work will be considered based on site access during corrective measures. Tree clearing at the site is limited to October 16 through March 31 but could change due to the Gray bat nesting season. RSA-013 CMI Work Plan Chapter 4.0		
4.1.1 Procurement and Subcontracting		
Subcontracted services and imported materials required for the completion of the project may include the following: • Vegetation clearance • Closure/Protection of existing monitoring wells within or adjacent to excavation area • Storm water erosion and sediment controls • Surveying • Excavation and site restoration • Transportation of common fill and topsoil • Analytical laboratory • Transportation and disposal of contaminated soil • EVO • Aggregate (crusher-run, riprap, and drainage stone) • Seed, fertilizer, and mulch • Heavy-duty plastic sheeting. RSA-013 CMI Work Plan Chapter 4.0		

Location: Redstone Arsenal, Madison County, Alabama		
Inspection Type: Field Inspection Checklist **Subject:** RSA-013 CMI Work Plan		
Descriptor / Requirements	**Comments**	**Results**
The following equipment may be utilized to complete field remediation activities: • Excavator/backhoe to excavate contaminated soil • Front-end loader to consolidate soil and move fill material • Compactor to compact fill material • Portable water tank, pumps, and equipment for mixing and application of EVO • Large capacity water truck (or equivalent) for site dust control and hydration of imported material for compaction • Portable fuel tank (mounted on pickup truck) • Miscellaneous support equipment (e.g., portable storage, radios, relief station, eyewash, etc.) Support equipment and materials will be procured through equipment vendors and scientific supply vendors and shipped directly to the site. RSA-013 CMI Work Plan Chapter 4.0		
4.1.2 Field Personnel		
Field personnel required to complete the field activities may include the following: • Site supervisor • Site safety officer • Field construction quality control site manager • Equipment operators • Laborers The number and schedule of personnel will be adjusted during the project as required. RSA-013 CMI Work Plan Chapter 4.0		
4.1.3 Quality Control Inspections for Field Activities		
Inspections may be performed and verified through visual observation, measurement of materials or equipment, examination of documentation/certification, evaluation of performance, or testing. RSA-013 CMI Work Plan Chapter 4.0		

Location: **Redstone Arsenal, Madison County, Alabama**		
Inspection Type: Field Inspection Checklist **Subject:** RSA-013 CMI Work Plan		
Descriptor / Requirements	**Comments**	**Results**
Inspections will be performed using a three-phase inspection method: 1) Preparatory inspection(s) are performed prior to start-up and will examine training, procedures, equipment and materials, work plans and documents, and overall readiness to perform work; 2) Initial inspection(s) are performed when work begins on a particular feature of work and include an examination of the quality of workmanship and a review of control testing for compliance with work plan requirements. Follow-up inspection(s) are then performed to verify compliance with procedures; and 3) Follow-up inspections will ensure a continuation of quality and safety standards established during preparatory and initial inspections until completion of the definable work feature. Final follow-up inspection(s) will be conducted at the completion of the activity. RSA-013 CMI Work Plan Chapter 4.0		
4.1.4 Daily Reports		
Daily reports (including daily construction logs, etc.) are provided to the APTIM Project Manager or their designee during CMI activities. These reports are being submitted weekly to CEHNC and RSA. The reports include a running inventory of excavated material. RSA-013 CMI Work Plan Chapter 4.0		
4.1.5 Health and Safety Requirements		
All personnel involved in the corrective measures are following this CMI work plan and the installation-wide accident prevention plan (APP) (CEHNC, 2019). Personnel will abide by the health and safety requirements presented in the site-specific safety and health plan (SSHP). RSA-013 CMI Work Plan Chapter 4.0		

Location: Redstone Arsenal, Madison County, Alabama

Inspection Type: Field Inspection Checklist
Subject: RSA-013 CMI Work Plan

Descriptor / Requirements	Comments	Results
4.2 Preliminary Activities		
Preliminary activities include mobilization, fulfilling requirements for base access, surveying, utility marking and obtaining dig permits, establishing site control as needed, installation of storm water erosion and sediment controls, vegetation clearing, protection of existing monitoring wells, closure of wells within excavation area, and establishment of soil stockpiles. In accordance with 40 Code of Federal Regulations (CFR) 112, a Spill Prevention, Control, and Countermeasures plan will be prepared if fuel storage is required on site and the aboveground storage capacity of a single container is in excess of 660 gallons or the aggregate aboveground storage capacity is greater than 1,320 gallons. All field personnel will follow the CMI work plan including the site-specific quality assurance project plan (QAPP) (Appendix D), SSHP (Appendix E) and APP (CEHNC, 2019) including updates to these attached plans prepared by APTIM as required. All field activities will be conducted using on-call unexploded ordnance (UXO) construction support personnel for site access and intrusive activities. RSA-013 CMI Work Plan Chapter 4.0		
4.2.1 Permitting		
A UIC permit will be obtained for the ISEB activities to be performed RSA-013. A draft UIC permit application is provided in Appendix J of the CMI work plan and provides details regarding the EVO solution to be applied to the excavation floor and details necessary to comply with the requirements for obtaining this permit. ADEM approval of the UIC permit is required prior to its application to the excavation floor. Since the excavation at RSA-013 will be more than 1 acre in size, a NPDES construction permit issued by the ADEM will be required. A construction best management practices (BMP) plan prepared for the construction effort is included as Appendix G of the CMI work plan. RSA-013 CMI Work Plan Chapter 4.0		
4.2.2 Mobilization		
Mobilization will include deployment of personnel, equipment, subcontractors, and materials necessary to commence CMI activities. RSA-013 CMI Work Plan Chapter 4.0		

Location: Redstone Arsenal, Madison County, Alabama		
Inspection Type: Field Inspection Checklist **Subject:** RSA-013 CMI Work Plan		
Descriptor / Requirements	**Comments**	**Results**
All APTIM and subcontractor personnel have completed required training and health and safety requirements. This includes: • OSHA 40 hour HAZWOPER and 8 hour updates • Reviewed and signed site specific health and safety plan • Any additional site or contract specific training or health and safety requirements RSA-013 CMI Work Plan Chapter 4.0		
4.2.3 Access to Redstone Arsenal		
New personnel and subcontractor personnel have registered at the Redstone Arsenal Visitors Center at Gate 9 (Rideout Road). Personnel with prior approval from a host RSA organization will be issued a personnel badge upon presentation of proper identification. Temporary passes may be required for some vehicles. RSA-013 CMI Work Plan Chapter 4.0		
Personnel may access the RSA via any active gate but should note that gate access hours vary. Commercial trucks must pass through the inspection facilities at either Gate 1 or Gate 9 each time they enter RSA. RSA-013 CMI Work Plan Chapter 4.0		
APTIM will contact the Redstone Test Center and RSA Safety Office in advance of the CMI field activities to schedule access into the OB/OD area. Access to the OB/OD area will be requested by contacting Jim Mayo (256-313-0948) to verify access into OB/OD area is permissible. APTIM and subcontractor personnel will be required to sign in at the OB/OD area and upon exiting the site on a daily basis. Based on the OB/OD area operational status, weekend and/or night work will be considered based on OB/OD area access during the corrective measures. RSA-013 CMI Work Plan Chapter 4.0		
4.2.4 On-Call UXO Support		
The probability of encountering UXO has been determined to be low at this site, and on-call UXO support has been provided during the conduct of the corrective measures involving intrusive activities (berm removal, excavation, utility abandonment). The on-call explosive ordnance disposal personnel are available 24/7 through the U.S. Army Aviation and Missile Command Safety Office if suspected UXO is encountered. Notification was provided to the Safety Office prior to the start of the intrusive activities. RSA-013 CMI Work Plan Chapter 4.0		

Location: Redstone Arsenal, Madison County, Alabama		
Inspection Type: Field Inspection Checklist **Subject:** RSA-013 CMI Work Plan		
Descriptor / Requirements	**Comments**	**Results**
4.2.5 Measurement of Water Levels		
Water table elevations were measured from wells located near RSA-013 to determine the average depth to groundwater. These data were used to determine the target depth of excavation for the corrective measures. RSA-013 CMI Work Plan Chapter 4.0		
4.2.6 Location, Marking, and Surveying of Excavation		
A licensed land surveyor was subcontracted to delineate the project work boundary and mark the excavation areas. The surveyor located these areas based on coordinates provided by APTIM and marked items in the field with highly visible wooden stakes, tape, or pin flags. The proposed excavation areas with coordinates are shown on Figure 3-1 of the CMI Work Plan. RSA-013 CMI Work Plan Chapter 4.0		
4.2.7 Digging Permit and Utility Marking		
APTIM has submitted a job order request (JOR) that describes the proposed activities and has received RSA approval of the JOR. The JOR information was reviewed by various RSA entities to verify that potential impacts to RSA resources (e.g., natural, cultural, etc.) are properly managed. RSA-013 CMI Work Plan Chapter 4.0		
APTIM has coordinated with the appropriate RSA personnel within 14 days of intrusive activities requesting a work order for a digging permit to ensure that any underground utilities in the proposed excavation are properly marked and protected. The procedure requires notification by telephone ([256] 876-9881). Water lines are located within the RSA-013 excavation area. Water lines will be capped and removed, as appropriate, and any remaining electrical service will be removed, if present. No other underground utilities are expected to be identified in the RSA-013 excavation area based on previous intrusive activities. The digging permit must be renewed every 30 days. To avoid temporary shutdown, APTIM will make a request for permit extension at least 1½ weeks prior to digging permit expiration for the extension to be granted. RSA-013 CMI Work Plan Chapter 4.0		
4.2.8 Site Control		
APTIM using temporary construction fencing materials, barricades, and warning tape, as necessary, to delineate the site exclusion zone, contamination reduction zone, and site support zone in compliance with the site-specific safety and health plan. RSA-013 CMI Work Plan Chapter 4.0		

Location: Redstone Arsenal, Madison County, Alabama

Inspection Type: Field Inspection Checklist
Subject: RSA-013 CMI Work Plan

Descriptor / Requirements	Comments	Results
4.2.9 Storm Water Erosion and Sediment Controls		
BMPs have been installed to manage site stormwater in accordance with the BMP layout included in the CMI Work Plan (Figure 4-1 of the CMI work plan) or an updated figure prepared by APTIM in accordance with the Alabama Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Areas (Alabama Soil and Water Conservation Committee, 2018). RSA-013 CMI Work Plan Chapter 4.0		
Documented inspections of erosion control devices occur at least weekly and also within 72 hours of any qualifying precipitation event. RSA-013 CMI Work Plan Chapter 4.0		
Maintenance of BMPs is being performed in accordance with the specifications included in the CMI Work Plan and its attachments and being documented in the daily reports. RSA-013 CMI Work Plan Chapter 4.0		
4.2.10 Vegetation Clearing		
Vegetation clearance is being performed in accordance with the CMI Work Plan, and in coordination with RSA forester for removal of any commercial quality trees. The remaining trees and brush will be cleared using manual and mechanical means (e.g., chainsaw, line trimmer, or heavy equipment). RSA-013 CMI Work Plan Chapter 4.0		
The cleared materials have been mulched and stockpiled for use during site restoration (if deemed practical). Materials not used for site restoration was disposed at the RSA construction and demolition (C&D) landfill. Material in contact with site soils (e.g., root wads) was disposed at the C&D landfill, if below CGs, or in the same manner as the surrounding soil. RSA-013 CMI Work Plan Chapter 4.0		
4.2.11 Well Closure and Replacement/Existing Well Protection		
Monitoring wells (e.g., P13-RS110 and P13-RS476) located within or close to the work zones have been closed in accordance with an ADEM approved well closure plan or conspicuously marked for protection during CMI activities. RSA-013 CMI Work Plan Chapter 4.0		
If needed, monitoring wells are closed in accordance with the AEIRG and Army approved SOPs. Two potential well closures are planned. RSA-013 CMI Work Plan Chapter 4.0		

Location: Redstone Arsenal, Madison County, Alabama

Inspection Type: Field Inspection Checklist
Subject: RSA-013 CMI Work Plan

Descriptor / Requirements	Comments	Results
If needed, replacement monitoring wells were installed in accordance with the Alabama Environmental Investigation and Remediation Guidance (AEIRG) and Army approved standard operating procedures (SOP). No replacement wells are planned. RSA-013 CMI Work Plan Chapter 4.0		
4.2.12 Stockpile Work Area		
Soil stockpile area(s) are properly lined and constructed per the requirements of the CMI Work Plan, or updated figure provided by APTIM. RSA-013 CMI Work Plan Chapter 4.0		
4.2.13 Removal and Sampling of Blast Berms		
Soil from the blast berms was sampled for perchlorate and RDX (one sample for every 200 cubic yards) to determine its suitability for use as backfill. Soil exhibiting perchlorate/RDX results below CGs was considered suitable for RSA-013 backfill. Soil from the berms exhibiting either perchlorate or RDX concentrations greater than CGs was disposed off-site along with excavated soil from RSA-013. RSA-013 CMI Work Plan Chapter 4.0		
4.3 Excavation of Contaminated Soil		
Obtain water level measurements from wells closest to the excavation area in the months prior to implementation of the corrective measures to calculate a representative average depth to water to be used as the excavation target depth. RSA-013 CMI Work Plan Chapter 4.0		
The limits of the soil excavation area along with the proposed stockpile locations are depicted on Figure 4-1 of the CMI work plan. Excavation will be accomplished according to the Safety and Health Regulations for Excavations (Occupational Safety and Health Administration [OSHA] 29 Code of Federal Regulations Part 1926 Subpart P). Perform the excavation of perchlorate-contaminated soils along with a small area (approximately 400 square feet) located around former boring P13-SB02 that contained RDX - contaminated surface soil located within the larger perchlorate-contaminated area. The proposed excavation areas are shown on Figure 3-1 of the CMI work plan. RSA-013 CMI Work Plan Chapter 4.0		
Excavate soils down to the average depth to groundwater (approximately 8 feet below ground surface). Excavation areas as shown on Figure 3-1 extend to the proposed depths as presented in the CMI Work Plan. RSA-013 CMI Work Plan Chapter 4.0		

Location: Redstone Arsenal, Madison County, Alabama

Inspection Type: Field Inspection Checklist
Subject: RSA-013 CMI Work Plan

Descriptor / Requirements	Comments	Results
Excavations over 4 feet in depth are shored, sloped, or benched in accordance with OSHA regulations for excavations (29 CFR Part 1926 Subpart P) prior to any personnel entering the excavation. Spoils must be placed a minimum of 3 feet from the edge of the excavation. Soil generated by benching/sloping near the perimeter of the excavations will be segregated and sampled to determine if it may be used as backfill. RSA-013 CMI Work Plan Chapter 4.0		
Unless preapproved for direct load prior to disposal at a properly licensed landfill, the excavated material is stockpiled or staged prior to waste characterization sampling and off-site disposal. The excavated material was staged on impervious material such plastic sheeting and covered with waterproof material (i.e., tarpaulin or 10-mil plastic sheeting). RSA-013 CMI Work Plan Chapter 4.0		
Asphalt pavement or concrete surfaces (e.g. roadways and sidewalks) will be saw cut prior to excavation. The concrete debris will be transported to the RSA C&D landfill or another appropriately permitted facility for disposal. Asphalt will be transported to the RSA recycling program's designated location for recycling or another appropriately permitted facility for disposal. RSA-013 CMI Work Plan Chapter 4.0		
Soil excavated from below 4 feet deep were segregated from soil excavated less than 4 feet deep for sampling and disposition.		
Water was used during excavation and hauling activities to control fugitive dust, as necessary. RSA-013 CMI Plan Section 4.0		
Particulate meters are being used to monitor dust/particulate levels per the CMI Work Plan requirements. RSA-013 CMI Plan Section 4.0		
4.4 Confirmation Sampling		
Confirmation samples are collected from each sidewall at a maximum spacing of 25 feet between samples with a minimum of one sample per 125 square feet of sidewall area. If the sidewall length is greater than 25 linear feet, then one confirmation sample will be collected for every 25 linear feet of sidewall. Sidewall confirmation samples are collected using six-point composites consisting of aliquots collected from upper and lower section of the center of the sidewall plus aliquots from the upper and lower left and right quadrants of the sidewall section (Figure 4-4 in the CMI work plan). Because the depth of the excavation is expected to be 8 feet, two sidewall samples per 25-foot length of sidewall are planned. Each of the samples at RSA-013 consist of composites collected every 5 feet of depth to the maximum depth of excavation (i.e., composites samples are collected at intervals from 0 to 5 and 5 to 8 feet bgs). RSA-013 CMI Plan Section 4.0		

Location: Redstone Arsenal, Madison County, Alabama

Inspection Type: Field Inspection Checklist
Subject: RSA-013 CMI Work Plan

Descriptor / Requirements	Comments	Results
Confirmation samples are collected from the floor of any excavation areas that do not extend to the saturated soil zone. Floor samples are collected with a minimum of one sample per 625 square feet of floor area (maximum floor areas equal to 25- by 25-foot sections). The multipoint sample include a center point of the 25- by 25-foot floor section plus aliquots from the north, south, east, and west quadrants of the floor area. RSA-013 CMI Plan Section 4.0		
Confirmation samples collected from the small excavation area at former boring P13-SB02 are sent to an off-site analytical laboratory for analysis of RDX (EPA Method 8330B) on a 5-day turnaround basis. Confirmation samples from the large excavation area are sent to an off-site analytical laboratory for analysis of perchlorate (EPA Method 6850) on a 5-day turnaround basis. RSA-013 CMI Plan Section 4.0		
Confirmation samples are collected and submitted for laboratory analysis in accordance with the QAPP provided as Appendix D of the CMI Work Plan or as updated by APTIM. RSA-013 CMI Plan Section 4.0		
4.5 In Situ Enhanced Bioremediation Application		
A carbon source (e.g. emulsified vegetable oil substrate) is placed at the bottom of the excavation to promote biodegradation of perchlorate in the smear zone and possibly into saturated zone soils in accordance with the ADEM-approved UIC permit. RSA-013 CMI Plan Section 4.0		
4.6 Waste Characterization		
Stockpile samples represent a maximum of 200 cubic yards of stockpiled soil. RSA-013 CMI Plan Section 4.0		
Stockpile samples are collected and submitted for laboratory analysis in accordance with the QAPP provided as Appendix D of the CMI Work Plan or as updated by APTIM. RSA-013 CMI Plan Section 4.0		
Waste characterization results are submitted to ADEM for approval, and an ADEM waste certification number obtained prior to disposal of the excavated soils. RSA-013 CMI Plan Section 4.0		
4.7 RDW Management		
Remediation-derived waste (RDW) generated during the CMI activities at RSA-013 is expected to include decontamination fluids and solid materials such as disposable personal protective equipment (PPE). RSA-013 CMI Plan Section 4.0		

Location: Redstone Arsenal, Madison County, Alabama		
Inspection Type: Field Inspection Checklist **Subject:** RSA-013 CMI Work Plan		
Descriptor / Requirements	**Comments**	**Results**
APTIM personnel are managing waste in accordance with the CMI Work Plan and the site-specific generator knowledge. RSA-013 CMI Plan Section 4.0		
IDW is containerized, labeled, and stored in accordance with AAC 335-14 as applicable and as described in the Alabama Environmental Investigation and Remediation Guidance (ADEM, 2017). IDW PPE will be disposed as normal household trash. Other types of IDW, if generated, will be managed in accordance with Table 2 of Appendix G of ADEM (2017). RSA-013 CMI Plan Section 4.0		
4.8 Waste Soil Transportation and Disposal		
All soil is transported by a licensed transportation subcontractor. RSA-013 CMI Work Plan Chapter 4.0		
APTIM is documenting the quantities of waste loaded onto the dump trucks and facilitate the Bill of Lading or shipping paper documentation for the non-hazardous waste shipments. Any hazardous waste sent offsite for disposal is on a hazardous waste manifest and has a Land Disposal Restriction notification. Transportation complies with all U.S. Department of Transportation regulations. RSA-013 CMI Work Plan Chapter 4.0		
4.9. Site Restoration and Demobilization		
4.9.1 Backfilling and Site Restoration		
Soil removed from the RSA-013 blast berms and any stockpiled soil removed during excavation and determined to be “clean” by sampling (i.e., perchlorate and RDX do not exceed cleanup goals) are used as backfill. RSA-013 CMI Work Plan Chapter 4.0		
As needed, additional fill material comes from an RSA borrow area or an approved off-site borrow source. Prior to bringing any fill material on-site, APTIM provided analytical data from samples collected from the proposed source to confirm it is acceptable for use as backfill at the sites. This includes at least one 5-point composite samples analyzed for TCL SVOCs, TCL pesticides/PCBs, and TAL metals and one grab sample analyzed for TCL VOCs from each off-site borrow source, with additional samples being submitted based on changes in material. RSA-013 CMI Work Plan Chapter 4.0		
Fill material is placed and spread in maximum 12 inch loose lifts and compacted prior to placement of the next lift. RSA-013 CMI Work Plan Chapter 4.0		

Location: Redstone Arsenal, Madison County, Alabama		
Inspection Type: Field Inspection Checklist **Subject:** RSA-013 CMI Work Plan		
Descriptor / Requirements	**Comments**	**Results**
During backfill and site restoration, dust at the site will be controlled as described in Section 4.3 of the CMI work plan. RSA-013 CMI Work Plan Chapter 4.0		
Fill material will be compacted to a minimum of 90 percent relative compaction at a moisture content ±5 percent of the optimum moisture. The optimum moisture content and maximum density of fill materials will be determined in accordance with ASTM D 698. RSA-013 CMI Work Plan Chapter 4.0		
The in-place density and moisture content of fill material will be determined per lift for every 10,000 square feet of material placed. When a failing test is encountered, an additional test shall be performed near the same location. If the re-test fails, the nonconforming area of the lift shall be repaired and tested again. RSA-013 CMI Work Plan Chapter 4.0		
Topsoil placed over the affected areas, if needed. Disturbed areas are seeded and mulched to promote revegetation per the BMP handbook from the ASWCC (included as Appendix G of the CMI Work Plan). RSA-013 CMI Work Plan Chapter 4.0		
4.9.2 Equipment Decontamination		
An area is designated within the boundary of the work areas at RSA-013, adjacent to vehicular ingress and egress areas, for equipment decontamination as shown on Figure 4-1 of the CMI work plan. A decontamination pad is constructed consisting of a soil-bermed area covered with multiple layers of plastic sheeting where gross contamination was removed from equipment. The decontamination pad contains a sump area or low area where wash water from pressure washing was pumped into a portable holding tank. Decontamination fluids are sampled for perchlorate and RDX. Decontamination fluids are managed as discussed in Section 4.7 of the CMI work plan. Settled soil within the sump is disposed of with the excavated materials. RSA-013 CMI Work Plan Chapter 4.0		
Nondisposable sampling equipment is decontaminated prior to beginning work at the site and prior to the collection of individual samples to prevent cross contamination and maintain the integrity of the environmental samples collected. All sampling equipment and in situ enhanced bioremediation injection equipment will be decontaminated in accordance with procedures specified in the RSA installation-wide quality assurance program plan (HGL, 2019), which was prepared in accordance with Appendix E of the AEIRG (ADEM, 2017). RSA-013 CMI Work Plan Chapter 4.0		

Location: Redstone Arsenal, Madison County, Alabama

Inspection Type: Field Inspection Checklist
Subject: RSA-013 CMI Work Plan

Descriptor / Requirements	Comments	Results
4.9.3 Temporary Storm Water, Erosion Control, and Sediment Control Removal		
After vegetation is established, temporary erosion and sediment controls are removed and disposed of off site at the RSA construction debris landfill or with the RDW from the excavation. The silt fence will remain in place until after the vegetation is established. RSA-013 CMI Work Plan Chapter 4.0		
4.9.4 Demobilization		
Personnel, equipment, and subcontractors were demobilized from the project site after completion of remedial activities. RSA-013 CMI Work Plan Chapter 4.0		
4.11 Corrective Measure Implementation Reporting		
Upon completion of the approved CMI, a final report will be prepared and submitted to ADEM in accordance with Section VIII.D of the Permit and AEIRG (ADEM, 2017). The CMI report will include the following: a) A description of activities completed b) As-built construction drawings presenting the final limits of soil excavations at each site and the locations of confirmation samples c) Waste manifests indicating the handling of the excavated material that has been shipped off site to a certified disposal facility d) Monitoring data (soil, air, dust, and water) collected for any reason during the construction period for the purposes of monitoring potential for human and ecological exposure e) Certification, prepared in accordance with AAC 335-13-8-02 (2)(d) by RSA and a registered professional engineer (State of Alabama), that the corrective measures required by the Permit are complete f) Appendices consisting of site photographs, analytical reports, data validation documentation, and waste manifests RSA-013 CMI Work Plan Chapter 4.0		

Location: Redstone Arsenal, Madison County, Alabama		
Inspection Type: Field Inspection Checklist **Subject:** RSA-013 CMI Work Plan		
Descriptor / Requirements	**Comments**	**Results**
If completion of the CMI requires more than 180 days, the Army will submit quarterly CMI progress reports in accordance with Section VIII.D.1 of the Permit. RSA-013 CMI Work Plan Chapter 4.0		

Results:
S = Satisfactory
I = Incomplete at the time of audit or surveillance. To be verified at a later date
O = Observation
F = Finding
NA = Not Applicable

Comments:_____

QA Manager:_____ **Date:**_____

Location: Redstone Arsenal, Madison County, Alabama		
Inspection Type: Field Inspection Checklist **Subject:** RSA-013 CMI Work Plan		
Descriptor / Requirements	**Comments**	**Results**

References:

Alabama Department of Environmental Management (ADEM), 2017a, ***Alabama Environmental Investigation and Remediation Guidance, Revision 4.0,*** February.

Alabama Soil and Water Conservation Committee (ASWCC), 2018, ***Alabama Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Areas***, July.

HydroGeoLogic, Inc. (HGL), 2019, ***Final Revision 4 Installation-Wide Quality Assurance Program Plan, U.S. Army Garrison – Redstone, Madison County, Alabama***, December.

U.S. Army Corps of Engineers Huntsville Center (CEHNC), 2019, Final Installation-Wide Accident Prevention Plan, Redstone Arsenal, Madison County, Alabama, prepared for U.S. Army Engineering and Support Center-Huntsville, October.

APPENDIX I

DERIVATION OF CLEANUP GOAL FOR RDX

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I1.0 Introduction

An RSA-013-site-specific cleanup goal (CG) for RDX in soil was developed using Alabama Department of Environmental Management (ADEM) Alabama Risk-Based Corrective Action (ARBCA) guidance for groundwater resource protection per Sections 6.9, 6.11, Appendix D and Appendix E of ADEM's ARBCA guidance (ADEM, 2017). The approach recommended for use in this guidance has been included in a software package developed under contract to ADEM (ADEM, 2010). This software package was developed to be consistent with the ADEM's ARBCA guidance manuals (ADEM, 2008; 2017). This software package combines the allowable concentration of contaminants in leachate from soil, based on the standard soil to the groundwater zone under the source calculations (explained in Shaw Environmental, Inc. [Shaw] [2011]) with the Domenico model for horizontal transport to a point of exposure (POE) as recommended in ADEM guidance (Appendix E of ADEM [2017]).

To apply this model, site-specific parameters for soil and groundwater were integrated with updates to the default exposure factors, physical parameters and toxicity values present within this software package. The following sections provide information on the exposure factors, physical parameters, and toxicity values used to develop a site-specific soil CG for RDX for protection of groundwater.

I2.0 Input Parameters

Input parameters used in the ADEM ARBCA computational software (ADEM, 2010) are discussed in this section.

I2.1 User-Specified Chemicals of Concern and Properties - Physical and Chemical Properties

The U.S. Environmental Protection Agency (EPA) has developed updates to physical and chemical properties as well as to toxicity factors for copper, selenium, and thallium since 2008. These factors are available in EPA regional screening level (RSL) tables. Unless otherwise noted, values shown on Table B-1 were taken from EPA (2019).

I2.2 Exposure Factors

As shown in Table I-2, the ARBCA model default values were used for many exposure factors as a conservative approach. Factors that have been updated based on recent EPA exposure factor guidance have been identified on Table I-2.

I2.3 Fate and Transport Parameters

This section explains the fate and transport parameters using to model the site-specific SSL for RDX for protection of groundwater at RSA-013. These factors and their parameter values are presented in Table I-3. Note that Table I-3 presents all of the parameters and parameter values to be used in ADEM's ARBCA software package to calculate risks or CGs from many pathways included protection of groundwater use, protection of surface water, soil, and groundwater protective of indoor inhalation, and others. Not all values listed in this table are needed to calculate the protection of groundwater use CG for RDX.

Length of groundwater source area parallel to groundwater flow. Width and length of groundwater source are perpendicular to groundwater flow direction. The source of RDX elevated above the screening-level Redstone Arsenal (RSA) dilution-attenuation factor (DAF)$_4$ soil screening level (SSL) is very localized, and was, therefore, considered to be a small source area. The model default value of 1500 centimeters was selected for this parameter.

Depth to subsurface soil sources. The depth used was the average depth of the results that exceed the RDX DAF$_4$ SSL of 0.009 milligrams per kilogram (mg/kg). The following table provides the sample location, depth of the sample, and result for each of these locations.

RDX Results Over DAF$_4$ SSL		
Locations	**Sample Depth (feet bgs)**	**Result (mg/kg)**
P13-SB02	0 – 1	1.3
P13-SB02	2 – 4	0.23 J
013-HP006	0 - 1	0.2 J
013-HP006	2 – 4	0.0921 J
P13-SB05	0 - 1	0.25 J

bgs – Below ground surface.
J – Estimated value.

Based on these results, the average depth of the source area equals 3 feet bgs or 91.44 centimeters. The maximum detected concentration (MDC) of 1.3 mg/kg is located at P13-SB02.

Total soil porosity, volumetric water content, dry soil bulk density, and fractional organic carbon content. The values used are the standard parameters from the RSA DAF SSL development white paper (Shaw, 2011). As recommended in ADEM (2017), the same parameter values were used for the saturated and unsaturated soil zones.

Capillary fringe thickness. As recommended by ADEM (2017), the value of this parameter is based on literature values. A good summary of the thickness of the capillary fringe zone for various soil types can be found in Liu et al. (2014). The value for a clay soil was rounded down to 100 centimeters as a conservative approach.

Protection of Groundwater Use Parameters. As shown in Table I-4, the POE for the MDC sample location for RDX was assumed to be the distance to the nearest off-site well from the source area in the downgradient direction of groundwater flow (monitoring well P13-RS190).

COC	MDC Location	POE Well	Distance from MDC to POE (feet)
RDX	P13-SB02	P13-RS190	397.75

The point of compliance (POC) was considered to be the closest distance from the source area to the site boundary in the downgradient direction. The POC and the distance used as inputs into the model are as follows:

COC	MDC Location	Distance from MDC to POC (feet)
RDX	P13-SB02	139.46

Using these parameters will result in a CG that is protective of groundwater within the core of the existing plume area. The ADEM RSL for RDX is based on the EPA RSL of 0.00097 milligrams per liter. This value is considered to be conservative for two reasons:

1. Potable use of groundwater is currently prohibited in accordance with RSA's site access control program, which implements RSA's installation-wide groundwater interim record of decision (Shaw, 2007).

2. Risks from exposure to groundwater contamination in groundwater unit RSA-151, which is that unit below RSA-013, are unacceptable, and therefore, groundwater use in the future will be prohibited at this site until corrective measures for the groundwater unit have been completed.

I3.0 Results—Protection of Groundwater Use – Without Biodegradation

Table I-5 presents the CG developed for the protection of groundwater use at all locations beyond the plume core associated with RSA-013. This evaluation assumed that no biodegradation is occurring for RDX at this site. The site-specific CG developed for RSA-013 is as follows:

COC	CG (mg/kg)
RDX	4.5E-01

I4.0 Discussion

The site-specific CG at RSA-013 ensures that the groundwater concentration of RDX at the POE does not exceed the EPA tap water RSL/ADEM groundwater RSL. This CG will be used during soil confirmation sampling for RDX in the RSA-013 corrective measures to ensure that soil source material posing a threat to groundwater has been removed.

I5.0 References

Alabama Department of Environmental Management (ADEM), 2017, ***Alabama Risk-Based Corrective Action Guidance Manual,*** Revision 3.0, February.

Alabama Department of Environmental Management (ADEM), 2010, ***ARBCA Computational Software, Version 2.1-R***, December.

Alabama Department of Environmental Management (ADEM), 2008, ***Alabama Risk-Based Corrective Action Guidance Manual, Revision 2.0***, April.

Liu, Q. Yasufuku, N., Miao, J, Ren J., 2014, ***An Approach for Quick Estimation Of Maximum Height Of Capillary Rise***, Japanese Geotechnical Society, Soils and Foundations, December.

Shaw Environmental, Inc. (Shaw), 2011, ***Development of a Facility-Wide Dilution Attenuation Factor and Process for Evaluating Migration from Soil to Groundwater, Redstone Arsenal, Huntsville, Alabama***, U.S. Army Garrison-Redstone, Madison County, Alabama, February.

Shaw Environmental, Inc. (Shaw), 2007, ***Final Interim Record of Decision, Interim Remedial Action for Installation-Wide Groundwater, Redstone Arsenal, Madison County, Alabama***, prepared for U.S. Army Corps of Engineers, Savannah District, September.

U.S. Environmental Protection Agency (EPA), 2019, ***Regional Screening Levels for Chemical Contaminants at Superfund Sites***, May.

TABLES

Table I-1

User-Specified Chemicals of Concern and Properties
RSA-013
Redstone Arsenal, Madison County, Alabama

PHYSICAL AND CHEMICAL PROPERTIES

Chemicals	CAS #	MCL or RSL[1] [mg/L]	Molecular Weight (MW) [g/g-mol]	Water Solubility (S) [mg/L]	Henry's Law Constant (H) [L-water/L-air]	Org. Carbon Adsorption Coeff. (K_{oc}) [cm^3/g]	Soil-Water Partition Coefficient (K_d) [cm^3/g]	Molecular Diffusion Coefficient	
								in air (D^a) [cm^2/s]	in water (D^w) [cm^2/s]
RDX 2020	121-82-4	9.70E-04	2.22E+02	5.98E+01	8.20E-10	8.91E+01	NA	3.10E-02	8.50E-06

TOXICOLOGICAL PROPERTIES

Chemicals	Cancer Group	Slope Factor		Reference Dose		Absorption Factor		Bioconcentration Factor in Fish (BCF) [L/kg]
		Oral (SF_o) [kg-day/mg]	Inh. (SF_i) [kg-day/mg]	Oral (RfD_o) [mg/kg-day]	Inh. (RfD_i) [mg/kg-day]	Dermal (RAF_d) [--]	Oral (RAF_o) [--]	
RDX 2020		8.00E-02	NA	4.00E-03	NA	0.01	1	NA

NA: Not Available

1 An MCL has not been established for RDX. The source of the value of 9.70E-04 is the regional screening level tables in EPA (2019).

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Table I-2

Exposure Factors
RSA-013
Redstone Arsenal, Madison County, Alabama

Parameter	Symbol	Unit	Default Value	Value Used	Comment
Averaging Time for Carcinogen	AT_c	year	70	70	Default Value
Averaging Time for Non-Carcinogen	AT_n	year	=ED	=ED	Default Value
Body Weight:					
Resident Child	BW	kg	15	15	Default Value
Resident Adult	BW	kg	70	80	Site-Specific Value
Trespasser	BW	kg	45	45	Default Value
Commercial Worker	BW	kg	70	80	Site-Specific Value
Construction Worker	BW	kg	70	80	Site-Specific Value
Exposure Duration:					
Resident Child	ED	year	6	6	Default Value
Resident Adult	ED	year	30	26	Site-Specific Value
Trespasser	ED	year	10	10	Default Value
Commercial Worker	ED	year	25	25	Default Value
Construction Worker	ED	year	1	1	Default Value
Exposure Frequency:					
Resident Child	EF	day/year	350	350	Default Value
Resident Adult	EF	day/year	350	350	Default Value
Trespasser	EF	day/year	350	52	Site-Specific Value
Commercial Worker	EF	day/year	250	225	Site-Specific Value
Construction Worker	EF	day/year	250	250	Default Value
Soil Ingestion Rate:					
Resident Child	IRS	mg/day	200	200	Default Value
Resident Adult	IRS	mg/day	100	100	Default Value
Trespasser	IRS	mg/day	100	100	Default Value
Commercial Worker	IRS	mg/day	75	100	Site-Specific Value
Construction Worker	IRS	mg/day	177	177	Default Value
Water Ingestion Rate:					
Resident Child	IRW	L/day	1	1	Site-Specific Value
Resident Adult	IRW	L/day	2	3	Site-Specific Value
Hourly Indoor Inhalation Rate:					
Resident Child	IR_{ai}	m^3/hr	0.5	0.500	Default Value
Resident Adult	IR_{ai}	m^3/hr	0.833	0.833	Default Value
Trespasser	IR_{ai}	m^3/hr	1.5	1.500	Default Value
Commercial Worker	IR_{ai}	m^3/hr	1.5	1.500	Default Value
Construction Worker	IR_{ai}	m^3/hr	1.5	1.500	Default Value
Exposure Time for Indoor Inhalation:					
Resident Child	ET_{in}	hr/day	24	24	Default Value
Resident Adult	ET_{in}	hr/day	24	24	Default Value
Trespasser	ET_{in}	hr/day	24	24	Default Value
Commercial Worker	ET_{in}	hr/day	10	8	Site-Specific Value
Construction Worker	ET_{in}	hr/day	10	10	Default Value
Daily Indoor Inhalation Rate:					
Resident Child	IR_{ai_d}	m^3/day	12.0	12.0	Calculated
Resident Adult	IR_{ai_d}	m^3/day	20.0	20.0	Calculated
Trespasser	IR_{ai_d}	m^3/day	36.0	36.0	Calculated
Commercial Worker	IR_{ai_d}	m^3/day	15.0	12.0	Calculated
Construction Worker	IR_{ai_d}	m^3/day	15.0	15.0	Calculated

Table I-2

Exposure Factors
RSA-013
Redstone Arsenal, Madison County, Alabama

Parameter	Symbol	Unit	Default Value	Value Used	Comment
Hourly Outdoor Inhalation Rate:					
Resident Child	IR_{ao}	m^3/hr	0.5	0.625	Site-Specific Value
Resident Adult	IR_{ao}	m^3/hr	0.833	0.833	Default Value
Trespasser	IR_{ao}	m^3/hr	1.5	1.900	Site-Specific Value
Commercial Worker	IR_{ao}	m^3/hr	1.5	2.500	Site-Specific Value
Construction Worker	IR_{ao}	m^3/hr	1.5	2.500	Site-Specific Value
Exposure Time for Outdoor Inhalation:					
Resident Child	ET_{out}	hr/day	10	10	Default Value
Resident Adult	ET_{out}	hr/day	10	10	Default Value
Trespasser	ET_{out}	hr/day	10	6	Site-Specific Value
Commercial Worker	ET_{out}	hr/day	10	8	Site-Specific Value
Construction Worker	ET_{out}	hr/day	10	8	Site-Specific Value
Daily Outdoor Inhalation Rate:					
Resident Child	IR_{ao_d}	m^3/day	5.0	6.3	Calculated
Resident Adult	IR_{ao_d}	m^3/day	8.3	8.3	Calculated
Trespasser	IR_{ao_d}	m^3/day	15.0	11.4	Calculated
Commercial Worker	IR_{ao_d}	m^3/day	15.0	20.0	Calculated
Construction Worker	IR_{ao_d}	m^3/day	15.0	20.0	Calculated
Soil to Skin Adherence Factor:					
Resident Child	M	mg/cm^2	0.2	0.2	Default Value
Resident Adult	M	mg/cm^2	0.07	0.07	Default Value
Trespasser	M	mg/cm^2	0.2	0.04	Site-Specific Value
Commercial Worker	M	mg/cm^3	0.2	0.1	Site-Specific Value
Construction Worker	M	mg/cm^2	0.2	0.1	Site-Specific Value
Skin Surface Area for Dermal Contact:					
Resident Child	SA	cm^2/day	2800	2373	Site-Specific Value
Resident Adult	SA	cm^2/day	5700	6032	Site-Specific Value
Trespasser	SA	cm^2/day	5700	3700	Site-Specific Value
Commercial Worker	SA	cm^2/day	5700	3527	Site-Specific Value
Construction Worker	SA	cm^2/day	5700	3527	Site-Specific Value

The values in red are calculated.

The values in green are model default values.

cm^2 - Square centimeter.

cm^3 - Cubic centimeter.

hr - Hour.

m^3 - Cubic meter.

mg - Milligram.

Table I-3

Fate and Transport Parameters
RSA-013
Redstone Arsenal, Madison Countym Alabama

Parameter	Symbol	Unit	Default Value	Value Used	Comment
SOIL PARAMETERS:					
Length of soil source area parallel to wind direction	W_a	cm	**	1500	Model default for small source area. See ** footnote.
Depth to subsurface soil sources	L_s	cm	30.48	91.44	Average depth of source area = 3 feet bgs
Lower depth of surficial soil zone	d	cm	30.48	30.48	ARBCA model Default Value
Depth to soil vapor measurement	d_{sv}	cm	30.48	30.48	ARBCA model Default Value
VADOSE ZONE:					
Total soil porosity	q_T	cm^3/cm^3-soil	0.30	0.41	Site-Specific Value
Volumetric water content	q_{ws}	cm^3/cm^3	0.10	0.08	Site-Specific Value
Volumetric air content	q_{as}	cm^3/cm^3	0.20	0.33	Calculated
Thickness	h_v	cm	295	231.67	Calculated
Dry soil bulk density	r_s	g/cm^3	1.8	1.59	Site-Specific Value
Fractional organic carbon content	f_{oc}	g-C/g-soil	0.002	0.035	Site-Specific Value
FOUNDATION/WALL CRACKS:					
Total soil porosity	q_{Tcrack}	cm^3/cm^3-soil	0.30	0.41	Site-Specific Value
Volumetric water content	q_{wcrack}	cm^3/cm^3	0.10	0.08	Site-Specific Value
Volumetric air content	q_{acrack}	cm^3/cm^3	0.20	0.33	Calculated
CAPILLARY FRINGE:					
Total soil porosity	q_{Tcap}	cm^3/cm^3-soil	0.30	0.41	Site-Specific Value
Volumetric water content	q_{wcap}	cm^3/cm^3	0.27	0.37	Calculated
Volumetric air content	q_{acap}	cm^3/cm^3	0.03	0.04	Calculated
Thickness	h_{cap}	cm	5	100	ARBCA (2017), Liu, et al. (2014)
GROUNDWATER PARAMETERS:					
Depth to groundwater	L_{gw}	cm	300	236.6772	Site-Specific Value
Width of GW source perpendicular to GW flow direct	Y	cm	**	1500	Model default for small source area. See ** footnote.
Length of GW source parallel to GW flow direction	W	cm	**	1500	Model default for small source area. See ** footnote.
Total soil porosity in the saturated zone	q_{TS}	cm^3/cm^3	0.30	0.41	Shaw (2011)
Dry soil bulk density in the saturated zone	r_{ss}	g/cm^3	1.8	1.59	Shaw (2011)
Fractional organic carbon content in the saturated zo	f_{ocs}	g-C/g-soil	0.002	0.035	Shaw (2011)
Groundwater mixing zone thickness	d_{gw}	cm	200	710	Shaw (2011)
Hydraulic conductivity in the saturated zone	K	cm/year	31536	18200	Shaw (2011)
Hydraulic gradient in the saturated zone	i	cm/cm	0.005	0.02	Shaw (2011)
Groundwater darcy velocity	U_{gw}	cm/year	364	364.00	Calculated
Infiltration rate	I	cm/year	14.8	19	Shaw (2011)

Table I-3

Fate and Transport Parameters
RSA-013
Redstone Arsenal, Madison Countym Alabama

Parameter	Symbol	Unit	Default Value	Value Used	Comment
AMBIENT AIR PARAMETERS:					
Breathing zone height	d_a	cm	200	200	Default Value
Wind speed within the breathing zone	Ua	cm/s	225	225	Default Value
ENCLOSED SPACE PARAMETERS:					
Enclosed Space Air Exchange Rate:					
Residential	ER	1/sec	0.00014	0.00014	ARBCA model Default Value
Trespasser	ER	1/sec	0.00014	0.00014	ARBCA model Default Value
Commercial/construction worker	ER	1/sec	0.00023	0.00023	ARBCA model Default Value
Enclosed Space Volume/Infiltration Area Ratio:					
Residential	L_B	cm	200	200	ARBCA model Default Value
Trespasser	L_B	cm	200	200	ARBCA model Default Value
Commercial/construction worker	L_B	cm	300	300	ARBCA model Default Value
Enclosed Space Foundation or Wall Thickness:					
Residential	L_{crack}	cm	15	15	ARBCA model Default Value
Trespasser	L_{crack}	cm	15	15	ARBCA model Default Value
Commercial/construction worker	L_{crack}	cm	15	15	ARBCA model Default Value
Area Fraction of Cracks in Foundation/Walls:					
Residential	h	cm^2/cm^2	0.01	0.01	ARBCA model Default Value
Trespasser	h	cm^2/cm^2	0.01	0.01	ARBCA model Default Value
Commercial/construction worker	h	cm^2/cm^2	0.01	0.01	ARBCA model Default Value
PARTICULATE EMISSION RATE:					
Residential and commercial	P_e	g/cm^2sec	6.9E-14	6.90E-14	ARBCA model Default Value
Trespasser	P_e	g/cm^2sec	6.9E-09	6.90E-09	ARBCA model Default Value
Construction worker	P_e	g/cm^2sec	6.9E-09	6.90E-09	ARBCA model Default Value
AVERAGING TIME FOR VAPOR FLUX:					
Resident child	t	sec	1.89E+08	1.89E+08	Calculated
Resident adult	t	sec	9.46E+08	9.46E+08	Calculated
Trespasser	t	sec	3.15E+08	3.15E+08	Calculated
Commercial worker	t	sec	7.88E+08	7.88E+08	Calculated
Construction worker	t	sec	3.15E+07	3.15E+07	Calculated

****:** The source area (assumed to be square) should be classified as either (i) small (270 yd^2) = (1500 cm X 1500 cm), (ii) medium (1/2 acre) = (4,498 cm X 4,498 cm), or (iii) large (1 acre) = (6,362 cm X 6,362 cm).

The values in green are model default values.

The values in red are calculated values.

Table I-4

Protection of Groundwater Use - RDX
RSA-013
Redstone Arsenal, Madison County, Alabama

Parameter	Symbol	Unit	Default Value	Value Used	Comment
Distance from the Downgradient Edge of the Groundwater Source to the Point of Exposure	X_{poe}	ft	variable	397.75	Site-specific- Distance to the nearest offsite well from the source area in the downgradient direction
Longitudinal Dispersivity	a_x	ft	variable	39.775	Calculated
Transverse Dispersivity	a_y	ft	variable	13.258	Calculated
Vertical Dispersivity	a_z	ft	variable	1.989	Calculated
Distance from the Downgradient Edge of the Groundwater Source to the Point of Compliance	X_{poc}	ft	variable	139.46	Site-specific- Closest distance from the source area to the site boundary in the downgradient direction
Longitudinal Dispersivity	a_x	ft	variable	13.946	Calculated
Transverse Dispersivity	a_y	ft	variable	4.649	Calculated
Vertical Dispersivity	a_z	ft	variable	0.697	Calculated

Enter additional chemical-specific values on the "Chemical-Specific Inputs for Other Exposure Pathways" table.

The values in red are calculated.

ft - Feet.

Table I-5

Protection of Groundwater Use - Without Biodegradation
RSA-013
Redstone Arsenal, Madison County, Alabama

CHEMICALS OF CONCERN	DILUTION ATTENTUATION FACTORS			ALLOWABLE CONCENTRATION AT				
	Unsaturated Zone [--]	Point of Compliance (Sentry Well) [--]	Point of Exposure [--]	Soil Source [mg/kg]	Groundwater Source [mg/L]	Point of Compliance (Sentry Well) [mg/L]	Point of Exposure [mg/L]	
RDX 2020	1.00E+00	2.19E+00	1.20E+01	4.5E-01	1.16E-02	5.31E-03	9.70E-04	R

Notes:
R - EPA tap water regional screening value (May 2019).
mg/L - Milligrams per liter.

APPENDIX J

UNDERGROUND INJECTION CONTROL PERMIT APPLICATION

Class V Underground Injection Control Permit Application for Enhanced Biodegradation of Perchlorate in Groundwater RSA-013, Unlined Inactive Open Burn Pad Operable Unit 14 U.S. Army Garrison-Redstone Madison County, Alabama

Prepared for:

U.S. Army Engineering and Support Center
Huntsville Engineering and Support Center
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5021 Bradford Drive East
Huntsville, Alabama 35805

Prepared by:
Aptim Federal Services, LLC
11400 Parkside Drive, Suite 400
Knoxville, TN 37934

Contract No. W912DY-17-D-0003
APTIM Project Number 501388
Delivery Order W912DY19F1116

November 2021

Class V Underground Injection Control Permit Application for Enhanced Biodegradation of Perchlorate in Groundwater RSA-013, Unlined Inactive Open Burn Pad Operable Unit 14 U.S. Army Garrison-Redstone Madison County, Alabama

Certification

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

_____ _____

Maura Maloney, Alabama PG No. 1262 Date

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List of Figures

Attachments

J1.0 General Information for Class V Underground Injection Control Permit

A. Facility

Applicant: U.S. Army Garrison-Redstone, Environmental Management Division
Owner: U.S. Army Garrison-Redstone
Address: 4488 Martin Road, Redstone Arsenal, Alabama 35898-5000
Phone: 256-842-3702
Responsible Official: Clint Howard
Contact Person: Robert Gorman
Phone: 256-876-3814

B. Facility Name

Facility Name: RSA-013, Unlined Inactive Open Burn Pad, Redstone Arsenal, Alabama

Address: U.S. Army Garrison-Redstone

Location: RSA-013 is located in the southern portion of RSA, within the fenced boundary of the active open burn (OB)/open detonation (OD) area (Figure 1). RSA-013 originally comprised a 4.3-acre area but was expanded to 5 acres in 2009 to include two noncontiguous sites: RSA-132, Dismantled Popping Furnace (0.5 acre), and RSA-133, Inactive Rocket Washrack/Sump (0.2 acre) (Figure 2). Surface media at RSA-132 and RSA-133 (i.e., soil) received Alabama Department of Environmental Management (ADEM) approval for no further action on May 25, 2017. Figure 3 presents a site map of RSA-013.

Injection Well Description: Not applicable. Contaminated soil will be excavated, and emulsified vegetable oil (EVO) will be placed directly in the floor of the RSA-013 excavation to promote biodegradation of perchlorate to enhance remediation of the smear zone and saturated zone soils.

C. Location

Injection Location: See Figure 4, *Proposed Excavation Area*.

Public and Private Water Supply Wells: None within 0.5-mile radius.

Source Area Assessment Areas: None.

Wellhead Protection Areas: None.

Surface Waters and Pertinent Surface Features: Surface runoff within the RSA-013 site boundary is conveyed to a series of man-made drainage ditches, which in turn direct the water off site as shown on Figure 3. The entire site lies within the 100-year floodplain, generally defined as the 565-foot elevation contour. Wetlands are located to the north and west of the site. An embayment of the Tennessee River is located approximately 200 feet north of the site, and the Tennessee River is located approximately 800 feet west of RSA-013.

Topography: The topography in the vicinity of RSA-013 is relatively flat with the exception of two earthen berms located directly to the west of the former burn pads (Figure-3). The RSA-013 berms and former burn pads are overgrown with vegetation; the remainder of the site is primarily maintained grass.

D. Test Description

The Army proposes to initiate bioremediation of contaminants in the smear zone and saturated soils beneath RSA-013 by adding a carbon source (EVO) at the bottom of the excavated area before backfilling. Upon achieving maximum vertical extent of excavation based on depth of 8 feet below ground surface (bgs) or encountering of groundwater and prior to placing backfill, approximately 10,750 pounds of EVO will be mixed in the bottom of the excavation as sections of the excavation are completed to enhance remediation of the smear zone and saturated zone soils. If there is water in the excavation, the undiluted EVO will be added to the excavation section and mixed into the smear zone using the excavator bucket. If water is not present in the excavation, the EVO will be diluted to get greater distribution. The EVO solution will be metabolized to create reducing conditions and promote contaminant degradation at or near the groundwater/soil interface.

E. Design

Soil requiring excavation at RSA-013 is primarily limited to the presence of perchlorate. However, excavation of a small area containing RDX-contaminated soil located within the larger perchlorate-contaminated area will be performed. The proposed excavation areas are shown on Figure 4.

The total excavation are will cover approximately 81,675 square feet. The depth of the excavation for the excavation areas was selected as 8 feet (the average depth to groundwater). If groundwater is encountered at a depth shallower than the average depth to groundwater, the excavation will go no deeper than the depth groundwater is encountered. Water level measurements collected from wells closest to the excavation area in the months prior to implementation of the corrective measures will be used to calculate a representative average depth to water to be used as the excavation target depth.

An estimated 24,200 bank cubic yards of soil will be removed for transport and disposal. An estimated 31,460 loose cubic yards of soil may be required for backfilling the excavation to account for shrinkage/swelling of the soil during compaction.

EVO Solution

Approximately 10,750 pounds of EVO will be added to the bottom of the excavation (approximately 0.13 pounds per square foot). A summary of the dosage calculations is attached (Attachment 1). The Safety Data Sheet for EVO is included in Attachment 2.

Injection Location

EVO will be placed in the bottom of the RSA-013 excavation. The location of the excavation is depicted on Figure 4.

Performance Monitoring

Performance monitoring will not be conducted for the RSA-013 corrective measures because RSA-013 is a surface media site and is not required. However, groundwater beneath the OB/OD Area, which includes RSA-013, is sampled on an annual basis in accordance with RSA's Hazardous Waste Facility Permit for Hazardous Waste Storage Units/Thermal Treatment Units/Solid Waste Management Unit Corrective Action (Permit No. AL7 210 020 742), last modified July 19, 2021. Eight Permit-required monitoring wells are sampled for the Resource Conservation and Recovery Act Appendix IX parameters per Part VII.D of the Permit. The parameters include perchlorate, target analyte list metals and tin, total cyanide, sulfide, dioxins/furans, Appendix IX herbicides, Appendix IX pesticides and polychlorinated biphenyls, nitroaromatic compounds, target compound list semivolatile organic compounds, Appendix IX polynuclear aromatic hydrocarbons, and Appendix IX and target compound list volatile organic compounds based on Tables VII.2 and VII.3 of the Permit, and analytes listed in Alabama Administrative Code 335-14-5.

F. Hydrological Data

Groundwater is encountered at relatively shallow depths at RSA-013, ranging from 1.69 to 10.89 feet bgs (CMI work plan Table 1). Figure 5 depicts the potentiometric surface, based upon measurements collected in February 2016. The primary direction of groundwater flow is to the north-northwest, towards the embayment to the Tennessee River.

Form 531 is included in Attachment 3. Boring logs for piezometers, soil borings, and existing wells at RSA-013 are provided in Attachment 4.

G. Financial Responsibility

The federal government is the owner/operator of this facility.

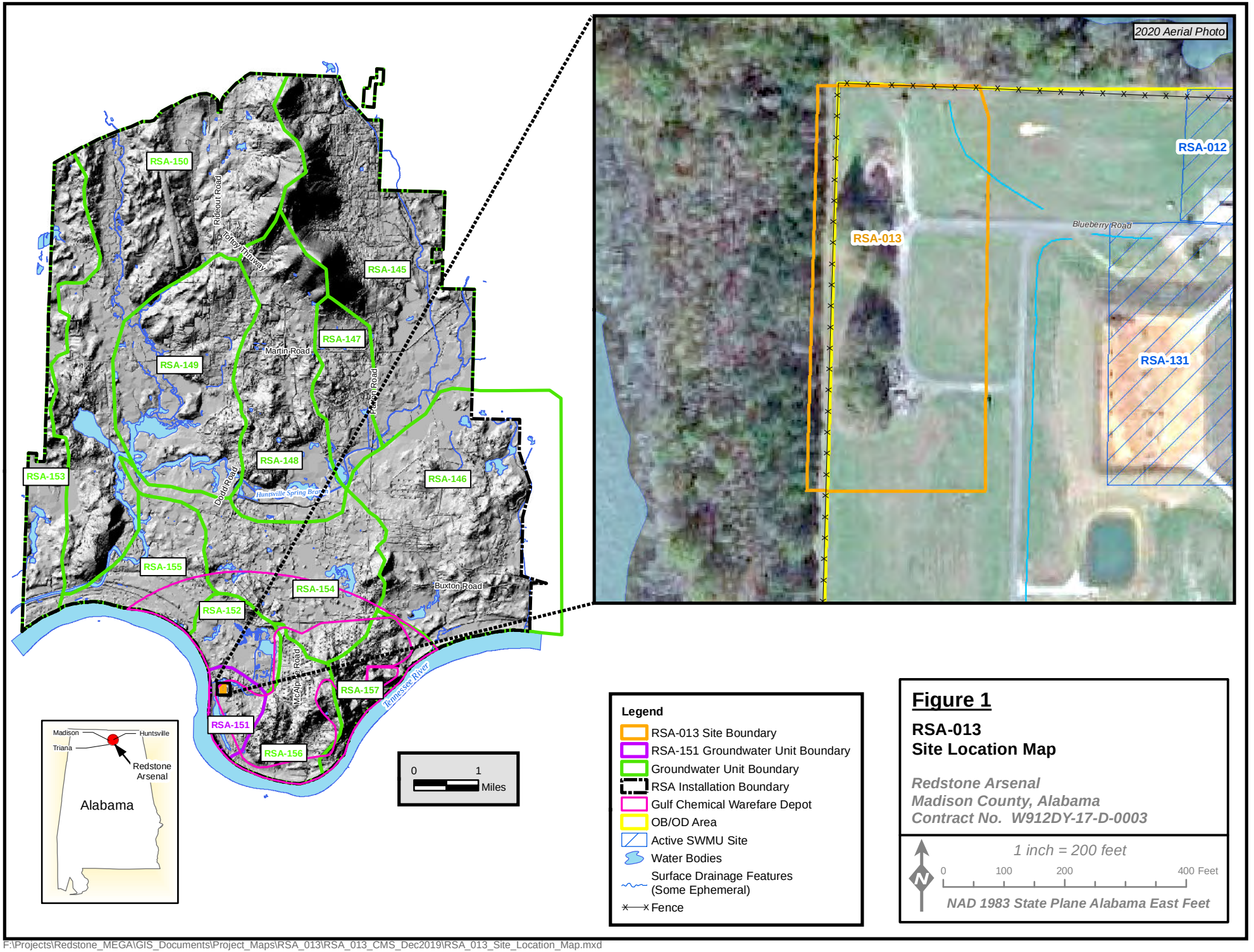
H. Certification

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this application and all attachments and that, based on my inquiry of those persons immediately responsible for obtaining the information contained in the application, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

Signed,

Clint Howard
Acting Chief, Environmental Management Division

FIGURES



F:\Projects\Redstone_MEGA\GIS_Documents\Project_Maps\RSA_013\RSA_013_CMS_Dec2019\RSA_013_Site_Location_Map.mxd

2018 & 2020 Aerial Photo

RSA-066
RSA-068
RSA-152
RSA-069
RSA-151
RSA-065
RSA-012
RSA-013
RSA-131
RSA-014
North
RSA-133
OB/OD
Area
RSA-132
RSA-014
South
RSA-110
OU-14
RSA-156
Tennessee River

Legend

- RSA-013 Site Boundary
- Environmental Site Boundary
- Active SWMU Site
- RSA-151 Groundwater Unit Boundary
- RSA-152 & RSA-156 Groundwater Unit Boundary
- OB/OD Area
- RSA Installation Boundary
- Surface Drainage Features (Some Ephemeral)
- Water Bodies
- 100-yr Flood Zone
- Wetland Area
- Fence

Figure 2

RSA-013
Nearby Sites

Redstone Arsenal
Madison County, Alabama
Contract No. W912DY-17-D-0003

1 inch = 600 feet

0 300 600 1,200 Feet

NAD 1983 State Plane Alabama East Feet

Document Path: F:\Projects\Redstone_MEGA\GIS_Documents\Project_Maps\RSA_013\RSA_013_CMS_Dec2019\RSA_013_Nearby_Sites.mxd

2018 Aerial Photo

Former Burn Pad

Blueberry Road

Berms

Former Burn Pad

Legend

- RSA-013 Site Boundary
- 10' Topographic Contour, 2013 (Above Mean Sea Level)
- 2' Topographic Contour, 2013 (Above Mean Sea Level)
- Surface Water Drainage (some ephemeral)

Figure 3

RSA-013
Site Map

Redstone Arsenal
Madison County, Alabama
Contract No. W912DY-17-D-0003

1 inch = 60 feet

0 30 60 120 Feet

NAD 1983 State Plane Alabama East Feet

Document Path: F:\Projects\Redstone_MEGA\GIS_Documents\Project_Maps\RSA_013\RSA_013_CMS_Dec2019\RSA_013_Site_Map.mxd

2020 Aerial Photo

Excavation Corner	Easting	Northing
1	404560.87	1482494.01
2	404672.02	1482352.55
3	404745.77	1482336.75
4	404749.05	1482291.74
5	404647.73	1482240.69
6	404649.04	1482199.89
7	404743.97	1482152.16
8	404736.16	1482109.32
9	404551.40	1482099.81
10	404476.92	1482193.01
11	404450.33	1482277.54
12	404461.22	1482420.40
13	404540.66	1482474.94
14	404560.47	1482474.94
15	404560.94	1482453.00
16	404540.57	1482453.27

013-SB001
013-HP009
013-SB002
013-HP001
013-HP005
013-HP010
1
13
14
P13-SB02
16
15
013-SB004
013-HP006
Blueberry Road
12
013-HP011
013-SB006
013-SB005
013-SB010
013-HP018
RSA-013
2
013-HP019
3
013-HP007
013-SB009
013-SB011
013-SB008
013-SB007
4
11
013-HP003
013-HP020
5
013-HP021
013-HP012
P13-RS110
RSA-
6
10
P13-RS476
7
013-HP017
013-HP022
013-HP008
013-HP013
013-SB012
013-HP004
8
013-HP023
9
013-HP016
013-HP015
013-HP014
013-SB013
013-HP024
013-HP025

Legend

- Excavation Corner
- Well to be abandoned/replaced
- Hydropunch Location
- Soil Boring Location
- Area to be Excavated
- Environmental Site Boundaries
- RSA-013 Site Boundary
- Area for Confirmation Sampling for RDX only
- Surface Water Drainage (some ephemeral)

Notes:

1. Excavation will be completed to approximately 8 feet bgs (average depth to groundwater) or saturated zone if the groundwater table is encountered.
2. Excavated soil not suitable for backfill will be transported to Subtitle D landfill for disposal as nonhazardous waste.
3. Two monitoring wells (P13-RS110 and P13-RS476) located within or close to the excavation area are expected to be abandoned and replaced, if necessary.
4. The proposed excavation limits may be revised based upon results of confirmation soil sampling.

bgs - Below ground surface
CG - Cleanup goal

Green symbol - Perchlorate and RDX were either not detected or below CG
Red symbol - Perchlorate and/or RDX exceeded the respective CG of 1.7 and 0.45 milligrams per kilogram (mg/kg)

Figure 4

RSA-013
Proposed Excavation Area

Redstone Arsenal
Madison County, Alabama
Contract No. W91ZLK-17-D-0003

1 inch = 60 feet

N

0 30 60 120 Feet

NAD 1983 State Plane Alabama East Feet

Document Path: F:\Projects\Redstone_MEGA\GIS_Documents\Project_Maps\RSA_013\CMIP_July2021\RSA_013_Proposed_Excav_Area.mxd

2020 Aerial Photo

P12-RS237
559.51

P13-RS558
560.02

P12-RS241
559.60

P13-RS475
560.10

560

P13-RS109
559.57

P13-RS188
559.58

P13-RS238
NM

Blueberry Road

560

P13-RS190
559.46

P13-RS189
559.52

P13-RS239
NM

P13-RS110
559.77

561

P13-RS476
NM

562

563

560

P13-RS477
NM

564

561

P131-RS212
559.51

P131-RS211
559.47

562

Legend

NM = Not Measured

- Overburden Well
- Interface Well
- Bedrock Well
- Deep Bedrock Well
- RSA-013 Site Boundary
- Potentiometric Groundwater Contour (feet above mean sea level)
- Surface Water Drainage (some ephemeral)

Figure 5

RSA-013
Poteniometric Surface Map, February 2016

Redstone Arsenal
Madison County, Alabama
Contract No. W912DY-17-D-0003

1 inch = 100 feet

N

0 50 100 200 Feet

NAD 1983 State Plane Alabama East Feet

Document Path: F:\Projects\Redstone_MEGA\GIS_Documents\Project_Maps\RSA_013\CMIP_July2021\RSA_013_Potentiometric_Feb2016.mxd

ATTACHMENT 1

CALCULATIONS

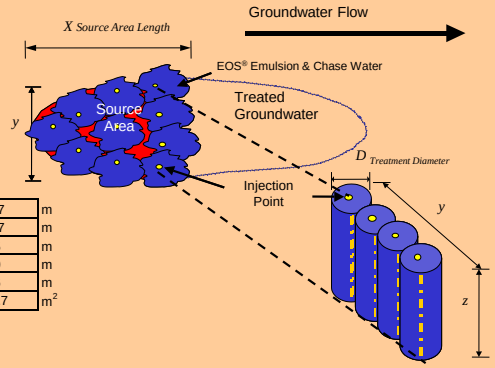
EOS Remediation, LLC

EOS® SOURCE AREA & DNAPL DESIGN WORKSHEET

U.S. Version 2.1f, Rev. Date: June 18, 2008
www.EOSRemediation.com

Help

Site Name:	RSA 013	perchlorate
Location:	Redstone Arsenal	
Project No.:		



Step 1: Select a Substrate from the EOS® Family of Bioremediation Products

Substrate Selected (pick from drop down list): EOS® 598
For Product Literature Click Here

Step 2: EOS® Consumption During Contaminant Biodegradation / Biotransformation

Section A: Source Area Dimensions

Length of treatment area parallel to groundwater flow, "x"	268	ft	81.7	m
Width of treatment area perpendicular to groundwater flow, "y"	268	ft	81.7	m
Minimum depth to contamination	5	ft	1.5	m
Maximum depth of contamination	10	ft	3.0	m
Treatment thickness, "z"	5	ft	1.6	m
Treatment zone cross-sectional area, A = y * z	1,386	ft^2	128.7	m^2

Section B: Groundwater Flow Rate / Site Data

Soil Characteristics

Nominal Soil Type (pick from drop down list)	Silty Sand			
Total Porosity (accept default or enter n)	0.30	(decimal)		
Effective Porosity (accept default or enter n_e)	0.28	(decimal)		
Soil bulk density; (1-n)*2.65 g/cc (accept calculated or enter dry bulk density)	1.86	g/cc	116	lbs / ft^3
Fraction of organic carbon: foc	0.0050	range: 0.0001 to 0.01		

Hydraulic Characteristics

Hydraulic Conductivity (accept default or enter K)	1	ft/day	3.5E-04	cm/sec
Hydraulic Gradient (accept default or enter i)	0.0006	ft/ft		

Note: Since the hydraulic gradient ($i = dh/dx$) is negative, we ask you to enter $-i$ in the EOS® Design Tool so that you can enter a positive number for convenience.

Non-reactive Transport Velocity, $V_x = -(K \times i) / n_e$	LESS THAN 0.01	ft/day	LESS THAN	0.003	m/day
Groundwater flow rate through treatment zone, $Q = -KiA$	6.22	gallons/day	LESS THAN	109.86	L/day

Section C: Calculated Contact Length

Contact time (τ) between oil and contaminants (accept default or enter τ)		60	typical values 60 to 180 days, see comment	
Calculated Contact Length (X) = $\tau * V_x$	Suggested Minimum	5.0	ft	1.5 m

Treatment zone volume	371,330	ft^3	10,515	m^3
Treatment zone groundwater volume (volume * porosity)	833,265	gallons	3,154,469	L

Section D: Design Lifespan For One Application

	3	year(s)	typical values 5 to 10 years	
Estimated total groundwater volume treated over design life	840,074	gallons	3,274,763	L

Section E: Electron Acceptors

Dissolved Phase Electron Donor Demand

Inputs	Typical Value	GW Conc. (mg/L)	MW (g/mole)	e^- equiv./ mole	Stoichiometry *Contaminant/* H_2 *(wt/wt* H_2*)*	Hydrogen Demand ($g\ H_2$)
Dissolved Oxygen (DO)	0 to 8	5.19	32.0	4	7.94	2141.366127
Nitrate Nitrogen (NO_3^- - N)	1 to 10		62.0	5	12.30	
Sulfate (SO_4^{2-})	10 to 500	21	96.1	8	11.91	5772.644614
Tetrachloroethene (PCE), C_2Cl_4		0.005	165.8	8	20.57	0.796129444
Trichloroethene (TCE), C_2HCl_3		0.121	131.4	6	21.73	18.23791618
cis-1,2-dichloroethene (c-DCE), $C_2H_2Cl_2$		0.002	96.9	4	24.05	0.272374985
Vinyl Chloride (VC), C_2H_3Cl		0.002	62.5	2	31.00	0.211244922
Carbon tetrachloride, CCl_4			153.8	8	19.08	
Chloroform, $CHCl_3$			119.4	6	19.74	
sym-tetrachloroethane, $C_2H_2Cl_4$			167.8	8	20.82	
1,1,1-Trichloroethane (TCA), CH_3CCl_3			133.4	6	22.06	
1,1-Dichloroethane (DCA), CH_2CHCl_2			99.0	4	24.55	
Chloroethane, C_2H_5Cl			64.9	2	32.18	
Perchlorate, ClO_4^-		22.4	99.4	8	12.33	5948.701885
Hexavalent Chromium, Cr[VI]			52.0	3	17.20	
User added						
User added						
User added						

Sorbed Phase Electron Donor Demand

The concentration of the sorbed contaminant can be estimated by: $C_{SOIL} = K_{OC} \times f_{oc} \times C_{WATER}$

Where: K_{oc} is partition coefficient with respect to organic carbon.
f_{oc} (fraction organic carbon) is the mass of organic matter in soil divided by the total mass of soil
C_{WATER} is the concentration of the contaminant in the groundwater

Default values for Koc taken from: US EPA, Superfund Section, APPENDIX K, Soil Organic Carbon (Koc) / Water (Kow) Partition Coefficients (Average Value Used)

Inputs Adjust *Koc* as necessary to provide site specific estimates or enter sediment concentration (C_{SOIL})	K_{oc} (L/kg)	C_{SOIL} (mg/Kg)	Mass (g)	Hydrogen Demand ($g\ H_2$)
Tetrachloroethene (PCE), C_2Cl_4	272	0.01	132.64	6.45
Trichloroethene (TCE), C_2HCl_3	97	0.06	1144.66	52.68
cis-1,2-dichloroethene (c-DCE), $C_2H_2Cl_2$	38	0.00	7.41	0.31
Vinyl Chloride (VC), C_2H_3Cl	241	0.00	47.01	1.52
Carbon tetrachloride, CCl_4	158			
Chloroform, $CHCl_3$	53			
sym-tetrachloroethane, $C_2H_2Cl_4$	79			
1,1,1-Trichloroethane (TCA), CH_3CCl_3	139			
1,1-Dichloroethane (DCA), CH_2CHCl_2	54			
User added				
User added				
User added				

Section F: Additional Hydrogen Demand and Carbon Losses

Generation (Potential Amount Formed)	Typical Value	GW Conc. (mg/L)	MW (g/mole)	e^- equiv./ mole	Stoichiometry *Contaminant* / H_2	Hydrogen Demand ($g\ H_2$)	DOC Released *(moles)*
Estimated Amount of $Fe2^+$ Formed	10 to 100	50	55.8	1	55.41	2955.173478	
Estimated Amount of Manganese (Mn^{2+}) Formed		5	54.9	2	27.25	600.7923946	
Estimated Amount of CH_4 Formed	5 to 20	10	16.0	8	1.99	16459.34329	
Target Amount of DOC to Release	60 to 100	100	12.0				27264.70

Design Safety Factor: 2.0 typical values 1 to 3

Calculations assume:

1.) all reactions go to completion during passage through emulsified edible oil treated zone; and,
2.) perfect reaction stoichiometry.

EOS® Requirement Calculations Based on Hydrogen Demand and Carbon Losses

Stoichiometric Hydrogen Demand	149.6	pounds
DOC Released	3,113.2	pounds

EOS® Requirement Based on Hydrogen Demand and Carbon Loss

3,795 lbs

Step 3: EOS® Requirement Based on Attachment by Aquifer Material

Soil Characteristics

Effective treatment thickness, "z_e" (typically less than 40%) 0.25

For Additional Information on Effective Thickness, Click Here

Weight of sediment to be treated 10,750,365 lbs

Adsorptive Capacity of Soil (accept default or enter site specific value) 0.0010 lbs EOS® / lbs sediment

EOS® Attachment by Aquifer Material[1]

- Fine sand with some clay 0.001 to 0.002 lbs EOS®* / lbs soil
- Sand with higher silt/clay content 0.002 to 0.004 lbs EOS® / lbs soil

[1]Default values provided based on laboratory studies completed by NCSU

For Additional Data, Click Here

EOS® Requirement Based on Oil Entrapment by Aquifer Material

10,750 lbs

Summary – How much EOS® do you need?

Suggested Quantity of EOS® for Your Project 26 drums

ATTACHMENT 2

SAFETY DATA SHEETS

EMULSIFIED VEGETABLE OIL SAFETY DATA SHEET

MATERIAL SAFETY DATA SHEET

LACTOIL®
SOY MICROEMULSION

SECTION I PRODUCT IDENTIFICATION

PRODUCT NAME:	LactOil® Soy Microemulsion
PRODUCT USE:	In-situ Bioremediation
SUPPLIER:	JRW Bioremediation, LLC 14321 W. 96th Terrace Lenexa, KS 66215 913-438-5544
EMERGENCY TELEPHONE:	800-779-5545 x 116 (Mon-Fri 9am-5pm CST) 913-961-6644 (afterhours)
DATE REVISED:	06-27-2011

SECTION II COMPOSITION/INFORMATION ON INGREDIENTS

Name	CAS #	% by Weight
LactOil®	Proprietary blend	100%

SECTION III PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling point:	Not applicable
Vapor pressure (Mg Hg):	Not determined
Vapor density (air = 1):	Not determined
Solubility in water:	Not determined
Appearance and odor:	Brown to yellow with bland odor
Specific gravity (H_2O = 1):	Not determined
Melting point:	Not determined
Evaporation rate:	Not determined
Density	1.05
pH:	7.5
Molecular Weight:	Not determined
Physical State:	Liquid

SECTION IV FIRE AND EXPLOSION HAZARD DATA

Closed cup Flash point:	>75C vis Pensky-Martens Closed Cup Test (ASTM std D93
Open cup Flash point:	Not determined
Auto Ignition:	Not determined
Fire Point:	Not determined
Flammable limits:	Not determined
LEL:	Not determined
UEL:	Not determined
Extinguishing media:	Dry chemical, foam, carbon dioxide, or water fog.
Special Fire Fighting procedures:	Wear full protective clothing and positive pressure breathing apparatus

SECTION V REACTIVITY DATA

Stability:	Unstable [ ] Stable [X]
Conditions to avoid:	Hydrolysis may occur in the presence of strong acids

or bases.

Incompatibility (materials to avoid): May react with strong oxidizing agents.

Hazardous decomposition or byproducts: None known

SECTION VI **HEALTH HAZARD DATA** Based on concentration as sold

Route/s of Entry:

Inhalation: Inhalation of vapors or mist may cause mild irritation of respiratory system. If symptoms are experienced, remove source of contamination or move to fresh air. If affected person is not breathing, apply artificial respiration. If breathing is difficult, give oxygen.

Skin contact: In case of contact with skin, immediately wash with plenty of soap and water while removing contaminated clothing. Seek medical attention if skin irritation develops or persists.

Eye contact: In case of contact with eyes, immediately flush eyes with water for at least 15 minutes, lifting eyelids to facilitate irrigation. Get medical attention if necessary.

Ingestion: If swallowed, get medical attention.

Carcinogenicity: Not determined.

Signs and symptoms of exposure: Slight irritation to skin, eyes, respiratory system, headache, nausea, drowsiness. May cause abdominal discomfort, nausea, and diarrhea.

Medical conditions aggravated by exposure: Soybean derived product. Avoid if sensitive to soy products.

SECTION VII **PRECAUTIONS FOR SAFE HANDLING AND USE**

Steps to be taken in case material is released or spilled: Contain spill with absorbant materials such as clay or soil and shovel and place material in drum for disposal. Surfaces may become slippery after spillage. Dispose of according to all local, state, and federal regulations at an approved waste treatment facility.

Precautions to be taken in handling and storage: Use personal protective equipment. Prevent spills, contamination, and leakage. Keep container tightly closed. Keep in properly labeled containers. Store in a cool, dry area. Avoid freezing or excessive heat.

Other precautions: Prevent material from entering waterways.

SECTION VIII **CONTROL MEASURES**

Respiratory protection (specify type): Respiratory protection may be required if material is used in poorly ventilated areas or if material is sprayed or heated. OSHA respiratory regulations found in 29 CFR 1910.134. Use an NIOSH approved respirator when necessary.

Ventilation: General ventilation and local exhaust are recommended.

Protective gloves: Chemical resistant gloves recommended.

Eye protection: Chemical goggles recommended.

Other protective clothing or equipment: Unnecessary if other control measures are used.

Hygiene practices: Avoid contact with skin. When using, do not eat,

drink, or smoke. Remove and wash contaminated clothing before re-use.

SECTION IX	**DOT INFORMATION**
DOT hazard class:	Not Applicable, non-regulated
Labeling:	Not Applicable
Proper Shipping Name:	LactOil® Soy Microemulsion
NMFC#:	144920
Class	**65**

ATTACHMENT 3

FORM 531

ADEM HYDROGEOLOGY SITE EVALUATION REPORT FORM

HYDROGEOLOGIST CONDUCTING EVALUATION: Maura Maloney DATE OF SITE VISIT

OTHERS PRESENT DURING THE EVALUATION:

FACILITY NAME: Redstone Arsenal, RSA-013, Unlined Inactive Open Burn Pad

ADDRESS: RSA-013

CITY: Redstone Arsenal, Huntsville ZIP: 35898 COUNTY: Madison

CONTACT: Robert Gorman TELEPHONE: 256-876-3814

TYPE OF INSPECTION: *(Indicate permit type.)* Class V UIC

TOPO QUADRANGLE / SECTION / TOWNSHIP / RANGE	LATITUDE & LONGITUDE:
Triana Quadrangle/ Section 30 / Township 5S / Range 1W	34.571 degrees -86.669 degrees
	method: check one 1) GPS___ 2) surveyed___ 3) digitized from map___ 4) computer map program ✓ 5) measured from map___ 6) unknown___

CHECKLIST: (Y) *yes or (N) no*

PITS EXCAVATED AND LOGGED	(N)		
DEPTH TO GROUNDWATER DETERMINED	(Y)	FEET BELOW SURFACE	Average 7.38 feet bgs
DEPTH TO BEDROCK DETERMINED	(Y)	FEET BELOW SURFACE	20 to 40.5 feet bgs
WATER WELLS INVENTORIED	(Y)	NUMBER OF RESIDENTIAL WELLS	0
SAMPLES COLLECTED	(Y)	DISTANCE TO CLOSEST RESIDENTIAL WELL	>0.5 miles
		NUMBER OF PUBLIC SUPPLY WELLS	0
		DISTANCE TO CLOSEST PUBLIC WELL	>0.5 miles

TOPOGRAPHIC DESCRIPTION and SURFACE DRAINAGE: The topography in the vicinity of RSA-013 is relatively flat with the the exception of two earthern berms located directly to the west of the former burn pads. Ground elevations range from approximately 560 to 578 feet above mean sea level. With the exception of the berms, the site lies within the 100-year flood plain. There are no permanant surface water bodies within the RSA-013 site boundary. Overland flow at RSA-013 drains to roadside ephemeral drainage ditches.

PHYSIOGRAPHIC PROVINCE: Highland Rim

SCS SOIL TYPES: Limestone Bedrock

GEOLOGIC FORMATION: Tuscumbia Limestone

SURFACE WATER BODIES: Tennessee River, wetlands, unnamed surface water drainages

ADEM DIVISION 6 RECEIVING STREAM CLASSIFICATION: Public water supply / fish and wildlife

USGS FLOOD PRONE AREA : within 100-year flood zone

SITE HYDROGEOLOGIC DESCRIPTION: (Attach additional pages as necessary) The subsurface geologic setting beneath RSA-013 includes unconsolidated overburden consisting of fluvial deposits of sand, silt, and clay with gravel from the Tennessee River and residuum derived from in situ chemical weathering of limestone bedrock. Intervals of chert and chert fragments increase with depth and represent residual deposits formed by in situ chemical weathering of chert nodules and layers within the limestone bedrock. Bedrock encountered at RSA-013 consists of the Mississippian-aged lowermost Monteage Limestone or the uppermost Tuscumbia Limestone. Depth to bedrock ranges from 20 to 40.5 feet below ground. The highly variable pinnacle-and-cutter topography is the product of in situ weathering and is referred to as epikarst. Groundwater is encountered at relatively shallow depths at RSA-013, ranging from 1.69 to 10.89 feet below ground surface. The primary direction of groundwater flow is to the north-northwest towards the embayment to the Tennessee River, located approximately 200 feet to the north of the site.

WELL HEAD PROTECTION AREA: None

NOTES:

ACCESS INFORMATION: Contact Robert Gorman (256) 876-3814

EXPLORATORY PITS OR BORING LOGS: ***Attach additional pages as necessary. Include notes and dates.***

RSA-013 boring logs are included in Attachment 4 of the RSA-013 Class V UIC Permit Appication.

ATTACHMENT 4

BORING LOGS

REDSTONE ARSENAL RI/FS

BORING AND WELL CONSTRUCTION LOG

PELA

WELL NO.: RS109 UNIT/AREA: UNIT 2 LOCATION: X 248,280 Y 1,482,423
DRILLER: B. BUTLER PELA REP.: T. BEESON
DATE DRILLED: 9/16/87 DATE INSTALLED: 9/22/87
DRILLING METHOD: HOLLOW - STEM AUGER
TOTAL DEPTH (BOREHOLE): 25 FEET BOREHOLE DIAMETER: 7"
MP ELEVATION: 565.91 LS ELEVATION: 563.77
TOTAL DEPTH (WELL): 25 FEET BLS
WATER LEVEL DURING DRILLING (BLS): 12.2 ▽
WATER LEVEL AFTER DEVELOPMENT: 10.39 FEET (BLS)
DATE / TIME: 9/7/87 8:47A

DEPTH FEET BLS	SAMPLE	UNIFIED SOIL CLASSIFICATION (VISUAL)	DESCRIPTION / OBSERVATIONS
0		CL/CH	CLAY, SLIGHTLY SILTY, MODERATE YELLOWISH BROWN AND LIGHT OLIVE GRAY
		CL/CH	CLAY, SLIGHTLY SILTY, MODERATE YELLOWISH BROWN, TRACE OF BLOCK ORGANIC MATERIAL
5		CL/CH	AS ABOVE WITH CHERT PEBBLES UP TO .5" DIAMETER
		CL/CH	CLAY, SILTY, MODERATE YELLOWISH BROWN AND DARK YELLOWISH ORANGE. ALSO PEBBLES AS ABOVE
		CL/SC	CLAY, VERY SILTY, GRADING TO VERY FINE SAND, MODERATE YELLOWISH BROWN
10			
15		SM*	SAND VERY FINE TO FINE GRAINED, CLAYED MODERATE YELLOWISH BROWN
20		SC-SM*	SAND AS ABOVE
			SPOON REFUSAL @ 20.5'
25			
30			

WATER LEVEL ▽

WELL CONST.: GROUT; SAND PACK; RISER; SCREEN; BUMP

REMARKS: *UNIFIED SOIL CLASSIFICATION FROM GEOTECHNICAL ANALYSIS

REDSTONE ARSENAL RI/FS

BORING AND WELL CONSTRUCTION LOG

PELA

WELL NO.: RS110 UNIT/AREA: UNIT 2 LOCATION: X 248,284 Y 1,482,137
DRILLER: B. BUTLER PELA REP.: T. BEESON
DATE DRILLED: 9/15/87 DATE INSTALLED: 9/15/87
DRILLING METHOD: HOLLOW - STEM AUGER
TOTAL DEPTH (BOREHOLE): 25 FEET BOREHOLE DIAMETER: 7"
MP ELEVATION: 567.29 LS ELEVATION: 565.01
TOTAL DEPTH (WELL): 25 FEET
WATER LEVEL DURING DRILLING (BLS): 12.6' ▽
WATER LEVEL AFTER DEVELOPMENT: 10.53' BLS
DATE / TIME: 10/7/87 3:18A

DEPTH FEET BLS	SAMPLE	UNIFIED SOIL CLASSIFICATION (VISUAL)	DESCRIPTION / OBSERVATIONS
0		CH	CLAY, SLIGHTLY SILTY, MODERATE BROWN GRADING TO DARK YELLOWISH ORANGE AND LIGHT OLIVE GRAY
		CH/CL	CLAY, SLIGHTLY SILTY, LIGHT OLIVE GRAY AND DARK YELLOWISH ORANGE
5		CH/CL	AS ABOVE
		CH/CL	CLAY, SLIGHTLY SILTY, MODERATE BROWN GRADING TO LIGHT BROWN, LIGHT OLIVE GRAY AND DARK YELLOWISH ORANGE
		CH/CL	CLAY, SLIGHTLY SILTY, DARK YELLOWISH ORANGE AND LIGHT OLIVE GRAY
10			DRILLER NOTED GRAVEL @ 13.0'
15		SM*	SAND, CLAYEY, FINE GRAINED ROUNDED TO SUBROUNDED WELL TO MODERATE SORTING, SOME MICA, MODERATE YELLOWISH BROWN
20		SC-SM*	AS ABOVE WITH GRAVEL UP TO 2" DIAMETER
25			
30			

WATER LEVEL ▽

WELL CONST.: GROUT; BENT SEAL; SAND PACK; RISER; SCREEN; SUMP

REMARKS: *UNIFIED SOIL CLASSIFICATION FROM GEOTECHNICAL ANALYSIS

PELA

REDSTONE ARSENAL RI/FS

BORING AND WELL CONSTRUCTION LOG

WELL NO.: RS18S UNIT/AREA: 2/Optional LOCATION: X 248286 Y 1482423
DRILLER: D. Montgomery PELA REP.: W. Townsend
DATE DRILLED: April 27, 1988 DATE INSTALLED: April 27, 1988
DRILLING METHOD: Hollow-Stem Auger
TOTAL DEPTH (BOREHOLE): 30.1 feet BOREHOLE DIAMETER: 7 inches
MP ELEVATION: 566.13 feet LS ELEVATION: 563.98 feet
TOTAL DEPTH (WELL): 29.5 feet
WATER LEVEL DURING DRILLING (BLS): 12.0 feet▼
WATER LEVEL AFTER DEVELOPMENT:
DATE/TIME: June 6, 1988/11:01 a.m.

DEPTH FEET BLS	SAMPLE	UNIFIED SOIL CLASSIFICATION (VISUAL)	DESCRIPTION/OBSERVATIONS
0	X	CL	Clay, sandy, silty, light brown and light olive gray
	X	CL	Clay, sandy, silty, light brown and light olive gray
	X	CL	Clay, sandy, dark yellowish orange and light olive gray
	X	CL*	Clay, very sandy, dark yellowish orange and light brown
	X	SP/SM	Sand, fine grained well rounded with gravel up to 1.5 inches in diameter, dark yellowish orange
10			
	X	SM	Sand, fine to medium grained with some silt, mica and trace of clay, dark yellowish orange and moderate yellowish brown
15			17 feet - chatter coarse rounded gravel up to 1.5 inches in diameter
	X		Spoon refusal - no recovery - gravel lodged in tip of spoon
20			
			26.0 feet - chatter coarse rounded gravel up to 2.0 inch in diameter
25			
30	X	SC*	(6 inch recovery) - sand and gravel up to 1 inch in diameter

WATER LEVEL ▼

WELL CONST.: Grout; Bent. Seal; Riser; Sand Pack; Screen

REMARKS: Auger refusal at 30.1 feet bls. 2 inch well installed inside augers, no sump.

PELA

REDSTONE ARSENAL RI/FS

BORING AND WELL CONSTRUCTION LOG

WELL NO.: RS188 UNIT/AREA: 2/Optional LOCATION: X ______ Y ______
DRILLER: ______ PELA REP.: ______
DATE DRILLED: ______ DATE INSTALLED: ______
DRILLING METHOD: ______
TOTAL DEPTH (BOREHOLE): ______ BOREHOLE DIAMETER: ______
MP ELEVATION: ______ LS ELEVATION: ______
TOTAL DEPTH (WELL): ______
WATER LEVEL DURING DRILLING (BLS): ______
WATER LEVEL AFTER DEVELOPMENT: ______
DATE/TIME: ______

DEPTH FEET BLS	SAMPLE	UNIFIED SOIL CLASSIFICATION (VISUAL)	DESCRIPTION/OBSERVATIONS	WATER LEVEL	WELL CONST.
30	X	SC*	Medium to coarse grained sand, dark yellowish orange and moderate yellowish brown. Dark yellowish brown contaminant residue present in sample. Correlated to a 20 ppm response from field monitoring flame ionizing detector (OVA). Auger refusal at 30.1 feet.		

REMARKS:

551.4
541.4

PELA

REDSTONE ARSENAL RI/FS

BORING AND WELL CONSTRUCTION LOG

WELL NO.: RS189 UNIT/AREA: Unit 2 LOCATION: X _____ Y _____
DRILLER: D. Montgomery PELA REP.: W. Townsend
DATE DRILLED: April 27, 1988 DATE INSTALLED: April 27, 1988
DRILLING METHOD: Hollow-Stem Auger
TOTAL DEPTH (BOREHOLE): 35.0 feet BOREHOLE DIAMETER: 7 inches
MP ELEVATION: 563.67 feet LS ELEVATION: 561.43 feet
TOTAL DEPTH (WELL): 25.0 feet
*WATER LEVEL DURING DRILLING (BLS): 13.5 feet▼
WATER LEVEL AFTER DEVELOPMENT: 555.86 feet
DATE/TIME: June 6, 1988 10:52 a.m.

DEPTH FEET BLS	SAMPLE	UNIFIED SOIL CLASSIFICATION (MS/AL)	DESCRIPTION/OBSERVATIONS	WATER LEVEL	WELL CONSTR.
0		SC	Clay, sand and silt, fine- to medium-grained sand, dark yellowish brown and moderate reddish brown		
		CL	Clay, silty-sandy with a trace of mica, dark yellowish brown and light olive gray		Grout
		CL	As above		
		CL	As above		
		CL/ML	Clay, sandy with some mica (moist sample), dark yellowish brown		Bent. Seal
10					
				▼	
15		SM/SC	Sand, fine-grained, silty with some clay pockets, dark yellowish brown		Sand Pack
			18.0 feet chatter - gravel		
20		ML*	Spoon refusal at 20.0 feet on gravel - Sand, medium-grained, silty with clay pockets and gravel up to 1.5 inches in diameter, moderate yellowish brown		Screen
			21.0 feet - chatter - gravel		
25			25.0 feet chatter - heavy gravel		
			29.0 feet chatter - gravel No sampling due to flowing sands		

REMARKS: *Geotechnical analysis; 3" well

PELA

REDSTONE ARSENAL RI/FS

BORING AND WELL CONSTRUCTION LOG

WELL NO.: RS189 UNIT/AREA: Unit 2 LOCATION: X_____ Y_____
DRILLER:_____ PELA REP.:_____
DATE DRILLED:_____ DATE INSTALLED:_____
DRILLING METHOD:_____
TOTAL DEPTH (BOREHOLE):_____ BOREHOLE DIAMETER:_____
MP ELEVATION:_____ LS ELEVATION:_____
TOTAL DEPTH (WELL):_____
WATER LEVEL DURING DRILLING (BLS):_____
WATER LEVEL AFTER DEVELOPMENT:_____
DATE/TIME:_____

DEPTH FEET BLS	SAMPLE	UNIFIED SOIL CLASSIFICATION (VISUAL)	DESCRIPTION/OBSERVATIONS	WATER LEVEL	WELL CONST.
30					
			34.0 feet - residual cuttings - angular chert and plastic clay recovered from augers.		
35			Boring terminated at 35.0 feet		

REMARKS:

PELA

REDSTONE ARSENAL RI/FS

BORING AND WELL CONSTRUCTION LOG

WELL NO.: RS190 UNIT/AREA: Unit 2 LOCATION: X 247996 Y 1482257
DRILLER: D. Montgomery PELA REP.: V. Townsend
DATE DRILLED: May 5, 1988 DATE INSTALLED: May 5, 1988
DRILLING METHOD: Hollow-Stem Auger
TOTAL DEPTH (BOREHOLE): 40.5 feet BOREHOLE DIAMETER: 7 inches
MP ELEVATION: 563.58 feet LS ELEVATION: 561.46 feet
TOTAL DEPTH (WELL): 38.0 feet
WATER LEVEL DURING DRILLING (BLS): 10.0 feet▼
WATER LEVEL AFTER DEVELOPMENT: 555.85 feet
DATE/TIME: June 6, 1988 10:53 a.m.

DEPTH FEET BLS	SAMPLE	UNIFIED SOIL CLASSIFICATION (VISUAL)	DESCRIPTION/OBSERVATIONS
0			
	X	CL	Clay, very sandy, moderate reddish brown
	X	CL	Clay, silty, trace of sand, dark yellowish brown and light olive gray (trace of mica)
5	X	CL	As above
	X	CL	As above
	X	CL*	Silty and sand with some clay and a trace of mica, dark yellowish brown
10			
	X	CL*	Sand, silty with some clay and mica, dark yellowish brown
15			17.5 feet - chatter - gravel up to 2-inches in diameter
	X		No recovery due to gravel lodged in spoon
20			21 - 23 feet - chatter - heavy gravel up to 2-inches in diameter
25			27.0 feet - chatter - heavy gravel
30	X		No recovery flowing sands in augers

WATER LEVEL ▼

WELL CONST.: Grout; Bent. Seal; Sand Pack; Riser; Screen

REMARKS: *Geotechnical Analysis

PELA

REDSTONE ARSENAL RI/FS

BORING AND WELL CONSTRUCTION LOG

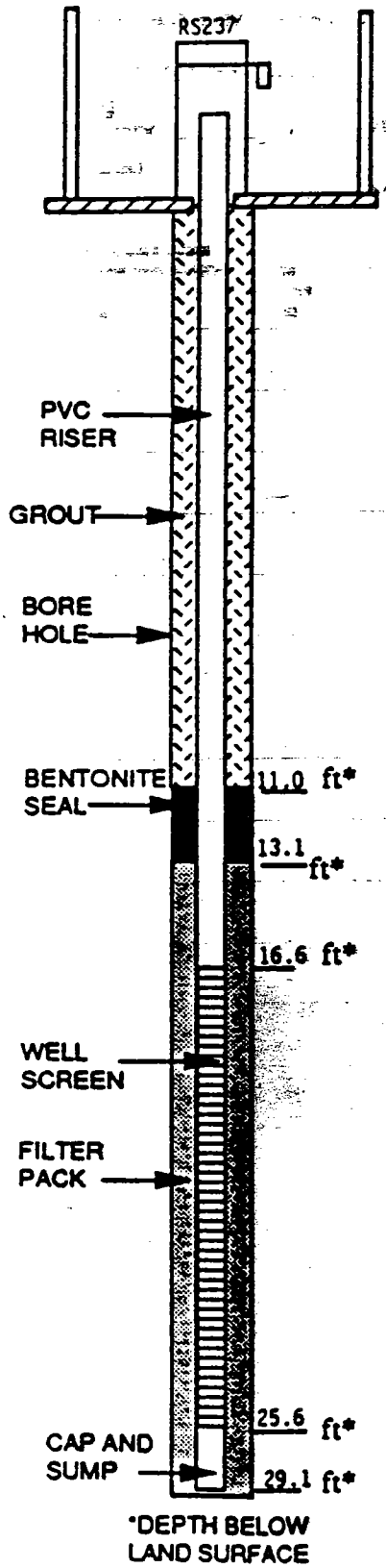
WELL NO.: RS190 UNIT/AREA: Unit 2 LOCATION: X_____ Y_____
DRILLER:_____ PELA REP.:_____
DATE DRILLED:_____ DATE INSTALLED:_____
DRILLING METHOD:_____
TOTAL DEPTH (BOREHOLE):_____ BOREHOLE DIAMETER:_____
MP ELEVATION:_____ LS ELEVATION:_____
TOTAL DEPTH (WELL):_____
WATER LEVEL DURING DRILLING (BLS):_____
WATER LEVEL AFTER DEVELOPMENT:_____
DATE/TIME:_____

DEPTH FEET BLS	SAMPLE	UNIFIED SOIL CLASSIFICATION (MSUAL)	DESCRIPTION/OBSERVATIONS	WATER LEVEL	WELL CONST.
30			33.0 - 34.0 feet - chatter - gravel		Sand Pack / Screen
35					Sump
40			40.5 feet - auger refusal		

REMARKS: 2" well constructed inside hollow-stem augers

WELL CONSTRUCTION LOG

Project Name: Redstone Arsenal, Alabama
Well: RS237
Location: N: 1482941.4280 E: 248366.4106
Site I.D.: Unit 2
Client: U.S. Army Corps of Engineers
Prepared By: Patrick Wise



Drilling Summary

Total Depth bls: 29.1
Borehole Diameter(s): 10"
Drilling Contractor: Testing, Inc.
Drillers:
Drilling Method: Hollow Stem Auger
Drilling Fluid (Amount/Type): None
But 35 gallons added to hole to assist in filter pack installation

Elevations (Surveyed)/Datum:
Land Surface 563.23' amsl
Top of Well Casing 565.79' amsl
Depth to Water first encountered
static 6.78' bmp (4/30/91)

Well Design

Surface Casing: Material NA
Manufacturer
Diameter
Length
Setting

Screen: Material PVC
Manufacturer Triloc
Diameter 2.406"
Slot 0.010"
Setting 16.6' - 25.6'

Casing: Material Flush Threaded PVC (Triloc)
Diameter 2.406 I.D. 2.04"
Length 19.16'
Setting 2.56' als - 16.6 bls

Filter Pack: Material 20/40 Graded Sand
Setting 13.1' - 29.1'
Amount 5 100 lb sacks

Grout: Type Portland, Type 1, w/3% Bentonite
Setting Land surface - 11'
Amount 3 sacks/wet tag @ 3.5' bls

Seals: Type 3/8" Bentonite pellets
Setting 11.0' - 13.1' bls
Amount 1 1/3 5-gallon buckets

Well Protection: Steel protective casing, lockable cap, concrete pad, protective posts

Time Log:

	Started	Completed
Drilling:	8/1/90 (1500)	8/3/90 (1000)
Installation:	8/3/90 (1000)	8/3/90 (1530)
Development:		

Well Development:

Method/Equipment:
Static DTW Pumping DTW (ft below MP)
Pumping Rate: gpm Pumping Duration:
Specific Capacity: gpm/ft Water Removed During Development 75 gallons
pH: Conductivity: (umhos/cm)
Temp oC: Nephlemetric Turbidity:

Remarks:

GERAGHTY & MILLER, INC.
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SAMPLE/CORE LOG

Boring/Well R5237 Project/No. Redstone / [illegible] Page ____ of ____

Site Location [illegible] 2 Drilling Started [illegible] Drilling Completed ________

Total Depth Drilled ________ feet Hole Diameter [illegible] inches Type of Sample/Coring Device SPLIT SPOON

Length and Diameter of Coring Device 2' x 2" Sampling Interval [illegible] feet

Land-Surface Elev. 563.23 feet ☒ Surveyed ☐ Estimated Datum ________

Drilling Fluid Used NONE Drilling Method ________

Drilling Contractor Testing, Inc Driller [illegible] Helper [illegible]

Prepared By [illegible] Hammer Weight ________ Hammer Drop ________ inches

Sample/Core Depth (feet below land surface) From	To	USCS (Core Recovery (feet))	Unfiltered OVA	Filtered OVA	PID	Sample/Core Description
0	2	First Hole	0	-	0	Clay, silty, [illegible], trace [illegible]; trace
		(OL)				mica, light brown (5 YR 5/6)
2	4	(OL)	0	-	0	Clay, silty, [illegible]
						trace mica, mottled light brown [illegible]
						/ Yellowish gray (5 Y 7/2)
4	6	(OL)	0	-	0	Same as above (SAA) - very hard
6	8	(OL)	0	-	0	Same as above - [illegible] hard / compacted
8	10	(OL)	0	-	0	Clay, silty, sandy (v.f. grained), trace
						mica, dark yellowish orange (10 YR 5/4)
[illegible]	[illegible]					
						* Drilling became like gravel at 12'
15	16	(GC)	N/A		→	* Saturated sample *
		* Had to hammer sample				Gravel, medium-grained (50%), broken,
						angular; clay (50%) silty, wet,
						unconsolidated, dark yellowish orange
		1' recovery				(10 YR 5/4)
16	17	(GP)				Gravel (50%) medium-grained ~~[illegible]~~ to coarse,
						sub-rounded, multi-colored [siliceous];
						Sand (50%) medium - to coarse-grained, quartz

* Drilled too far →

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SAMPLE/CORE LOG (Cont.d)

Boring/Well R-2437 Page _____ of _____

Prepared By Richard Wise

* Slopey rock begins @ 28'

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	UNFILTERED OVA	FILTERED OVA	PID	Sample/Core Description
19	21	1' (GM)				Gravel (50%) medium- to coarse-grained, sub-rounded, siliceous; Sand (50%) quartzose, medium-grained, silty, sl. clayey, dark yellowish orange (10 YR 6/6)
24	24.25	1' (GW)				Gravel (50%) medium- to coarse (Pebble category), sub-rounded; light brown (5 YR 5/6); SAND (50%) medium grained, sl. silty, dark yellowish-orange (10 YR 6/6)
25	26					Gravel (50%) coarse, sub-angular, light brown (5 YR 5/6). SAND (50%) medium-grained, silty, dusky yellowish-brown (10 YR 2/2)
						* Auger began to drill along sloping rock face @ 28'. Drilled erratic to 29', ceased drilling

G&M Form 04 4-89

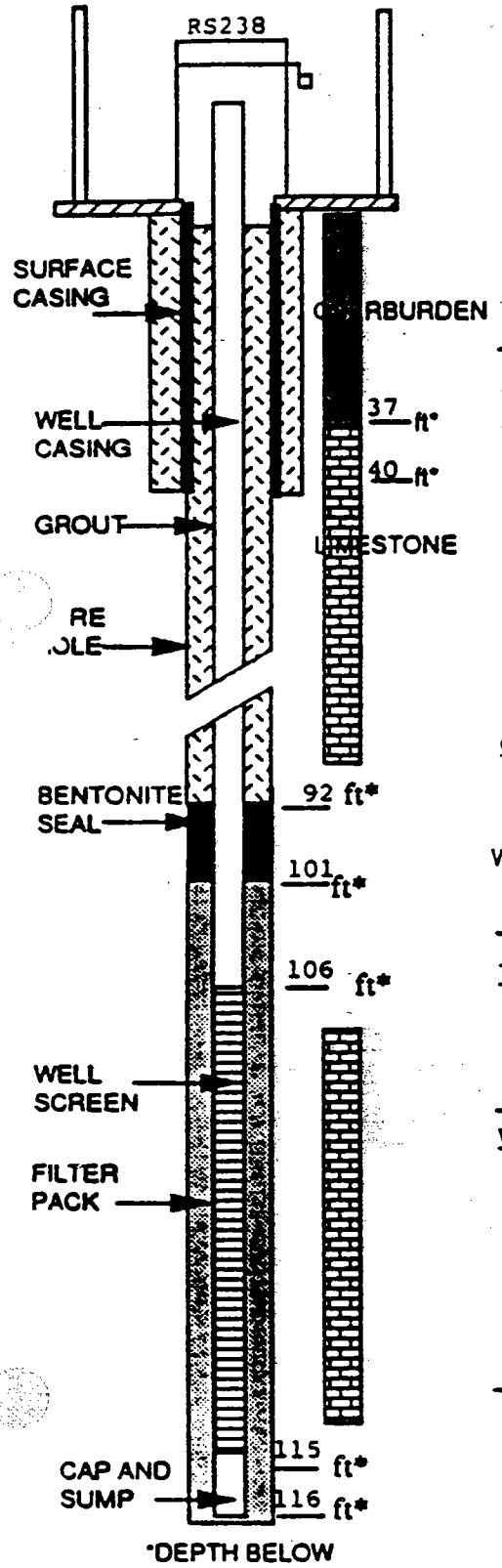
Soutronnt 89-0910

WELL CONSTRUCTION LOG

Project Name: Redstone Arsenal, Alabama Well: RS238

Location: N: 1482398.6745 E: 248283.1605 Site I.D.: Unit 2

Client: U.S. Army Corps of Engineers Prepared By: J. Kirkpatrick



Drilling Summary

Total Depth bls: 116.0'

Borehole Diameter(s): 13 inches for 40'
6 inches for 76'

Drilling Contractor: Miller Drilling

Drillers: Boo Butler

Drilling Method: Air Rotary & Hollow Auger

Drilling Fluid (Amount/Type): Water

Elevations (Surveyed)/Datum:

Land Surface 563.90' amsl

Top of Well Casing 566.59' amsl

Depth to Water: first encountered ~12' bls
static 6.84' bmp (4/30/91)

Well Design

Surface Casing: Material Steel
Manufacturer
Diameter 6 inches
Length 40
Setting 40' to 0'

Screen: Material PVC
Manufacturer Triloc
Diameter 2.406"
Slot 0.010"
Setting 115' to 106'

Casing: Material PVC
Diameter 2.406" I.D 2.04"
Length 108.6'
Setting 2.69' als to 106.0' bls

Filter Pack: Material 40/60 Sand
Setting 116' to 101'
Amount 4.5 bags

Grout: Type Portland
Setting: 92' to 0'
Amount : 16 bags

Seals: Type Bentonite Pellets
Setting 101' to 92'
Amount 1 bucket

Well Protection: Steel protective casing, lockable cap, concrete pad, protective posts

Time Log:	Started	Completed
Drilling:	10/5/90	10/8/90
Installation:	10/8/90	10/8/90
Development:	11/13/90	11/13/90

Well Development:

Method/Equipment: PVC Hand Pump

Static DTW 13.0 Pumping DTW NA (ft below MP)

Pumping Rate: ~1 bmp gpm Pumping Duration: 2 hrs

Specific Capacity: NA gpm/ft Water Removed During Development 110 gallons

pH: 8.10 Conductivity: 230 (umhos/cm)

Temp oC: NA Nephlemetric Turbidity: 32 NTU

Remarks:

GERAGHTY & MILLER, INC.
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SAMPLE/CORE LOG

Boring/Well RS-238 Project/No. TF48011 Page 1 of 2

Site Location Unit 2 Drilling Started 1320 Drilling Completed _____

Total Depth Drilled _____ feet Hole Diameter _____ inches Type of Sample/ Coring Device _____

Length and Diameter of Coring Device 24" x 3" Sampling Interval 2 feet to 10 feet 5 Feet after 10 feet

Land-Surface Elev. 563.90 feet ☒ Surveyed ☐ Estimated Datum _____

Drilling Fluid Used none Drilling Method Hollow stem auger

Drilling Contractor Testing Inc. Driller Roo Helper Anthony + Jeff

Prepared By Jason K. Kpatrick Hammer Weight 140 Hammer Drop _____ inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Time/Hydraulic Pressure or Blows per 6 inches	Sample/Core Description	OVA	PID
0	2	24"	Pushed in	Silt, grayish orange (10 YR 7/4), hard packed, contains some clay, and organic material	0	0
2	4	24"	1	Silt, grayish orange (10 YR 7/4), hard packed silt with small amt. of clay, organic material.	0	0
4	6	24"		Silt, dark yellowish ~~brown~~ orange (10 YR 6/6) hard packed, some clay content, mottled coloring, clay lenses (.1" thick)	0	0
6	8	24"		Silt, with globs of clayey sand, dark yellowish ~~brown~~ orange (10 YR 6/6) some small pebbles (chert) noted, organic material noted	0	0
8	10	24"		Sand, with clay, medium to fine grained (some silts) dark yellowish orange (10 YR 6/6), loose packed	3.0	0
14	16	24"		Sand, medium to fine grained, some silts, moderate yellowish orange (10 YR 5/4) Saturated.		
19	21	20"		Sand, medium to coarse, dark yellowish		

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SAMPLE/CORE LOG

Boring/Well PS-32S Project/No. TE48011 Page 2 of 2

Site Location 238 Elm Drilling Started ____ Drilling Completed ____

Total Depth Drilled ____ feet Hole Diameter ____ inches Type of Sample/ Coring Device ____

Length and Diameter of Coring Device ____ Sampling Interval ____ feet

Land-Surface Elev. 563.90 feet ☒ Surveyed ☐ Estimated Datum ____

Drilling Fluid Used ____ Drilling Method ____

Drilling Contractor Testing Inc. Driller ____ Helper ____

Prepared By Jason. Hammer Weight ____ Hammer Drop ____ inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Time/Hydraulic Pressure or Blows per 6 inches	Sample/Core Description	OVA	PI
			↓	brown (10 YR 6/6) some well rounded pebbles, saturated		
24	26	20"	Pushed	Sand, medium grained, some pebbles		
			in	grayish orange (10 YR 7/4) pebbles are		
				well rounded, (one pebble ≈ 1" diameter)		
				saturated.		
29	31	21"		Sand, medium to coarse grained,		
				grayish orange (10 YR 7/4). Pebbles		
				and cobbles (well rounded), some		
				clay blebs, saturated.		
				Auger refusal 34.5'		
				Spoon refusal 34.5'		

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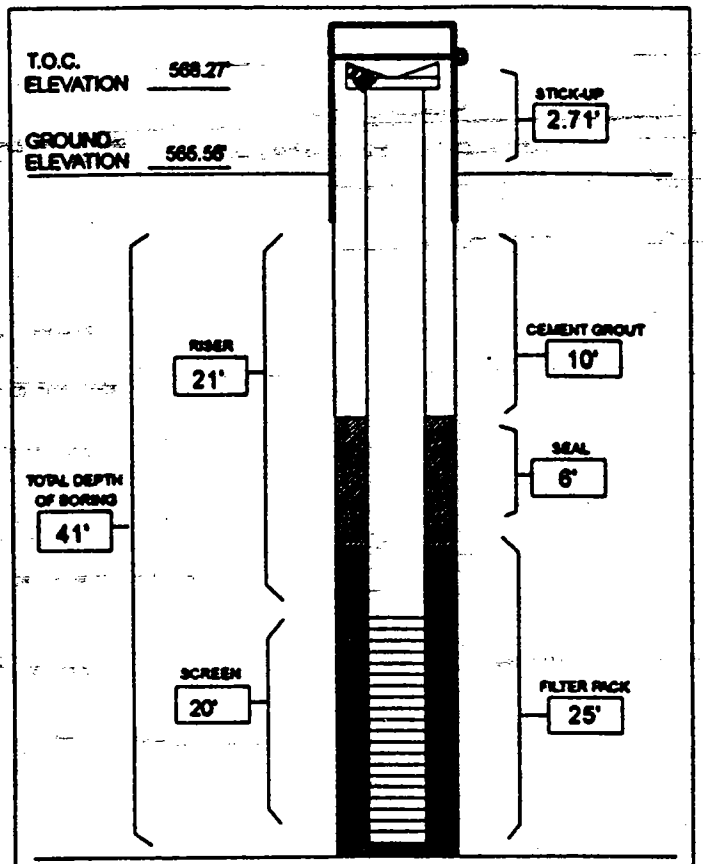
SAMPLE/CORE LOG (Cont.d)

Boring/Well RS 238 Page 3 of 3

Prepared By Jason Kirkpatrick (EA)

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Time/Hydraulic Pressure or Blows per 6 Inches	Sample/Core Description
34.5	37.1			Fractured + weathered limestone
37.1	114.0			Solid Limestone
114.0	114.5			Fractured Limestone - major water maker
114.5	116.0			Solid Limestone

ENSERCH ENVIRONMENTAL



WELL CONSTRUCTION LOG

FS 1-6U2

SITE NUMBER: RSA UNIT #2

BORING NUMBER: 5

WELL NUMBER: EX-07 (RS 47A)

LOCATION: N1482539.5590
E249097.5453

ADDRESS: REDSTONE ARSENAL
HUNTSVILLE, ALA.

INSTALLED BY: IVEY/GREENE

DRILLER: C. IVEY/ W. GREENE

DATE: 21JUNE 94

BORING DIAMETER: 10" DIA

LOGGED BY: BRUCE RAABE

RISER-TYPE: THREADED, FLUSH JOINT, PVC

RISER-SIZE: 6" ID, SCHED 80 PVC

SCREEN-TYPE: MACHINE SLOT SS

SCREEN-SIZE: 6" X 20' SS 0.020 SLOT

FILTER-TYPE: 6-10 SAND

SEAL-TYPE: BENTONITE CHIPS

AMOUNT: 2 BAGS

WELL PURGE INFORMATION, PRIOR TO SAMPLING: BAILED X PUMPED ____

DEPTH TO WATER (FROM TOC) 17.1' TOTAL WELL DEPTH (FROM TOC) 43.71' DATE OF MEASUREMENT 22 JUNE 94

GALLONS	PH MEASUREMENTS	SPEC. CONDUCTANCE (uS)	TURBIDITY
6161 GALLONS	7.0		4.6 NTU

METER TYPE/MODEL: PH: ____

CONDUCTANCE: ____

WATER LEVEL: ____

COMMENTS:

SWABBED AND SURGED WELL FOR 4 HOURS
TOP LIME 21.5 FEET

HTW DRILLING LOG

HOLE NO. EX-7 (RS474)

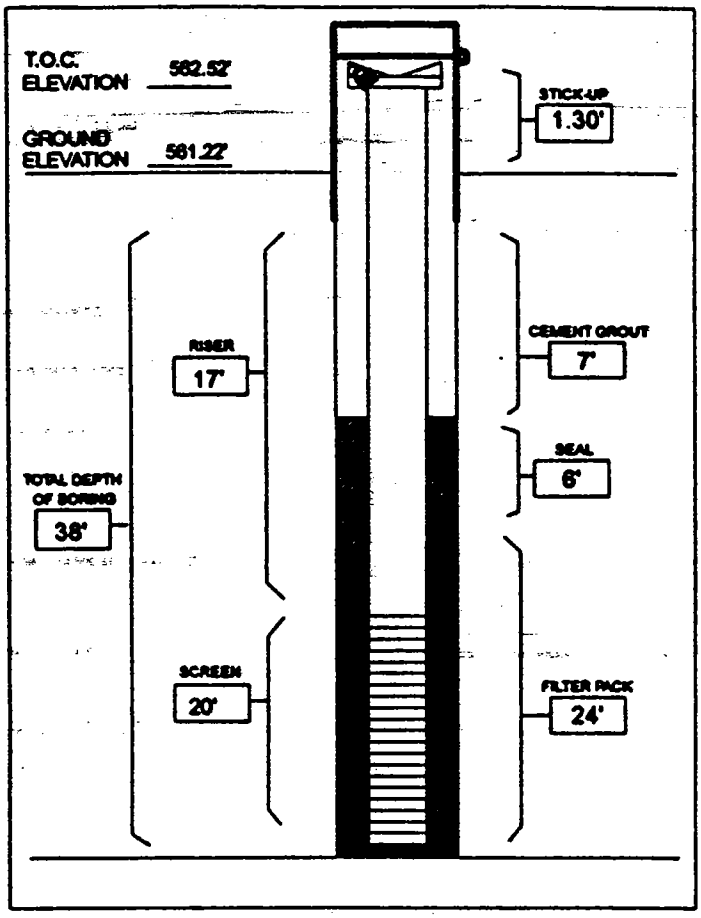
SHEET 1 OF 1 SHEETS

1. COMPANY NAME: ENSERCH
2. DRILLING SUBCONTRACTOR: IVEY/GREENE
3. PROJECT: RSA-UNIT #2
4. LOCATION: BETWEEN SWAMP AND BURN KETTLE
5. NAME OF DRILLER: CLEO IVEY / WAYNE GREENE
6. MANUFACTURER'S DESIGNATION OF DRILL: (HSA) CME 75 / (AIR) IR T-4
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: 4" & 10" HSA CME 75; 6 & 10" AIR HAMMER BITS (IR T-4)
8. HOLE LOCATION: NEAR FENCE
9. SURFACE ELEVATION: N/A
10. DATE STARTED: 5/25/94
11. DATE COMPLETED: 6/21/94
12. OVERBURDEN THICKNESS: 21.5'
13. DEPTH GROUNDWATER ENCOUNTERED: 2'
14. DEPTH DRILLED INTO ROCK: 19.5'
15. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED:
16. TOTAL DEPTH OF HOLE: 41'
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY):
18. GEOTECHNICAL SAMPLES: X — DISTURBED: COMP GRAB — UNDISTURBED:
19. TOTAL NUMBER OF CORE BOXES: N/A
20. SAMPLES FOR CHEMICAL ANALYSIS: NONE — VOC: — METALS: — OTHER (SPECIFY): — OTHER (SPECIFY): — OTHER (SPECIFY): — 21. TOTAL CORE RECOVERY %
22. DISPOSITION OF HOLE: EX-7 EXTRACTION WELL — BACKFILLED: — MONITORING WELL: — OTHER (SPECIFY): X
23. SIGNATURE OF INSPECTOR: Bruce A. Rabe

ELEV. a.	DEPTH b.	DESCRIPTION OF MATERIALS c.	FIELD SCREENING RESULTS d.	GEOTECH SAMPLE OR CORE BOX NO. e.	ANALYTICAL SAMPLE NO. f.	BLOW COUNTS g.	REMARKS h.
	0	RED HOMO. SANDY CLAY					4" ORD. HOLE TO 16' ON 5/17/94
		USCS CL					
	10	PREDOM. RED SANDY CLAY					
	20	Hume @ 21.5	HSA ↕ AIR				AUGER REFUSAL @ 21.5'
				COMP. GRAB SAMPLE @ 28'			
	30						DRILLER ESTIMATE 30-40 GPM
	40	TD @ 41'					

PROJECT: RSA-UNIT #2 — HOLE NO.: EX-7

ENSERCH ENVIRONMENTAL



WELL CONSTRUCTION LOG

R34-013

SITE NUMBER: RSA UNIT #2
BORING NUMBER: 6
WELL NUMBER: EX-06 (RS47)
LOCATION: N1482578.5250
E248392.5948
ADDRESS: REDSTONE ARSENAL
HUNTSVILLE, ALA.
INSTALLED BY: IVEY/GREENE
DRILLER: C. IVEY/ W. GREENE
DATE: 2 JUNE 94
BORING DIAMETER: 10" DIA
LOGGED BY: BRUCE RAABE

RISER-TYPE: THREADED, FLUSH JOINT, PVC
RISER-SIZE: 6" ID, SCHED 80 PVC
SCREEN-TYPE: MACHINE SLOT SS
SCREEN-SIZE: 6" X 20' SS 0.020 SLOT
FILTER-TYPE: 6-10 SAND
SEAL-TYPE: BENTONITE CHIPS
AMOUNT: 2 BAGS

WELL PURGE INFORMATION, PRIOR TO SAMPLING: BAILED X PUMPED ____

DEPTH TO WATER (FROM TOC) 10.3' TOTAL WELL DEPTH (FROM TOC) 39.30' DATE OF MEASUREMENT 16 JUNE 94

GALLONS	PH MEASUREMENTS	SPEC. CONDUCTANCE (uS)	TURBIDITY
550 GALLONS	6.5		9.8 NTU

METER TYPE/MODEL: PH: ____
CONDUCTANCE: ____
WATER LEVEL: ____

COMMENTS:

SWABBED AND SURGED WELL FOR 2.5 HOURS
TOP LIME 25 FEET

HTW DRILLING LOG

HOLE NO. EX-9 (RS475) 6

1. COMPANY NAME: ENSERCH ENVIRONMENTAL
2. DRILLING SUBCONTRACTOR: IVEY / GREENE
SHEET 1 OF 1 SHEETS
PROJECT: RSA - UNIT #2
4. LOCATION: 15' FROM FENCE, NEAR GATE, SW CORNER
5. NAME OF DRILLER: CLEO IVEY / WAYNE GREENE
6. MANUFACTURER'S DESIGNATION OF DRILL: (HSA) CME 75 / (AIR) IR T-4
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: 4 1/2" AUGERS HSA CME 75; 6 & 10" AIR HAMMER 375 (IR T-4)
8. HOLE LOCATION: NEAR FENCE & BURN AREA & SWAMP
9. SURFACE ELEVATION: N/A
10. DATE STARTED: 5/25/94
11. DATE COMPLETED: 6/1/94
12. OVERBURDEN THICKNESS: 25'
13. DEPTH GROUNDWATER ENCOUNTERED: 4' BGS
14. TOTAL DEPTH OF HOLE: 38'
15. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED:
16. DEPTH DRILLED INTO ROCK: 13'
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY):
18. GEOTECHNICAL SAMPLES: GRAB SAMPLE @ 15' — DISTURBED: X — UNDISTURBED:
19. TOTAL NUMBER OF CORE BOXES: N/A
20. SAMPLES FOR CHEMICAL ANALYSIS: NONE — VOC: — METALS: — OTHER (SPECIFY): — OTHER (SPECIFY): — OTHER (SPECIFY): — 21. TOTAL CORE RECOVERY: %
22. DISPOSITION OF HOLE: EXTRACTION WELL — BACKFILLED: — MONITORING WELL: — OTHER (SPECIFY):
23. SIGNATURE OF INSPECTOR: Bruce A. Raale

ELEV. a.	DEPTH b.	DESCRIPTION OF MATERIALS c.	FIELD SCREENING RESULTS d.	GEOTECH SAMPLE OR CORE BOX NO. e.	ANALYTICAL SAMPLE NO. f.	BLOW COUNTS g.	REMARKS h.
		RED SANDY CLAY					H_2O IN HOLE @ 4' BGS.
		CL USCS					4" OD. HOLE TO 16' ON 5/17/94
	10	CHERTY LENS @ 10'					
		RED FG CLAYEY SAND GRAB SAMPLE AT 15'		COMP. GRAB @ 15'			
		SC USCS					
	20	HIT WEATHERED LM @ 23'	HSA	COMP. GRAB SAMPLE @ 20-25'			DRILL TORQUES UP
		~~SOUND LIME @ 25'~~	AIR				AUGER REFUSAL @ 25'
	30						
		T.D IN LIME @ 38'					
	40						DRILLER ESTIMATES 35-40 GPM FLOW RATE

PROJECT: RSA - UNIT #2 HOLE NO. EX-8

P13-R555E

PARSONS ENGINEERING SCIENCE
SOIL BORING LOG AND WELL CONSTRUCTION RECORD

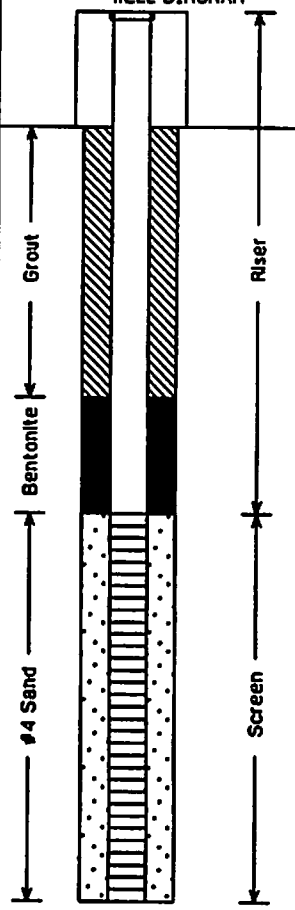
Page 1 of 1

Client U.S. Army Corps of Engineers Huntsville Center
Site Redstone Arsenal (UNIT-2)
Boring I.D. SB-558
Geologist/Engineer A. Mitchell
Drilling Method Hollow Stem Auger
Sampling Method Split-Spoon
Date Started 10/25/96
Date Completed 10/25/96
Driller Miller Drilling Company
Borehole Diameter (in) 8"
Depth Drilled (ft) 20
Ground Elevation (ft) 565 ?
Depth to Water (ft)
Date Measured 10/ /96

Project I.D. 729364.01
Well I.D. RS-558
Date Installed
Date Grouted
Casing Material 2" Schedule 40 PVC
Screen Material 2" Schedule 40 PVC 0.010 slot
Casing Interval (ft) 0-10
Screened Interval (ft) 10-20
Sump Installed?
Well Depth (ft) 20
TOC Elevation (ft)
Water Level (ft)
Date Measured

DEPTH (feet)	SAMPLE	BLOWS/6 IN	% REC.	HNu/OVA (ppm)	LITHOLOGIC DESCRIPTION	SOIL CLASS	GRAPHIC LOG
0					SILTY CLAY, topsoil, brown, stiff, hard; dry.		
5					SILTY CLAY, brown to light brown, hard, stiff; moderately plastic; dry.		
10					SILTY CLAY, as above; dry.		
		4,6,6,7	100	0	SILTY CLAY, as above; very plastic; at 13.2' silt lense 8" thick with clay throughout; black; very moist.		
15							
		5,25, 17,18	100	0	SILTY SAND, light brown to tan to white; clay, limestone, and chert throughout; wet. Refusal encountered at 20' BGS.		
20					Boring terminated at 20' BGS.		
25							
30							

WELL DIAGRAM



KRAP

HTRW DRILLING LOG

Company Name: GSE	Client: CB&T	Hole Number: 013-HP001	
Project: Redstone Arsenal	Drilling Subcontractor: GSE	Sheet: 1 of 4	Sheets
Name of Driller: Harry Hyatoon	Location: RSA-013		
Sizes and Types of Drilling and Sampling Equipment: Hand Auger; 2" Macro Core	Manufacturer's Designation of Drill: Geoprobe 6620 DT		
	Surface Elevation: TBD		
	Date Started: 6-6-13	Date Completed: 6-6-13	
Overburden Thickness: 2ft	Depth Groundwater Encountered: 13'		
Depth Drilled into Rock: 0	Depth to Water and Elapsed Time After Drilling Completed: NA 8' bgs after 10mk		
Total Depth of Hole: 2ft	Other Water Level Measurements (Specify): NA		

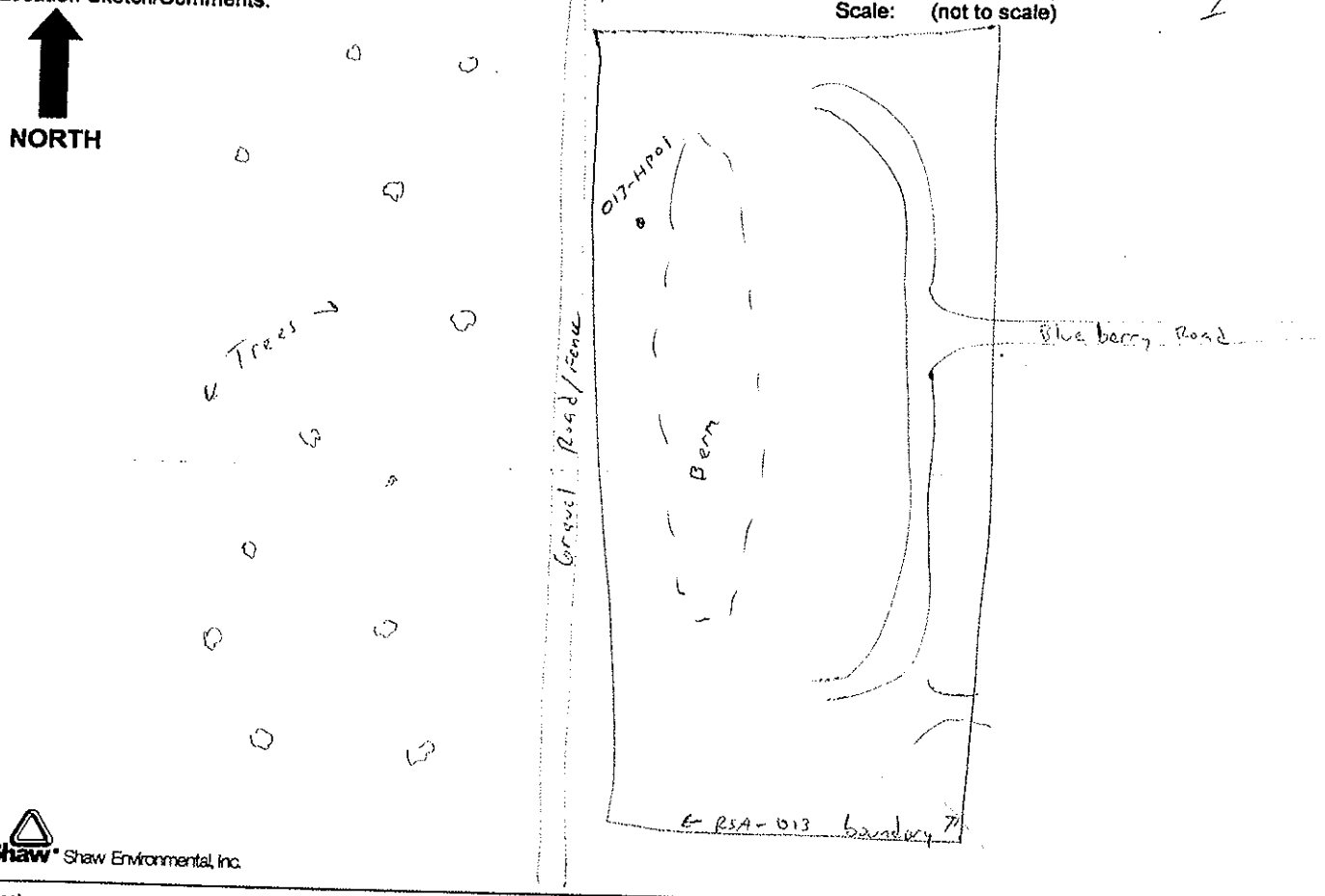
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	✓	NA	perchlorate	Explosives	TOC	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	NA	NA	piezometer	J. Ryan Bailey

Location Sketch/Comments:

Scale: (not to scale)



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Project: Redstone Arsenal	Hole Number: 013-HP01

Shaw — HTRW DRILLING LOG (continuation sheet)

Hole Number: 013-HP01

Project: R. Bailey Redstone Arsenal (NG)

Geologist: R. Bailey

Sheet 2 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/Lithology	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	0	0-5 → Reddish brown (5YR 5/4) clay, some silt, some grey mottling, med stiff, med plast. moist.	CL	0-5 1.3	NA	AB60001 AB60002 (0-1)	5/5	Hand Auger to 5 ft
	1							
	2					AB60003 (2-4)		
	3							
	4							
	5	5-10 → yellowish red (5YR 5/8) clay with silt & some sand, med. stiff, med. plast. moist.	CL	5-10 4.0			5/5	
	6							
	7							
	8							
	9							
	10							

Project: Redstone Arsenal

Hole Number: 013-HP01

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HTRW DRILLING LOG

(continuation sheet)

Hole Number 013-HP 01

Project Redstone Arsenal

Geologist R. Bailey

Sheet 3 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS Type	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	10	10-15 → Brown (7.5YR 5/4) silty/ sandy clay, stiff, low plast. Moist, Wet from 13-14.	CL	10-15 1.7	NA ↓		5/5	
	11							
	12							
	13					ABG0004 (11-13)		▽ 13'
	14							
	15	15-20 → yellowish brown 10 YR 5/6 sandy clay. saturated from above. med. stiff.	CH	15-20 0.7			5/5	
	16							
	17							
	18							
	19							
	20							

Shaw Shaw Environmental, Inc.

HTRW DRILLING LOG

(continuation sheet)

Hole Number 013-HP01

Project Redstone Arsenal

Geologist R. Bailey

Sheet 4 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS Code	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	20	20-25 → Brownish yellow (10YR 6/8) sand with clay, saturated.	~~cl~~	20-25 0.1	NA ↓			
	21							
	22							
	23							
	24							
	25	25-28 → same as above. DPT refusal at 28 ft.		25-28 0.0				
	26							
	27							Constructed piezometer
	28							
	29							
	30							

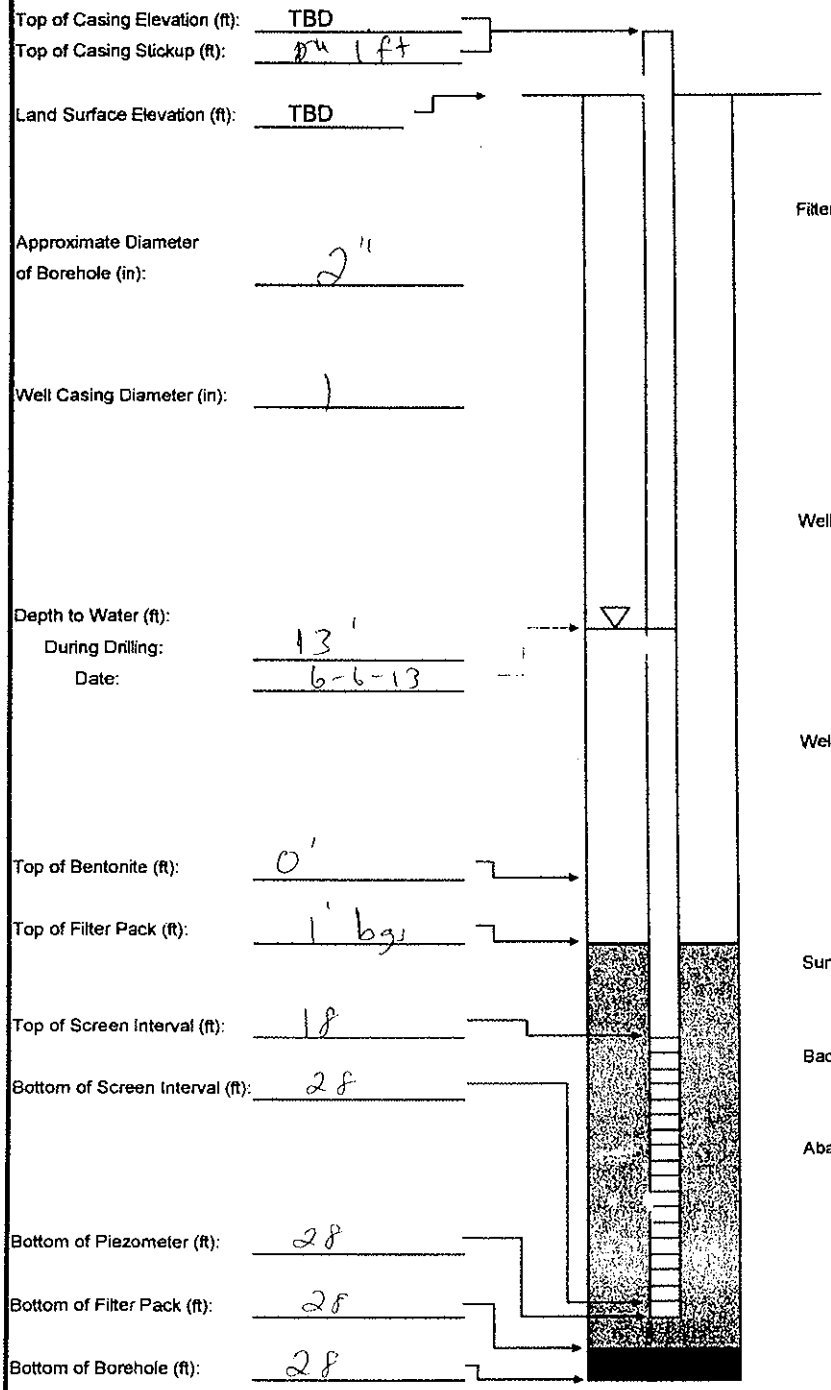
Project Redstone Arsenal

Hole Number 013-HP01

Temporary Piezometer

Project: Redstone Arsenal
Location: Huntsville, Madison County, AL
Client: Shaw E&I
Subcontractor: GSE
Driller: Harry Huntoon
Shaw Field Representative: Brian Rhodes

Piezometer Number: 013-HP01
Site Location: RSA-013
Installation Date: 6-6-13
Northing: TBD
Easting: TBD
Project Number: 136973



Top of Casing Elevation (ft): TBD
Top of Casing Stickup (ft): ~1 ft
Land Surface Elevation (ft): TBD
Approximate Diameter of Borehole (in): 2"
Well Casing Diameter (in): 1
Depth to Water (ft): During Drilling: 13'
Date: 6-6-13
Top of Bentonite (ft): 0'
Top of Filter Pack (ft): 1' bgs
Top of Screen Interval (ft): 18
Bottom of Screen Interval (ft): 28
Bottom of Piezometer (ft): 28
Bottom of Filter Pack (ft): 28
Bottom of Borehole (ft): 28

Filter Pack Material:
Manufacturer: Southern Filter Media
Product Name: Filter Media
Size: 20/40
Installation: Prepacked Screen, Filter Sock, (Gravity), Tremie

Well Casing:
Manufacturer: Mono Flex
Type: Sch 40 PVC
Diameter (in): 1

Well Screen Casing:
Manufacturer: Mono Flex
Type: Sch 40 PVC
Slot Size (in): 0.010
Slot Type: Continuous wrap, (Factory slot)

Sump/End Cap: ~

Backfill Material: None

Abandonment:
Date: TBD
Procedure: Natural fill, Grouted, Casing Removed
Completed as Well: TBD

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Depths and heights are referenced to ground surface unless specified TOC.
All elevations are referenced to MSL (NAVD 88).
If completed as well - see well construction diagram.

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Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

06102013
ABG-~~061013~~-W-EP

RFA / COC Number: ABG-061013-W-SAC

Location Code: 013-HP001
Sample Number: ABG3001
Sample Name: 013-HP001-GW-ABG3001-REG
Sampling Method: LF
Sample Type: GW *Sample Purpose:* REG
Sampling Equip: Peristaltic

Task: 013
Collection Date: 6-7-13
Collection Time: 0930
Start Depth: 23' bgs
End Depth: 28'
Sample Matrix: WATER
Sample Team: RB, HH, CE

QC Partners:
(TB) 06102013-TB (ER) NA (FB) NA

ERPIMS Values:
Sacode:
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
PERCH_6850	N	B	1	250	mL	HDPE
EXPLOSIVES+	N	C	2	1	L	Amb. Glass
THIANES	N	D	2	1	L	Amb. Glass
THIODIGLYCOL	N	E	1	500	mL	Amb. Glass

Groundwater Information:
Measured Well Depth: 28' BGS **Depth To Water:** 5.20' BGS

Comments: Temp = 22.36 °C, Cond = 0.177, pH = 9.16, Eh -7, Do = 9.83, Turbidity = >1000

Sketch Location: See Drill Log

Logged BY / Date: R. Bailey 6-7-13 *Reviewed BY / Date* Don Burton 6/7/13

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Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-061013-W-SAC

RFA / COC Number: ABG-06102013-W-EP

Location Code: 013-HP001
Sample Number: ABG3001-MS
Sample Name: 013-HP001-GW-ABG3001-MS
Sampling Method: LF
Sample Type: GW *Sample Purpose:* MS
Sampling Equip: Peristaltic

Task: 013
Collection Date: 6-7-13
Collection Time: 0530
Start Depth: 23' 6.5'
End Depth: 28'
Sample Matrix: WATER
Sample Team: RB, HH, CE

QC Partners:
(TB) 06102013-TB (ER) NA (FB) NA

ERPIMS Values:
Sacode:
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
PERCH_6850	N	B	1	250	mL	HDPE
EXPLOSIVES+	N	C	2	1	L	Amb. Glass
THIANES	N	D	2	1	L	Amb. Glass
THIODIGLYCOL	N	E	1	500	mL	Amb. Glass

Groundwater Information:
Measured Well Depth: 28' **Depth To Water:** 5.20'

Comments: See ABG3001,

Sketch Location: See Drill Log

Logged BY / Date: R. Bailey 6-7-13 *Reviewed BY / Date:* 6/7/13

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Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-06102013-W-EP

RFA / COC Number: ABG-061013-W-SAC

Location Code: 013-HP001
Sample Number: ABG3001-MSD
Sample Name: 013-HP001-GW-ABG3001-MSD
Sampling Method: LF
Sample Type: GW *Sample Purpose:* MSD
Sampling Equip: Peristaltic

Task: 013
Collection Date: 6-7-13
Collection Time: 0930
Start Depth: 23' bgs
End Depth: 28'
Sample Matrix: WATER
Sample Team: RB

QC Partners:
(TB) ABG-06102013-TB (ER) NA (FB) NA

ERPIMS Values:
Sacode:
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
PERCH_6850	N	B	1	250	mL	HDPE
EXPLOSIVES+	N	C	2	1	L	Amb. Glass
THIANES	N	D	2	1	L	Amb. Glass
THIODIGLYCOL	N	E	1	500	mL	Amb. Glass

Groundwater Information:
Measured Well Depth: 28' **Depth To Water:** 5.20'

Comments: See ABG3001

Sketch Location: See Drill Log

Logged BY / Date: R. Bailey 6-7-13 *Reviewed BY / Date:* Walker Dunton 6/7/13

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Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-06172013-S-EP
ABG-061713-S-SAC
ABG-061013-S-ECBC

RFA / COC Number: ABG-060613-S-ECBC

Location Code: 013-HP001
Sample Number: ABG0001
Sample Name: 013-HP001-SS-ABG0001-REG
Sampling Method: ~~DP~~ HA
Sample Type: SS *Sample Purpose:* REG
Sampling Equip: HA

Task: 013
Collection Date: 6-6-13
Collection Time: 1310
Start Depth: 0' bgs
End Depth: 1'
Sample Matrix: SOIL

QC Partners:
(TB) NA (ER) NA (FB) NA

Sample Team: RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-HI-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
MUSTARD_SCREEN	N	J	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID = 1.3 ppm

Sketch Location: See Drill Log

Logged BY / Date: R. Bailey 6-6-13
Reviewed BY / Date: 6-6-13

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-061712D13-S-EP
ABG-061713-S-SAC
RFA / COC Number: ABG-061D13-S-ECBC

Location Code: 013-HP001
Sample Number: ABG0002
Sample Name: 013-HP001-SS-ABG0002-FD
Sampling Method: ~~DPT~~ HA
Sample Type: SS *Sample Purpose:* FD
Sampling Equip: HA

Task: 013
Collection Date: 6-6-13
Collection Time: 1310
Start Depth: 0' bgs
End Depth: 1'
Sample Matrix: SOIL

QC Partners:
(TB) NA (ER) NA (FB) NA

Sample Team: KB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
~~MUSTARD_SCREEN~~	~~N~~	~~J~~	~~1~~	~~4~~	~~oz~~	~~CWM~~

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID= 1.3 ppm

Sketch Location:
See Drill Log

Logged BY / Date: K. Bailey 6-6-13
Reviewed BY / Date: DQC 6.6.13

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Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-06172013-S-EP
ABG-061713-S-SAC
ABG-061013-S-FCBC
RFA / COC Number: ABG-060613-S-ECBC

Location Code: 013-HP001
Sample Number: ABG0003
Sample Name: 013-HP001-DS-ABG0003-REG
Sampling Method: ~~DP~~ NA
Sample Type: DS *Sample Purpose:* REG
Sampling Equip: HA

Task: 013
Collection Date: 6-6-13
Collection Time: 1400
Start Depth: 2' bgs
End Depth: 4'
Sample Matrix: SOIL
Sample Team: RB

QC Partners:
(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
SPLP PERCH	N	B	1	4	oz	CWM
SPLP_TCE clear	N	D	1	4	oz	CWM
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
TOC	N	H	1	4	oz	CWM
MUSTARD_SCREEN	N	J	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID = 1.3 ppm

Sketch Location: See Drill Log

Logged BY / Date: R. Bailey 6-6-13
Reviewed BY / Date: DRC 6-6-13

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-061720 13-S-EP
ABG-061713-S-SAC
ABG-061013-S-ECBC
RFA / COC Number: ABG-060613-S-EBCB

Location Code: 013-HP001
Sample Number: ABG0004
Sample Name: 013-HP001-DS-ABG0004-REG
Sampling Method: DP
Sample Type: DS *Sample Purpose:* REG
Sampling Equip: DPT

Task: 013
Collection Date: 6-6-13
Collection Time: 1440
Start Depth: ~~6~~ 11' bgs
End Depth: ~~8~~ 13'
Sample Matrix: SOIL
Sample Team: RB

QC Partners:
(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
SPLP PERCH	N	C	1	4	oz	CWM
SPLP_TCE	N	D	1	4	oz	CWM
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
TOC	N	H	1	4	oz	CWM
MUSTARD_SCREEN	N	J	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID = 1.7 ppm

Sketch Location:
See Drill Log

Logged BY / Date: R. Bailey 6-6-13 *Reviewed BY / Date:* 6-6-13

HTRW DRILLING LOG

Company Name: GSE	Client: CB&J	Hole Number: 013-HP02	
	Drilling Subcontractor: GSE	Sheet: 1 of 5 Sheets	
Project: Redstone Arsenal	Location: RSA-013		
Name of Driller: Harry Hunter	Manufacturer's Designation of Drill: Geoprobe 6620 DT		
Sizes and Types of Drilling and Sampling Equipment: Hand Auger; 2" Macro Core	Surface Elevation: TBD		
	Date Started: 6-6-13	Date Completed: 6-7-13	
Overburden Thickness: 32'	Depth Groundwater Encountered: 14'		
Depth Drilled into Rock: 0	Depth to Water and Elapsed Time After Drilling Completed: 7.4' after 1 hour		
Total Depth of Hole: 32'	Other Water Level Measurements (Specify): NA		

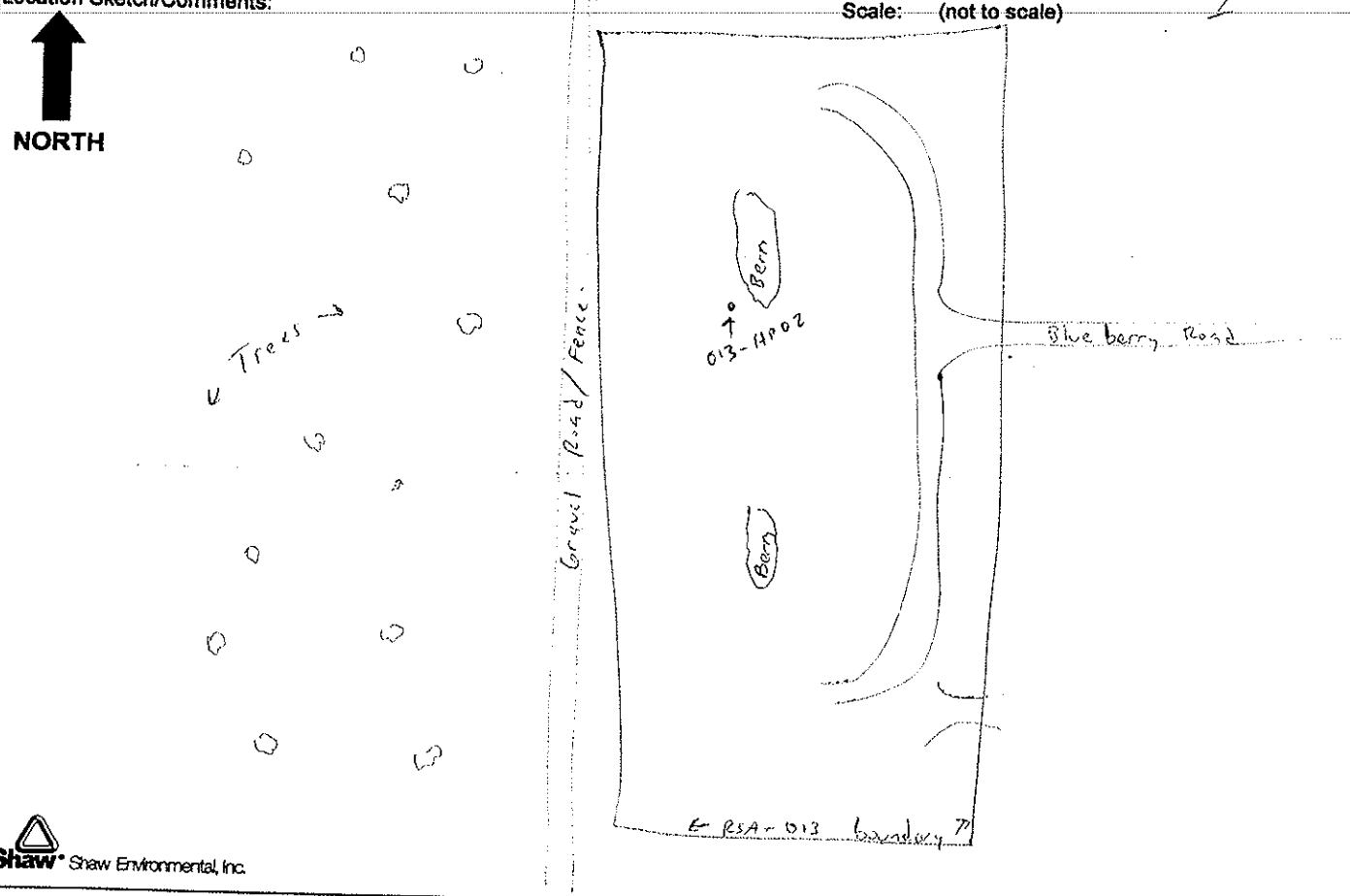
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	✓	NA	TOC	Perchlorate	Explosives	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	NA	NA	piezometer	J. Ayon Bailey

Location Sketch/Comments:

Scale: (not to scale)



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Project: Redstone Arsenal	Hole Number: 013-HP02

Shaw — HTRW DRILLING LOG (continuation sheet)

Hole Number: 013-HP02

Project: ~~R~~ (AB) Bailey Redstone Arsenal

Geologist: R. Bailey

Sheet 2 of 5 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Lithology	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	0	0-5 → Brown (7.5YR 5/4) silty clay. Some gray mottling. med. stiff. Low Plast. Dry	CL	0-5 0.0	NA ↓	AB60005 (0-1)	5/5	Hand Auger to 5 ft
	1							
	2					AB60006 AB60007 (2-4)		
	3							
	4							
	5	5-10 → strong brown (7.5YR 5/6) silty, sandy clay. Med stiff. Low Plast. Moist.	CL	5-10 0.1			5/5	
	6							
	7							
	8							
	9							
	10							

Project: Redstone Arsenal

Hole Number: 013-HP02

Shaw Environmental Inc.

HTRW DRILLING LOG

(continuation sheet)

Hole Number 013-HP02

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 3 of 5 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS Label	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	10	10-15 → Reddish yellow (7.5YR 6/8) silty, sandy clay. Med stiff. Low Plast. V. moist to 14 ft. Wet from 14-15 ft.	CL	10-15: 3.4	NA ↓		5/5	
	11							
	12					ABG0008 (12-14)		
	13							
	14							▽ 14'
	15	15-20 → yellowish brown (10YR 5/4) ~~clay~~ sandy clay. Soft. saturated	CL CH	15-20: 3.0			4/5	
	16							
	17							
	18							
	19							
	20							

Shaw

HTRW DRILLING LOG

(continuation sheet)

Hole Number 013-HP02

Project Redstone Arsenal

Geologist R. Bailey

Sheet 4 of 5 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS Code	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	20	20-25→ Same as above		20-25 1.6	NA ↓		3/5	
	21							
	22							
	23							
	24							
	25	25-30→ Brownish yellow (10YR 6/6) sand with clay, saturated, sand is fine to medium grain,		25-30 0.3			3/5	
	26							
	27							
	28							
	29							
	30							

Shaw

HTRW DRILLING LOG

(continuation sheet)

Hole Number 013-HP02

Project Redstone Arsenal

Geologist R. Bailey

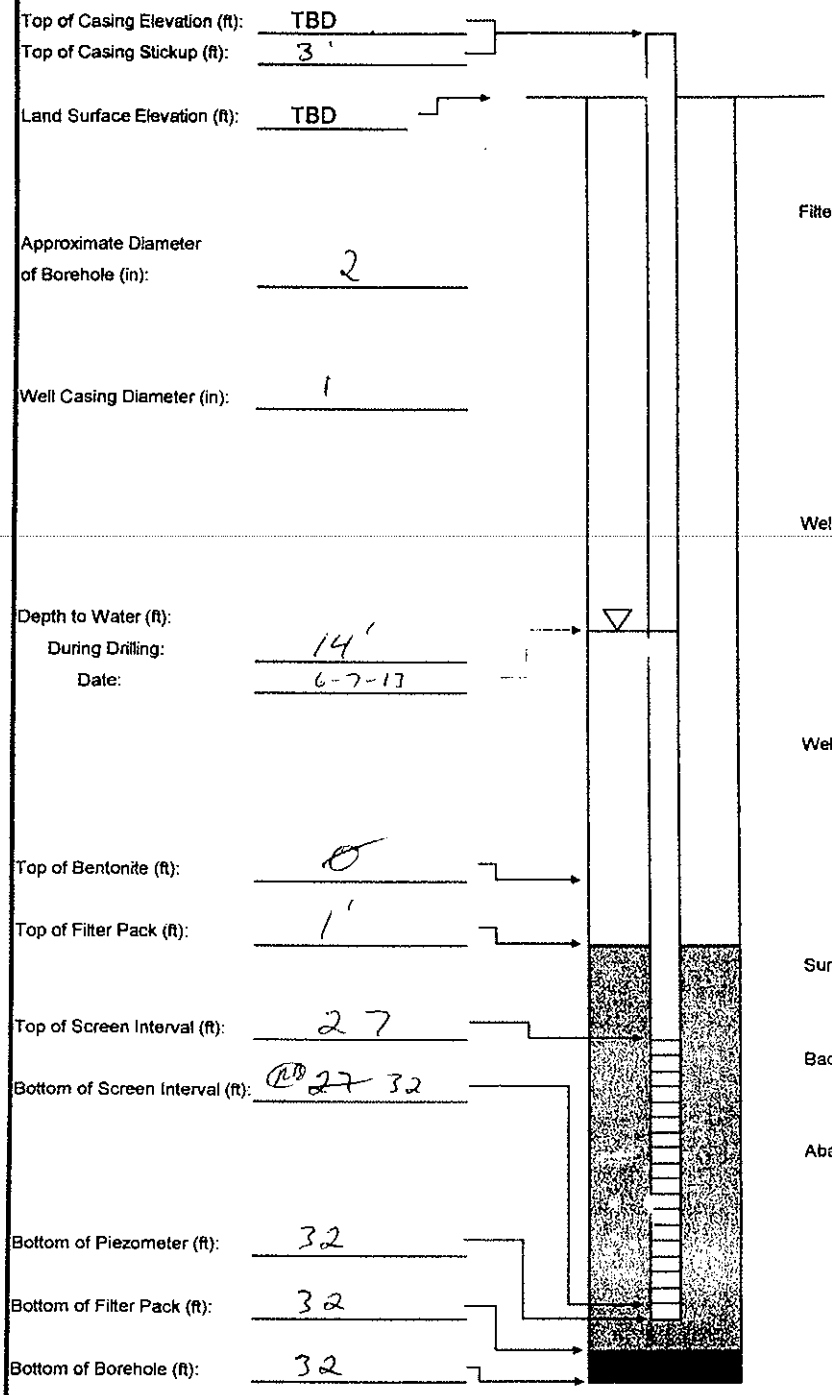
Sheet 5 of 5 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Lithology	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	30	30-32 → Same as above. DPT refusal @ 32' Constructed Piezometer		30-32 2.0	N.A ↓	NA ↓	2/5	
	31							
	32							
	33							
	34							
	35							
	36							
	37							
	38							
	39							
	40							

Temporary Piezometer

Project: Redstone Arsenal
Location: Huntsville, Madison County, AL
Client: Shaw E&I
Subcontractor: GSE
Driller: Harry Huntoon
Shaw Field Representative: Brian Rhodes

Piezometer Number: 013-HP02
Site Location: RSA-013
Installation Date: 6-7-13
Northing: TBD
Easting: TBD
Project Number: 136973



Filter Pack Material:
- Manufacturer: Southern Filter Media
- Product Name: Filter Media
- Size: 20/40
- Installation: Prepacked Screen / Filter Sock / (Gravity) / Tremie

Well Casing:
- Manufacturer: Mono Flex
- Type: Sch 40 PVC
- Diameter (in): 1

Well Screen Casing:
- Manufacturer: Mono Flex
- Type: Sch 40 PVC
- Slot Size (in): 0.010
- Slot Type: Continuous wrap / (Factory slot)

Sump/End Cap: -0-

Backfill Material: None

Abandonment:
- Date: TBD
- Procedure: Natural fill / Grouted / Casing Removed
- Completed as Well: TBD

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Depths and heights are referenced to ground surface unless specified TOC.
All elevations are referenced to MSL (NAVD 88).
If completed as well - see well construction diagram.

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Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-060103-W-SAC

RFA / COC Number: ABG-00102013-W-EP

Location Code: 013-HP002
Sample Number: ABG3002
Sample Name: 013-HP002-GW-ABG3002-REG
Sampling Method: LF
Sample Type: GW *Sample Purpose:* REG
Sampling Equip: PERISTALTIC PUMP

Task: 013
Collection Date: 6-7-13
Collection Time: 1540
Start Depth: ~~2~~ 3 ~~BTOC~~ bgs
End Depth: 32' ~~BTOC~~ bgs
Sample Matrix: WATER
Sample Team: KR

QC Partners:
(TB) 00102013-TB (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
PERCH_6850	N	B	1	250	mL	HDPE
EXPLOSIVES+	N	C	2	1	L	Amb. Glass
THIANES	N	D	2	1	L	Amb. Glass
THIODIGLYCOL	N	E	1	500	mL	Amb. Glass

ERPIMS Values:
Sacode:
Lot Control#:

Groundwater Information:
Measured Well Depth: 32' ~~BTOC~~ bgs **Depth To Water:** 7.21' ~~BTOC~~ bgs

Comments:

TIME	TEMP	pH	ORP	SPC	TURB	DO
1540	25.30	8.33	109	0.116	>1000	7.09

Sketch Location:

Logged BY / Date: Kiley Roberts 6-7-13

Reviewed BY / Date: [signature] 6/7/13

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Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-061?2613-S-EP
ABG-061713-S-SAC
ABG-061013-S-ECBC
RFA / COC Number: ABG-060613-S-ECBC

Location Code: 013-HP002
Sample Number: ABG0005
Sample Name: 013-HP002-SS-ABG0005-REG
Sampling Method: ~~DP~~ HA
Sample Type: SS *Sample Purpose:* REG
Sampling Equip: HA

Task: 013
Collection Date: 6-6-13
Collection Time: 1550
Start Depth: 0' bgs
End Depth: 1'
Sample Matrix: SOIL

QC Partners:
(TB) NA (ER) NA (FB) NA

Sample Team: RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
MUSTARD_SCREEN	N	J	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID= 0.0 ppm

Sketch Location: See Drill Log

Logged BY / Date: R. Bailey 6-6-13 *Reviewed BY / Date:* 6-6-13

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Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-061?2013-S-EP
ABG-061?13-S-SAC
ABG-061013-S-ECBC

RFA / COC Number: ABG-060713-S-ECBC

Location Code: 013-HP002
Sample Number: ABG0006
Sample Name: 013-HP002-DS-ABG0006-REG
Sampling Method: ~~DP~~ HA
Sample Type: DS *Sample Purpose:* REG
Sampling Equip: HA

Task: 013
Collection Date: 6-7-13
Collection Time: 1020
Start Depth: 2' bgs
End Depth: 4'
Sample Matrix: SOIL

QC Partners:
(TB) NA (ER) NA (FB) NA

Sample Team: RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
SPLP PERCH	N	C	1	4	oz	CWM
SPLP_TCE	N	D	1	4	oz	CWM
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
TOC	N	H	1	4	oz	CWM
MUSTARD_SCREEN	N	J	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:
See Drill Log

Logged BY / Date: R. Bailey 6-7-13 *Reviewed BY / Date:* 6-7-13

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Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-06172013-S-EP
ABG-061713-S-SAC
RFA / COC Number: ABG-061013-S-ECBC

Location Code: 013-HP002
Sample Number: ABG0007
Sample Name: 013-HP002-DS-ABG0007-FD
Sampling Method: ~~DP~~ HA
Sample Type: DS *Sample Purpose:* FD
Sampling Equip: HA

Task: 013
Collection Date: 6-7-13
Collection Time: 1020
Start Depth: 2' bgs
End Depth: 4'
Sample Matrix: SOIL

QC Partners:
(TB) NA (ER) NA (FB) NA

Sample Team: RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
SPLP PERCH	N	C	1	4	oz	CWM
SPLP_TCE	N	D	1	4	oz	CWM
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
TOC	N	H	1	4	oz	CWM
~~MUSTARD_SCREEN~~	N	J	1	4	oz	CWM (FD)

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID= 0.0 ppm

Sketch Location: See Drill Log

Logged BY / Date: R. Bailey 6-7-13

Reviewed BY / Date: QC 6-7-13

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Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-06172013-S-EP
ABG-061713-S-SAC
ABG-061013-S-ECBC
RFA / COC Number: ABG-060713-S-ECBC

Location Code: **013-HP002**
Sample Number: **ABG0008**
Sample Name: **013-HP002-DS-ABG0008-REG**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**
Sampling Equip: DPT

Task: **013**
Collection Date: 6-7-13
Collection Time: 1100
Start Depth: 12'
End Depth: 14'
Sample Matrix: **SOIL**

QC Partners:
(TB) NA (ER) NA (FB) NA
Sample Team: RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-HI-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
SPLP PERCH	N	C	1	4	oz	CWM
SPLP_TCE	N	D	1	4	oz	CWM
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
TOC	N	H	1	4	oz	CWM
MUSTARD_SCREEN	N	J	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID=3.4 ppm

Sketch Location: See Drill Log

Logged BY / Date: R. Bailey 6-7-13
Reviewed BY / Date: QC 6-7-13

HTRW DRILLING LOG

Company Name: GSE	Client: CB&T	Hole Number: 013-HP03	
Project: Redstone Arsenal	Drilling Subcontractor: GSE	Sheet: 1 of 5	Sheets
Name of Driller: Harry Huntoon	Location:		
Sizes and Types of Drilling and Sampling Equipment: Hand Auger; 2" Macro Core	Manufacturer's Designation of Drill: Geoprobe 6620 DT		
	Surface Elevation: TBD		
	Date Started: 6-7-13	Date Completed: 6-7-13	
Overburden Thickness: 33'	Depth Groundwater Encountered: 10'		
Depth Drilled into Rock: 0	Depth to Water and Elapsed Time After Drilling Completed: 9.26' @ Hr. 30min		
Total Depth of Hole: 33'	Other Water Level Measurements (Specify): NA		

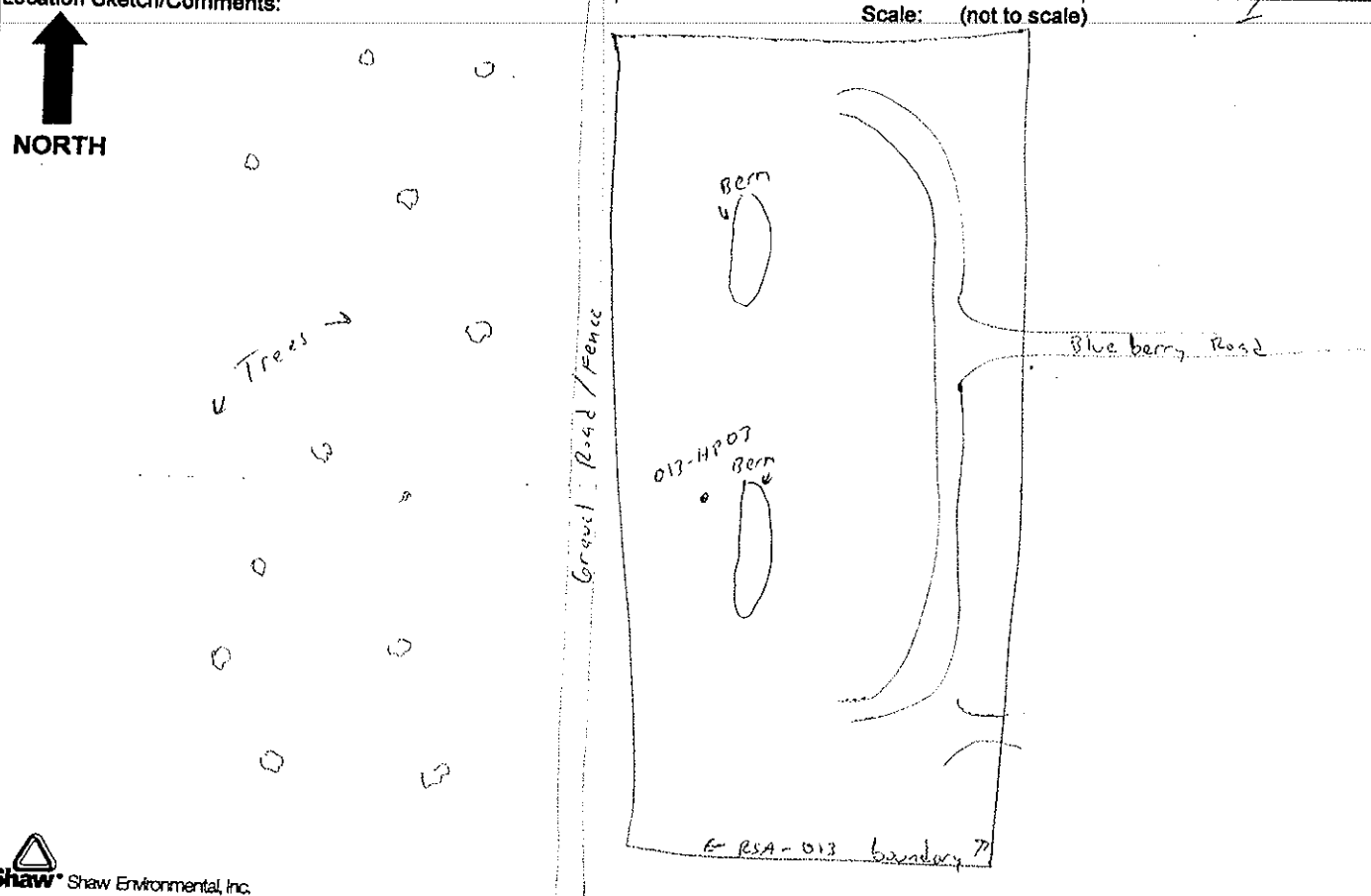
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	✓	NA	Perchlorate	Explosives	Toc	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	NA	NA	piezometer	J. Ryan Bailey

Location Sketch/Comments:

Scale: (not to scale)



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Project: Redstone Arsenal	Hole Number: 013 - HP03

Shaw — HTRW DRILLING LOG (continuation sheet)

Hole Number: 013 - HP03

Project: R. Bailey Redstone Arsenal (RB)

Geologist: R. Bailey

Sheet 2 of 5 Sheets

Elev (ft)	Depth (ft bgs)	Description of Materials	USCS Class	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	0	0-5 → Brown (7.5 YR 4/4) clay with silt, med. stiff, low plast. Dry.	CL	0-5 0.8	NA ↓	ABG0009 (0-1)	5/5	Hand Auger to 5 ft
	1							
	2					ABG0010 (2-4)		
	3							
	4							
	5	5-10 → strong brown (7.5 YR 5/6) silty clay, some sand, med stiff. Low Plast. (RB) ~~Hight~~ Moist, wet in sandy zone at 10 ft.	CL	5-10 2-3			5/5	
	6							
	7							
	8							
	9					ABG0011 (8-10)		
	10							▽ 10'

Project: Redstone Arsenal

Hole Number: 013 - HP03

Shaw | HTRW DRILLING LOG | (continuation sheet) | Hole Number 013-HP07

Project: Redstone Arsenal | Geologist: R. Bailey | Sheet 3 of 5 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS Symbol	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	10	10-15 → strong brown (7.5 YR 4/6) silty, sandy clay. Med stiff. Low Plast, V. Moist, wet from zone above.	CL	10-15 1.1	NA ↓	NA ↓	5/5	
	11							
	12							
	13							
	14							
	15	15-20 → yellowish brown (10YR5/6) silty, sandy, clay. Mel. soft. wet.	CL	15-20 4.0			5/5	
	16							
	17							
	18							
	19							
	20							

Project: Redstone Arsenal | Hole Number: 013-HP07

Shaw | HTRW DRILLING LOG | (continuation sheet) | Hole Number 013-HP03

Project: Redstone Arsenal | Geologist: R. Bailey | Sheet 4 of 5 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS Code	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	20	20-25 → Brownish yellow (10YR 5/4) clayey sand, saturated	SM	20-25: 3.4	NA ↓	NA ↓	3/5	
	21							
	22							
	23							
	24							
	25	25-30 → No recovery, saturated		—			0/5	
	26							
	27							
	28							
	29							
	30							

Project: Redstone Arsenal | Hole Number: 013-HP03

Shaw | **HTRW DRILLING LOG** (continuation sheet) | Hole Number 013-HP07

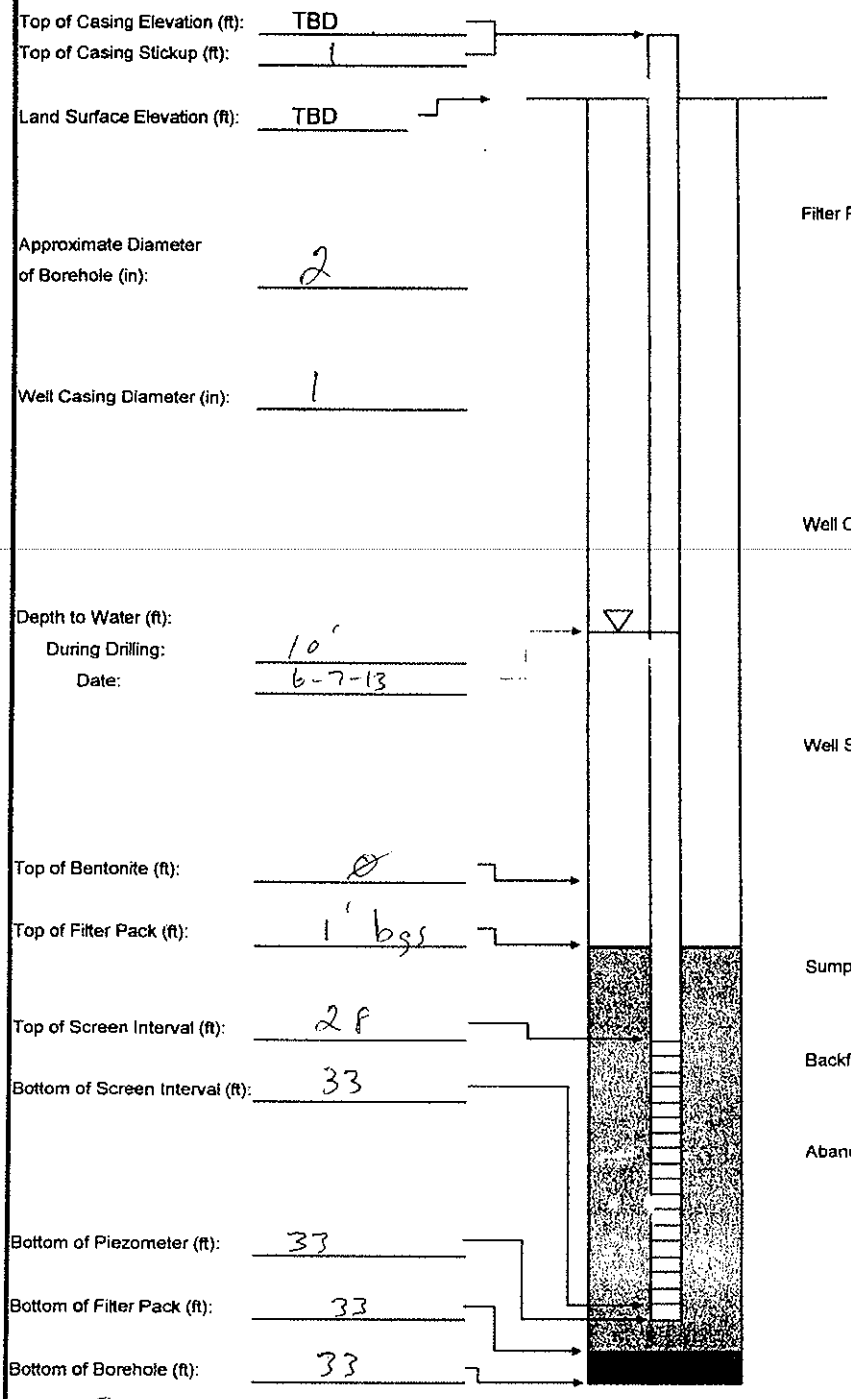
Project: Redstone Arsenal | Geologist: R. Bailey | Sheet 5 of 5 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS Lithology	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	30	30-37 → No recovery.		NA ↓	NA ↓		0/5	
	31	DPT refusal at 37 ft.						
	32	Construted piezometer						
	33							
	34							
	35							
	36							
	37							
	38							
	39							
	40							

Project: Redstone Arsenal | Hole Number: 013-HP07

Temporary Piezometer

Project:	Redstone Arsenal	Piezometer Number:	013-HP03
Location:	Huntsville, Madison County, AL	Site Location:	RIA-013
Client:	Shaw E&I	Installation Date	6-7-13
Subcontractor:	GSE	Northing:	TBD
Driller:	Harry Huntson	Easting:	TBD
Shaw Field Representative:	Brian Rhodes	Project Number:	136973



Top of Casing Elevation (ft): TBD
Top of Casing Stickup (ft): 1
Land Surface Elevation (ft): TBD
Approximate Diameter of Borehole (in): 2
Well Casing Diameter (in): 1
Depth to Water (ft): During Drilling: 10'
Date: 6-7-13
Top of Bentonite (ft): 0
Top of Filter Pack (ft): 1' bgs
Top of Screen Interval (ft): 28
Bottom of Screen Interval (ft): 33
Bottom of Piezometer (ft): 33
Bottom of Filter Pack (ft): 33
Bottom of Borehole (ft): 33

Filter Pack Material:
Manufacturer: Southern Filter Media
Product Name: Filter Media
Size: 20/40
Installation: Prepacked Screen | Filter Sock | (Gravity) | Tremie

Well Casing:
Manufacturer: Mono Flex
Type: Sch 40 PVC
Diameter (in): 1

Well Screen Casing:
Manufacturer: Mono Flex
Type: Sch 40 PVC
Slot Size (in): 0.010
Slot Type: Continuous wrap | (Factory slot)

Sump/End Cap: 0

Backfill Material: None

Abandonment:
Date: TBD
Procedure: Natural fill | Grouted | Casing Removed
Completed as Well: TBD

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Depths and heights are referenced to ground surface unless specified TOC.
All elevations are referenced to MSL (NAVD 88).
If completed as well - see well construction diagram.

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Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-06102013-W-EP

RFA / COC Number: ABG-061013-W-SAC

Location Code: 013-HP003
Sample Number: ABG3003
Sample Name: 013-HP003-GW-ABG3003-REG
Sampling Method: LF
Sample Type: GW *Sample Purpose:* REG
Sampling Equip: PERISTALTIC PUMP

Task: 013
Collection Date: 6-7-13
Collection Time: 1600
Start Depth: 28' bgs
End Depth: 33' bgs
Sample Matrix: WATER
Sample Team: KR

QC Partners:
(TB) 06102013-TB (ER) NA (FB) NA

ERPIMS Values:
Sacode:
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
PERCH_6850	N	B	1	250	mL	HDPE
EXPLOSIVES+	N	C	2	1	L	Amb. Glass
THIANES	N	D	2	1	L	Amb. Glass
THIODIGLYCOL	N	E	1	500	mL	Amb. Glass

Groundwater Information:
Measured Well Depth: 33' bgs **Depth To Water:** 8.3' bgs

Comments:

TIME	TEMP	pH	ORP	SPC	TURB	DO
1600	24.04	8.37	100	0.279	>1000	6.21

Sketch Location:

Logged BY / Date: Kelley Robinson 6-7-13

Reviewed BY / Date: Don Burton 6/7/13

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Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-06102013-W-EP

RFA / COC Number: ABG-061013-W-SAC

Location Code: **013-HP003**
Sample Number: **ABG3004**
Sample Name: **013-HP003-GW-ABG3004-FD**
Sampling Method: **LF**
Sample Type: **GW** *Sample Purpose:* **FD**
Sampling Equip: PERISTALTIC PUMP

Task: **013**
Collection Date: 6-7-13
Collection Time: 1600
Start Depth: 28' bgs
End Depth: 33' bgs
Sample Matrix: **WATER**
Sample Team: KL

QC Partners:
(TB) 06102013-TB (ER) NA (FB) NA

ERPIMS Values:
Sacode:
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-HI-W	N	A	3	40	mL	GVIAL,SEP
PERCH_6850	N	B	1	250	mL	HDPE
EXPLOSIVES+	N	C	2	1	L	Amb. Glass
THIANES	N	D	2	1	L	Amb. Glass
THIODIGLYCOL	N	E	1	500	mL	Amb. Glass

Groundwater Information:
Measured Well Depth: 33' bgs **Depth To Water:** 8.3' bgs

Comments:

Time	Temp	pH	ORP	SPC	TURB	DO
1600	24.04	8.37	100	0.279	>1000	6.21

Sketch Location:

Logged BY / Date: Kelly Robinson 6-7-13

Reviewed BY / Date: [signature] 6/7/13

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Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-061213-S-EP
ABG-061713-S-SAC
ABG-061013-S-ECBC
RFA / COC Number: ABG-060713-S-ECBC

Location Code: 013-HP003
Sample Number: ABG0009
Sample Name: 013-HP003-SS-ABG0009-REG
Sampling Method: ~~DPHA~~
Sample Type: SS *Sample Purpose:* REG
Sampling Equip: HA

Task: 013
Collection Date: 6-7-13
Collection Time: 1240
Start Depth: 0' bgs
End Depth: 1'
Sample Matrix: SOIL

QC Partners:
(TB) NA (ER) NA (FB) NA

Sample Team: ~~SBe~~ RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-HI-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
MUSTARD_SCREEN	N	J	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID = 0.8 ppm

Sketch Location: See Drill Log

Logged BY / Date: R. Bailey 6-7-13
Reviewed BY / Date: OK 6-7-13

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-06172013-S-EP
ABG-061713-S-SAC
ABG-061013-S-ECBC
RFA / COC Number: ABG-060713-S-ECBC

Location Code: 013-HP003
Sample Number: ABG0010
Sample Name: 013-HP003-DS-ABG0010-REG
Sampling Method: ~~DT~~ HA
Sample Type: DS *Sample Purpose:* REG
Sampling Equip: HA

Task: 013
Collection Date: 6-7-13
Collection Time: 1250
Start Depth: 2' bgs
End Depth: 4'
Sample Matrix: SOIL

QC Partners:
(TB) NA (ER) NA (FB) NA

Sample Team: RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
SPLP PERCH	N	C	1	4	oz	CWM
SPLP_TCE	N	D	1	4	oz	CWM
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
TOC	N	H	1	4	oz	CWM
MUSTARD_SCREEN	N	J	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID = 0.8 ppm

Sketch Location: See Drill Log

Logged BY / Date: A. Bailey 6-7-13
Reviewed BY / Date: [signature] 6.7.13

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-061720 13-S-EP
ABG-0617 13-S-SAC
ABG-0610 13-S-ECBC
RFA / COC Number: ABG-060713-S-ECBC

Location Code: 013-HP003
Sample Number: ABG0011
Sample Name: 013-HP003-DS-ABG0011-REG
Sampling Method: DP
Sample Type: DS *Sample Purpose:* REG
Sampling Equip: DPT

Task: 013
Collection Date: 6-7-13
Collection Time: 1310
Start Depth: 8' bgs
End Depth: 10'
Sample Matrix: SOIL

QC Partners:
(TB) NA (ER) NA (FB) NA

Sample Team: RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-HI-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
SPLP PERCH	N	C	1	4	oz	CWM
SPLP_TCE	N	D	1	4	oz	CWM
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
TOC	N	H	1	4	oz	CWM
MUSTARD_SCREEN	N	J	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID = 2.3 ppm

Sketch Location: See Drill Log

Logged BY / Date: R. Bailey 6-7-13 *Reviewed BY / Date:* 6-7-13

HTRW DRILLING LOG

Company Name: GSE	Client: CB&T	Hole Number: 013-HP04	
	Drilling Subcontractor: GSE	Sheet: 1 of 5	Sheets
Project: Redstone Arsenal	Location: RSA-013		
Name of Driller: Harry Hylton	Manufacturer's Designation of Drill: Geoprobe 6620 DT		
Sizes and Types of Drilling and Sampling Equipment: Hand Auger; 2" Macro Core	Surface Elevation: TBD		
	Date Started: 6-7-13	Date Completed: 6-7-13	
Overburden Thickness: 35'	Depth Groundwater Encountered: 10'		
Depth Drilled into Rock: 0	Depth to Water and Elapsed Time After Drilling Completed: 8.65 ft/e 30min		
Total Depth of Hole: 35'	Other Water Level Measurements (Specify): NA		

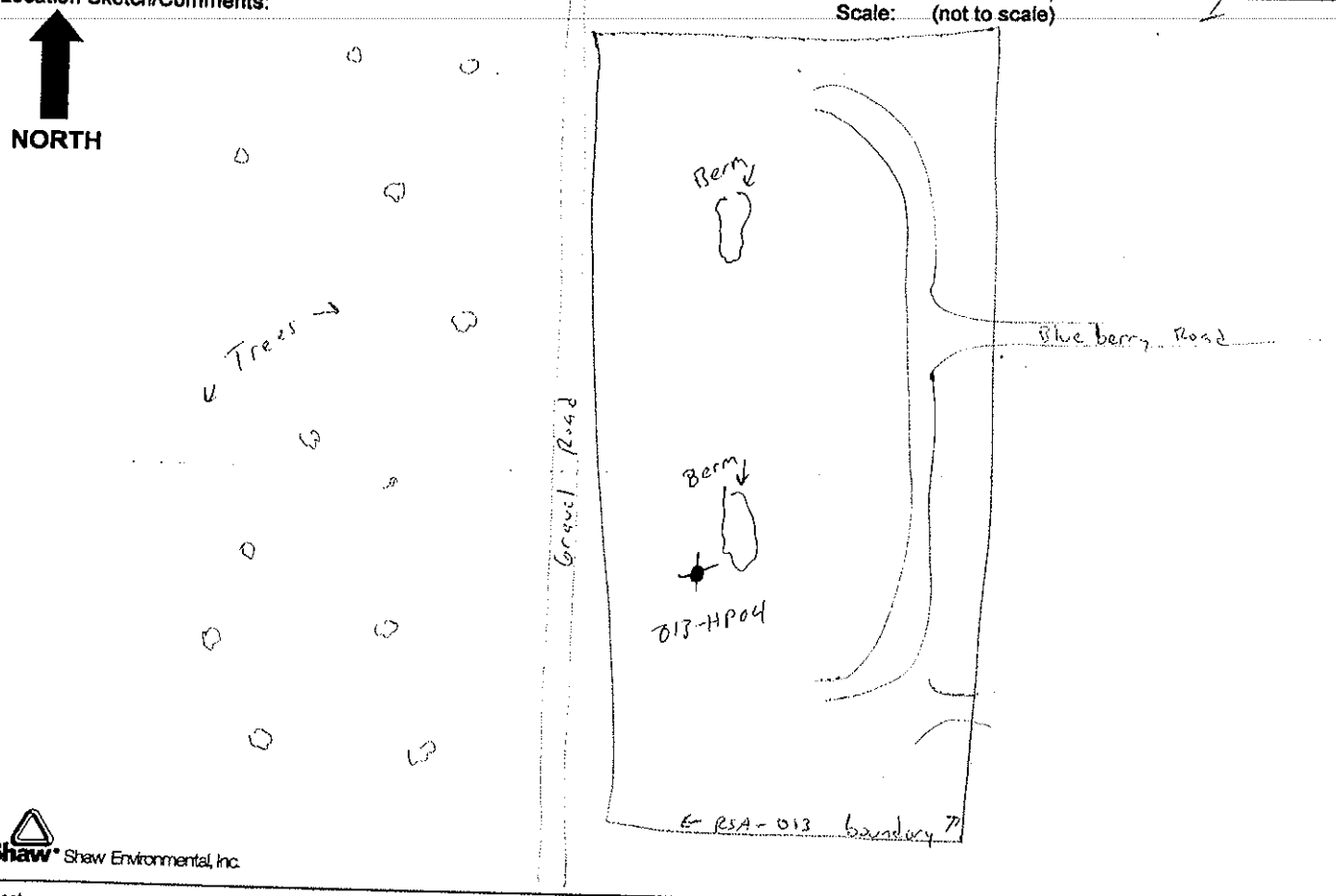
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	V	NA	TOC	perchlorate	explosives	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	NA	NA	piezometer	J. Ryan Bailey

Location Sketch/Comments:

Scale: (not to scale)



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Project: Redstone Arsenal	Hole Number: 013-HP04

Shaw | HTRW DRILLING LOG (continuation sheet) | Hole Number 013-HP04

Project R. Bailey Redstone Arsenal | Geologist R. Bailey | Sheet 2 of 5 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS Class	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	0	0-5 → Brown (7.5YR 4/4) silty clay, med. stiff, low plast. moist.	CL	0-5 0.6	NA ↓	ABG0012 (0-1)	5/5	Hand Auger to 5 ft
	1							
	2							
	3					ABG0013 (2-4)		
	4							
	5	5-10 → strong brown (7.5YR 5/6) silty clay, med. stiff low plast. moist. wet in silty, sandy zone at 10 ft.	CL	5-10 6.2			5/5	
	6							
	7							
	8							
	9					ABG0014 (8-10)		
	10							

Project Redstone Arsenal | Hole Number 013-HP04

Shaw — HTRW DRILLING LOG (continuation sheet)

Hole Number 013-HP04

Project: Redstone Arsenal | Geologist: R. Bailey | Sheet 3 of 5 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS Symbol	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	10	10-15 → strong brown (7.5YR 4/6) silty, sandy clay, med. stiff. wet.	CL	10-15 ↓ 1.4	NA ↓	NA	5/5	
	11							
	12							
	13							
	14							
	15	15-20 → yellowish brown (10YR5/6) sandy clay, med. stiff. some chert gravel, wet.		15-20 3.4 2.6				
	16							
	17							
	18							
	19							
	20							

Project: Redstone Arsenal | Hole Number 013-HP04

Shaw | HTRW DRILLING LOG | (continuation sheet) | Hole Number 013-HP04

Project: Redstone Arsenal | Geologist: R. Bailey | Sheet 4 of 5 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/Lithology	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	20	20-25 → yellowish brown, (10YR 5/8) clayey sand with gravel wet.		20-25 2.7	NA ↓	NA ↓	3/5	
	21							
	22							
	23							
	24							
	25	25-30 → No recovery		NA			0/5	
	26							
	27							
	28							
	29							
	30							

Project: Redstone Arsenal | Hole Number: 013-HP04

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HTRW DRILLING LOG

(continuation sheet)

Hole Number 013-HP04

Project Redstone Arsenal

Geologist R. Bailey

Sheet 5 of 5 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/Rock Class	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	30	30-35→ No recovery. DPT refusal at 35 ft. Constructed piezometer.		NA ↓	N.A ↓	NA ↓	0/5	
	31							
	32							
	33							
	34							
	35							
	36							
	37							
	38							
	39							
	40							

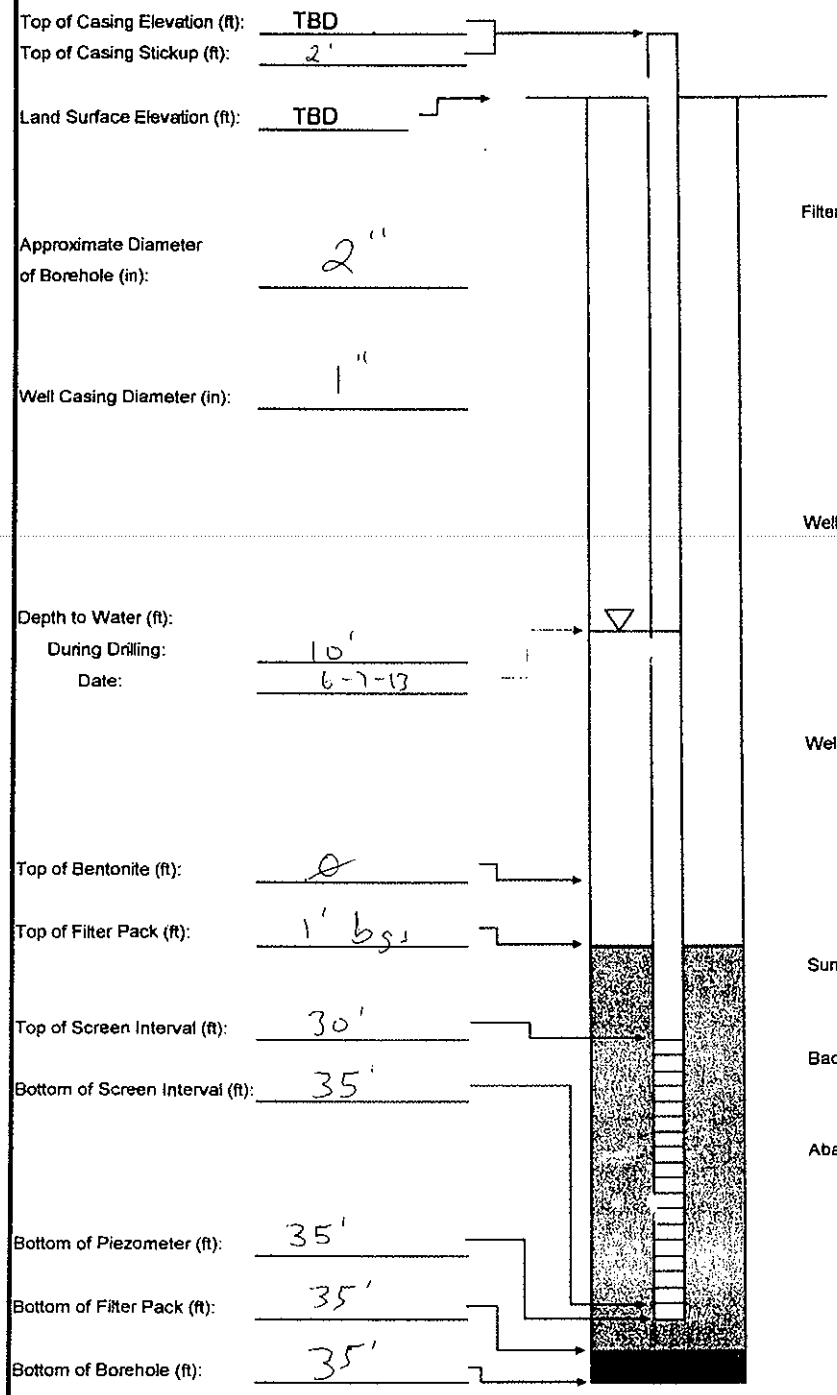
Project Redstone Arsenal

Hole Number 013-HP04

Temporary Piezometer

Project: Redstone Arsenal
Location: Huntsville, Madison County, AL
Client: Shaw E&I
Subcontractor: GSE
Driller: Harry Huntoon
Shaw Field Representative: Brian Rhodes

Piezometer Number: 013 - HP04
Site Location: RSA - 013
Installation Date: 6-7-13
Northing: TBD
Easting: TBD
Project Number: 136973



Top of Casing Elevation (ft): TBD
Top of Casing Stickup (ft): 2'
Land Surface Elevation (ft): TBD
Approximate Diameter of Borehole (in): 2"
Well Casing Diameter (in): 1"
Depth to Water (ft):
During Drilling: 10'
Date: 6-7-13
Top of Bentonite (ft): 0
Top of Filter Pack (ft): 1' bgs
Top of Screen Interval (ft): 30'
Bottom of Screen Interval (ft): 35'
Bottom of Piezometer (ft): 35'
Bottom of Filter Pack (ft): 35'
Bottom of Borehole (ft): 35'

Filter Pack Material:
Manufacturer: Southern Filter Media
Product Name: Filter Media
Size: 20/40
Installation: Prepacked Screen, Filter Sock, (Gravity), Tremie

Well Casing:
Manufacturer: Mono Flex
Type: Sch 40 PVC
Diameter (in): 1

Well Screen Casing:
Manufacturer: Mono Flex
Type: Sch 40 PVC
Slot Size (in): 0.010
Slot Type: Continuous wrap, (Factory slot)

Sump/End Cap: ø

Backfill Material: None

Abandonment:
Date: TBD
Procedure: Natural fill, Grouted, Casing Removed
Completed as Well: TBD

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Depths and heights are referenced to ground surface unless specified TOC.
All elevations are referenced to MSL (NAVD 88).
If completed as well - see well construction diagram.

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Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-06102013-W-EP

RFA / COC Number: ABG-061013-W-SAC

Location Code: 013-HP004
Sample Number: ABG3005
Sample Name: 013-HP004-GW-ABG3005-REG
Sampling Method: LF
Sample Type: GW *Sample Purpose:* REG
Sampling Equip: PERISTALTIC PUMP

Task: 013
Collection Date: 6-7-13
Collection Time: 1620
Start Depth: ~~30~~ 25' bgs
End Depth: 35' bgs
Sample Matrix: WATER
Sample Team: KR

QC Partners:
(TB) 06102013-TB (ER) NA (FB) NA

ERPIMS Values:
Sacode:
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
PERCH_6850	N	B	1	250	mL	HDPE
EXPLOSIVES+	N	C	2	1	L	Amb. Glass
THIANES	N	D	2	1	L	Amb. Glass
THIODIGLYCOL	N	E	1	500	mL	Amb. Glass

Groundwater Information:
Measured Well Depth: 35' bgs **Depth To Water:** 8.65' bgs

Comments:

TIME	TEMP	pH	ORP	SPC	TURB	DO
1620	21.74	8.27	94	0.290	0.00	5.57

Sketch Location:

Logged BY / Date: Kelly Robinson 6-7-13 *Reviewed BY / Date:* [signature] 6/7/13

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Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-061713-S-EP
ABG-061713-S-SAC
ABG-061013-S-ECBC
RFA / COC Number: ABG-060713-S-ECBC

Location Code: 013-HP004
Sample Number: ABG0012
Sample Name: 013-HP004-SS-ABG0012-REG
Sampling Method: ~~DPT~~ HA
Sample Type: SS *Sample Purpose:* REG
Sampling Equip: HA

Task: 013
Collection Date: 6-7-13
Collection Time: 1420
Start Depth: 0' bgs
End Depth: 1'
Sample Matrix: SOIL

QC Partners:
(TB) NA (ER) NA (FB) NA

Sample Team: RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
MUSTARD_SCREEN	N	J	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID = 0.6 ppm

Sketch Location: See Drill Log

Logged BY / Date: R. Bailey 6-7-13
Reviewed BY / Date: Dec 6-7-13

Shaw
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-061720 13-S-EP
ABG-061713-S-SAC
ABG-061013-S-ECBC
RFA / COC Number: ABG-060713-S-ECBC

Location Code: 013-HP004
Sample Number: ABG0013
Sample Name: 013-HP004-DS-ABG0013-REG
Sampling Method: ~~DPHA~~
Sample Type: DS *Sample Purpose:* REG
Sampling Equip: HA

Task: 013
Collection Date: 6-7-13
Collection Time: 1430
Start Depth: 2' bgs
End Depth: 4'
Sample Matrix: SOIL

QC Partners:
(TB) NA (ER) NA (FB) NA

Sample Team: RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
SPLP PERCH	N	C	1	4	oz	CWM
SPLP_TCE	N	D	1	4	oz	CWM
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
TOC	N	H	1	4	oz	CWM
MUSTARD_SCREEN	N	J	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID = 0.6 ppm

Sketch Location:
See Drill Log

Logged BY / Date: R. Bailey 6-7-13
Reviewed BY / Date: 6-7-13

Shaw
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-06172013-S-EP
ABG-061713-S-SAC
ABG-061013-S-ECBC
RFA / COC Number: ABG-060713-S-ECBC

Location Code: 013-HP004
Sample Number: ABG0014
Sample Name: 013-HP004-DS-ABG0014-REG
Sampling Method: DP
Sample Type: DS *Sample Purpose:* REG
Sampling Equip: DPT
QC Partners:
(TB) NA (ER) NA (FB) NA

Task: 013
Collection Date: 6-7-13
Collection Time: 1440
Start Depth: 8' bgs
End Depth: 10'
Sample Matrix: SOIL
Sample Team: RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
SPLP PERCH	N	C	1	4	oz	CWM
SPLP_TCE	N	D	1	4	oz	CWM
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
TOC	N	H	1	4	oz	CWM
MUSTARD_SCREEN	N	J	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID = 6.2 ppm

Sketch Location: See Drill Log

Logged BY / Date: R. Bailey 6-7-13 *Reviewed BY / Date:* DQK 6-7-13

HTRW DRILLING LOG

Company Name: GSE	Client: CB&T	Hole Number: 013-HP005	
	Drilling Subcontractor: GSE	Sheet: 1 of 4 Sheets	
Project: Redstone Arsenal	Location: RSA-013		
Name of Driller: Harry Hyatt	Manufacturer's Designation of Drill: Geoprobe 6620 DT		
Sizes and Types of Drilling and Sampling Equipment: Hand Auger; 2" Macro Core	Surface Elevation: TBD		
	Date Started: 6-10-13	Date Completed: 6-10-13	
Overburden Thickness: 28'	Depth Groundwater Encountered: 13		
Depth Drilled into Rock: 0	Depth to Water and Elapsed Time After Drilling Completed: 6.12		
Total Depth of Hole: 28'	Other Water Level Measurements (Specify): NA		

Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

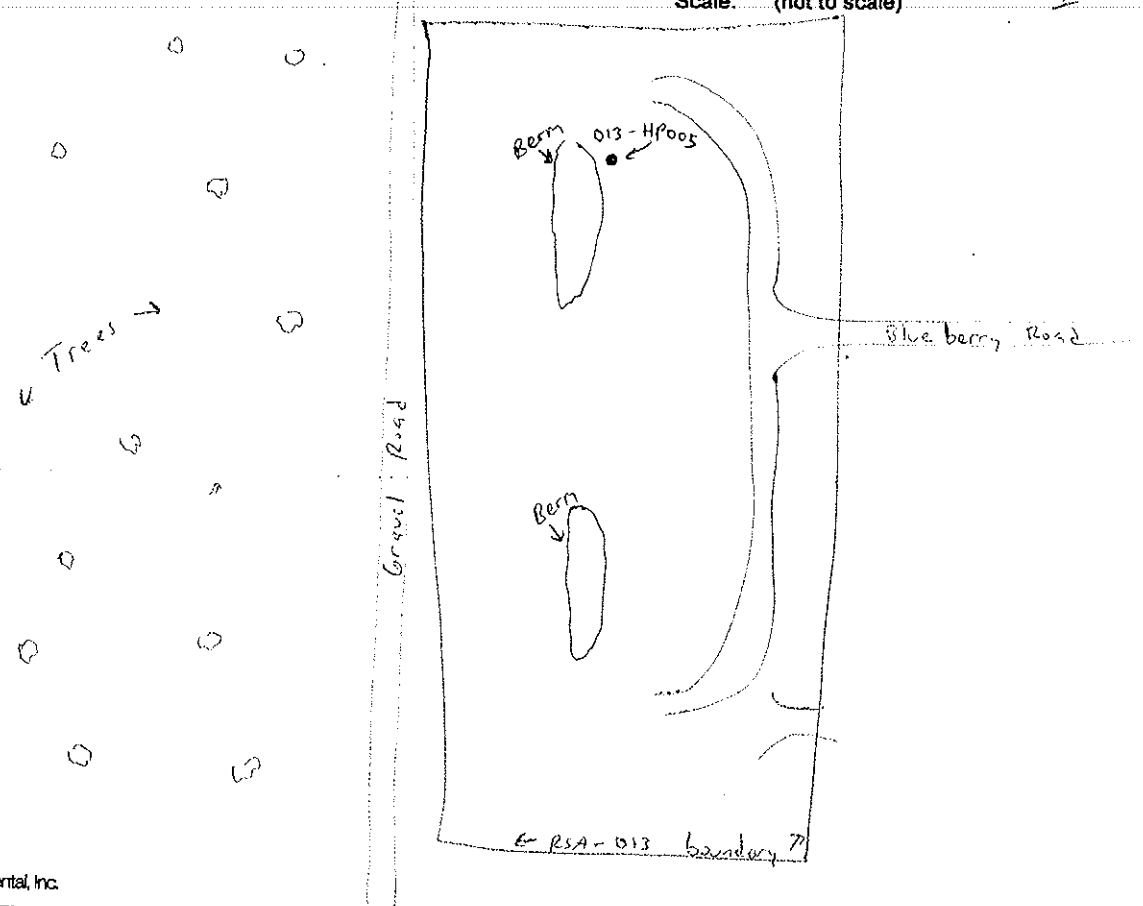
Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	✓	NA	perchlorate	Thiodiglycol	Thiony	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	NA	NA	piezometer	J. Ryan Bailey

Location Sketch/Comments:

NORTH

Scale: (not to scale)



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Project: Redstone Arsenal	Hole Number: 013-HP005

Shaw — HTRW DRILLING LOG (continuation sheet)

Hole Number: 013 - HP005

Project: R. Bailey Redstone Arsenal (RB)

Geologist: R. Bailey

Sheet 2 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS Lithology	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	0	0-5 → yellowish brown (10YR 5/4) silty clay, med. stiff, low plast. dry.	CL	0-5 4.4	NA ↓	ABG0015 (0-1)	5/5	Hand Auger to 5 ft
	1							
	2					ABG0016 MS/MSD (2-4)		
	3							
	4							
	5	5-10 → Dark yellowish brown (10YR 4/6) silty clay, stiff med. plast. moist.		5-10			5/5	
	6		CL	2.6				
	7							
	8							
	9							
	10							

Project: Redstone Arsenal

Hole Number: 013 - HP005

Shaw | HTRW DRILLING LOG | (continuation sheet) | Hole Number 013-HP005

Project: Redstone Arsenal | Geologist: R. Bailey | Sheet 3 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS Line	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	10	10-15 → Dark yellowish brown (10 YR 4/4) silty, sandy clay. Abundant sand & wood frags from 14-15 ft. Wet at 13 ft.	CL ϕ	10-15 7.9	NA ↓	1 AGB0017 (11-13)	5/5	▽ 13'
	15	15-20 → yellowish brown (10 YR 5/4) sandy clay, loose, wet.	CL	15-20 2.4			4/5	
	20							

Project: Redstone Arsenal | Hole Number: 013-HP005

Shaw | HTRW DRILLING LOG | (continuation sheet) | Hole Number 013-HP005

Project: Redstone Arsenal | Geologist: R. Bailey | Sheet 4 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS Line	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	20	20-25 → same as above.		20-25 1.8	NA ↓	NA ↓	3/5	
	21							
	22							
	23							
	24							
	25	25-28 → olive yellow (2.5Y 6/6) sand with some clay, saturated, loose. DPT refusal at 28 ft. Constructed piezometer @		25-28 6.7			3/5	
	26							
	27							
	28							
	29							
	30							

Project: Redstone Arsenal | Hole Number: 013-HP005

Temporary Piezometer

Project:	Redstone Arsenal	Piezometer Number:	013-HP005
Location:	Huntsville, Madison County, AL	Site Location:	RSA-013
Client:	Shaw E&I	Installation Date	6-10-13
Subcontractor:	GSE	Northing:	TBD
Driller:	Harry Huntoon	Easting:	TBD
Shaw Field Representative:	Brian Rhodes	Project Number:	136973

Top of Casing Elevation (ft): TBD
Top of Casing Stickup (ft): 1.5'

Land Surface Elevation (ft): TBD

Approximate Diameter of Borehole (in): 2

Well Casing Diameter (in): 1

Depth to Water (ft):
During Drilling: 13' bgs
Date: 6-10-13

Top of Bentonite (ft): 0

Top of Filter Pack (ft): 1' bgs

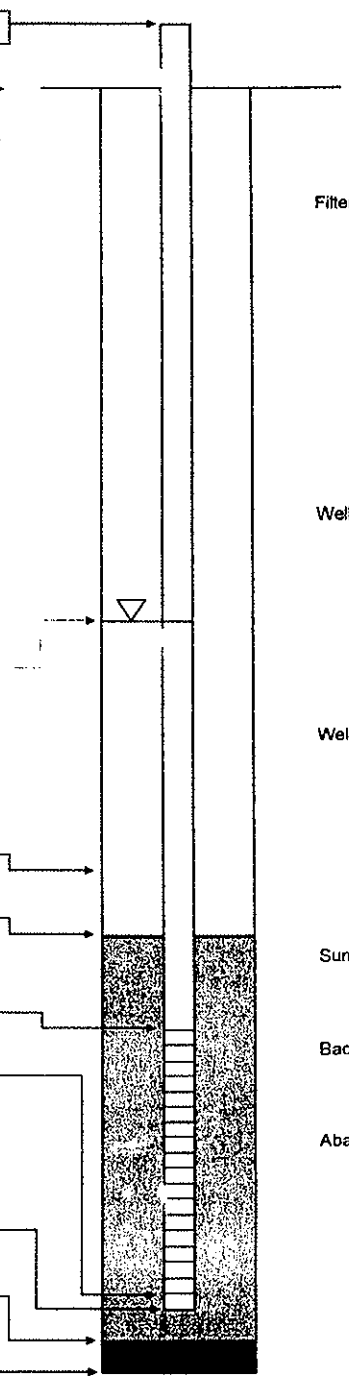
Top of Screen Interval (ft): 23

Bottom of Screen Interval (ft): 28

Bottom of Piezometer (ft): 28

Bottom of Filter Pack (ft): 28

Bottom of Borehole (ft): 28



Filter Pack Material:
Manufacturer: Southern Filter Media
Product Name: Filter Media
Size: 20/40
Installation: Prepacked Screen | Filter Sock | (Gravity) | Tremie

Well Casing:
Manufacturer: Mono Flex
Type: Sch 40 PVC
Diameter (in): 1

Well Screen Casing:
Manufacturer: Mono Flex
Type: Sch 40 PVC
Slot Size (in): 0.010
Slot Type: Continuous wrap | (Factory slot)

Sump/End Cap: 0

Backfill Material: None

Abandonment:
Date: TBD
Procedure: Natural fill | Grouted | Casing Removed | Completed as Well: TBD

Shaw
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Depths and heights are referenced to ground surface unless specified TOC.
All elevations are referenced to MSL (NAVD 88).
If completed as well - see well construction diagram.

Shaw™
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Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-06122013-W-EP

RFA / COC Number: ABG-060113-W-SAC

Location Code: 013-HP005
Sample Number: ABG3006
Sample Name: 013-HP005-GW-ABG3006-REG
Sampling Method: LF
Sample Type: GW *Sample Purpose:* REG
Sampling Equip: Peristaltic pump

Task: 013
Collection Date: 6/10/13
Collection Time: 1630
Start Depth: 23' BTOC
End Depth: 28' BTOC
Sample Matrix: WATER
Sample Team: CS/RB

QC Partners:
(TB) 06122013-TB (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
PERCH_6850	N	B	1	250	mL	HDPE
EXPLOSIVES+	N	C	2	1	L	Amb. Glass
THIANES	N	D	2	1	L	Amb. Glass
THIODIGLYCOL	N	E	1	500	mL	Amb. Glass

ERPIMS Values:
Sacode:
Lot Control#:

Groundwater Information:
Measured Well Depth: 28'BTOC **Depth To Water:** 12.65' BTOC

Comments:

Temp	PH	ORPmv	mS/cm	NTU	DO
26.99	8.69	51	0.336	71000	3.74

Sketch Location:

See drilling Log

Logged BY / Date: Chas Spencer 6/10/13
Chas Spencer

Reviewed BY / Date: Don Burton 6/10/13

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Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-061713-S-SAC
ABG-061113-S-EQBC

RFA / COC Number: ABG-061013-S-EBC

Location Code: 013-HP005
Sample Number: ABG0015
Sample Name: 013-HP005-SS-ABG0015-REG
Sampling Method: ~~DPT~~ HA
Sample Type: SS *Sample Purpose:* REG
Sampling Equip: HA
QC Partners:
(TB) NA (ER) NA (FB) NA

Task: 013
Collection Date: 6-10-13
Collection Time: (RB) ~~1520~~ 1520
Start Depth: 0' bgs
End Depth: 1'
Sample Matrix: SOIL
Sample Team: RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-HI-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
MUSTARD_SCREEN	N	J	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID = 4.4 ppm

Sketch Location: See Drill Log

Logged BY / Date: R. Bailey 6-10-13 *Reviewed BY / Date:* [illegible] 6-13

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-061713-S-SAC
ABG-061113-S-ECBC

RFA / COC Number: ABG-061013-S-BBC

Location Code: 013-HP005
Sample Number: ABG0016
Sample Name: 013-HP005-DS-ABG0016-REG
Sampling Method: ~~DP~~ HA
Sample Type: DS *Sample Purpose:* REG
Sampling Equip: HA

Task: 013
Collection Date: 6-10-13
Collection Time: 1530
Start Depth: 2' bgs
End Depth: 4'
Sample Matrix: SOIL
Sample Team: RB

QC Partners:
(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
SPLP PERCH	N	C	1	4	oz	CWM
SPLP_TCE	N	D	1	4	oz	CWM
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
TOC	N	H	1	4	oz	CWM
MUSTARD_SCREEN	N	J	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID = 4.4 ppm

Sketch Location: See Drill Log

Logged BY / Date: L. Bailey 6-10-13 *Reviewed BY / Date:* Andrea Preston 6/10/13

Shaw
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-061713-S-EP
ABG-061713-S-61C
ABG-061113-S-ECBC
RFA / COC Number: ~~ABG-061013-S-BEC~~ 0104

Location Code: 013-HP005
Sample Number: ABG0016-MS
Sample Name: 013-HP005-DS-ABG0016-MS
Sampling Method: ~~DP~~ HA
Sample Type: DS *Sample Purpose:* MS
Sampling Equip: HA

Task: 013
Collection Date: 6-10-13
Collection Time: 1530
Start Depth: 2' bgs
End Depth: 4'
Sample Matrix: SOIL
Sample Team: RB

QC Partners:
(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
SPLP PERCH	N	C	1	4	oz	CWM
SPLP_TCE	N	D	1	4	oz	CWM
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
TOC	N	H	1	4	oz	CWM
~~MUSTARD_SCREEN~~	~~N~~	~~J~~	~~1~~	~~4~~	~~oz~~	~~CWM~~ OLA

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID = 4.4 ppm

Sketch Location: See Drill Log

Logged BY / Date: R. Bailey 6-10-13 *Reviewed BY / Date:* Debbie Durston 6-10-13

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-061713-S-SAC
ABG-061113-S-ECBC
ABG-061013-S-BEC

RFA / COC Number: ~~ABG-061013-S-BEC~~ OK

Location Code: 013-HP005
Sample Number: ABG0016-MSD
Sample Name: 013-HP005-DS-ABG0016-MSD
Sampling Method: ~~DP~~ HA
Sample Type: DS *Sample Purpose:* MSD
Sampling Equip: HA

Task: 013
Collection Date: 6-10-13
Collection Time: 1530
Start Depth: 2' bgs
End Depth: 4'
Sample Matrix: SOIL
Sample Team: RB

QC Partners:
(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
SPLP PERCH	N	C	1	4	oz	CWM
SPLP_TCE	N	D	1	4	oz	CWM
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
TOC	N	H	1	4	oz	CWM
~~MUSTARD_SCREEN~~	~~N~~	~~J~~	~~1~~	~~4~~	~~oz~~	~~CWM~~ OCA

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID= 4.4 ppm

Sketch Location: See Drill Log

Logged BY / Date: R. Bailey 6-10-13 *Reviewed BY / Date:* [signature] 6/10/13

Sample Collection Log

Shaw E & I, Inc.

136973 - Redstone PMC

Manager: Don Burton

ABG-06172013-S-EP
ABG-061713-S-SAC
ABG-061113-S-EC3C

RFA / COC Number: ABG-061013-S-BBC

Location Code: 013-HP005

Task: 013

Sample Number: ABG0017

Collection Date: 6-10-13

Sample Name: 013-HP005-DS-ABG0017-REG

Collection Time: 1545

Sampling Method: DP

Start Depth: 11' bgs

Sample Type: DS *Sample Purpose:* REG

End Depth: 13'

Sampling Equip: DPT

Sample Matrix: SOIL

QC Partners:
(TB) NA (ER) NA (FB) NA

Sample Team: RB

ERPIMS Values:
Sacode:
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
SPLP PERCH	N	C	1	4	oz	CWM
SPLP_TCE	N	D	1	4	oz	CWM
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
TOC	N	H	1	4	oz	CWM
MUSTARD_SCREEN	N	J	1	4	oz	CWM

Comments: PID = 7.9 ppm

Sketch Location:

See Drill Log

Logged BY / Date: R. Bailey 6-10-13 *Reviewed BY / Date:* [signature] 6-10-13

HTRW DRILLING LOG

Company Name: GSE	Client: CB&T	Hole Number: 013-HP006	
Project: Redstone Arsenal	Drilling Subcontractor: GSE	Sheet: 1 of 4 Sheets	
Name of Driller: Harry Huntoon	Location: RSA-013		
Sizes and Types of Drilling and Sampling Equipment: Hand Auger; 2" Macro Core	Manufacturer's Designation of Drill: Geoprobe 6620 DT		
	Surface Elevation: TBD		
	Date Started: 6-10-13	Date Completed: 6-10-13	
Overburden Thickness: 26'	Depth Groundwater Encountered: 14'		
Depth Drilled into Rock: 0	Depth to Water and Elapsed Time After Drilling Completed: 7.04 after 10min		
Total Depth of Hole: 26'	Other Water Level Measurements (Specify): NA		

Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

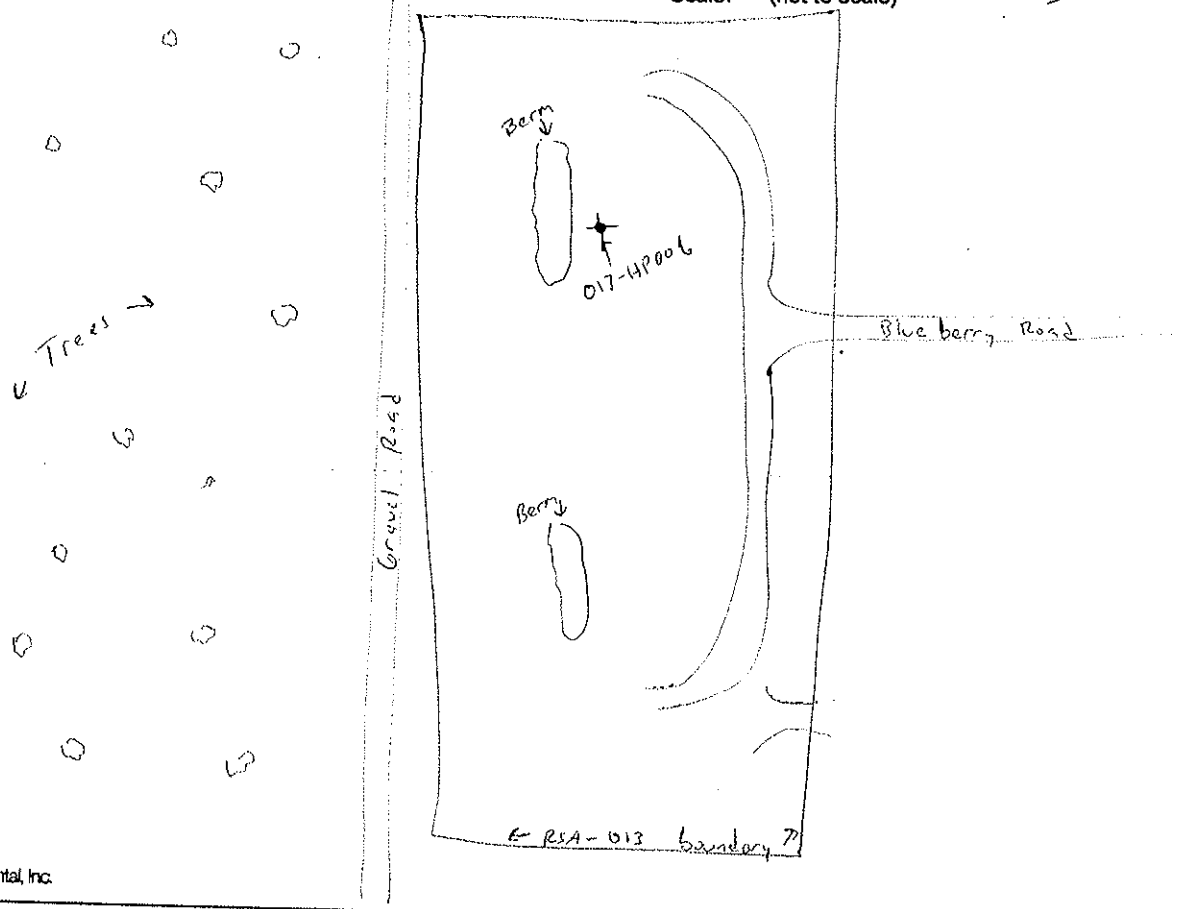
Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	✓	NA	Perchlorate	Thianes	Thiodiglycol	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	NA	NA	piezometer	J. Ryan Bailey

Location Sketch/Comments:

NORTH

Scale: (not to scale)



Shaw Shaw Environmental, Inc.

Project: Redstone Arsenal	Hole Number: 013-HP006

Shaw | HTRW DRILLING LOG | (continuation sheet) | Hole Number 013-HP006

Project: R. Bailey Redstone Arsenal | Geologist: R. Bailey | Sheet 2 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS Code	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	0	0-5 → Reddish yellow (7.5 YR 6/6) silty clay. stiff. low plast. Dry	CL	0-5 2.2	NA ↓	ABC0018 (0-1)	5/5	Hand Auger to 5 ft
	1							
	2							
	3					ABC0019 (2-4)		
	4							
	5	5-10 → strong brown (7.5 YR 5/6) silty clay with some gray mottling. stiff. med. Plast. slightly moist.	CL	5-10 0.6			5/5	
	6							
	7							
	8							
	9							
	10							

Project: Redstone Arsenal | Hole Number: 013-HP006

Shaw

HTRW DRILLING LOG

(continuation sheet)

Hole Number 013-HP006

Project Redstone Arsenal | Geologist R. Bailey | Sheet 3 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS Line	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	10	10-15 → Dark yellowish brown (10 YR 4/4) silty, sandy clay. med. stiff. med. plast. V. Moist to ~~on~~ 14 ft where wet.	CL	10-15 5.8	NA ↓	ABG0020 (12-14)	5/5	▽ 14'
	15	15-20 → yellowish brown (10 YR 5/6) sandy clay. saturated.		15-20 6.4			5/5	
	20							

Project Redstone Arsenal | Hole Number 013-HP006

Shaw

HTRW DRILLING LOG

(continuation sheet)

Hole Number 013-HP006

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 4 of 4 Sheets

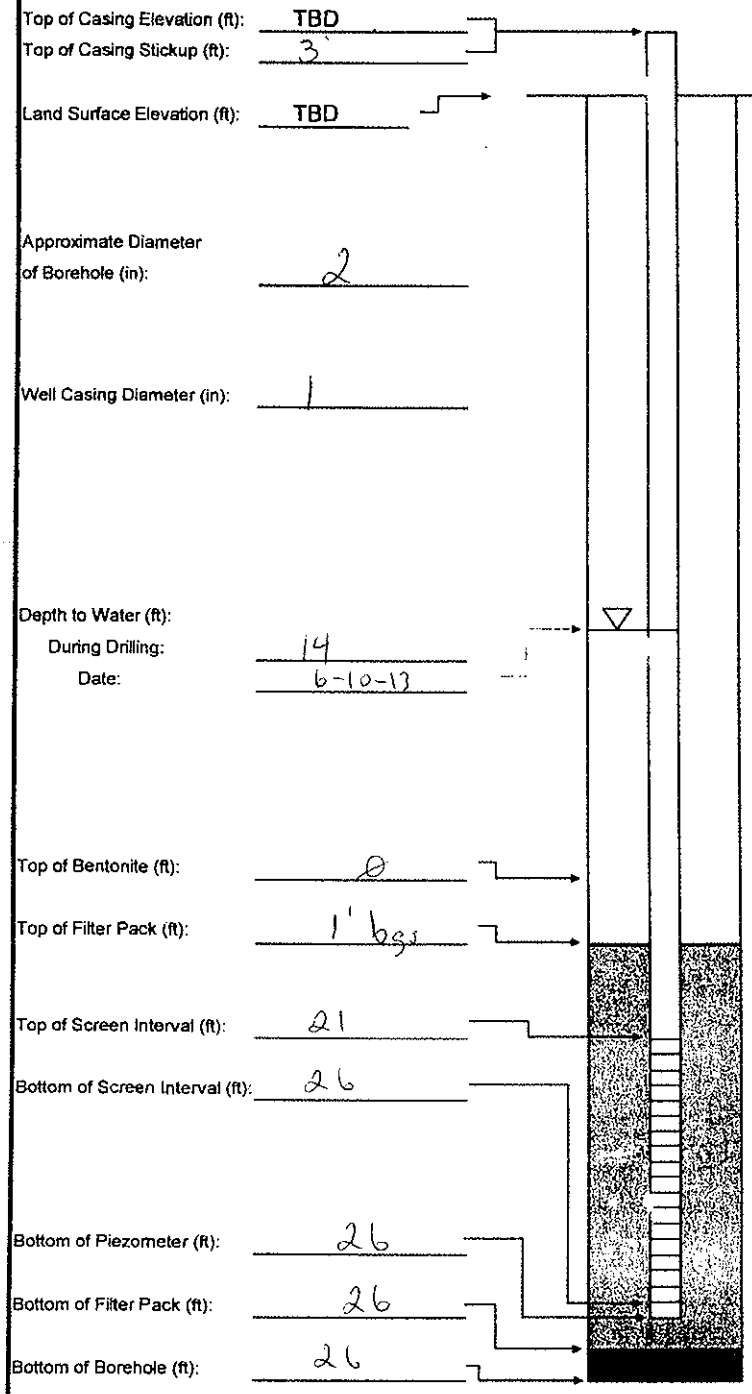
Elev (ft)	Depth (ft) bgs	Description of Materials	USCS Code	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	20	20-25 → Brownish yellow (10YR 6/8) sand with clay. Loose, saturated,		20-25 ↓ 7.9	NA ↓	NA ↓	5/5	
	21							
	22							
	23							
	24							
	25	25-26 → No recovery. DPT refusal at 26 ft.		NA				
	26							
	27							
	28							
	29							
	30							

Project: Redstone Arsenal

Hole Number: 013-HP006

Temporary Piezometer

Project:	Redstone Arsenal	Piezometer Number:	013-HP006
Location:	Huntsville, Madison County, AL	Site Location:	RSA - 013
Client:	Shaw E&I	Installation Date	6-10-13
Subcontractor:	GSE	Northing:	TBD
Driller:	Harry Huntoon	Easting:	TBD
Shaw Field Representative:	Brian Rhodes	Project Number:	136973



Top of Casing Elevation (ft): TBD
Top of Casing Stickup (ft): 3
Land Surface Elevation (ft): TBD
Approximate Diameter of Borehole (in): 2
Well Casing Diameter (in): 1
Depth to Water (ft):
During Drilling: 14
Date: 6-10-13
Top of Bentonite (ft): 0
Top of Filter Pack (ft): 1' bgs
Top of Screen Interval (ft): 21
Bottom of Screen Interval (ft): 26
Bottom of Piezometer (ft): 26
Bottom of Filter Pack (ft): 26
Bottom of Borehole (ft): 26

Filter Pack Material:
Manufacturer: Southern Filter Media
Product Name: Filter Media
Size: 20/40
Installation: Prepacked Screen, Filter Sock, (Gravity), Tremie

Well Casing:
Manufacturer: Mono Flex
Type: Sch 40 PVC
Diameter (in): 1

Well Screen Casing:
Manufacturer: Mono Flex
Type: Sch 40 PVC
Slot Size (in): 0.010
Slot Type: Continuous wrap, (Factory slot)

Sump/End Cap: ~~0~~

Backfill Material: None

Abandonment:
Date: TBD
Procedure: Natural fill, Grouted, Casing Removed
Completed as Well: TBD

Shaw
Shaw E & I, Inc.

Depths and heights are referenced to ground surface unless specified TOC.
All elevations are referenced to MSL (NAVD 88).
If completed as well - see well construction diagram.

Sample Collection Log

Shaw E & I, Inc.

136973 - Redstone PMC

Manager: Don Burton

ABG-06122013-W-EQ

RFA / COC Number: ABG-061113-W-SAC

Location Code: 013-HP006

Sample Number: ABG3007

Sample Name: 013-HP006-GW-ABG3007-REG

Sampling Method: LF

Sample Type: GW *Sample Purpose:* REG

Sampling Equip: Peristaltic pump

QC Partners:

(TB) 06122013-TB (ER) NA (FB) NA

Task: 013

Collection Date: 6/10/13

Collection Time: 1610

Start Depth: 21' BTOC

End Depth: 26' BTOC

Sample Matrix: WATER

Sample Team: CS/RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
PERCH_6850	N	B	1	250	mL	HDPE
EXPLOSIVES+	N	C	2	1	L	Amb. Glass
THIANES	N	D	2	1	L	Amb. Glass
THIODIGLYCOL	N	E	1	500	mL	Amb. Glass

ERPIMS Values:

Sacode:

Lot Control#:

Groundwater Information:

Measured Well Depth: 26' BTOC **Depth To Water:** 9.04' BTOC

Comments:

Temp	pH	ORP mV	mS/cm	NTU	mg/L DO
31.17	8.80	32	0.345	71000	3.15

Sketch Location:

See drilling log

Logged BY / Date: Chris Spencer 6/10/13

Chris Spencer

Reviewed BY / Date: 6/10/13

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Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-061713-S-SAC
ABG-061113-S-EQBC

RFA / COC Number: ABG-061013-S-EBC

Location Code: 013-HP006
Sample Number: ABG0018
Sample Name: 013-HP006-SS-ABG0018-REG
Sampling Method: ~~DPT~~ HA
Sample Type: SS *Sample Purpose:* REG
Sampling Equip: HA

Task: 013
Collection Date: 6-10-13
Collection Time: 1310
Start Depth: 0' bgs
End Depth: 1'
Sample Matrix: SOIL

QC Partners:
(TB) NA (ER) NA (FB) NA

Sample Team: RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
MUSTARD_SCREEN	N	J	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID= 2.2 ppm

Sketch Location: See Drill Log

Logged BY / Date: L. Bailey 6-10-13 *Reviewed BY / Date:* 6-10-13

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Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-06172013-S-EA
ABG-061713-S-SAC
ABG-061113-S-ECBC

RFA / COC Number: ABG-061013-S-EBC

Location Code: 013-HP006
Sample Number: ABG0019
Sample Name: 013-HP006-DS-ABG0019-REG
Sampling Method: ~~DP~~ HA
Sample Type: DS *Sample Purpose:* REG
Sampling Equip: HA

QC Partners:
(TB) NA (ER) NA (FB) NA

Task: 013
Collection Date: 6-10-13
Collection Time: 1340
Start Depth: 2' bgs
End Depth: 4'
Sample Matrix: SOIL
Sample Team: RB

ERPIMS Values:
Sacode:
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
SPLP PERCH	N	C	1	4	oz	CWM
SPLP_TCE	N	D	1	4	oz	CWM
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
TOC	N	H	1	4	oz	CWM
MUSTARD_SCREEN	N	J	1	4	oz	CWM

Comments: PID = 2.2 ppm

Sketch Location:
See Drill Log

Logged BY / Date: R. Bailey 6-10-13 *Reviewed BY / Date:* 6-10-13

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Shaw E & I, Inc.

Sample Collection Log

ABG-061713-S-EA
ABG-061713-S-SAC
ABG-061113-S-EQBC

136973 - Redstone PMC
Manager: Don Burton

RFA / COC Number: ABG-061013-S-EBC

Location Code: **013-HP006**
Sample Number: **ABG0020**
Sample Name: **013-HP006-DS-ABG0020-REG**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**
Sampling Equip: DPT
QC Partners:
(TB) NA (ER) NA (FB) NA

Task: 013
Collection Date: 6-10-13
Collection Time: 1400
Start Depth: 12' bgs
End Depth: 14'
Sample Matrix: **SOIL**
Sample Team: RB

ERPIMS Values:
Sacode:
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
SPLP PERCH	N	C	1	4	oz	CWM
SPLP_TCE	N	D	1	4	oz	CWM
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
TOC	N	H	1	4	oz	CWM
MUSTARD_SCREEN	N	J	1	4	oz	CWM

Comments: PID= 5.8 ppm

Sketch Location: See Drill Log

Logged BY / Date: R. Bailey 6-10-13 *Reviewed BY / Date:* [signature] 6-10-1

HTRW DRILLING LOG

Company Name: GSE	Client: CB&I
Project: Redstone Arsenal	Drilling Subcontractor: GSE
Name of Driller: Harry Huntoon	Location: RSA-013
Sizes and Types of Drilling and Sampling Equipment: Hand Auger; 2" Macro Core	Manufacturer's Designation of Drill: Geoprobe 6620 DT
	Surface Elevation: TBD
	Date Started: 6-10-13 / Date Completed: 6-10-13
Overburden Thickness: 32'	Depth Groundwater Encountered: 12'
Depth Drilled into Rock: 0	Depth to Water and Elapsed Time After Drilling Completed: 11.25 after 10min
Total Depth of Hole: 32'	Other Water Level Measurements (Specify): NA

Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

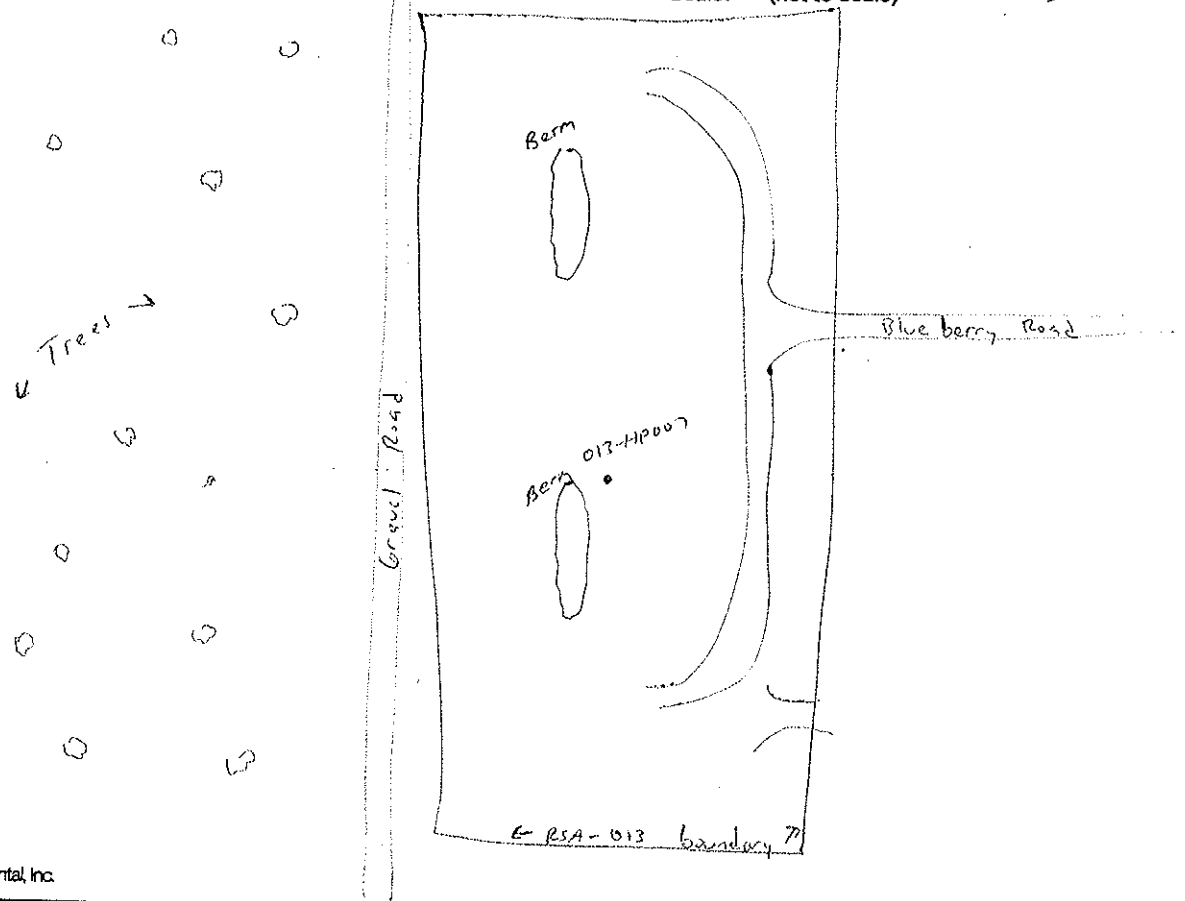
Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	✓	NA	Perchlorate	Thiodiglycol	Mustard	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	NA	NA	piezometer	J. Ryan Bailey

Location Sketch/Comments:

NORTH

Scale: (not to scale)



Shaw® Shaw Environmental, Inc.

Project: Redstone Arsenal

Hole Number: 013-HP007

Shaw Environmental, Inc.

HTRW DRILLING LOG

(continuation sheet)

Hole Number 013-HP007

Project R. Bailey Redstone Arsenal

Geologist R. Bailey

Sheet 2 of 5 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS Name	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	0	0-5 → Yellowish brown (10 YR 5/6) silty clay, med. stiff Low Plast. Dry.	CL	0-5 0.2	NA ↓	ABG0021 (0-1)	5/5	Hand Auger to 5 ft
	1							
	2							
	3					ABG0022 ABG0023 (2-4)		
	4							
	5	5-10 → Dark yellowish brown (10 YR 4/6) silty clay, stiff. med. plast. moist	CL	5-10 2.6			5/5	
	6							
	7							
	8							
	9							
	10							

Project Redstone Arsenal

Hole Number 013-HP007

Shaw — HTRW DRILLING LOG (continuation sheet)

Hole Number: 013-HP007

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 3 of 5 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS Letter	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	10	10-15 → strong brown (7.5 YR 4/6) silty, sandy clay, med. soft. wet at 12 ft.		10-15 4.7	NA ↓	ABG0024 (10-12)	5/5	▽ 12'
	15	15-20 → yellowish brown (10 YR 5/6) sandy, silty clay, stiff. med. plast. wet.		15-20 6.6			5/5	
	20							

Project: Redstone Arsenal

Hole Number: 013-HP007

Shaw — HTRW DRILLING LOG (continuation sheet)

Hole Number: 013-HP007

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 4 of 5 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS Code	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	20	20-25→ brownish yellow (10yr 5/8) sandy clay. Loose, saturated.		20-25 1.7	NA ↓	NA ↓	2/5	
	21							
	22							
	23							
	24							
	25	25-30→ Brownish yellow (10yr 6/6) sand with clay. Saturated.		25-30 5.1			2/5	
	26							
	27							
	28							
	29							
	30							

Project: Redstone Arsenal

Hole Number: 013-HP007

Shaw Shaw Environmental Inc.

HTRW DRILLING LOG

(continuation sheet)

Hole Number 013 - HP007

Project Redstone Arsenal

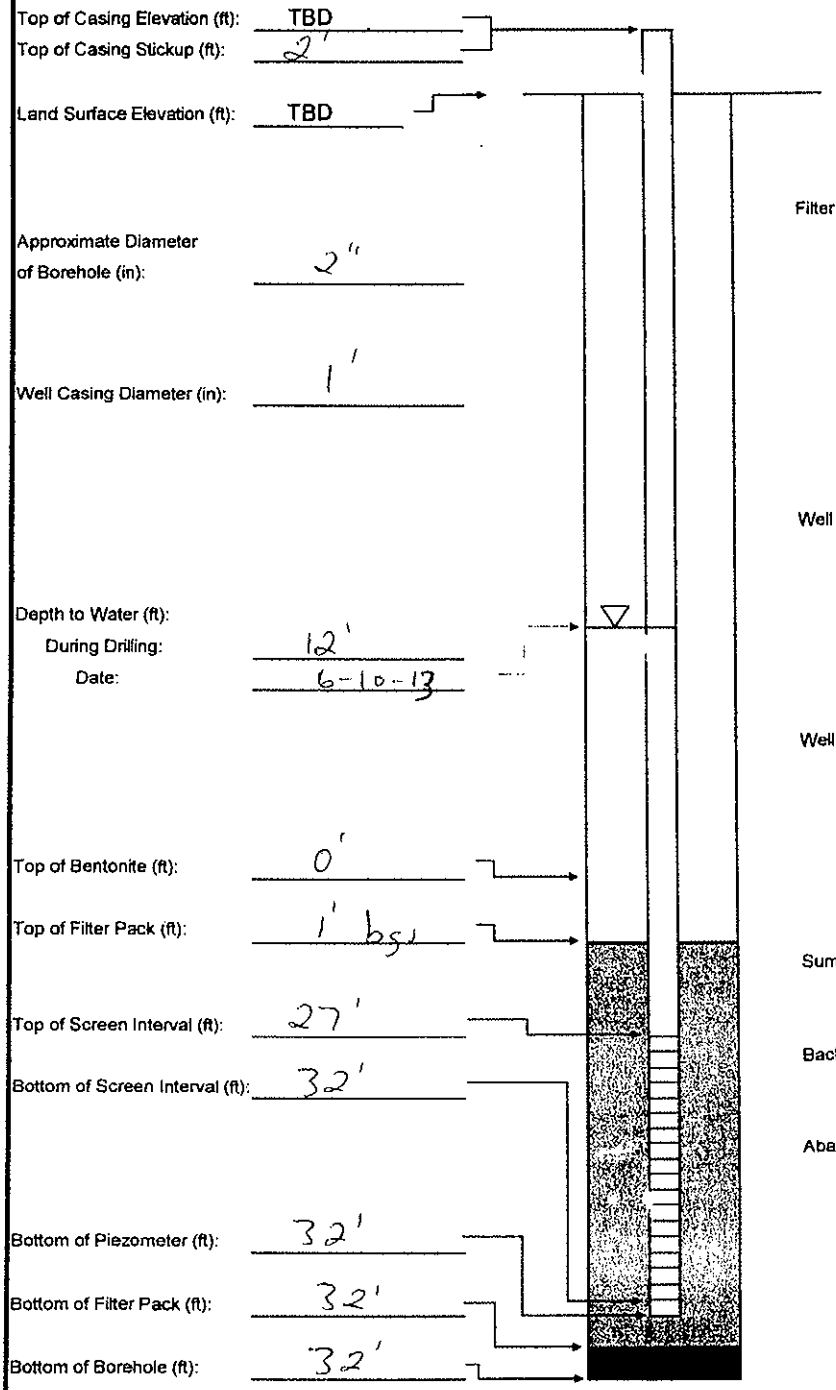
Geologist R. Bailey

Sheet 5 of 5 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS Code	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	30	30-32 → No recovery.		~~307~~ NA	N.A ↓	NA	0/5	
	31	DPT refusal at 32 ft.						
	32	Constructed piezometer.						
	33							
	34							
	35							
	36							
	37							
	38							
	39							
	40							

Temporary Piezometer

Project:	Redstone Arsenal	Piezometer Number:	013-HP007
Location:	Huntsville, Madison County, AL	Site Location:	RSA-013
Client:	Shaw E&I	Installation Date	6-10-13
Subcontractor:	GSE	Northing:	TBD
Driller:	Harry Hunton	Easting:	TBD
Shaw Field Representative:	Brian Rhodes	Project Number:	136973



Top of Casing Elevation (ft): TBD
Top of Casing Stickup (ft): 2'
Land Surface Elevation (ft): TBD
Approximate Diameter of Borehole (in): 2"
Well Casing Diameter (in): 1"
Depth to Water (ft):
During Drilling: 12'
Date: 6-10-13
Top of Bentonite (ft): 0'
Top of Filter Pack (ft): 1' bgs
Top of Screen Interval (ft): 27'
Bottom of Screen Interval (ft): 32'
Bottom of Piezometer (ft): 32'
Bottom of Filter Pack (ft): 32'
Bottom of Borehole (ft): 32'

Filter Pack Material:
Manufacturer: Southern Filter Media
Product Name: Filter Media
Size: 20/40
Installation: Prepacked Screen, Filter Sock, (Gravity), Tremie

Well Casing:
Manufacturer: Mono Flex
Type: Sch 40 PVC
Diameter (in): 1

Well Screen Casing:
Manufacturer: Mono Flex
Type: Sch 40 PVC
Slot Size (in): 0.010
Slot Type: Continuous wrap, (Factory slot)

Sump/End Cap: -0-

Backfill Material: None

Abandonment:
Date: TBD
Procedure: Natural fill, Grouted, Casing Removed
Completed as Well: TBD

Shaw
Shaw E & I, Inc.

Depths and heights are referenced to ground surface unless specified TOC.
All elevations are referenced to MSL (NAVD 88).
If completed as well - see well construction diagram.

Shaw™
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Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-06122013-W-EP

RFA / COC Number: ABG-061113-W-SAC

Location Code: 013-HP007
Sample Number: ABG3008
Sample Name: 013-HP007-GW-ABG3008-REG
Sampling Method: LF
Sample Type: GW *Sample Purpose:* REG
Sampling Equip: ~~Bladder~~ Peristaltic pump

Task: 013
Collection Date: 6/10/13
Collection Time: 1455
Start Depth: 27' BTOC
End Depth: 32' BTOC
Sample Matrix: WATER
Sample Team: CS/RB

QC Partners:
(TB) ABG06122013-TB (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
PERCH_6850	N	B	1	250	mL	HDPE
EXPLOSIVES+	N	C	2	1	L	Amb. Glass
THIANES	N	D	2	1	L	Amb. Glass
THIODIGLYCOL	N	E	1	500	mL	Amb. Glass

ERPIMS Values:
Sacode:
Lot Control#:

Groundwater Information:
Measured Well Depth: 32'BTOC **Depth To Water:** 49.85'BTOC

Comments: None CS

Temp	pH	ORPmV	mS/cm	NTU	DO
26.40	9.59	62	0.396	71000	21.50

Sketch Location:

See boring Log

Logged BY / Date: Chris Spencer 6/10/13 Chris Spencer
Reviewed BY / Date: 6/10/13

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Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-061713-S-SAC
ABG-061113-S-ECBC
ABG-061013-S-EBC

RFA / COC Number: ABG-061013-S-EBC

Location Code: **013-HP007**
Sample Number: **ABG0021**
Sample Name: **013-HP007-SS-ABG0021-REG**
Sampling Method: ~~DPT~~ HA
Sample Type: **SS** *Sample Purpose:* **REG**
Sampling Equip: HA

Task: **013**
Collection Date: 6-10-13
Collection Time: 1140
Start Depth: 0' bgs
End Depth: 1'
Sample Matrix: **SOIL**
Sample Team: KB

QC Partners:
(TB) NA (ER) NA (FB) NA

ERPIMS Values:
Sacode:
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
MUSTARD_SCREEN	N	J	1	4	oz	CWM

Comments: PID = 0.2 ppm

Sketch Location:

See Drill Log

Logged BY / Date: R. Bailey 6-10-13 *Reviewed BY / Date:* [signature] 6-10-13

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-061713-S-EA
ABG-061713-S-EAC
ABG-061113-S-EQBC
RFA / COC Number: ABG-061013-S-EBC

Location Code: 013-HP007
Sample Number: ABG0022
Sample Name: 013-HP007-DS-ABG0022-REG
Sampling Method: ~~DP~~ HA
Sample Type: DS *Sample Purpose:* REG
Sampling Equip: HA

Task: 013
Collection Date: 6-10-13
Collection Time: 1150
Start Depth: 2' bgs
End Depth: 4'
Sample Matrix: SOIL
Sample Team: RB

QC Partners:
(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
SPLP PERCH	N	C	1	4	oz	CWM
SPLP_TCE	N	D	1	4	oz	CWM
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
TOC	N	H	1	4	oz	CWM
MUSTARD_SCREEN	N	J	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID= 0.2 ppm

Sketch Location:

See Drill Log

Logged BY / Date: R. Bailey 6-10-13 *Reviewed BY / Date:* [signature] 6-10-13

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG- 061713-S-EA
ABG- 061713-S-SAC
ABG- 061113-S-ECBC
~~ABG-061013-S-EBG~~ 0104

RFA / COC Number:

Location Code: 013-HP007
Sample Number: ABG0023
Sample Name: 013-HP007-DS-ABG0023-FD
Sampling Method: ~~DPT~~ HA
Sample Type: DS *Sample Purpose:* FD
Sampling Equip: HA
QC Partners:
(TB) NA (ER) NA (FB) NA

Task: 013
Collection Date: 6-10-13
Collection Time: 1150
Start Depth: 2' bgs
End Depth: 4'
Sample Matrix: SOIL
Sample Team: RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-HI-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
SPLP PERCH	N	C	1	4	oz	CWM
SPLP_TCE	N	D	1	4	oz	CWM
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
TOC	N	H	1	4	oz	CWM
~~MUSTARD_SCREEN~~	~~N~~	~~J~~	~~1~~	~~4~~	~~oz~~	~~CWM~~

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID= 0.2 ppm

Sketch Location:

See Drill Log

Logged BY / Date: R. Bailey 6-10-13 *Reviewed BY / Date:* [signature] 6-10-13

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-061712013-S-EP
ABG-061713-S-SAC
ABG-061113-S-ECBC
RFA / COC Number: ABG-061013-S-EBC

Location Code: 013-HP007
Sample Number: ABG0024
Sample Name: 013-HP007-DS-ABG0024-REG
Sampling Method: ~~DPT~~ NA
Sample Type: DS *Sample Purpose:* REG
Sampling Equip: DPT

Task: 013
Collection Date: 6-10-13
Collection Time: 1210
Start Depth: 10' 6"
End Depth: 12'
Sample Matrix: SOIL

QC Partners:
(TB) NA (ER) NA (FB) NA

Sample Team: RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
SPLP PERCH	N	C	1	4	oz	CWM
SPLP_TCE	N	D	1	4	oz	CWM
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
TOC	N	H	1	4	oz	CWM
MUSTARD_SCREEN	N	J	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID= 4.7 ppm

Sketch Location: See Drill Log

Logged BY / Date: R. Bailey 6-10-13 *Reviewed BY / Date:* [signature] 6-10-13

HTRW DRILLING LOG

Company Name: GSE	Client: CB&J
Project: Redstone Arsenal	Drilling Subcontractor: GSE
Name of Driller: Harry Huntoon	Location: RSA-013
Sizes and Types of Drilling and Sampling Equipment: Hand Auger; 2" Macro Core	Manufacturer's Designation of Drill: Geoprobe 6620 DT
	Surface Elevation: TBD
Overburden Thickness: 34'	Date Started: 6-10-13 / Date Completed: 6-10-13
Depth Drilled into Rock: 0	Depth Groundwater Encountered: 14'
Total Depth of Hole: 34'	Depth to Water and Elapsed Time After Drilling Completed: 10.20 after 10 min
	Other Water Level Measurements (Specify): NA

Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

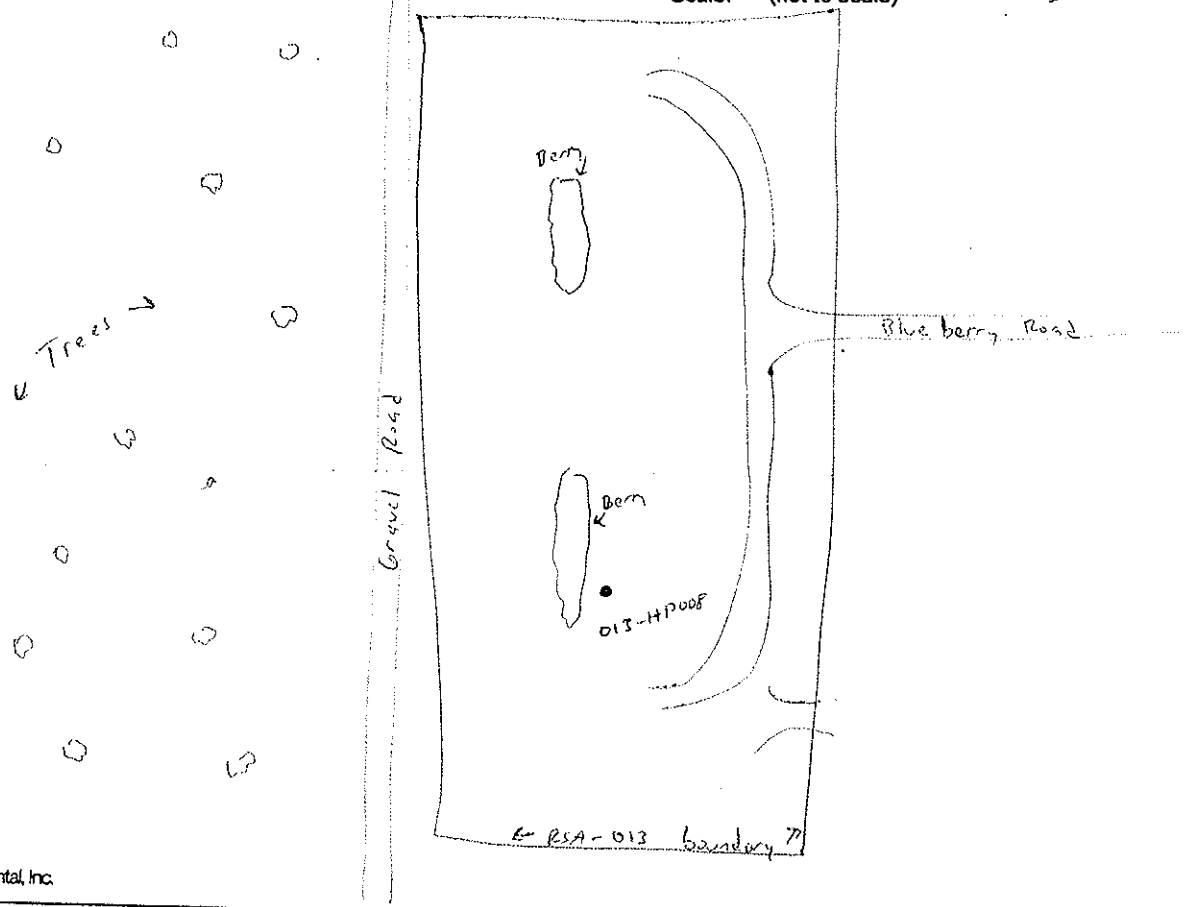
Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	V	NA	Perchlorate	Explosives	mustard	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	(PB) Yes NA	NA	(PB) NA piezometer	J. Ryan Bailey

Location Sketch/Comments:

NORTH

Scale: (not to scale)



Shaw Shaw Environmental, Inc.

Project: Redstone Arsenal	Hole Number: 013-HP008

Shaw Stone & Webster, Inc.

HTRW DRILLING LOG

(continuation sheet)

Hole Number 013-HP008

Project R. Bailey Redstone Arsenal

Geologist R. Bailey

Sheet 2 of 5 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS Line	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	0	0-5 → Dark yellowish brown 10YR 4/6 silty clay, stiff. Low plast. Dry.	CL	0-5 0.7	NA ↓	ABG0025 MS/MSD (0-1)	5/5	Hand Auger to 5 ft
	1							
	2							
	3					ABG0026 (2-4)		
	4							
	5	5-10 → Brown (7.5 YR 4/4) clay with sand & silt. Med. stiff. Med. plast. moist.		5-10			5/5	
	6			7.5				
	7							
	8							
	9							
	10							

Project Redstone Arsenal

Hole Number 013-HP008

Shaw — HTRW DRILLING LOG (continuation sheet)

Hole Number 013-HP008

Project: Redstone Arsenal | Geologist: R. Bailey | Sheet 3 of 5 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS Line	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	10	10-15 → Brown (7.5 YR 4/4) silty, sandy clay, Med. soft Low Plast. V. moist to 14 ft. wet from 14-15 ft.	CL	10-15 6.8	NA ↓	ABG00027 (12-14)	5/5	▽ 14'
	11							
	12							
	13							
	14							
	15	15-20 → yellowish brown (10 YR 5/6) silty, sandy clay, med. soft. Low Plast. V. moist to wet.		15-20 11.4				
	16							
	17							
	18							
	19							
	20							

Project: Redstone Arsenal | Hole Number: 013-HP008

Shaw

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-HP008

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 4 of 5 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS Line	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	20	20-25 → Brownish yellow (10YR 6/6) sandy clay, soft, saturated		20-25 6.2	NA ↓	NA	5/5	
	21							
	22							
	23							
	24							
	25	25-30 → same as above		25-30 f.4				
	26							
	27							
	28							
	29							
	30							

Project: Redstone Arsenal

Hole Number: 013-HP008

Shaw | HTRW DRILLING LOG | (continuation sheet) | Hole Number 013-HP008

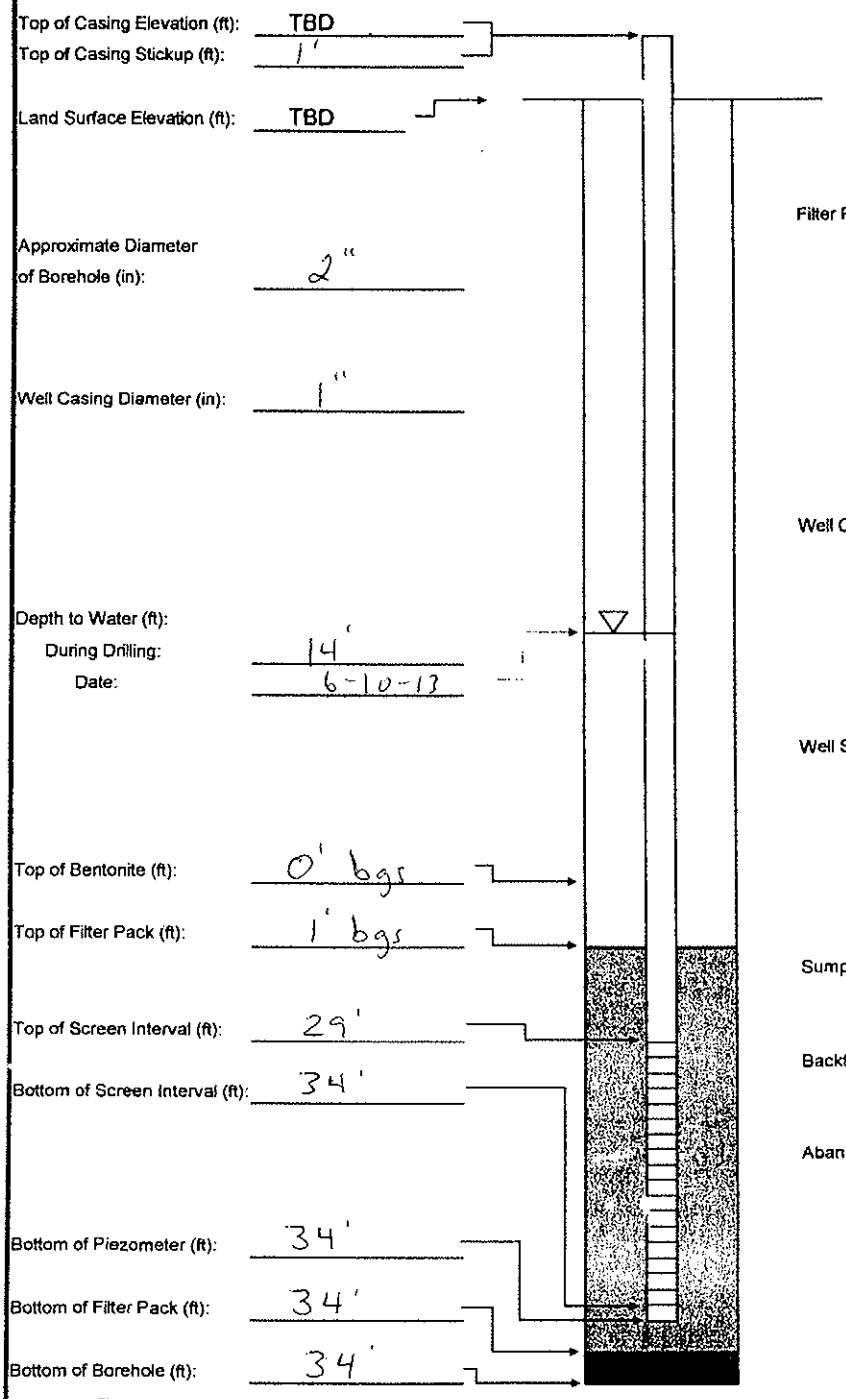
Project: Redstone Arsenal | Geologist: R. Bailey | Sheet 5 of 5 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/Lithology	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	30	30-34 → No recovery. Almost pure sand determined from empty sleeve. Saturated DPT refusal at 34' bgs. Constructed piezometer		NA	NA ↓	NA	0/5	
	31							
	32							
	33							
	34							
	35							
	36							
	37							
	38							
	39							
	40							

Project: Redstone Arsenal | Hole Number 013-HP008

Temporary Piezometer

Project:	Redstone Arsenal	Piezometer Number:	013-HP008
Location:	Huntsville, Madison County, AL	Site Location:	RSA-013
Client:	Shaw E&I	Installation Date	6-10-13
Subcontractor:	GSE	Northing:	TBD
Driller:	Harry Huntoon	Easting:	TBD
Shaw Field Representative:	Brian Rhodes	Project Number:	136923



Top of Casing Elevation (ft): TBD
Top of Casing Stickup (ft): 1'
Land Surface Elevation (ft): TBD
Approximate Diameter of Borehole (in): 2"
Well Casing Diameter (in): 1"
Depth to Water (ft): During Drilling: 14' Date: 6-10-13
Top of Bentonite (ft): 0' bgs
Top of Filter Pack (ft): 1' bgs
Top of Screen Interval (ft): 29'
Bottom of Screen Interval (ft): 34'
Bottom of Piezometer (ft): 34'
Bottom of Filter Pack (ft): 34'
Bottom of Borehole (ft): 34'

Filter Pack Material:
Manufacturer: Southern Filter Media
Product Name: Filter Media
Size: 20/40
Installation: Prepacked Screen, Filter Sock, (Gravity), Tremie

Well Casing:
Manufacturer: Mono Flex
Type: Sch 40 PVC
Diameter (in): 1

Well Screen Casing:
Manufacturer: Mono Flex
Type: Sch 40 PVC
Slot Size (in): 0.010
Slot Type: Continuous wrap, (Factory slot)

Sump/End Cap: -0-

Backfill Material: None

Abandonment:
Date: TBD
Procedure: Natural fill, Grouted, Casing Removed
Completed as Well: TBD

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Depths and heights are referenced to ground surface unless specified TOC.
All elevations are referenced to MSL (NAVD 88).
If completed as well - see well construction diagram.

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Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-06122013-W-SA

RFA / COC Number: ABG-061113-W-SAC

Location Code: **013-HP008**
Sample Number: **ABG3009**
Sample Name: **013-HP008-GW-ABG3009-REG**
Sampling Method: **LF**
Sample Type: **GW** *Sample Purpose:* **REG**
Sampling Equip: Peristaltic pump
QC Partners:
(TB) 06122013-TB (ER) NA (FB) NA

Task: **013**
Collection Date: 6/10/13
Collection Time: 1530
Start Depth: 29' BTOC
End Depth: 34' BTOC
Sample Matrix: **WATER**
Sample Team: CS/RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
PERCH_6850	N	B	1	250	mL	HDPE
EXPLOSIVES+	N	C	2	1	L	Amb. Glass
THIANES	N	D	2	1	L	Amb. Glass
THIODIGLYCOL	N	E	1	500	mL	Amb. Glass

ERPIMS Values:
Sacode:
Lot Control#:

Groundwater Information:
Measured Well Depth: 34'BTOC **Depth To Water:** 6.65'BTOC.

Comments:

Temp	pH	ORP mv	mS/cm	NTU	mg/L DO
24.67	9.07	79	0.219	~~000~~ 71000	7.32

Sketch Location:

See drilling log

Logged BY / Date: Chris Spencer 6/10/13
Chris Spencer

Reviewed BY / Date: 6/19/13

Shaw
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-061720 13-S-EP
ABG-061713-S-SAC
ABG-061113-S-ECBC

RFA / COC Number: ABG-061013-S-EBC

Location Code: **013-HP008**
Sample Number: **ABG0025**
Sample Name: **013-HP008-SS-ABG0025-REG**
Sampling Method: ~~DP~~ HA
Sample Type: **SS** *Sample Purpose:* **REG**
Sampling Equip: Hand Auger
QC Partners:
(TB) NA (ER) NA (FB) NA

Task: **013**
Collection Date: 6-10-13
Collection Time: 0930
Start Depth: 0' bgs
End Depth: 1'
Sample Matrix: **SOIL**
Sample Team: RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
MUSTARD_SCREEN	N	J	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID = 0.3 ppm

Sketch Location:
See Drill Log

Logged BY / Date: L Bailey 6-10-13 *Reviewed BY / Date:* Don Burton 6-10-13

Shaw
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-061720 13-S-EA
ABG-061713-S-SAC
ABG-061113-S-ECBC

RFA / COC Number: ~~ABG-061013-S-EBG~~ OK

Location Code: 013-HP008
Sample Number: ABG0025-MS
Sample Name: 013-HP008-SS-ABG0025-MS
Sampling Method: ~~DPHA~~
Sample Type: SS *Sample Purpose:* MS
Sampling Equip: Hand Auger

Task: 013
Collection Date: 6-10-13
Collection Time: 0930
Start Depth: 0' bgs
End Depth: 1'
Sample Matrix: SOIL

QC Partners:
(TB) NA (ER) NA (FB) NA

Sample Team: RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
~~MUSTARD_SCREEN~~	~~N~~	~~J~~	~~1~~	~~4~~	~~oz~~	~~CWM~~ OKA

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID = 0.3 ppm

Sketch Location:
See Drill Log

Logged BY / Date: R. Bailey (RB) 6-10-17
Reviewed BY / Date: Andrew Purston 6-10-17

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Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-061713-S-SAC
ABG-061113-S-ECBC
ABG-061T2013-S-EP
~~ABG-061013-S-EBC~~ OKA

RFA / COC Number:

Location Code: 013-HP008
Sample Number: ABG0025-MSD
Sample Name: 013-HP008-SS-ABG0025-MSD
Sampling Method: DP
Sample Type: SS *Sample Purpose:* MSD
Sampling Equip: HA
QC Partners:
(TB) NA (ER) NA (FB) NA

Task: 013
Collection Date: 6-10-13
Collection Time: 0930
Start Depth: 0' bgs
End Depth: 1'
Sample Matrix: SOIL
Sample Team: RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
~~MUSTARD_SCREEN~~	~~N~~	~~J~~	~~1~~	~~4~~	~~oz~~	~~CWM~~ OKA

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID= 0.3 ppm

Sketch Location:
See Drill Log

Logged BY / Date: R. Bailey 6-10-13 *Reviewed BY / Date:* Don Burton 6-10-13

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-061713-S-EP
ABG-061713-S-SAC
ABG-061113-S-ECBC

RFA / COC Number: ABG-061013-S-EBC

Location Code: 013-HP008
Sample Number: ABG0026
Sample Name: 013-HP008-DS-ABG0026-REG
Sampling Method: ~~DP~~ HA
Sample Type: DS *Sample Purpose:* REG
Sampling Equip: HA

Task: 013
Collection Date: 6-10-13
Collection Time: 1040
Start Depth: 2' bgs
End Depth: 4'
Sample Matrix: SOIL
Sample Team: RB

QC Partners:
(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
SPLP PERCH	N	C	1	4	oz	CWM
SPLP_TCE	N	D	1	4	oz	CWM
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
TOC	N	H	1	4	oz	CWM
MUSTARD_SCREEN	N	J	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID= 0.3 ppm

Sketch Location: See Drill Log

Logged BY / Date: R. Bailey 6-10-13 *Reviewed BY / Date:* [signature] 6-10-13

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Sample Collection Log

136973 - Redstone PMC
Manager: Don Burton

ABG-061713-S-EP
ABG-061713-S-SAC
ABG-061113-S-ECBC
RFA / COC Number: ABG-061013-S-EBC

Location Code: 013-HP008
Sample Number: ABG0027
Sample Name: 013-HP008-DS-ABG0027-REG
Sampling Method: ~~DP~~ DP
Sample Type: DS *Sample Purpose:* REG
Sampling Equip: DPT

Task: 013
Collection Date: 6-10-13
Collection Time: 1100
Start Depth: 12' bgs
End Depth: 14'
Sample Matrix: SOIL
Sample Team: RB

QC Partners:
(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
SPLP PERCH	N	C	1	4	oz	CWM
SPLP_TCE	N	D	1	4	oz	CWM
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
TOC	N	H	1	4	oz	CWM
MUSTARD_SCREEN	N	J	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID = 6.8 ppm

Sketch Location:
See Drill Log

Logged BY / Date: R. Bailey 6-10-13 *Reviewed BY / Date:* Don Burton 6-10-13

HTRW DRILLING LOG

Company Name: GSE	Client: CB&T	Hole Number: 013-HP009	
Project: Redstone Arsenal	Drilling Subcontractor: GSE	Sheet: 1 of 3 Sheets	
Name of Driller: Harry Hunt	Location: RSA-013		
Sizes and Types of Drilling and Sampling Equipment: Hand Auger; 2" Macro Core	Manufacturer's Designation of Drill: Geoprobe 6620 DT		
	Surface Elevation: TBD		
	Date Started: 6-11-13	Date Completed: 6-11-13	
Overburden Thickness: 20'	Depth Groundwater Encountered: 10		
Depth Drilled into Rock: 0	Depth to Water and Elapsed Time After Drilling Completed: 5.08 after 10 min		
Total Depth of Hole: 20'	Other Water Level Measurements (Specify): NA		

Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

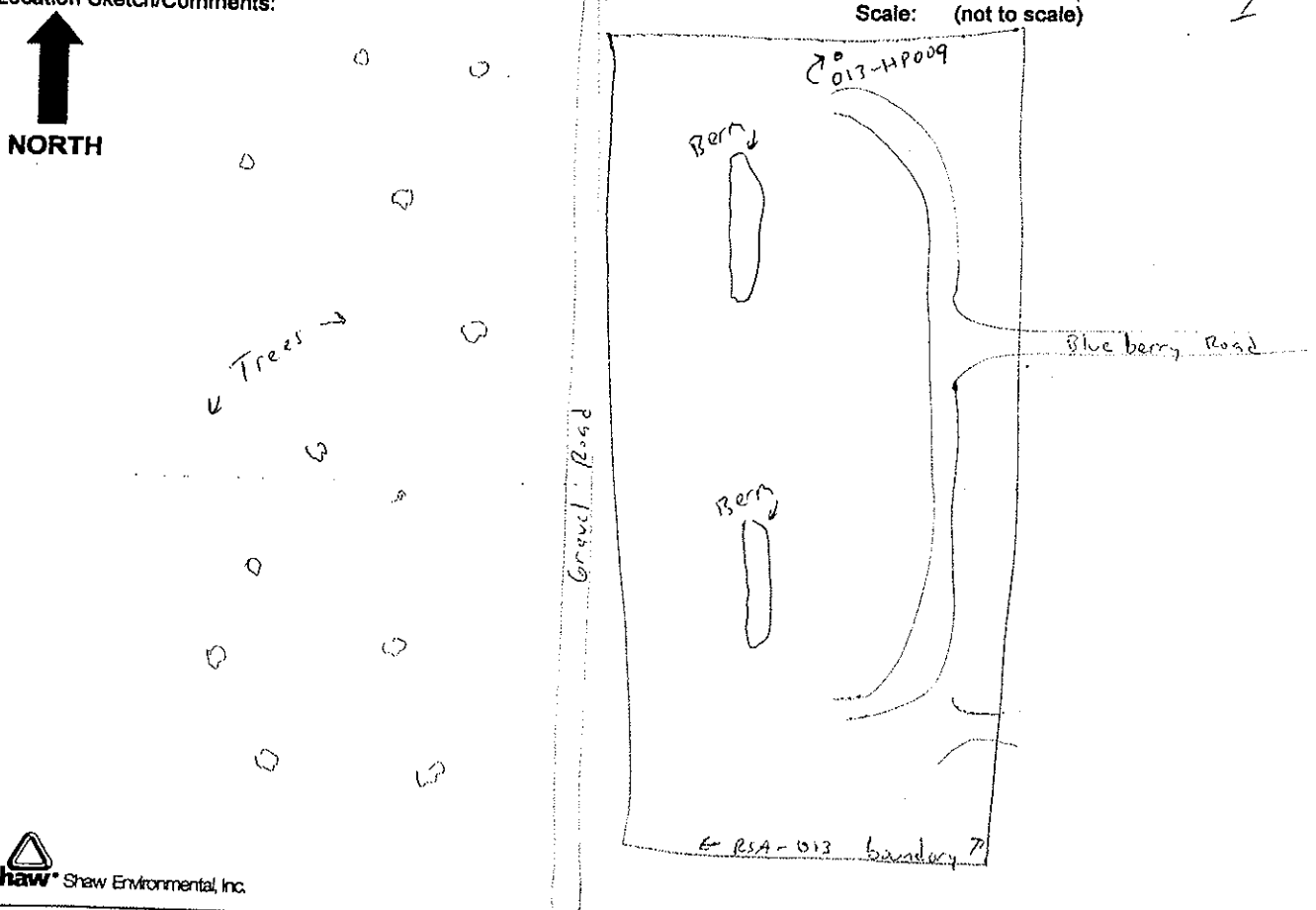
Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	✓	NA	perchlorate	Explosives	Mustard	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	NA	NA	piezometer	J. Ryan Bailey

Location Sketch/Comments:

NORTH

Scale: (not to scale)



Shaw® Shaw Environmental, Inc.

Project: Redstone Arsenal	Hole Number: 013-HP009

Shaw

HTRW DRILLING LOG

(continuation sheet)

Hole Number 013 - HP009

Project ~~R. Bailey~~ Redstone Arsenal

Client R. Bailey

Sheet 2 of 3 Sheets

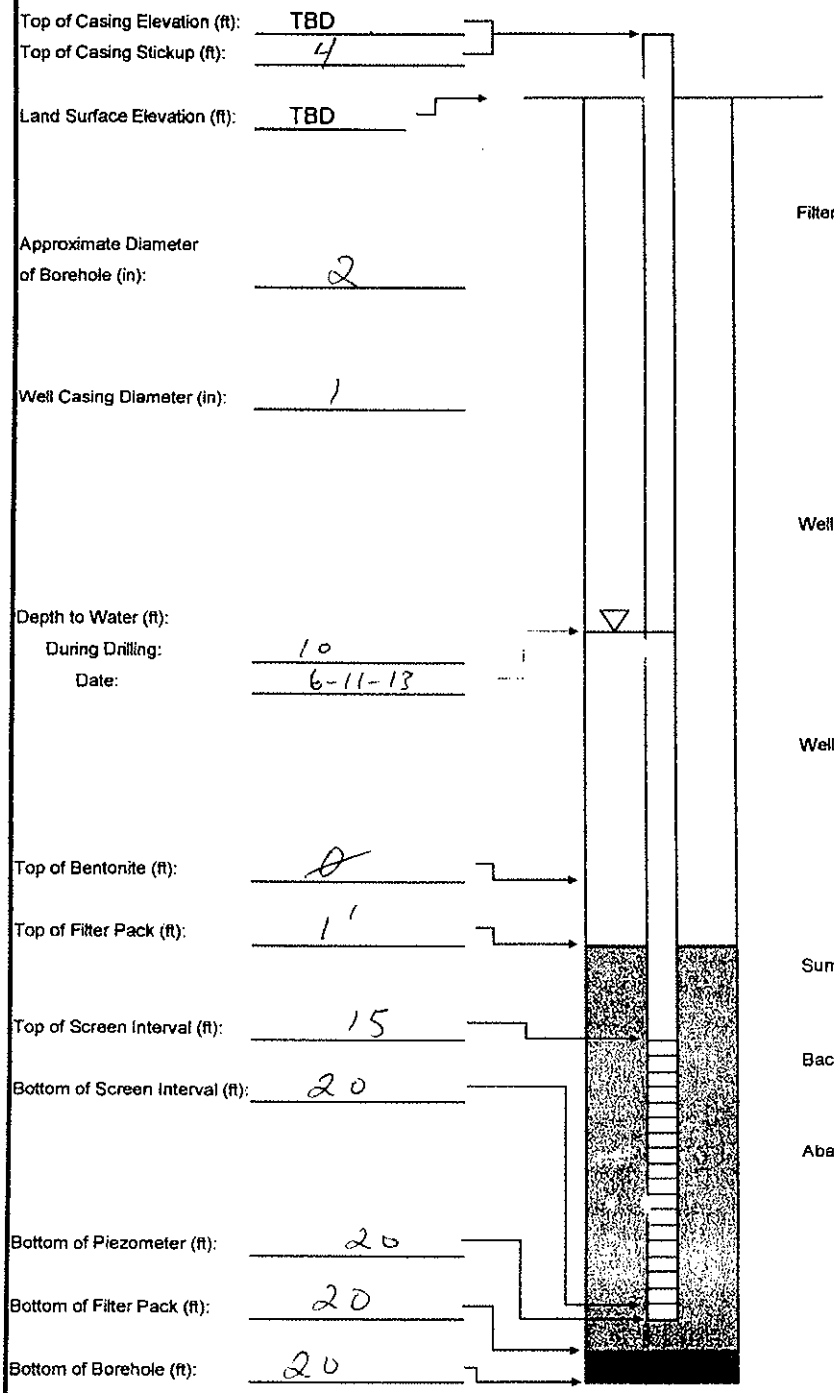
Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Lithology	Field Screening Results (ppm)	Geotech Sample or Core Box No	Analytical Sample No	Recovery (ft)	Remarks
	0	0-5 → strong brown (7.5 YR 4/6) silty clay. Soft. Low Plast. Moist.	CL	0-5 4.2	NA ↓	ABG0028 (0-1)	3/5	Hand Auger to 5 ft
	5	5-10 → strong brown (7.5 YR 5/6) silty clay with some sand. Med. Plast. V. Moist Wet at 10 ft.	CL	5-10 2.1		ABG0029 (2-4) ABG0030 (8-10)	5/5	▽ 10'

Project Redstone Arsenal

Hole Number 013 - HP009

Temporary Piezometer

Project:	Redstone Arsenal	Piezometer Number:	013-HP009
Location:	Huntsville, Madison County, AL	Site Location:	RSA-013
Client:	Shaw E&I	Installation Date	6-11-13
Subcontractor:	GSE	Northing:	TBD
Driller:	Harry Huntoon	Easting:	TBD
Shaw Field Representative:	Brian Rhodes	Project Number:	136973



Top of Casing Elevation (ft): TBD
Top of Casing Stickup (ft): 4
Land Surface Elevation (ft): TBD
Approximate Diameter of Borehole (in): 2
Well Casing Diameter (in): 1
Depth to Water (ft):
During Drilling: 10
Date: 6-11-13
Top of Bentonite (ft): 0
Top of Filter Pack (ft): 1'
Top of Screen Interval (ft): 15
Bottom of Screen Interval (ft): 20
Bottom of Piezometer (ft): 20
Bottom of Filter Pack (ft): 20
Bottom of Borehole (ft): 20

Filter Pack Material:
Manufacturer: Southern Filter Media
Product Name: Filter Media
Size: 20/40
Installation: Prepacked Screen, Filter Sock, (Gravity), Tremie

Well Casing:
Manufacturer: Mono Flex
Type: Sch 40 PVC
Diameter (in): 1

Well Screen Casing:
Manufacturer: Mono Flex
Type: Sch 40 PVC
Slot Size (in): 0.010
Slot Type: Continuous wrap, (Factory slot)

Sump/End Cap: -0-

Backfill Material: None

Abandonment:
Date: TBD
Procedure: Natural fill, Grouted, Casing Removed
Completed as Well: TBD

Shaw
Shaw E & I, Inc.

Depths and heights are referenced to ground surface unless specified TOC.
All elevations are referenced to MSL (NAVD 88).
If completed as well - see well construction diagram.

Sample Collection Log

Shaw™
Shaw E & I, Inc.

136973 - Redstone PMC
Manager: Don Burton

ABG-06122013-W-EP
RFA / COC Number: ABG-061113-W-SAC

Location Code: 013-HP009
Sample Number: ABG3010
Sample Name: 013-HP009-GW-ABG3010-REG
Sampling Method: LF
Sample Type: GW *Sample Purpose:* REG
Sampling Equip: Peristaltic pump
QC Partners:
(TB) 06122013-TB (ER) NA (FB) NA

Task: 013
Collection Date: 6/11/13
Collection Time: 0905
Start Depth: 15' ~~BTOC~~ BGS
End Depth: 20' ~~BTOC~~ BGS
Sample Matrix: WATER
Sample Team: CS/RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
PERCH_6850	N	B	1	250	mL	HDPE
EXPLOSIVES+	N	C	2	1	L	Amb. Glass
THIANES	N	D	2	1	L	Amb. Glass
THIODIGLYCOL	N	E	1	500	mL	Amb. Glass

ERPIMS Values:
Sacode:
Lot Control#:

Groundwater Information:
Measured Well Depth: 20' ~~BTOC~~ BGS **Depth To Water:** 3.03' BGS

Comments:

Temp	pH	ORPmv	mS/cm	NTU	mg/L DO
24.36	5.97	119	0.238	7000	4.73

Sketch Location:

See drilling Log

Logged BY / Date: Chris Spencer 6/11/13
Chris Spencer
Reviewed BY / Date: 6/11/13

Shaw
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Sample Collection Log

136973 - Redstone PMC

Manager: Don Burton

RFA / COC Number: ABG-061113-S-EBC

Location Code: **013-HP009**
Sample Number: **ABG0028**
Sample Name: **013-HP009-SS-ABG0028-REG**
Sampling Method: **DP**
Sample Type: **SS** *Sample Purpose:* **REG**
Sampling Equip: HA

Task: **013**
Collection Date: 6-11-13
Collection Time: 0820
Start Depth: 0' 6"
End Depth: 1'
Sample Matrix: **SOIL**
Sample Team: RB

QC Partners:
(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
MUSTARD_SCREEN	N	J	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID = 4.2 ppm

Sketch Location: See Drill Log

Logged BY / Date: R. Bailey 6-11-13

Reviewed BY / Date: 6-11-13

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: Don Burton

RFA / COC Number: ABG-061113-S-EBC

Location Code: 013-HP009
Sample Number: ABG0029
Sample Name: 013-HP009-DS-ABG0029-REG
Sampling Method: DP
Sample Type: DS *Sample Purpose:* REG
Sampling Equip: HA

Task: 013
Collection Date: 6-11-13
Collection Time: 0830
Start Depth: 2' bgs
End Depth: 4'
Sample Matrix: SOIL
Sample Team: RB

QC Partners:
(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
SPLP PERCH	N	C	1	4	oz	CWM
SPLP_TCE	N	D	1	4	oz	CWM
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
TOC	N	H	1	4	oz	CWM
MUSTARD_SCREEN	N	J	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID = 4.2 ppm

Sketch Location: See Drill Log

Logged BY / Date: R. Bailey 6-11-13 *Reviewed BY / Date:* Don Burton 6-11-13

Shaw
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: Don Burton

RFA / COC Number: ABG-061113-S-EBC

Location Code: 013-HP009
Sample Number: ABG0030
Sample Name: 013-HP009-DS-ABG0030-REG
Sampling Method: DP
Sample Type: DS *Sample Purpose:* REG
Sampling Equip: DPT

Task: 013
Collection Date: 6-11-13
Collection Time: 0840
Start Depth: 8' bgs
End Depth: 10'
Sample Matrix: SOIL
Sample Team: EB

QC Partners:
(TB) NA (ER) NA (FB) NA

ERPIMS Values:
Sacode:
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-HI-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	CWM
PERCH_6850	N	B	1	4	oz	CWMG
SPLP PERCH	N	C	1	4	oz	CWM
SPLP_TCE	N	D	1	4	oz	CWM
MUSTARD	N	F	1	4	oz	CWM
THIANES	N	F	1	4	oz	CWM
THIODIGLYCOL	N	G	1	4	oz	CWM
TOC	N	H	1	4	oz	CWM
MUSTARD_SCREEN	N	J	1	4	oz	CWM

Comments: PID = 2.1 ppm

Sketch Location: See Drill Log

Logged BY / Date: R. Bailey 6-11-13

Reviewed BY / Date: [signature] 6-11-13

HTRW DRILLING LOG

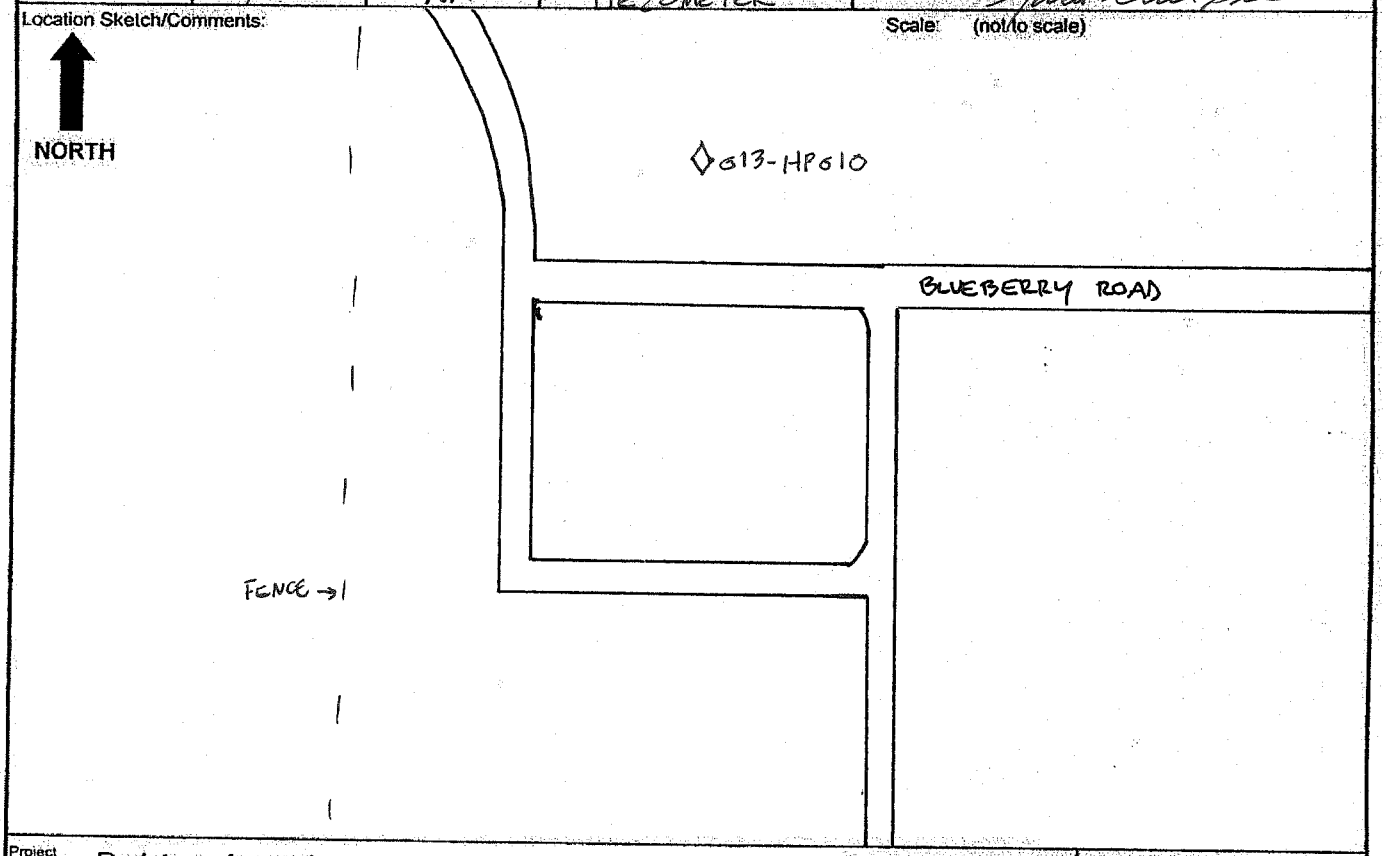
Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

Client: CB+I			Hole Number: 013-HP010
Company Name: Shaw Environmental, Inc.		Drilling Subcontractor: GSE	Sheet: 1 of 2 Sheets
Project: Redstone Arsenal		Location: RSA-013	
Name of Driller: JUSTIN WINGERTER		Manufacturer's Designation of Drill: GEOPROBE 7822 DT	
Sizes and Types of Drilling and Sampling Equipment: HAND AUGER; 2" MACROCORE		Surface Elevation: TBD	
		Date Started: 2-26-2014	Date Completed: 2-26-2014
Overburden Thickness: 20.8' BGS		Depth Groundwater Encountered: ~13' BGS	
Depth Drilled into Rock: Ø		Depth to Water and Elapsed Time After Drilling Completed: 2.1' BGS AFTER 25 MINUTES	
Total Depth of Hole: 20.8' BGS		Other Water Level Measurements (Specify)	

Geotechnical Samples	Disturbed: NA	Undisturbed: NA	Total Number of Core Boxes: NA				
Samples for Chemical Analysis	VOC: ✓	Metals: ✓	Other: THIANES/THIODIGLYCOL	Other: PERCHLORATE	Other: EXPLOSIVES	Total Core Recovery: NA	
Disposition of Hole	Backfilled: NA	Monitoring Well: NA	Other: PIEZOMETER	Signature of Geologist:			

Location Sketch/Comments:

Scale: (not to scale)



Project: Redstone Arsenal		Hole Number: 013-HP010

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-HP010

Project: REDSTONE ARSENAL

Geologist: JULIE SCHENCK BROWN

Sheet 2 of 2 Sheets

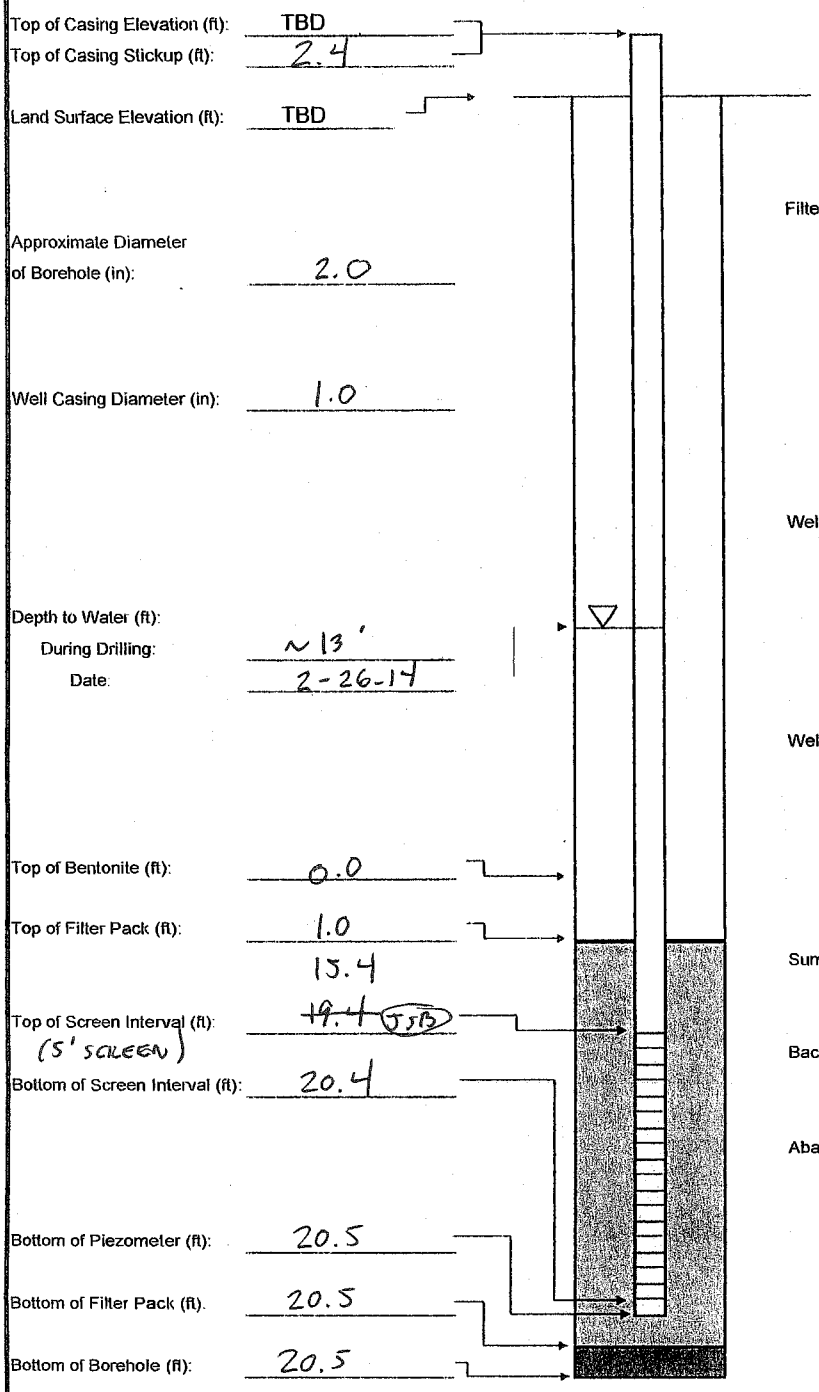
Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	SURFACE = GRASS						
		(0-1): BROWN SANDY CLAY (7.5 YR 4/4) LOW PLASTICITY MEDIUM STIFFNESS VERY FINE SAND MAGANESE DEPOSITS AND STAINING SLIGHT MOISTURE	CL	(0-5) 0.0	NA ↓	ABG 0061 (0-1)	5/5	HAND AUGER TO 5' BGS
	1	(1-5): YELLOWISH BROWN SANDY CLAY LOW PLASTICITY MEDIUM STIFFNESS VERY FINE SAND 30% MOTTLING (GRAY) MAGANESE DEPOSITS AND HEAVY STAINING AT 3-4' BGS SLIGHT MOISTURE	CL					
	2					ABG 0062 (2-4)		
	3							
	4							
	5	(5-10): YELLOWISH BROWN SANDY CLAY (10 YR 5/6) LOW PLASTICITY MEDIUM STIFFNESS VERY FINE SAND 20% MOTTLING (GRAY) MAGANESE DEPOSITS HEAVY STAINING AT 9-10' BGS SLIGHT MOISTURE	CL	(5-10) 0.0			5/5	
	6							
	7					ABG 0063 (8-10)		
	8							PER MARK SHOEMAKER CB&I CAM, SOIL LITHOLOGY DESCRIPTION IS ONLY REQUIRED TO 10' BGS
	9							
	10							

Project: RSA

Hole Number: 013-HP010

Temporary Piezometer

Project:	Redstone Arsenal	Piezometer Number:	013-HP010
Location:	Huntsville, Madison County, AL	Site Location:	RSA-013
Client:	CB+I	Installation Date	2-26-2014
Subcontractor:	GSE	Northing:	TBD
Driller:	JUSTIN WINGERTER	Easting:	TBD
Shaw Field Representative:	BRIAN RHODES	Project Number:	136973



Top of Casing Elevation (ft): TBD
Top of Casing Stickup (ft): 2.4
Land Surface Elevation (ft): TBD
Approximate Diameter of Borehole (in): 2.0
Well Casing Diameter (in): 1.0
Depth to Water (ft): During Drilling: ~13'; Date: 2-26-14
Top of Bentonite (ft): 0.0
Top of Filter Pack (ft): 1.0
15.4
Top of Screen Interval (ft): 19.4 JJB (5' SCREEN)
Bottom of Screen Interval (ft): 20.4
Bottom of Piezometer (ft): 20.5
Bottom of Filter Pack (ft): 20.5
Bottom of Borehole (ft): 20.5

Filter Pack Material:
- Manufacturer: CONSOLIDATED AGGREGATES
- Product Name: FILTER MEDIA
- Size: No. 2
- Installation: Prepacked Screen; Filter Sock; (Gravity); Tremie

Well Casing:
- Manufacturer: MONOFLEX
- Type: SCHEDULE 40 PVC
- Diameter (in): 1.0

Well Screen Casing:
- Manufacturer: MONOFLEX
- Type: SCHEDULE 40 PVC
- Slot Size (in): 0.010
- Slot Type: Continuous wrap; (Factory slot)

Sump/End Cap: 0.1' POINT

Backfill Material: NONE

Abandonment:
- Date: TBD
- Procedure: Natural fill; Grouted; Casing Removed
- Completed as Well: TBD

Depths and heights are referenced to ground surface unless specified TOC
All elevations are referenced to MSL (NAVD 88)
If completed as well - see well construction diagram

Shaw Environmental & Infrastructure Inc
(A CB&I Company)

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC (EJM)

Manager: ~~Don Burton~~ John Nenni

ABG-022714-W-SAC

RFA / COC Number: ABG-02272014-W-EP

Location Code: **013-HP010**

Sample Number: **ABG3011**

Sample Name: **013-HP010-GW-ABG3011-REG**

Sampling Method: **SP**

Sample Type: **GW** *Sample Purpose:* **REG**

Sampling Equip: Peristaltic pump

QC Partners:

(TB) ABG 02272014-TB (ER) NA (FB) NA

Task: **013**

Collection Date: 2-27-14

Collection Time: 0850

Start Depth: 7.5' ~~4.82~~ 'BTOC

End Depth: 7.5' ~~4.82~~ 'BTOC

Sample Matrix: **WATER**

Sample Team: CE

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
PERCH_6850	N	B	1	125	mL	HDPE
EXPLOSIVES+	N	C	2	1	L	Amb. Glass
THIANES	N	E	2	1	L	Amb. Glass
THIODIGLYCOL	N	F	1	500	mL	B.R.

ERPIMS Values:

Sacode: N/A

Lot Control#:

Groundwater Information:

Measured Well Depth: 20.75' **Depth To Water:** 4.82' BTOC

Comments: Turbidity: 974 NTU Temp.: 13.74°C pH: 5.46 D.O.: 34.07 mg/L
Conductivity: 0.139 mS/cm Redox: 36 mV

Sketch Location:

See Drilling Log

Logged BY / Date: Cody Eakin 2-27-14 *Reviewed BY / Date:* DJC 2-27-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC EQM
Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG-022714-S-SAC / ABG-022714-S-EP

Location Code: **013-HP010**
Sample Number: **ABG0061**
Sample Name: **013-HP010-SS-ABG0061-REG**
Sampling Method: **HA**
Sample Type: **SS** *Sample Purpose:* **REG**
Sampling Equip: HA

Task: **013**
Collection Date: 2-26-14
Collection Time: 1125
Start Depth: 0' BGS
End Depth: 1' BGS
Sample Matrix: **SOIL**

QC Partners:
(TB) NA (ER) NA (FB) NA

Sample Team: JSB, JW, CE

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: [signature] 2-26-14

Reviewed BY / Date: OQK 2-26-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: ~~Don Burton~~ John Nenni

ABG-022714-S-EP
RFA / COC Number: ABG-0227014-S-EP

Location Code: **013-HP010**
Sample Number: **ABG0062**
Sample Name: **013-HP010-DS-ABG0062-REG**
Sampling Method: **HA**
Sample Type: **DS** *Sample Purpose:* **REG**
Sampling Equip: HA

Task: **013**
Collection Date: 2-26-14
Collection Time: 1130
Start Depth: 2' BGS
End Depth: 4' BGS
Sample Matrix: **SOIL**
Sample Team: JSB, JW, CE

QC Partners:
(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID = 0.0ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2-26-14
Reviewed BY / Date: OK 2-26-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nemi

ABG-022714-S-SAC

RFA / COC Number: ABG-0227 2014-S-EP

Location Code: **013-HP010**

Sample Number: **ABG0063**

Sample Name: **013-HP010-DS-ABG0063-REG**

Sampling Method: **DP**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: DP

Task: **013**

Collection Date: 2-26-14

Collection Time: 1135

Start Depth: 6' BGS

End Depth: 8' BGS

Sample Matrix: **SOIL**

Sample Team: JSB, JW, CE

QC Partners:

(TB) N.A (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2-26-14

Reviewed BY / Date: OK 2-26-14

HTRW DRILLING LOG

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

Client: CB+I			Hole Number: 013-HP011
Company Name: Shaw Environmental, Inc.	Drilling Subcontractor: GSE		Sheet: 1 of 2 Sheets
Project: Redstone Arsenal	Location: RSA-013		
Name of Driller: JUSTIN WINGERTER	Manufacturer's Designation of Drill: GEOPROBE 7822 DT		
Sizes and Types of Drilling and Sampling Equipment: HAND AUGER; 2" MACROCORE	Surface Elevation: TBD		
	Date Started: 2-26-2014	Date Completed: 2-26-2014	
Overburden Thickness: 23' BGS	Depth Groundwater Encountered: ~14' BGS		
Depth Drilled into Rock: Ø	Depth to Water and Elapsed Time After Drilling Completed: 3.4' BGS AFTER ~20 MINUTES		
Total Depth of Hole: 23' BGS	Other Water Level Measurements (Specify): NA		

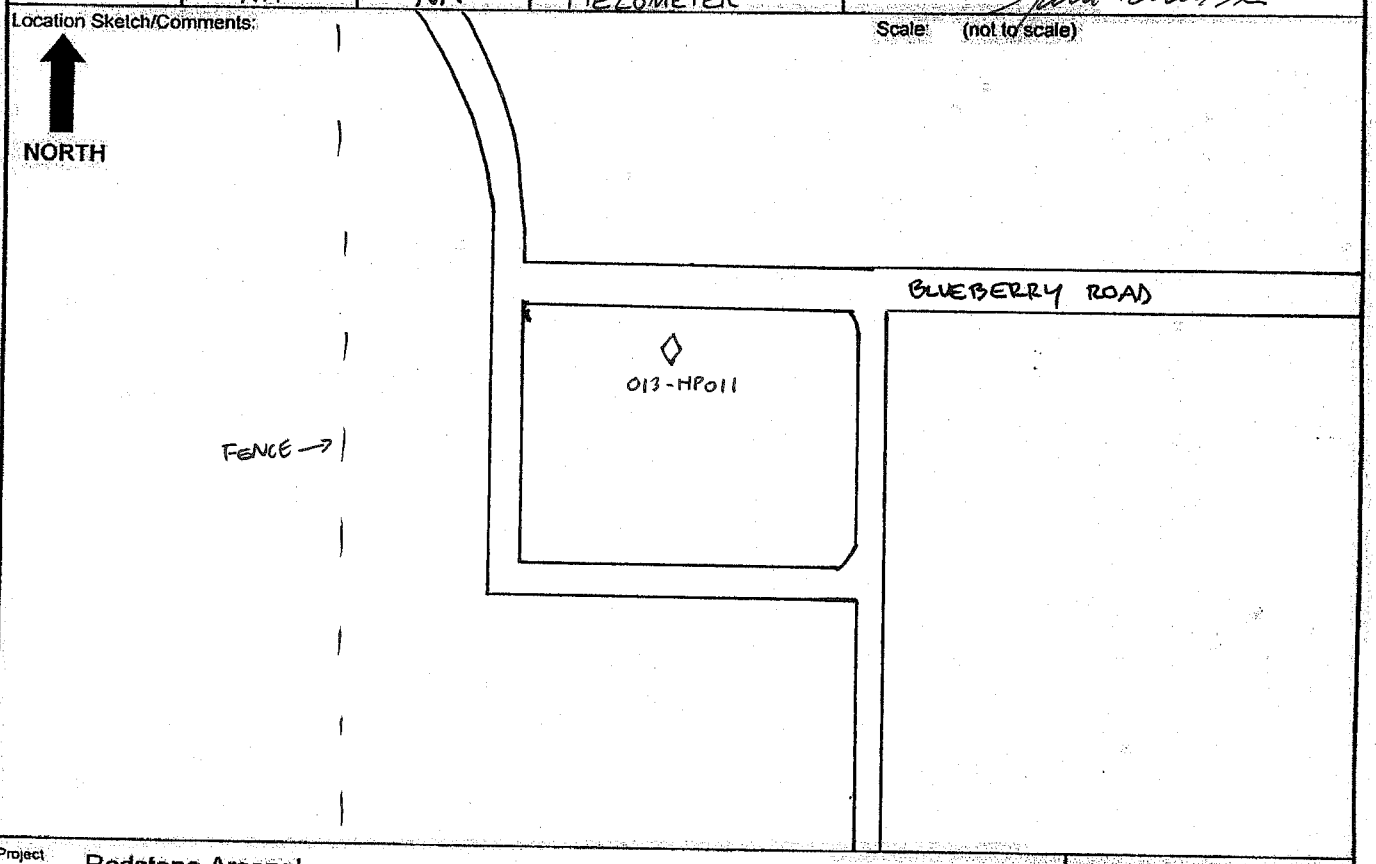
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	✓	✓	THIANES/THIODIGLYCOL	PERCHLORATE	EXPLOSIVES	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	NA	NA	PIEZOMETER	

Location Sketch/Comments:

Scale: (not to scale)



Project	Hole Number
Redstone Arsenal	013-HP011

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-HP011

Project: REDSTONE ARSENAL

Geologist: JULIE SCHENCK BROWN

Sheet 2 of 2 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	SURFACE = GRASS						
		(0-1): DARK YELLOWISH BROWN SANDY CLAY (10 YR 4/4) LOW PLASTICITY, LOW STIFFNESS VERY FINE SAND SLIGHT TRACES OF MAGANESE MOIST	CL	(0.5) 0.0	NA ↓	ABA 0064 (0-1)	5/5	HAND AUGER TO 5' BGS
	1	(1-5): YELLOWISH BROWN SANDY CLAY (10 YR 5/8) LOW PLASTICITY MEDIUM STIFFNESS VERY FINE SAND TRACES OF MAGANESE SLIGHT MOISTURE	CL					
	2					ABA 0065 0065-MS 0065-MSD (2-4)		
	3							
	4							
	5	(5-10): YELLOWISH BROWN SANDY CLAY (10 YR 5/8) LOW PLASTICITY MEDIUM-HIGH STIFFNESS VERY FINE SAND 20% MOTTLING (GRAY) TRACES OF MAGANESE SLIGHT MOISTURE	CL	(5-10) 0.0			5/5	
	6					ABA 0066 (6-8)		
	7							
	8							
	9							PER MARK SHOEMAKER, CB+I CAM, A DESCRIPTION OF SOIL LITHOLOGY ONLY REQUIRED TO 10' BGS
	10							

Project: RSA

Hole Number: 013-HP011

Temporary Piezometer

Project:	Redstone Arsenal	Piezometer Number:	013-HP011
Location:	Huntsville, Madison County, AL	Site Location:	RSA-013
Client:	CB+I	Installation Date	2-26-2014
Subcontractor:	GSE	Northing:	TBD
Driller:	JUSTIN WINKERTER	Easting:	TBD
Shaw Field Representative:	BRIAN RHODES	Project Number:	136973

Top of Casing Elevation (ft): TBD
Top of Casing Stickup (ft): 2.2

Land Surface Elevation (ft): TBD

Approximate Diameter of Borehole (in): 2.0

Well Casing Diameter (in): 1.0

Depth to Water (ft):
During Drilling: ~14'
Date: 2-26-14

Top of Bentonite (ft): 0.0

Top of Filter Pack (ft): 1.0

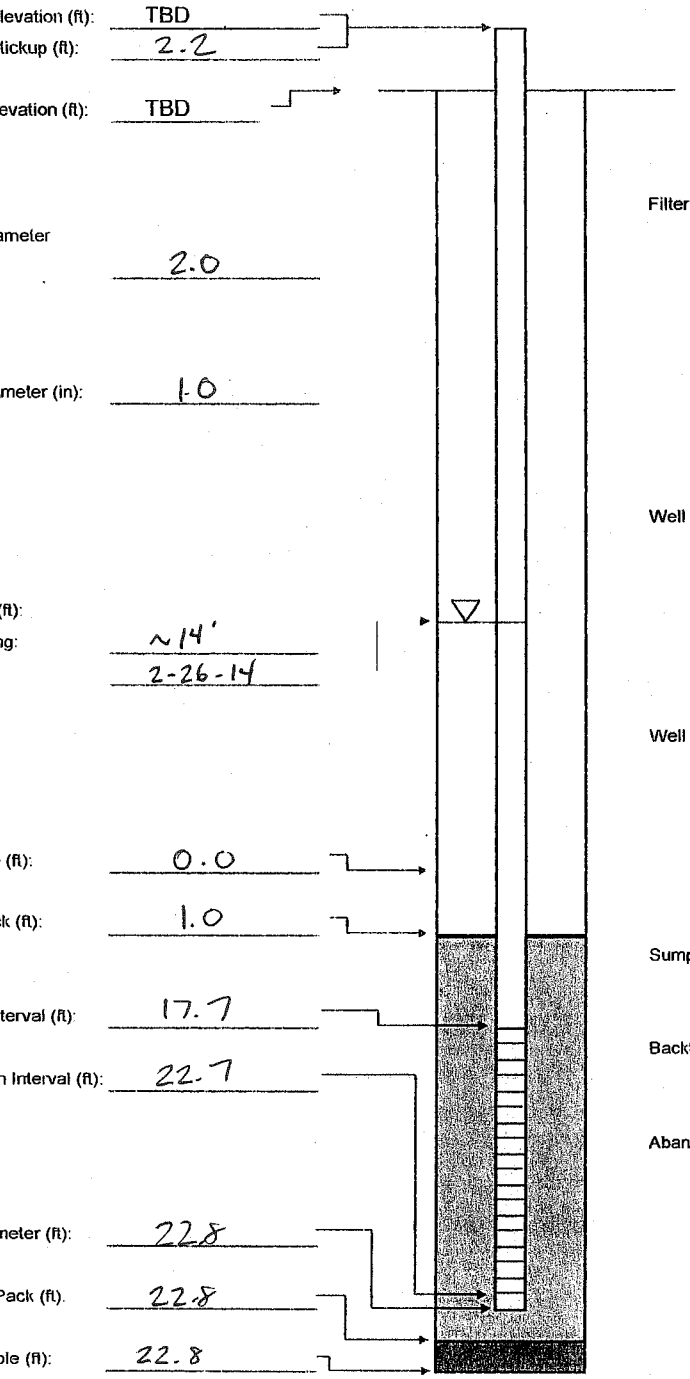
Top of Screen Interval (ft): 17.7

Bottom of Screen Interval (ft): 22.7

Bottom of Piezometer (ft): 22.8

Bottom of Filter Pack (ft): 22.8

Bottom of Borehole (ft): 22.8



Filter Pack Material:
Manufacturer: CONSOLIDATED AGGREGATES
Product Name: FILTER MEDIA
Size: No. 2
Installation: Prepacked Screen | Filter Sock | Gravity (circled) | Tremie

Well Casing:
Manufacturer: MONOFLEX
Type: SCHEDULE 40 PVC
Diameter (in): 1.0

Well Screen Casing:
Manufacturer: MONOFLEX
Type: SCHEDULE 40 PVC
Slot Size (in): 0.010
Slot Type: Continuous wrap | Factory slot (circled)

Sump/End Cap: 0.1' POINT

Backfill Material: NONE

Abandonment:
Date: TBD
Procedure: Natural fill | Grouted | Casing Removed
Completed as Well: TBD

Depths and heights are referenced to ground surface unless specified TOC
All elevations are referenced to MSL (NAVD 88)
If completed as well - see well construction diagram

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC (EJM)
Manager: ~~Don Burton~~ John Nenni

ABG-D22814-W-SAC
RFA / COC Number: ABG-D2272014-W-EP

Location Code: 013-HP011
Sample Number: ABG3012
Sample Name: 013-HP011-GW-ABG3012-REG
Sampling Method: SP
Sample Type: GW *Sample Purpose:* REG
Sampling Equip: Peristaltic Pump

Task: 013
Collection Date: 2-27-14
Collection Time: 1430
Start Depth: 5.05 'BTOC
End Depth: 5.05 'BTOC
Sample Matrix: WATER
Sample Team: CE

QC Partners:
(TB) D2272014-TB (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
PERCH_6850	N	B	1	125	mL	HDPE
EXPLOSIVES+	N	C	2	1	L	Amb. Glass
THIANES	N	E	2	1	L	Amb. Glass
THIODIGLYCOL	N	F	1	500	mL	B.R.

ERPIMS Values:
Sacode: N/A
Lot Control#:

Groundwater Information:
Measured Well Depth: 22.8 'BTOC **Depth To Water:** 5.05 'BTOC

Comments: Turbidity: >1000 Temperature: 16.58°C pH: 6.26 D.O.: 34.27 mg/L mV: 230 Conductivity: 0.167 mS/cm

Sketch Location:

See Drilling Log

Logged BY / Date: [signature] 2/27/14 *Reviewed BY / Date:* DQC 2-27-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC EJM
Manager: ~~Don Burton~~ John Nenni

ABG-022714-S-EMD
RFA / COC Number: ABG-0227014-TO

Location Code: **013-HP011**
Sample Number: **ABG0064**
Sample Name: **013-HP011-SS-ABG0064-REG**
Sampling Method: **HA**
Sample Type: **SS** *Sample Purpose:* **REG**
Sampling Equip: HA

Task: **013**
Collection Date: 2-26-14
Collection Time: 1335
Start Depth: 0' BGS
End Depth: 1' BGS
Sample Matrix: **SOIL**
Sample Team: SSB, JW, CE

QC Partners:
(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: [signature] 2-26-14

Reviewed BY / Date: OK 2-26-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC EJM

Manager: ~~Don Burton~~ John Nenni

ABG-022714-S-SAC

RFA / COC Number: ABG-02272014-S-EP

Location Code: **013-HP011**

Sample Number: **ABG0065**

Sample Name: **013-HP011-DS-ABG0065-REG**

Sampling Method: **HA**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: HA

Task: **013**

Collection Date: 2-26-14

Collection Time: 1345

Start Depth: 2' BGS

End Depth: 4' BGS

Sample Matrix: **SOIL**

Sample Team: JSB, JW, CE

QC Partners:

(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2-26-14

Reviewed BY / Date: 2-26-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG-022714-S-SAC
ABG-0227 2014-S-EA

Location Code: **013-HP011**
Sample Number: **ABG0065-MS**
Sample Name: **013-HP011-DS-ABG0065-MS**
Sampling Method: **HA**
Sample Type: **DS** *Sample Purpose:* **MS**
Sampling Equip: HA

Task: **013**
Collection Date: 2-26-14
Collection Time: ~~1345~~ 1345
Start Depth: 2 'BGS
End Depth: 4 'BGS
Sample Matrix: **SOIL**
Sample Team: JSB, JW, CE

QC Partners:
(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2-26-14

Reviewed BY / Date: OK 2-26-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC EPM

Manager: ~~Don Burton~~ John Nenni

ABG-022714-S-EP

RFA / COC Number: ABG-022714-S-EP

Location Code: **013-HP011**

Sample Number: **ABG0065-MSD**

Sample Name: **013-HP011-DS-ABG0065-MSD**

Sampling Method: **HA**

Sample Type: **DS** *Sample Purpose:* **MSD**

Sampling Equip: HA

QC Partners:

(TB) NA (ER) NA (FB) NA

Task: **013**

Collection Date: 2-26-14

Collection Time: 1345

Start Depth: 2' BGS

End Depth: 4' BGS

Sample Matrix: **SOIL**

Sample Team: JJB, JW, CE

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2-26-14

Reviewed BY / Date: QAC 2-26-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC (EPM)

Manager: ~~Don Burton~~ John Nenni

ABG-022714-S-EP

RFA / COC Number: ABG-022714-S-EP

Location Code: **013-HP011**

Sample Number: **ABG0066**

Sample Name: **013-HP011-DS-ABG0066-REG**

Sampling Method: **DP**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: DP

Task: **013**

Collection Date: 2-26-14

Collection Time: 1355

Start Depth: 6' BGS

End Depth: 8' BGS

Sample Matrix: **SOIL**

QC Partners:

(TB) NA (ER) NA (FB) NA

Sample Team: JSB, JW, CE

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2-26-14

Reviewed BY / Date: 2-26-14

HTRW DRILLING LOG

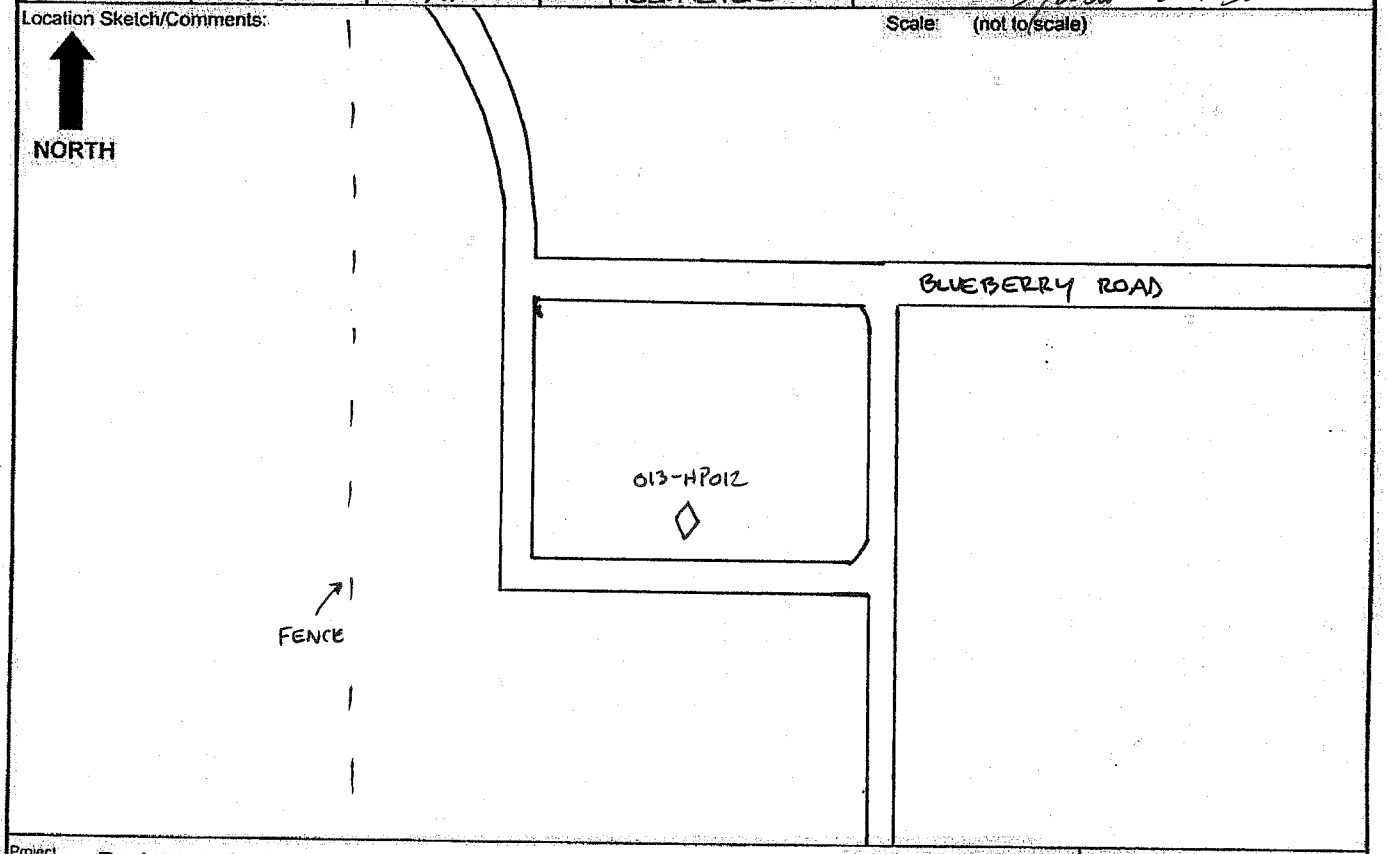
Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

Client	CB+I	Hole Number	013-HP012
Company Name	Shaw Environmental, Inc.	Drilling Subcontractor	GSE
Sheet	1 of 2 Sheets		
Project	Redstone Arsenal	Location	RSA-013
Name of Driller	JUSTIN WINGERTER	Manufacturer's Designation of Drill	GEOPROBE 7822 DT
Sizes and Types of Drilling and Sampling Equipment	HAND AUGER 2" MACROCORE	Surface Elevation	TBD
		Date Started	2-26-2014
		Date Completed	2-26-2014
Overburden Thickness	27.5' BGS	Depth Groundwater Encountered	~15' BGS
Depth Drilled into Rock	Ø	Depth to Water and Elapsed Time After Drilling Completed	23.4' BGS AFTER ~15 MINUTES
Total Depth of Hole	27.5' BGS	Other Water Level Measurements (Specify)	

Geotechnical Samples	Disturbed: NA	Undisturbed: NA			Total Number of Core Boxes: NA		
Samples for Chemical Analysis	VOC: ✓	Metals: ✓	Other: THIANES/THIODIGLYCOL	Other: PERCHLORATE	Other: EXPLOSIVES	Total Core Recovery: NA	
Disposition of Hole	Backfilled: NA	Monitoring Well: NA	Other: PIEZOMETER	Signature of Geologist:			

Location Sketch/Comments:

Scale: (not to scale)



Project	Redstone Arsenal	Hole Number	013-HP012

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-HP012

Project: REDSTONE ARSENAL

Geologist: JULIE SCHENCK BROWN

Sheet 2 of 2 Sheets

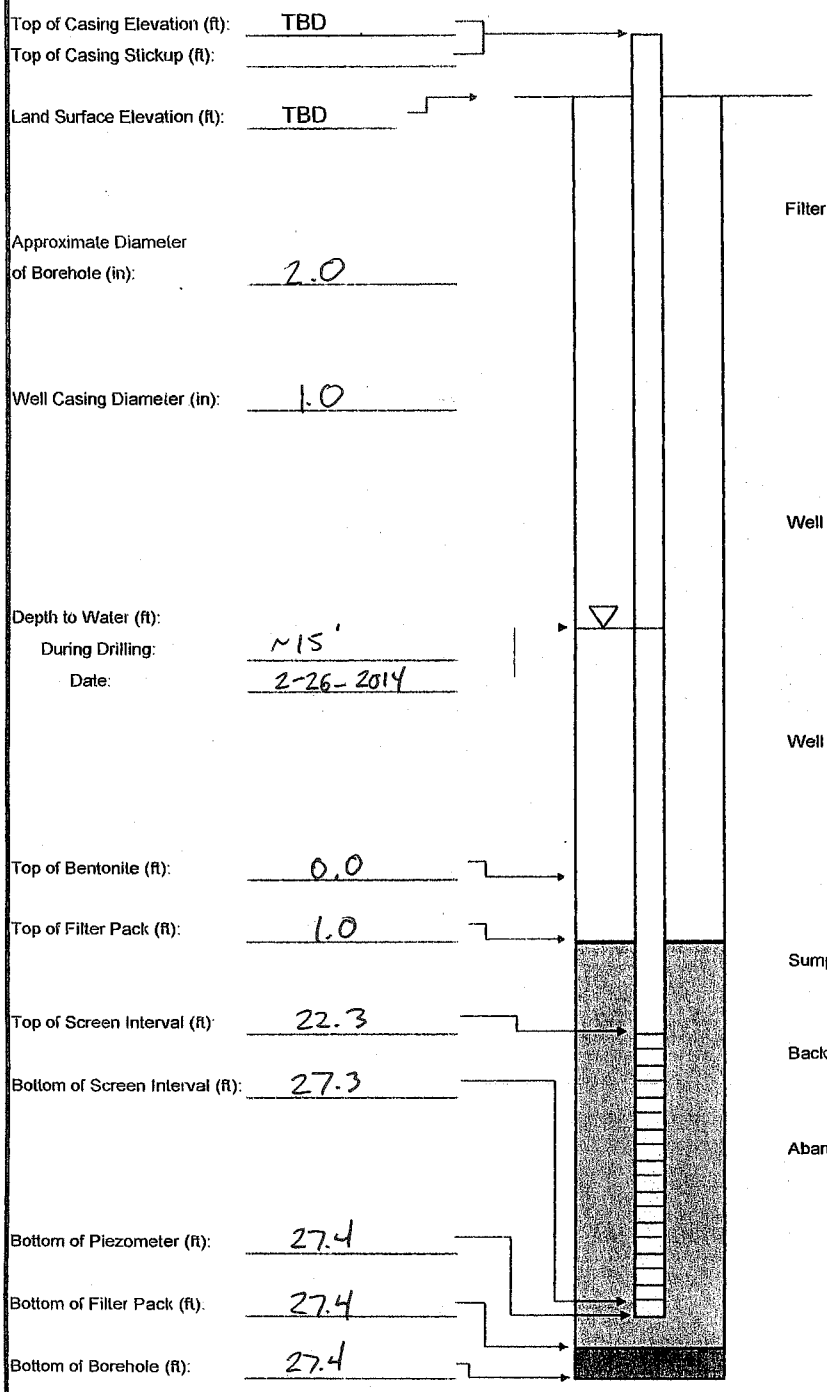
Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	SURFACE = GRASS						
		(0-1): BROWN SANDY CLAY (10 YR 4/3) LOW PLASTICITY LOW STIFFNESS VERY FINE SAND SLIGHT MOISTURE	CL	(6.5) 0.0	NA ↓	ABH 0067 (0-1)	5/5	HAND AUGER TO 5' BGS
	1	(1-5): YELLOWISH BROWN SANDY CLAY (10 YR 5/8) LOW PLASTICITY MEDIUM STIFFNESS VERY FINE SAND 10% MOTTLING (LIGHT GRAY) SLIGHT TRACES OF MANGANESE VERY SLIGHT MOISTURE	CL					
	2					ABH 0068 (2-4)		
	3							
	4							
	5	(5-10): YELLOWISH BROWN SANDY CLAY (10 YR 5/8) LOW PLASTICITY MEDIUM-HIGH STIFFNESS VERY FINE SAND STAINING AT 9-10' BGS SLIGHT MOISTURE	CL	(5-10) 0.0				
	6					ABH 0069 (6-8)		
	7							
	8							
	9							PER MARK SHOEMAKER, CB+I CAM, A DESCRIPTION OF SOIL LITHOLOGY IS ONLY REQUIRED TO 10' BGS
	10							

Project: RSA

Hole Number: 013-HP012

Temporary Piezometer

Project:	Redstone Arsenal	Piezometer Number:	013-HP012
Location:	Huntsville, Madison County, AL	Site Location:	RSA-013
Client:	CB+I	Installation Date	2-26-2014
Subcontractor:	GSE	Northing:	TBD
Driller:	JUSTIN WINGERTER	Easting:	TBD
Shaw Field Representative:	BRIAN RHODES	Project Number:	136973



Top of Casing Elevation (ft): TBD

Top of Casing Stickup (ft):

Land Surface Elevation (ft): TBD

Approximate Diameter of Borehole (in): 2.0

Well Casing Diameter (in): 1.0

Depth to Water (ft):
- During Drilling: ~15'
- Date: 2-26-2014

Top of Bentonite (ft): 0.0

Top of Filter Pack (ft): 1.0

Top of Screen Interval (ft): 22.3

Bottom of Screen Interval (ft): 27.3

Bottom of Piezometer (ft): 27.4

Bottom of Filter Pack (ft): 27.4

Bottom of Borehole (ft): 27.4

Filter Pack Material:
- Manufacturer: CONSOLIDATED AGGREGATES
- Product Name: FILTER MEDIA
- Size: No. 2
- Installation: Prepacked Screen; Filter Sock; (Gravity); Tremie

Well Casing:
- Manufacturer: MONOFLEX
- Type: SCHEDULE 40 PVC
- Diameter (in): 1.0

Well Screen Casing:
- Manufacturer: MONOFLEX
- Type: SCHEDULE 40 PVC.
- Slot Size (in): 0.010
- Slot Type: Continuous wrap; (Factory slot)

Sump/End Cap: 0.1' POINT

Backfill Material: NONE

Abandonment:
- Date: TBD
- Procedure: Natural fill; Grouted; Casing Removed
- Completed as Well: TBD

Depths and heights are referenced to ground surface unless specified TOC

All elevations are referenced to MSL (NAVD 88)

If completed as well - see well construction diagram

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

Shaw
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG-022814-W-SAC
ABG-02272014-W-EP

Location Code: 013-HP012
Task: 013
Sample Number: ABG3013
Collection Date: 2-27-14
Sample Name: 013-HP012-GW-ABG3013-REG
Collection Time: 1555
Sampling Method: SP
Start Depth: 22.4' ~~6.42~~' BTOC
Sample Type: GW
Sample Purpose: REG
End Depth: 22.4' ~~6.42~~' BTOC
Sampling Equip: Peristaltic Pump
Sample Matrix: WATER

QC Partners:
(TB) 02272014TB (ER) NA (FB) NA
Sample Team: [illegible]

ERPIMS Values:
Sacode: N/A
Lot Control#:

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
PERCH_6850	N	B	1	125	mL	HDPE
EXPLOSIVES+	N	C	2	1	L	Amb. Glass
THIANES	N	E	~~2~~ 1	1	L	Amb. Glass
THIODIGLYCOL	N	F	1	500	mL	B.R.

Groundwater Information:
Measured Well Depth: 27.4' BTOC **Depth To Water:** 6.42' BTOC

Comments: Unable to collect parameter due to ~~well~~ piezometer going dry.

Sketch Location:
See Drilling Log

Logged BY / Date: [signature] 2/27/14
Reviewed BY / Date: [signature] 2-27-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC EPM

Manager: ~~Don Burton~~ John Nemi

ABG-022714-S-EP

RFA / COC Number: ABG-022714-S-EP

Location Code: **013-HP012**

Sample Number: **ABG0067**

Sample Name: **013-HP012-SS-ABG0067-REG**

Sampling Method: **HA**

Sample Type: **SS** *Sample Purpose:* **REG**

Sampling Equip: HA

Task: **013**

Collection Date: 2-26-14

Collection Time: 1445

Start Depth: 0' BGS

End Depth: 1' BGS

Sample Matrix: **SOIL**

QC Partners:

(TB) NA (ER) NA (FB) NA

Sample Team: JSB, JW, CE

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: [signature] 2-26-14

Reviewed BY / Date: [signature] 2-26-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: ~~Don Burton~~ John Nenni

ABG-02272014-S-EA SAC

RFA / COC Number: ABG-02272014-S-EA

Location Code: **013-HP012**
Sample Number: **ABG0068**
Sample Name: **013-HP012-DS-ABG0068-REG**
Sampling Method: **HA**
Sample Type: **DS** *Sample Purpose:* **REG**
Sampling Equip: HA

Task: **013**
Collection Date: 2-26-14
Collection Time: 1450
Start Depth: 2' BGS
End Depth: 4' BGS
Sample Matrix: **SOIL**
Sample Team: JSB, JW, CE

QC Partners:
(TB) NA (ER) NA (FB) NA

ERPIMS Values:
Sacode: N/A
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: [signature] 2-26-14

Reviewed BY / Date: [signature] 2-26-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: Don Burton

ABG-02272014-S-SA

RFA / COC Number: ABG-02272014-S-EP

Location Code: 013-HP012
Sample Number: ABG0069
Sample Name: 013-HP012-DS-ABG0069-REG
Sampling Method: DP
Sample Type: DS *Sample Purpose:* REG
Sampling Equip: DP

Task: 013
Collection Date: 2-26-14
Collection Time: 1455
Start Depth: 6' BGS
End Depth: 8' BGS
Sample Matrix: SOIL
Sample Team: JSB, JW, CE

QC Partners:
(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID = 0.0ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: [signature] 2-26-14

Reviewed BY / Date: [signature] 2-26-14

HTRW DRILLING LOG

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

Client	CB+I	Hole Number	013-HP013
Company Name	Shaw Environmental, Inc.	Drilling Subcontractor	GSE
Sheet	1 of 2		
Project	Redstone Arsenal	Location	RSA-013
Name of Driller	JUSTIN WINGERTER	Manufacturer's Designation of Drill	GEOPROBE 7822 DT
Sizes and Types of Drilling and Sampling Equipment	HAND AUGER 2" MACROCORE	Surface Elevation	TBD
		Date Started	2-26-2014
		Date Completed	2-26-2014
Overburden Thickness	27.0' BGS	Depth Groundwater Encountered	~15' BGS
Depth Drilled into Rock	Ø	Depth to Water and Elapsed Time After Drilling Completed	15.4' BGS AFTER 30 MINUTES
Total Depth of Hole	27.0' BGS	Other Water Level Measurements (Specify)	

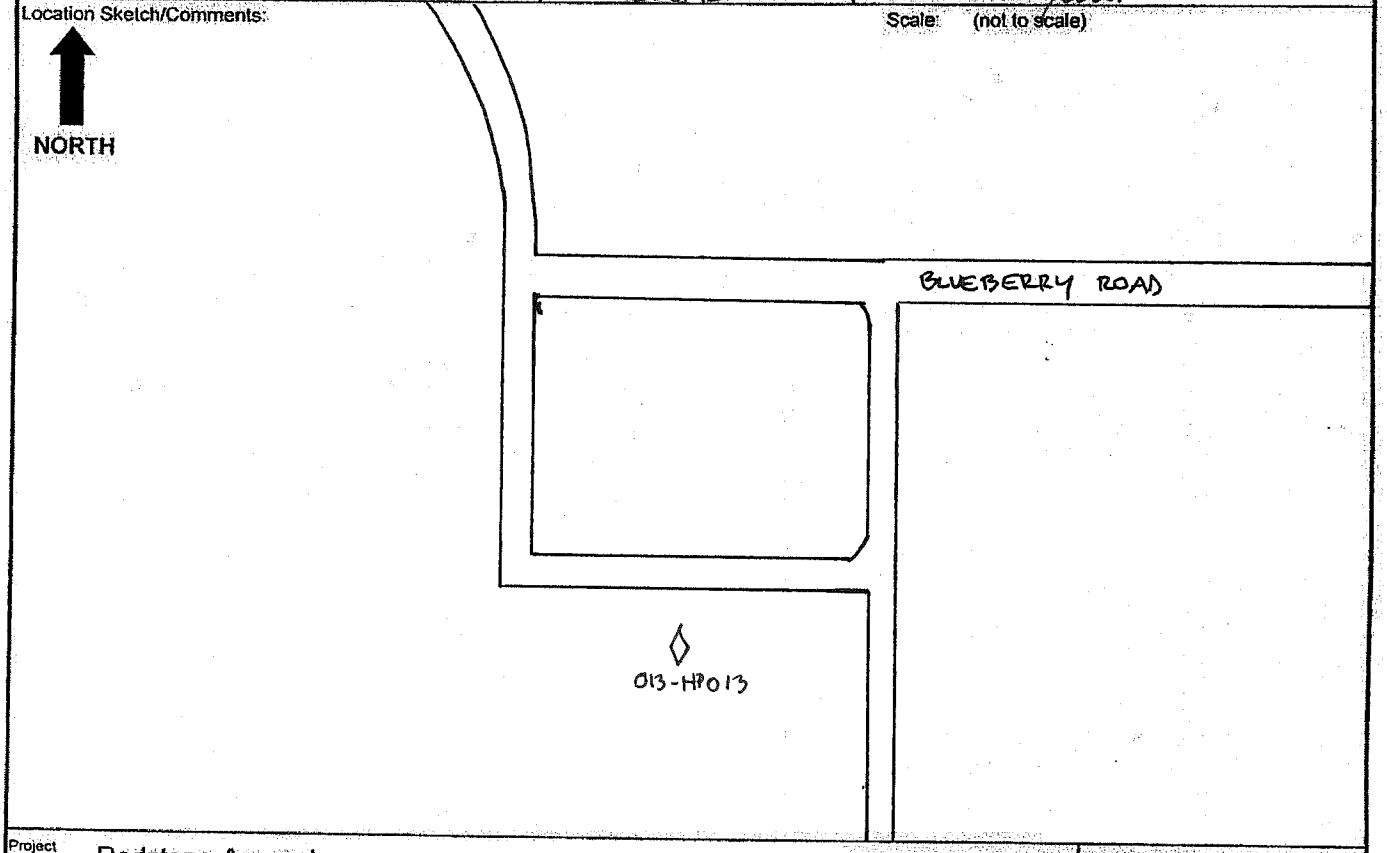
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	✓	✓	THIANES/THIODIGLYCOL	PERCHLORATE	EXPLOSIVES	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	NA	NA	PIEZOMETER	

Location Sketch/Comments:

Scale: (not to scale)



Project	Redstone Arsenal	Hole Number	013-HP013

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-HP013

Project: REDSTONE ARSENAL

Geologist: JULIE SCHENCK BROWN

Sheet 2 of 2 Sheets

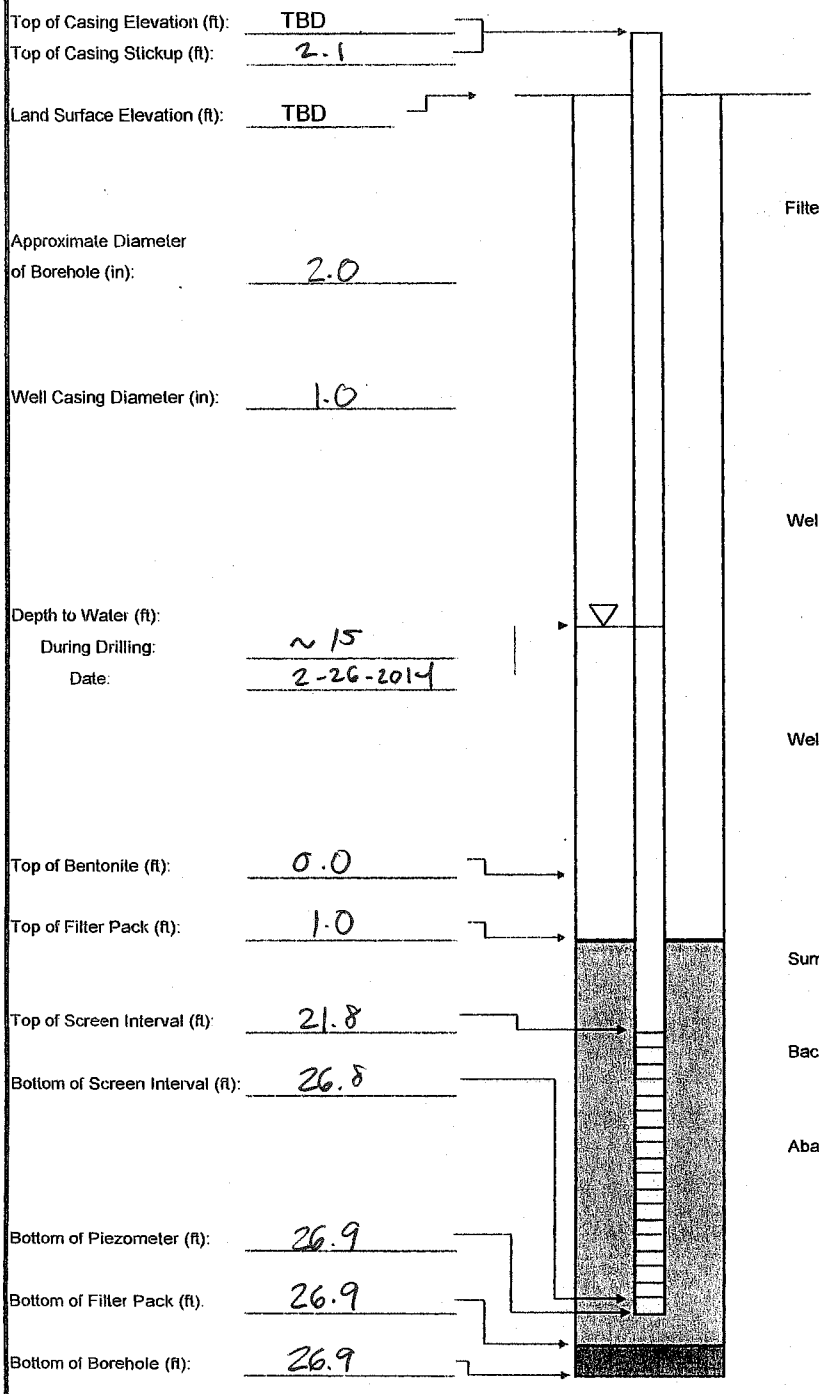
Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	SURFACE = GRASS						
		(0-1): YELLOWISH BROWN SANDY CLAY (10YR5/4) LOW PLASTICITY LOW STIFFNESS VERY FINE SAND SLIGHT MOISTURE	CL	(0-5) 0.0	NA ↓	ABA 0070 (0-1)	5/5	HAND AUGER TO 5' BGS
	1	(1-5): YELLOWISH BROWN SANDY CLAY (10 YR 5/6) LOW PLASTICITY MEDIUM → HIGH STIFFNESS VERY FINE SAND HEAVY CONCENTRATION OF MANGANESE AT 2-3' BGS 60% MOTTLING (GRAY) SLIGHT MOISTURE	CL			ABA 0071 ABA 0072 (2-4)		
	2							
	3							
	4							
	5	(5-10): YELLOWISH BROWN SANDY CLAY (10 YR 5/6) LOW PLASTICITY MEDIUM STIFFNESS VERY FINE SAND 30% MOTTLING (LIGHT GRAY) TRACES OF MANGANESE AT 8-10' BGS SLIGHT MOISTURE	CL	(5-10) 0.0		ABA 0073 (6-8)	5/5	
	6							
	7							
	8							
	9							
	10							

Project: RSA

Hole Number: 013-HP013

Temporary Piezometer

Project:	Redstone Arsenal	Piezometer Number:	013-HP013
Location:	Huntsville, Madison County, AL	Site Location:	RSA-013
Client:	CB+I	Installation Date	2-26-2014
Subcontractor:	GSE	Northing:	TBD
Driller:	JUSTIN WINGERTER	Easting:	TBD
Shaw Field Representative:	BRIAN RHODES	Project Number:	136973



Top of Casing Elevation (ft): TBD
Top of Casing Stickup (ft): 2.1
Land Surface Elevation (ft): TBD
Approximate Diameter of Borehole (in): 2.0
Well Casing Diameter (in): 1.0
Depth to Water (ft):
During Drilling: ~ 15
Date: 2-26-2014
Top of Bentonite (ft): 0.0
Top of Filter Pack (ft): 1.0
Top of Screen Interval (ft): 21.8
Bottom of Screen Interval (ft): 26.8
Bottom of Piezometer (ft): 26.9
Bottom of Filter Pack (ft): 26.9
Bottom of Borehole (ft): 26.9

Filter Pack Material:
Manufacturer: CONSOLIDATED AGGREGATES
Product Name: FILTER MEDIA
Size: NO. 2
Installation: Prepacked Screen | Filter Sock | (Gravity) | Tremie

Well Casing:
Manufacturer: MONOFLEX
Type: SCHEDULE 40 PVC
Diameter (in): 1.0

Well Screen Casing:
Manufacturer: MONOFLEX
Type: SCHEDULE 40 PVC
Slot Size (in): 0.010
Slot Type: Continuous wrap | (Factory slot)

Sump/End Cap: 0.1' POINT

Backfill Material: NONE

Abandonment:
Date: TBD
Procedure: Natural fill | Grouted | Casing Removed
Completed as Well: TBD

Depths and heights are referenced to ground surface unless specified TOC
All elevations are referenced to MSL (NAVD 88)
If completed as well - see well construction diagram

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

Shaw™
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Sample Collection Log

136973 - Redstone PMC (EQM)
Manager: ~~Don Burton~~ John Nemi

ABG-022814-W-SAC
RFA / COC Number: ABG-0227201 4-W-EP

Location Code: **013-HP013**
Sample Number: **ABG3014**
Sample Name: **013-HP013-GW-ABG3014-REG**
Sampling Method: **SP**
Sample Type: **GW** *Sample Purpose:* **REG**
Sampling Equip: Peristaltic pump
QC Partners:
(TB) 0227201 4-TB (ER) NA (FB) NA

Task: **013**
Collection Date: 2-27-14
Collection Time: 1620
Start Depth: 7.89' BTOC
End Depth: 7.89 BTOC
Sample Matrix: **WATER**
Sample Team: CEG

ERPIMS Values:
Sacode: N/A
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
PERCH_6850	N	B	1	125	mL	HDPE
EXPLOSIVES+	N	C	2	1	L	Amb. Glass
THIANES	N	E	2/1	1	L	Amb. Glass
THIODIGLYCOL	N	F	1	500	mL	B.R.

Groundwater Information:
Measured Well Depth: 26.9' BTOC **Depth To Water:** 7.89' BTOC

Comments: Unable to collect paramater due to piezometer going dry

Sketch Location: See Drilling Log

Logged BY / Date: 2/27/14 *Reviewed BY / Date:* 2-27-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nemi

RFA / COC Number: ABG-020714-S-SAC / ABG-0207014-S-EP

Location Code: **013-HP013**

Sample Number: **ABG0070**

Sample Name: **013-HP013-SS-ABG0070-REG**

Sampling Method: **HA**

Sample Type: **SS** *Sample Purpose:* **REG**

Sampling Equip: HA

QC Partners: BK

(TB) ~~0227~~ NA (ER) NA (FB) NA

Task: **013**

Collection Date: 2-26-14

Collection Time: 1535

Start Depth: 0' BGS

End Depth: 1' BGS

Sample Matrix: **SOIL**

Sample Team: JSB, JW, CE

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID=0.0ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: [signature] 2-26-14

Reviewed BY / Date: [signature] 2-26-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: ~~Don Burton~~ John Nenni

ABG-022714-S-SAC
RFA / COC Number: ABG-022714-S-EA

Location Code: **013-HP013**
Sample Number: **ABG0071**
Sample Name: **013-HP013-DS-ABG0071-REG**
Sampling Method: **HA**
Sample Type: **DS** *Sample Purpose:* **REG**
Sampling Equip: HA

Task: **013**
Collection Date: 2-26-14
Collection Time: 1540
Start Depth: 2' BGS
End Depth: 4' BGS
Sample Matrix: **SOIL**

QC Partners:
(TB) N/A (ER) N/A (FB) N/A

Sample Team: JSB, JW, CE

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID = 0.0ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2-26-14

Reviewed BY / Date: 2-26-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nenni

ABG-D22714-S-SAC

RFA / COC Number: ABG-D2272014-S-EA

Location Code: **013-HP013**

Sample Number: **ABG0072**

Sample Name: **013-HP013-DS-ABG0072-FD**

Sampling Method: **HA**

Sample Type: **DS** *Sample Purpose:* **FD**

Sampling Equip: HA

Task: **013**

Collection Date: 2-26-14

Collection Time: 1540

Start Depth: 2' BGS

End Depth: 4' BGS

Sample Matrix: **SOIL**

Sample Team: JSB, JW, CE

QC Partners:

(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: [signature] 2-26-14

Reviewed BY / Date: DQC 2-26-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nenni

ABG-022714-S-SAC

RFA / COC Number: ABG-0227201 4-S-EP

Location Code: **013-HP013**

Sample Number: **ABG0073**

Sample Name: **013-HP013-DS-ABG0073-REG**

Sampling Method: **DP**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: DP

Task: **013**

Collection Date: 2-26-14

Collection Time: 1550

Start Depth: 6' BGS

End Depth: 8' BGS

Sample Matrix: **SOIL**

Sample Team: JSB, JW, CE

QC Partners:

(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2-26-14

Reviewed BY / Date: OK 2-26-14

HTRW DRILLING LOG

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

Client: CB+I			Hole Number: 013-HP014
Company Name: Shaw Environmental, Inc.		Drilling Subcontractor: GSE	Sheet: 1 of 2 Sheets
Project: Redstone Arsenal		Location: RSA-013	
Name of Driller: JUSTIN WINGERTER		Manufacturer's Designation of Drill: GEOPROBE 7822 DT	
Sizes and Types of Drilling and Sampling Equipment: HAND AUGER; 2" MACROCORE		Surface Elevation: TBD	
		Date Started: 2-27-2014	Date Completed: 2-27-2014
Overburden Thickness: 27' BGS		Depth Groundwater Encountered	
Depth Drilled into Rock: Ø		Depth to Water and Elapsed Time After Drilling Completed: 12.9' BGS AFTER 15 MINUTES	
Total Depth of Hole: 27.0' BGS (DPT) 26.6' BGS (PIEZOMETER)		Other Water Level Measurements (Specify)	

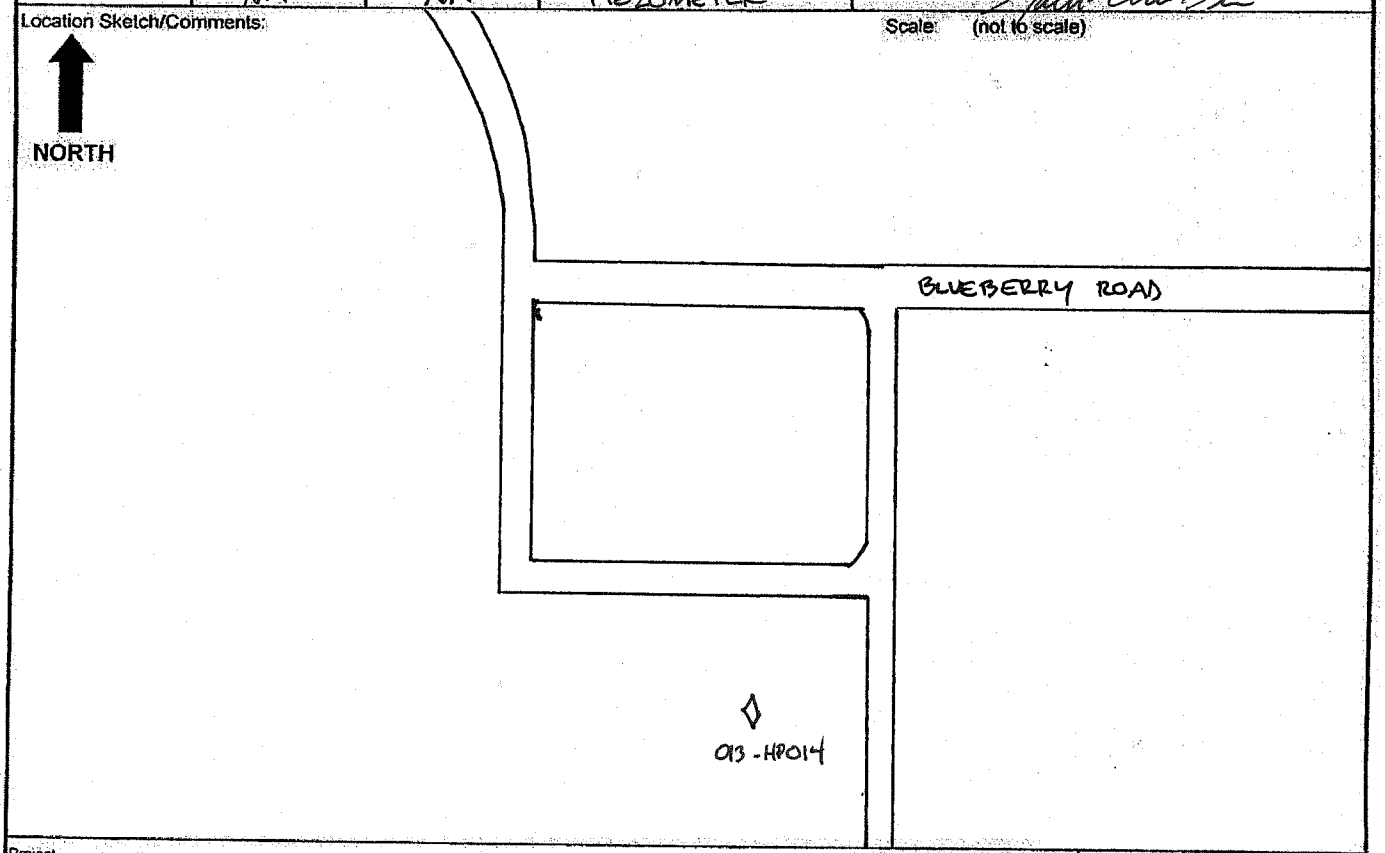
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	✓	✓	THFANES/THIODIGLYCOL	PERCHLORATE	EXPLOSIVES	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	NA	NA	PIEZOMETER	

Location Sketch/Comments:

Scale: (not to scale)



Project	Hole Number
Redstone Arsenal	013-HP014

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-HP014

Project: REDSTONE ARSENAL

Geologist: JULIE SCHENCK BROWN

Sheet 2 of 2 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	SURFACE = GRASS						
		(0-1): DARK YELLOWISH BROWN SANDY CLAY (10 YR 4/4) LOW PLASTICITY LOW STIFFNESS VERY FINE SAND MOIST	CL	(0-5)	NA ↓	ABG 0074 (0-1)	5/5	HAND AUGER TO 5' BGS
	1	(1-3): LIGHT OLIVE BROWN SANDY CLAY (2.5 Y 5/3) MEDIUM PLASTICITY LOW STIFFNESS VERY FINE SAND 20% MOTTLING (GRAY) MOIST	CL					
	2					ABG 0075 (2-4)		
	3	(3-5): YELLOWISH BROWN SANDY CLAY (10 YR 5/6) LOW PLASTICITY LOW-MEDIUM STIFFNESS VERY FINE SAND 30% MOTTLING (GRAY) TRACES OF MAGANESE SLIGHT MOISTURE	CL					
	4							
	5	(5-10): DARK YELLOWISH BROWN SANDY CLAY (10 YR 4/4) LOW PLASTICITY MEDIUM STIFFNESS MAGANESE DEPOSITS VERY FINE SAND MOIST	CL	(5-10)			5/5	
	6					ABG 0076 (6-8)		
	7							
	8							
	9							PER MARK STOREMAKER, CO-S COM, A DESCRIPTION OF SOIL LITHOLOGY IS ONLY NEEDED IN 10' BGS
	10							

Project: RSA

Hole Number: 013-HP014

Temporary Piezometer

Project:	Redstone Arsenal	Piezometer Number:	013-HP014
Location:	Huntsville, Madison County, AL	Site Location:	RSA-013
Client:	CB+I	Installation Date	2-27-2014
Subcontractor:	ASE	Northing:	TBD
Driller:	JUSTIN WINGALTER	Easting:	TBD
Shaw Field Representative:	BRIAN RHODES	Project Number:	136973

Top of Casing Elevation (ft): TBD
Top of Casing Stickup (ft): 2.5

Land Surface Elevation (ft): TBD

Approximate Diameter of Borehole (in): 2.0

Well Casing Diameter (in): 1.0

Depth to Water (ft):
During Drilling: ~ 14'
Date: 2-27-2014

Top of Bentonite (ft): 0.0

Top of Filter Pack (ft): 1.0

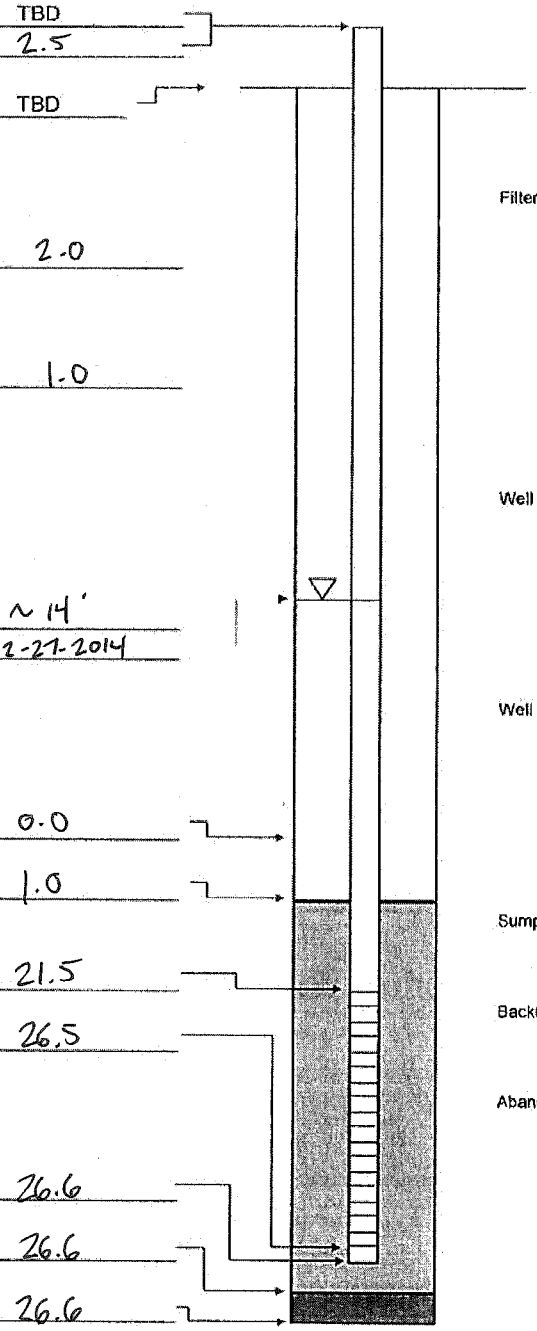
Top of Screen Interval (ft): 21.5

Bottom of Screen Interval (ft): 26.5

Bottom of Piezometer (ft): 26.6

Bottom of Filter Pack (ft): 26.6

Bottom of Borehole (ft): 26.6



Filter Pack Material:
- Manufacturer: CONSOLIDATED AGGREGATES
- Product Name: FILTER MEDIA
- Size: No. 2
- Installation: Prepacked Screen; Filter Sock; (Gravity); Tremie

Well Casing:
- Manufacturer: MONOFLEX
- Type: SCHEDULE 40 PVC
- Diameter (in): 1.0

Well Screen Casing:
- Manufacturer: MONOFLEX
- Type: SCHEDULE 40 PVC
- Slot Size (in): 0.010
- Slot Type: Continuous wrap; (Factory slot)

Sump/End Cap: 0.1' POINT

Backfill Material: NONE

Abandonment:
- Date: TBD
- Procedure: Natural fill; Grouted; Casing Removed
- Completed as Well: TBD

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

Depths and heights are referenced to ground surface unless specified TOC
All elevations are referenced to MSL (NAVD 88)
If completed as well - see well construction diagram

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC (EJM)

Manager: ~~Don Burton~~ John Nenni

ABP-022714-S-SAC

RFA / COC Number: ABP-022714-S-EP

Location Code: **013-HP014**

Sample Number: **ABG0074**

Sample Name: **013-HP014-SS-ABG0074-REG**

Sampling Method: **HA**

Sample Type: **SS** *Sample Purpose:* **REG**

Sampling Equip: HA

QC Partners:

(TB) NA (ER) NA (FB) NA

Task: **013**

Collection Date: 2-27-14

Collection Time: 1010

Start Depth: 0' BGS

End Depth: 1' BGS

Sample Matrix: **SOIL**

Sample Team: JSB, JW

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: [signature] 2-27-14

Reviewed BY / Date: OK 2-27-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nenni

ABG-022714-S-SAC

RFA / COC Number: ABG-0227014-S-EP

Location Code: **013-HP014**

Sample Number: **ABG0075**

Sample Name: **013-HP014-DS-ABG0075-REG**

Sampling Method: **HA**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: HA

QC Partners:

(TB) NA (ER) NA (FB) NA

Task: **013**

Collection Date: 2-27-14

Collection Time: 1015

Start Depth: 2' BGS

End Depth: 4' BGS

Sample Matrix: **SOIL**

Sample Team: JSB, JW

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: [signature] 2-27-14

Reviewed BY / Date: OK 2-27-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: ~~Don Burton~~ John Nemi EJM

ABG-022714-S-SAC
RFA / COC Number: ABG-022714-S-EA

Location Code: **013-HP014**
Sample Number: **ABG0076**
Sample Name: **013-HP014-DS-ABG0076-REG**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**
Sampling Equip: DP

Task: **013**
Collection Date: 2-27-14
Collection Time: 1020
Start Depth: 6' BGS
End Depth: 8' BGS
Sample Matrix: **SOIL**
Sample Team: JSB, JW

QC Partners:
(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2-27-14

Reviewed BY / Date: OK 2-27-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC EPM

Manager: ~~Don Burton~~ John Nenni

ABG-03042014-W-SAC

RFA / COC Number: ABG-03042014-W-EP

Location Code: **013-HP014**

Sample Number: **ABG3015**

Sample Name: **013-HP014-GW-ABG3015-REG**

Sampling Method: **SP**

Sample Type: **GW** *Sample Purpose:* **REG**

Sampling Equip: Peristaltic Pump

Task: **013**

Collection Date: 2-28-14

Collection Time: 0820

Start Depth: 8.34' BTOC

End Depth: 8.34' BTOC

Sample Matrix: **WATER**

Sample Team: CE

QC Partners:

(TB) 03042014-TB (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
PERCH_6850	N	B	1	125	mL	HDPE
EXPLOSIVES+	N	C	2	1	L	Amb. Glass
THIANES	N	E	2	1	L	Amb. Glass
THIODIGLYCOL	N	F	1	500	mL	B.R.

ERPIMS Values:

Sacode:

Lot Control#: N/A

Groundwater Information:

Measured Well Depth: 26.6' BTOC **Depth To Water:** 8.34' BTOC

Comments: Turbidity: >1000 Temp.: 10.05°C pH: 7.51 Conductivity: 0.275 MS/cm DO: 22.97 mg/L Redox: 32 MV

Sketch Location:

See Drilling Log

Logged BY / Date: Cody Ellis 2-28-14 *Reviewed BY / Date:* 2-28-14

HTRW DRILLING LOG

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

Client: CB+I			Hole Number: 013-HP015
Company Name: Shaw Environmental, Inc.		Drilling Subcontractor: GSE	Sheet: 1 of 2 Sheets
Project: Redstone Arsenal		Location: RSA-013	
Name of Driller: JUSTIN WINGERTER		Manufacturer's Designation of Drill: GEOPROBE 7822 DT	
Sizes and Types of Drilling and Sampling Equipment: HAND AUGER; 2" MACROCORE		Surface Elevation: TBD	
		Date Started: 2-27-2014	Date Completed: 2-27-2014
Overburden Thickness: 40' BGS		Depth Groundwater Encountered: ~15' BGS	
Depth Drilled into Rock: Ø		Depth to Water and Elapsed Time After Drilling Completed: 6.2' BGS AFTER 90 MINUTES	
Total Depth of Hole: 23.9' BGS DUE TO CAVE-IN OF CLAYEY SAND		Other Water Level Measurements (Specify): NA	

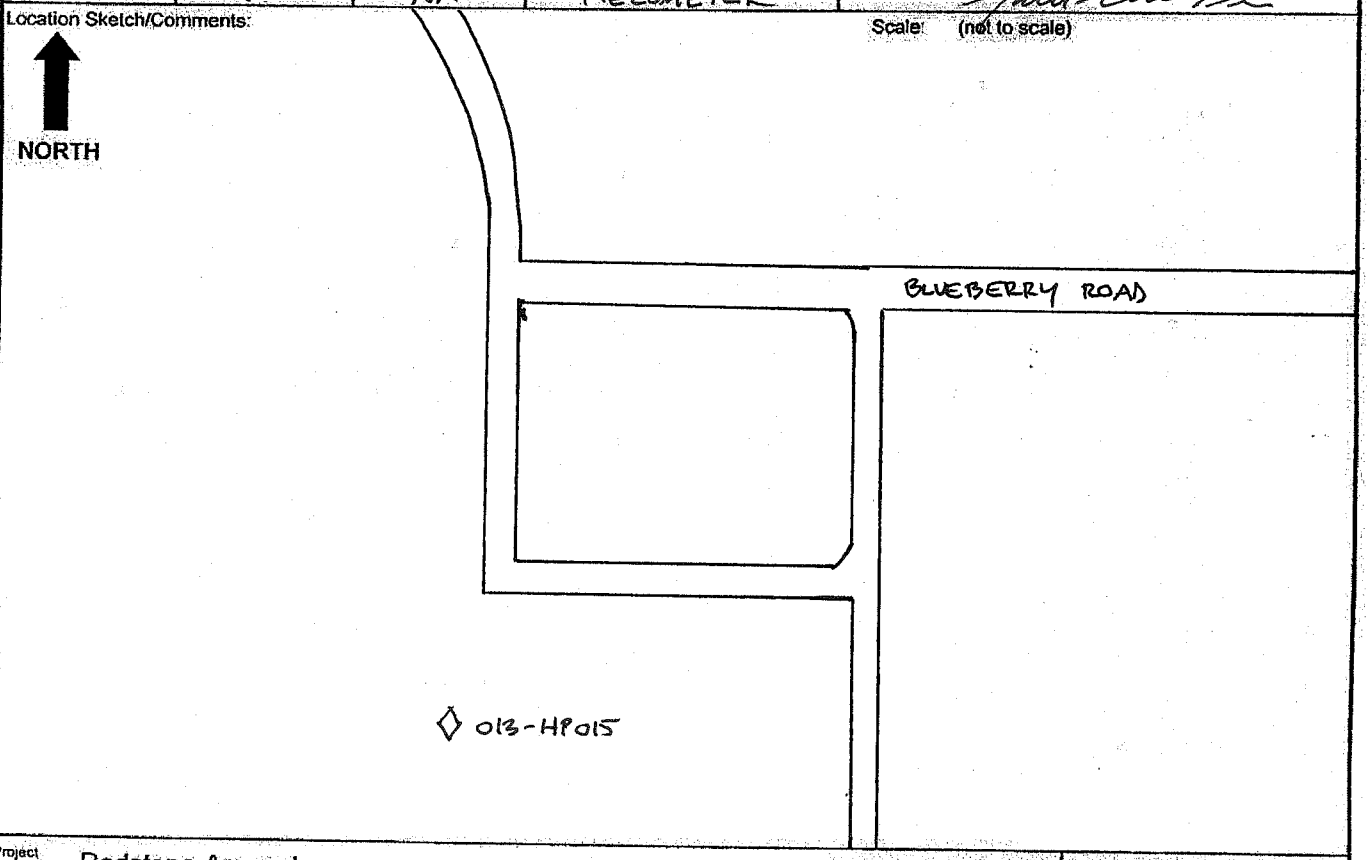
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	✓	✓	THIANES/THIODIGLYCOL	PERCHLORATE	EXPLOSIVES	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	NA	NA	PIEZOMETER	

Location Sketch/Comments:

Scale: (not to scale)



Project	Hole Number
Redstone Arsenal	013-HP015

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-HP015

Project: REDSTONE ARSENAL

Geologist: JULIE SCHENCK BROWN

Sheet 2 of 2 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	SURFACE = GRASS						
		(0-1): YELLOWISH BROWN SANDY CLAY (10 YR 5/8) MEDIUM PLASTICITY LOW STIFFNESS VERY FINE SAND MANGANESE DEPOSITS MOIST	CL	(0-5)	NA ↓	ABG 0077 (0-1)	5/5	HAND AUGER TO 5' BGS
	1	(1-5): YELLOWISH BROWN SANDY CLAY (10 YR 5/8) LOW PLASTICITY MEDIUM STIFFNESS VERY FINE SAND MANGANESE DEPOSITS SLIGHT MOISTURE	CL					
	2					ABG 0078		
	3					ABG 0080 (2-4)		
	4							
	5	(5-10): YELLOWISH BROWN SANDY CLAY (10 YR 5/8) LOW PLASTICITY MEDIUM STIFFNESS VERY FINE SAND FINE TO MEDIUM SIZE ANGULAR CHERT AT 7' BGS 20% MOTTLING (GRAY) TRACES OF MANGANESE SLIGHT MOISTURE	CL					
	6							
	7					ABG 0079 (6-8)		
	8							
	9							PER MARKSTHEMAKER, CB+I CAM, A DESCRIPTION OF SOIL LITHOLOGY ONLY REQUIRED TO 10' BGS
	10							

Project: RSA

Hole Number: 013-HP015

Temporary Piezometer

Project:	Redstone Arsenal	Piezometer Number:	013-HP015
Location:	Huntsville, Madison County, AL	Site Location:	RSA-013
Client:	CB+I	Installation Date	2-27-14
Subcontractor:	GSE	Northing:	TBD
Driller:	JUSTIN WINGERTER	Easting:	TBD
Shaw Field Representative:	BRIAN RHODES	Project Number:	136973

Top of Casing Elevation (ft): TBD
Top of Casing Stickup (ft): 2.3

Land Surface Elevation (ft): TBD

Approximate Diameter of Borehole (in): 2.0

Well Casing Diameter (in): 1.0

Depth to Water (ft):
During Drilling: ~~15~~ ~15'
Date: 2-27-14

Top of Bentonite (ft): 0.0

Top of Filter Pack (ft): 1.0

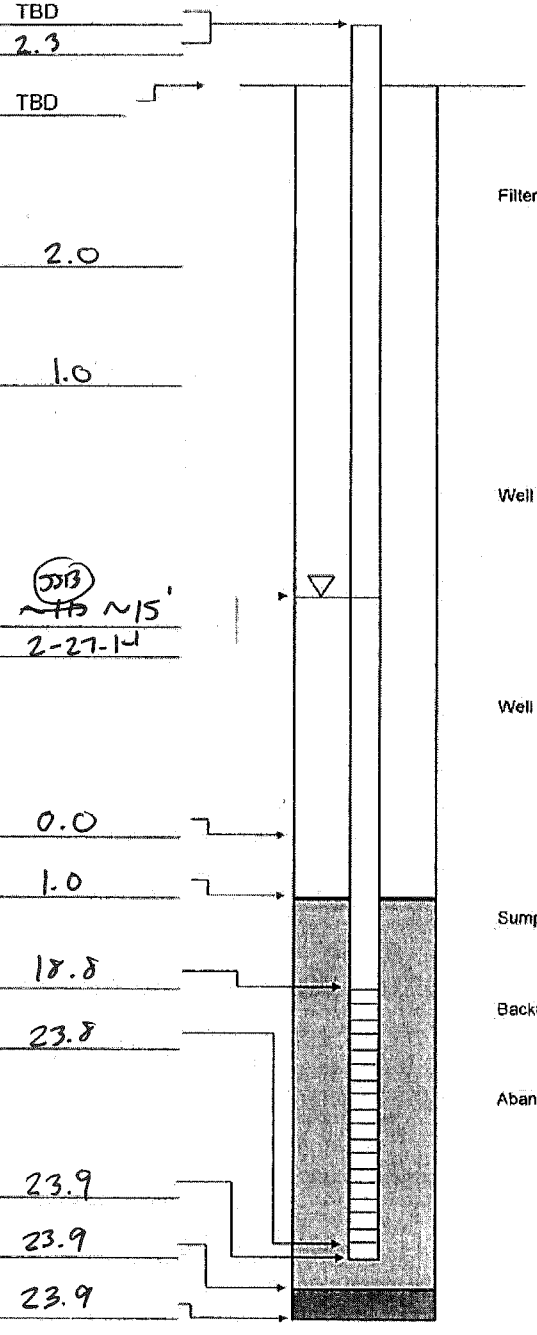
Top of Screen Interval (ft): 18.8

Bottom of Screen Interval (ft): 23.8

Bottom of Piezometer (ft): 23.9

Bottom of Filter Pack (ft): 23.9

Bottom of Borehole (ft): 23.9



Filter Pack Material:
Manufacturer: CONSOLIDATED AGGREGATES
Product Name: FILTER MEDIA
Size: No. 2
Installation: Prepacked Screen | Filter Sock | (Gravity) | Tremie

Well Casing:
Manufacturer: MONOFLEX
Type: SCHEDULE 40 PVC
Diameter (in): 1.0

Well Screen Casing:
Manufacturer: MONOFLEX
Type: SCHEDULE 40 PVC
Slot Size (in): 0.010
Slot Type: Continuous wrap | (Factory slot)

Sump/End Cap: 0.1' POINT

Backfill Material: NONE

Abandonment:
Date: TBD
Procedure: Natural fill | Grouted | Casing Removed | Completed as Well | TBD

Shaw Environmental & Infrastructure Inc
(A CB&I Company)

Depths and heights are referenced to ground surface unless specified TOC
All elevations are referenced to MSL (NAVD 88)
If completed as well - see well construction diagram

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC EPM

Manager: ~~Don Burton~~ John Nenni

ABG-02282014-G-SAC ORA

RFA / COC Number: ABG-02272014-S-EP

Location Code: **013-HP015**

Sample Number: **ABG0077**

Sample Name: **013-HP015-SS-ABG0077-REG**

Sampling Method: **HA**

Sample Type: **SS** *Sample Purpose:* **REG**

Sampling Equip: HA

Task: **013**

Collection Date: 2-27-14

Collection Time: 1505

Start Depth: 0' BGS

End Depth: 1' BGS

Sample Matrix: **SOIL**

QC Partners:

(TB) NA (ER) NA (FB) NA

Sample Team: JSB, JW

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: [signature] 2-27-14

Reviewed BY / Date: OK 2-27-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC (EPM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG-022814-S-SAC / ABG-02272014-S-EA

Location Code: **013-HP015**

Sample Number: **ABG0078**

Sample Name: **013-HP015-DS-ABG0078-REG**

Sampling Method: **HA**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: HA

Task: **013**

Collection Date: 2-27-14

Collection Time: 1510

Start Depth: 2' BGS

End Depth: 4' BGS

Sample Matrix: **SOIL**

QC Partners:

(TB) NA (ER) NA (FB) NA

Sample Team: JSB, JW

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: [signature] 2-27-14

Reviewed BY / Date: OK 2-27-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC (EPM)

Manager: ~~Don Burton~~ John Ninni

ABG-022814-S-SAC

RFA / COC Number: ABG-0227014-S-EP

Location Code: **013-HP015**

Sample Number: **ABG0080**

Sample Name: **013-HP015-DS-ABG0080-FD**

Sampling Method: ~~DP~~ HA (EPM)

Sample Type: **DS** *Sample Purpose:* **FD**

Sampling Equip: ~~DP~~ (JSB) HA

Task: **013**

Collection Date: 2-27-14

Collection Time: 1510

Start Depth: 2' ~~BGS~~

End Depth: 4' BGS

Sample Matrix: **SOIL**

Sample Team: JSB, JW

QC Partners:

(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: J. Schulz 2-27-14

Reviewed BY / Date: OK 2-27-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC (ESMM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG-022814-S-SAC / ABG-0272014-S-EP

Location Code: **013-HP015**

Sample Number: **ABG0079**

Sample Name: **013-HP015-DS-ABG0079-REG**

Sampling Method: **DP**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: DP

Task: **013**

Collection Date: 2-27-14

Collection Time: 1520

Start Depth: (JSB) ~~2' BGS~~ 6' BGS

End Depth: (JSB) ~~4' BGS~~ 8' BGS

Sample Matrix: **SOIL**

QC Partners:

(TB) NA (ER) NA (FB) NA

Sample Team: JSB, JW

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID =

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2.27.14 J.S.B

Reviewed BY / Date: 2.27.14 OK

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: ~~Don Burton~~ John Ninni

ABG-03042014-W-SK
RFA / COC Number: ABG-03042014-W-EP

Location Code: **013-HP015**
Sample Number: **ABG3016**
Sample Name: **013-HP015-GW-ABG3016-REG**
Sampling Method: **SP**
Sample Type: **GW** *Sample Purpose:* **REG**
Sampling Equip: Peristaltic Pump
QC Partners:
(TB) 03042014-TB (ER) NA (FB) NA

Task: **013**
Collection Date: 2-28-14
Collection Time: 0925
Start Depth: 21.2 9.18 'BTOC
End Depth: 21.2 9.18 'BTOC
Sample Matrix: **WATER**
Sample Team: CE

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
PERCH_6850	N	B	1	125	mL	HDPE
EXPLOSIVES+	N	C	2	1	L	Amb. Glass
THIANES	N	E	2	1	L	Amb. Glass
THIODIGLYCOL	N	F	1	500	mL	B.R.

ERPIMS Values:
Sacode: N/A
Lot Control#:

Groundwater Information:
Measured Well Depth: 26.2 'BTOC **Depth To Water:** 9.18 'BTOC

Comments: Turbidity: 899 Temperature: 12.82°C pH: 7.54 Conductivity: 0.219 ms/cm D.O.: 6.38 mg/L Redox: 45 mV

Sketch Location: See Drilling Log

Logged BY / Date: 2-28-14 *Reviewed BY / Date:* OK 2-28-14

HTRW DRILLING LOG

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

Client	CB+I	Hole Number	013-HP016
Company Name	Shaw Environmental, Inc.	Drilling Subcontractor	GSE
		Sheet	1 of 2 Sheets
Project	Redstone Arsenal	Location	RSA-013
Name of Driller	JUSTIN WINGERTER	Manufacturer's Designation of Drill	GEOPROBE 7822 DT
Sizes and Types of Drilling and Sampling Equipment	HAND AUGER 2" MACROCORE	Surface Elevation	TBD
		Date Started	2-28-2014
		Date Completed	2-28-2014
Overburden Thickness	49' BGS	Depth Groundwater Encountered	~20' BGS
Depth Drilled into Rock	Ø	Depth to Water and Elapsed Time After Drilling Completed	10.1' BGS AFTER 15 MINUTES
Total Depth of Hole	22.2' BGS FOR PIEZOMETER DUE TO COLLAPSE	Other Water Level Measurements (Specify)	

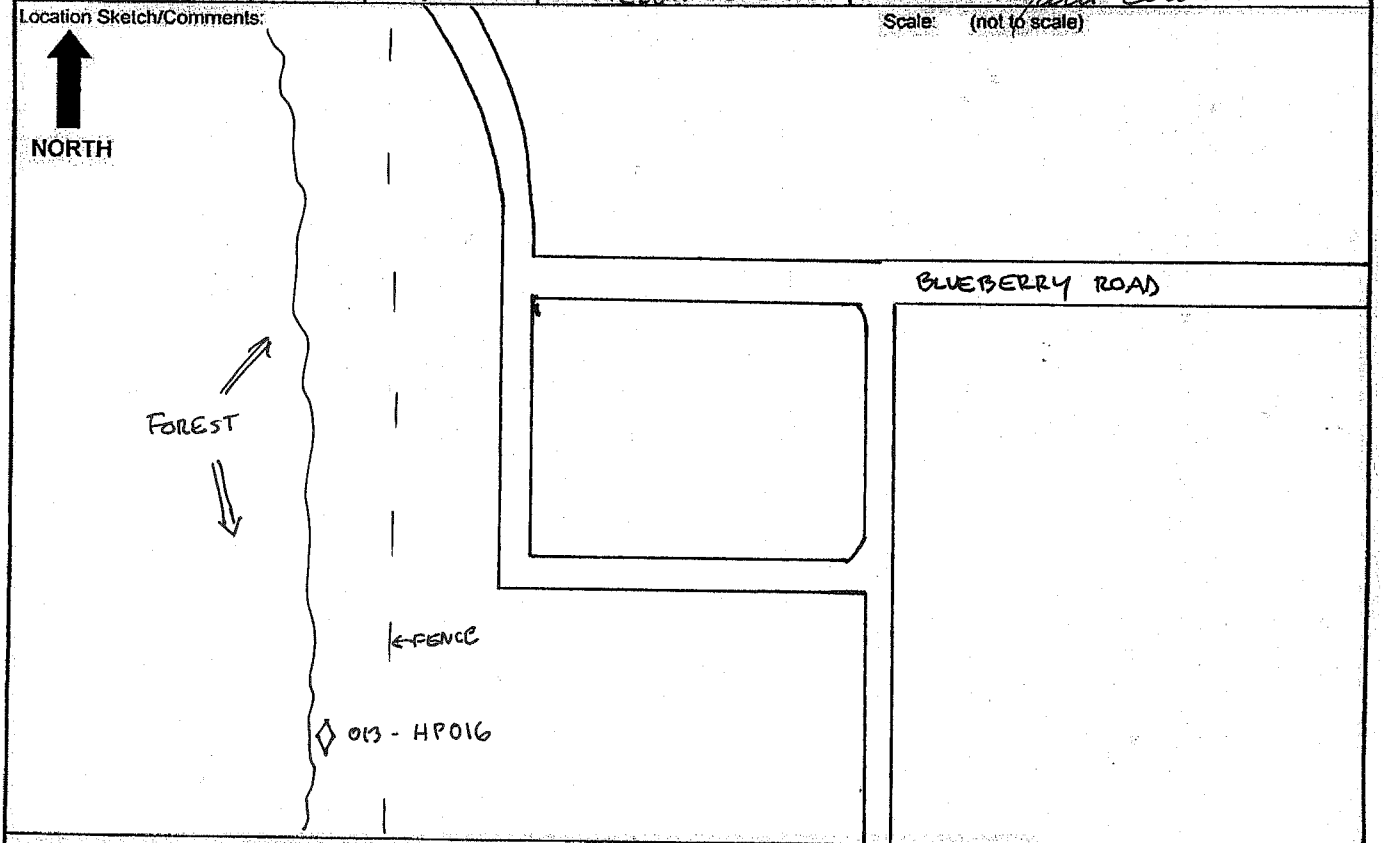
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	✓	✓	THIANES/THIODIGLYCOL	PERCHLORATE	EXPLOSIVES	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	NA	NA	PIEZOMETER	

Location Sketch/Comments:

Scale: (not to scale)



Project	Hole Number
Redstone Arsenal	013-HP016

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-HP016

Project: REDSTONE ARSENAL

Geologist: JULIE SCHENCK BROWN

Sheet 2 of 2 Sheets

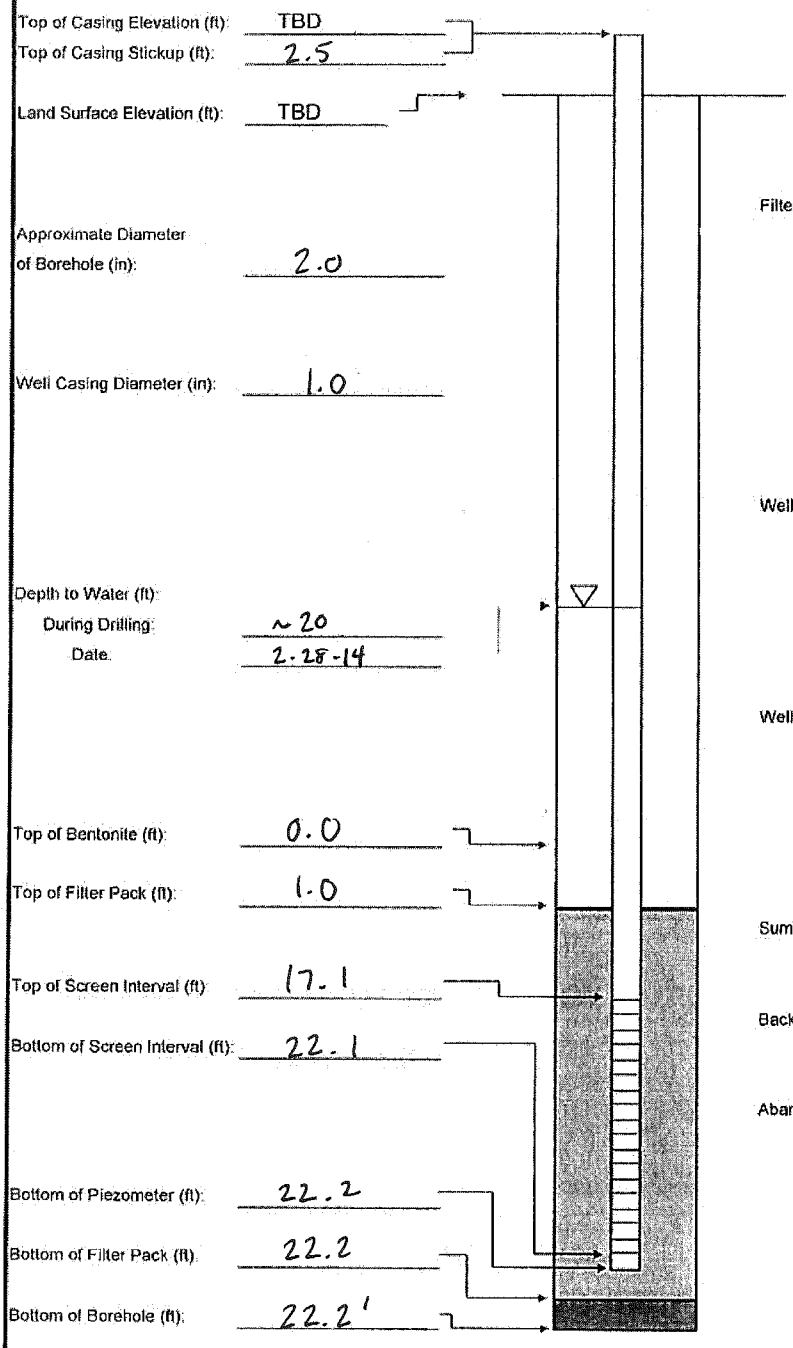
Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	SURFACE = ORGANICS						
		(0-1): DARK YELLOWISH BROWN SILTY CLAY (10 YR 4/4) LOW PLASTICITY LOW STIFFNESS MOIST	OL	(0-5) 0.0	NA ↓	ABG 0081 (0-1)	5/5	HAND AUGER TO 5' BGS
	1	(1-5): DARK YELLOWISH BROWN SANDY CLAY (10 YR 4/6) LOW PLASTICITY LOW STIFFNESS VERY FINE SAND 40% MOTTLING (GRAY) MAGANESE DEPOSITS SLIGHT MOISTURE	CL					
	2							
	3					ABG 0082 (2-4)		
	4							
	5	(5-10): DARK YELLOWISH BROWN SANDY CLAY (10 YR 4/6) LOW PLASTICITY MEDIUM-HIGH STIFFNESS VERY FINE SAND 10% MOTTLING (LIGHT GRAY) SLIGHT TRACES OF MAGANESE SLIGHT MOISTURE	CL	(5-10) 0.0			5/5	
	6					ABG 0083 (6-8)		
	7							
	8							
	9							PER MARK STOEMAKER, CB+I CAM, A DESCRIPTION OF SOIL LITHOLOGY ONLY NEEDED TO 10' BGS
	10							

Project: RSA

Hole Number: 013-HP016

Temporary Piezometer

Project:	Redstone Arsenal	Piezometer Number:	013-HP016
Location:	Huntsville, Madison County, AL	Site Location:	RSA-013
Client:	CB+I	Installation Date	2-28-2014
Subcontractor:	GSE	Northing:	TBD
Driller:	JUSTIN WINGERTER	Easting:	TBD
Shaw Field Representative:	BRIAN RHODES	Project Number:	136973



Top of Casing Elevation (ft): TBD
Top of Casing Stickup (ft): 2.5
Land Surface Elevation (ft): TBD
Approximate Diameter of Borehole (in): 2.0
Well Casing Diameter (in): 1.0
Depth to Water (ft):
During Drilling: ~20
Date: 2-28-14
Top of Bentonite (ft): 0.0
Top of Filter Pack (ft): 1.0
Top of Screen Interval (ft): 17.1
Bottom of Screen Interval (ft): 22.1
Bottom of Piezometer (ft): 22.2
Bottom of Filter Pack (ft): 22.2
Bottom of Borehole (ft): 22.2'

Filter Pack Material:
Manufacturer: CONSOLIDATED AGGREGATES
Product Name: FILTER MEDIA
Size: No. 2
Installation: Prepacked Screen | Filter Sock | (Gravity) | Tremie

Well Casing:
Manufacturer: MONOFLEX
Type: SCHEDULE 40 PVC
Diameter (in): 1-0

Well Screen Casing:
Manufacturer: MONOFLEX
Type: SCHEDULE 40 PVC
Slot Size (in): 0.010
Slot Type: Continuous wrap | (Factory slot)

Sump/End Cap: 0.1' POINT

Backfill Material: NONE

Abandonment:
Date: TBD
Procedure: Natural fill | Grouted | Casing Removed
Completed as Well: TBD

Depths and heights are referenced to ground surface unless specified TOC
All elevations are referenced to MSL (NAVD 88)
If completed as well - see well construction diagram

Shaw Environmental & Infrastructure Inc
(A CB&I Company)

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC (EPM)

Manager: ~~Don Burton~~ John Nenni

ABG-03042014-S-SAC

RFA / COC Number: ABG-03042014-S-EA

Location Code: **013-HP016**

Sample Number: **ABG0081**

Sample Name: **013-HP016-SS-ABG0081-REG**

Sampling Method: **HA**

Sample Type: **SS** *Sample Purpose:* **REG**

Sampling Equip: HA

Task: **013**

Collection Date: 2-28-14

Collection Time: 1940

Start Depth: 0' BGS

End Depth: 1' BGS

Sample Matrix: **SOIL**

QC Partners:

(TB) NA (ER) NA (FB) NA

Sample Team: JSB, JW

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: [signature] 2-28-14

Reviewed BY / Date: DCK 2-28-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nenni

ABG-03042014-S-SAC

RFA / COC Number: ABG-03042014-S-EA

Location Code: **013-HP016**

Sample Number: **ABG0082**

Sample Name: **013-HP016-DS-ABG0082-REG**

Sampling Method: **HA**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: HA

QC Partners:

(TB) NA (ER) NA (FB) NA

Task: **013**

Collection Date: 2-28-14

Collection Time: 0945

Start Depth: 2' BGS

End Depth: 4' BGS

Sample Matrix: **SOIL**

Sample Team: JSB, JW

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: [signature] 2-28-14

Reviewed BY / Date: [signature]

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG-03042014-S-SAC / ABG-03042014-S-EP

Location Code: **013-HP016**
Sample Number: **ABG0083**
Sample Name: **013-HP016-DS-ABG0083-REG**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**
Sampling Equip: DP

Task: **013**
Collection Date: 2-28-14
Collection Time: 0950
Start Depth: 6' BGS
End Depth: 8' BGS
Sample Matrix: **SOIL**
Sample Team: JSB, JW

QC Partners:
(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID = 0.0ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: J. Schultz 2-28-14

Reviewed BY / Date: DCK 2-28-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: ~~Don Burton~~ John Nenni

ABG-03042014-W-SAC
RFA / COC Number: ABG-03042014-W-EP

Location Code: 013-HP016
Sample Number: ABG3017
Sample Name: 013-HP016-GW-ABG3017-REG
Sampling Method: SP
Sample Type: GW *Sample Purpose:* REG
Sampling Equip: Peristaltic Pump

Task: 013
Collection Date: 2-28-14
Collection Time: 1325
Start Depth: 19.07 ~~9.78~~ BTOC
End Depth: 19.07 ~~9.78~~ BTOC
Sample Matrix: WATER

QC Partners:
(TB) 03042014-TB (ER) NA (FB) NA
Sample Team: CE

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
PERCH_6850	N	B	1	125	mL	HDPE
EXPLOSIVES+	N	C	2	1	L	Amb. Glass
THIANES	N	E	2	1	L	Amb. Glass
THIODIGLYCOL	N	F	1	500	mL	B.R.

ERPIMS Values:
Sacode: N/A
Lot Control#:

Groundwater Information:
Measured Well Depth: 24.07' BTOC **Depth To Water:** 9.78' BTOC

Comments: Turbidity: >1000 Temperature: 14.76°C pH: 7.16 D.O.: 15.02mg/L Conductivity: 0.243mS/cm Redox: 41mV

Sketch Location: See Drilling Log

Logged BY / Date: 2-28-14 *Reviewed BY / Date:* OK 2-28-14

HTRW DRILLING LOG

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

Client	CB+I	Hole Number	013-HP017
Company Name	Shaw Environmental, Inc.	Drilling Subcontractor	GSE
Sheet	1 of 2 Sheets		
Project	Redstone Arsenal	Location	RSA-013
Name of Driller	JUSTIN WINGERTER	Manufacturer's Designation of Drill	GEOPROBE 7822 DT
Sizes and Types of Drilling and Sampling Equipment	HAND AUGER 2" MACROCORE	Surface Elevation	TBD
		Date Started	2-28-2014
		Date Completed	2-28-2014
Overburden Thickness	7.30' BGS	Depth Groundwater Encountered	~15' BGS
Depth Drilled into Rock	Ø	Depth to Water and Elapsed Time After Drilling Completed	8.7' BGS AFTER ~15 MINUTES
Total Depth of Hole	22.5' BGS FOR PIEZOMETER DUE TO COLLAPSE	Other Water Level Measurements (Specify)	

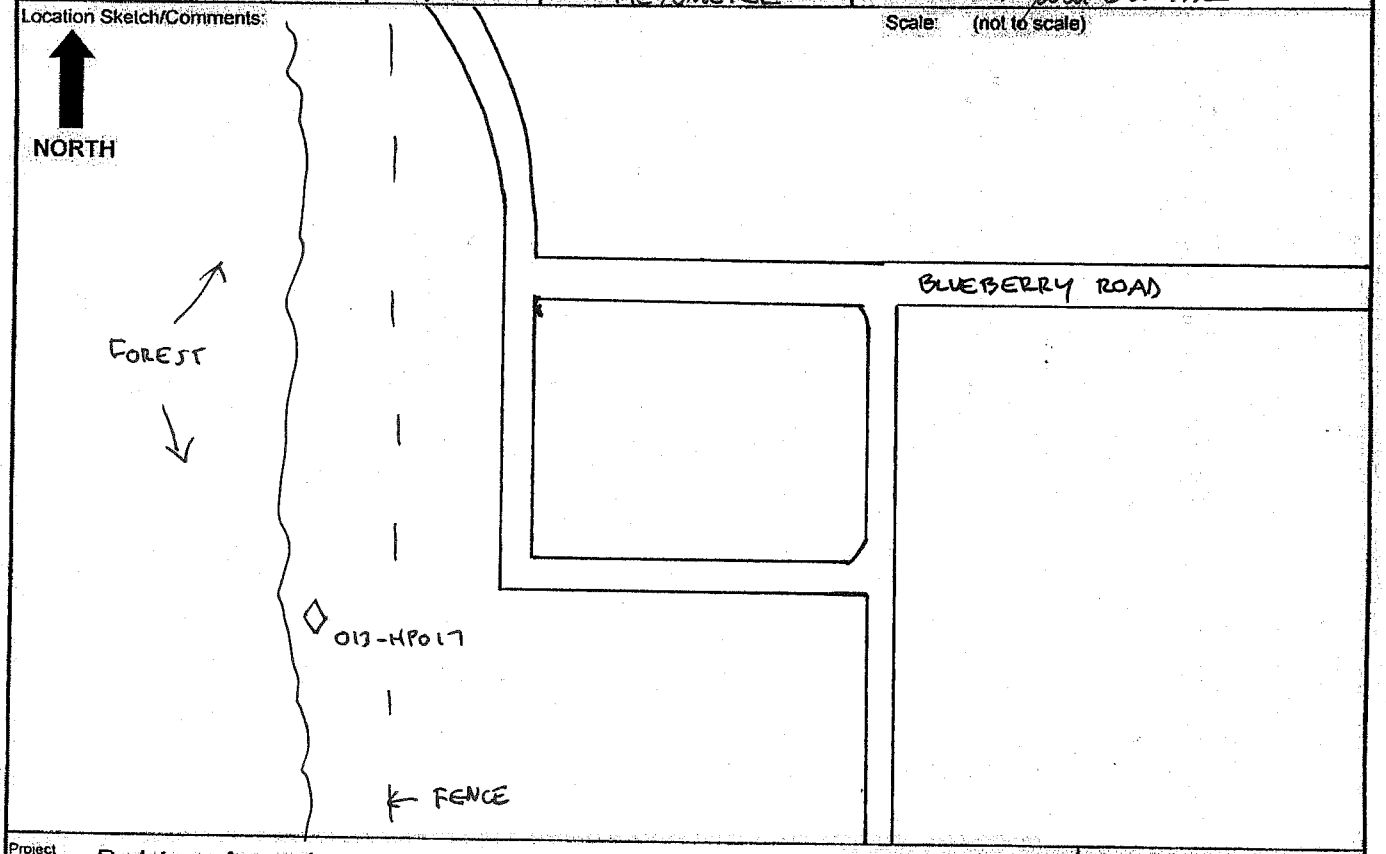
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	✓	✓	THIANES/THIODIGLYCOL	PERCHLORATE	EXPLOSIVES	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	NA	NA	PIEZOMETER	

Location Sketch/Comments:

Scale: (not to scale)



Project: Redstone Arsenal

Hole Number: 013-HP017

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-HP017

Project: REDSTONE ARSENAL

Geologist: JULIE SCHENCK BROWN

Sheet 2 of 2 Sheets

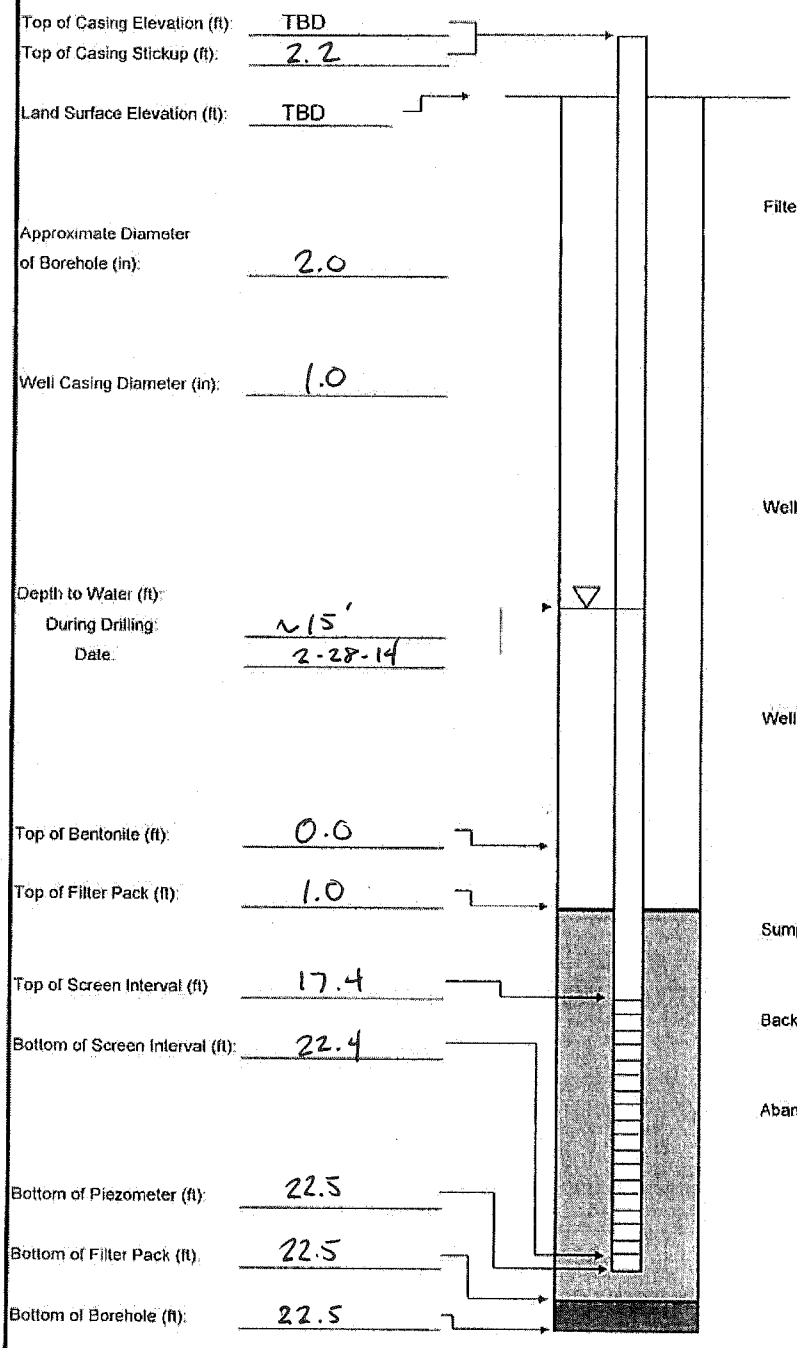
Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	SURFACE = GRASS						
		(0-1): DARK YELLOWISH BROWN SANDY CLAY (10 YR 4/4) LOW PLASTICITY LOW STIFFNESS VERY FINE SAND 20% MOTTLING (DARK RED), MOIST	CL	(0-5) 0.0	NA ↓	ABG 0084 (0-1)	5/5	HAND AUGER TO 5' BGS
	1	(1-5): DARK YELLOWISH BROWN SANDY CLAY (10 YR 4/6) LOW PLASTICITY MEDIUM STIFFNESS VERY FINE SAND 20% MOTTLING (TAN) MANGANESE DEPOSITS AND STAINING SLIGHT MOISTURE	CL					
	2					ABG 0085 0085-MS 0085-MSD (2-4)		
	3							
	4							
	5	(5-10): DARK YELLOWISH BROWN SANDY CLAY (10 YR 4/6) LOW PLASTICITY MEDIUM STIFFNESS VERY FINE SAND 20% MOTTLING (GRAY) MANGANESE DEPOSITS SLIGHT MOISTURE	CL	(5-10) 0.0			5/5	
	6							
	7					ABG 0086 (6-8)		
	8							
	9							PER MARK SHOEMAKER, CB+I CAM, A DESCRIPTION OF SOIL LITHOLOGY IS ONLY NEEDED TO 10' BGS
	10							

Project: RSA

Hole Number: 013-HP017

Temporary Piezometer

Project:	Redstone Arsenal	Piezometer Number:	013-HP017
Location:	Huntsville, Madison County, AL	Site Location:	RSA-013
Client:	CB+I	Installation Date	2-28-2014
Subcontractor:	GSE	Northing:	TBD
Driller:	JUSTIN WINGERTER	Easting:	TBD
Shaw Field Representative:	BRIAN RHODES	Project Number:	136973



Top of Casing Elevation (ft): TBD
Top of Casing Stickup (ft): 2.2
Land Surface Elevation (ft): TBD
Approximate Diameter of Borehole (in): 2.0
Well Casing Diameter (in): 1.0
Depth to Water (ft):
During Drilling: ~15'
Date: 2-28-14
Top of Bentonite (ft): 0.0
Top of Filter Pack (ft): 1.0
Top of Screen Interval (ft): 17.4
Bottom of Screen Interval (ft): 22.4
Bottom of Piezometer (ft): 22.5
Bottom of Filter Pack (ft): 22.5
Bottom of Borehole (ft): 22.5

Filter Pack Material:
Manufacturer: CONSOLIDATED AGGREGATES
Product Name: FILTER MEDIA
Size: No. 2
Installation: Prepacked Screen | Filter Sock | (Gravity) | Tremie

Well Casing:
Manufacturer: MONOFLEX
Type: SCHEDULE 40 PVC
Diameter (in): 1.0

Well Screen Casing:
Manufacturer: MONOFLEX
Type: SCHEDULE 40 PVC
Slot Size (in): 0.010
Slot Type: Continuous wrap | (Factory slot)

Sump/End Cap: 0.1' POINT

Backfill Material: NONE

Abandonment:
Date: TBD
Procedure: Natural fill | Grouted | Casing Removed
Completed as Well: TBD

Shaw Environmental & Infrastructure Inc
(A CB&I Company)

Depths and heights are referenced to ground surface unless specified TOC
All elevations are referenced to MSL (NAVD 88)
If completed as well - see well construction diagram

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nenni

ABG-03042014-S-SAC

RFA / COC Number: ABG-03042014-S-EA

Location Code: **013-HP017**

Sample Number: **ABG0084**

Sample Name: **013-HP017-SS-ABG0084-REG**

Sampling Method: **HA**

Sample Type: **SS** *Sample Purpose:* **REG**

Sampling Equip: HA

QC Partners:

(TB) NA (ER) NA (FB) NA

Task: **013**

Collection Date: 2-28-14

Collection Time: 1125

Start Depth: 0 'BGS

End Depth: 1 'BGS

Sample Matrix: **SOIL**

Sample Team: JSD, JW

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2-28-14

Reviewed BY / Date: 2-28-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG-03042014-S-SAC / ABG-03042014-S-EP

Location Code: **013-HP017**

Sample Number: **ABG0085**

Sample Name: **013-HP017-DS-ABG0085-REG**

Sampling Method: **HA**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: HA

Task: **013**

Collection Date: 2-28-14

Collection Time: 1130

Start Depth: 2' BGS

End Depth: 4' BGS

Sample Matrix: **SOIL**

Sample Team: JSB, JW

QC Partners:

(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: [signature] *Reviewed BY / Date:* [signature] 2-28-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: Don Burton

ABG-03042014-S-EP

RFA / COC Number: ABG-03042014-S-EP

Location Code: 013-HP017

Sample Number: ABG0084-MS (85)

Sample Name: 013-HP017-SS-ABG0084-MS (85)

Sampling Method: HA

Sample Type: SS *Sample Purpose:* MS

Sampling Equip: HA

Task: 013

Collection Date: 2-27-14

Collection Time: 1130

Start Depth: 2' bgs

End Depth: 4' bgs

Sample Matrix: SOIL

Sample Team: JSB, JW

QC Partners:

(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: [signature] 2-28-14

Reviewed BY / Date: DCK 2-28-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC EPM

Manager: ~~Don Burton~~ John Nenni

ABG-03042014-S-SAC

RFA / COC Number: ABG-03042014-S-EA

Location Code: 013-HP017

Sample Number: ABG0085-MSD

Sample Name: 013-HP017-SS-ABG0085-MSD

Sampling Method: HA

Sample Type: SS *Sample Purpose:* MSD

Sampling Equip: HA

Task: 013

Collection Date: 2-28-14

Collection Time: 1130

Start Depth: 2' BGS

End Depth: 4' BGS

Sample Matrix: SOIL

Sample Team: JSB, JW

QC Partners:

(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2-28-14

Reviewed BY / Date: 2-28-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC EYM

Manager: ~~Don Burton~~ John Nenni

ABG-03042014-S-SAC

RFA / COC Number: ABG-03042014-S-EP

Location Code: **013-HP017**

Sample Number: **ABG0086**

Sample Name: **013-HP017-DS-ABG0086-REG**

Sampling Method: **DP**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: DP

Task: **013**

Collection Date: 2-28-14

Collection Time: 1145

Start Depth: 6' BGS

End Depth: 8' BGS

Sample Matrix: **SOIL**

QC Partners:

(TB) NA (ER) NA (FB) NA

Sample Team: JSB, JW

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2-28-14

Reviewed BY / Date: DCK 2-28-14

Sample Collection Log

Shaw™
Shaw E & I, Inc.

136973 - Redstone PMC (JM)
Manager: ~~Don Burton~~ John Nenni

ABG-030414-W-SAC

RFA / COC Number: ABG-03042014-W-EA

Location Code: **013-HP017**
Sample Number: **ABG3018**
Sample Name: **013-HP017-GW-ABG3018-REG**
Sampling Method: **SP**
Sample Type: **GW** *Sample Purpose:* **REG**
Sampling Equip: Peristaltic Pump

Task: **013**
Collection Date: 2-28-14
Collection Time: 1415
Start Depth: ~~19.7~~ 9.05' BTOC
End Depth: ~~9.05~~ 19.7' BTOC
Sample Matrix: **WATER**

QC Partners:
(TB) 03042014-TB (ER) NA (FB) NA

Sample Team: CE

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
PERCH_6850	N	B	1	125	mL	HDPE
EXPLOSIVES+	N	C	2	1	L	Amb. Glass
THIANES	N	E	2	1	L	Amb. Glass
THIODIGLYCOL	N	F	1	500	mL	B.R.

} 3 SAC

ERPIMS Values:
Sacode: N/A
Lot Control#:

Groundwater Information:
Measured Well Depth: 24.7' BTOC **Depth To Water:** 9.05' BTOC

Comments: Turbidity: >1000 Temperature: 14.76°C pH: 6.74 D.O.: 6.64 mg/L Conductivity: 0.339 mS/cm Redox: 25 mV

Sketch Location: See Drilling Log

Logged BY / Date: 2-28-14 *Reviewed BY / Date:* DQC 2-28-14

HTRW DRILLING LOG

Shaw Environmental & Infrastructure Inc
(A CB&I Company)

Client: CB&I			Hole Number: 013-HP018
Company Name: Shaw Environmental, Inc.		Drilling Subcontractor: GSE	Sheet: 1 of 4 Sheets
Project: Redstone Arsenal		Location: RSA-013	
Name of Driller: Wesley Casteel		Manufacturer's Designation of Drill: Geoprobe 7822 DT	
Sizes and Types of Drilling and Sampling Equipment: Hand Auger; 2" Macro Core		Surface Elevation: TBD	
		Date Started: 8-18-15	Date Completed: 8-18-15
Overburden Thickness: > 25 '		Depth Groundwater Encountered: Unknown	
Depth Drilled into Rock: 0		Depth to Water and Elapsed Time After Drilling Completed: 11.92 ' after 10 min	
Total Depth of Hole: 25 '		Other Water Level Measurements (Specify): NA	

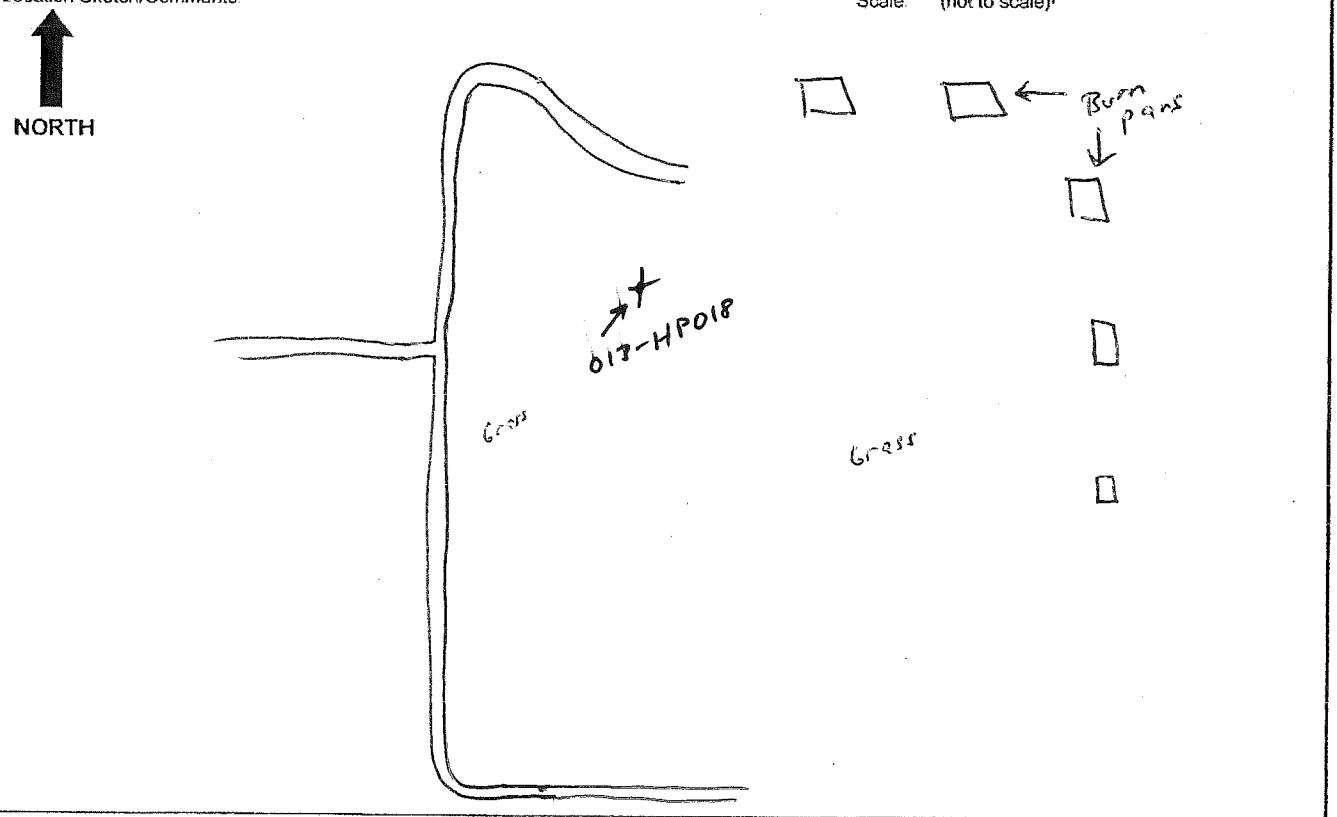
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	V		Explosives, Perch	NA	NA	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	NA	NA	piezometer	J. Ryan Bailey

Location Sketch/Comments:

Scale: (not to scale)



Project	Hole Number
Redstone Arsenal	013-HP018

CB&I

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-HP018

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 2 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	0-5 → yellowish red (5YR 5/8) silty clay. Med. stiff. Med. Plast. Slightly moist.	CL	0-5: 0.0	NA ↓	ABG 0147 (0-1)	5/5	Hand Auger to 5 ft.
	5	5-10 → yellowish red (5YR 4/6) silty clay. Med. stiff. Med. Plast. Moist.	CL	5-10: 0.0		ABG 0148, 0149 (2-4); ABG 0150 (6-8)	5/5	

Project: RSA

Hole Number: 013-HP018

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-HP018

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 3 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	10	10-20 → No lithology per CB&I Plan		~~to 15~~ RB	NA ↓			
	11							
	12							
	13							
	14							
	15			~~15-20~~ RB				
	16							
	17							
	18							
	19							
	20							

Project: RSA

Hole Number: 013-HP018

CB&I

Shaw Environmental & Infrastructure Inc
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-HP018

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 4 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	20	20-25 → No lithology per CB&I plan.		~~20-25~~ RB	NA ↓			
	21							
	22							
	23							
	24							
	25							
	26			~~25-30~~ RB				
	27							
	28							
	29							
	30							

Project: RSA

Hole Number: 013-HP018

Temporary Piezometer

Project:	Redstone Arsenal	Piezometer Number:	013-HP018
Location:	Huntsville, Madison County, AL	Site Location:	RSA-013
Client:	CB&I	Installation Date	8-18-15
Subcontractor:	GSE	Northing:	TBD
Driller:	Cody Eakin	Easting:	TBD
Field Geologist:	Ryan Bailey	Project Number:	500382

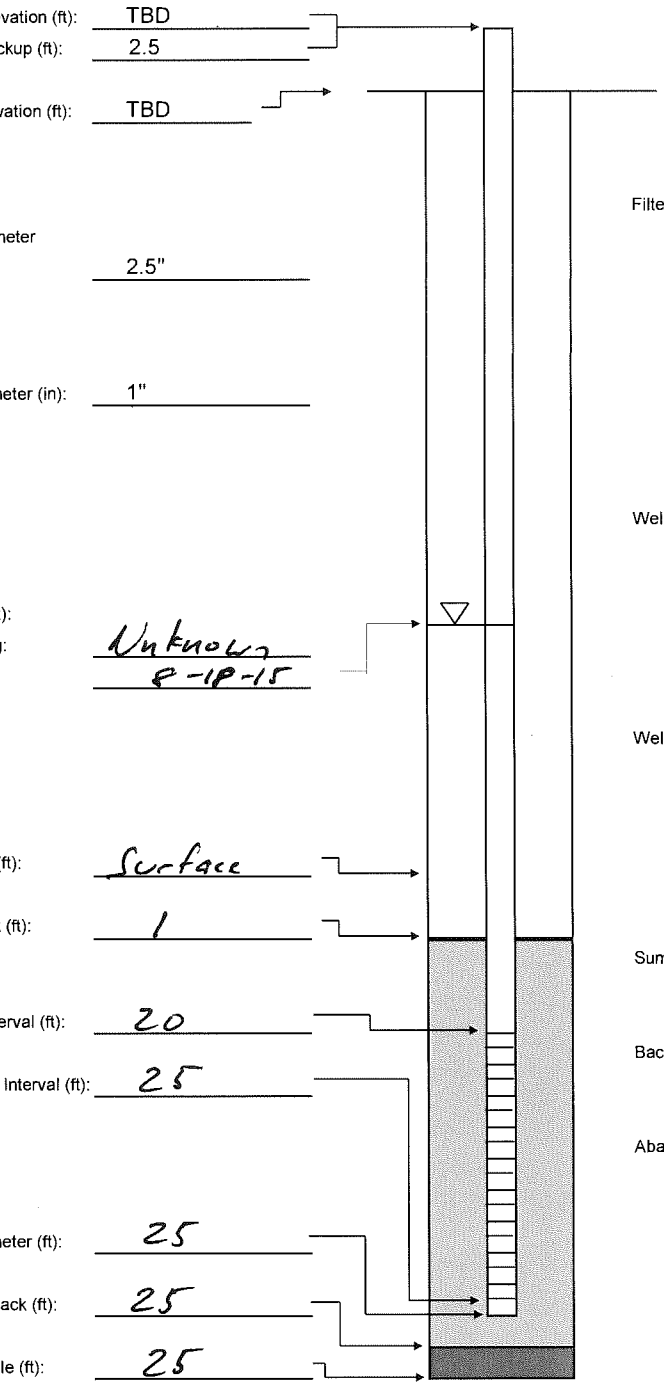
Top of Casing Elevation (ft): TBD
Top of Casing Stickup (ft): 2.5
Land Surface Elevation (ft): TBD

Approximate Diameter of Borehole (in): 2.5"

Well Casing Diameter (in): 1"

Depth to Water (ft):
During Drilling: Unknown
Date: 8-18-15

Top of Bentonite (ft): Surface
Top of Filter Pack (ft): 1
Top of Screen Interval (ft): 20
Bottom of Screen Interval (ft): 25
Bottom of Piezometer (ft): 25
Bottom of Filter Pack (ft): 25
Bottom of Borehole (ft): 25



Filter Pack Material:
- Manufacturer: Southern Filter Media
- Product Name: Filter Media
- Size: 20/40
- Installation: Prepacked Screen | Filter Sock | Gravity | Tremie

Well Casing:
- Manufacturer: Mono-Flex
- Type: Sch. 40 PVC
- Diameter (in): 1"

Well Screen Casing:
- Manufacturer: Mono-Flex
- Type: Sch. 40 PVC
- Slot Size (in): 0.010
- Slot Type: Continuous wrap | Factory slot

Sump/End Cap: Point

Backfill Material: N/A

Abandonment:
- Date: TBD
- Procedure: Natural fill | Grouted | Casing Removed | Completed as Well: TBD

Depths and heights are referenced to ground surface unless specified TOC.
All elevations are referenced to MSL (NAVD 88).
If completed as well - see well construction diagram.

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

Sample Collection Log

500382
~~136973~~ - Redstone PMC (ERPIMS)
Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG 08192015-W-EMR

Location Code: **013-HP018**
Sample Number: **ABG3019**
Sample Name: **013-HP018-GW-ABG3019-REG**
Sampling Method: **LF**
Sample Type: **GW** *Sample Purpose:* **REG**
Sampling Equip: PERISTALTIC PUMP

Task: **013**
Collection Date: 8-18-15
Collection Time: 1000
Start Depth: 20' bgs
End Depth: 25'
Sample Matrix: **WATER**
Sample Team: KR, CR

QC Partners:
(TB) N/A (ER) N/A (FB) N/A

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
EXPLOSIVES+	N	B	2	1	L	Amb. Glass
PERCH_6850	N	C	1	125	mL	HDPE

ERPIMS Values:
Sacode:
Lot Control#: N/A

Groundwater Information:
Measured Well Depth: 25' BTOC **Depth To Water:** 10.53' BTOC

Comments: PID=Ø

Sketch Location:
SEE BORING LOG

Logged BY / Date: 8/18/15 *Reviewed BY / Date:* 8/18/15

Sample Collection Log

Project: ~~136973~~ 500382 Redstone PMC (EJM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-HP018**
Sample Number: **ABG0147**
Sample Name: **013-HP018-SS-ABG0147-REG**
Sampling Method: **HA**
Sample Type: **SS** *Sample Purpose:* **REG**

Collection Date: **18-AUG-15**
Collection Time: **14:10**
Start Depth: **0**
End Depth: **1**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* BM 8/18/15

Sample Collection Log

Project: ~~136973~~ 500382 Redstone PMC (EPM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-HP018**
Sample Number: **ABG0148**
Sample Name: **013-HP018-DS-ABG0148-REG**
Sampling Method: **HA**
Sample Type: **DS** *Sample Purpose:* **REG**

Collection Date: **18-AUG-15**
Collection Time: **14:20**
Start Depth: **2**
End Depth: **4**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location: See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* BM 8/18/15

Sample Collection Log

Project: ~~136973~~ 500382 ~~Redstone~~ PMC (EJM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-HP018**
Sample Number: **ABG0149**
Sample Name: **013-HP018-DS-ABG0149-FD**
Sampling Method: **HA**
Sample Type: **DS** *Sample Purpose:* **FD**

Collection Date: **18-AUG-15**
Collection Time: **14:20**
Start Depth: **2**
End Depth: **4**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* [illegible] 8/18/15

Sample Collection Log

Project: ~~136973~~ 146 500382 ~~Redstone~~ PMC (EPM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-HP018**
Sample Number: **ABG0150**
Sample Name: **013-HP018-DS-ABG0150-REG**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**

Collection Date: **18-AUG-15**
Collection Time: **14:30**
Start Depth: **6**
End Depth: **8**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments:

N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* BM 8/16/15

HTRW DRILLING LOG

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

Client: CB&I			Hole Number: 013-HP019
Company Name: Shaw Environmental, Inc.		Drilling Subcontractor: GSE	Sheet: 1 of 4 Sheets
Project: Redstone Arsenal		Location: RSA-013	
Name of Driller: Wesley Casteel		Manufacturer's Designation of Drill: Geoprobe 7822 DT	
Sizes and Types of Drilling and Sampling Equipment: Hand Auger; 2" Macro Core		Surface Elevation: TBD	
		Date Started: 8-18-15	Date Completed: 8-18-15
Overburden Thickness: >25'		Depth Groundwater Encountered: Unknown	
Depth Drilled into Rock: 0		Depth to Water and Elapsed Time After Drilling Completed: 12.43 after 10 min	
Total Depth of Hole: 25'		Other Water Level Measurements (Specify): NA	

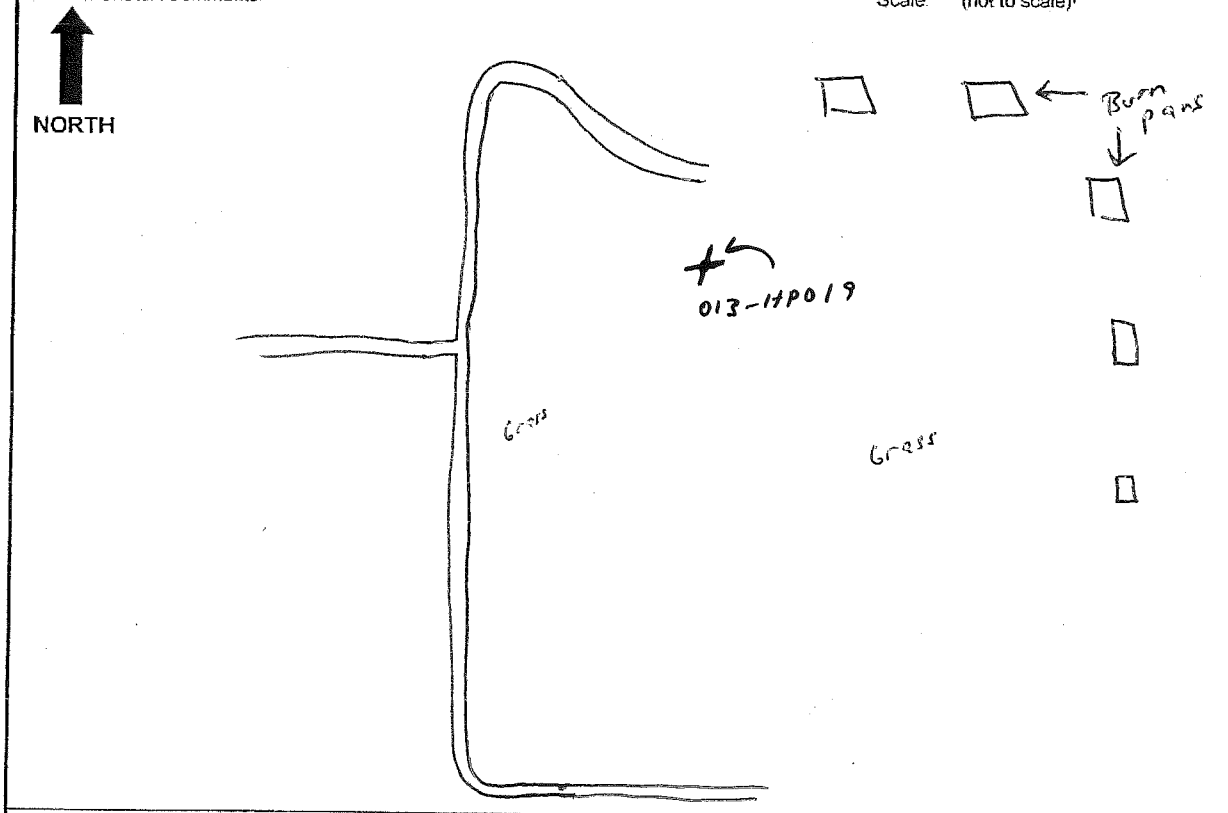
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	V		Explosives, Perc	NA	NA	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	NA	NA	piezometer	J. Ryan Bailey

Location Sketch/Comments:

Scale: (not to scale)



Project	Hole Number
Redstone Arsenal	013-HP019

CB&I

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-HP019

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 2 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	0-5 → Reddish brown (5YR 4/4) silty clay. Med stiff. Med. Plast. Moist.	CL	0-5 0.0	NA ↓	ARG 0151 (0-1)	5/5	Hand Auger to 5 ft.
	5	5-10 → yellowish red (5YR 4/6) silty clay. Med. stiff. med. plast. Moist.	CL	5-10 0.0		ARG 0152 (2-4) ARG 0153 (6-8)	5/5	
	10							

Project: RSA

Hole Number: 013-HP019

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-HP019

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 3 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	10	10-20 → No lithology per CB&I Plan		~~10-15~~ RB	NA ↓			
	11							
	12							
	13							
	14							
	15			~~15-20~~ RB				
	16							
	17							
	18							
	19							
	20							

Project: RSA

Hole Number: 013-HP019

Shaw Environmental & Infrastructure Inc
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-HP019

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 4 of 4 Sheets

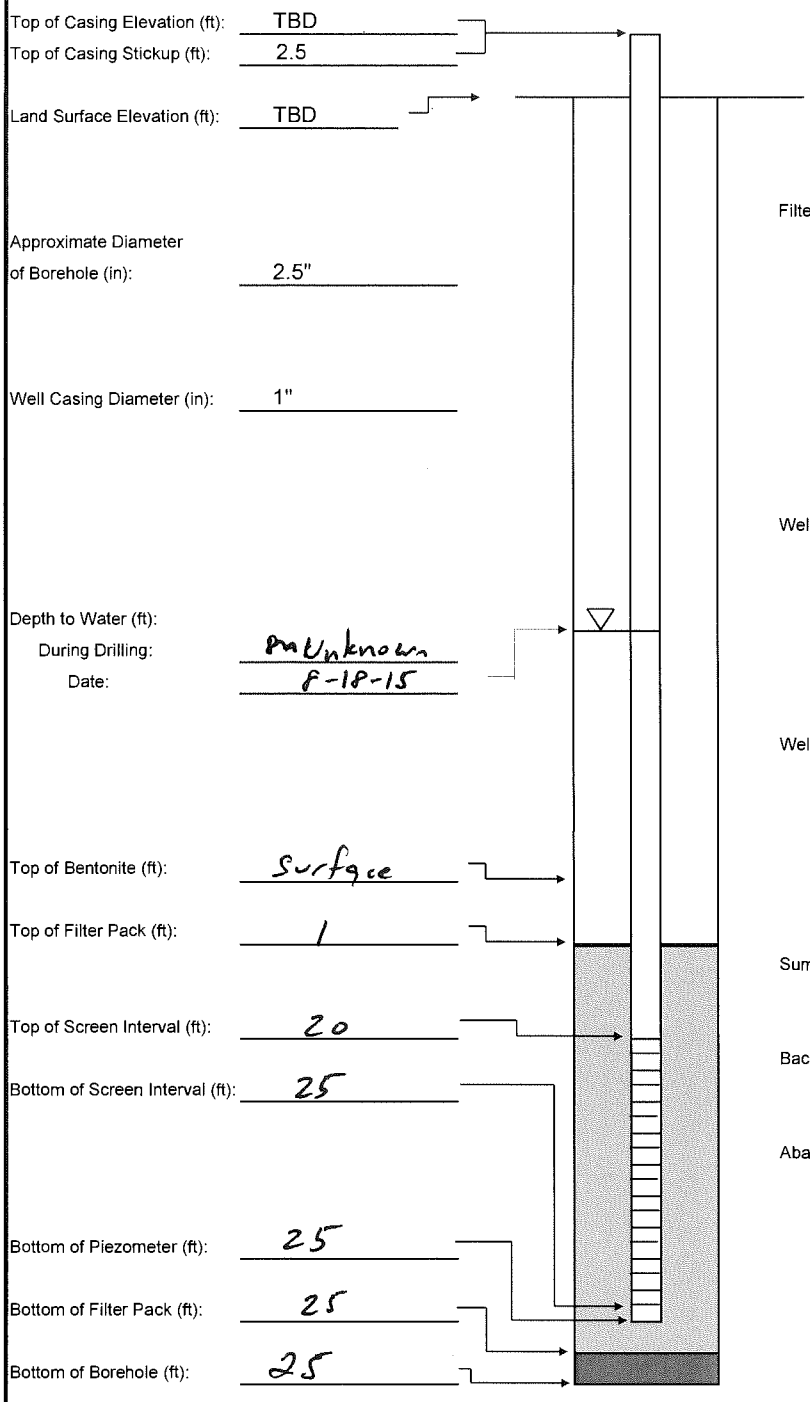
Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	20	20-25 → No lithology per CB&I plan		20-25 RB	NA			
	21							
	22							
	23							
	24							
	25							
	26			25-30 RB				
	27							
	28							
	29							
	30							

Project: RSA

Hole Number: 013-HP019

Temporary Piezometer

Project:	Redstone Arsenal	Piezometer Number:	013-HP019
Location:	Huntsville, Madison County, AL	Site Location:	RSA-013
Client:	CB&I	Installation Date	8-18-15
Subcontractor:	GSE	Northing:	TBD
Driller:	Cody Eakin	Easting:	TBD
Field Geologist:	Ryan Bailey	Project Number:	500382



Top of Casing Elevation (ft): TBD
Top of Casing Stickup (ft): 2.5
Land Surface Elevation (ft): TBD
Approximate Diameter of Borehole (in): 2.5"
Well Casing Diameter (in): 1"
Depth to Water (ft): During Drilling: Unknown Date: 8-18-15
Top of Bentonite (ft): Surface
Top of Filter Pack (ft): 1
Top of Screen Interval (ft): 20
Bottom of Screen Interval (ft): 25
Bottom of Piezometer (ft): 25
Bottom of Filter Pack (ft): 25
Bottom of Borehole (ft): 25

Filter Pack Material:
- Manufacturer: Southern Filter Media
- Product Name: Filter Media
- Size: 20/40
- Installation: Prepacked Screen; Filter Sock; Gravity; Tremie

Well Casing:
- Manufacturer: Mono-Flex
- Type: Sch. 40 PVC
- Diameter (in): 1"

Well Screen Casing:
- Manufacturer: Mono-Flex
- Type: Sch. 40 PVC
- Slot Size (in): 0.010
- Slot Type: Continuous wrap; Factory slot

Sump/End Cap: Point

Backfill Material: N/A

Abandonment:
- Date: TBD
- Procedure: Natural fill; Grouted; Casing Removed; Completed as Well: TBD

Depths and heights are referenced to ground surface unless specified TOC.
All elevations are referenced to MSL (NAVD 88).
If completed as well - see well construction diagram.

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

Sample Collection Log

500382
~~136973~~ · Redstone PMC

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-W-EMA

Location Code: **013-HP019**
Sample Number: **ABG3020**
Sample Name: **013-HP019-GW-ABG3020-REG**
Sampling Method: **LF**
Sample Type: **GW** *Sample Purpose:* **REG**
Sampling Equip: PERISTALTIC PUMP

Task: **013**
Collection Date: 8-18-15
Collection Time: 1520
Start Depth: 20' bgs
End Depth: 25'
Sample Matrix: **WATER**
Sample Team: KR, CR

QC Partners:
(TB) N/A (ER) N/A (FB) N/A

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
EXPLOSIVES+	N	B	2	1	L	Amb. Glass
PERCH_6850	N	C	1	125	mL	HDPE

ERPIMS Values:
Sacode: N/A
Lot Control#:

Groundwater Information:
Measured Well Depth: 25' BTOC **Depth To Water:** 12.34' BTOC

Comments: PID=0

TEMP	pH	ORP	SPC	TURB	DO
21.25°C	5.33	110	0.130 ms/cm	109 NTU	10.72

Sketch Location:
SEE BORING LOG

Logged BY / Date: 8-18-15 *Reviewed BY / Date:* 8/18/15

Sample Collection Log

500382
~~136973~~ - Redstone PMC (EJM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG 08192015-W-EMP

Location Code: **013-HP019**

Sample Number: **ABG3020-MS**

Sample Name: **013-HP019-GW-ABG3020-MS**

Sampling Method: **LF**

Sample Type: **GW** *Sample Purpose:* **MS**

Sampling Equip: PERISTALTIC PUMP

Task: **013**

Collection Date: 8-18-15

Collection Time: 1520

Start Depth: 20' bgs

End Depth: 25'

Sample Matrix: **WATER**

Sample Team: KR, CR

QC Partners:

(TB) N/A (ER) N/A (FB) N/A

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
EXPLOSIVES+	N	B	2	1	L	Amb. Glass
PERCH_6850	N	C	1	125	mL	HDPE

ERPIMS Values:

Sacode: N/A

Lot Control#:

Groundwater Information:

Measured Well Depth: 25' BTOC **Depth To Water:** 12.34' BTOC

Comments: PID=0

TEMP	pH	ORP	SPC	TURB	DO
21.25°C	5.33	110	0.130 ms/cm	109 NTU	10.72

Sketch Location:

SEE BORING LOG

Logged BY / Date: Kelly Robinson 8/18/15

Reviewed BY / Date: BCL 8/18/15

Sample Collection Log

~~136973~~ 500382 - Redstone PMC (egm)
Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-W-EMP

Location Code: 013-HP019
Sample Number: ABG3020-MSD
Sample Name: 013-HP019-GW-ABG3020-MSD
Sampling Method: LF
Sample Type: GW *Sample Purpose:* MSD
Sampling Equip: PERISTALTIC PUMP

Task: 013
Collection Date: 8-18-15
Collection Time: 1520
Start Depth: 20' bgs
End Depth: 25'
Sample Matrix: WATER
Sample Team: KR, CR

QC Partners:
(TB) N/A (ER) N/A (FB) N/A

ERPIMS Values:
Sacode: N/A
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
EXPLOSIVES+	N	B	2	1	L	Amb. Glass
PERCH_6850	N	C	1	125	mL	HDPE

Groundwater Information:
Measured Well Depth: 25' BTOC **Depth To Water:** 12.34' BTOC

Comments: PID=Ø

TEMP	pH	ORP	SPC	TURB	DO
21.25°C	5.33	110	0.130 ms/cm	109 NTU	10.72

Sketch Location:
SEE BORING LOG

Logged BY / Date: Kelly Robinson 8-18-15 *Reviewed BY / Date:* [signature] 8/18/15

Sample Collection Log

Project: ~~136973~~ 500382 Redstone PMC

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-HP019**
Sample Number: **ABG0151**
Sample Name: **013-HP019-SS-ABG0151-REG**
Sampling Method: **HA**
Sample Type: **SS** *Sample Purpose:* **REG**

Collection Date: **18-AUG-15**
Collection Time: **14:50**
Start Depth: **0**
End Depth: **1**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* BRM 8/18/15

Sample Collection Log

Project: ~~136973~~ 500382 **Redstone PMC** (EDM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-HP019**
Sample Number: **ABG0152**
Sample Name: **013-HP019-DS-ABG0152-REG**
Sampling Method: **HA**
Sample Type: **DS** *Sample Purpose:* **REG**

Collection Date: **18-AUG-15**
Collection Time: **14:55**
Start Depth: **2**
End Depth: **4**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* BNL 8/18/15

Sample Collection Log

Project: ~~136973~~ 500382 Redstone PMC (EJM)

Manager: ~~Don Burton~~ John Nemni

RFA / COC Number: ABG08192015-S-EMP

Location Code:	**013-HP019**	*Collection Date:*	**18-AUG-15**
Sample Number:	**ABG0153**	*Collection Time:*	**15:00**
Sample Name:	**013-HP019-DS-ABG0153-REG**	*Start Depth:*	**6**
Sampling Method:	**DP**	*End Depth:*	**8**
Sample Type:	**DS**	*Sample Purpose:* **REG**	*Sample Matrix:* **SOIL**
			Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* BJL 8/18/15

HTRW DRILLING LOG

Shaw Environmental & Infrastructure Inc
(A CB&I Company)

Client: CB&I			Hole Number: 013-HP020
Company Name: Shaw Environmental, Inc.		Drilling Subcontractor: GSE	Sheet: 1 of 4 Sheets
Project: Redstone Arsenal		Location: RSA-013	
Name of Driller: Wesley Casteel		Manufacturer's Designation of Drill: Geoprobe 7822 DT	
Sizes and Types of Drilling and Sampling Equipment: Hand Auger; 2" Macro Core		Surface Elevation: TBD	
		Date Started: 8-18-15	Date Completed: 8-18-15
Overburden Thickness: ~~>25~~ RB 21'		Depth Groundwater Encountered: Unknown	
Depth Drilled into Rock:		Depth to Water and Elapsed Time After Drilling Completed: 6.82 after 10 min	
Total Depth of Hole: ~~25~~ RB 21'		Other Water Level Measurements (Specify): NA	

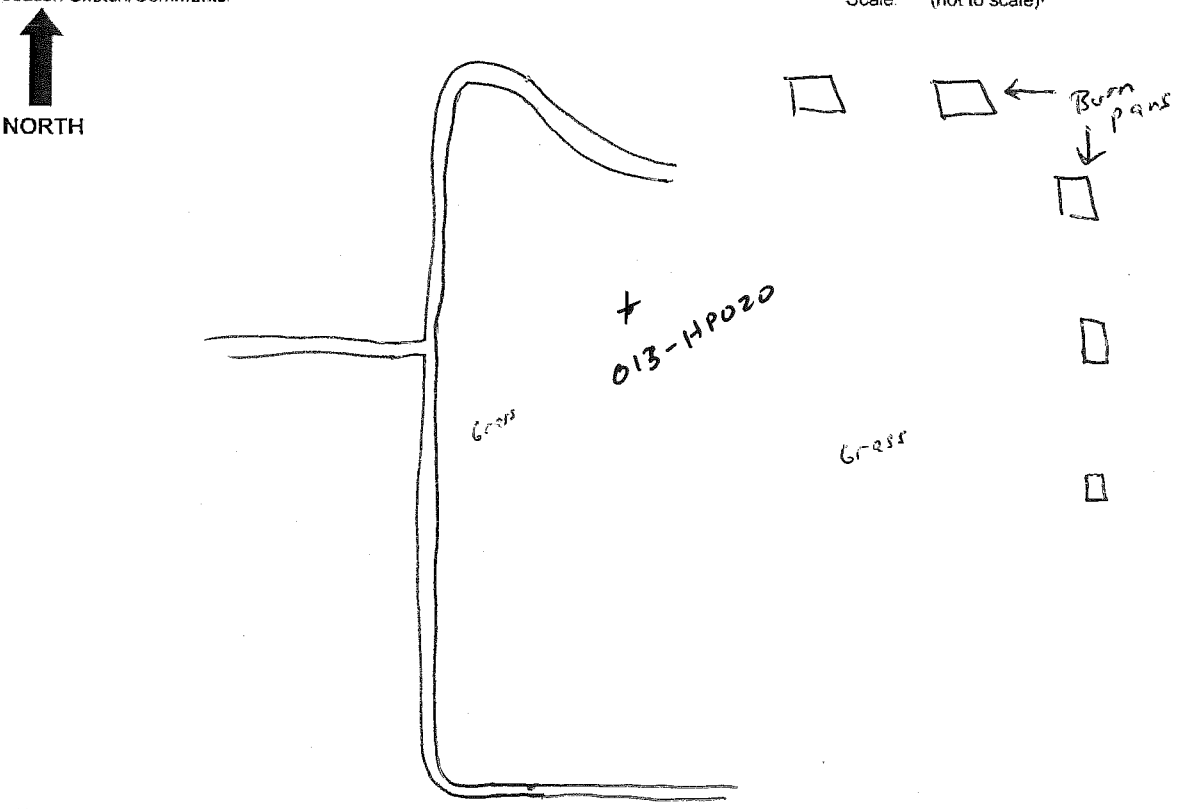
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	V		Explosives, Perc	NA	NA	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	NA	NA	piezometer	J. Ryan Bailey

Location Sketch/Comments:

Scale: (not to scale)



CB&I

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-HP020

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 2 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	0-5 → Brown (7.5 YR 4/3) silty clay. med. stiff. low plast. Moist.	CL	0-5 0.0	NA ↓	ABG 0154 (0-1)	5/5	Hand Auger to 5 ft.
	5	5-10 → yellowish red (5YR 4/6) clay. red. stiff. Med. Plast. Moist.	CL	5-10 0.0		ABG 0155 MS/MSD (2-4) ABG 0156 (6-F)	5/5	
	10							

Project: RSA

Hole Number: 013-HP020

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-H P020

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 3 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	10	10-20 → No lithology required per CB&I Plan.		10-15 RB	NA ↓			
	11							
	12							
	13							
	14							
	15			~~15-20~~ RB				
	16							
	17							
	18							
	19							
	20							

Project: RSA

Hole Number: 013-HP020

Shaw Environmental & Infrastructure Inc
(A CB&I Company)

HTRW DRILLING LOG (continuation sheet)

Hole Number: 013-HP020

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 4 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	20	20-~~25~~ 21 → No. lithology per CB&I Plan. Refusal at 21 ft.	CL	~~20-25~~ RB	NA ↓	NA ↓		
	21							
	22							
	23							
	24							
	25							
	26							
	27			~~25-30~~ RB				
	28							
	29							
	30							

Project: RSA

Hole Number: 013-HP020

Temporary Piezometer

Project:	Redstone Arsenal	Piezometer Number:	013-HP020
Location:	Huntsville, Madison County, AL	Site Location:	RSA-013
Client:	CB&I	Installation Date	8-18-15
Subcontractor:	GSE	Northing:	TBD
Driller:	Cody Eakin	Easting:	TBD
Field Geologist:	Ryan Bailey	Project Number:	500382

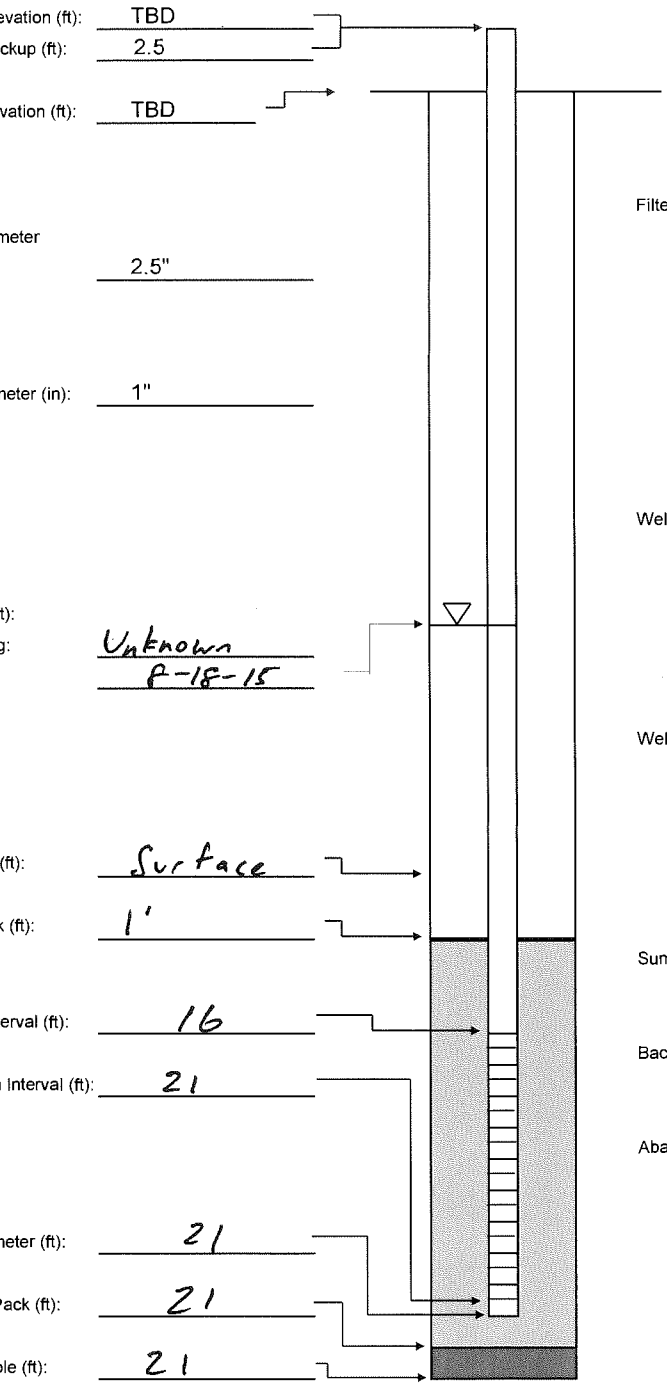
Top of Casing Elevation (ft): TBD
Top of Casing Stickup (ft): 2.5
Land Surface Elevation (ft): TBD

Approximate Diameter of Borehole (in): 2.5"

Well Casing Diameter (in): 1"

Depth to Water (ft):
During Drilling: Unknown
Date: 8-18-15

Top of Bentonite (ft): Surface
Top of Filter Pack (ft): 1'
Top of Screen Interval (ft): 16
Bottom of Screen Interval (ft): 21
Bottom of Piezometer (ft): 21
Bottom of Filter Pack (ft): 21
Bottom of Borehole (ft): 21



Filter Pack Material:
- Manufacturer: Southern Filter Media
- Product Name: Filter Media
- Size: 20/40
- Installation: Prepacked Screen; Filter Sock; Gravity; Tremie

Well Casing:
- Manufacturer: Mono-Flex
- Type: Sch. 40 PVC
- Diameter (in): 1"

Well Screen Casing:
- Manufacturer: Mono-Flex
- Type: Sch. 40 PVC
- Slot Size (in): 0.010
- Slot Type: Continuous wrap; Factory slot

Sump/End Cap: Point

Backfill Material: N/A

Abandonment:
- Date: TBD
- Procedure: Natural fill; Grouted; Casing Removed; Completed as Well: TBD

Depths and heights are referenced to ground surface unless specified TOC.
All elevations are referenced to MSL (NAVD 88).
If completed as well - see well construction diagram.

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

Sample Collection Log

~~136973~~ 500382 - **Redstone PMC** (cpm)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG 08192015-W-CUP

Location Code: **013-HP020**

Sample Number: **ABG3021**

Sample Name: **013-HP020-GW-ABG3021-REG**

Sampling Method: **LF**

Sample Type: **GW** *Sample Purpose:* **REG**

Sampling Equip: PERISTALTIC PUMP

Task: **013**

Collection Date: 8-18-15

Collection Time: 1505

Start Depth: 16' BTOC

End Depth: 21' BTOC

Sample Matrix: **WATER**

Sample Team: KR

QC Partners:

(TB) N/A (ER) N/A (FB) N/A

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
EXPLOSIVES+	N	B	2	1	L	Amb. Glass
PERCH_6850	N	C	1	125	mL	HDPE

ERPIMS Values:

Sacode: N/A

Lot Control#:

Groundwater Information:

Measured Well Depth: 23' BTOC **Depth To Water:** 8.64' BTOC

Comments: PID = 0

TEMP	pH	ORP	SPC	TURB	DO
26.17°C	5.13	290 mV	0.062 ms/cm	585 NTU	10.05 mg/L

Sketch Location:

SEE BORING LOG

Logged BY / Date: Kelley Robertson 8-18-15

Reviewed BY / Date: BM 8/18/15

Sample Collection Log

Project: ~~136973~~ 500382 Redstone PMC (EJM)

Manager: ~~Don Burton~~ John Nemri

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-HP020**
Sample Number: **ABG0154**
Sample Name: **013-HP020-SS-ABG0154-REG**
Sampling Method: **HA**
Sample Type: **SS** *Sample Purpose:* **REG**

Collection Date: **18-AUG-15**
Collection Time: **13:10**
Start Depth: **0**
End Depth: **1**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log (EJM)

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* BM 8/18/15

Sample Collection Log

Project: ~~136973~~ 500382 Redstone PMC (EDM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-HP020**
Sample Number: **ABG0155**
Sample Name: **013-HP020-DS-ABG0155-REG**
Sampling Method: **HA**
Sample Type: **DS** *Sample Purpose:* **REG**

Collection Date: **18-AUG-15**
Collection Time: **13:20**
Start Depth: **2**
End Depth: **4**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* BM 8/18/15

Sample Collection Log

500382

Project: ~~136973~~ Redstone PMC (EJM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-HP020**
Sample Number: **ABG0155-MS**
Sample Name: **013-HP020-DS-ABG0155-MS-MS**
Sampling Method: **HA**
Sample Type: **DS** *Sample Purpose:* **MS**

Collection Date: **18-AUG-15**
Collection Time: **13:20**
Start Depth: **2**
End Depth: **4**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* BVL 8/18/15

Sample Collection Log

Project: ~~136973~~ 500382 Redstone PMC

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-HP020**
Sample Number: **ABG0155-MSD**
Sample Name: **013-HP020-DS-ABG0155-MSD-MSD**
Sampling Method: **HA**
Sample Type: **DS** *Sample Purpose:* **MSD**

Collection Date: **18-AUG-15**
Collection Time: **13:20**
Start Depth: **2**
End Depth: **4**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* BM 8/18/15

Sample Collection Log

Project: ~~136973~~ 500382 Redstone PMC (EDM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-HP020**
Sample Number: **ABG0156**
Sample Name: **013-HP020-DS-ABG0156-REG**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**

Collection Date: **18-AUG-15**
Collection Time: **13:30**
Start Depth: **6**
End Depth: **8**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* BM 8/18/15

HTRW DRILLING LOG

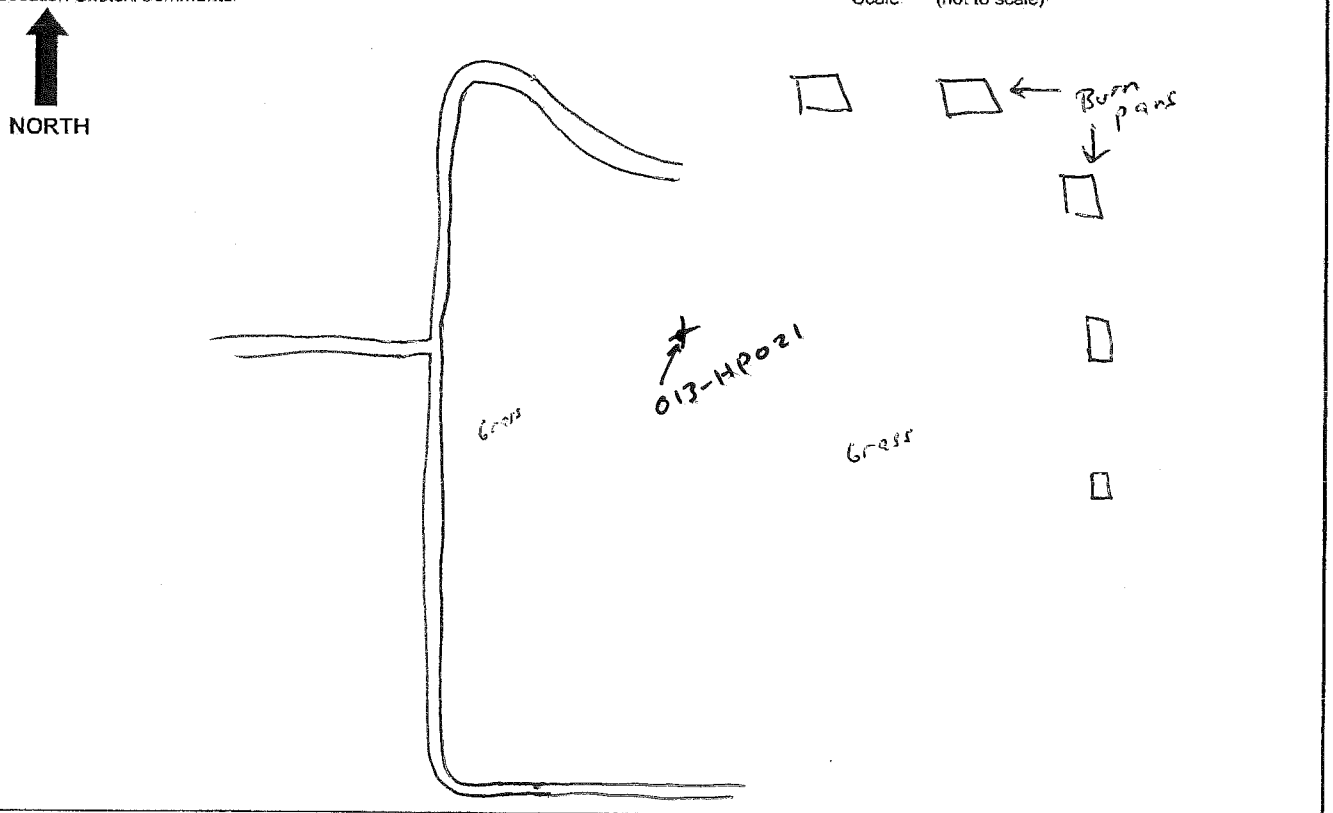
Shaw Environmental & Infrastructure Inc
(A CB&I Company)

Client: CB&I			Hole Number: 013-HP021
Company Name: Shaw Environmental, Inc.		Drilling Subcontractor: GSE	Sheet: 1 of 4 Sheets
Project: Redstone Arsenal		Location: RSA-013	
Name of Driller: Wesley Casteel		Manufacturer's Designation of Drill: Geoprobe 7822 DT	
Sizes and Types of Drilling and Sampling Equipment: Hand Auger; 2" Macro Core		Surface Elevation: TBD	
		Date Started: 8-18-15	Date Completed: 8-18-15
Overburden Thickness: > 25		Depth Groundwater Encountered: Unknown	
Depth Drilled into Rock: 0		Depth to Water and Elapsed Time After Drilling Completed: 7.51' after 30 Min	
Total Depth of Hole: 25		Other Water Level Measurements (Specify): NA	

Geotechnical Samples	Disturbed: NA	Undisturbed: NA		Total Number of Core Boxes: NA		
Samples for Chemical Analysis	VOC: V	Metals:	Other: Explosives, Perch	Other: NA	Other: NA	Total Core Recovery: NA
Disposition of Hole	Backfilled: NA	Monitoring Well: NA	Other: piezometer	Signature of Geologist: L. Ryan Bailey		

Location Sketch/Comments:

Scale: (not to scale)



CB&I

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-HP021

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 2 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	0-5 → Reddish brown (5YR4/4) silty clay, med stiff, Low plast. Moist.	CL	0-5 0.0	NA ↓	AB6 0157 (0-1)		Hand Auger to 5 ft.
	5	5-10 → strong brown (7.5YR5/6) silty clay, some gray mottling. med. stiff, med. plast. slightly moist.	CL	5-10 0.0		AB6 0158 (2-4) AB6 0159 (6-8)		
	10							

Project: RSA

Hole Number: 013-HP021

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-HP021

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 3 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	10	10-20 No lithology required per CB&I Plan		~~10-15~~ RB	NA ↓	NA ↓		
	11							
	12							
	13							
	14							
	15			~~15-20~~ RB				
	16							
	17							
	18							
	19							
	20							

Project: RSA

Hole Number: 013-HP021

CB&I

Shaw Environmental & Infrastructure Inc
(A CB&I Company)

HTRW DRILLING LOG (continuation sheet)

Hole Number: 013-HP021

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 4 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	20	20-25 → No lithology required per CB&I Plan.		~~20-25~~ (RP)	NA ↓	NA ↓		
	21							
	22							
	23							
	24							
	25							
	26			~~25-30~~ (RP)				
	27							
	28							
	29							
	30							

Project: RSA

Hole Number: 013-HP021

Temporary Piezometer

Project:	Redstone Arsenal	Piezometer Number:	013 - HP021
Location:	Huntsville, Madison County, AL	Site Location:	RSA-013
Client:	CB&I	Installation Date	8-18-15
Subcontractor:	GSE	Northing:	TBD
Driller:	Cody Eakin	Easting:	TBD
Field Geologist:	Ryan Bailey	Project Number:	500382

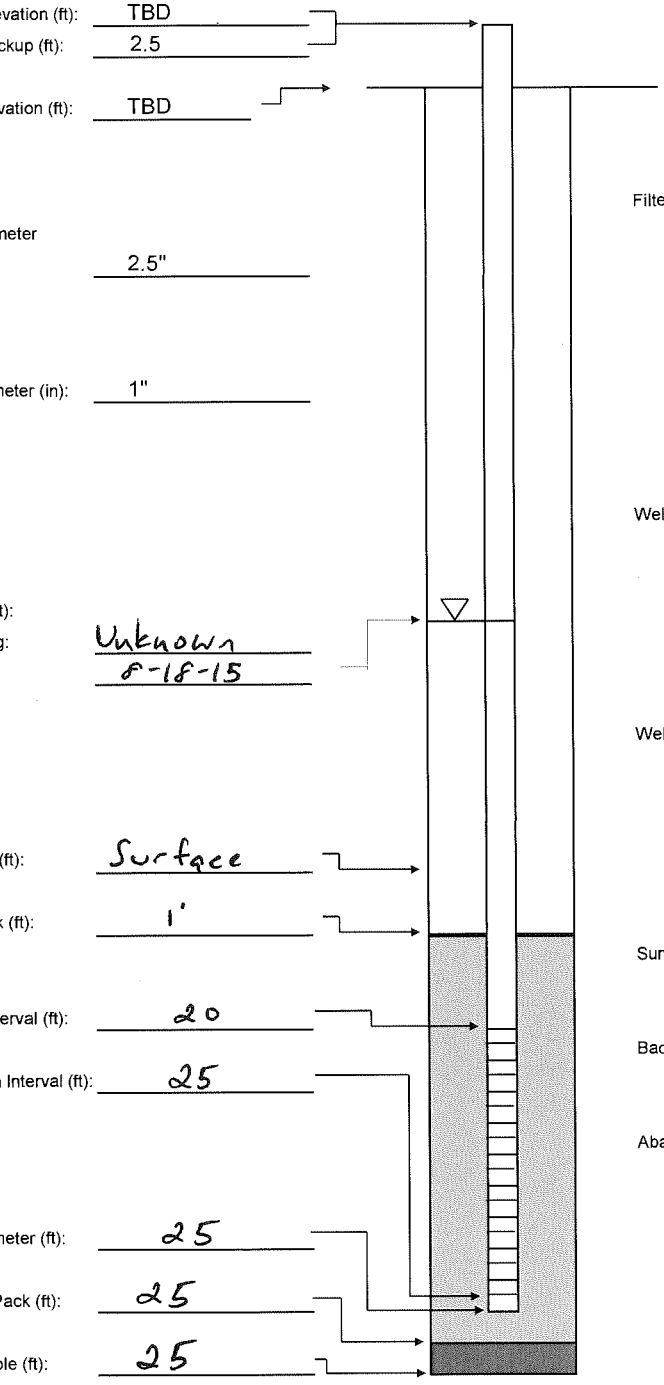
Top of Casing Elevation (ft): TBD
Top of Casing Stickup (ft): 2.5
Land Surface Elevation (ft): TBD

Approximate Diameter of Borehole (in): 2.5"

Well Casing Diameter (in): 1"

Depth to Water (ft):
During Drilling: Unknown
Date: 8-18-15

Top of Bentonite (ft): Surface
Top of Filter Pack (ft): 1'
Top of Screen Interval (ft): 20
Bottom of Screen Interval (ft): 25
Bottom of Piezometer (ft): 25
Bottom of Filter Pack (ft): 25
Bottom of Borehole (ft): 25



Filter Pack Material:
- Manufacturer: Southern Filter Media
- Product Name: Filter Media
- Size: 20/40
- Installation: Prepacked Screen / Filter Sock / Gravity / Tremie

Well Casing:
- Manufacturer: Mono-Flex
- Type: Sch. 40 PVC
- Diameter (in): 1"

Well Screen Casing:
- Manufacturer: Mono-Flex
- Type: Sch. 40 PVC
- Slot Size (in): 0.010
- Slot Type: Continuous wrap / Factory slot

Sump/End Cap: Point

Backfill Material: N/A

Abandonment:
- Date: TBD
- Procedure: Natural fill / Grouted / Casing Removed / Completed as Well: TBD

Depths and heights are referenced to ground surface unless specified TOC.
All elevations are referenced to MSL (NAVD 88).
If completed as well - see well construction diagram.

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

Sample Collection Log

~~136973~~ 500382 - Redstone PMC

Manager: ~~Don Burton~~ John Nenni

EPM

RFA / COC Number: ABG08192015-W-EMP

Location Code:	013-HP021
Sample Number:	ABG3022
Sample Name:	013-HP021-GW-ABG3022-REG
Sampling Method:	LF
Sample Type:	GW
Sample Purpose:	REG
Sampling Equip:	PERISTALTIC PUMP
Task:	013
Collection Date:	8-18-15
Collection Time:	1430
Start Depth:	20' BTOC
End Depth:	25' BTOC
Sample Matrix:	WATER
Sample Team:	KR

QC Partners:

(TB) N/A (ER) N/A (FB) N/A

ERPIMS Values:

Sacode: N/A

Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
EXPLOSIVES+	N	B	2	1	L	Amb. Glass
PERCH_6850	N	C	1	125	mL	HDPE

Groundwater Information:

Measured Well Depth: 27' BTOC **Depth To Water:** 8.67' BTOC

Comments: PID=Ø

INSUFFICIENT WATER FOR WATER QUALITY PARAMETERS.

Sketch Location:

SEE BORING LOG

Logged BY / Date: Kelly Robinson 8-18-15 *Reviewed BY / Date:* [signature] 8/18/15

Sample Collection Log

Project: ~~136973~~ 500382 **Redstone PMC**

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-HP021**
Sample Number: **ABG0157**
Sample Name: **013-HP021-SS-ABG0157-REG**
Sampling Method: **HA**
Sample Type: **SS** *Sample Purpose:* **REG**

Collection Date: **18-AUG-15**
Collection Time: **12:20**
Start Depth: **0**
End Depth: **1**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location: See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* BNL 8/18/15

Sample Collection Log

Project: ~~136973~~ 500382 Redstone PMC (EJM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-HP021**
Sample Number: **ABG0158**
Sample Name: **013-HP021-DS-ABG0158-REG**
Sampling Method: **HA**
Sample Type: **DS** *Sample Purpose:* **REG**

Collection Date: **18-AUG-15**
Collection Time: **12:30**
Start Depth: **2**
End Depth: **4**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* 8/18/15

Sample Collection Log

500382
Project: ~~136973~~ Redstone PMC (EPM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-HP021**
Sample Number: **ABG0159**
Sample Name: **013-HP021-DS-ABG0159-REG**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**

Collection Date: **18-AUG-15**
Collection Time: **12:40**
Start Depth: **6**
End Depth: **8**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* BRL 8/18/15

HTRW DRILLING LOG

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

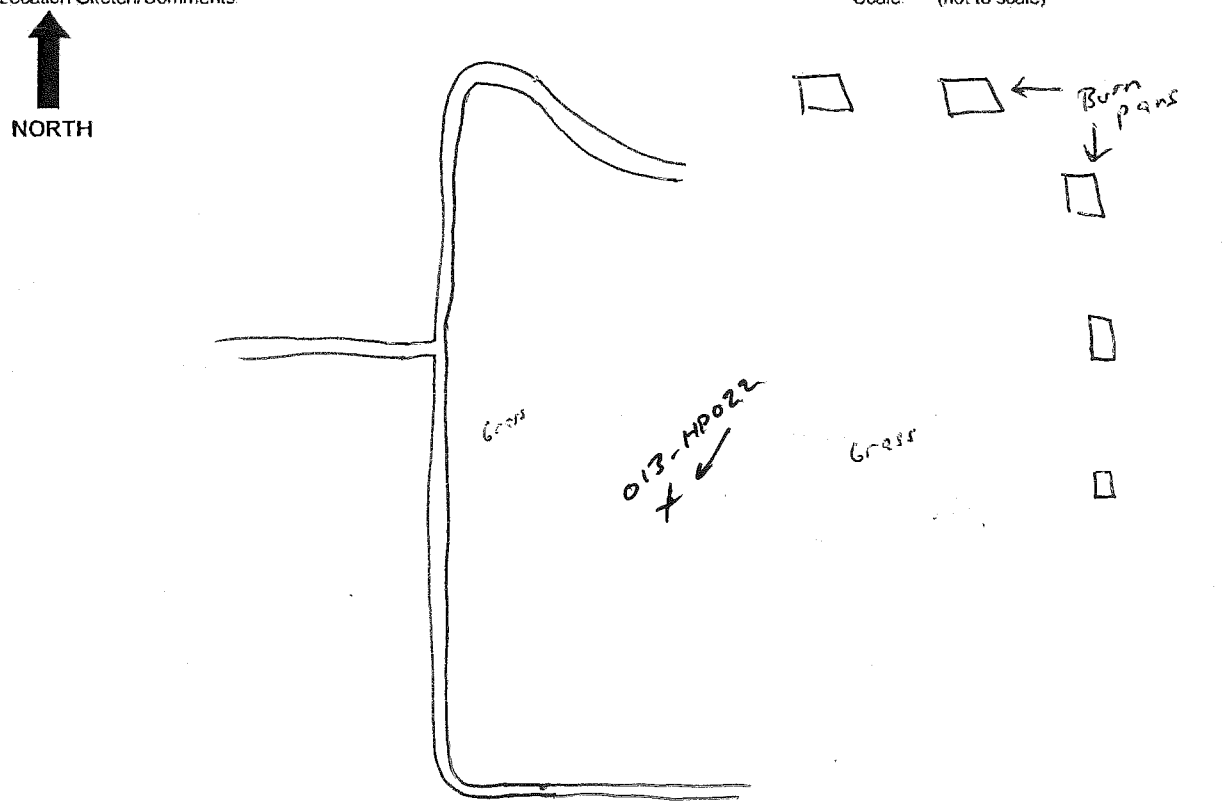
Client: CB&I			Hole Number: 013-HP022
Company Name: Shaw Environmental, Inc.		Drilling Subcontractor: GSE	Sheet: 1 of 4 Sheets
Project: Redstone Arsenal		Location: RSA-013	
Name of Driller: Wesley Casteel		Manufacturer's Designation of Drill: Geoprobe 7822 DT	
Sizes and Types of Drilling and Sampling Equipment: Hand Auger; 2" Macro Core		Surface Elevation: TBD	
		Date Started: 8-18-15	Date Completed: 8-18-15
Overburden Thickness: 7.25'		Depth Groundwater Encountered: Unknown	
Depth Drilled into Rock: 0		Depth to Water and Elapsed Time After Drilling Completed: 9.52' after 1hr	
Total Depth of Hole: 25'		Other Water Level Measurements (Specify): NA	

Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	V		Explosives, Perch	NA	NA	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	NA	NA	piezometer	J. Ryan Bailey

Location Sketch/Comments: Scale: (not to scale)



Project: Redstone Arsenal	Hole Number: 013-HP022

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-HP022

Project: Redstone Arsenal

Geologist: R. Bailer

Sheet 2 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	0-5→ yellowish brown (10YR 5/6) silty clay. Med. stiff. Med. plast. slightly moist		0-5: 0.0	NA ↓	ABG 0160 (0-1)		Hand Auger to 5 ft.
	1							
	2							
	3					ABG 0161 (2-4)		
	4							
	5	5-10→		5-10: 0.0				
	6							
	7					ABG 0162 0163 (6-8)		
	8							
	9							
	10							

Project: RSA

Hole Number: 013-HP022

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG (continuation sheet)

Hole Number: 013-HP022

Project: Redstone Arsenal | Geologist: R. Bailey | Sheet 3 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	10	10-20 → No logging per CB&I plan		~~10-11~~ NA	NA ↓	NA ↓		
	11							
	12							
	13							
	14							
	15			~~15-20~~ NA				
	16							
	17							
	18							
	19							
	20							

Project: RSA | Hole Number: 013-HP022

CB&I

Shaw Environmental & Infrastructure Inc
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-HP022

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 4 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	20	20-25 → No lossins per CB&I plan		20-25 (RB)	NA ↓	NA ↓		
	21							
	22							
	23							
	24							
	25	DPT to 25 Ft. Constructed 1" PVC piezometer		25-30 (RB)				
	26							
	27							
	28							
	29							
	30							

Project: RSA

Hole Number: 013-HP022

Temporary Piezometer

Project:	Redstone Arsenal	Piezometer Number:	017-HP022
Location:	Huntsville, Madison County, AL	Site Location:	RSA-013
Client:	CB&I	Installation Date	8-18-15
Subcontractor:	GSE	Northing:	TBD
Driller:	Cody Eakin	Easting:	TBD
Field Geologist:	Ryan Bailey	Project Number:	500382

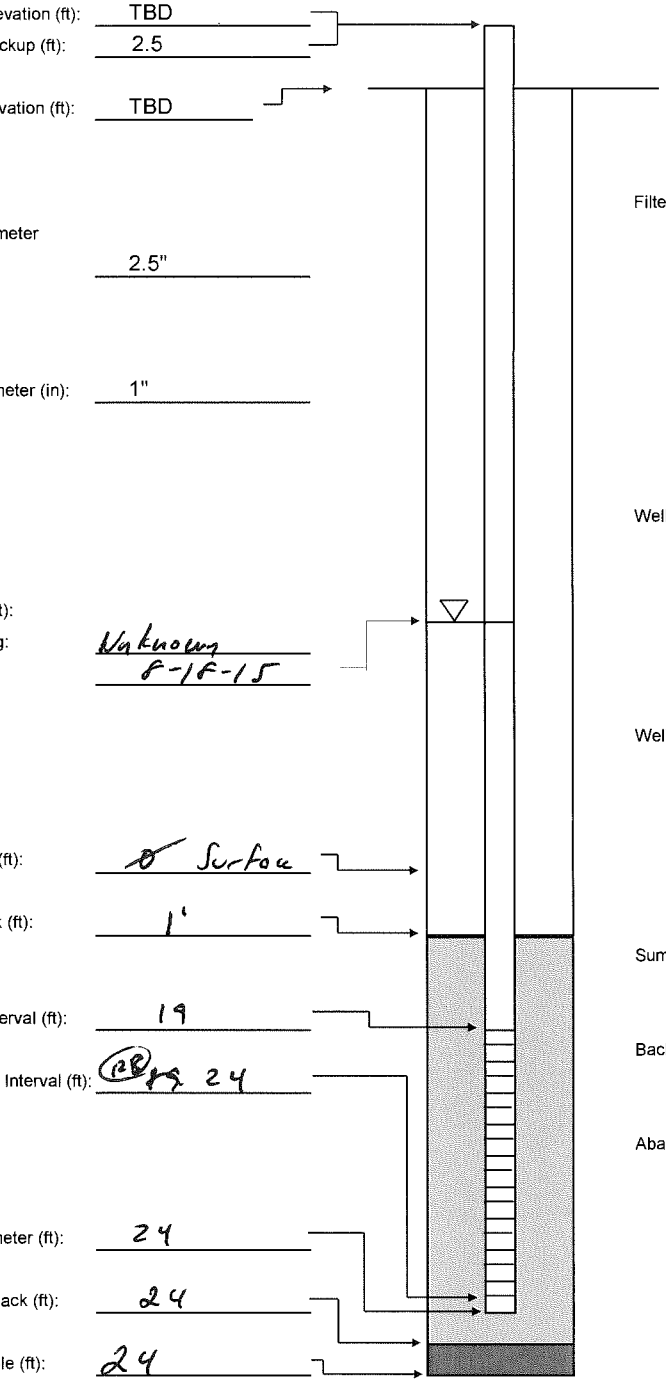
Top of Casing Elevation (ft): TBD
Top of Casing Stickup (ft): 2.5
Land Surface Elevation (ft): TBD

Approximate Diameter of Borehole (in): 2.5"

Well Casing Diameter (in): 1"

Depth to Water (ft):
During Drilling: Unknown
Date: 8-18-15

Top of Bentonite (ft): 0 Surface
Top of Filter Pack (ft): 1'
Top of Screen Interval (ft): 19
Bottom of Screen Interval (ft): (18) 24
Bottom of Piezometer (ft): 24
Bottom of Filter Pack (ft): 24
Bottom of Borehole (ft): 24



Filter Pack Material:
- Manufacturer: Southern Filter Media
- Product Name: Filter Media
- Size: 20/40
- Installation: Prepacked Screen; Filter Sock; [Gravity]; Tremie

Well Casing:
- Manufacturer: Mono-Flex
- Type: Sch. 40 PVC
- Diameter (in): 1"

Well Screen Casing:
- Manufacturer: Mono-Flex
- Type: Sch. 40 PVC
- Slot Size (in): 0.010
- Slot Type: Continuous wrap; [Factory slot]

Sump/End Cap: Point

Backfill Material: N/A

Abandonment:
- Date: TBD
- Procedure: Natural fill; Grouted; Casing Removed; Completed as Well; TBD

Depths and heights are referenced to ground surface unless specified TOC.
All elevations are referenced to MSL (NAVD 88).
If completed as well - see well construction diagram.

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

Sample Collection Log

500382
~~136973~~ - Redstone PMC (EPM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-W-EMP

Location Code: **013-HP022**
Sample Number: **ABG3023**
Sample Name: **013-HP022-GW-ABG3023-REG**
Sampling Method: **LF**
Sample Type: **GW** *Sample Purpose:* **REG**
Sampling Equip: PERISTALTIC PUMP

Task: **013**
Collection Date: 8-18-15
Collection Time: 1400
Start Depth: 19' BTOC
End Depth: 24' BTOC
Sample Matrix: **WATER**
Sample Team: KR

QC Partners:
(TB) N/A (ER) N/A (FB) N/A

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
EXPLOSIVES+	N	B	2	1	L	Amb. Glass
PERCH_6850	N	C	1	125	mL	HDPE

ERPIMS Values:
Sacode: N/A
Lot Control#:

Groundwater Information:
Measured Well Depth: 24.35' BTOC **Depth To Water:** 7.80' BTOC

Comments: PID=0

TEMP	pH	ORP	SPC	TURB	DO
23.54°C	5.80	19 mV	0.121 ms/cm	>1000 NTU	8.57 mg/L

Sketch Location:
SEE BORING LOG

Logged BY / Date: Kelly Robinson 8/18/15 *Reviewed BY / Date:* Bcl 8/18/15

Sample Collection Log

Project: ~~136973~~ 500382 Redstone PMC (EPM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-HP022**
Sample Number: **ABG0160**
Sample Name: **013-HP022-SS-ABG0160-REG**
Sampling Method: **HA**
Sample Type: **SS** *Sample Purpose:* **REG**

Collection Date: **18-AUG-15**
Collection Time: **10:40**
Start Depth: **0**
End Depth: **1**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* BM 8/18/15

Sample Collection Log

500382

Project: ~~136973~~ Redstone PMC (EJM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-HP022**
Sample Number: **ABG0161**
Sample Name: **013-HP022-DS-ABG0161-REG**
Sampling Method: **HA**
Sample Type: **DS** *Sample Purpose:* **REG**

Collection Date: **18-AUG-15**
Collection Time: **10:50**
Start Depth: **2**
End Depth: **4**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* Bnl 8/18/15

Sample Collection Log

Project: ~~136973~~ 500382 ~~Redstone~~ PMC (EPM)
Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-HP022**
Sample Number: **ABG0162**
Sample Name: **013-HP022-DS-ABG0162-REG**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**

Collection Date: **18-AUG-15**
Collection Time: **11:00**
Start Depth: **6**
End Depth: **8**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* BRL 8/19/15

Sample Collection Log

Project: ~~136973~~ 500382 Redstone PMC

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-HP022**
Sample Number: **ABG0163**
Sample Name: **013-HP022-DS-ABG0163-FD**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **FD**

Collection Date: **18-AUG-15**
Collection Time: **11:00**
Start Depth: **6**
End Depth: **8**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R-Bailey 8-18-15 *Reviewed BY / Date:* 8/18/15

Shaw Environmental & Infrastructure Inc
(A CB&I Company)

HTRW DRILLING LOG

Client: CB&I			Hole Number: 013-HP023
Company Name: Shaw Environmental, Inc.		Drilling Subcontractor: GSE	Sheet: 1 of 2 Sheets
Project: Redstone Arsenal		Location: RSA-013	
Name of Driller: Wesley Casteel		Manufacturer's Designation of Drill: Geoprobe 7822 DT	
Sizes and Types of Drilling and Sampling Equipment: Hand Auger; 2" Macro Core		Surface Elevation: TBD	
		Date Started: 8-18-15	Date Completed: 8-18-15
Overburden Thickness: >25'		Depth Groundwater Encountered: Unknown	
Depth Drilled into Rock: 0		Depth to Water and Elapsed Time After Drilling Completed: 7.66 after 1 hour	
Total Depth of Hole: 25'		Other Water Level Measurements (Specify): NA	

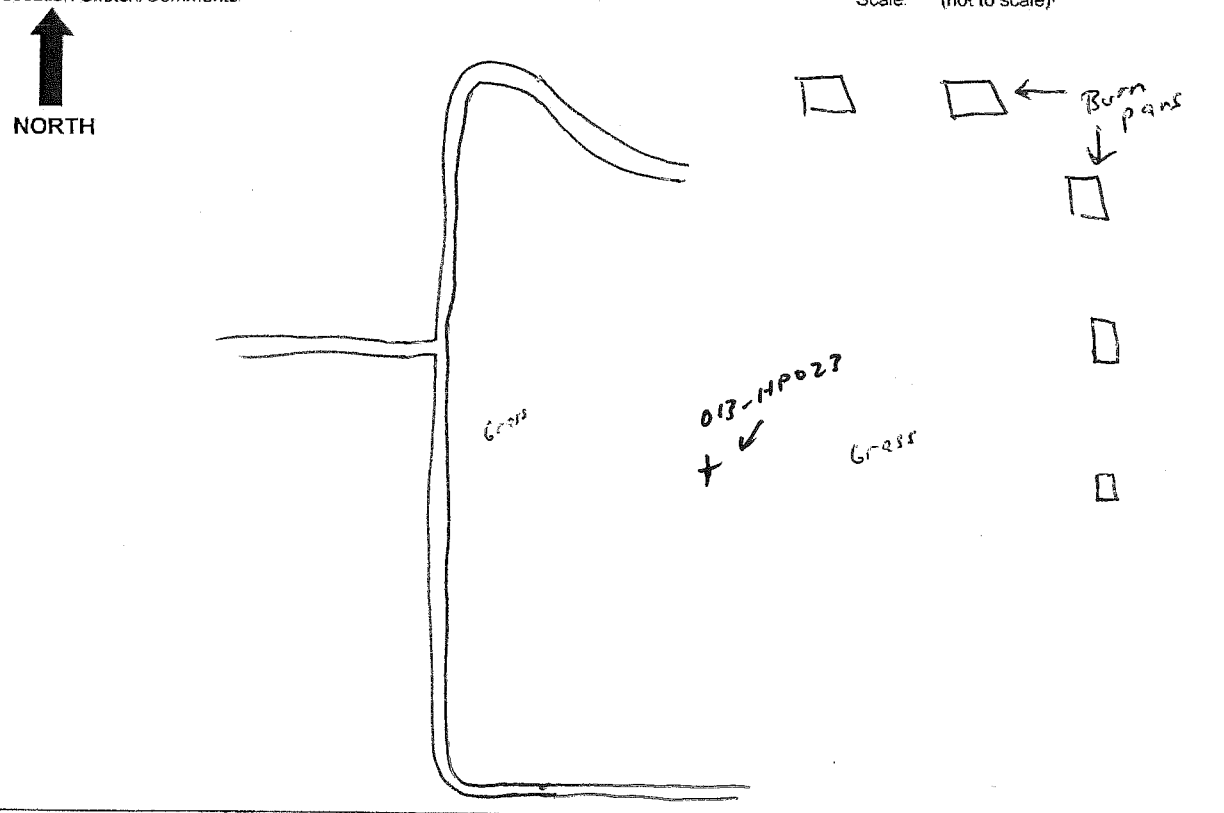
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	V		Explosives, Perch	NA	NA	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	NA	NA	piezometer	J. Ryan Bailey

Location Sketch/Comments:

Scale: (not to scale)



Project	Hole Number
Redstone Arsenal	013-HP023

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-HP023

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 2 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	0-5 → Brown (7.5 YR 4/4) silty clay, med. stiff. Low plast. slightly moist	CL	0-5: 0.0	NA ↓	ABG 0164 (0-1)	5/5	Hand Auger to 5 ft.
	5	5-10 → strong brown (7.5 YR 5/6) silty clay, med stiff. Med. plast. slightly moist.	CL	5-10: 0.0		ABG 0165 (2-4)	5/5	
	10					ABG 016P (6-8)		

Project: RSA

Hole Number: 013-HP023

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-HP023

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 3 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	10	10-20 - No lithology per CB&I plan		~~bkgd~~ RB	NA ↓	NA ↓		
	11							
	12							
	13							
	14							
	15			~~15-20~~ RB				
	16							
	17							
	18							
	19							
	20							

Project: RSA

Hole Number: 013-HP023

CB&I

Shaw Environmental & Infrastructure Inc
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-HP023

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 4 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	20	20-25 → No lithology per CB&I Plan.		~~20-25~~ RB	NA ↓	NA ↓		
	21							
	22							
	23							
	24							
	25							
	26			~~25-30~~ RB				
	27							
	28							
	29							
	30							

Project: RSA

Hole Number: 013-HP023

Temporary Piezometer

Project:	Redstone Arsenal	Piezometer Number:	013-HP023
Location:	Huntsville, Madison County, AL	Site Location:	RSA-013
Client:	CB&I	Installation Date	8-18-15
Subcontractor:	GSE	Northing:	TBD
Driller:	Cody Eakin	Easting:	TBD
Field Geologist:	Ryan Bailey	Project Number:	500382

Top of Casing Elevation (ft): TBD
Top of Casing Stickup (ft): 2.5

Land Surface Elevation (ft): TBD

Approximate Diameter of Borehole (in): 2.5"

Well Casing Diameter (in): 1"

Depth to Water (ft):
During Drilling: Unknown
Date: 8-18-15

Top of Bentonite (ft): Surface

Top of Filter Pack (ft): 1'

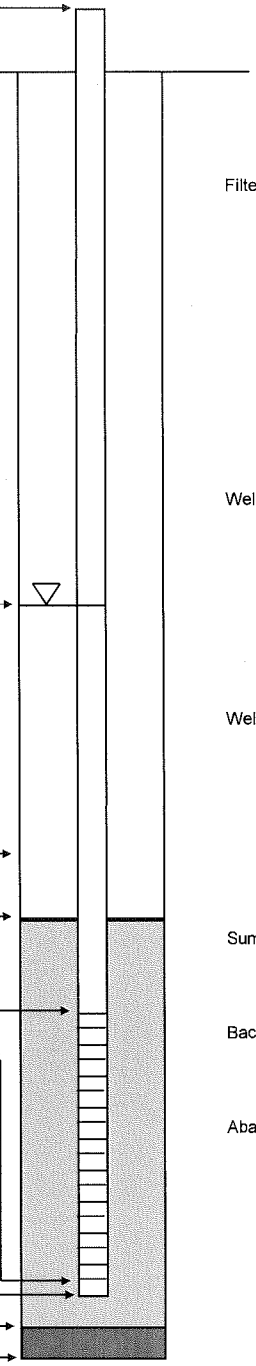
Top of Screen Interval (ft): 20

Bottom of Screen Interval (ft): 25

Bottom of Piezometer (ft): 25

Bottom of Filter Pack (ft): 25

Bottom of Borehole (ft): 25



Filter Pack Material:
- Manufacturer: Southern Filter Media
- Product Name: Filter Media
- Size: 20/40
- Installation: Prepacked Screen / Filter Sock / Gravity / Tremie

Well Casing:
- Manufacturer: Mono-Flex
- Type: Sch. 40 PVC
- Diameter (in): 1"

Well Screen Casing:
- Manufacturer: Mono-Flex
- Type: Sch. 40 PVC
- Slot Size (in): 0.010
- Slot Type: Continuous wrap / Factory slot

Sump/End Cap: Point

Backfill Material: N/A

Abandonment:
- Date: TBD
- Procedure: Natural fill / Grouted / Casing Removed / Completed as Well: TBD

Depths and heights are referenced to ground surface unless specified TOC.
All elevations are referenced to MSL (NAVD 88).
If completed as well - see well construction diagram.

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

Sample Collection Log

500382
~~136973~~ - Redstone PMC EDM

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG 08192015-W-EMP

Location Code: **013-HP023**
Sample Number: **ABG3024**
Sample Name: **013-HP023-GW-ABG3024-REG**
Sampling Method: **LF**
Sample Type: **GW** *Sample Purpose:* **REG**
Sampling Equip: PERISTALTIC PUMP

Task: **013**
Collection Date: 8/18/15
Collection Time: 1300
Start Depth: 20' BTOC
End Depth: 25' BTOC
Sample Matrix: **WATER**
Sample Team: KR

QC Partners:
(TB) N/A (ER) N/A (FB) N/A

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
EXPLOSIVES+	N	B	2	1	L	Amb. Glass
PERCH_6850	N	C	1	125	mL	HDPE

ERPIMS Values:
Sacode:
Lot Control#: N/A

Groundwater Information:
Measured Well Depth: 26.68' BTOC **Depth To Water:** 9.52' BTOC

Comments: PID=0

TEMP	pH	ORP	SPC	TURB	DO
23.13°C	6.24	108 mV	0.092 mS/cm	>1000 NTU	10.06 mg/L

Sketch Location:
SEE BORING LOG

Logged BY / Date: Kelley Rafferty 8-18-15 *Reviewed BY / Date:* BM 8/18/15

Sample Collection Log

500382
~~136973~~ - Redstone PMC (EDM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG 08192015-W-EMP

Location Code: **013-HP023**

Sample Number: **ABG3025**

Sample Name: **013-HP023-GW-ABG3025-FD**

Sampling Method: **LF**

Sample Type: **GW** *Sample Purpose:* **FD**

Sampling Equip: PERISTALTIC PUMP

Task: **013**

Collection Date: 8-18-15

Collection Time: 1300

Start Depth: 20' BTOC

End Depth: 25' BTOC

Sample Matrix: **WATER**

Sample Team: KR

QC Partners:

(TB) N/A (ER) N/A (FB) N/A

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
EXPLOSIVES+	N	B	2	1	L	Amb. Glass
PERCH_6850	N	C	1	125	mL	HDPE

ERPIMS Values:

Sacode: N/A

Lot Control#:

Groundwater Information:

Measured Well Depth: 26.68' BTOC **Depth To Water:** 9.52' BTOC

Comments: PID=0

TEMP	pH	ORP	SPC	TURB	DO
23.13°C	6.24	108 mV	0.092 ms/cm	>1000 NTU	10.06 mg/L

Sketch Location:

SEE BORING LOG

Logged BY / Date: Kelly Robinson 8-18-15

Reviewed BY / Date: Bal 8/18/15

Sample Collection Log

500382

Project: ~~136973~~ Redstone PMC

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-HP023**
Sample Number: **ABG0164**
Sample Name: **013-HP023-SS-ABG0164-REG**
Sampling Method: **HA**
Sample Type: **SS** *Sample Purpose:* **REG**

Collection Date: **18-AUG-15**
Collection Time: **11:20**
Start Depth: **0**
End Depth: **1**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* BAL 8/18/15

Sample Collection Log

Project: ~~136973~~ 500382 Redstone PMC (EPM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-HP023**
Sample Number: **ABG0165**
Sample Name: **013-HP023-DS-ABG0165-REG**
Sampling Method: **HA**
Sample Type: **DS** *Sample Purpose:* **REG**

Collection Date: **18-AUG-15**
Collection Time: **11:25**
Start Depth: **2**
End Depth: **4**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R Bailey 8-18-15 *Reviewed BY / Date:* BM 8/19/15

Sample Collection Log

500382

Project: ~~136973~~ Redstone PMC

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-HP023**
Sample Number: **ABG0166**
Sample Name: **013-HP023-DS-ABG0166-REG**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**

Collection Date: **18-AUG-15**
Collection Time: **11:30**
Start Depth: **6**
End Depth: **8**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* BLL 8/18/15

HTRW DRILLING LOG

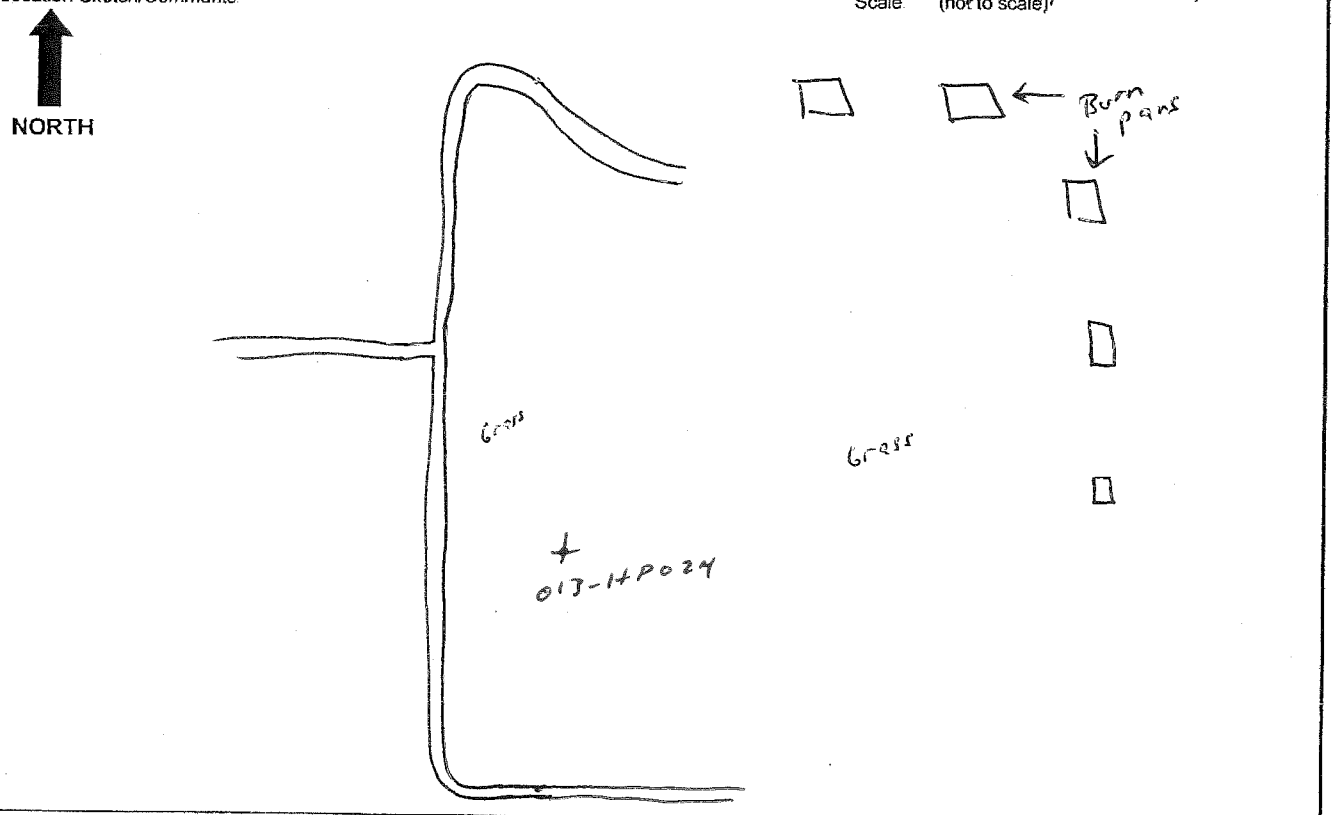
Shaw Environmental & Infrastructure, Inc (A CB&I Company)

Client: CB&I			Hole Number: 013-HP024
Company Name: Shaw Environmental, Inc.		Drilling Subcontractor: GSE	Sheet: 1 of 4 Sheets
Project: Redstone Arsenal		Location: RSA-013	
Name of Driller: Wesley Casteel		Manufacturer's Designation of Drill: Geoprobe 7822 DT	
Sizes and Types of Drilling and Sampling Equipment: Hand Auger; 2" Macro Core		Surface Elevation: TBD	
		Date Started: 8-17-15	Date Completed: 8-17-15
Overburden Thickness: >25'		Depth Groundwater Encountered: Unknown	
Depth Drilled into Rock: 0		Depth to Water and Elapsed Time After Drilling Completed: 21.75' after 1 hr	
Total Depth of Hole: 25'		Other Water Level Measurements (Specify): NA	

Geotechnical Samples	Disturbed: NA	Undisturbed: NA		Total Number of Core Boxes: NA		
Samples for Chemical Analysis	VOC: V	Metals:	Other: Explosives, Perc	Other: NA	Other: NA	Total Core Recovery: NA
Disposition of Hole	Backfilled: NA	Monitoring Well: NA	Other: piezometer	Signature of Geologist: J. Ryan Bailey		

Location Sketch/Comments:

Scale: (not to scale)



Project: Redstone Arsenal		Hole Number: 013-HP024

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-HP024

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 2 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	0-5 → Yellowish red (5YR 5/8) silty, sandy clay, med stiff, med plast, slightly moist.	CL	0-5: 0.0	NA ↓	ABG 0167 (0-1)	5/5	Hand Auger to 5 ft.
	1							
	2							
	3					ABG 0168 (2-4)		
	4							
	5	5-10 → Reddish yellow (5YR 6/8) silty, sandy clay, med. stiff, med. plast, slightly moist	CL	5-10: 0.0		ABG 0169 (6-8)	5/5	
	6							
	7							
	8							
	9							
	10							

Project: RSA

Hole Number: 013-HP024

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-HP024

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 3 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	10	10-20 – No P lithology per CB&I		~~10-15~~ (2B)	NA ↓	NA ↓		
	11							
	12							
	13							
	14							
	15			~~15-20~~ (2B)				
	16							
	17							
	18							
	19							
	20							

Project: RSA

Hole Number: 013-HP024

Shaw Environmental & Infrastructure Inc
(A CB&I Company)

HTRW DRILLING LOG (continuation sheet)

Hole Number: 013-HP024

Project: Redstone Arsenal | Geologist: R. Bailey | Sheet 4 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	20	20-25 → No lithology per CB&E.		20-25 NA	NA			
	21							
	22							
	23							
	24							
	25	stopped at 25 ft. Constructed 1" pvc piezometer						
	26							
	27			25-27 RJ				
	28							
	29							
	30							

Project: RSA | Hole Number: 013-HP024

Temporary Piezometer

Project:	Redstone Arsenal	Piezometer Number:	013-HP024
Location:	Huntsville, Madison County, AL	Site Location:	RSA-013
Client:	CB&I	Installation Date	8-17-15
Subcontractor:	GSE	Northing:	TBD
Driller:	Cody Eakin	Easting:	TBD
Field Geologist:	Ryan Bailey	Project Number:	500382

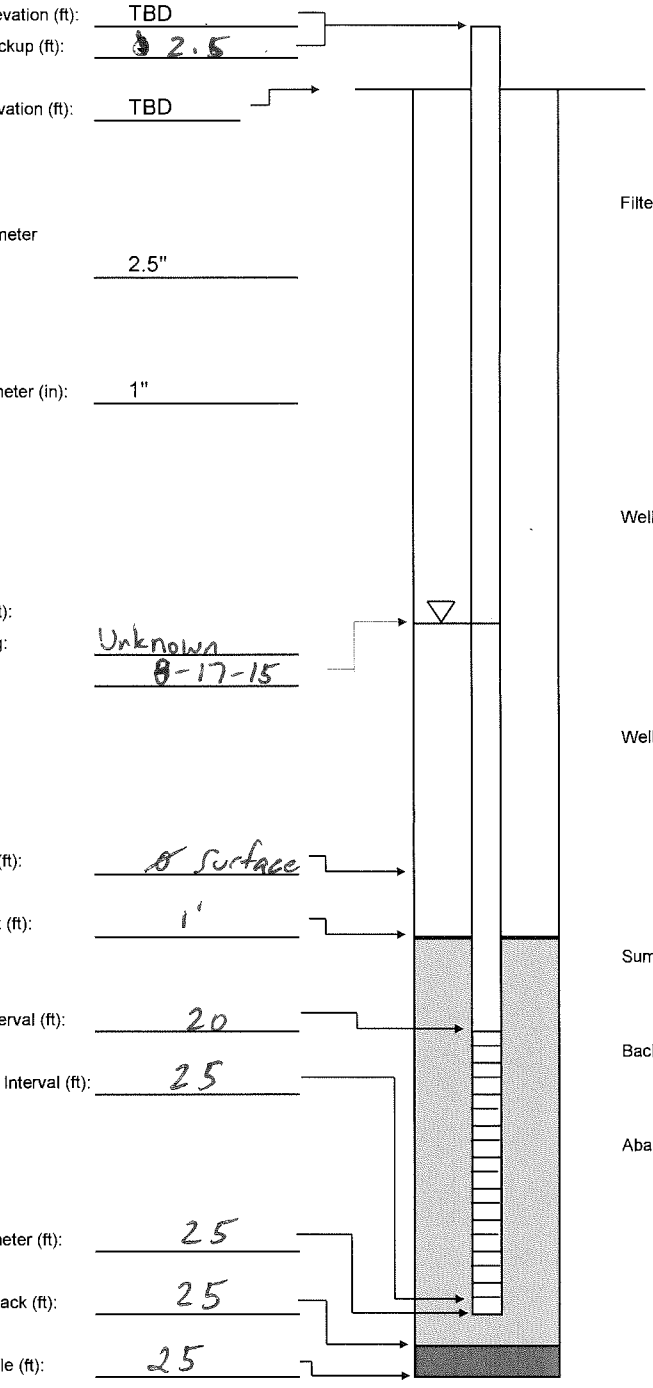
Top of Casing Elevation (ft): TBD
Top of Casing Stickup (ft): 2.5
Land Surface Elevation (ft): TBD

Approximate Diameter of Borehole (in): 2.5"

Well Casing Diameter (in): 1"

Depth to Water (ft):
During Drilling: Unknown
Date: 8-17-15

Top of Bentonite (ft): 0' Surface
Top of Filter Pack (ft): 1'
Top of Screen Interval (ft): 20
Bottom of Screen Interval (ft): 25
Bottom of Piezometer (ft): 25
Bottom of Filter Pack (ft): 25
Bottom of Borehole (ft): 25



Filter Pack Material:
- Manufacturer: Southern Filter Media
- Product Name: Filter Media
- Size: 20/40
- Installation: Prepacked Screen; Filter Sock; [Gravity]; Tremie

Well Casing:
- Manufacturer: Mono-Flex
- Type: Sch. 40 PVC
- Diameter (in): 1"

Well Screen Casing:
- Manufacturer: Mono-Flex
- Type: Sch. 40 PVC
- Slot Size (in): 0.010
- Slot Type: Continuous wrap; [Factory slot]

Sump/End Cap: Point

Backfill Material: N/A

Abandonment:
- Date: TBD
- Procedure: Natural fill; Grouted; Casing Removed; Completed as Well: TBD

Depths and heights are referenced to ground surface unless specified TOC.
All elevations are referenced to MSL (NAVD 88).
If completed as well - see well construction diagram.

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

Sample Collection Log

Project: ~~136973~~ 500382 Redstone PMC (EPM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08182015-S-EMP

Location Code: **013-HP024**
Sample Number: **ABG0167**
Sample Name: **013-HP024-SS-ABG0167-REG**
Sampling Method: **HA**
Sample Type: **SS** *Sample Purpose:* **REG**

Collection Date: **17-AUG-15**
Collection Time: **14:30**
Start Depth: **0**
End Depth: **1**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

8-17-15

Logged BY / Date: R. Bailey *Reviewed BY / Date:* BM 8/17/15

Sample Collection Log

Project: ~~136973~~ 500382 Redstone PMC (EPM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08182015-S-EMP

Location Code: **013-HP024**
Sample Number: **ABG0168**
Sample Name: **013-HP024-DS-ABG0168-REG**
Sampling Method: **HA**
Sample Type: **DS** *Sample Purpose:* **REG**

Collection Date: **17-AUG-15**
Collection Time: **14:40**
Start Depth: **2**
End Depth: **4**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-17-15 *Reviewed BY / Date:* BM 8/17/15

Sample Collection Log

Project: ~~136973~~ 570382 Redstone PMC (EPM)

Manager: ~~Don Burton~~ John Nemi

RFA / COC Number: ABG08182015-S-EMP

Location Code: **013-HP024**
Sample Number: **ABG0169**
Sample Name: **013-HP024-DS-ABG0169-REG**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**

Collection Date: **17-AUG-15**
Collection Time: **14:50**
Start Depth: **6**
End Depth: **8**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-17-15 *Reviewed BY / Date:* BM 8/17/15

Sample Collection Log

500382
~~136973~~ Redstone PMC (EJM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG 08192015-W-EMP

Location Code: **013-HP024**

Sample Number: **ABG3026**

Sample Name: **013-HP024-GW-ABG3026-REG**

Sampling Method: **LF**

Sample Type: **GW** *Sample Purpose:* **REG**

Sampling Equip: PERISTALTIC PUMP

Task: **013**

Collection Date: 8-18-15

Collection Time: 1155

Start Depth: ~20' bgs

End Depth: 25'

Sample Matrix: **WATER**

Sample Team: KR

QC Partners:

(TB) N/A (ER) N/A (FB) N/A

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
EXPLOSIVES+	N	B	2	1	L	Amb. Glass
PERCH_6850	N	C	1	125	mL	HDPE

ERPIMS Values:

Sacode: N/A

Lot Control#:

Groundwater Information:

Measured Well Depth: 24.60' BTOC **Depth To Water:** 8.73' BTOC

Comments: PID = 0

Temp	pH	ORP	SPC	TURB	DO
22.87°C	5.73	241 mV	0.430 ms/cm	339 NTU	11.75 mg/L

Sketch Location:

SEE BORING LOG

Logged BY / Date: Kelly R Burris 8/18/15

Reviewed BY / Date: BRL 8/18/15

HTRW DRILLING LOG

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

Client: CB&I			Hole Number: 013-HP025
Company Name: Shaw Environmental, Inc.		Drilling Subcontractor: GSE	Sheet: 1 of 4 Sheets
Project: Redstone Arsenal		Location: RSA-013	
Name of Driller: Wesley Casteel		Manufacturer's Designation of Drill: Geoprobe 7822 DT	
Sizes and Types of Drilling and Sampling Equipment: Hand Auger; 2" Macro Core		Surface Elevation: TBD	
		Date Started: 8-17-15	Date Completed: 8-17-15
Overburden Thickness: >25		Depth Groundwater Encountered: Unknown	
Depth Drilled into Rock: 0		Depth to Water and Elapsed Time After Drilling Completed: 23.12' after 10min	
Total Depth of Hole: 25		Other Water Level Measurements (Specify): NA	

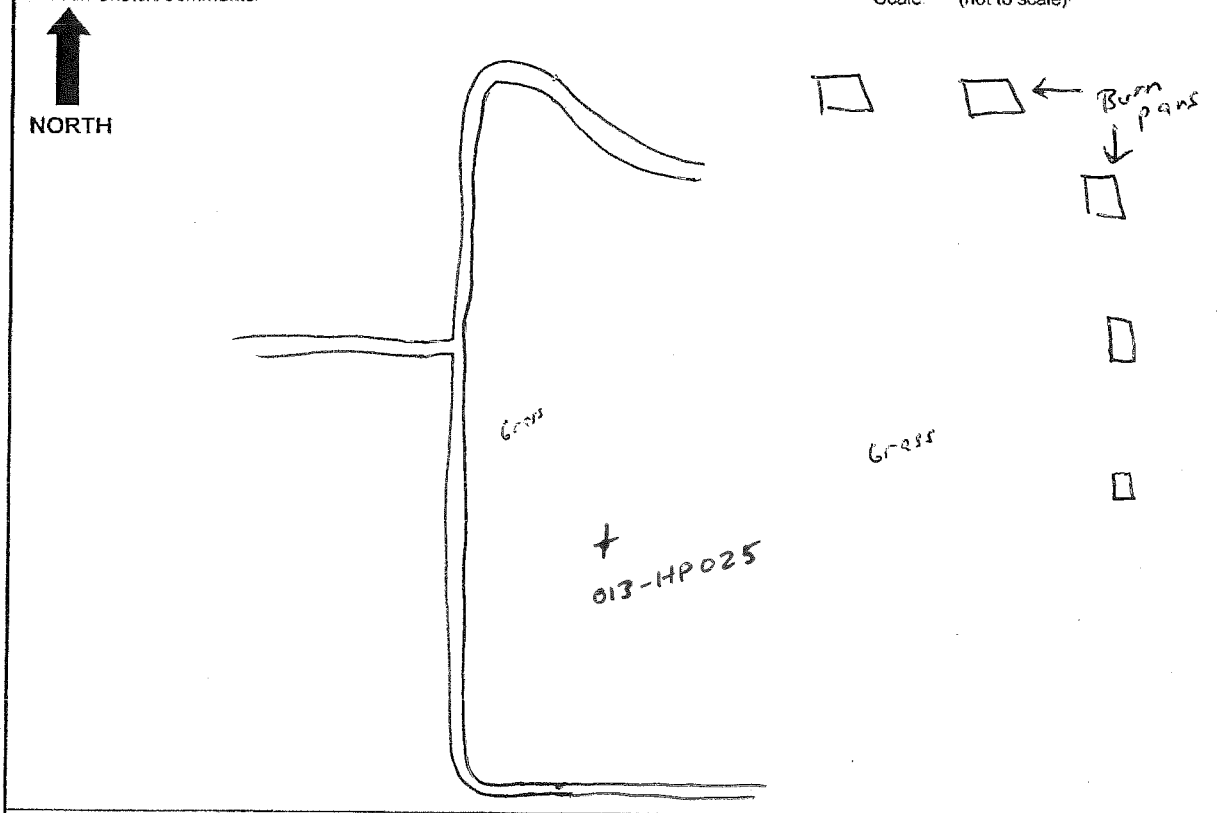
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	V		Explosives, Perch	NA	NA	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	NA	NA	piezometer	L. Ryan Bailey

Location Sketch/Comments:

Scale: (not to scale)



Project	Hole Number
Redstone Arsenal	013-HP025

CB&I

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-HP025

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 2 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	0-5 → yellowish red (5YR 5/6) silty clay w/ some sand med. stiff. med. plast. slightly moist	CL	0-5 0.0	NA ↓	ABG 0170 (0-1)	5/5	Hand Auger to 5 ft.
	1							
	2					ABG 0171 (2-4)		
	3							
	4							
	5	5-10 → Reddish yellow (5YR 6/8) silty clay w/ some sand. med. stiff. med. plast. slightly moist.	CL	5-10 0.0		ABG 0172 (6-8)		
	6							
	7							
	8							
	9							
	10							

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG (continuation sheet)

Hole Number: 013-HP025

Project: Redstone Arsenal | Geologist: R. Bailey | Sheet 3 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	10	10-20 → No lithology per CB&I work plan		10-15 0.0	NA ↓	NA ↓		
	11							
	12							
	13							
	14							
	15			15-20 0.0				
	16							
	17							
	18							
	19							
	20							

Project: RSA | Hole Number: 013-HP025

Shaw Environmental & Infrastructure Inc
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-HP025

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 4 of 4 Sheets

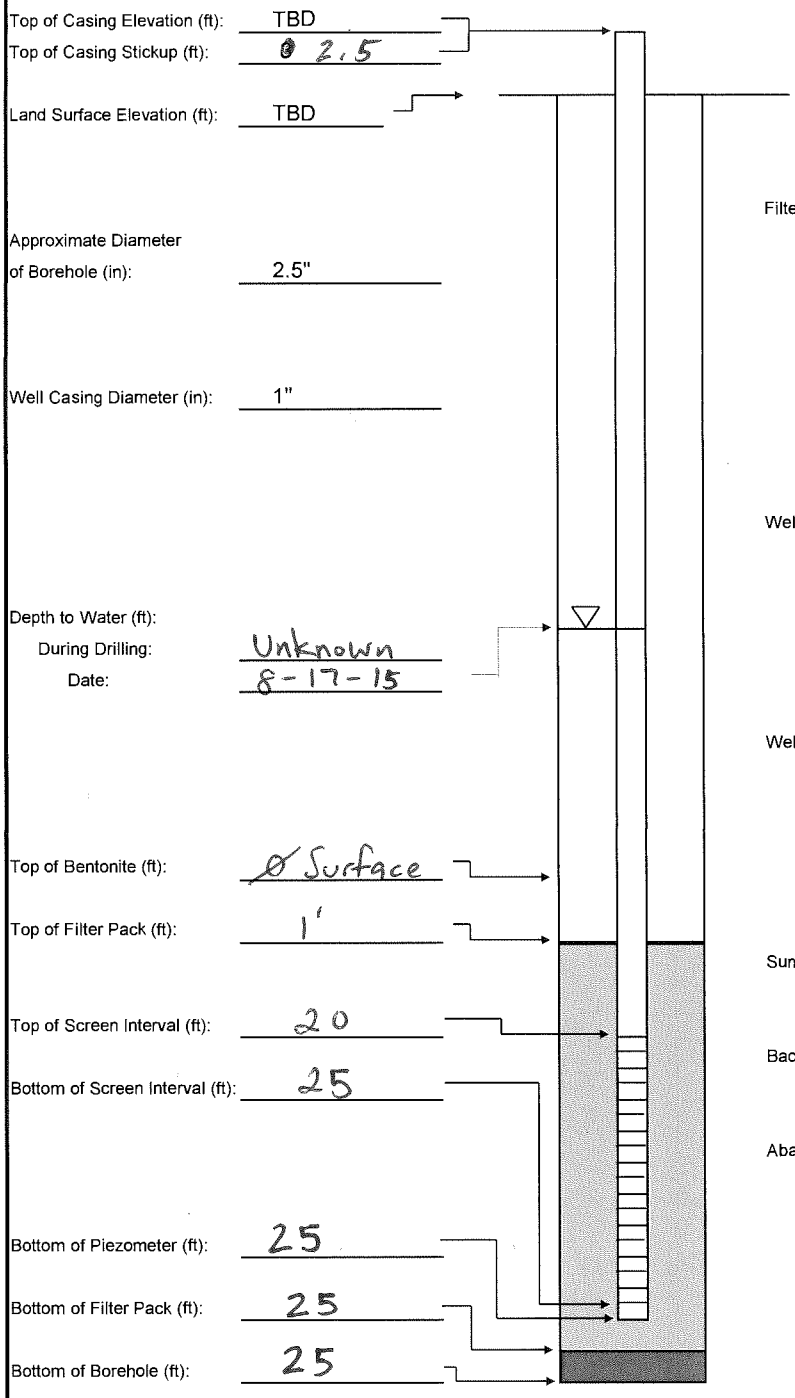
Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	20	20-25 → No lithology per-			NA	NA		
		CB&I Work Plan	CL	20-25				
	21			NA				
	22							
	23							
	24							
	25	Constructed 1" PVC piezometer						
		@ 25 ft						
	26							
				~~25-30~~ RB				
	27							
	28							
	29							
	30							

Project: RSA

Hole Number: 013-HP025

Temporary Piezometer

Project:	Redstone Arsenal	Piezometer Number:	013-HP25
Location:	Huntsville, Madison County, AL	Site Location:	RSA-013
Client:	CB&I	Installation Date	8-17-15
Subcontractor:	GSE	Northing:	TBD
Driller:	Cody Eakin	Easting:	TBD
Field Geologist:	Ryan Bailey	Project Number:	500382



Top of Casing Elevation (ft): TBD
Top of Casing Stickup (ft): 2.5
Land Surface Elevation (ft): TBD
Approximate Diameter of Borehole (in): 2.5"
Well Casing Diameter (in): 1"
Depth to Water (ft): During Drilling: Unknown Date: 8-17-15
Top of Bentonite (ft): Surface
Top of Filter Pack (ft): 1'
Top of Screen Interval (ft): 20
Bottom of Screen Interval (ft): 25
Bottom of Piezometer (ft): 25
Bottom of Filter Pack (ft): 25
Bottom of Borehole (ft): 25

Filter Pack Material:
- Manufacturer: Southern Filter Media
- Product Name: Filter Media
- Size: 20/40
- Installation: Prepacked Screen / Filter Sock / Gravity / Tremie

Well Casing:
- Manufacturer: Mono-Flex
- Type: Sch. 40 PVC
- Diameter (in): 1"

Well Screen Casing:
- Manufacturer: Mono-Flex
- Type: Sch. 40 PVC
- Slot Size (in): 0.010
- Slot Type: Continuous wrap / Factory slot

Sump/End Cap: Point

Backfill Material: N/A

Abandonment:
- Date: TBD
- Procedure: Natural fill / Grouted / Casing Removed / Completed as Well: TBD

Depths and heights are referenced to ground surface unless specified TOC.
All elevations are referenced to MSL (NAVD 88).
If completed as well - see well construction diagram.

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

Sample Collection Log

Project: ~~136973~~ 500382 ~~Redstone~~ PMC (EDM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08182015-S-EMP

Location Code: **013-HP025**
Sample Number: **ABG0170**
Sample Name: **013-HP025-SS-ABG0170-REG**
Sampling Method: **HA**
Sample Type: **SS** *Sample Purpose:* **REG**

Collection Date: **17-AUG-15**
Collection Time: **15:50**
Start Depth: **0**
End Depth: **1**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location: See drilling log

Logged BY / Date: R. Bailey 8-17-15 *Reviewed BY / Date:* [illegible] 8/17/15

Sample Collection Log

Project: ~~136973~~ 500382 Redstone PMC (EDM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08182015-S-EMP

Location Code: **013-HP025**
Sample Number: **ABG0171**
Sample Name: **013-HP025-DS-ABG0171-REG**
Sampling Method: **HA**
Sample Type: **DS** *Sample Purpose:* **REG**

Collection Date: **17-AUG-15**
Collection Time: **16:00**
Start Depth: **2**
End Depth: **4**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-17-15 *Reviewed BY / Date:* BM 8/17/15

Sample Collection Log

500382
Project: ~~136973~~ Redstone PMC (EPM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08182015-S-EMP

Location Code: **013-HP025**
Sample Number: **ABG0172**
Sample Name: **013-HP025-DS-ABG0172-REG**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**

Collection Date: **17-AUG-15**
Collection Time: **16:10**
Start Depth: **6**
End Depth: **8**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location: See drilling log

Logged BY / Date: R. Bailey 8-17-15 *Reviewed BY / Date:* BAL 8/17/15

Sample Collection Log

~~136973~~ 500382 - Redstone PMC
Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG 08192015-W-EMP

Location Code: 013-HP025
Task: 013
Sample Number: ABG3027
Collection Date: 8-18-15
Sample Name: 013-HP025-GW-ABG3027-REG
Collection Time: 1125
Sampling Method: LF
Start Depth: 20' bgs
Sample Type: GW
Sample Purpose: REG
End Depth: 25'
Sampling Equip: PERISTALTIC PUMP
Sample Matrix: WATER

QC Partners:
(TB) N/A (ER) N/A (FB) N/A
Sample Team: KR

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-W	N	A	3	40	mL	GVIAL,SEP
EXPLOSIVES+	N	B	~~2~~ 1	1	L	Amb. Glass
PERCH_6850	N	C	1	125	mL	HDPE

ERPIMS Values:
Sacode: N/A
Lot Control#: N/A

Groundwater Information:
Measured Well Depth: 24.7' BTOC
Depth To Water: 10.38' BTOC

Comments: PID=Ø
INSUFFICIENT WATER FOR WATER QUALITY PARAMETERS & ONLY 1 AMBER (EXPL) COLLECTED

Sketch Location:
SEE BORING LOG

Logged BY / Date: Kelly Robunie 8-18-15
Reviewed BY / Date: [signature] 8/18/15

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

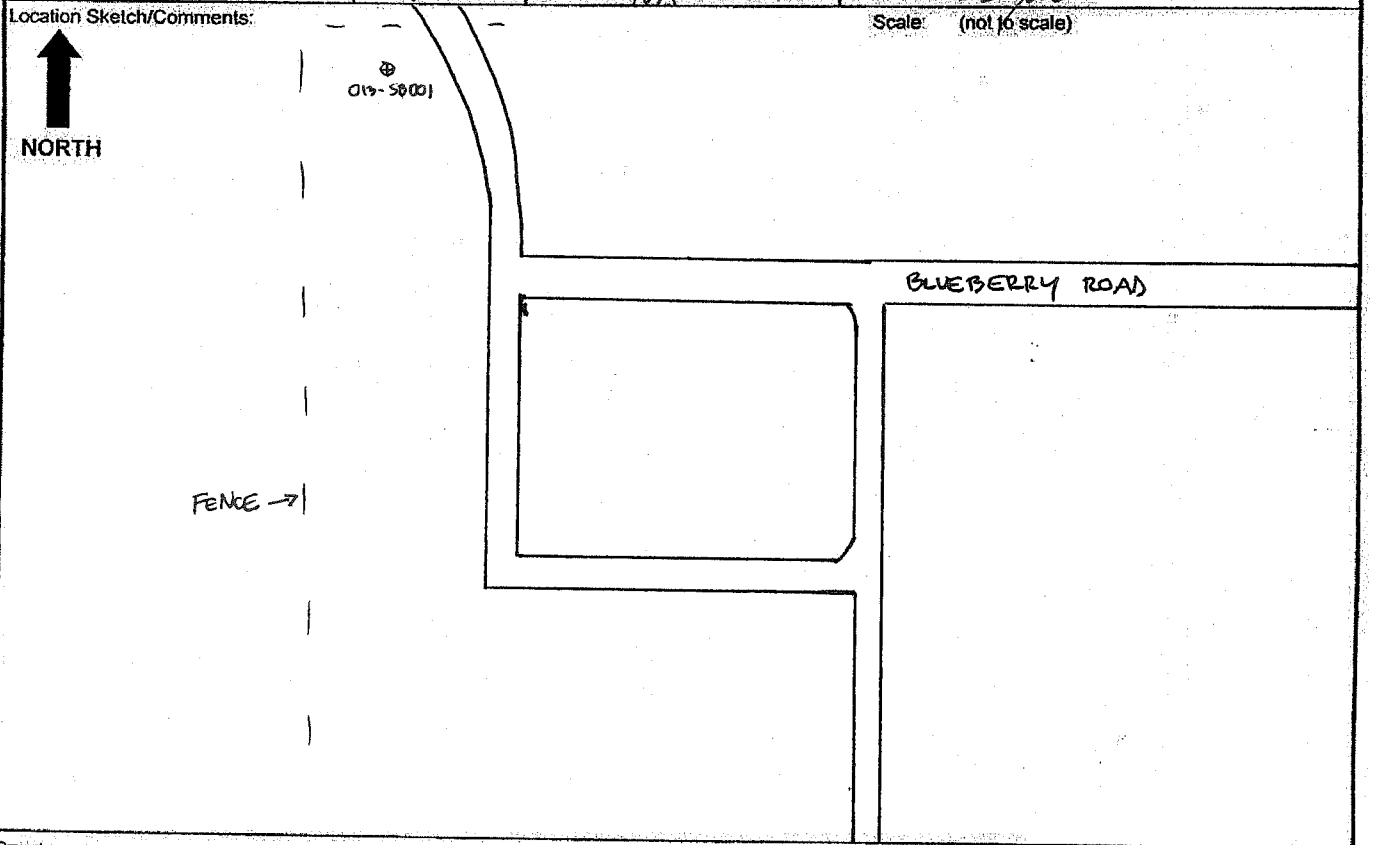
HTRW DRILLING LOG

Client: CB+I			Hole Number: 013-SB001
Company Name: Shaw Environmental, Inc.		Drilling Subcontractor: GSE	Sheet: 1 of 2 Sheets
Project: Redstone Arsenal		Location: RSA-013	
Name of Driller: JUSTIN WINGERTER		Manufacturer's Designation of Drill: GEOPROBE 7822 DT	
Sizes and Types of Drilling and Sampling Equipment: HAND AUGER; 2" MACROCORE		Surface Elevation: TBD	
		Date Started: 2-25-2014	Date Completed: 2-25-2014
Overburden Thickness: 7 10' BGS		Depth Groundwater Encountered: Ø	
Depth Drilled into Rock: Ø		Depth to Water and Elapsed Time After Drilling Completed: NA	
Total Depth of Hole: 10' BGS		Other Water Level Measurements (Specify): NA	

Geotechnical Samples	Disturbed: NA		Undisturbed: NA			Total Number of Core Boxes: NA	
Samples for Chemical Analysis	VOC: ✓	Metals: ✓	Other: THIANES/THIODIGLYCOL	Other: PERCHLORATE	Other: EXPLOSIVES	Total Core Recovery: NA	
Disposition of Hole	Backfilled: BENTONITE	Monitoring Well: NA	Other: NA	Signature of Geologist:			

Location Sketch/Comments:

Scale: (not to scale)



Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG (continuation sheet)

Hole Number: 013-SB001

Project: REDSTONE ARSENAL

Geologist: JULIE SCHENCK BROWN

Sheet 2 of 2 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	SURFACE = GRASS						
		(0-1): DARK YELLOWISH BROWN SILTY CLAY (10 YR 4/4) LOW PLASTICITY LOW STIFFNESS MOIST	OL	(0-5) 0.0	NA ↓	ABG 0031 (0-1)	5/5	HAND AUGER TO 5' BGS
	1	(1-3): YELLOWISH BROWN SILTY CLAY (10YR 5/6) MEDIUM PLASTICITY LOW STIFFNESS 50% MOTTLING (DARK GRAY) MOIST	CL			ABG 0032 (0-1)		
	2							
						ABG 0033 (2-4)		
	3	(3-5): YELLOWISH BROWN SILTY CLAY (10 YR 5/6) LOW PLASTICITY MEDIUM STIFFNESS 30% MOTTLING (GRAY) MANGANESE DEPOSITS SLIGHT MOISTURE	CL					
	4							
	5	(5-10): DARK YELLOWISH BROWN SANDY CLAY (10 YR 4/6) LOW PLASTICITY MEDIUM STIFFNESS 30% MOTTLING (LIGHT RED) VERY FINE SAND VERY SLIGHT MOISTURE	CL	(5-10) 0.0			5/5	
	6					ABG 0034 (6-8)		
	7							
	8							
	9							DPT BORING TERMINATED AT 10' BGS AND BACKFILLED
	10							

Project: RSA

Hole Number: 013-SB001

Shaw
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ~~ABG-02272014-S-EP~~ ABG-022714-S-SAC

Location Code:	013-SB001	*Task:*	013
Sample Number:	ABG0031	*Collection Date:*	2-25-14
Sample Name:	013-SB001-SS-ABG0031-REG	*Collection Time:*	0915
Sampling Method:	HA	*Start Depth:*	0' BGS
Sample Type:	SS *Sample Purpose:* REG	*End Depth:*	1' BGS
Sampling Equip:	HA	*Sample Matrix:*	SOIL

QC Partners:

(TB) NA (ER) NA (FB) NA

Sample Team: JJB, JW, CE

ERPIMS Values:
Sacode: N/A
Lot Control#:

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

Comments: PID = 0.0ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: [signature] 2-25-14

Reviewed BY / Date: [signature] 2-25-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC (SAW)

Manager: ~~Don Burton~~ John Nemu

ABG-022714-S-SAC

RFA / COC Number: ABG-02272014-S-EP

Location Code: **013-SB001**

Sample Number: **ABG0032**

Sample Name: **013-SB001-SS-ABG0032-FD**

Sampling Method: **HA**

Sample Type: **SS** *Sample Purpose:* **FD**

Sampling Equip: HA

Task: **013**

Collection Date: 2-25-14

Collection Time: 0915

Start Depth: 0' BGS

End Depth: 1' BGS

Sample Matrix: **SOIL**

Sample Team: JSB, JW, CE

QC Partners:

(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: [signature] 2-25-14

Reviewed BY / Date: QC 2-25-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nunn

ABG-022714-S-SAC

RFA / COC Number: ABG-02272014-S-EA

Location Code: **013-SB001**

Sample Number: **ABG0033**

Sample Name: **013-SB001-DS-ABG0033-REG**

Sampling Method: **HA**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: HA

Task: **013**

Collection Date: 2-25-14

Collection Time: 0925

Start Depth: 2' BGS

End Depth: 4' BGS

Sample Matrix: **SOIL**

QC Partners:

(TB) NA (ER) NA (FB) NA

Sample Team: JSB, JW, CE

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2-25-14

Reviewed BY / Date: QC 2-25-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nemi

ABG-022714-S-SAC

RFA / COC Number: ABG-0227 2014-S-EP

Location Code: **013-SB001**
Sample Number: **ABG0034**
Sample Name: **013-SB001-DS-ABG0034-REG**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**
Sampling Equip: DP

Task: **013**
Collection Date: 2-25-14
Collection Time: 0930
Start Depth: 6' BGS
End Depth: 8' BGS
Sample Matrix: **SOIL**
Sample Team: JSB, JW, CE

QC Partners:
(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: J. Schuster 2-25-14

Reviewed BY / Date: QC 2-25-14

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

HTRW DRILLING LOG

Client: CB+I			Hole Number: 013-SB002
Company Name: Shaw Environmental, Inc.		Drilling Subcontractor: GSE	Sheet: 1 of 2 Sheets
Project: Redstone Arsenal		Location: RSA-013	
Name of Driller: JUSTIN WINGERTER		Manufacturer's Designation of Drill: GEOPROBE 7822 DT	
Sizes and Types of Drilling and Sampling Equipment: HAND AUGER; 2" MACROCORE		Surface Elevation: TBD	
		Date Started: 2-26-2014	Date Completed: 2-26-2014
Overburden Thickness: > 10' BGS		Depth Groundwater Encountered: Ø	
Depth Drilled into Rock: Ø		Depth to Water and Elapsed Time After Drilling Completed: NA	
Total Depth of Hole: 10' BGS		Other Water Level Measurements (Specify): NA	

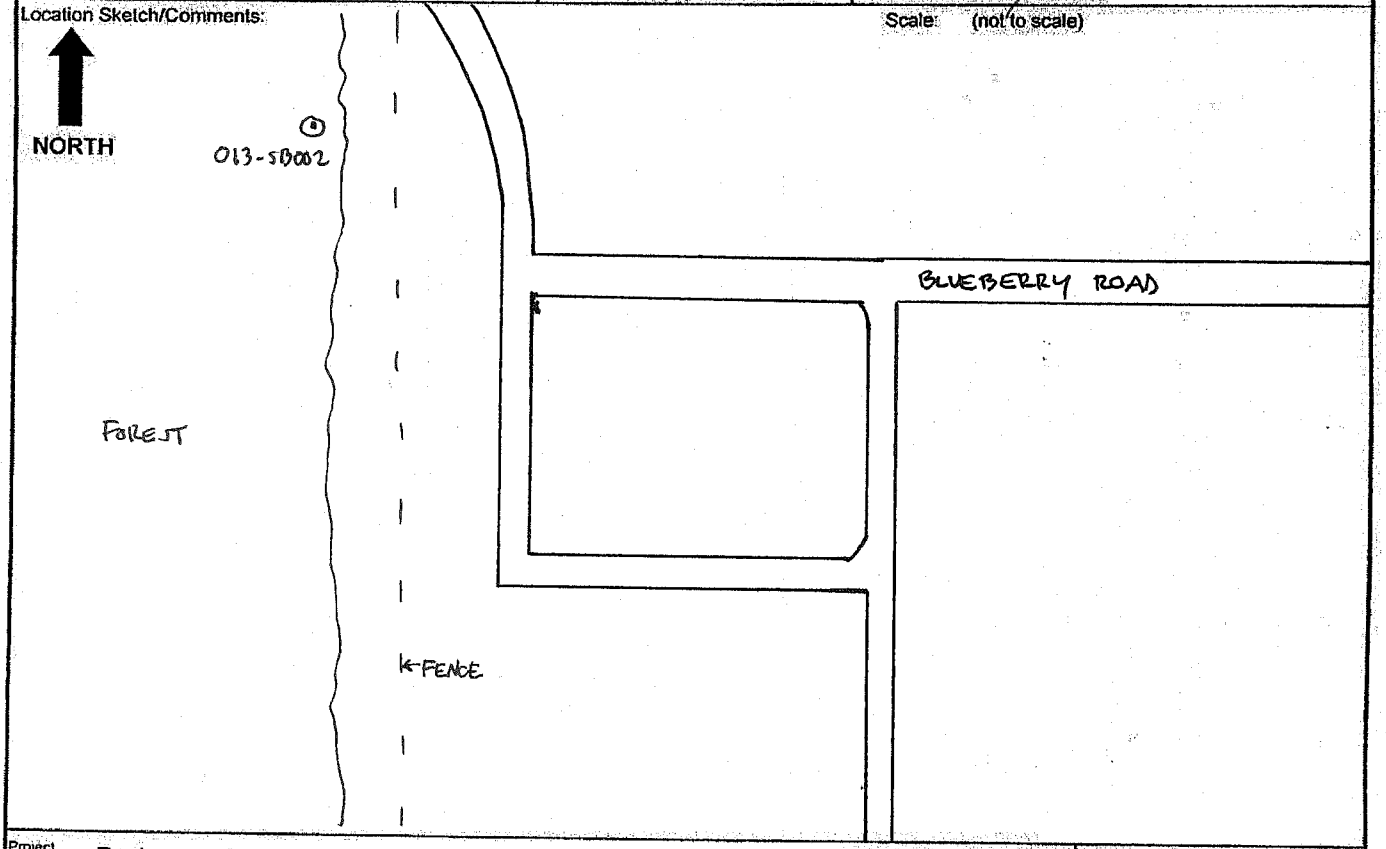
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	✓	✓	THIANES/THIODIGLYCOL	PERCHLORATE	EXPLOSIVES	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	BENTONITE	NA	NA	

Location Sketch/Comments:

Scale: (not to scale)



Project	Hole Number
Redstone Arsenal	013-SB002

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-SB002

Project: REDSTONE ARSENAL

Geologist: JULIE SCHENCK BROWN

Sheet 2 of 2 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	SURFACE = ORGANIC DEBRIS						
		(0-1): BROWN SILTY CLAY (10 YR 4/3) LOW PLASTICITY LOW STIFFNESS MOIST	OL	(0-5) 0.0	NA ↓	ABG 0035 (0-1)	5/5	HAND AUGER TO 5' BGS
	1	(1-2): YELLOWISH BROWN SILTY CLAY (10 YR 5/6) LOW PLASTICITY MEDIUM STIFFNESS SLIGHT MOISTURE	CL					
	2	(2-3): BROWN SILTY CLAY (10 YR 5/3) LOW PLASTICITY MEDIUM-HIGH STIFFNESS VERY SLIGHT MOISTURE	CL			ABG 0036 (2-4)		
	3	(3-5): STRONG BROWN SANDY CLAY (10 YR 5/8) LOW PLASTICITY MEDIUM STIFFNESS VERY FINE SAND 40% MOTTLING (GRAY)	CL					
	4	TRACES OF MAGANESE VERY SLIGHT MOISTURE						
	5	(5-10): STRONG BROWN GRAVELLY CLAY (7.5 YR 4/6) LOW PLASTICITY MEDIUM STIFFNESS	CL	(5-10) 6.0			5/5	
	6	VERY FINE WEATHERED CHERT SLIGHT TRACES OF MAGANESE VERY SLIGHT MOISTURE				ABG 0037 (6-8)		
	7							
	8							
	9							DPT BORING TERMINATED AT 10' BGS AND BACKFILLED WITH BENTONITE
	10							

Project: RSA

Hole Number: 013-SD002

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nenni

ABG-022714-S-SAC

RFA / COC Number: ABG-02272014-S-EA

Location Code: **013-SB002**
Sample Number: **ABG0035**
Sample Name: **013-SB002-SS-ABG0035-REG**
Sampling Method: **HA**
Sample Type: **SS** *Sample Purpose:* **REG**
Sampling Equip: HA

Task: **013**
Collection Date: 2-26-14
Collection Time: 0955
Start Depth: 0' BGS
End Depth: 1' BGS
Sample Matrix: **SOIL**

QC Partners:
(TB) NA (ER) NA (FB) NA

Sample Team: JSB, JW, CE

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2-26-14

Reviewed BY / Date: QC 2-26-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nemi

ABG-022714-S-SAC

RFA / COC Number: ABG-022714-S-EA

Location Code: **013-SB002**

Sample Number: **ABG0036**

Sample Name: **013-SB002-DS-ABG0036-REG**

Sampling Method: **HA**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: HA

QC Partners:

(TB) NA (ER) NA (FB) NA

Task: **013**

Collection Date: 2-26-14

Collection Time: 1000

Start Depth: 2' BGS

End Depth: 4' BGS

Sample Matrix: **SOIL**

Sample Team: JSB, JW, CE

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2-26-14

Reviewed BY / Date: OK 2-26-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

~~T465&?~~ 136973
~~136973~~ - Redstone PMC John Nenni
Manager: ~~Don Burton~~ ~~Mike Higgs~~

RFA / COC Number: ~~ABG-02272014-S-EA~~ ABG-022714-S-SAC

Location Code: 013-SB002

Sample Number: ABG0037

Sample Name: 013-SB002-DS-ABG0037-REG

Sampling Method: DP

Sample Type: DS (JSB)

Sample Purpose: REG

Sampling Equip: ~~HA~~ DP

Task: 013

Collection Date: 2-26-14

Collection Time: 1005

Start Depth: 6' BGS

End Depth: 8' BGS

Sample Matrix: SOIL

Sample Team: JSB, JW, CE

QC Partners:
(TB) NA (ER) NA (FB) NA

ERPIMS Values:
Sacode: N/A
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

Comments: PID= 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: [signature] 2-26-14

Reviewed BY / Date: DOK 2-26-14

HTRW DRILLING LOG

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

Client: CB+I		Hole Number: 013-SB003	
Company Name: Shaw Environmental, Inc.	Drilling Subcontractor: GSE	Sheet: 1 of 2 Sheets	
Project: Redstone Arsenal	Location: RSA-013		
Name of Driller: JUSTIN WINGERTER	Manufacturer's Designation of Drill: GEOPROBE 7822 DT		
Sizes and Types of Drilling and Sampling Equipment: HAND AUGER; 2" MACROCORE	Surface Elevation: TBD		
	Date Started: 2-25-2014	Date Completed: 2-25-2014	
Overburden Thickness: 710' BGS	Depth Groundwater Encountered: Ø		
Depth Drilled into Rock: Ø	Depth to Water and Elapsed Time After Drilling Completed: Ø		
Total Depth of Hole: 10' BGS	Other Water Level Measurements (Specify): NA		

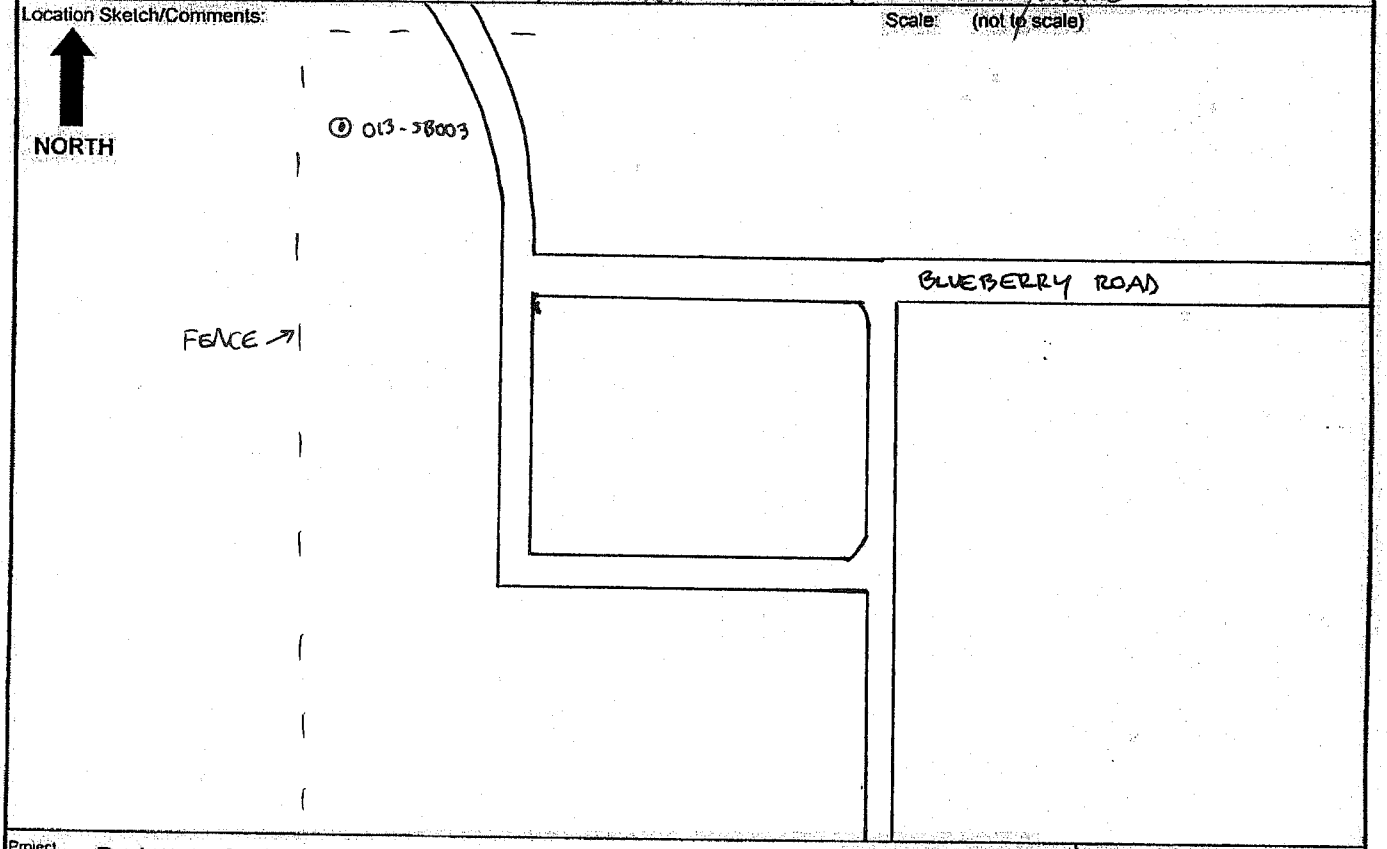
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	✓	✓	THFANES/THIODIGLYCOL	PERCHLORATE	EXPLOSIVES	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	BENTONITE	NA	NA	

Location Sketch/Comments:

Scale: (not to scale)



Project	Hole Number
Redstone Arsenal	013-SB003

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-SB003

Project: REDSTONE ARSENAL

Geologist: JULIE SCHENCK BROWN

Sheet 2 of 2 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	SURFACE = GRASS						
		(0-1): DARK YELLOWISH BROWN SILTY CLAY (10 YR 4/4) LOW PLASTICITY LOW STIFFNESS 30% MOTTLING (GRAY); MOIST	OL	(0-5) 0.0	NA ↓	ABG 0038 (0-1)	5/5	HAND AUGER TO 5' BGS
	1	(1-5) → YELLOWISH BROWN SILTY CLAY (10 YR 5/6) LOW PLASTICITY MEDIUM STIFFNESS 40% MOTTLING (GRAY) STAINING AT 4-5' BGS SLIGHT MOISTURE	CL			ABG 0039 (2-4)		
	2							
	3							
	4							
	5	(5-10): YELLOWISH BROWN GRAVELLY CLAY (10 YR 5/8) LOW PLASTICITY MEDIUM-HIGH STIFFNESS VERY FINE TO FINE WEATHERED GRAVEL 40% MOTTLING (DARK GRAY) TRACES OF MAGANESE SLIGHT MOISTURE	CL	(5-10) 0.0		ABG 0040 (6-8)	5/5	
	6							
	7							
	8							
	9							DPT BORING TERMINATED AT 10' BGS AND BACKFILLED
	10							

Project: RSA

Hole Number: 013-SB003

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC (EPM)

Manager: ~~Don Burton~~ John Nemmi

ABG-0227 14-S-SAC

RFA / COC Number: ABG-0227 2014-S-EP

Location Code: 013-SB003
Sample Number: ABG0038
Sample Name: 013-SB003-SS-ABG0038-REG
Sampling Method: HA
Sample Type: SS *Sample Purpose:* REG
Sampling Equip: HA

QC Partners:
(TB) NA (ER) NA (FB) NA

Task: 013
Collection Date: 2-25-14
Collection Time: 1015
Start Depth: 0' BGS
End Depth: 1' BGS
Sample Matrix: SOIL
Sample Team: JSB, JW, CE

ERPIMS Values:
Sacode: N/A
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

Comments: PID = 0.0ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: [signature] 2-25-14

Reviewed BY / Date: QC 2-25-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: ~~Don Burton~~ John Nimmo

ABG-022714-S-S1C
RFA / COC Number: ABG-0227014-S-EP

Location Code: **013-SB003**
Sample Number: **ABG0039**
Sample Name: **013-SB003-DS-ABG0039-REG**
Sampling Method: **HA**
Sample Type: **DS** *Sample Purpose:* **REG**
Sampling Equip: HA
QC Partners:
(TB) NA (ER) NA (FB) NA

Task: **013**
Collection Date: 2-25-14
Collection Time: 1020
Start Depth: 2' BGS
End Depth: 4' BGS
Sample Matrix: **SOIL**
Sample Team: JSB, JW, CE

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: [signature] 2-25-14
Reviewed BY / Date: OK 2-25-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nemi

ABG-022714-S-SAC

RFA / COC Number: ABG-0227 2014-S-EP

Location Code: **013-SB003**
Sample Number: **ABG0040**
Sample Name: **013-SB003-DS-ABG0040-REG**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**
Sampling Equip: DP

Task: **013**
Collection Date: 2-25-14
Collection Time: 1025
Start Depth: 6 'BGS
End Depth: 8 'BGS
Sample Matrix: **SOIL**

QC Partners:
(TB) NA (ER) NA (FB) NA

Sample Team: JSB, JW, CE

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2-25-14

Reviewed BY / Date: 2-25-14

HTRW DRILLING LOG

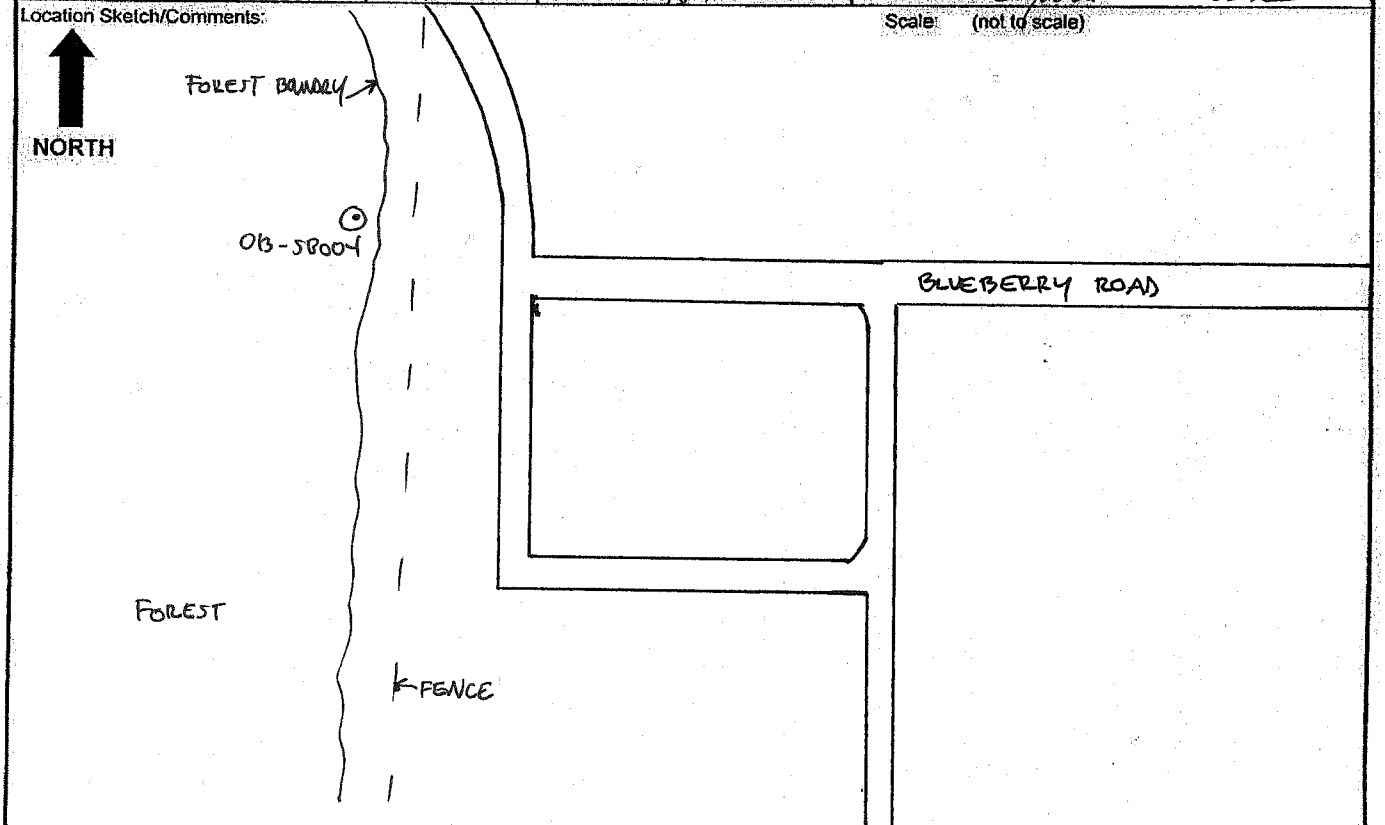
Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

Client: CB+I			Hole Number: 013-SB004
Company Name: Shaw Environmental, Inc.		Drilling Subcontractor: GSE	Sheet: 1 of 2 Sheets
Project: Redstone Arsenal		Location: RSA-013	
Name of Driller: JUSTIN WINGERTER		Manufacturer's Designation of Drill: GEOPROBE 7822 DT	
Sizes and Types of Drilling and Sampling Equipment: HAND AUGER; 2" MACROCORE		Surface Elevation: TBD	
		Date Started: 2-25-2014	Date Completed: 2-25-2014
Overburden Thickness: > 10' BGS		Depth Groundwater Encountered: Ø	
Depth Drilled into Rock: Ø		Depth to Water and Elapsed Time After Drilling Completed: NA	
Total Depth of Hole: 10' BGS		Other Water Level Measurements (Specify): NA	

Geotechnical Samples	Disturbed: NA	Undisturbed: NA	Total Number of Core Boxes: NA				
Samples for Chemical Analysis	VOC: ✓	Metals: ✓	Other: THIANES/THIODIGLYCOL	Other: PERCHLORATE	Other: EXPLOSIVES	Total Core Recovery: NA	
Disposition of Hole	Backfilled: BENTONITE	Monitoring Well: NA	Other: NA	Signature of Geologist:			

Location Sketch/Comments:

Scale: (not to scale)



Project: Redstone Arsenal		Hole Number: 013-SB004

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-SB004

Project: REDSTONE ARSENAL

Geologist: JULIE SCHENCK BROWN

Sheet 2 of 2 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	SURFACE = ORGANIC DEBRIS						
		(0-1): DARK YELLOWISH BROWN SILTY CLAY (10 YR 4/6) LOW PLASTICITY LOW STIFFNESS MOIST	OL	(0-5)	NA ↓	ABG 0041 (0-1)	5/5	HAND AUGER TO 5' BGS
	1	(1-5): YELLOWISH BROWN SILTY CLAY (10 YR 5/8) LOW PLASTICITY MEDIUM - HIGH STIFFNESS	CL					
	2	30% MOTTLING (GRAYISH TAN) MANGANESE DEPOSITS (1-5') WITH HEAVY STAINING AT 4-5' SLIGHT MOISTURE				ABG 0042 0043 (2-4)		
	3							
	4							
	5	(5-10): DARK YELLOWISH BROWN SANDY CLAY (10 YR 4/4)	CL	(5-10)				
	6	LOW PLASTICITY MEDIUM - HIGH STIFFNESS VERY FINE SAND 30% MOTTLING (GRAYISH TAN) MANGANESE DEPOSITS WITH						
	7	HEAVY STAINING AT 8-10 BGS SLIGHT MOISTURE				ABG 0044 (6-8)		
	8							
	9							
	10							

Project: RSA

Hole Number: 013-SB004

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nemi

ABG-022714-S-SAC

RFA / COC Number: ABG-022714-S-EP

Location Code: **013-SB004**

Sample Number: **ABG0041**

Sample Name: **013-SB004-SS-ABG0041-REG**

Sampling Method: **HA**

Sample Type: **SS** *Sample Purpose:* **REG**

Sampling Equip: HA

QC Partners:

(TB) NA (ER) NA (FB) NA

Task: **013**

Collection Date: 2-25-14

Collection Time: 1530

Start Depth: 0' BGS

End Depth: 1' BGS

Sample Matrix: **SOIL**

Sample Team: JSB, JW, CE

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2-25-14

Reviewed BY / Date: QC 2-25-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Ninni

ABG-022714-6-SAC

RFA / COC Number: ABG-0227201 4-S-EP

Location Code: **013-SB004**

Sample Number: **ABG0042**

Sample Name: **013-SB004-DS-ABG0042-REG**

Sampling Method: **HA**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: HA

QC Partners:

(TB) NA (ER) NA (FB) NA

Task: **013**

Collection Date: 2-25-14

Collection Time: 1535

Start Depth: 2' BGS

End Depth: 4' BGS

Sample Matrix: **SOIL**

Sample Team: JSB, JW, CE

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2-25-14

Reviewed BY / Date: 2-25-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Ninni

ABG-022712-S-SAC

RFA / COC Number: ABG-0227201 4-S-EP

Location Code: **013-SB004**
Sample Number: **ABG0043**
Sample Name: **013-SB004-DS-ABG0043-FD**
Sampling Method: **HA**
Sample Type: **DS** *Sample Purpose:* **FD**
Sampling Equip: HA

Task: **013**
Collection Date: 2-25-14
Collection Time: 1535
Start Depth: 2 'BGS
End Depth: 4 'BGS
Sample Matrix: **SOIL**

QC Partners:
(TB) NA (ER) NA (FB) NA

Sample Team: JSB, JW, CE

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2-25-14

Reviewed BY / Date: 2-25-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nenni

ABG-022714-S-SAC

RFA / COC Number: ABG-02272014-S-EP

Location Code: **013-SB004**

Sample Number: **ABG0044**

Sample Name: **013-SB004-DS-ABG0044-REG**

Sampling Method: **DP**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: DP

QC Partners:

(TB) NA (ER) NA (FB) NA

Task: **013**

Collection Date: 2-25-14

Collection Time: 1540

Start Depth: 6' BGS

End Depth: 8' BGS

Sample Matrix: **SOIL**

Sample Team: JSD, JW, CE

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: J. Schulz 2-25-14

Reviewed BY / Date: OQK 2-25-14

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

HTRW DRILLING LOG

Client: CB+I			Hole Number: 013-SB005
Company Name: Shaw Environmental, Inc.		Drilling Subcontractor: GSE	Sheet: 1 of 2 Sheets
Project: Redstone Arsenal		Location: RSA-013	
Name of Driller: JUSTIN WINGERTER		Manufacturer's Designation of Drill: GEOPROBE 7822 DT	
Sizes and Types of Drilling and Sampling Equipment: HAND AUGER; 2" MACROCORE		Surface Elevation: TBD	
		Date Started: 2-25-2014	Date Completed: 2-25-2014
Overburden Thickness: 7/10' BGS		Depth Groundwater Encountered: Ø	
Depth Drilled into Rock: Ø		Depth to Water and Elapsed Time After Drilling Completed: Ø	
Total Depth of Hole: 10' BGS		Other Water Level Measurements (Specify): NA	

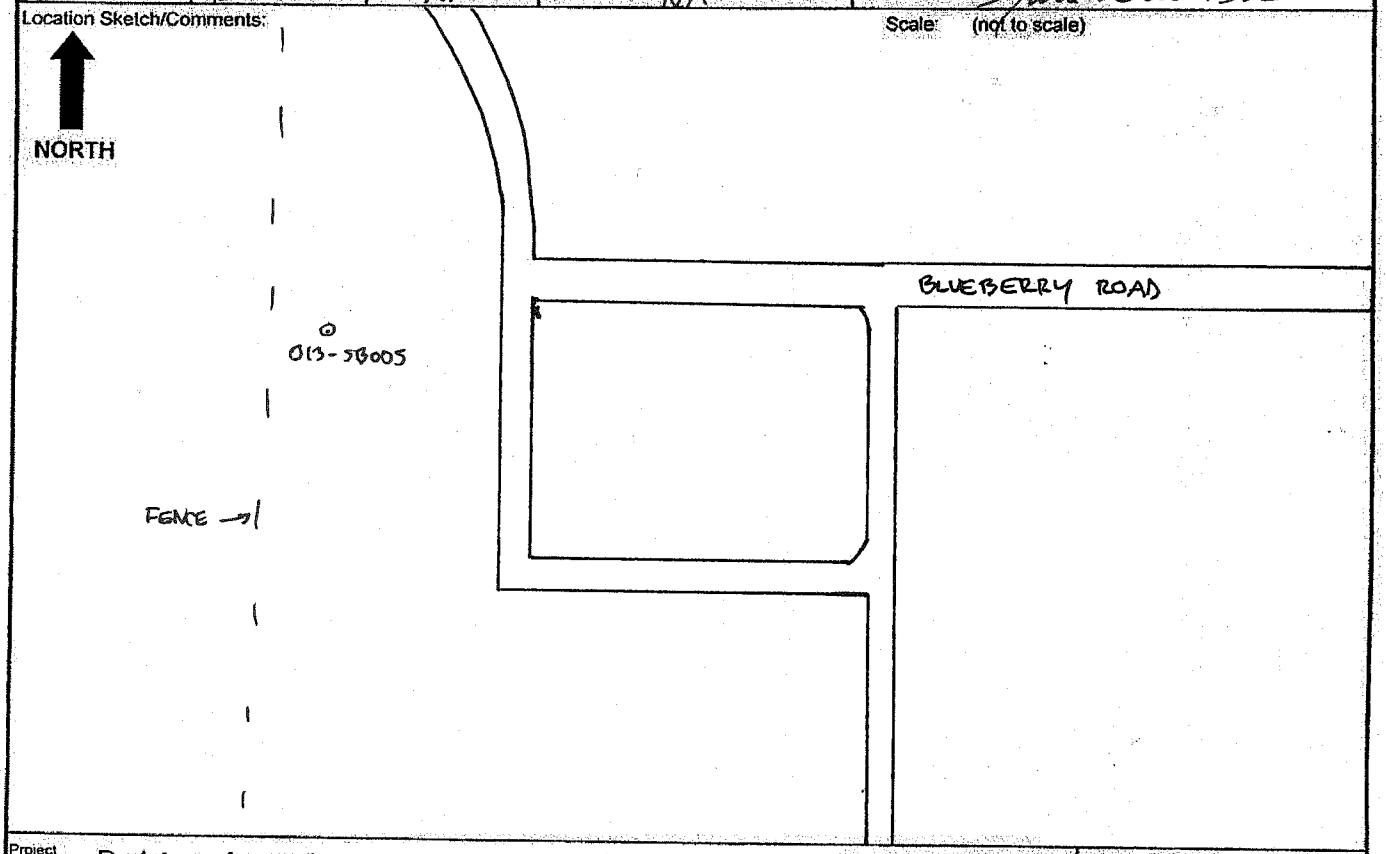
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	✓	✓	THIANES/THIODIGLYCOL	PERCHLORATE	EXPLOSIVES	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	BENTONITE	NA	NA	

Location Sketch/Comments:

Scale: (not to scale)



Project	Hole Number
Redstone Arsenal	013-SB005

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-SB005

Project: REDSTONE ARSENAL

Geologist: JULIE SCHENCK BROWN

Sheet 2 of 2 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	SURFACE = GRASS						
		(0-1): YELLOWISH RED SILTY CLAY (5YR 4/6) LOW PLASTICITY LOW STIFFNESS MOIST	CL	(0-5) 0.0	NA ↓	ABH 0045 (0-1)	5/5	HAND AUGER TO 5' BGS
	1	(1-5): DARK YELLOWISH BROWN SANDY CLAY (10 YR 4/6) LOW PLASTICITY MEDIUM STIFFNESS VERY FINE SAND 40% MOTTLING (LIGHT GRAY) HEAVY MAGANESE DEPOSITS AND STAINING SLIGHT MOISTURE	CL					
	2					ABH 0046 0046-MS 0046-MSD (2-4)		
	3							
	4							
	5	(5-10): DARK YELLOWISH BROWN SANDY CLAY (10YR 4/6) LOW PLASTICITY MEDIUM STIFFNESS VERY FINE SAND 20% MOTTLING (LIGHT GRAY) MAGANESE DEPOSITS VERY SLIGHT MOISTURE	CL	(5-10) 0.0			5/5	
	6					ABH 0047 (6-8)		
	7							
	8							
	9							DPT BORING TERMINATED AT 10' BGS AND BACKFILLED
	10							

Project: RSA

Hole Number: 013-SB005

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: ~~Don Burton~~ John Nenni

ABG-022714-S-SAC
RFA / COC Number: ABG-0227014-S-EP

Location Code: **013-SB005**
Sample Number: **ABG0045**
Sample Name: **013-SB005-SS-ABG0045-REG**
Sampling Method: **HA**
Sample Type: **SS** *Sample Purpose:* **REG**
Sampling Equip: HA

Task: **013**
Collection Date: 2-25-14
Collection Time: 1115
Start Depth: 0' BGS
End Depth: 1' BGS
Sample Matrix: **SOIL**
Sample Team: JSB, JW, CE

QC Partners:
(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID= 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2-25-14
Reviewed BY / Date: OK 2-25-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: ~~Don Burton~~ John Nemi

ABG-022714-S-SAC
RFA / COC Number: ABG-0227 2014-S-EP

Location Code: **013-SB005**
Sample Number: **ABG0046**
Sample Name: **013-SB005-DS-ABG0046-REG**
Sampling Method: **HA**
Sample Type: **DS** *Sample Purpose:* **REG**
Sampling Equip: HA

Task: **013**
Collection Date: 2-25-14
Collection Time: 1120
Start Depth: 2' BGS
End Depth: 4' BGS
Sample Matrix: **SOIL**

QC Partners:
(TB) NA (ER) NA (FB) NA

Sample Team: JSB, JW, CE

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: [signature] 2-25-14

Reviewed BY / Date: OK 2-25-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: ~~Don Burton~~ John Nenn

ABG-022714-5-SAC
RFA / COC Number: ABG-0227 2014-5-EP

Location Code: **013-SB005**
Sample Number: **ABG0046-MS**
Sample Name: **013-SB005-DS-ABG0046-MS**
Sampling Method: **HA**
Sample Type: **DS** *Sample Purpose:* **MS**
Sampling Equip: HA

Task: **013**
Collection Date: 2-25-14
Collection Time: 1120
Start Depth: 2' BGS
End Depth: 4' BGS
Sample Matrix: **SOIL**

QC Partners:
(TB) NA (ER) NA (FB) NA

Sample Team: JSB, JW, CE

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: [signature] 2-25-14

Reviewed BY / Date: OK 2-25-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nenni

ABG-022714-S-SAC

RFA / COC Number: ABG-0227 2014-S-EA

Location Code: **013-SB005**

Sample Number: **ABG0046-MSD**

Sample Name: **013-SB005-DS-ABG0046-MSD**

Sampling Method: **HA**

Sample Type: **DS** *Sample Purpose:* **MSD**

Sampling Equip: HA

QC Partners:

(TB) NA (ER) NA (FB) NA

Task: **013**

Collection Date: 2-25-14

Collection Time: 1120

Start Depth: 2' BGS

End Depth: 4' BGS

Sample Matrix: **SOIL**

Sample Team: JSB, JW, CE

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2-25-14

Reviewed BY / Date: OK 2-25-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nimmo

ABG-022714-S-SAC

RFA / COC Number: ABG-0227201 4-S-EP

Location Code: **013-SB005**
Sample Number: **ABG0047**
Sample Name: **013-SB005-DS-ABG0047-REG**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**
Sampling Equip: DP

Task: **013**
Collection Date: 2-25-14
Collection Time: 1125
Start Depth: 6' BGS
End Depth: 8' BGS
Sample Matrix: **SOIL**

QC Partners:
(TB) NA (ER) NA (FB) NA

Sample Team: JJB, JW, CE

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID = 0.0ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2-25-14

Reviewed BY / Date: OK 2-25-14

HTRW DRILLING LOG

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

Client	CB+I	Hole Number	013-SB006
Company Name	Shaw Environmental, Inc.	Drilling Subcontractor	GSE
		Sheet	1 of 2 Sheets
Project	Redstone Arsenal	Location	RSA-013
Name of Driller	JUSTIN WINGERTER	Manufacturer's Designation of Drill	GEOPROBE 7822 DT
Sizes and Types of Drilling and Sampling Equipment	HAND AUGER 2" MACROCORE	Surface Elevation	TBD
		Date Started	2-25-2014
		Date Completed	2-25-2014
Overburden Thickness	~10' BGS	Depth Groundwater Encountered	Ø
Depth Drilled into Rock	Ø	Depth to Water and Elapsed Time After Drilling Completed	NA
Total Depth of Hole	10' BGS	Other Water Level Measurements (Specify)	NA

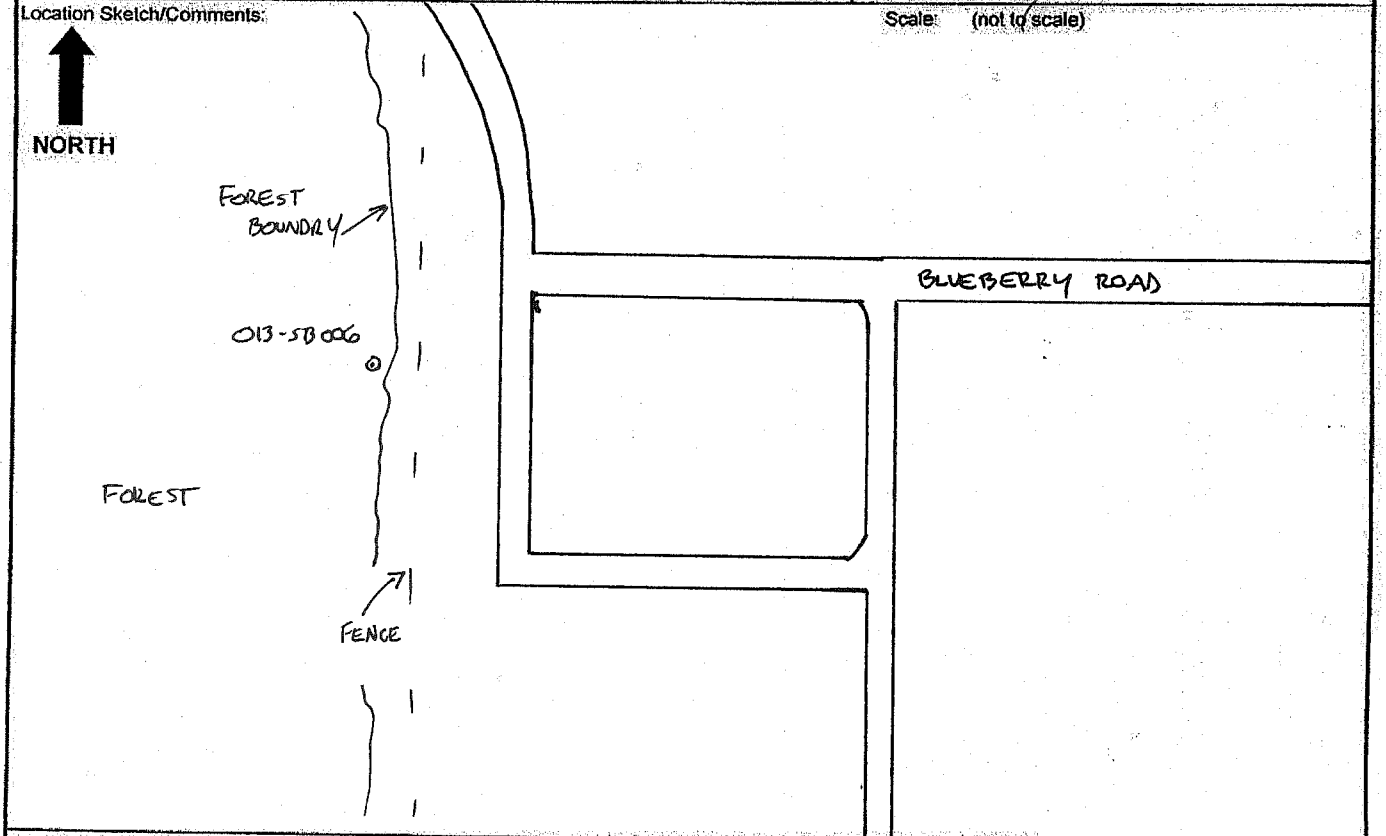
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	✓	✓	THIANES/THIODIGLYCOL	PERCHLORATE	EXPLOSIVES	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	BENTONITE	NA	NA	

Location Sketch/Comments:

Scale: (not to scale)



Project	Hole Number
Redstone Arsenal	013-SB006

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-SB006

Project: REDSTONE ARSENAL

Geologist: JULIE SCHENCK BROWN

Sheet 2 of 2 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	SURFACE = ORGANICS						
		(0-1): DARK YELLOWISH BROWN SANDY CLAY (10 YR 4/6) MEDIUM PLASTICITY LOW STIFFNESS VERY FINE SAND MOIST	CL	(0-5) 0.0	NA ↓	ABG 0048 (0-1)	5/5	HAND AUGER TO 5' BGS
	1	(1-5): DARK YELLOWISH BROWN SANDY CLAY (10 YR 4/6) LOW PLASTICITY MEDIUM-HIGH STIFFNESS VERY FINE SAND	CL					
	2	30% MOTTLING (PALE BROWN) MANGANESE DEPOSITS SLIGHT MOISTURE				ABG 0049 (2-4)		
	3							
	4							
	5	(5-10): DARK YELLOWISH BROWN SANDY CLAY (10 YR 4/4) LOW PLASTICITY HIGH STIFFNESS	CL	(5-10) 0.0			5/5	
	6	30% MOTTLING (TAN) VERY FINE SAND MANGANESE DEPOSITS AND HEAVY STAINING						
	7	VERY SLIGHT MOISTURE				ABG 0050 (6-8)		
	8							
	9							DPT BORING TERMINATED AT 10' BGS AND BACKFILLED
	10							

Project: RSA

Hole Number: 013-SB006

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nenni

ABG-022714-S-SAC

RFA / COC Number: ABG-0227 2014-S-EP

Location Code: **013-SB006**

Sample Number: **ABG0048**

Sample Name: **013-SB006-SS-ABG0048-REG**

Sampling Method: **HA**

Sample Type: **SS** *Sample Purpose:* **REG**

Sampling Equip: HA

QC Partners:

(TB) NA (ER) NA (FB) NA

Task: **013**

Collection Date: 2-25-14

Collection Time: 1430

Start Depth: 0' BGS

End Depth: 1' BGS

Sample Matrix: **SOIL**

Sample Team: JSB, JW, CE

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2-25-14

Reviewed BY / Date: OK 2-25-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nenni

ABG-022714-S-SAC

RFA / COC Number: ABG-02272014-S-EP

Location Code: **013-SB006**

Sample Number: **ABG0049**

Sample Name: **013-SB006-DS-ABG0049-REG**

Sampling Method: **HA**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: HA

Task: **013**

Collection Date: 2-25-14

Collection Time: 1435

Start Depth: 2' BGS

End Depth: 4' BGS

Sample Matrix: **SOIL**

QC Partners:

(TB) NA (ER) NA (FB) NA

Sample Team: JSB, JW, CE

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 6.0ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2-25-14

Reviewed BY / Date: OK 2-25-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG-022714-S-EP ABG-0227014-S-EP

Location Code: **013-SB006**
Sample Number: **ABG0050**
Sample Name: **013-SB006-DS-ABG0050-REG**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**
Sampling Equip: DP

Task: **013**
Collection Date: 2-25-14
Collection Time: 1440
Start Depth: 6' BGS
End Depth: 8' BGS
Sample Matrix: **SOIL**

QC Partners:
(TB) NA (ER) NA (FB) NA

Sample Team: JSB, JW, CE

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2-25-14

Reviewed BY / Date: 2-25-14 OK

HTRW DRILLING LOG

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

Client: CB+I		Hole Number: 013-SB007	
Company Name: Shaw Environmental, Inc.	Drilling Subcontractor: GSE	Sheet: 1 of 2 Sheets	
Project: Redstone Arsenal	Location: RSA-013		
Name of Driller: JUSTIN WINGERTER	Manufacturer's Designation of Drill: GEOPROBE 7822 DT		
Sizes and Types of Drilling and Sampling Equipment: HAND AUGER; 2" MACROCORE	Surface Elevation: TBD		
	Date Started: 2-28-2014	Date Completed: 2-28-2014	
Overburden Thickness: 7.10' BGS	Depth Groundwater Encountered: Ø		
Depth Drilled into Rock: Ø	Depth to Water and Elapsed Time After Drilling Completed: NA		
Total Depth of Hole: 10' BGS	Other Water Level Measurements (Specify): NA		

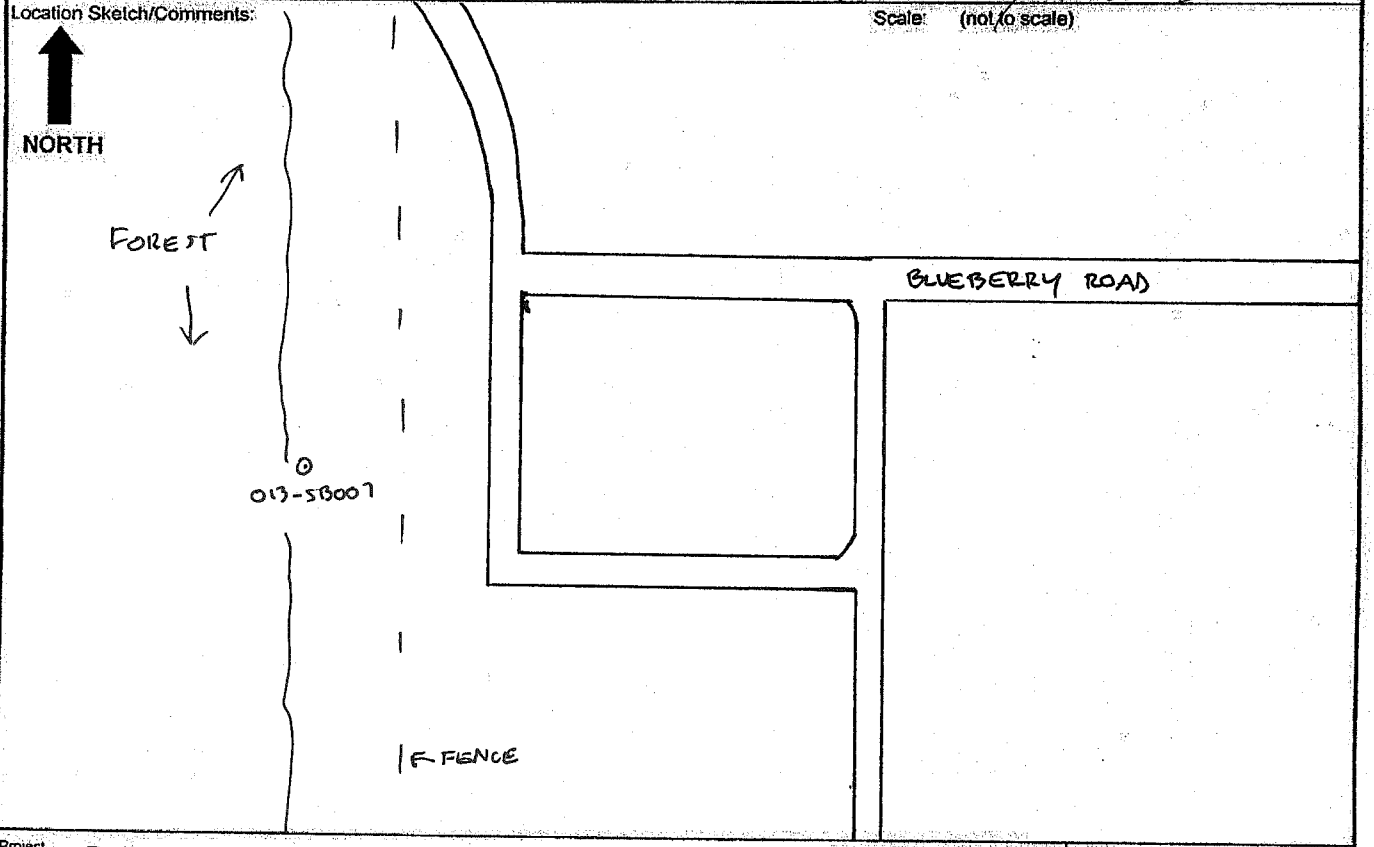
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	✓	✓	THIANES/THIODIGLYCOL	PERCHLORATE	EXPLOSIVES	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	BENTONITE	NA	NA	

Location Sketch/Comments:

Scale: (not to scale)



Project: Redstone Arsenal	Hole Number: 013-SB007

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-SB007

Project: REDSTONE ARSENAL

Geologist: JULIE SCHENCK BROWN

Sheet 2 of 2 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	SURFACE = GRASS						
		(0-1): DARK BROWN SILTY CLAY (10 YR 3/3) LOW PLASTICITY LOW STIFFNESS MOIST	OL	(0-5) 0.0	NA ↓	ABG 0051 (0-1)	5/5	HAND AUGER TO 5' BGS
	1	(1-5): DARK YELLOWISH BROWN SILTY CLAY (10 YR 4/6) LOW PLASTICITY MEDIUM STIFFNESS 20% MOTTLING (LIGHT GRAY) MANGANESE DEPOSITS SLIGHT MOISTURE	CL					
	2					ABG 0052		
	3					ABG 0053 (2-4)		
	4							
	5	(5-10): DARK YELLOWISH BROWN SANDY CLAY (10 YR 4/4) LOW PLASTICITY MEDIUM - HIGH STIFFNESS VERY FINE SAND FINE WEATHERED CHERT 10% MOTTLING (TAN) MANGANESE DEPOSITS SLIGHT MOISTURE	CL	(5-10) 6.0			5/5	
	6							
	7					ABG 0054 (6-8)		
	8							
	9							
	10							DPT BORING TERMINATED AT 10' BGS AND BACKFILLED

Project: RSA

Hole Number: 013-SB007

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC EPM
Manager: ~~Don Burton~~ John Nenni

ABG-030414-S-SAC
RFA / COC Number: ABG-03042014-S-EP

Location Code: **013-SB007**
Sample Number: **ABG0051**
Sample Name: **013-SB007-SS-ABG0051-REG**
Sampling Method: **HA**
Sample Type: **SS** *Sample Purpose:* **REG**
Sampling Equip: HA

Task: **013**
Collection Date: 2-28-14
Collection Time: 1400
Start Depth: 0' BGS
End Depth: 1' BGS
Sample Matrix: **SOIL**
Sample Team: JSD, JW

QC Partners:
(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

} SAC

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2-28-14

Reviewed BY / Date: 2-28-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nimmi

ABG-03042014-S-SAC

RFA / COC Number: ABG-03042014-S-EP

Location Code: **013-SB007**

Sample Number: **ABG0052**

Sample Name: **013-SB007-DS-ABG0052-REG**

Sampling Method: **HA**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: HA

QC Partners:

(TB) NA (ER) NA (FB) NA

Task: **013**

Collection Date: 2-28-14

Collection Time: 1405

Start Depth: 2' BGS

End Depth: 4' BGS

Sample Matrix: **SOIL**

Sample Team: JSB, JW

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: [signature] 2-28-14

Reviewed BY / Date: OK 2-28-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: ~~Don Burton~~ John Nenni

ABG-03042014-S-SAC
RFA / COC Number: ABG-03042014-S-EP

Location Code: **013-SB007**
Sample Number: **ABG0053**
Sample Name: **013-SB007-DS-ABG0053-FD**
Sampling Method: **HA**
Sample Type: **DS** *Sample Purpose:* **FD**
Sampling Equip: HA

Task: **013**
Collection Date: 2-28-14
Collection Time: 1405
Start Depth: 2' BGS
End Depth: 4' BGS
Sample Matrix: **SOIL**

QC Partners:
(TB) NA (ER) NA (FB) NA

Sample Team: JJB, JW

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: [signature] 2-28-14

Reviewed BY / Date: [signature] 2-26-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: ~~Don Burton~~ John Nenni

ABG-03042014-S-SAC
RFA / COC Number: ABG-03042014-S-EP

Location Code: 013-SB007
Sample Number: ABG0054
Sample Name: 013-SB007-DS-ABG0054-REG
Sampling Method: DP
Sample Type: DS *Sample Purpose:* REG
Sampling Equip: DP

Task: 013
Collection Date: 2-28-14
Collection Time: 1415
Start Depth: 6' BGS
End Depth: 8' BGS
Sample Matrix: SOIL

QC Partners:
(TB) NA (ER) NA (FB) NA

Sample Team: JSB, JW

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:
SEE DRILLING LOG.

Logged BY / Date: 2-28-14
Reviewed BY / Date: 2-28-14

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

HTRW DRILLING LOG

Client: CB+I			Hole Number: 013-SB008
Company Name: Shaw Environmental, Inc.		Drilling Subcontractor: GSE	Sheet: 1 of 2 Sheets
Project: Redstone Arsenal		Location: RSA-013	
Name of Driller: JUSTIN WINGERTER		Manufacturer's Designation of Drill: GEOPROBE 7822 DT	
Sizes and Types of Drilling and Sampling Equipment: HAND AUGER; 2" MACROCORE		Surface Elevation: TBD	
		Date Started: 2-28-2014	Date Completed: 2-28-2014
Overburden Thickness: >10' BGS		Depth Groundwater Encountered: ∅	
Depth Drilled into Rock: ∅		Depth to Water and Elapsed Time After Drilling Completed: NA	
Total Depth of Hole: 10' BGS		Other Water Level Measurements (Specify): NA	

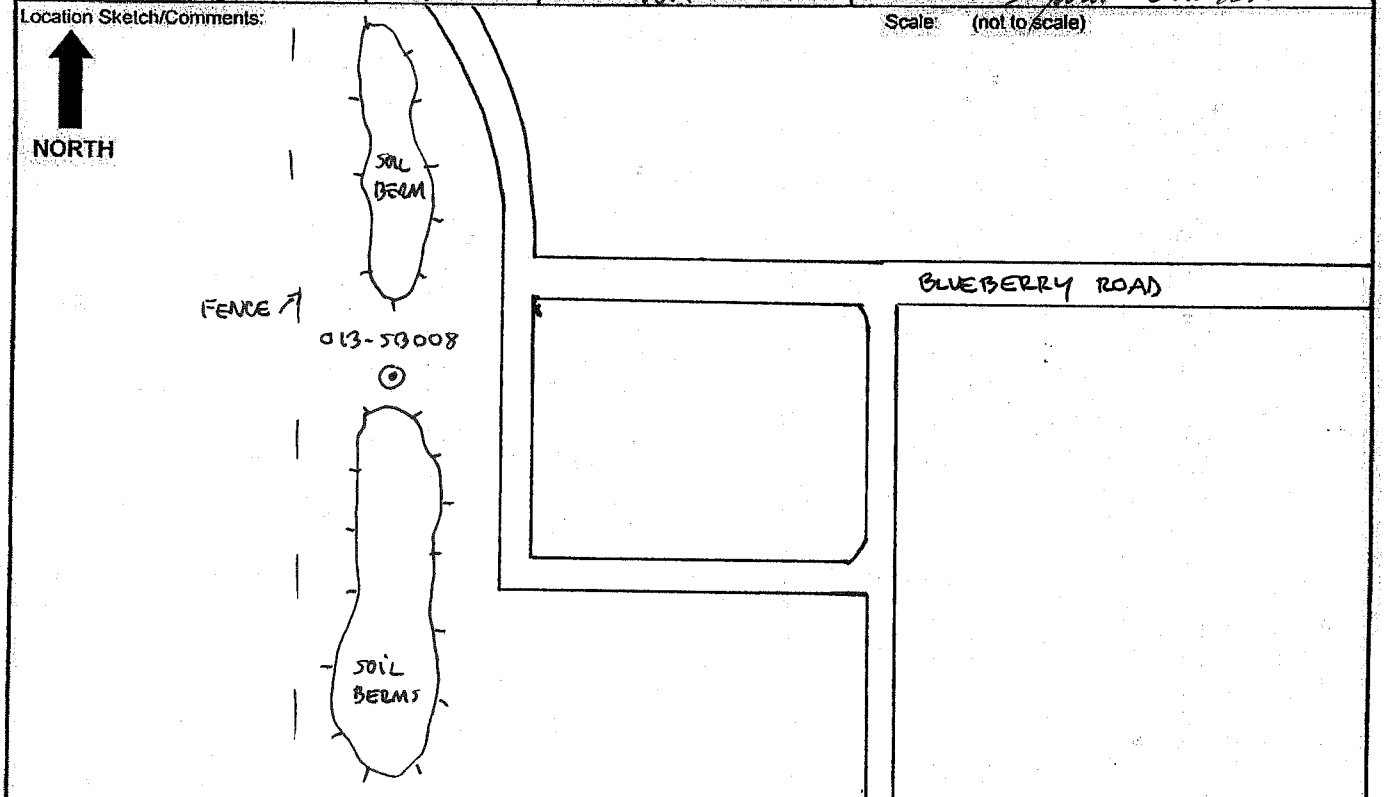
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	✓	✓	THIANES/THIODIGLYCOL	PERCHLORATE	EXPLOSIVES	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	BENTONITE	NA	NA	

Location Sketch/Comments:

Scale: (not to scale)



Project	Hole Number
Redstone Arsenal	013-SB008

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-SB008

Project: REDSTONE ARSENAL

Geologist: JULIE SCHENCK BROWN

Sheet 2 of 2 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	SURFACE = GRASS						
		(0-5): YELLOWISH BROWN SANDY CLAY (10 YR 5/8) LOW PLASTICITY MEDIUM - HIGH STIFFNESS VERY FINE SAND 10% MOTTLING (GRAY) SLIGHT TRACES OF MANGANESE SLIGHT MOISTURE	CL	(0-5) 0.0	NA ↓	ABG 0055 (0-1)	5/5	HAND AUGER TO 5' BGS
	2					ABG 0056 (2-4)		
	5	(5-10): YELLOWISH BROWN SANDY CLAY (10 YR 5/8) LOW PLASTICITY MEDIUM STIFFNESS VERY FINE SAND 10% MOTTLING (PALE GRAY) MOIST	CL	(5-10) 0.0		ABG 0057 (6-8)	5/5	
	10	Boring terminated at 10' EJM						

Project: RSA

Hole Number: 013-SB008

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG-03042014-S-SAC / ABG-03042014-S-EP

Location Code: **013-SB008**
Sample Number: **ABG0055**
Sample Name: **013-SB008-SS-ABG0055-REG**
Sampling Method: **HA**
Sample Type: **SS** *Sample Purpose:* **REG**
Sampling Equip: HA

Task: **013**
Collection Date: 2-28-14
Collection Time: 1520
Start Depth: 0' BGS
End Depth: 1' BGS
Sample Matrix: **SOIL**

QC Partners:
(TB) NA (ER) NA (FB) NA

Sample Team: JSB, JW

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: [signature] 2-28-14

Reviewed BY / Date: [signature] 2-28-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nemi

ABG-03042014-S-SAC

RFA / COC Number: ABG-03042014-S-EA

Location Code: **013-SB008**

Sample Number: **ABG0056**

Sample Name: **013-SB008-DS-ABG0056-REG**

Sampling Method: **HA**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: HA

Task: **013**

Collection Date: 2-28-14

Collection Time: 1525

Start Depth: 2' BGS

End Depth: 4' BGS

Sample Matrix: **SOIL**

QC Partners:

(TB) NA (ER) NA (FB) NA

Sample Team: JSD, JW

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: 2-28-14

Reviewed BY / Date: OK 2-28-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC (EPM)

Manager: ~~Don Burton~~ John Nenni

ABG-03042014-S-SAC

RFA / COC Number: ABG-03042014-S-EP

Location Code: **013-SB008**

Sample Number: **ABG0057**

Sample Name: **013-SB008-DS-ABG0057-REG**

Sampling Method: **DP**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: DP

Task: **013**

Collection Date: 2-28-14

Collection Time: 1530

Start Depth: 6' BGS

End Depth: 8' BGS

Sample Matrix: **SOIL**

Sample Team: JSB, JW

QC Partners:

(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: [signature] 2-28-14

Reviewed BY / Date: [signature] 2-28-14

HTRW DRILLING LOG

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

Client: CB+I		Hole Number: 013-SB009	
Company Name: Shaw Environmental, Inc.	Drilling Subcontractor: GSE	Sheet: 1 of 2	Sheets
Project: Redstone Arsenal	Location: RSA-013		
Name of Driller: JUSTIN WINGERTER	Manufacturer's Designation of Drill: GEOPROBE 7822 DT		
Sizes and Types of Drilling and Sampling Equipment: HAND AUGER, 2" MACROCORE	Surface Elevation: TBD		
	Date Started: 2-27-2014	Date Completed: 2-27-2014	
Overburden Thickness: 7 10' BGS	Depth Groundwater Encountered: Ø		
Depth Drilled into Rock: Ø	Depth to Water and Elapsed Time After Drilling Completed: NA		
Total Depth of Hole: 10' BGS	Other Water Level Measurements (Specify): NA		

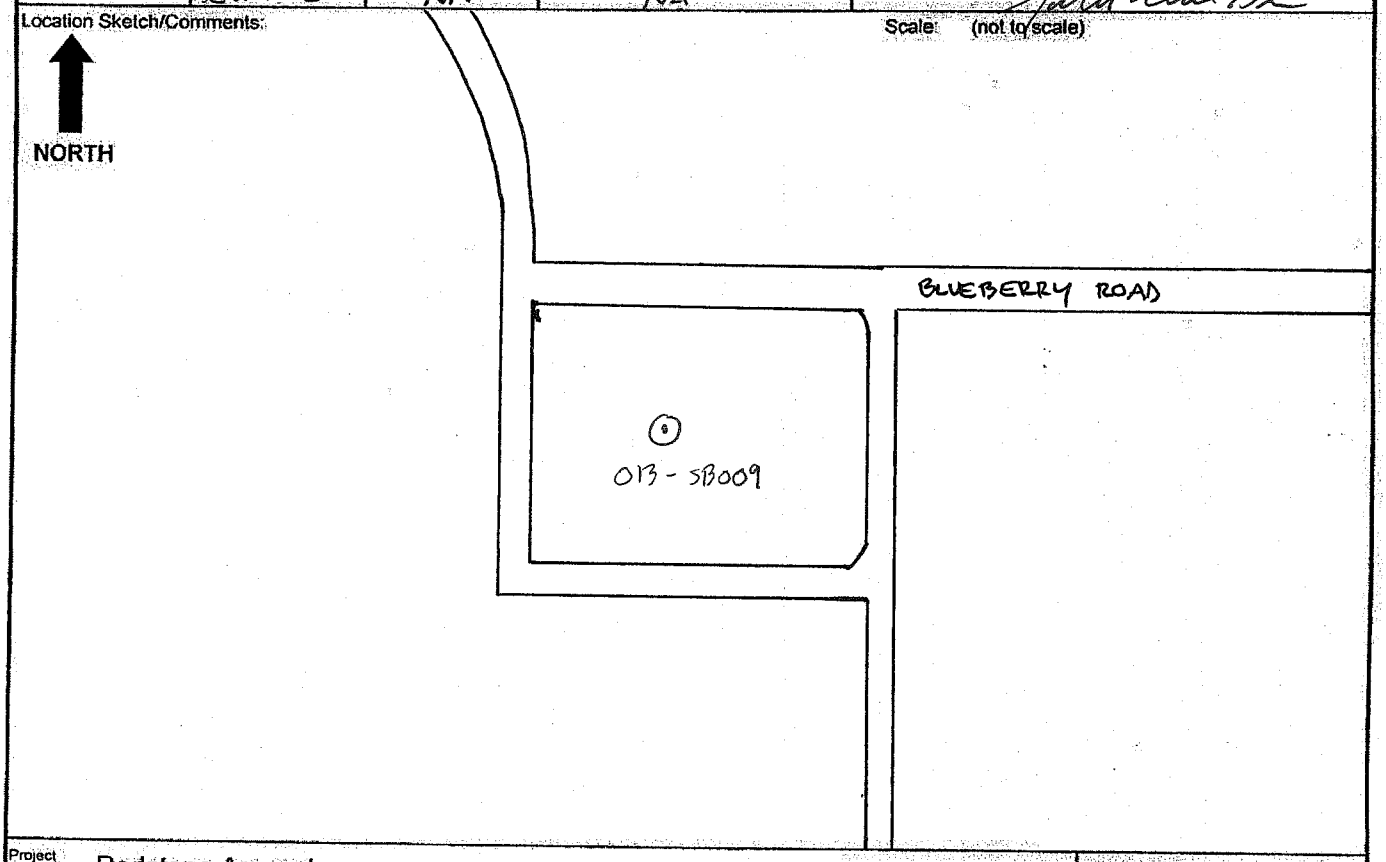
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	✓	✓	THFANES/THIODIGLYCOL	PERCHLORATE	EXPLOSIVES	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	BENTONITE	NA	NA	

Location Sketch/Comments:

Scale: (not to scale)



Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG (continuation sheet)

Hole Number: 013-SB009

Project: REDSTONE ARSENAL

Geologist: JULIE SCHENCK BROWN

Sheet 2 of 2 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	SURFACE = GRASS						
	1–2	(0-5): YELLOWISH BROWN SANDY CLAY (10 YR 5/8) LOW PLASTICITY LOW STIFFNESS VERY FINE SAND MANGANESE DEPOSITS AND STAINING AT 0-2' BGS 10% MOTTLING (GRAY) MOIST	CL	(0-5) 0.0	NA ↓	ABH 0058 (0-1)	5/5	HAND AUGER TO 5' BGS
	3					ABH 0059 (2-4)		
	4							
	5–6	(5-10): DARK YELLOWISH BROWN SANDY CLAY (10 YR 4/6) LOW PLASTICITY LOW - MEDIUM STIFFNESS VERY FINE SAND TRACES OF MANGANESE MOIST	CL	(5-10) 0.0				
	7					ABH 0060 (6-8)		
	8							
	9							
	10	Boring terminated @ 10' esm						

Project: RSA

Hole Number: 013-SB009

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC EJM
Manager: ~~Don Burton~~ John Nemm

ABG-022714-S-SAC
RFA / COC Number: ABG-0227014-S-EA

Location Code: 013-SB009
Sample Number: ABG0058
Sample Name: 013-SB009-SS-ABG0058-REG
Sampling Method: HA
Sample Type: SS *Sample Purpose:* REG
Sampling Equip: HA

Task: 013
Collection Date: 2-27-14
Collection Time: 0915
Start Depth: 0' BGS
End Depth: 1' BGS
Sample Matrix: SOIL
Sample Team: JSB, JW

QC Partners:
(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: J. Schultz 2-27-14

Reviewed BY / Date: 2-27-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC (EJM)

Manager: ~~Don Burton~~ John Nenni

ABG-022714-S-SAC

RFA / COC Number: ABG-0227014-S-EP

Location Code: 013-SB009
Sample Number: ABG0059
Sample Name: 013-SB009-DS-ABG0059-REG
Sampling Method: HA
Sample Type: DS *Sample Purpose:* REG
Sampling Equip: HA

Task: 013
Collection Date: 2-27-14
Collection Time: 0920
Start Depth: 2' BGS
End Depth: 4' BGS
Sample Matrix: SOIL
Sample Team: JJB, JW

QC Partners:
(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: J. Schultz 2-27-14

Reviewed BY / Date: DQC 2-27-14

Shaw™
Shaw E & I, Inc.

Sample Collection Log

136973 - Redstone PMC
Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG-022714-S-SAC / ABG-022714-S-EX

Location Code: **013-SB009**
Sample Number: **ABG0060**
Sample Name: **013-SB009-DS-ABG0060-REG**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**
Sampling Equip: DP

Task: **013**
Collection Date: 2-27-14
Collection Time: 0930
Start Depth: 6' BGS
End Depth: 8' BGS
Sample Matrix: **SOIL**
Sample Team: JSB, JW

QC Partners:
(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOC-III-S	N	A	3	40	mL	TerraCore
EXPLOSIVES+	N	B	1	4	oz	Amb. Glass
PERCH_6850	N	B	1	4	oz	Amb. Glass
METALS-III-S	N	C	1	4	oz	CWM
THIANES	N	D	1	4	oz	CWM
THIODIGLYCOL	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

SEE DRILLING LOG.

Logged BY / Date: J. Rhodes 2-27-14
Reviewed BY / Date: OK 2-27-14

HTRW DRILLING LOG

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

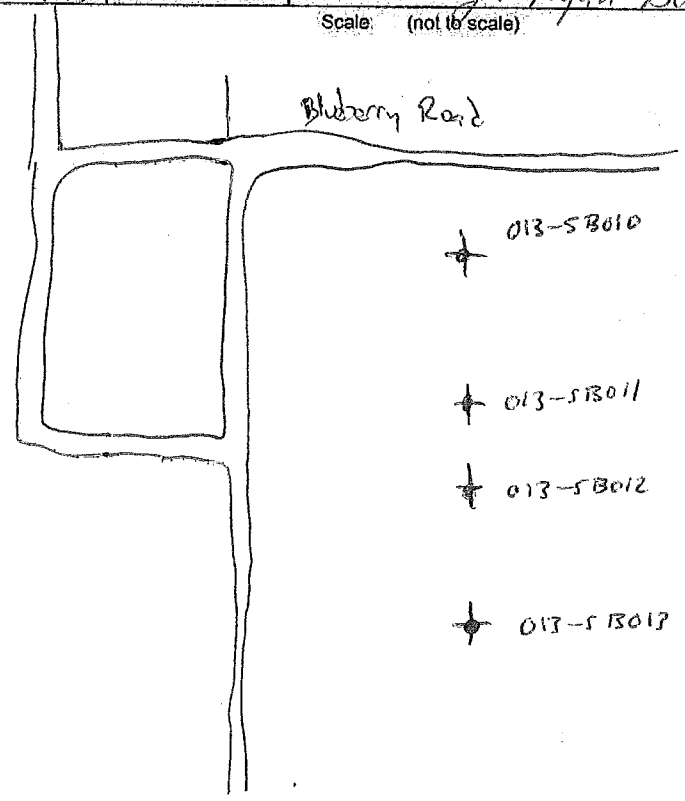
Client: CB&I			Hole Number: 013-SB010
Company Name: Shaw Environmental, Inc.		Drilling Subcontractor: GSE	Sheet: 1 of 2 Sheets
Project: Redstone Arsenal		Location: RSA-013	
Name of Driller: James Blackwood		Manufacturer's Designation of Drill: Geoprobe 7822 DT	
Sizes and Types of Drilling and Sampling Equipment: Hand Auger; 2" Macro Core		Surface Elevation: TBD	
		Date Started: 5-20-14	Date Completed: 5-20-14
Overburden Thickness: > 8'		Depth Groundwater Encountered: Did not encounter	
Depth Drilled into Rock: 0		Depth to Water and Elapsed Time After Drilling Completed: NA	
Total Depth of Hole: 8'		Other Water Level Measurements (Specify): NA	

Geotechnical Samples	Disturbed: NA	Undisturbed: NA	Total Number of Core Boxes: NA				
Samples for Chemical Analysis	VOC: NA	Metals: NA	Other: Perchlorate	Other: NA	Other: NA	Total Core Recovery: NA	
Disposition of Hole	Backfilled: Yes	Monitoring Well: NA	Other: NA	Signature of Geologist: J. Ryan Bailey			

Location Sketch/Comments:

NORTH

Scale: (not to scale)



Project: Redstone Arsenal	Hole Number: 013-SB010

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-SB010

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 2 of 2 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	0-5→ Dark reddish brown (5YR 7/4) silty clay, med. soft. Low plast. slightly moist.	CL	0-5: 0.0	NA ↓	ABC 0087 0088 0-1	5/5	Hand Auger to 5 feet
	1							
	2							
	3					ABC 0089 (2-4)		
	4							
	5	5-8→ strong brown (7.5YR 5/8) silty clay, med. stiff, med. plast. slightly moist.	CL	5-8: 0.0		ABC 0090 (4-6)	3/3	
	6							
	7							
	8							
	9							
	10							

Project: Redstone Arsenal

Hole Number: 013-SB010

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG-05232014-S-EP

Location Code: **013-SB010**
Sample Number: **ABG0087**
Sample Name: **013-SB010-SS-ABG0087-REG**
Sampling Method: **HA**
Sample Type: **SS** *Sample Purpose:* **REG**
Sampling Equip: HA

Task: **013**
Collection Date: 5-20-14
Collection Time: 0870
Start Depth: 0' bgs
End Depth: 1'
Sample Matrix: **SOIL**
Sample Team: RB

QC Partners:
(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

See Drill Log

Logged BY / Date: R. Bailey 5-20-14 *Reviewed BY / Date:* ORK 5-20-14

Sample Collection Log

136973 - Redstone PMC (ejm)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG-05232014-S-EP

Location Code: **013-SB010**

Sample Number: **ABG0088**

Sample Name: **013-SB010-SS-ABG0088-FD**

Sampling Method: **HA**

Sample Type: **SS** *Sample Purpose:* **FD**

Sampling Equip: N/A

QC Partners:

(TB) NA (ER) NA (FB) NA

Task: **013**

Collection Date: 5-20-14

Collection Time: 0930

Start Depth: 0' bgs

End Depth: 1'

Sample Matrix: **SOIL**

Sample Team: RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

See Drill Log

Logged BY / Date: R. Bailey 5-20-14 *Reviewed BY / Date:* DOKC 5-20-14

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG-05232014-S-EP

Location Code: **013-SB010**

Sample Number: **ABG0089**

Sample Name: **013-SB010-DS-ABG0089-REG**

Sampling Method: **HA**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: HA

QC Partners:

(TB) NA (ER) NA (FB) NA

Task: **013**

Collection Date: 5-20-14

Collection Time: 0835

Start Depth: 2' 6in

End Depth: 4'

Sample Matrix: **SOIL**

Sample Team: RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID= 0.0 ppm

Sketch Location:

See Drill Log

Logged BY / Date: R. Bailey 5-20-14 *Reviewed BY / Date:* DQIC 5-20-14

Sample Collection Log

136973 - Redstone PMC (EPM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG-05232014-S-EA

Location Code: **013-SB010**
Sample Number: **ABG0090**
Sample Name: **013-SB010-DS-ABG0090-REG**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**
Sampling Equip: ~~DPT~~ DPT

Task: **013**
Collection Date: 5-20-14
Collection Time: 0840
Start Depth: 6' bgs
End Depth: 8'
Sample Matrix: **SOIL**
Sample Team: RB

QC Partners:
(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

See Drill Log

Logged BY / Date: R. Bailey 5-20-14

Reviewed BY / Date: DCK 5-20-14

HTRW DRILLING LOG

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

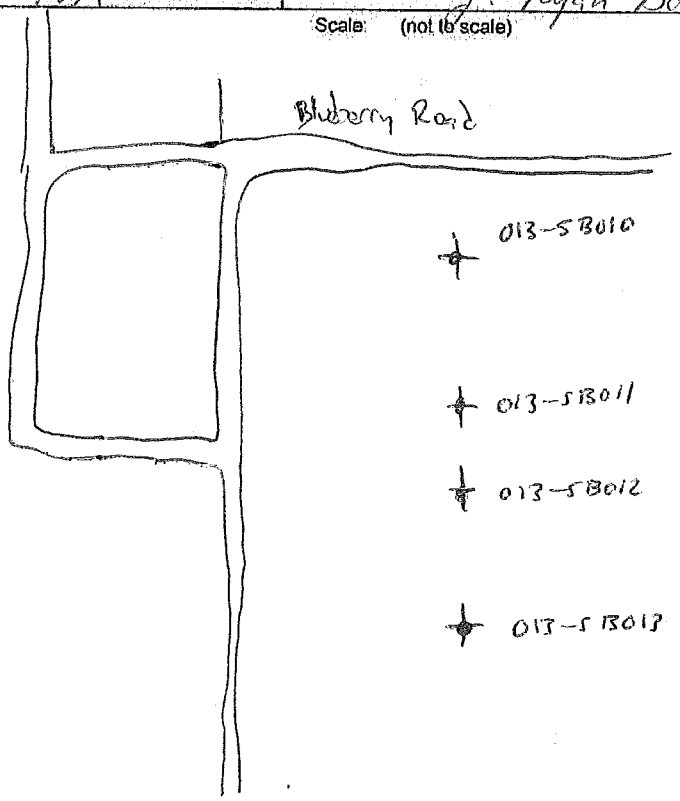
Client: CB&I			Hole Number: 013-SB011
Company Name: Shaw Environmental, Inc.		Drilling Subcontractor: GSE	Sheet: 1 of 2 Sheets
Project: Redstone Arsenal		Location: RSA-013	
Name of Driller: James Blackwood		Manufacturer's Designation of Drill: Geoprobe 7822 DT	
Sizes and Types of Drilling and Sampling Equipment	Hand Auger 2" Macro Core	Surface Elevation: TBD	
		Date Started: 5-20-14	Date Completed: 5-20-14
Overburden Thickness: > 8'		Depth Groundwater Encountered: Did not encounter	
Depth Drilled into Rock: 0		Depth to Water and Elapsed Time After Drilling Completed: NA	
Total Depth of Hole: 8'		Other Water Level Measurements (Specify): NA	

Geotechnical Samples	Disturbed: NA	Undisturbed: NA		Total Number of Core Boxes: NA			
Samples for Chemical Analysis	VOC: NA	Metals: NA	Other: Perchlorate	Other: NA	Other: NA	Total Core Recovery: NA	
Disposition of Hole	Backfilled: Yes	Monitoring Well: NA	Other: NA	Signature of Geologist: J. Ryan Bailey			

Location Sketch/Comments:

NORTH

Scale: (not to scale)



Project: Redstone Arsenal			Hole Number: 013-SB011

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-SB011

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 2 of 2 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	0-5 → Brown (7.5YR 4/4) silty clay, stiff, low plast. slightly moist.	CL	0-5 0.0	NA ↓	ARG 0091 0-1	5/5	Hand Auger to 5 feet
	5	5-8 → strong brown (7.5YR 5/6) silty clay, med. stiff. med. plast. slightly moist.	CL	5-8 0.1		ARG 0092 2-4 ARG 0093 6-8	5/5 3/3	
	10							

Project: Redstone Arsenal

Hole Number: 013-SB011

Sample Collection Log

136973 - Redstone PMC (EPM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG-05232014-S-EP

Location Code: **013-SB011**

Sample Number: **ABG0091**

Sample Name: **013-SB011-SS-ABG0091-REG**

Sampling Method: **HA**

Sample Type: **SS** *Sample Purpose:* **REG**

Sampling Equip: HA

Task: **013**

Collection Date: 5-20-14

Collection Time: ~~0910~~ 0900

Start Depth: 0' bs

End Depth: 1'

Sample Matrix: **SOIL**

QC Partners:

(TB) NA (ER) NA (FB) NA

Sample Team: RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location:

See Drill Log

Logged BY / Date: L. Bailey 5-20-14 *Reviewed BY / Date:* DQC 5-20-14

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG-052320 14-S-EP

Location Code: **013-SB011**

Sample Number: **ABG0092**

Sample Name: **013-SB011-DS-ABG0092-REG**

Sampling Method: **HA**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: HA

QC Partners:

(TB) NA (ER) NA (FB) NA

Task: **013**

Collection Date: 5-20-14

Collection Time: 0905

Start Depth: 2' bgs

End Depth: 4'

Sample Matrix: **SOIL**

Sample Team: RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location: See Drill Log

Logged BY / Date: R. Bailey 5-20-14

Reviewed BY / Date: DQK 5-20-14

Sample Collection Log

136973 · Redstone PMC

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG-DS232014-S-EA

Location Code: **013-SB011**

Sample Number: **ABG0093**

Sample Name: **013-SB011-DS-ABG0093-REG**

Sampling Method: **DP**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: DPT

Task: **013**

Collection Date: 5-20-14

Collection Time: 0910

Start Depth: 6' bgs

End Depth: 8'

Sample Matrix: **SOIL**

Sample Team: RB

QC Partners:

(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.1 ppm

Sketch Location: See Drill Log

Logged BY / Date: R Bailey 5-20-14 *Reviewed BY / Date:* DQJCC 5-20-14

HTRW DRILLING LOG

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

Client: CB&I			Hole Number: 013-SB012
Company Name: Shaw Environmental, Inc.		Drilling Subcontractor: GSE	Sheet: 1 of 2 Sheets
Project: Redstone Arsenal		Location: RSA-013	
Name of Driller: James Blackwood		Manufacturer's Designation of Drill: Geoprobe 7822 DT	
Sizes and Types of Drilling and Sampling Equipment: Hand Auger; 2" Macro Core		Surface Elevation: TBD	
		Date Started: 5-20-14	Date Completed: 5-20-14
Overburden Thickness: > 8'		Depth Groundwater Encountered: Did not encounter	
Depth Drilled into Rock: 0		Depth to Water and Elapsed Time After Drilling Completed: NA	
Total Depth of Hole: 8'		Other Water Level Measurements (Specify): NA	

Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

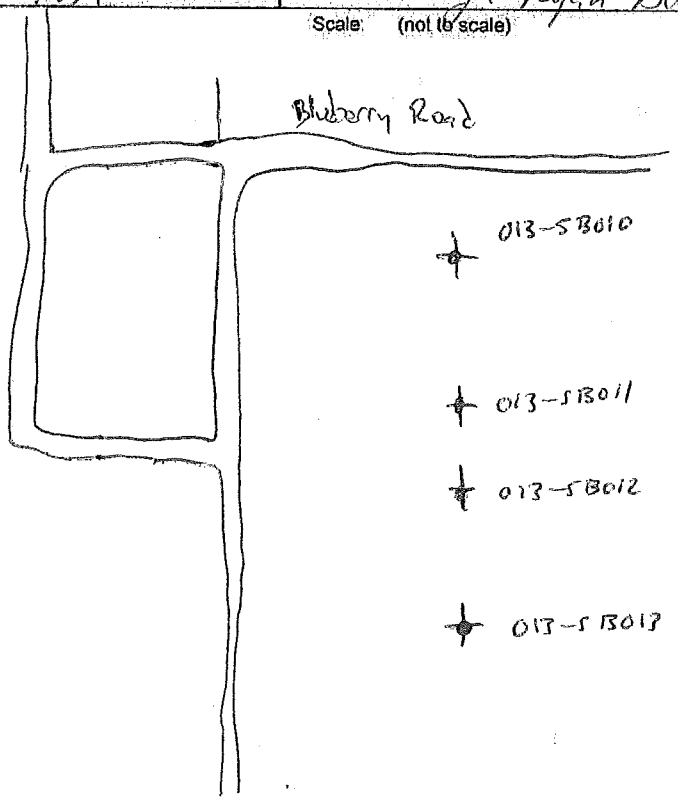
Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	NA	NA	Perchlorate	NA	NA	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	Yes	NA	NA	J. Ryan Bailey

Location Sketch/Comments:

NORTH

Scale: (not to scale)



Project	Hole Number
Redstone Arsenal	013-SB012

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-SB012

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 2 of 2 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	0-5 → Brown (7.5 YR 4/4) silty clay. Med. Stiff. Low Plast. Slightly moist.	CL	0-5 0.4	NA ↓	ABG 00014 (0-1)	5/5	Hand Auger to 5 feet
	1							
	2							
	3					ABG 00015 (2-4)		
	4							
	5	5-8 → strong brown (7.5 YR 5/8) silty clay. Med. stiff. Med. plast. Moist.	CL	5-8 0.3		ABG 00016 MS (6-8)	3/3	
	6							
	7							
	8							
	9							
	10							

Project: Redstone Arsenal

Hole Number: 013-SB012

Sample Collection Log

136973 - Redstone PMC (EPM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG-05232014-S-EP

Location Code: **013-SB012**

Sample Number: **ABG0094**

Sample Name: **013-SB012-SS-ABG0094-REG**

Sampling Method: **HA**

Sample Type: **SS** *Sample Purpose:* **REG**

Sampling Equip: HA

QC Partners:

(TB) NA (ER) NA (FB) NA

Task: **013**

Collection Date: 5-20-14

Collection Time: 0730

Start Depth: 0' bgs

End Depth: 1'

Sample Matrix: **SOIL**

Sample Team: RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.4 ppm

Sketch Location: See Drill Log

Logged BY / Date: R. Bailey 5-20-14

Reviewed BY / Date: DQK 5-20-14

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG-05232014-S-EP

Location Code: **013-SB012**
Sample Number: **ABG0095**
Sample Name: **013-SB012-DS-ABG0095-REG**
Sampling Method: **HA**
Sample Type: **DS** *Sample Purpose:* **REG**
Sampling Equip: HA

Task: **013**
Collection Date: 5-20-14
Collection Time: 0935
Start Depth: 2' bgs
End Depth: 4'
Sample Matrix: **SOIL**
Sample Team: RB

QC Partners:
(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: PID = 0.4 ppm

Sketch Location:

See Drill Log

Logged BY / Date: R. Bailey 5-20-14 *Reviewed BY / Date:* 5-20-14

Sample Collection Log

136973 - Redstone PMC (ERM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG-05232014-S-EP

Location Code: **013-SB012**

Sample Number: **ABG0096**

Sample Name: **013-SB012-DS-ABG0096-REG**

Sampling Method: **DP**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: ~~NA~~ DPT

Task: **013**

Collection Date: 5-20-14

Collection Time: 0940

Start Depth: 6' bgs

End Depth: 8'

Sample Matrix: **SOIL**

Sample Team: RB

QC Partners:

(TB) NA (ER) NA (FB) NA

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.3 ppm

Sketch Location: See Drill Log

Logged BY / Date: R. Bailey 5-20-14

Reviewed BY / Date: 5-20-14

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

HTRW DRILLING LOG

Client: CB&I			Hole Number: 013-SB013
Company Name: Shaw Environmental, Inc.		Drilling Subcontractor: GSE	Sheet: 1 of 2 Sheets
Project: Redstone Arsenal		Location: RSA-013	
Name of Driller: James Blackwood		Manufacturer's Designation of Drill: Geoprobe 7822 DT	
Sizes and Types of Drilling and Sampling Equipment: Hand Auger; 2" Macro Core		Surface Elevation: TBD	
		Date Started: 5-20-14	Date Completed: 5-20-14
Overburden Thickness: > 8'		Depth Groundwater Encountered: Did not encounter	
Depth Drilled into Rock: 0		Depth to Water and Elapsed Time After Drilling Completed: NA	
Total Depth of Hole: 8'		Other Water Level Measurements (Specify): NA	

Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

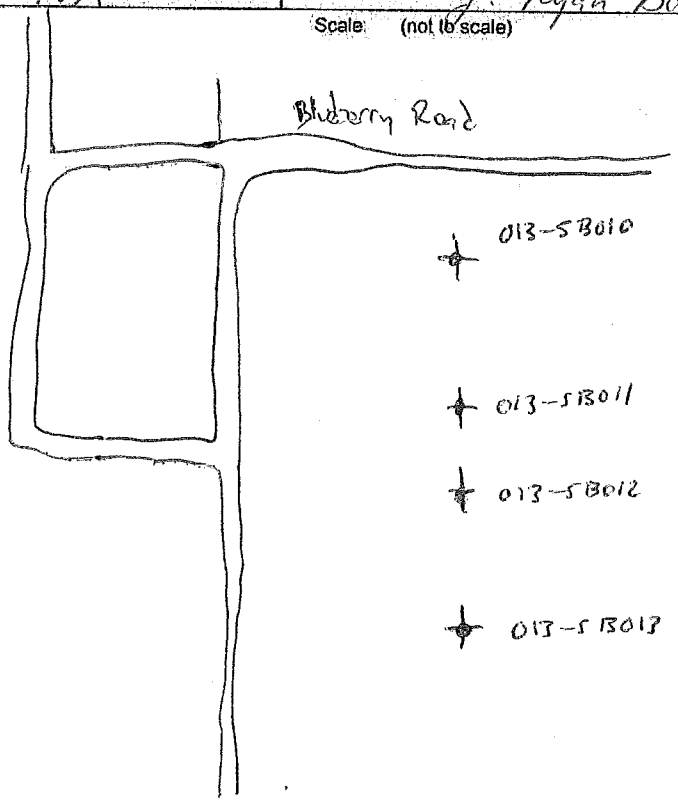
Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	NA	NA	Perchlorate	NA	NA	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	Yes	NA	NA	J. Ryan Bailey

Location Sketch/Comments:

NORTH

Scale: (not to scale)



Project	Hole Number
Redstone Arsenal	013-SB013

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-SB013

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 2 of 2 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	0-5 → Brownish yellow (10YR 6/6) silty clay, med. soft, low plast. Moist	CL	0-5 0.0	NA ↓	ABG 0097 (0-1)	5/5	Hand Auger to 5 feet
	1							
	2							
	3					ABG 0098 MS/MSD (2-4)		
	4							
	5	5-8 → Same as above.	CL	5-8 0.0			3/3	
	6							
	7					ABG 0099 (6-8)		
	8							
	9							
	10							

Project: Redstone Arsenal

Hole Number: 013-SB013

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nenni EJM

RFA / COC Number: ABG-05232014-S-EP

Location Code: **013-SB013**

Sample Number: **ABG0097**

Sample Name: **013-SB013-SS-ABG0097-REG**

Sampling Method: **HA**

Sample Type: **SS** *Sample Purpose:* **REG**

Sampling Equip: HA

QC Partners:

(TB) NA (ER) NA (FB) NA

Task: **013**

Collection Date: 5-20-14

Collection Time: 0955

Start Depth: 0' bgs

End Depth: 1'

Sample Matrix: **SOIL**

Sample Team: RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID= 0.0 ppm

Sketch Location:

See Drill Log

Logged BY / Date: R. Bailey 5-20-14

Reviewed BY / Date: DEK 5-20-14

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nenni (EJM)

RFA / COC Number: ABG-05232014-S-EP

Location Code: **013-SB013**

Sample Number: **ABG0098**

Sample Name: **013-SB013-DS-ABG0098-REG**

Sampling Method: **HA**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: HA

QC Partners:

(TB) NA (ER) NA (FB) NA

Task: **013**

Collection Date: 5-20-14

Collection Time: 1000

Start Depth: 2' bgs

End Depth: 4'

Sample Matrix: **SOIL**

Sample Team: RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location: See Drill Log

Logged BY / Date: R. Bailey 5-20-14

Reviewed BY / Date: 5-20-14

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Penni (EPM)

RFA / COC Number: ABG-05232014-S-EP

Location Code: **013-SB013**

Sample Number: **ABG0098-MS**

Sample Name: **013-SB013-DS-ABG0098-MS**

Sampling Method: **HA**

Sample Type: **DS** *Sample Purpose:* **MS**

Sampling Equip: HA

QC Partners:

(TB) NA (ER) NA (FB) NA

Task: **013**

Collection Date: 5-20-14

Collection Time: 1000

Start Depth: 2' bgs

End Depth: 4'

Sample Matrix: **SOIL**

Sample Team: RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID = 0.0 ppm

Sketch Location: See Drill Log

Logged BY / Date: R. Bailey 5-20-14

Reviewed BY / Date: DQK 5-20-14

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nenni (EBW)

RFA / COC Number: ABG-052320 14-S-EA

Location Code: **013-SB013**

Sample Number: **ABG0098-MSD**

Sample Name: **013-SB013-DS-ABG0098-MSD**

Sampling Method: **HA**

Sample Type: **DS** *Sample Purpose:* **MSD**

Sampling Equip: HA

QC Partners:

(TB) NA (ER) NA (FB) NA

Task: **013**

Collection Date: 5-20-14

Collection Time: 1000

Start Depth: 2' bgs

End Depth: 4'

Sample Matrix: **SOIL**

Sample Team: RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
PERCH_6850	N	B	1	4	oz	CWM

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID= 0.0 ppm

Sketch Location:

See Drill Log

Logged BY / Date: R. Bailey 5-20-14 *Reviewed BY / Date:* DJC 5-20-14

Sample Collection Log

136973 - Redstone PMC

Manager: ~~Don Burton~~ John Nenni (EJM)

RFA / COC Number: ABG-05232014-S-EP

Location Code: **013-SB013**

Sample Number: **ABG0099**

Sample Name: **013-SB013-DS-ABG0099-REG**

Sampling Method: **DP**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: DPT

QC Partners:

(TB) NA (ER) NA (FB) NA

Task: **013**

Collection Date: 5-20-14

Collection Time: 1005

Start Depth: 6' bgs

End Depth: 8'

Sample Matrix: **SOIL**

Sample Team: RB

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
PERCH_6850	N	B	1	4	oz	Amb. Glass

ERPIMS Values:

Sacode: N/A

Lot Control#:

Comments: PID= 0.0 ppm

Sketch Location:

See Drill Log

Logged BY / Date: R. Bailey 5-20-14

Reviewed BY / Date: OK 5-20-14

HTRW DRILLING LOG

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

Client: CB&I			Hole Number: 013-SB014
Company Name: Shaw Environmental, Inc.		Drilling Subcontractor: GSE	Sheet: 1 of 2 Sheets
Project: Redstone Arsenal		Location: RSA-013	
Name of Driller: Wesley Casteel		Manufacturer's Designation of Drill: Geoprobe 7822 DT	
Sizes and Types of Drilling and Sampling Equipment: Hand Auger; 2" Macro Core		Surface Elevation: TBD	
		Date Started: 8-18-15	Date Completed: 8-18-15
Overburden Thickness: >8'		Depth Groundwater Encountered: Did not encounter	
Depth Drilled into Rock: 0		Depth to Water and Elapsed Time After Drilling Completed: NA	
Total Depth of Hole: 8'		Other Water Level Measurements (Specify): NA	

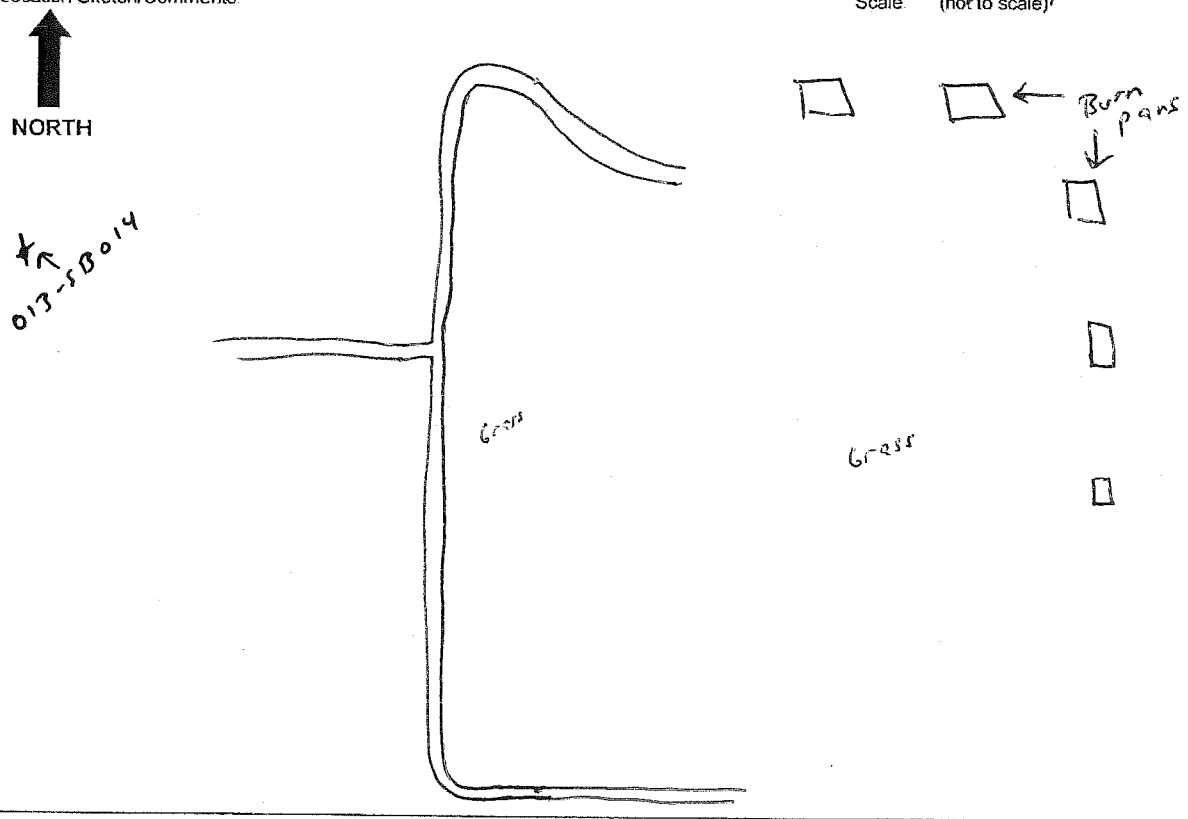
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	V		Explosives, Perch	NA	NA	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	Yes	NA	NA	L. Ryan Bailey

Location Sketch/Comments:

Scale: (not to scale)



Project	Hole Number
Redstone Arsenal	013-SB014

CB&I

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-SB014

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 2 of 2 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	0-5 → strong brown (7.5YR 5/8) silty clay. Med. stiff. Med. plast. Moist	CL	0-5 0.0	NA ↓	ABG 0173 (0-1)	5/5	Hand Auger to 5 ft.
	2					ABG 0174 0175 (2-4)		
	5	5-8 → SAME as above.	CL	(RB) ~~5-10~~ 5-8 0.0			5/5	
	7					ABG 0176 (6-8)		
	10							

Project: RSA

Hole Number: 013-SB014

Sample Collection Log

Project: ~~136973~~ 500382 Redstone PMC

Manager: ~~Don Burton~~ John Nemi

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-SB014**
Sample Number: **ABG0173**
Sample Name: **013-SB014-SS-ABG0173-REG**
Sampling Method: **HA**
Sample Type: **SS** *Sample Purpose:* **REG**

Collection Date: **18-AUG-15**
Collection Time: **15:25**
Start Depth: **0**
End Depth: **1**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SVOC-III-SL	N	A	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments:
N/A

Sketch Location:
See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* 8/19/15

Sample Collection Log

Project: ~~136973~~ 500382 Redstone PMC

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-SB014**
Sample Number: **ABG0174**
Sample Name: **013-SB014-DS-ABG0174-REG**
Sampling Method: **HA**
Sample Type: **DS** *Sample Purpose:* **REG**

Collection Date: **18-AUG-15**
Collection Time: **15:30**
Start Depth: **2**
End Depth: **4**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SVOC-III-SL	N	A	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log.

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* BRL 8/18/15

Sample Collection Log

500382

Project: ~~136973~~ Redstone PMC

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-SB014**
Sample Number: **ABG0175**
Sample Name: **013-SB014-DS-ABG0175-FD**
Sampling Method: **HA**
Sample Type: **DS** *Sample Purpose:* **FD**

Collection Date: **18-AUG-15**
Collection Time: **15:30**
Start Depth: **2**
End Depth: **4**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SVOC-III-SL	N	A	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* 8/19/15

Sample Collection Log

Project: ~~136973~~ 500382 Redstone PMC (EPM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-SB014**
Sample Number: **ABG0176**
Sample Name: **013-SB014-DS-ABG0176-REG**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**

Collection Date: **18-AUG-15**
Collection Time: **15:35**
Start Depth: **6**
End Depth: **8**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SVOC-III-SL	N	A	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* BM 8/19/15

HTRW DRILLING LOG

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

Client: CB&I			Hole Number: 013-SB015
Company Name: Shaw Environmental, Inc.		Drilling Subcontractor: GSE	Sheet: 1 of 2 Sheets
Project: Redstone Arsenal		Location: RSA-013	
Name of Driller: Wesley Casteel		Manufacturer's Designation of Drill: Geoprobe 7822 DT	
Sizes and Types of Drilling and Sampling Equipment: Hand Auger; 2" Macro Core		Surface Elevation: TBD	
		Date Started: 8-18-15	Date Completed: 8-18-15
Overburden Thickness: >10'		Depth Groundwater Encountered: Did not encounter	
Depth Drilled into Rock: 0		Depth to Water and Elapsed Time After Drilling Completed: N/A	
Total Depth of Hole: 10'		Other Water Level Measurements (Specify): NA	

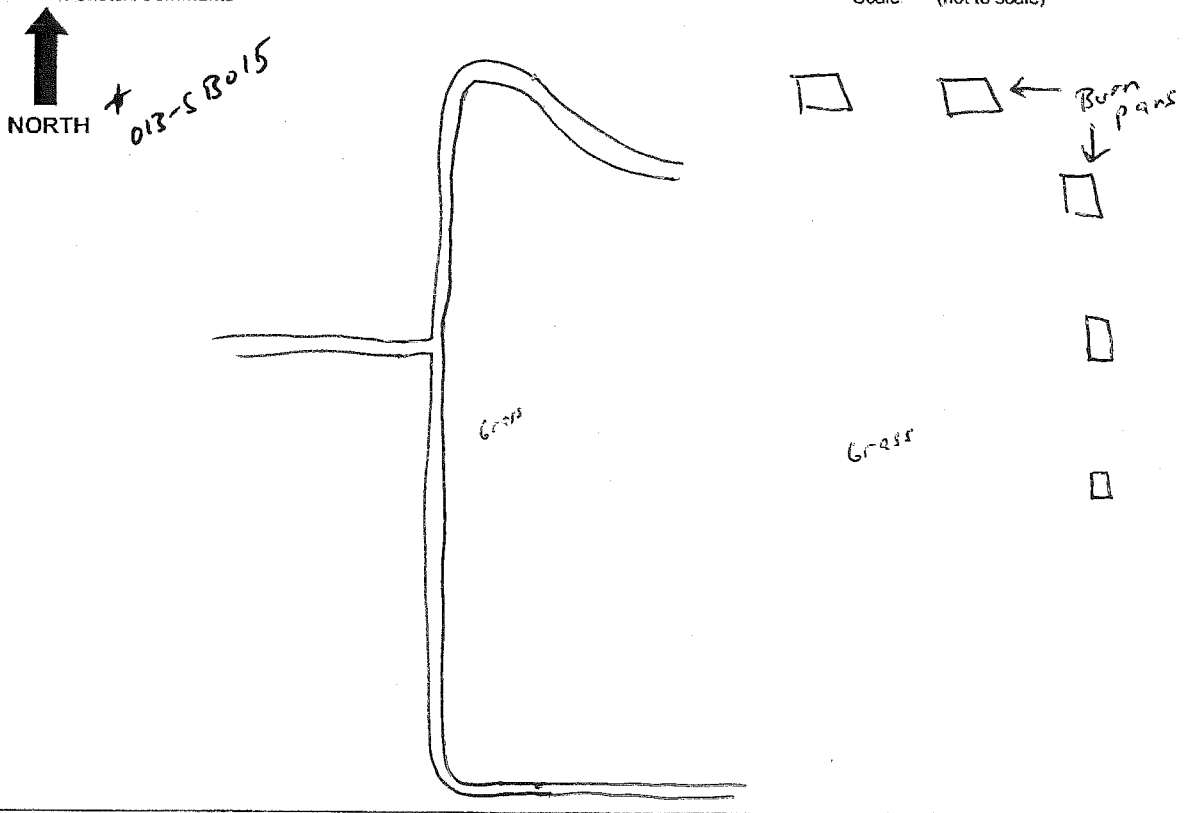
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	V		Explosives, Perch	NA	NA	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	Yes	NA	NA	L. Ryan Bailey

Location Sketch/Comments:

Scale: (not to scale)



Project	Hole Number
Redstone Arsenal	013-SB015

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-SB015

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 2 of 2 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	0-10 → strong brown (7.5 YR 5/8) silty clay. & med stiff low Plast. Moist.	CL	0-5: 0.0	NA ↓	ABG 0177 (0-1)	5/5	Hand Auger to 5 ft.
	2					ABG 0178 (2-4)		
	5	5-10	CL	5-10: 0.0		ABG 0179 (6-8)	5/5	
	10							

Project: RSA

Hole Number: 013-SB015

Sample Collection Log

Project: ~~136973~~ 500382 Redstone PMC

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-SB015**
Sample Number: **ABG0177**
Sample Name: **013-SB015-SS-ABG0177-REG**
Sampling Method: **HA**
Sample Type: **SS** *Sample Purpose:* **REG**

Collection Date: **18-AUG-15**
Collection Time: **15:50**
Start Depth: **0**
End Depth: **1**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SVOC-III-SL	N	A	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* BRL 8/18/15

Sample Collection Log

500382

Project: ~~136973~~ Redstone PMC (EJM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-SB015**
Sample Number: **ABG0178**
Sample Name: **013-SB015-DS-ABG0178-REG**
Sampling Method: **HA**
Sample Type: **DS** *Sample Purpose:* **REG**

Collection Date: **18-AUG-15**
Collection Time: **16:00**
Start Depth: **2**
End Depth: **4**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SVOC-III-SL	N	A	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* BAL 8/18/15

Sample Collection Log

Project: ~~136973~~ 500382 Redstone PMC

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-SB015**
Sample Number: **ABG0179**
Sample Name: **013-SB015-DS-ABG0179-REG**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**

Collection Date: **18-AUG-15**
Collection Time: **16:05**
Start Depth: **6**
End Depth: **8**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Analytical Suite	Containers Flt	Frtn	Qty	Size	Units	Type
SVOC-III-SL	N	A	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments:
N/A

Sketch Location:
See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* BLL 8/19/15

HTRW DRILLING LOG

Shaw Environmental & Infrastructure Inc
(A CB&I Company)

Client: CB&T			Hole Number: 013-SB016
Company Name: Shaw Environmental, Inc.		Drilling Subcontractor: GSE	Sheet: 1 of 2 Sheets
Project: Redstone Arsenal		Location: RSA-013	
Name of Driller: (CB) ~~Wesley Casteel~~ Cody Eakin		Manufacturer's Designation of Drill: Geoprobe 7822 DT	
Sizes and Types of Drilling and Sampling Equipment: Hand Auger; 2" Macro Core		Surface Elevation: TBD	
		Date Started: 8-19-15	Date Completed: 8-19-15
Overburden Thickness: > 10'		Depth Groundwater Encountered: Did not encounter	
Depth Drilled into Rock: 0		Depth to Water and Elapsed Time After Drilling Completed: NA	
Total Depth of Hole: 10'		Other Water Level Measurements (Specify): NA	

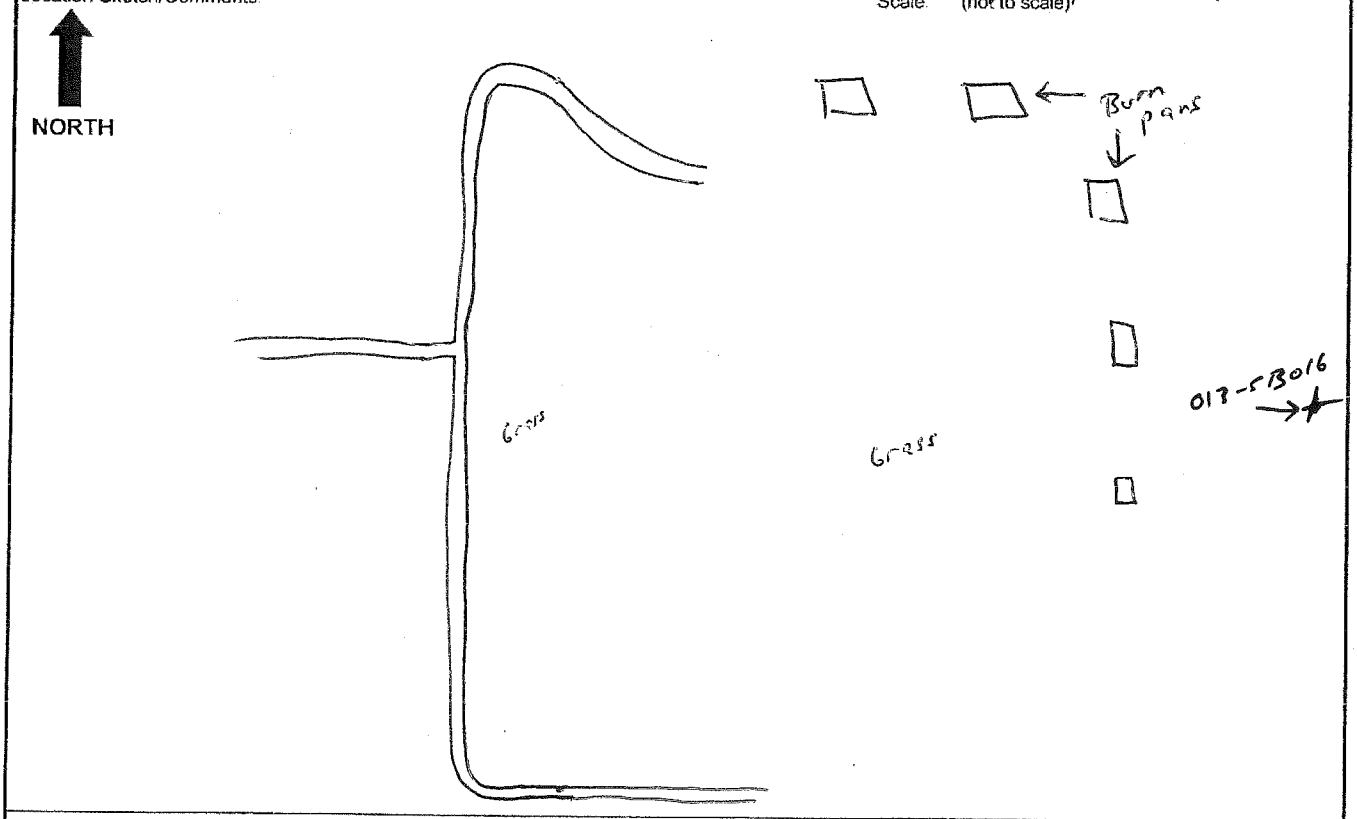
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	V		Explosives, Perch	NA	NA	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	yes	NA	NA	L. Ryan Bailey

Location Sketch/Comments:

Scale: (not to scale)



Project	Hole Number
Redstone Arsenal	013-SB016

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

HTRW DRILLING LOG (continuation sheet)

Hole Number: 013-SB016

Project: Redstone Arsenal | Geologist: R. Bailey | Sheet 2 of 2 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Lithe	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	0-5 → Red (2.5YR 4/8) silty clay, med stiff, med plast. moist.	CL	0-5 0.0	NA ↓	ABG 0180 MS/MSD (0-1)	5/5	Hand Auger to 5 ft.
	5	5-10 → Red (2.5YR 5/8) clay w/ gray mottling. stiff. med. plast. slightly moist.	CL	5-10 0.0		ABG 0181 (2-4) ABG 0182 (6-8)	5/5	
	10							

Project: RSA | Hole Number: 013-SB016

Sample Collection Log

500382
Project: ~~136973~~ Redstone PMC (EPM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-SB016**
Sample Number: **ABG0180**
Sample Name: **013-SB016-SS-ABG0180-REG**
Sampling Method: **HA**
Sample Type: **SS** *Sample Purpose:* **REG**

Collection Date: **19-AUG-15**
Collection Time: **10:35**
Start Depth: **0**
End Depth: **1**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SVOC-III-SL	N	A	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* BLA 8/19/15

Sample Collection Log

Project: ~~136973~~ 5003862 Redstone PMC (EPM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-SB016**
Sample Number: **ABG0180-MS**
Sample Name: **013-SB016-SS-ABG0180-MS-MS**
Sampling Method: **HA**
Sample Type: **SS** *Sample Purpose:* **MS**

Collection Date: **19-AUG-15**
Collection Time: **10:35**
Start Depth: **0**
End Depth: **1**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SVOC-III-SL	N	A	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* BM 8/19/15

Sample Collection Log

Project: ~~136973~~ 500382 Redstone PMC (EPM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-SB016**
Sample Number: **ABG0180-MSD**
Sample Name: **013-SB016-SS-ABG0180-MSD-MSD**
Sampling Method: **HA**
Sample Type: **SS** *Sample Purpose:* **MSD**

Collection Date: **19-AUG-15**
Collection Time: **10:35**
Start Depth: **0**
End Depth: **1**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SVOC-III-SL	N	A	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* BAL 8/19/15

Sample Collection Log

Project: ~~136973~~ 500382 Redstone PMC (EGM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-SB016**
Sample Number: **ABG0181**
Sample Name: **013-SB016-DS-ABG0181-REG**
Sampling Method: **HA**
Sample Type: **DS** *Sample Purpose:* **REG**

Collection Date: **19-AUG-15**
Collection Time: **10:40**
Start Depth: **2**
End Depth: **4**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SVOC-III-SL	N	A	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log (EGM)

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* BNL 8/19/15

Sample Collection Log

Project: ~~136973~~ 500382 Redstone PMC (EPM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-SB016**
Sample Number: **ABG0182**
Sample Name: **013-SB016-DS-ABG0182-REG**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**

Collection Date: **19-AUG-15**
Collection Time: **10:50**
Start Depth: **6**
End Depth: **8**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SVOC-III-SL	N	A	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* 8/19/15

HTRW DRILLING LOG

Shaw Environmental & Infrastructure Inc
(A CB&I Company)

Client: CB&I			Hole Number: 013-SB017
Company Name: Shaw Environmental, Inc.		Drilling Subcontractor: GSE	Sheet: 1 of 2 Sheets
Project: Redstone Arsenal		Location: RSA-013	
Name of Driller: ~~Wesley Casteel~~ (RB) Cody Eakin		Manufacturer's Designation of Drill: Geoprobe 7822 DT	
Sizes and Types of Drilling and Sampling Equipment: Hand Auger; 2" Macro Core		Surface Elevation: TBD	
		Date Started: 8-19-15	Date Completed: 8-19-15
Overburden Thickness: >10'		Depth Groundwater Encountered: Did not encounter	
Depth Drilled into Rock: 0		Depth to Water and Elapsed Time After Drilling Completed	
Total Depth of Hole: 10'		Other Water Level Measurements (Specify): NA	

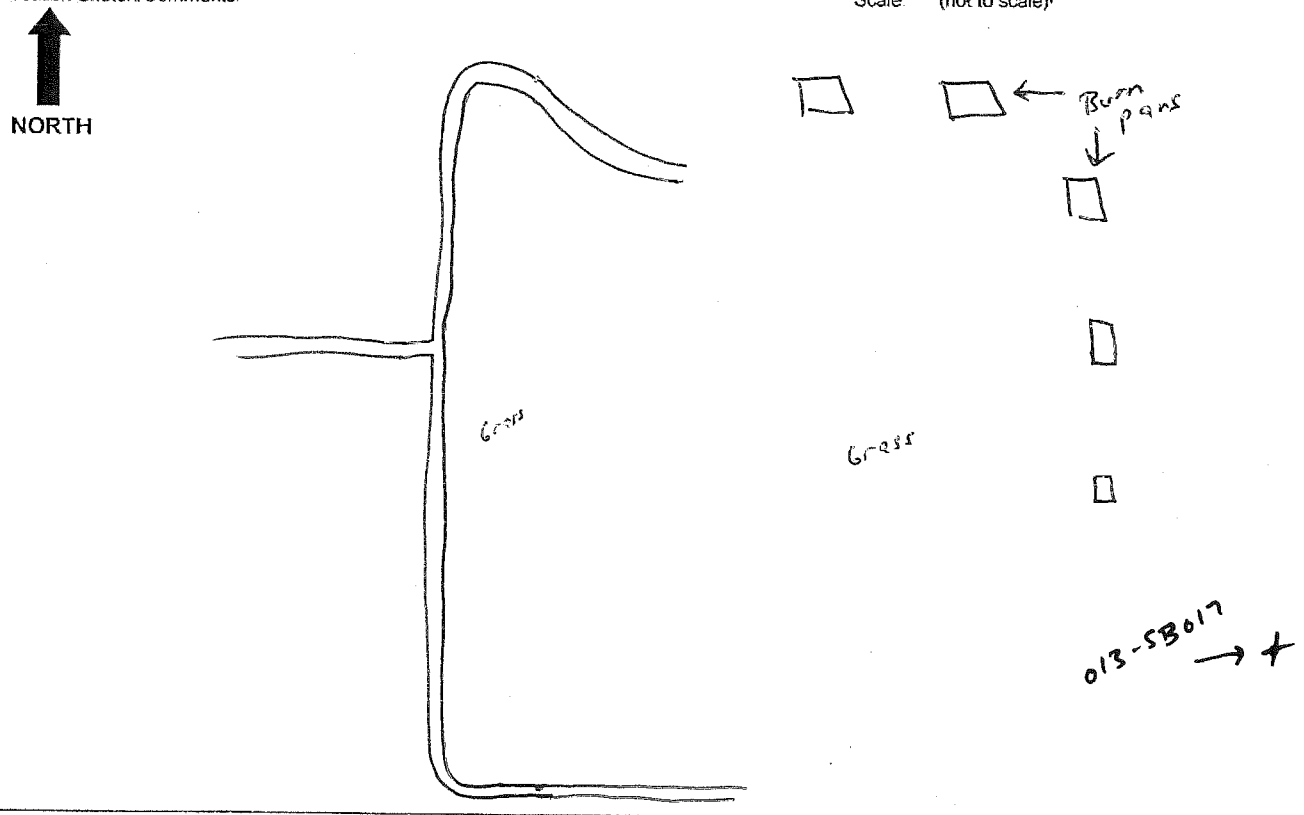
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
	NA	NA	NA

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	V		Explosives, Perc	NA	NA	NA

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	yes	NA	NA	L. Ryan Bailey

Location Sketch/Comments:

Scale: (not to scale)



Project: Redstone Arsenal	Hole Number: 013-SB017

Shaw Environmental & Infrastructure, Inc
(A CB&I Company)

HTRW DRILLING LOG

(continuation sheet)

Hole Number: 013-SB017

Project: Redstone Arsenal

Geologist: R. Bailey

Sheet 2 of 2 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0	0-5 → Brown (7.5 YR 4/3) silty clay. Some foreign debris from 0.5 inches to 1 ft. Seems to be burned material. From 2-5 ft is stained and has petro odor. clay is med soft Low Plast. Moist.	CL	0-5 0.0	NA ↓	ABG 0183 (0-1) ABG 0184 (2-4)	5/5	Hand Auger to 5 ft.
	5	5-10 → Brown (7.5 YR 4/3) silty clay. Med soft. Low plast. Moist. Petro odor from 5-10.		5-10 0.0		ABG 0185 (6-8)	5/5	

Project: RSA

Hole Number: 013-SB017

Sample Collection Log

Project: ~~136973~~ 500382 Redstone PMC (EJM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-SB017**
Sample Number: **ABG0183**
Sample Name: **013-SB017-SS-ABG0183-REG**
Sampling Method: **HA**
Sample Type: **SS** *Sample Purpose:* **REG**

Collection Date: **19-AUG-15**
Collection Time: **11:05**
Start Depth: **0**
End Depth: **1**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SVOC-III-SL	N	A	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-18-15 *Reviewed BY / Date:* BM 8/19/15

Sample Collection Log

Project: ~~136973~~ 500382 Redstone PMC (EQM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-SB017**
Sample Number: **ABG0184**
Sample Name: **013-SB017-DS-ABG0184-REG**
Sampling Method: **HA**
Sample Type: **DS** *Sample Purpose:* **REG**

Collection Date: **19-AUG-15**
Collection Time: **11:10**
Start Depth: **2**
End Depth: **4**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SVOC-III-SL	N	A	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: R. Bailey 8-18-15

Reviewed BY / Date: BM 8/19/15

Sample Collection Log

Project: ~~136973~~ 500382 Redstone PMC (EPM)

Manager: ~~Don Burton~~ John Nenni

RFA / COC Number: ABG08192015-S-EMP

Location Code: **013-SB017**
Sample Number: **ABG0185**
Sample Name: **013-SB017-DS-ABG0185-REG**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**

Collection Date: **19-AUG-15**
Collection Time: **11:15**
Start Depth: **6**
End Depth: **8**
Sample Matrix: **SOIL**
Sample Team: **RBG**

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SVOC-III-SL	N	A	1	4	oz	CWM

ERPIMS Values:
Sacode: N/A
Lot Control#:

Comments: N/A

Sketch Location:

See drilling log

Logged BY / Date: Ryan Bailey 8-18-15 *Reviewed BY / Date:* BNL 8/19/15

A/QC
AKD
7/30/98

HTRW DRILLING LOG

District: Savannah USACE		Hole Number: P13-SB01
Company Name: IT Corporation	Drill Subcontractor: Miller	Sheet: 1 of 3 Sheets
Project: Redstone Arsenal	Location: Madison County, Huntsville, Alabama	
Name of Driller: Doug Bishop	Manufacture's Designation of Drill: CME-55D	
Sizes and Types of Drilling and Sampling Equipment: 4¼" HSA, Carbon Steel 2"x2' split spoons; 2"x2" Stainless steel split spoons. SS bowl.	Hole Location: RSA-13	
	Surface Elevation:	
	Date Started: 6/28/98	Date Completed: 6/28/98
Overburden Thickness: NA	Depth Groundwater Encountered: ≈ 14 feet	
Depth Drilled into Rock: NA	Depth to Water and Elapsed Time After Drilling Completed: —	
Total Depth of Hole: 16 ft.	Other Water Level Measurements (Specify):	

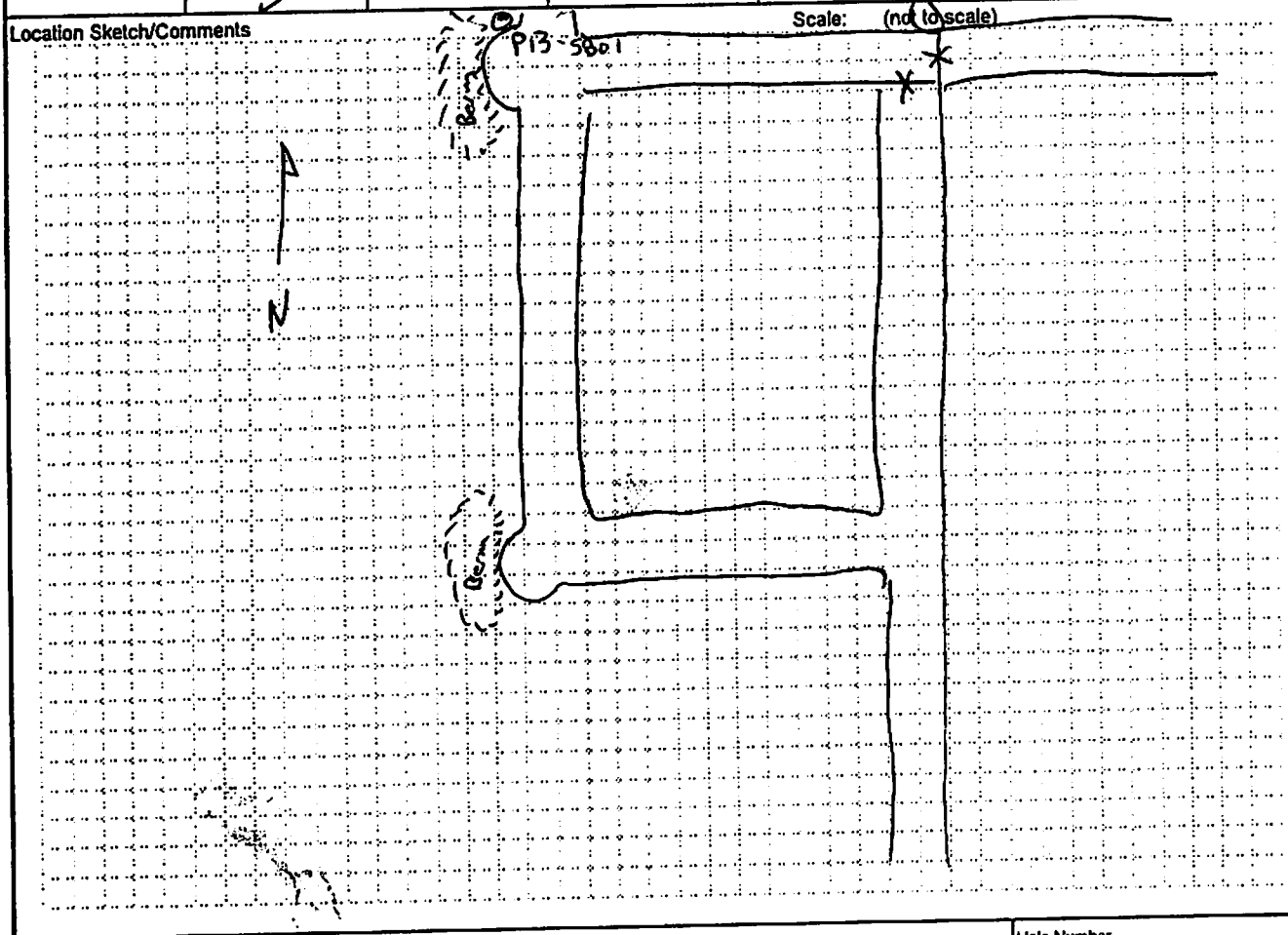
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
none			

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	✓	✓	SVOCs	Explosives	TPH-DRO	

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	✓			Wendy Wilt

Location Sketch/Comments

Scale: (not to scale)



Project	Hole Number
Redstone Arsenal, IT project number 772650	P13-SB01

HTRW DRILLING LOG (continuation sheet)

Hole Number: P13-SB01

Project: Redstone Arsenal | Geologist: W. White | Sheet 2 of 3 Sheets

Elev (ft)	Depth (ft bgs)	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	1	clay, silty (25%), medium plasticity, dry, high dry strength, homogeneous. very stiff. Dark Red (2.5YR 3/6)	ML	PID 30.14 FID 65.01			1.0	UXO cleared
	2			PID 29.12 FID 55.63			2.0	
	3							
	4					4.0 PX004 (1455)		UXO cleared metal near
	5			PID 26.41 FID 73.41			2.0	
	6	(35%) (6.0') Sand, silty, clayey, well sorted, poorly graded, moist fine sand, moderately well rounded, medium dense Yellowish Red (5YR 5/6)	SM	PID 23.40		6.0	3.0	UXO cleared
	7	decreasing silt and clay content to (15%)		FID 50.41				
	8	clay, silty, medium plasticity, moist, homogeneous. very stiff Yellowish Red (5YR 4/6) (8.5')	CL					UXO cleared
	9	Sand, silty (10%), well sorted, poorly graded, moist to wet. moderately well rounded to sub rounded, medium dense Yellowish Red (5YR 4/6)	SP	PID 26.79 FID 61.34			2.0	
	10							UXO cleared

Project: Redstone Arsenal, IT Project Number 772650 | Hole Number: P13-SB01

Htrwc

HTRW DRILLING LOG (continuation sheet)

Hole Number: P13-SB01

Project: Redstone Arsenal | Geologist: W. White | Sheet 3 of 3 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	11							
	12		SP					UXO cleared
	13							
		(14.0')						
	14	Sand, silty (10%) well sorted poorly graded, saturated, moderately well rounded to subrounded, medium dense to loose.	SP	PID 21.31 FID 23.41		PX005 (1520)	1.0 / 2.0	collected 2 spoons
	15							
		(16.0')						
	16	Total Depth of Boring 16.0 ft						
	17							
	0							
	9							
	8							

Project: Redstone Arsenal, IT Project Number 772650 | Hole Number: P13-SB01

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 772650 Redstone Arsenal

Manager: Donnie C. Burton

Operable Unit: **OU_14**
Site: **RSA-13**
Location Code: **P13-SB01**
Sample Number: **PX0001**
Sample Name: **RSA-P13-SB01-SS-PXOOO1-REG**
Sampling Method: **SS**

RFA / COC Number: _____
Collection Date: 9/3/98
Collection Time: 0810
Start Depth: 0'
End Depth: 1'

Sample Team: Dan Viggerman
Rick Gallagher

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	2	4	oz	CWM
DRO	N	B	1	8	oz	CWM
SEMIVOLATILES	N	B	1	8	oz	CWM
METALS	N	C	1	4	oz	CWM
PH	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	8	oz	CWM

Comments:

Sketch Location:

See Boring Log

Logged BY / Date: 9/3/98

Reviewed BY / Date: DD 9/3/98

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 772650 Redstone Arsenal

Manager: Donnie C. Burton

Operable Unit: OU_14
Site: RSA-13
Location Code: P13-SB01
Sample Number: PX0001-MS
Sample Name: RSA-P13-SB01-SS-PXOOO1-MS
Sampling Method: SS

RFA / COC Number: _____
Collection Date: 9/3/98
Collection Time: 0810
Start Depth: 0'
End Depth: 1'

Sample Team: Dan Opperman
Rick Gallagher

Analytical Suite	Flt	Frtn	Containers Qty	Size	Units	Type
VOLATILES	N	A	2	4	oz	CWM
DRO	N	B	1	8	oz	CWM
SEMIVOLATILES	N	B	1	8	oz	CWM
METALS	N	C	1	4	oz	CWM
PH	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	8	oz	CWM

Comments:

Sketch Location:

See Boring Log

Logged BY / Date: [signature] 9/3/98

Reviewed BY / Date: [signature] 9-3-98

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 772650 Redstone Arsenal

Manager: Donnie C. Burton

Operable Unit: OU_14
Site: RSA-13
Location Code: P13-SB01
Sample Number: PX0001-MSD
Sample Name: RSA-P13-SB01-SS-PXOOO1-MSD
Sampling Method: SS

RFA / COC Number: _____
Collection Date: 9/3/98
Collection Time: 0810
Start Depth: 0'
End Depth: 1'

Sample Team: Dan Vipperman
Rick Gallagher

Analytical Suite	Containers Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	2	4	oz	CWM
DRO	N	B	1	8	oz	CWM
SEMIVOLATILES	N	B	1	8	oz	CWM
METALS	N	C	1	4	oz	CWM
PH	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	8	oz	CWM

Comments:

Sketch Location:

See Boring log

Logged BY / Date: 9/3/98 DV

Reviewed BY / Date: DD 9-3-98

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 772650 Redstone Arsenal

Manager: Donnie C. Burton

Operable Unit: **OU_14**
Site: **RSA-13**
Location Code: **P13-SB01**
Sample Number: **.PX0002**
Sample Name: **RSA-P13-SB01-SS-PXOOO2-FD**
Sampling Method: **SS**

RFA / COC Number: _____
Collection Date: 9/3/98
Collection Time: 0810
Start Depth: 0'
End Depth: 1'

Sample Team: Dan Kippermon
Rick Gallagher

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	2	4	oz	CWM
DRO	N	B	1	8	oz	CWM
SEMIVOLATILES	N	B	1	8	oz	CWM
METALS	N	C	1	4	oz	CWM
PH	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	8	oz	CWM

Comments:

Sketch Location:

See Boring Log

Logged BY / Date: 9/3/98

Reviewed BY / Date: 9-3-98

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 772650 Redstone Arsenal

Manager: Donnie C. Burton

Operable Unit: **OU_14**
Site: **RSA-13**
Location Code: **P13-SB01**
Sample Number: **PX0003**
Sample Name: **RSA-P13-SB01-SS-PXOOO3-FS**
Sampling Method: **SS**

RFA / COC Number: _____
Collection Date: 9/3/98
Collection Time: 0810
Start Depth: 0'
End Depth: 1'

Sample Team: Dan Kilpatrick
Rick Gallagher

Analytical Suite	Containers Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	2	4	oz	CWM
DRO	N	B	1	8	oz	CWM
SEMIVOLATILES	N	B	1	8	oz	CWM
METALS	N	C	1	4	oz	CWM
PH	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	8	oz	CWM

Comments:

Sketch Location:

SEE Boring Log

Logged BY / Date: [signature] 9/3/98

Reviewed BY / Date: DB 9-3-98

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 772650 Redstone Arsenal

Manager: Donnie C. Burton

Operable Unit: **OU_14**
Site: **RSA-13**
Location Code: **P13-SB01**
Sample Number: **PX0004**
Sample Name: **RSA-P13-SB01-DS-PX0004-REG**
Sampling Method: **SS**

RFA / COC Number: _____
Collection Date: 8/28/98
Collection Time: 1455
Start Depth: 4.0'
End Depth: 6.0'
Sample Team: W. White

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	2	4	oz	CWM
DRO	N	B	1	8	oz	CWM
SEMIVOLATILES	N	B	1	8	oz	CWM
METALS	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	8	oz	CWM

Comments:

Sketch Location:

See boring log

Logged BY / Date: [signature] 8/28/98

Reviewed BY / Date: [signature] 8-26-98

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 772650 Redstone Arsenal

Manager: Donnie C. Burton

Operable Unit: **OU_14**
Site: **RSA-13**
Location Code: **P13-SB01**
Sample Number: **PX0005**
Sample Name: **RSA-P13-SB01-DS-PX0005-REG**
Sampling Method: **SS**

RFA / COC Number: _____
Collection Date: 8/28/98
Collection Time: 1520
Start Depth: 14.0'
End Depth: 16.0'
Sample Team: D. White

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	2	4	oz	CWM
DRO	N	B	1	8	oz	CWM
SEMIVOLATILES	N	B	1	8	oz	CWM
METALS	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	8	oz	CWM

Comments:

Sketch Location:

See boring log

Logged BY / Date: D. White 8/28/98 *Reviewed BY / Date:* DL 8-28-98

QA/QC
AKP
7/30/98

HTRW DRILLING LOG

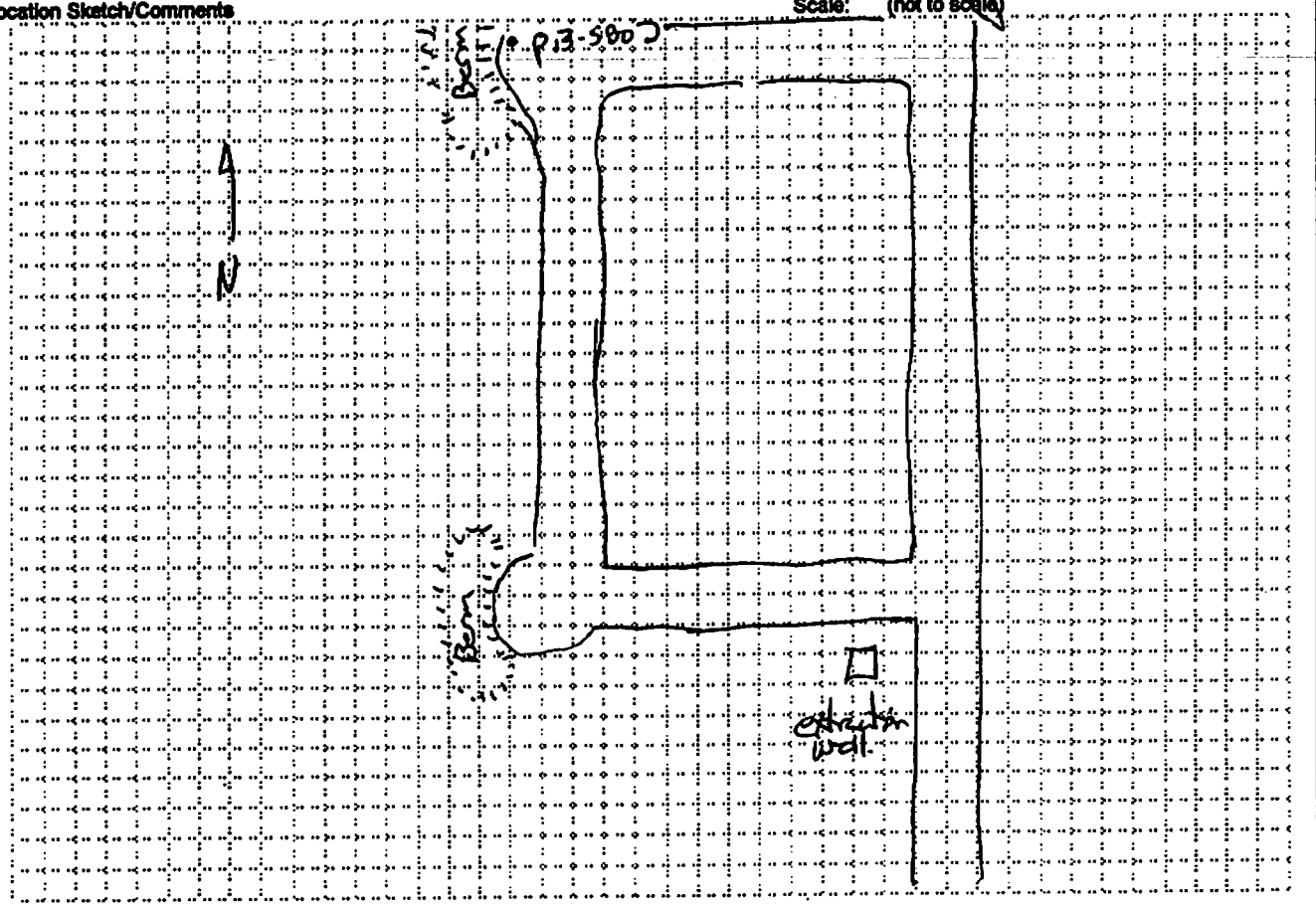
District: Savannah USACE		Hole Number: P13-SB02
Company Name: IT Corporation	Drill Subcontractor: M. Iler Drilling	Sheet: 1 of 3 & 4
Project: Redstone Arsenal	Location: Madison County, Huntsville, Alabama	
Name of Driller: Doug Bishop	Manufacture's Designation of Drill: CME - 550	
Sizes and Types of Drilling and Sampling Equipment: 8 1/4" HSA, Carbon Steel 2"x2" Split Spoons; 2x2" SS Split Spoon; SS bowl	Hole Location: RSA-13	
	Surface Elevation:	
	Date Started: 8/28/98	Date Completed: 8/28/98
Overburden Thickness: NA	Depth Groundwater Encountered: ± 15.0'	
Depth Drilled into Rock: NA	Depth to Water and Elapsed Time After Drilling Completed: NA	
Total Depth of Hole: 16.0'	Other Water Level Measurements (Specify): NA	

Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
none			

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	✓	✓	SVOCs	Explosives	TPH-DRO	

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	✓			

Location Sketch/Comments — Scale: (not to scale)



Project	Hole Number
Redstone Arsenal, IT project number 772650	P13-SB02

HTRW DRILLING LOG (continuation sheet)	Hole Number: P13-SB02
Project: Redstone Arsenal	Geologist: W. White — Sheet 2 of 3 Sheets

Elev (ft)	Depth (ft bgs)	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0–2			PID FID				
	2–4	clay, silty (20%), medium plasticity, dry, very stiff to hard, high dry strength. Dark Red (2.5YR3/6)	ML	PID 50.84 FID 13.26		2.0' PX007 (1305)	2.0	UXO cleared
	4–6	(4.0') silt content decreasing to 10%		PID 45.26 FID 52.31		4.0'	2.0	UXO cleared metal noted near borehole
	6–8	(6.25') Sand, clayey, silty, well sorted (poorly graded), micaceous, moist, moderately well sorted intermittent beds of clayey silt @ 2" thick. Yellowish Red (5YR 4/6).	SP	PID 60.24 FID 40.31	6.0' PX9003 (1335)		2.0	UXO cleared past most metal
	8–10			PID 2.36 FID 21.36	8.0'		2.0	UXO cleared

HTRW DRILLING LOG (continuation sheet)

Hole Number: P13-SB02

Project: Redstone Arsenal | Geologist: W. Whyte | Sheet 3 of 3 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/Lith	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	11							UXO cleared
	12	(12.5')						
	13				14.0	14.0		
	14	Sand, silty (10%), well sorted, poorly graded, micaceous, moist moderately well rounded, intermittent clayey silt. Yellowish Red (5YR 4/6)	SP	PID 48.13 FID 29.46	PX9004 (1355)	PX008 (1355)	2.0	
	15	(16.0')						
	16				16.0	16.0		
	17	Total Depth of Hole = 16.0 ft.						
	8							
	9							
	0							

Project: Redstone Arsenal, IT Project Number 772650 | Hole Number: P13-SB02

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 772650 Redstone Arsenal

Manager: Donnie C. Burton

Operable Unit: **OU_14**
Site: **RSA-13**
Location Code: **P13-SB02**
Sample Number: **PX0006**
Sample Name: **RSA-P13-SB02-SS-PXOOO6-REG**
Sampling Method: **SS**

RFA / COC Number: _____
Collection Date: 9/3/98
Collection Time: 0720
Start Depth: 0'
End Depth: 1'

Sample Team: Dan Vippermann
Rick Gallagher

Analytical Suite	Flt	Frtn	Containers Qty	Size	Units	Type
VOLATILES	N	A	2	4	oz	CWM
DRO	N	B	1	8	oz	CWM
SEMIVOLATILES	N	B	1	8	oz	CWM
METALS	N	C	1	4	oz	CWM
PH	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	8	oz	CWM

Comments:

Sketch Location:

See Boring log

Logged BY / Date: [signature] 9/3/98

Reviewed BY / Date: [signature] 9-3-98

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 772650 Redstone Arsenal

Manager: Donnie C. Burton

Operable Unit: **OU_14**
Site: **RSA-13**
Location Code: **P13-SB02**
Sample Number: **PX0007**
Sample Name: **RSA-P13-SB02-DS-PX0007-REG**
Sampling Method: **SS**

RFA / COC Number: _____
Collection Date: 8/28/98
Collection Time: 1305

Start Depth: 2.0
End Depth: 4.0

Sample Team: W. White

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	2	4	oz	CWM
DRO	N	B	1	8	oz	CWM
SEMIVOLATILES	N	B	1	8	oz	CWM
METALS	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	8	oz	CWM

Comments:

Sketch Location:

See boring log

Logged BY / Date: W. White 8/28/98 *Reviewed BY / Date:* DA 8-28-98

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 772650 Redstone Arsenal

Manager: Donnie C. Burton

Operable Unit: OU_14
Site: RSA-13
Location Code: P13-SB02
Sample Number: PX0008
Sample Name: RSA-P13-SB02-DS-PX0008-REG
Sampling Method: SS

RFA / COC Number:
Collection Date: 8/28/98
Collection Time: 1355
Start Depth: 14.0
End Depth: 16.0
Sample Team: W. White

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	2	4	oz	CWM
DRO	N	B	1	8	oz	CWM
SEMIVOLATILES	N	B	1	8	oz	CWM
METALS	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	8	oz	CWM

Comments:

Sketch Location:

See boring log

Logged BY / Date: W. White 8/28/98 *Reviewed BY / Date:* W. W. 8-28-98

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 772650 Redstone Arsenal

Manager: Donnie C. Burton

Operable Unit: **OU_14**
Site: **RSA-13**
Location Code: **P13-SB02**
Sample Number: **PX9003**
Sample Name: **RSA-P13-SB02-DS-PX9003-REG**
Sampling Method: **SS**

RFA / COC Number: _____
Collection Date: 8/28/98
Collection Time: 1335

Start Depth: 6.0'
End Depth: 8.0'

Sample Team: W. White

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
ASTM MOIST	N	A	1	8	oz	CWM
BULK DENSITY	N	A	1	8	oz	CWM
GRAIN	N	A	1	8	oz	CWM
POROSITY	N	A	1	8	oz	CWM

Comments:

Sketch Location:

See boring log

Logged BY / Date: W. White 8/28/98 *Reviewed BY / Date:* DL 8-28-98

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 772650 Redstone Arsenal

Manager: Donnie C. Burton

Operable Unit: OU_14
Site: RSA-13
Location Code: P13-SB02
Sample Number: PX9004
Sample Name: RSA-P13-SB02-DS-PX9004-REG
Sampling Method: SS

RFA / COC Number: _____
Collection Date: 8/28/98
Collection Time: 1355
Start Depth: 14.0'
End Depth: 16.0'

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
POROSITY	N	A	1	8	oz	CWM

Sample Team: W. White

Comments:

Sketch Location:

See boring log

Logged BY / Date: [signature] 8/28/98 *Reviewed BY / Date:* [signature] 8-28-98

A/QC
AKD
9/30/98

HTRW DRILLING LOG

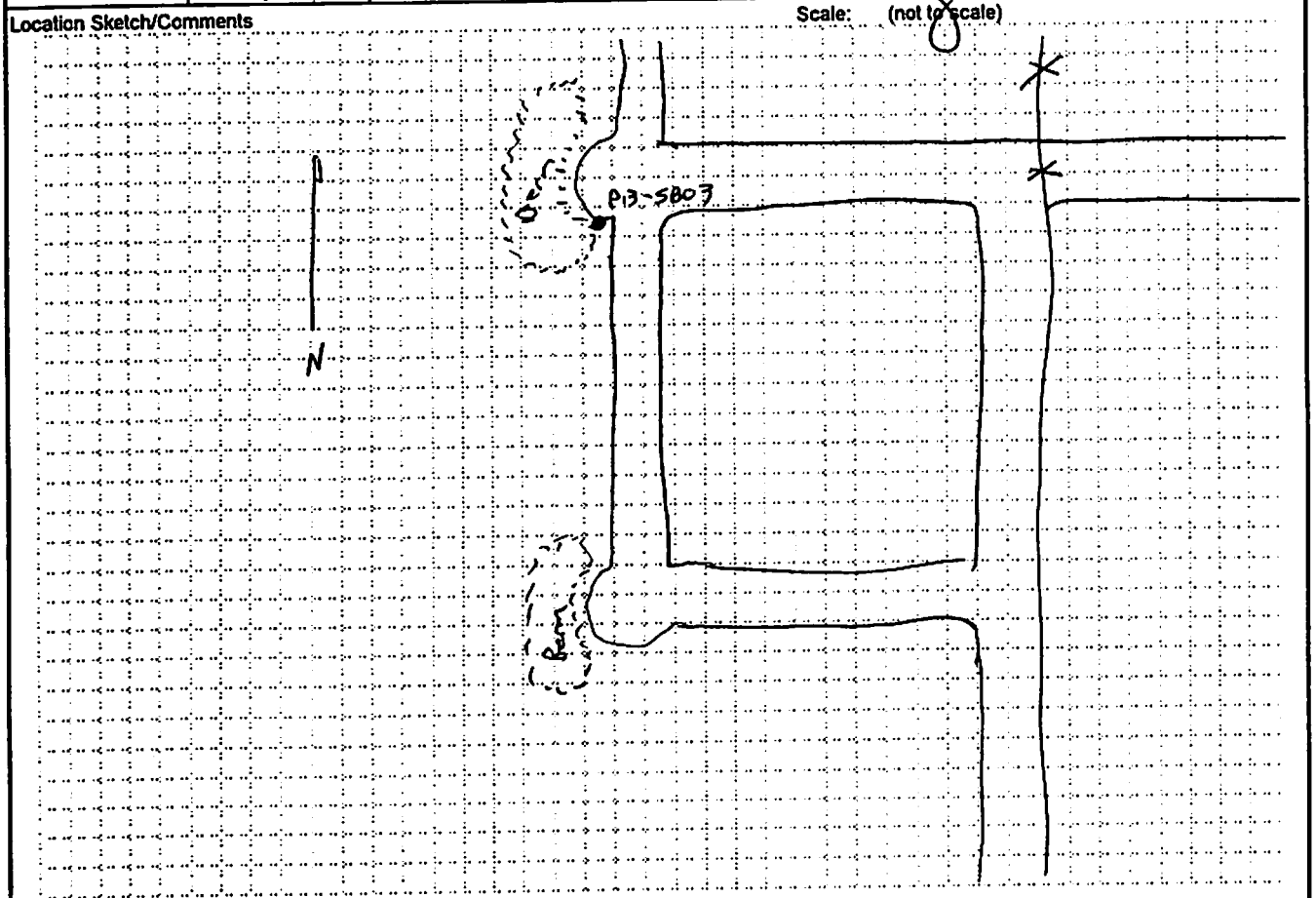
District: Savannah USACE		Hole Number: P13-SB03
Company Name: IT Corporation	Drill Subcontractor: Miller Drilling	Sheet: 1 of 3 Sheets
Project: Redstone Arsenal	Location: Madison County, Huntsville, Alabama	
Name of Driller: Doug Bishop	Manufacture's Designation of Drill: CME-550	
Sizes and Types of Drilling and Sampling Equipment: 4¼ HSA Carbon Steel, 2'x2" Split Spoon; 2'x2" SS Split Spoon; SS bowl	Hole Location: RSA-13	
	Surface Elevation:	
	Date Started: 8/28/98	Date Completed: 8/28/98
Overburden Thickness: NA	Depth Groundwater Encountered: ± 15	
Depth Drilled into Rock: NA	Depth to Water and Elapsed Time After Drilling Completed: NA	
Total Depth of Hole: 16.0 ft	Other Water Level Measurements (Specify): NA	

Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
None			

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	✓	✓	SVOCs	Explosives	TPH-DRO	

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	✓			Wesley Wilbanks

Location Sketch/Comments — Scale: (not to scale)



Project	Hole Number
Redstone Arsenal, IT project number 772650	P13-SB03

HTRW DRILLING LOG (continuation sheet)

Hole Number: P13-SB03

Project: Redstone Arsenal | Geologist: W. White | Sheet 2 of 3 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0–2	Clay, silty (30%), medium to low plasticity, dry, very stiff, homogeneous, blocky. Dark Red (2.5YR 3/6) (2.0)	CL	PID 72.43 FID 17.73			2.0	UXO cleared.
	2–4	Clay, silty (10%), medium plasticity, dry, very stiff to hard, homogeneous, carbonized organic matter, high dry strength. Dark Red (2.5YR 3/6)		PID 34.74 FID 27.04			2.0	UXO cleared
	4–6		ML	PID 67.16 FID 18.31			2.0	UXO cleared noted metal close near well
	6–8			PID 59.31 FID 27.13			1.0	UXO cleared past metal object.
	8–9	Sand, silty (40%), well sorted poorly graded, moist, homogeneous medium dense. Yellowish Red (5YR 4/6). (8.25')	SP	PID 17.85 FID 31.13		8.0' PXRD (1100) 10'	2.0	
	9–10							

Project: Redstone Arsenal, IT Project Number 772650 | Hole Number: P13-SB03

Htrwc

HTRW DRILLING LOG (continuation sheet)

Hole Number: P13-SB03

Project: Redstone Arsenal | Geologist: W. White | Sheet 3 of 3 Sheets

Elev (ft)	Depth (ft bgs)	Description of Materials	USCS/Lith	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	11		SP					UXO cleared
	12							
		(12.5')						
	13							
						14.0		
	14	Sand, silty (25%), well sorted, poorly graded, wet to saturated, micaceous, medium dense, Yellowish Red (5YR 4/6)	SP	PID 18.42 FID 21.74		PX011 (1105)	1.5	
	15							
						16.0		
	16	Total Depth of Hole = 16.0 feet.						
	17							
	18							
	19							
	20							

Project: Redstone Arsenal, IT Project Number 772650 | Hole Number: P13-SB03

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 772650 Redstone Arsenal

Manager: Donnie C. Burton

Operable Unit: **OU_14**
Site: **RSA-13**
Location Code: **P13-SB03**
Sample Number: **PX0009**
Sample Name: **RSA-P13-SB03-SS-PXOOO9-REG**
Sampling Method: **SS**

RFA / COC Number: _____
Collection Date: 9/2/98
Collection Time: 1515

Start Depth: 0'
End Depth: 1'

Sample Team: Dan Vipperman
Rick Gallagher

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	2	4	oz	CWM
DRO	N	B	1	8	oz	CWM
SEMIVOLATILES	N	B	1	8	oz	CWM
METALS	N	C	1	4	oz	CWM
PH	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	8	oz	CWM

Comments:

Sketch Location:

see Boring Log

Logged BY / Date: [signature] 9/2/98

Reviewed BY / Date: [signature] 9-2-98

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 772650 Redstone Arsenal

Manager: Donnie C. Burton

Operable Unit: **OU_14**
Site: **RSA-13**
Location Code: **P13-SB03**
Sample Number: **PX0010**
Sample Name: **RSA-P13-SB03-DS-PX0010-REG**
Sampling Method: **SS**

RFA / COC Number: _____
Collection Date: 8/28/98
Collection Time: 1100
Start Depth: 8.0
End Depth: 10.0
Sample Team: W. White

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	2	4	oz	CWM
DRO	N	B	1	8	oz	CWM
SEMIVOLATILES	N	B	1	8	oz	CWM
METALS	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	8	oz	CWM

Comments:

Sketch Location:

See boring log

Logged BY / Date: [signature] 8/28/98 *Reviewed BY / Date:* [signature] 8-28-98

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 772650 Redstone Arsenal

Manager: Donnie C. Burton

Operable Unit: **OU_14**
Site: **RSA-13**
Location Code: **P13-SB03**
Sample Number: **PX0011**
Sample Name: **RSA-P13-SB03-DS-PX0011-REG**
Sampling Method: **SS**

RFA / COC Number: _____
Collection Date: 8/25/98
Collection Time: 1105
Start Depth: 14.0'
End Depth: 16.0'

Sample Team: _____

Analytical Suite	Flt	Frtn	Containers Qty	Size	Units	Type
VOLATILES	N	A	2	4	oz	CWM
DRO	N	B	1	8	oz	CWM
SEMIVOLATILES	N	B	1	8	oz	CWM
METALS	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	8	oz	CWM

Comments:

Sketch Location:

See boring log

Logged BY / Date: [signature] 8/25/98 *Reviewed BY / Date:* [signature] 8-28-98

A/QC
AKD
7/30/98

HTRW DRILLING LOG

District: Savannah USACE		Hole Number: P13-SB04
Company Name: IT Corporation	Drill Subcontractor: Miller Drilling	Sheet: 1 of 3 Sheets
Project: Redstone Arsenal	Location: Madison County, Huntsville, Alabama	
Name of Driller: Doug Bishop	Manufacture's Designation of Drill: CME-550	
Sizes and Types of Drilling and Sampling Equipment: 4¼" HSA, Carbon Steel 2'x2" Split Spoons; 2'x2" SS Split Spoons; SS bowl.	Hole Location: RSA-19	
	Surface Elevation:	
	Date Started: 8/28/98	Date Completed: 8/28/98
Overburden Thickness: NA	Depth Groundwater Encountered: ≈ 15'	
Depth Drilled into Rock: NA	Depth to Water and Elapsed Time After Drilling Completed: NA	
Total Depth of Hole: 16.0 feet	Other Water Level Measurements (Specify): NA	

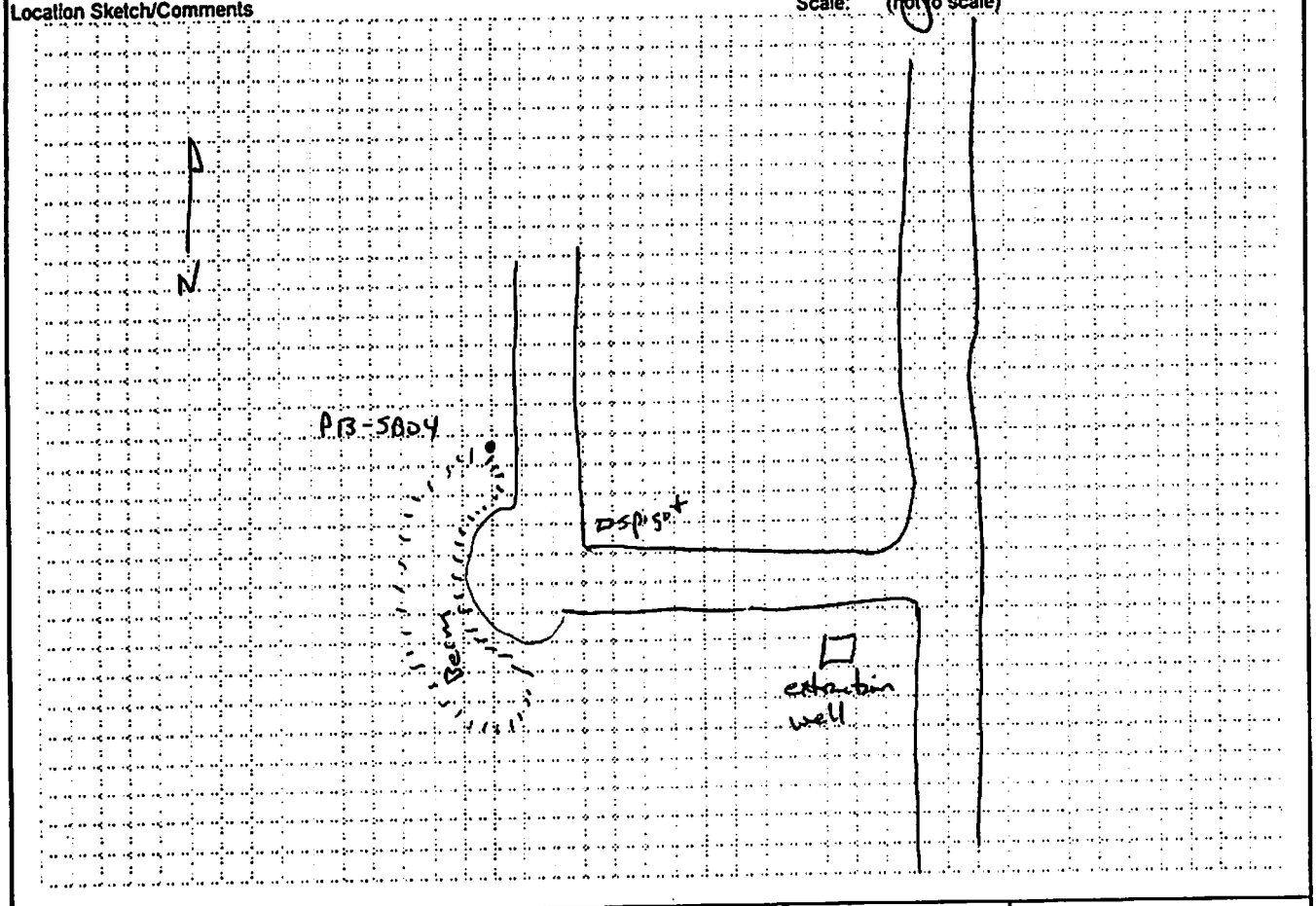
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
none			

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	✓	✓	SVOCs	Explosives	TPH-DRO	

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	✓			

Location Sketch/Comments

Scale: (not to scale)



Project	Hole Number
Redstone Arsenal, IT project number 772650	P13-SB04

HTRW DRILLING LOG (continuation sheet)

Hole Number: P13-SB04

Project: Redstone Arsenal | Geologist: W. White | Sheet 2 of 3 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Lithology	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	1	clay, silty, medium plasticity dry, high dry strength, very stiff to hard, homogeneous. Dark Red (2.5YR 3/6)	ML	PID 11.53 FID 41.07			2.0	
	2	(2.0')						UXO cleared
	3	clay, silty, medium plasticity dry, high dry strength, very stiff to hard, homogeneous. several layers ± 0.5 feet Thick of predominantly silt, low dry strength. Dark Red (2.5YR 3/6)		PID 18.18 FID 48.57			2.0	
	4	(4.0')						UXO cleared metal noted nearby
	5	silt, clayey, medium to low plasticity dry homogeneous, low dry strength Dark Red (2.5YR 3/6)	ML	PID 19.25			2.0	
	6	(5.0') clay, silty, medium plasticity dry, very stiff to hard, high dry strength. mottled. Dark Red (2.5YR 3/6) mottled with light grey (2.5YR)	CL	FID 49.36				UXO cleared
	7	(6.25') clay, silty (35%), medium plasticity. moist, stiff to very stiff. medium dry strength, homogeneous Dark Red (2.5YR 3/6)		PID 8.06 FID 92.31			2.0	
	8		CL			8.0 PXD13 (0925)		UXO cleared
	9			PID 10.31 FID 39.42			2.0	
	10							

Project: Redstone Arsenal, IT Project Number 772650 | 10.0' | Hole Number: P13-SB04

Htrwc

HTRW DRILLING LOG (continuation sheet)

Hole Number: P13-SB04

Project: Redstone Arsenal | Geologist: W. Whale | Sheet 3 of 3 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Lithology	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	11		CL					UXO cleared
	12							
		(12.5')						
	13							
						14.0		
	14	Sand, silty, well sorted, poorly graded, wet to saturated, well to moderately rounded, micaceous. Yellowish Red (5YR 4/6)	SP	PID 16.13		PX014 (0935)		
	15			FID 38.42			2.0	
		(16.0')						
	16					16.0		
		Total Depth of Borehole 16.0 feet						
	17							
	18							
	19							
	20							

Project: Redstone Arsenal, IT Project Number 772650 | Hole Number: P13-SB04

Htrwc

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 772650 Redstone Arsenal

Manager: Donnie C. Burton

Operable Unit: **OU_14**
Site: **RSA-13**
Location Code: **P13-SB04**
Sample Number: **PX0012**
Sample Name: **RSA-P13-SB04-SS-PXOO12-REG**
Sampling Method: **SS**

RFA / COC Number: _____
Collection Date: 9/2/98
Collection Time: 1500

Start Depth: 0'
End Depth: 1'

Sample Team: Dan Vipperman
Rick Gallagher

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	2	4	oz	CWM
DRO	N	B	1	8	oz	CWM
SEMIVOLATILES	N	B	1	8	oz	CWM
METALS	N	C	1	4	oz	CWM
PH	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	8	oz	CWM

Comments:

Sketch Location:

See Boring Log

Logged BY / Date: [signature] 9/2/98

Reviewed BY / Date: DL 9-2-98

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 772650 Redstone Arsenal

Manager: Donnie C. Burton

Operable Unit: **OU_14**
Site: **RSA-13**
Location Code: **P13-SB04**
Sample Number: **PX0013**
Sample Name: **RSA-P13-SB04-DS-PX0013-REG**
Sampling Method: **SS**

RFA / COC Number: _____
Collection Date: 8/28/98
Collection Time: 0925

Start Depth: 8.0
End Depth: 10.0

Sample Team: W. White

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	2	4	oz	CWM
DRO	N	B	1	8	oz	CWM
SEMIVOLATILES	N	B	1	8	oz	CWM
METALS	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	8	oz	CWM

Comments:

Sketch Location:

See boring log

Logged BY / Date: [signature] 8/28/98 *Reviewed BY / Date:* [signature] 8-28-98

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 772650 Redstone Arsenal

Manager: Donnie C. Burton

Operable Unit: OU_14
Site: RSA-13
Location Code: P13-SB04
Sample Number: PX0014
Sample Name: RSA-P13-SB04-DS-PX0014-REG
Sampling Method: SS

RFA / COC Number: _____
Collection Date: 8/28/98
Collection Time: 0935

Start Depth: 14.0
End Depth: 16.0

Sample Team: D. White

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	2	4	oz	CWM
DRO	N	B	1	8	oz	CWM
SEMIVOLATILES	N	B	1	8	oz	CWM
METALS	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	8	oz	CWM

Comments:

Sketch Location: See boring log

Logged BY / Date: [signature] 8/28/98

Reviewed BY / Date: [signature] 8-28-98

2A/QC
AKD
7/30/98

HTRW DRILLING LOG

District: Savannah USACE		Hole Number: P13-5B05
Company Name: IT Corporation	Drill Subcontractor: Miller Drilling	Sheet: 1 of 4 Sheets
Project: Redstone Arsenal	Location: Madison County, Huntsville, Alabama	
Name of Driller: Doug Bishop	Manufacture's Designation of Drill: CME-550	
Sizes and Types of Drilling and Sampling Equipment: 4¼ HSA, Carbon Steel 2' x 2" split spoon; 2' x 2" SS split spoon; SS bowl	Hole Location: RSA13	
	Surface Elevation:	
	Date Started: 8/28/98	Date Completed: 8/28/98
Overburden Thickness: NA	Depth Groundwater Encountered: ≈ 18.0 ft	
Depth Drilled into Rock: NA	Depth to Water and Elapsed Time After Drilling Completed: —	
Total Depth of Hole: 21.0 ft	Other Water Level Measurements (Specify): —	

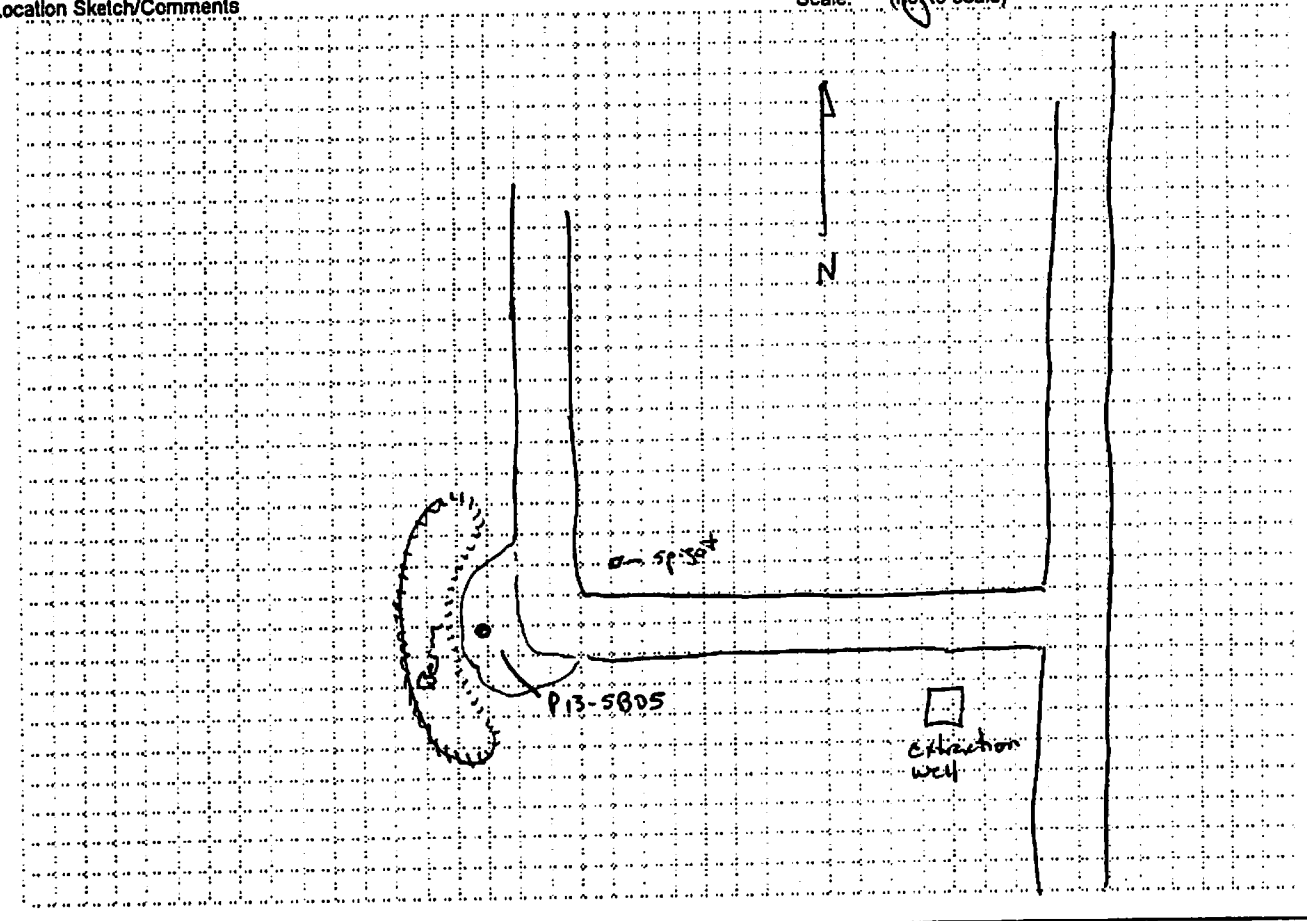
Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
none			

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	✓	✓	SVOC	Explosives	TPH-DRO	

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	✓			Wendy Wilt

Location Sketch/Comments

Scale: (not to scale)



Project	Hole Number
Redstone Arsenal, IT project number 772650	P13-5B05

HTRW DRILLING LOG (continuation sheet)

Hole Number: P13-SB05

Project: Redstone Arsenal | Geologist: W. White | Sheet 2 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0–2					2.0		Auger past first 2 feet of gravel base. UXO cleared
	2–4	Clay, silty (30%), medium plasticity, moist to slightly damp, very stiff, homogeneous. Dark Red (2.5YR 3/6)	CL	PID 30.37 FID 120		PX016 PX017 PX018 (¿740)	2.0	
	4–6			PID 43.21 FID 81.68		~~4.0~~	2.0	UXO cleared metal noted in the side walls
	6–8	(7.5')		PID 65.15 FID 144			2.0	UXO cleared past metal
	7.5–10	Silt, clayey, medium plasticity, moist, stiff, micaceous, homogeneous. Dark Red (2.5YR 3/6)	ML	PID 104 FID 120		8.0	2.0	UXO cleared

HTRW DRILLING LOG (continuation sheet)

Hole Number: P13-SB05

Project: Redstone Arsenal | Geologist: D. White | Sheet 3 of 4 Sheets

Elev (ft)	Depth (ft bgs)	Description of Materials	USCS/ Lithology	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	11		ML					oxo cleared
	12	(12.5)						
	13							
	14	Sand, silty, (30%) well sorted, poorly graded, medium dense. wet, micaceous, well rounded. Yellowish Red (5YR 4/6)	SP	PID 70.63		14.0 PX019 (0800)	2.0	
	15			FID 31.43				
	16					16.0		
	17	(17.5')						≈ ▽
	18		SP					
	19	Sand, silty (5%) well sorted poorly graded, medium dense to loose, saturated, micaceous well rounded, Yellowish Red (5YR 4/6)		PID 46.31			2.0	
	20							

Project: Redstone Arsenal, IT Project Number 772650 | Hole Number: P13-SB05

Htrwc

HTRW DRILLING LOG (continuation sheet)

Hole Number: P13-SB05

Project: Redstone Arsenal

Geologist: W. White

Sheet 4 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
			SP	FID 40.29				
	21	Total Depth of Borehole = 21.0'						
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	0							

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 772650 Redstone Arsenal

Manager: Donnie C. Burton

Operable Unit: **OU_14**
Site: **RSA-13**
Location Code: **P13-SB05**
Sample Number: **PX0015**
Sample Name: **RSA-P13-SB05-SS-PXOO15-REG**
Sampling Method: **SS**

RFA / COC Number: _____

Collection Date: ~~4/28/98~~ 9/1/98

Collection Time: 1450

Start Depth: 0'

End Depth: 1'

Sample Team: Dan Vipperman
Rick Gallagher

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	2	4	oz	CWM
DRO	N	B	1	8	oz	CWM
SEMIVOLATILES	N	B	1	8	oz	CWM
METALS	N	C	1	4	oz	CWM
PH	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	8	oz	CWM

Comments:

Sketch Location:

see Boring log

Logged BY / Date: 9/2/98

Reviewed BY / Date: 9-2-98

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 772650 Redstone Arsenal

Manager: Donnie C. Burton

Operable Unit: **OU_14**
Site: **RSA-13**
Location Code: **P13-SB05**
Sample Number: **PX0016**
Sample Name: **RSA-P13-SB05-DS-PX0016-REG**
Sampling Method: **SS**

RFA / COC Number: _____
Collection Date: 8/28/98
Collection Time: 0740

Start Depth: 2.0
End Depth: 8.0

Sample Team: W. White

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	2	4	oz	CWM
DRO	N	B	1	8	oz	CWM
SEMIVOLATILES	N	B	1	8	oz	CWM
METALS	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	8	oz	CWM

Comments:

Sketch Location:

See boring log

Logged BY / Date: [signature] 8/28/98 *Reviewed BY / Date:* [signature] 8-28-98

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 772650 Redstone Arsenal

Manager: Donnie C. Burton

Operable Unit: **OU_14**
Site: **RSA-13**
Location Code: **P13-SB05**
Sample Number: **PX0017**
Sample Name: **RSA-P13-SB05-DS-PX0017-FD**
Sampling Method: **SS**

RFA / COC Number: _____
Collection Date: 8/28/98
Collection Time: 0740
Start Depth: 2.0
End Depth: 8.0
Sample Team: W. White

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	2	4	oz	CWM
DRO	N	B	1	8	oz	CWM
SEMIVOLATILES	N	B	1	8	oz	CWM
METALS	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	8	oz	CWM

Comments:

Sketch Location:

See boring log

Logged BY / Date: W. White 8/28/98 *Reviewed BY / Date:* WJ 9-28-98

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 772650 Redstone Arsenal

Manager: Donnie C. Burton

Operable Unit: **OU_14**
Site: **RSA-13**
Location Code: **P13-SB05**
Sample Number: **PX0018**
Sample Name: **RSA-P13-SB05-DS-PX0018-FS**
Sampling Method: **SS**

RFA / COC Number: _____
Collection Date: 8/28/98
Collection Time: 0740
Start Depth: 2.0
End Depth: 8.0
Sample Team: D. White

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	2	4	oz	CWM
DRO	N	B	1	8	oz	CWM
SEMIVOLATILES	N	B	1	8	oz	CWM
METALS	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	8	oz	CWM

Comments:

Sketch Location:

See boring log

Logged BY / Date: D. White 8/28/98 *Reviewed BY / Date:* DL 8-28-98

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 772650 Redstone Arsenal

Manager: Donnie C. Burton

Operable Unit: **OU_14**
Site: **RSA-13**
Location Code: **P13-SB05**
Sample Number: **PX0019**
Sample Name: **RSA-P13-SB05-DS-PX0019-REG**
Sampling Method: **SS**

RFA / COC Number: _____
Collection Date: 8/28/98
Collection Time: 0800
Start Depth: 14.0
End Depth: 16.0
Sample Team: W. White

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	2	4	oz	CWM
DRO	N	B	1	8	oz	CWM
SEMIVOLATILES	N	B	1	8	oz	CWM
METALS	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	8	oz	CWM

Comments:

Sketch Location:

See boring log

Logged BY / Date: [signature] 8/28/98 *Reviewed BY / Date:* [signature] 8-28-98

xA/ac
AKD
9/30/98

HTRW DRILLING LOG

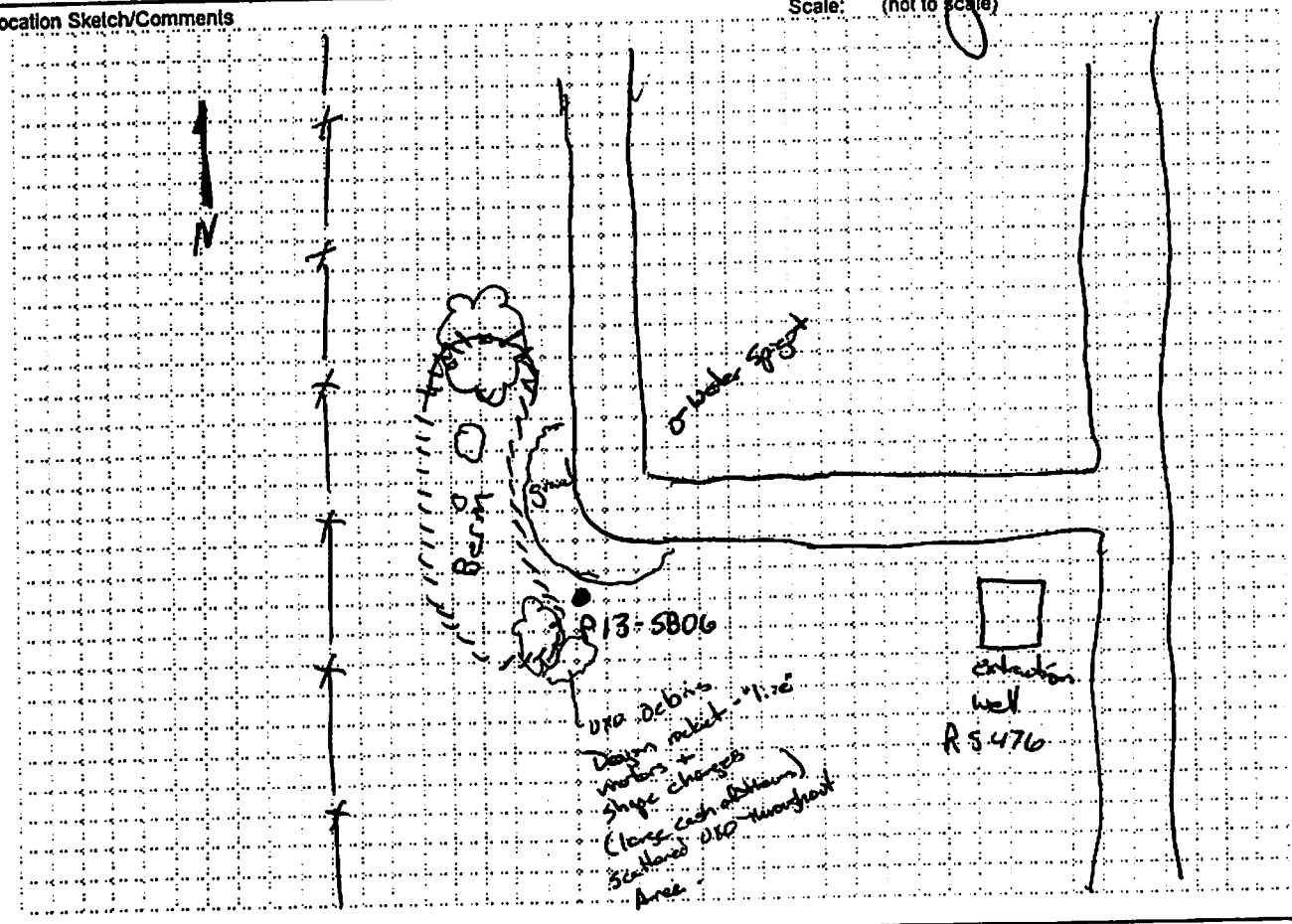
District: Savannah USACE		Hole Number: P13-SB06
Company Name: IT Corporation	Drill Subcontractor: Miller Drilling	Sheet: 1 of 4 Sheets
Project: Redstone Arsenal	Location: Madison County, Huntsville, Alabama	
Name of Driller: Doug Bishop	Manufacture's Designation of Drill: CME-550	
Sizes and Types of Drilling and Sampling Equipment: 4¼" OD Augers, 2½' SS split spoons; 2"x2' Carbon Steel split spoons, SS mond.	Hole Location: RSA-13	
	Surface Elevation:	
	Date Started: 8/27/98	Date Completed: 8/27/98
Overburden Thickness: ~ NA	Depth Groundwater Encountered: ≈18 ft	
Depth Drilled into Rock: ~ NA	Depth to Water and Elapsed Time After Drilling Completed: NA	
Total Depth of Hole: 21.0 ft	Other Water Level Measurements (Specify): NA	

Geotechnical Samples	Disturbed	Undisturbed	Total Number of Core Boxes
None			

Samples for Chemical Analysis	VOC	Metals	Other	Other	Other	Total Core Recovery
	✓	✓	SVOC	explosives	TPH-DRO	

Disposition of Hole	Backfilled	Monitoring Well	Other	Signature of Geologist
	✓			

Location Sketch/Comments — Scale: (not to scale)



Project	Hole Number
Redstone Arsenal, IT project number 772650	P13-SB06

HTRW DRILLING LOG (continuation sheet)

Hole Number: P13-SB06

Project: Redstone Arsenal | Geologist: W. White | Sheet 2 of 4 Sheets

Elev (ft)	Depth (ft bgs)	Description of Materials	USCS/ Litho	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	0						0.0	Augered past 2 feet due to the presence of gravel.
	1							
	2	Silt, clayey, medium to low plasticity, low dry strength, slightly damp, very stiff, Dark red (2.5YR 3/6)		PID 60.13				UXO cleared 1418 metal in the sides
	3		ML	FID 133			2.0	
	4	(4.0') Silt, trace clayey, low plasticity, low dry strength, micaceous, very stiff to stiff, homogeneous, slightly damp, Dark red (2.5YR 4/6)	ML	PID 302		PK021 (1500) 4.0		UXO cleared 1435 metal in the sides
	5			FID 360			2.0	VOC's gathered from 4-6' Pest/PCBs, explosives, metal gathered from 4-8'
	6			PID 172				UXO cleared 1456 past metal in the sides
	7			FID 436			2.0	
	8	(8.0') Becoming moist (8.3')	ML	PID 648		8.0		UXO cleared 1505
	9	fine sand, silty, well sorted, poorly graded, homogeneous, micaceous sand, moist, medium dense, Yellowish red (5YR 5/6)	SM	FID 1500			2.0	
	10							UXO cleared 1513

Project: Redstone Arsenal, IT Project Number 772650 | Hole Number: P13-SB06

Htrwc

HTRW DRILLING LOG (continuation sheet)

Hole Number: P13-SB06

Project: Redstone Arsenal

Geologist: W. White

Sheet 3 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ Unc	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	11							
	12							UXO cleared
	13		SM					
	14			PID 43.62		14 PKO27 1530	1.5	
	15			FID 80.71				
	16					16		
	17	(17.5')						
	18							
	19	Sand, s.Hy (30%), well sorted, poorly graded, saturated, homogeneous, medium dense, Yellowish Red (5YR 5/6)	SM					
	20							

Project: Redstone Arsenal, IT Project Number 772650

Hole Number: P13-SB06

Htrwc

HTRW DRILLING LOG (continuation sheet)

Hole Number: P13-SB06

Project: Redstone Arsenal

Geologist: W. White

Sheet 4 of 4 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/ASTM	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
		Sand, trace silt, well sorted, poorly graded, micaceous, saturated, loose to medium dense, subrounded, yellowish red. (5YR 4/6) (21.0')	SP	PID 47.54 FID 151			2.0	
	21	Total depth of borehole = 21.0 ft						

Project: Redstone Arsenal, IT Project Number 772650

Hole Number: P13-SB06

Htrwc

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 772650 Redstone Arsenal

Manager: Donnie C. Burton

Operable Unit: **OU_14**
Site: **RSA-13**
Location Code: **P13-SB06**
Sample Number: **PX0020**
Sample Name: **RSA-P13-SB06-SS-PXOO20-REG**
Sampling Method: **SS**

RFA / COC Number: _____
Collection Date: 9/2/98
Collection Time: ~~1420~~ 1420
Start Depth: 0'
End Depth: 1'

Sample Team: Dan Vi[illegible]
Rick Gallagher

			Containers			
Analytical Suite	**Flt**	**Frtn**	**Qty**	**Size**	**Units**	**Type**
VOLATILES	N	A	2	4	oz	CWM
DRO	N	B	1	8	oz	CWM
SEMIVOLATILES	N	B	1	8	oz	CWM
METALS	N	C	1	4	oz	CWM
PH	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	8	oz	CWM

Comments:

Sketch Location:

See Boring Log

Logged BY / Date: 9/2/98 *Reviewed BY / Date:* 9-2-98

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 772650 Redstone Arsenal

Manager: Donnie C. Burton

Operable Unit: **OU_14**
Site: **RSA-13**
Location Code: **P13-SB06**
Sample Number: **PX0021**
Sample Name: **RSA-P13-SB06-DS-PX0021-REG**
Sampling Method: **SS**

RFA / COC Number: _____
Collection Date: 8-27-98
Collection Time: 1500

Start Depth: 4
End Depth: 8

Sample Team: W. White

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	2	4	oz	CWM
DRO	N	B	1	8	oz	CWM
SEMIVOLATILES	N	B	1	8	oz	CWM
METALS	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	8	oz	CWM

Comments: See Boring Log

Sketch Location:

Logged BY / Date: DK 8-27-98 *Reviewed BY / Date:* DL 8-27-98

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 772650 Redstone Arsenal

Manager: Donnie C. Burton

Operable Unit: **OU_14**
Site: **RSA-13**
Location Code: **P13-SB06**
Sample Number: **PX0022**
Sample Name: **RSA-P13-SB06-DS-PX0022-REG**
Sampling Method: **SS**

RFA / COC Number: _____
Collection Date: 8-27-98
Collection Time: 1530
Start Depth: 8
End Depth: 12
Sample Team: W. White

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	2	4	oz	CWM
DRO	N	B	1	8	oz	CWM
SEMIVOLATILES	N	B	1	8	oz	CWM
METALS	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	8	oz	CWM

Comments: See Boring Log

Sketch Location:

Logged BY / Date: DS 8-27-98 *Reviewed BY / Date:* DS 8-27-98

RESPONSE TO COMMENTS

Responses to Alabama Department of Environmental Management (ADEM)
Review Comments on the Corrective Measures Implementation Work Plan,
RSA-013, Unlined Inactive Open Burn Pad, Operable Unit 14
Redstone Arsenal, Madison County, Alabama
Dated November 2021

Comments from ADEM dated January 10, 2022 (received via email).

Specific Comments

Comment 1: **Page 3-2, Section 3.4 Cleanup Goals for the Selected Corrective Measures: The last sentence on the page begins, "Cleanup to the 0.045 mg/kg CG will allow the RDX plume…" Please revise this number to 0.45 mg/kg.**

Response 1: The subject sentence on Page 3-2 in Section 3.4 has been revised to state a cleanup goal of 0.45 mg/kg.

Comment 2: **Page 3-4, Section 3.6 Extent of Contaminated Soil: Section states "RDX is present in one surface soil and one subsurface soil sample (boring P13-SB02) at concentrations above its CG (0.45 mg/kg)" and references Figure 2-1. However, the 2-4 foot interval is not colored orange denoting a CG exceedance. There seems to be confusion as to the concentration in this subsurface interval. Some sections of the report have the concentration as 1.23 mg.kg while others (Appendix I) have the concentration listed as 0.23. Clarification of the concentration in this interval is needed. See also Comment # 3.**

Response 2: The last sentence in the first paragraph of Section 3.6 on Page 3-4 has been revised to state: "RDX is present in one surface soil sample at a concentration above its CG (0.45 mg/kg) (Figure 2-1)".

Comment 3: **Figure 2-1 and Appendix I: The figure displays the 2-4 foot interval in boring P13-SB02 as containing a RDX concentration of 1.23 J. This would mean the sample exceeded the ARBCA-modeled SSL of 0.45 mg/kg and should be colored orange according to the key. However, in Appendix I, the concentration in this same interval is listed as 0.23 J. Figure 2-1 conflicts with the information provided in Section 2.3.5 Contaminant Fate and Transport and Appendix I. Please fix this discrepancy.**

Response 3: The RDX concentration at the 2-4 ft bgs interval of boring P13-SB02 has been revised on Figure 2-1 to reflect a concentration of 0.23 J mg/kg, consistent with other RDX concentration references to this boring interval in the document.